"IMPACT OF IRRIGATION ON AGRICULTURAL PRODUCTIVITY OF OSMANABAD DISTRICT: A GEOGRAPHICAL ANALYSIS"

Final Report of

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DECLARATION

I hereby declared that the Minor Research Project entitled ***"Impact of Irrigation on Agricultural Productivity of Osmanabad District: A Geographical Analysis"*** *being submitted to University Grants Commission, New Delhi for the fulfillment of Minor Research Project for teachers under UGC XII Plan (2012-2017). It is my original work and the conclusions drawn therein are based on the data and information collected by myself. To the best of my knowledge and belief, this work has not formed the basis for the award of any Degree or Diploma of similar title*

Place : Murud **MR. JADHAV GANESH LAXMAN**

Date : **Principal Investigator**

CERTIFICATE

This is to certify that the work incorporated in this Minor Research Project Report entitled ***"Impact of Irrigation on Agricultural Productivity of Osmanabad District: A Geographical Analysis"*** *is the original research work carried out by* ***Mr. Jadhav Ganesh Laxman****,* ***Assistant Professor, Dept. of Geography, Sambhaji College (Arts & Commerce), Murud, Ta. Dist. Latur****. The text of this project or any part of that text has not been published previously at anywhere for any degree or diploma. Present Minor Research Project Report is submitted through Principal, Sambhaji College (Arts & Commerce), Murud, Ta. Dist. Latur.*

Place : Murud *Principal*

Date :

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Place : *Barshi* ***MR. JADHAV GANESH LAXMAN***

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CHAPTER I

APPRAISAL OF THE PROBLEM

1.1 INTRODUCTION:

Geography deals with the spatial distribution of various characteristics on the earth surface. Geography involves such a wide range of knowledge that the subject has been divided into two major areas of study. The first, of these is physical geography, which is concerned with the physical environment, landforms, weather, climate, soils, plants etc. The second is Human Geography, which is concerned with man's activities on the surface of the earth. Environmental elements, which have been studied in geography, later on several branches have been developed and interrelated to each other. Geography is an integrative discipline, which combines natural and social sciences.

Agriculture is Man's one of the oldest and most important primary economic activities. The word agriculture comes from a Latin term ***'Agricultura'*** which has its origin in the words *Ager* means a field and *cultura* meaning to cultivate, the word agriculture as the 'science or the art or the practice of large scale soil cultivation' in order to produce crops (Watson, 1976). Agricultural Geography is the description of the art of large-scale soil cultivation with reference to natural environment and circumstances.

The study of relationship of agriculture with its environment may well deserve a title the science of ***'Geoagercultura'*** **Agricultural geography** can be considered a science in view of its techniques of analysis methods of interpretation and its approaches to the investigation of agriculture. As a science, agriculture geography is concerned with the formulation and testing of hypothesis, interpretation of spatial distribution and location of various characteristics of agricultural activities on the surface of the earth and measurement of geographic relationship are analyzed in it (Singh J. & Dhillon S.S., 2004).

Agricultural productivity is the most obvious aspects of Agricultural Geography. Agricultural productivity could be defined as the ratio of output to input in relation to land, labour, capital and overall resources employed in agriculture (*Noor Mohammad and Abdul Majeed* 1995). Productivity sometime it is considered to be the synonymous of efficiency or overall effectiveness of a productive unit, while at others

as ratio of output to resources expanded. Some have viewed productivity as the overall effectiveness of productive unit, be it a plant, farm or company, while some have confined the use of term productivity to denote the ratio of output to the corresponding input of labor. Agricultural productivity means the degree to which the economic, cultural, technical and variables are able to exploit the biotic resource of the area for agricultural production (Singh, 1979). It is closely related to the per hectare yield. Agriculture productivity is a function of number of factors including physical and non-physical factors. Technological variables have made a significant impact on both agricultural pattern and productivity.

Irrigation is essentially the artificial application of water to overcome deficiencies in rainfall for growing crops **(***Sivarama Krishnarao and M. I. Ali* 1986)**.**This could be done by artificial application of water to land for growing crops and is known by the term "irrigation". Irrigation is a pre-requisite for the adoption of new technology in agriculture and for the rapid growth of agricultural sector. The conversion of dry land into wet land, provides, security against the vagaries of rainfall, preventing crop failure and enabling higher yield per hectare. It also helps to the farmers to take two or more crops from the same field within a year and it increases the productivity of the land, by transforming the agriculture (*Gajhans D. S. and Suryawanshi M. T.* 2012). Irrigation leads to changes in cropping pattern, increases yield rates and labour utilization and in the ultimate analysis bring prosperity for socio-economic change that sets motion the productive forces in the agricultural sector **(***ChatterjeeNandini,* 1995**).**

Irrigation is identified as a decisive factor in Indian agriculture due to high variability and inadequacy of rainfall. Irrigation is essential for successful agriculture particularly in the area, where rainfall is inadequate uncertain, and unpredictable. Irrigation is generally the artificial application of water to the soil for crop production. It encourages the farmer to adopt scientific techniques and go in for more intensive cropping there by creating new opportunities for gainful employment. Irrigation cannot be considered for its protective role of insurance against the vagaries of rainfall and drought, but has to be studies in the context of adoption of high yielding varieties of rainfall and drought, but has to be studies in context of the adoption of high yielding varieties, chemical fertilizers and overall development of agriculture as well.

1.2 SIGNIFICANCE OF THE PROBLEM:

Agriculture can contribute significantly to overall development at it provides increased food surplus to the growing population, helps to expand the secondary and tertiary sectors, increases rural incomes and improves the welfare of the rural population of the region (*Munir Abdul*, 1995). It provides food, fodder and raw material and thus contributes to overall economic growth. Its good performance over the period of time helps in the generation of more employment, thereby reducing poverty, hunger and malnutrition. Apart from food, agriculture, meets many other needs of man from cultivation of plants to rearing animals.

Agriculture is the backbone of the Indian economy. Indian agriculture has been the source of supply of raw materials to our leading industries. Cotton and Jute textile industries, Sugar, Vanaspati and Plantations all these depend on agriculture directly. Importance of Indian agriculture also arises from the role it plays in India's trade. In Maharashtra State about 52.7 percent of the total workers depend on agriculture as cultivator and agricultural laborers. Government of Maharashtra made remarkable agricultural progress through five years plan. The state ranks second in India about net sown area.

Like India as well as Maharashtra state, the economy of Osmanabad district is also an agrarian. In Osmanabad district more than 60 per cent population is engaged in agricultural activity. Agriculture is the main support of the people. Mostly turnover of study region is based on agriculture. Agricultural development of any region is depended on agricultural productivity and agricultural productivity depends upon a number of factors including physical, socio-economic and technical organization. All these factors are highly variable and dynamic in both space and time leading to spatio-temporal variations in agricultural productivity. In the study area the rainfall is irregular, uncertain and unreliable. Rainfall variability is also high in the study region. Here agriculture is the gamble of monsoon. If rainfall is scare it results into crop failure. The agricultural productivity varies considerably among different tehsils of Osmanabad district depending upon variations in their agro-climatic factors and socio-economic factors. With the development of irrigation and other technological factors, agricultural productivity has increased considerably. There is considerable variation in agricultural productivity due to variation in irrigation and technological factors. The agricultural productivity is high in irrigated area in the study region while

it is low in the rain fed and inadequate irrigated area. The variability of production and per hectare yield is also high in rain fed area.

From the view point of this, attempt is made here to analyse the impact of irrigation on agricultural productivity of Osmanabad District.

1.3 CHOICE OF THE REGION:

The choice of the region under investigation is influenced by many considerations. Firstly, the Osmanabad district occupied south central part of Maharashtra plateau. The river Manjara, Terna, Sina and their tributaries drain the Osmanabad district. These river basins have suitable situation for irrigation potential and better agricultural productivity.

Secondly, the Osmanabad district is more or less situated in the Balaghat range and plateau area. These characteristics make this region homogeneous unit for geographical investigation.

Thirdly, the Osmanabad district is one of the most backward districts of Maharashtra State and district is known as 'Problem Region', on the basis of population resource relationship and its capacity to support non agricultural population. It suffers from the problem of less planned utilization of resources.

Fourthly, the district suffers from the drought prone area, which resulted in crop failure. The agricultural history of the district reveals that the frequency of drought is after every two or three years. This crop failure resulted into indebtedness of farmers which lead towards farmer's suicide.

Fifthly, due to unemployment problem in the study region, educated people started tilling land and they adopt modern technology instead of their traditional methods to enhance agricultural productivity. The Bhima-Sina Joint canal Project, Manjara and Lower Terna irrigation project will have lead to bring changes for better production of crops in the study region.

Sixthly the district has 88.65 per cent plain and plateau area which is favorable for farming operation. This condition offers better productivity for crops like cereals, pulses and oilseeds etc.

Seventhly, the Osmanabad district covers 42 per cent of shallow soil which is well dischargeable; due to this attribute the soil is too much favorable for fruit crops.

Eighthly, the study of agricultural productivity is essential to identify sure or weaker areas in order to make rational and scientific planning for agricultural development. Such study gives clue to planner where to tress for the better development of agriculture. In the view point of these considerations an attempt is made here to analyze impact of irrigation on agricultural productivity of Osmanabad district from a geographic point of view.

1.4 REVIEW OF THE LITERATURE:

In the modern agricultural geography the major thrust of geographers is to investigate the Spatio-temporal variation of agricultural activity. Land use and productivity are the most obvious spatial variable and effort has done into describing and classifying it. It is necessary to study the agricultural land use and productivity in connection with geographical and manmade factors. For the present investigation, the literature of different types has been reviewed. Majority of the research work has been done in the field of land use, cropping pattern, crop combination, crop diversification, influence of irrigation on agricultural productivity. A number of other studies have been referred to understand impact of different types of irrigation on agricultural productivity.

Canter (1967) has studied History of Irrigation. He focused on irrigation change over period of time and problem of irrigation besides impact of irrigation on cash crop cultivation in difference part of the world.

Hussain Majid (1976) had studied new approaches to the agricultural productivity regions of Satlaj-Ganga plain of India. In his study he focused on 'irrigation efficiency' which is the most important element for the agricultural development.

Surendra Singh and V.S. Chauhan (1977) have studied Measurement of Agricultural productivity of Uttar Pradesh. In this paper they emphasized on net cultivated area for considering agricultural productivity. To measure agricultural productivity they apply standard yield index, weighted crop equivalent index, cropping intensity Index, Agricultural worker Index.

Shinde S.D., Jadhav M.G., and Pawar C.T.(1978) have **s**tudied Agricultural productivity in Maharashtra. In this study attempt was made to utilize the district wise average production of 21 leading crops and their prevailing wholesale prices in tehsil markets places. With the help of statistical technique the production of all the crops

from each areal unit was converted into money value which formed the basis for measuring agricultural productivity in the region. The indices obtained were arranged in an ascending order and districts were divided in five categories that very high productivity, High productivity, moderate productivity, low productivity, very low productivity.

More K. S. (1981) ha**s s**tudied changing pattern of agricultural land use in Kolhapur district. In his work he emphasized the physical and non physical factors as basis of farming, land use pattern and changes, cropping pattern and changes therein, spatial organization of agriculture with cropping pattern regions and changes therein, technological determinants and agricultural changes.

Date V. S. and Gupte S. C.(1984) has worked on association between agricultural land use and physical economic phenomena: A multivariate approach. In this paper an attempt is made to explain how and to what extent do the factors of physio- socio-economic environmental influence the agricultural land use in Poona district.

More K. S. and Mustafa F. R. (1984) have studied irrigation requirements and development in Maharashtra. **Chandra H. Sekarn and Balakram (1985)** ha**s s**tudied groundwater: A parameter in determining land use pattern in Siwana region, Western Rajasthan.

Nandini Chatterjee (1986) has studied impact of irrigation on agriculture in Southern west Bengal. The objective of this paper was to make detail study of the impact of irrigation on the use of Land. She analyzed qualitatively the role of irrigation, based upon the detailed survey of twenty sample villages.

Noor Mohammad and Abdul Majeed (1995) studied Determinants of Agricultural Productivity in Arid Regions. In this paper they emphasized to identify the determinants of agricultural productivity and assessed their role in it. For this purpose he applied a step wise linear regression analysis.

Mansoor Ali and Hanafi Y.S. (1998) have studied on Correlation of Wheat Productivity with Fertilizer Consumption and Irrigation: A Case Study of Uttar Pradesh. The basic objective of their study is to examine and analyze the spatial variation in productivity of wheat, fertilizer consumption and irrigation in Uttar Pradesh during the period 1985-86 to 1995-96. On the basis of yield per hectare, the study region has been grouped into five categories. In this study, spatial variation of

irrigation with respect to productivity of wheat has been taken into consideration and conclusion is drawn.

Gambhire D. B. (2000) has studied critical study of Agricultural productivity in Osmanabad district (MS). Entire works is divided into eight chapters. In his study he considered physical as well as non physical determent of agriculture from the view point of agriculture development of the study region. He also throws light on general land use and agricultural land use, production and productivity of agricultural crops of the study region.

Munir et al. (2002) estimated a stochastic frontier production function of wheat production using farm level data from Pakistan. Three irrigation dummies (canal, tube well, and both canal and tube well) were included in the model. Canal irrigation is the least reliable source of water, the combination of tube well and canal is considered most reliable, and tube well irrigation is in the middle. His estimation results showed productivity of farms with any of the three types of irrigation to be significantly higher than that of farms without any irrigation.

Rameshwar Thakur (2007) has studied Crop combination Regions in South Bihar Plain. The main objectives of his study was to delineate crop regions to know the areas of dominance of the important cereal and non-cereal crops and he attempted to know the geographical conditions required for each combination.

Kaushik S. P. and Omprakash (2010) have studied Impact of Ground Water level on cropping pattern in district Karnal, the main objective of this paper is to assess the ground water resources and to examine the changes in cropping pattern. He concluded that the present cropping pattern is depletive the underground water reservoir at an alarming rate.

Norkhede D. S. and Gatade D. G. (2011) have studied Spatial pattern of Crop Productivity in Raigarh district (Maharashtra), the main objective of this paper is to analyze the spatial pattern of agricultural productivity of Raigarh district. For this study, Enyedi's method is employed to determine the agricultural productivity. They concluded that the productivity of present study region is the product of the rainfall, soil, irrigation facilities and the farmer's practices.

Jaybahye R. G. and Arude P. B.(2011) have studied Agriculture efficiency of Khed-Shirur SEZ, Pune district, the main objective of this paper is to study the agricultural efficiency and suggest the remedies to increase the efficiency for this purpose they used Kendall's ranking coefficient method.

With this background the present work is carried out with the following specific objectives, which are developed in order to outline and focus the research procedure.

1.5 OBJECTIVES:

1. To study the physical and non determinants of the study area as a basis for the agricultural productivity.
2. To analyze the general and agricultural land use pattern in the study region.
3. To measure agricultural productivity of the study region.
4. To find out the impact of irrigation on agricultural productivity.
5. To give remedies to improve agricultural productivity in the study region.

1.6 HYPOTHESIS:

1. The higher is the irrigated area, the more is per hectare yield and production of horticultural crops.
2. The available water resources in the district are scanty and become barrier in agricultural productivity.

1.7 DATA BASE AND METHODOLOGY:

1.7.1 Data Collection:

The study is carried out by acquiring data through primary as well as secondary data source. The relevant information and data regarding agricultural land use and production in general and horticulture cropping pattern in particular, used for the period of 1999-2014. The primary data is collected by extensive fieldwork through structured interview. For the micro level study, 24 villages have been selected by Stratified Random Sampling method on the basis of physiography. A questionnaire is prepared for farmers to get the information regarding non-physical determinants such as irrigation, use of fertilizers, pesticides, agricultural implements, High Yielding Varities, cropping pattern and productivity and field survey has been made. During field survey 240 farmers are interviewed. Exhaustive field notes have also been prepared for the subsequent micro-level analysis. Information is also collected through various Talathi Offices, Agricultural Officers and farmers. All efforts have been made to collect and the information from the respondent.

The secondary information is collected from the official statistics such as District Socio-economic Review and Statistical abstract of Osmanabad District, District Superintendent of Agriculture Office, Osmanabad, Epitome of agriculture Part-I, district wise statistical information of agriculture department, Commissioner of Agriculture Pune, Season and crop reports, Statistical Abstract of State, Report on Agricultural Census Maharashtra State Part-I and II, Gazzeter of Osmanabad District, Periodicals, Economic Survey of Maharashtra, Statistical Department of Agriculture Commissioner Pune and District Census Handbook of Osmanabad District.

Data regarding water resources is obtained from the water and irrigation commission Report Vol II, Senior Geoligist, Ground Water Survey and Development Agency Branch Osmanabad. Data about soil is obtained from the Soil Survey and Soil Testing Laboratory, Osmanabad. Information of percolation tank and K.T. wears is obtained from Z.P. office Osmanabad. Information also collected through the visit to the district and tehsil head quarters in the study area.

1.7.2 Methodology:

In the first phase of research, the data collected from different sources are processed and analyzed; maps and diagrams are used for effective analysis of the relevant statistical information pertaining to irrigation and agricultural productivity of the district concerned. The investigation is occurred in two levels: a macro level analysis that encompassed the entire district, and a micro level analysis which is focused on site selection at the local level.

For the quantitative measurement of the overall changes in general land use and agricultural land use during the period 1999-2014, the Weavers Index(1954) technique is used. The Methods of Rafiullah and Doi are applied for delimitation of crop combination in the study region. Bhatia's method (1956) of location quotient is also used for the calculation of crop concentration. To investigate the spatial pattern of crop diversification Bhatia's (1965) formula is used.

To calculate agricultural productivity the technique introduced by Jasbir Singh (1976) i.e. crop yield and concentration indices ranking co-efficient, M Shafi (1972) and Bhatia's technique is used. The procedure may be explained as follows,

$$Yi = \frac{Ya_e}{Ya_r} \times 100$$

Where,

Yi = is the crop yield index

Yae = is the average yield per hectare of crop ‘a’ in the component enumeration unit, and

Yar = is the average yield of the crop ‘a’ in the entire region

$$Ci = \frac{Pa_e}{Pa_r} \times 100$$

Where,

Ci = is the crop concentration index.

Pa_e = is the percentage strength of crop ‘a’ in the total copped area in the component enumeration unit.

Pa_r = is the percentage strength of crop ‘a’ in the total cropped area in the entire region.

$$\text{Crop Yield \& Concentration Indices Ranking Coefficient For Crop-A} = \frac{\text{Crop Yield Index Ranking crop ‘A’} + \text{Crop Concentration Index Ranking Crop ‘A’}}{2}$$

To examine the impact of the irrigated area on per hectare yield, the Pearson’s Coefficient of correlation technique is used. The functional form of linear relationship is measured by using regression equation i.e. y= a + bx. The rate of change in dependant variable is estimated with the help of ‘b’ coefficient, which is the line of best fit. *‘t’* test is used with the view to understand confidence level.

1.8 LIMITATIONS:

There are some limitations regarding the collection of secondary data for certain aspect, the Lohara and Washi tehsils are formed in 1999 by bifurcating of Omerga, Kalam and Bhum tehsils. So, secondary data is not available for some previous period of newly formed tehsils. To overcome this problem the researcher has bifurcated secondary data accordingly to area to find out the results.

It has been found that very few cultivators are literate and among them very few deliberately maintain detailed account of farm experience. The researcher therefore relate entirely on personal knowledge and memory of most of the cultivators. To overcome this problem attempt has been made by repeating the questions for conform the information of the farmers who are educated and expertise. However fortunately, though illiterate, most of the farmers could recapitulate quite clearly the details of the expenses, per hectare yield, production and earnings. Thus whatever relevant information to the subject would become available has been used for the purpose of the study.

1.9 ORGANIZATION OF THE RESEARCH WORK:

The entire work has been organized into eight chapters.

The first chapter opens with the introduction of the work which includes conceptual framework of agriculture and agricultural geography, irrigation and agricultural productivity, significances of research problem, choice of the region, review of related literature, objectives, hypothesis, data collection and research methodology, limitations and organization of research work.

The chapter second presents physical and non physical setting of the study region comprising the account of location and boundaries, physiography, geology, climate, drainage, soil types, water resources, natural vegetation; as they have crucial importance in understanding their suitability for agricultural productivity in the study region. This chapter also comprises demographic factors, irrigation, agricultural implements, chemical fertilizers, socio-cultural factors, farm workers, livestock, and infrastructural services such as marketing facilities, agricultural credit societies and transportation.

The third chapter is concerned with spatiotemporal analysis of general land use and agricultural land use, general land use pattern and changes in i.e. area under

forest, area not available for cultivation, other uncultivable land, fallow land net sown area, area sown more than once, correlation between different land use categories, overall volume of change in land use from 1999-00 to 2003-04 and 2009-10 to 2013-14 and land use efficiency. Agricultural land use with analysis of cropping pattern, overall change in cropping pattern and crop combination are included in the same chapter.

The forth chapter comprises an analysis of per hectare yield and production of selected crops, irrigated area and per hectare yield, impact of irrigated area on per hectare yield, Co-efficient of variation of per hectare yield and production, agricultural productivity, Composite index of agricultural productivity

The fifth chapter deals with the case study of selected villages. In this chapter an attempt is made to study the site and situation of selected villages, non-physical determinants such as demographic factors, irrigation, use of fertilizer, agricultural implements, livestock, general land use pattern and agricultural land use. This chapter also highlights agricultural productivity, impact of irrigated area on average per hectare yield of selected crops.

The chapter sixth covers with conclusion and suitable suggestion to solve them. This has been followed by the list of appendices and bibliography.

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CHAPTER– II
PHYSICAL AND NON-PHYSICAL DETERMINANTS OF STUDY REGION

2.1 INTRODUCTION:

Agriculture is man's one of the oldest and major primary economic activities. It is carried out under the control of natural environment. Agricultural activities are 'adjusting' to areas that contain the optimum physical characteristics for that crop (Baker, 1929). In spite of technological development, physical factors play an importantant role in the development of agriculture in the region. The various physical components like location, topography, soil, climate etc. determine the suitability of a particular area for certain crops in the area. Topographical limitations mostly restrict the ability to use equipments for cultivation. Climate refers to the long-term weather conditions of a region (De Blij & Muller, 1993). Climate determines the heat energy and moisture inputs require for agricultural production. However, agricultural practice is not only depended on physical condition, but also both the physical and socio-economic condition exerting influence on agricultural practice and its production.

The socio-economic factors govern to a large extent the actual agricultural production process. Socio-economic factors are among the factors that are capable of influencing adaptation strategies used by farmers (Adebisi-Adelani O, 2013). The density of population, cultivators, agricultural labour, irrigation facilities, use of fertilizers, seeds, pesticides, density of agricultural implements, landholding size, distribution of livestock, infrastructure services may determine the extent and nature of agriculture. Thus, to understand complete scenario of cropping pattern and productivity there is the need to study socio-economic factors affecting the agricultural activity.

Thus it is necessary to focus on the physical and non-physical factors of the study region to understand the agricultural scenario of the region. This chapter consists of two parts, i.e. physical determinants and non physical determinant of the study area. The first one describes the location, site and situation, physiography, geology, climate, drainage, soils, water resources and natural vegetation. Second part aims to assess the socio-economical and cultural background of the study region,

which consists of demography, per capita net sown area, irrigation, livestock, agricultural implements, fertilizers, cultural factors, transportation and credit agencies in relation to irrigation and agricultural productivity.

PART-A: PHYSICAL SETTING

2.2 LOCATION, SITE AND SITUATION:

Osmanabad district lies in the southern part of Maharashtra state of India which is south eastern part of Marathwada region. The absolute location of district lie within 17°39'45" to 18°42'30" North latitudes and 75°18'30" to 76°46'15 East longitude. It is bounded to the South-West by Solapur district, to the North-West Ahmednagar and Beed districts, to the east by Latur district and to the South by Bidar and Gulbarga districts of Karnataka State. It is extended with 280 kms from East to West and 240 kms from North to South. The total geographical area of district is 7512.40 Square kilometers. As for as area is concerned the district ranks 24th in the state of Maharashtra out of which 248 sq km is urban area (3.21 % of total area) and 7321 sq km is rural area (96.79 % of total area). For the administrative purpose the district is divided into 8 tehsils i.e., Osmanabad, Tuljapur, Omerga, Lohara, Kallam, Bhoom, Paranda, and Washi and having 729 villages. (Fig no.2.1)

It lies on the Deccan plateau at an average height of 600 meter above mean sea level. Most part of the district is surrounded by Balaghat Ranges and uneven patches of low level plains and plateau. The tehsils of Bhum, Washi, Kalam, Osmanabad and Tuljapur lie in the range of Balaghat Mountain. Remaining part of the district is covered by uneven patches of low level plains and plateaus. Some parts of the major rivers like Godavari and Bhima basins come under the Osmanabad district.

2.3 PHYSIOGRAPHY:

The relief features of the Osmanabad district are essentially the product of geological past, the nature of geological composition and the agents of denudation working on the geological mantle. The entire district belongs to Deccan Trap. All the geological setup of the region has a strong influence, through geomorphological processes on the physical setting. Northern and central portion of Osmanabad district is covered by the hills of the Balaghat Mountain Range (Fig.2.2). Bhum, Washi, Kalam, Osmanabad and Tuljapur Tehsils situated in the hilly areas of Balaghat and

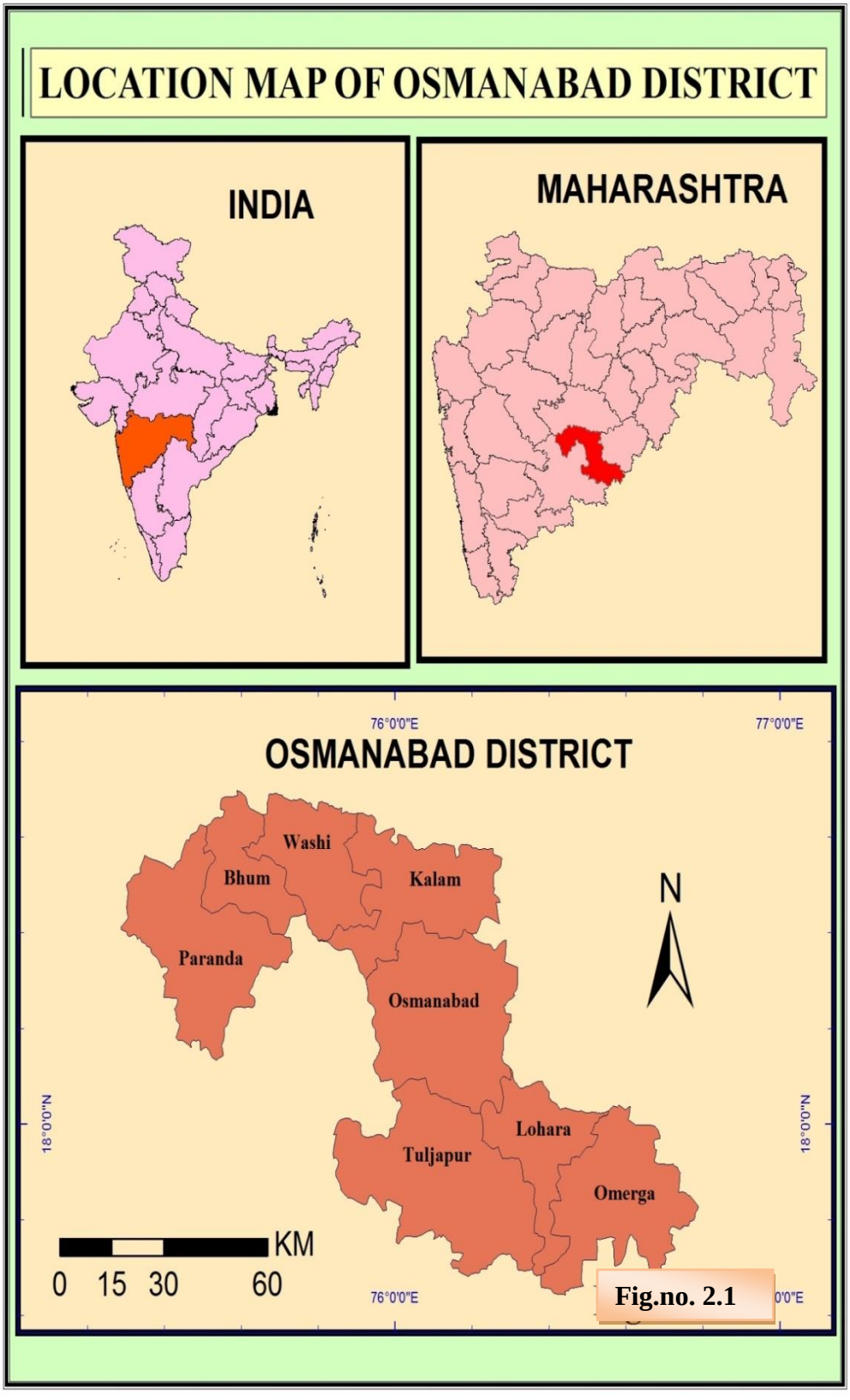
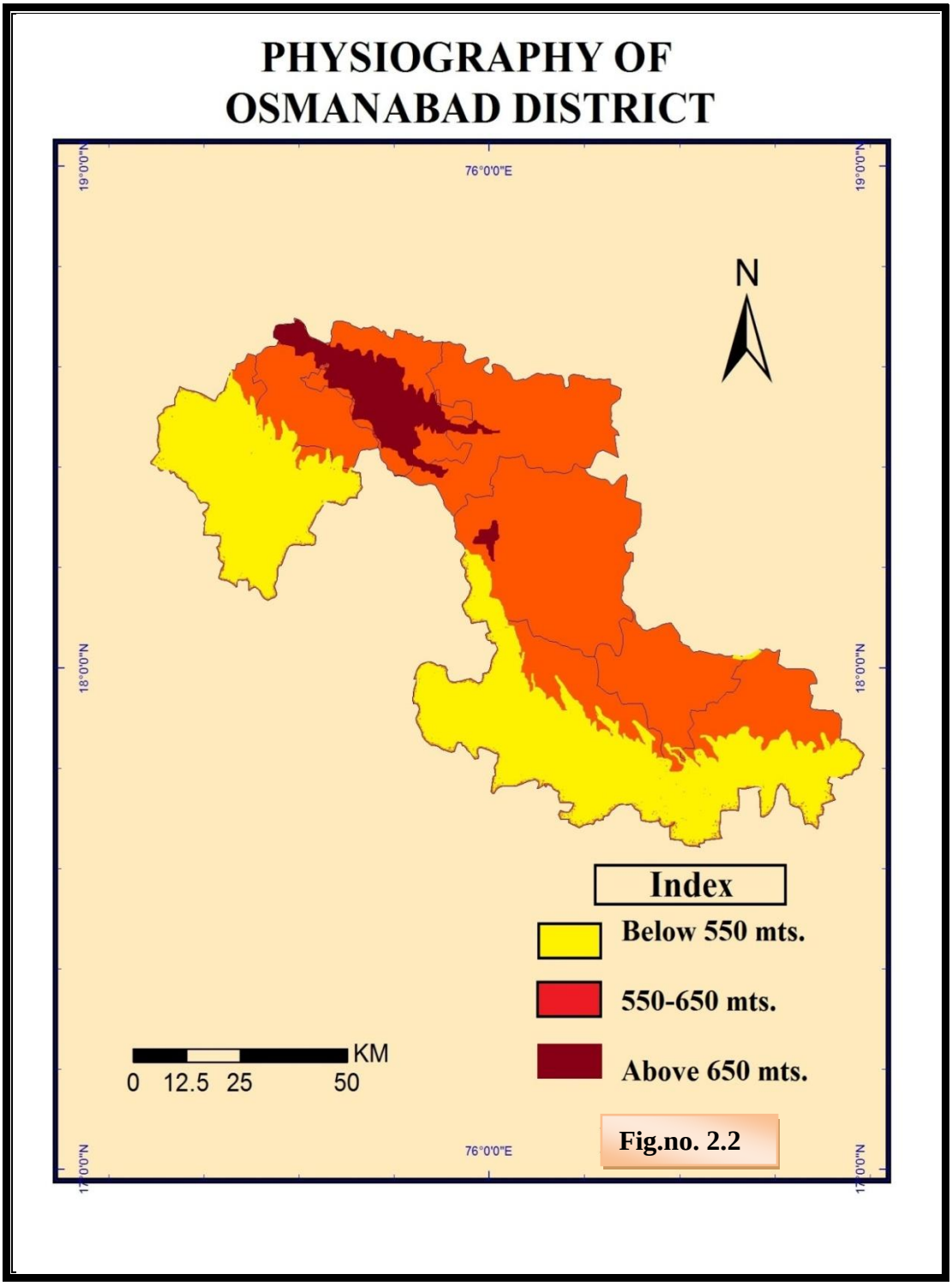

LOCATION MAP OF OSMANABAD DISTRICT
INDIA
MAHARASHTRA
OSMANABAD DISTRICT
76°0'0"E
77°0'0"E
18°0'0"N
Washi
Bhum
Kalam
Paranda
Osmanabad
Lohara
Tuljapur
Omerga
N
KM
0 15 30 60

Fig.no. 2.1



the remaining tehsils in the plateau and plain. Balaghat range is elongated towards southeast and south direction forming the water divide between the Godavari and the Bhima valley. On the basis of local variation in terrain the district may be grouped into the uplands and the lowlands. In general, the uplands of district are the Harishchandra Balaghat Hills, the Balaghat Plateau which are relatively more

dissected with hills. The low land is drained by Manjara, Terna, Bori, Benithora and Sina rivers. Among these river basins such as valley fills, pediments, Pedi plain, present and older flood surfaces are found in the district.

To study the physiography of the study area, the Osmanabad district is divided into two physiographic divisions i.e.Hilly Range as well as Plateau and Plains.

2.3.1 Balaghat Range:

The Northern bounding scarp of the Balaghat mountain range running generally Eastwards across the middle of the Bid district enters in Osmanabad district near Degaon of Bhum tehsil. The total length of Balaghat range is 65 k.m. having width of 4 to 30 k.m. within the district. In a subdued form, it runs first southwards and then eastwards gaining altitude. It again runs southward to the east of Chakur (Omerga) and passes out of the district. The southern bounding scarp of this plateau backed by a chain of hills enters the district just west of Malewadi and Pakhrud villages and runs in a general southeasterly direction though in some parts it has locally easterly and southerly trends. Passing just the West of Yermala, Yedsi, Osmanabad and Tuljapur, it runs nearly southeastwards passing the West of Naldurg. After a gap of Naldurg it continues in a subdued form and passes outside the district. The dissected slope both these scarps appear as a series of hills as seen from the plains bellow. Due to powerful head ward erosion of streams draining down, these scarps themselves have been retreating as also the water divide between these and plateau draining with the result that some of the greater heights are found often away from the steep faces. The high hill ranges are occurring mainly towards north with the maximum heights of 685 meters from mean sea level.

The north most divide in the district is that between the Manjara River and the Terana River just south of Beed district boundary. This is a low divide ranging from an about 550 meters above sea level in the west to about 500 meters in the east, the height of the hills ranging from 550 to 700 meters above mean sea level (District Gazetteer, 1972). The Balaghat range comprises of low-lying hills forming water divide. Many of the tributaries to Godavari and Bhima rivers originate from the Balaghat range. About 11.35 per cent of the land surface of the district is hilly.

2.3.2 Plateaus and Plains:

The western part of the district is characterized by irregular hard rock terrain with flat-topped Deccan basaltic plateau surfaces. The district as a whole is monotonously underlain by Deccan trap basaltic lava flows. This lava flows caused an

account of weathering given rise to undulating topography. The weathered and fractured trap occurs in topographic lows. The eastern part of the district is gently sloping to flat terrain consisting of alluvial material of Terna River and East-West trending escarpment. The district forms a part of Godavari and Bhima basin. It has a varied topography consisting of hills, plains and undulating topography near riverbanks. The main divide continues to run west of Terkhed in a southeasterly direction close to south western scarp of the Balaghat plateau as far as Bawi to the west of Dharur (Omerga) from here, it recedes from the scarps due to the active back cutting of the plateau by the headwater of the tributaries of the Sina and the Bhima rivers. Running nearly eastwards away from the scarp, it passes outside the district south of Kasar Sirsi. The active head ward erosion of the Bori River into the plateau has resulted in a valley floor about 30 meters below. The plateau level is leaving the remnant of the plateau edge on its west, as a prominent ridge running parallel to its course with a summit level of 610 meters south-eastwards as far as Naldurg. This bounding ridge of the plateau, which carries the road from Tuljapur to Naldurg, descends by a steep scarp face to the Harni basin.

Beyond the Naldurg gap, the continuing hills are of slightly lower elevation and after Alur (602.5meters), pass beyond the limits of the district (District Gazetteer, 1972). About 88.65 per cent of the land surface of the district is acquired by plateau and plain.

All these relief features have an expression in the district's economic activities particularly on farming operations. About 72 percent of the population is depending upon agriculture. The study of influence of environment upon the nature and the distribution of crop and livestock is prime importance in agricultural geography.

2.4 GEOLOGY:

The district lies in the Deccan Trap system of Peninsular India and is made up of a pile of black, compact, aphanites' basalt flows. The entire district is underlain by the Basaltic lava flows of upper Cretaceous to lower Eocene age. The shallow alluvial formation of recent age also occurs as narrow stretch along the major rivers flowing in the area. Deccan Traps occurs as Basaltic lava flows, which are around 280 Meters thick, normally horizontally disposed over a wide stretch and give rise to tableland type of topography, on weathering also known as plateau. These flows occur in layered sequence ranging in thickness from few meters to 55 Meters. Flows are

represented by massive portion at bottom and vesicular portion at top and are separated from each other by marker bed known as bole bed. Ground water in Deccan Trap Basalt occurs under prelatic and semi confined conditions (Lamsoge B.R. 2009). The geology of district leads to Regur soils but it is unfavorable of ground water resources.

2.5 CLIMATE:

Of all the physical factors, climate is quite significant that determines the agricultural land use and agricultural patterns of a region. Climate consists of temperature, rainfall, humidity, sunshine, fog, frost snow, hailstorms, winds and air pressure. All these elements of weather and climate, individually and collectively, determine the agricultural patterns of a region (Husain Majid, 2002). It is a key factor to determine agricultural land use and productivity. The potential crop-producing capability of a given area is depended mainly on the existing climatic condition. The success or failure of the cropping season is determined by the intensity of the climatic factors (Nanaware A.H, 2007). Temperature and rainfall are two major elements of climate, which is treated as primary determinants of crop growth. These factors fluctuate from time to time, season to season and from place to place. Consequently, they determine the type of crops raised and caused regional differences in crop association. In fact, different combinations of these factors are responsible for various types of cropping patterns. In this regard the following climatic elements are considered for the present study.

2.5.1 Temperature:

Temperature is an important factor affecting the distribution of plant species as well as crops, while temperature sets the limit for germination of plants and its optimal growth. Each crop plant needs a certain number of effective heat units for germination, growth, stalking, maturing and ripening. This is called thermal constant and varies from crop to crop. Temperature above the minimum is therefore effective in further growth of plant forwarded maturity and ripening; the crucial air temperature is 6^0 C at and above which plant grow (Schimper and William, 1903). It plays an important role in determining the success or failure of a crop in a particular locality. From the view point of growth of certain crops temperature prove significant role. High temperature and bright sunlight are favorable factors for cultivation of crops, if other factors are suitable.

Table No. 2.1 : Mean Monthly Maximum and Minimum Temperature (in °C) 1980-2014.

Sr.No.	Month	Maximum.	Minimum	Monthly Range
1	January	29.8	13.9	15.9
2	February	31.7	16.4	15.3
3	March	36.3	19.9	16.4
4	April	38.4	22.9	15.5
5	May	39.3	23.7	15.6
6	June	33.5	21.5	12
7	July	29.5	19.9	9.6
8	August	29.2	19.9	9.3
9	September	29.9	19.8	10.1
10	October	31.1	18.6	12.5
11	November	30.2	15.3	14.9
12	December	30.0	13.4	16.6

Source: Socio-economic Review and District Statistical Abstract of Osmanabad District. (1980-2014)

The temperature of the Osmanabad district is recorded by one meteorological observatory at Osmanabad. The data of Osmanabad station is available from 1980 to 2014. The records of Osmanabad station may be taken as representative of the meteorological conditions in the district in general.

Generally, the temperature is moderate and even, except the hot months in March, April and May. The maximum temperature is experienced in April and May, while minimum in December and January. Within the 34 years of duration the maximum and minimum temperature recorded as 45.1ºC and 9.2ºC respectively.

During the period of investigation, mean monthly maximum and minimum temperature of the district is recorded as 39.3ºC and 13.4ºC respectively (Table no. 2.1 and Fig.no. 2.3).

The heat during summer season is intensive and maximum temperature may sometimes go up above 40 ºC. The diurnal variation of temperature is high and the mean value range from 16.4ºC in March and 15.6ºC in May. High temperature in summer season causes high rate of evaporation and evapo-transpiration. So that summer crops became dry. In this condition frequency of water supply is increased.

In rainy season mean monthly maximum temperature for July and August is 29.5 ºC and 29.2 ºC respectively. At the end of September up to October temperature

again increases slightly called “October Heat”. This increasing temperature of September and October is helpful to ripening the Kharip crops.

In winter season minimum temperature ranges from 13.4 ºC to 15.9 ºC. December and January are the coldest months in the year with mean monthly minimum temperature of 13.4 ºC and the monthly range of temperature in December is 16.6 ºC.

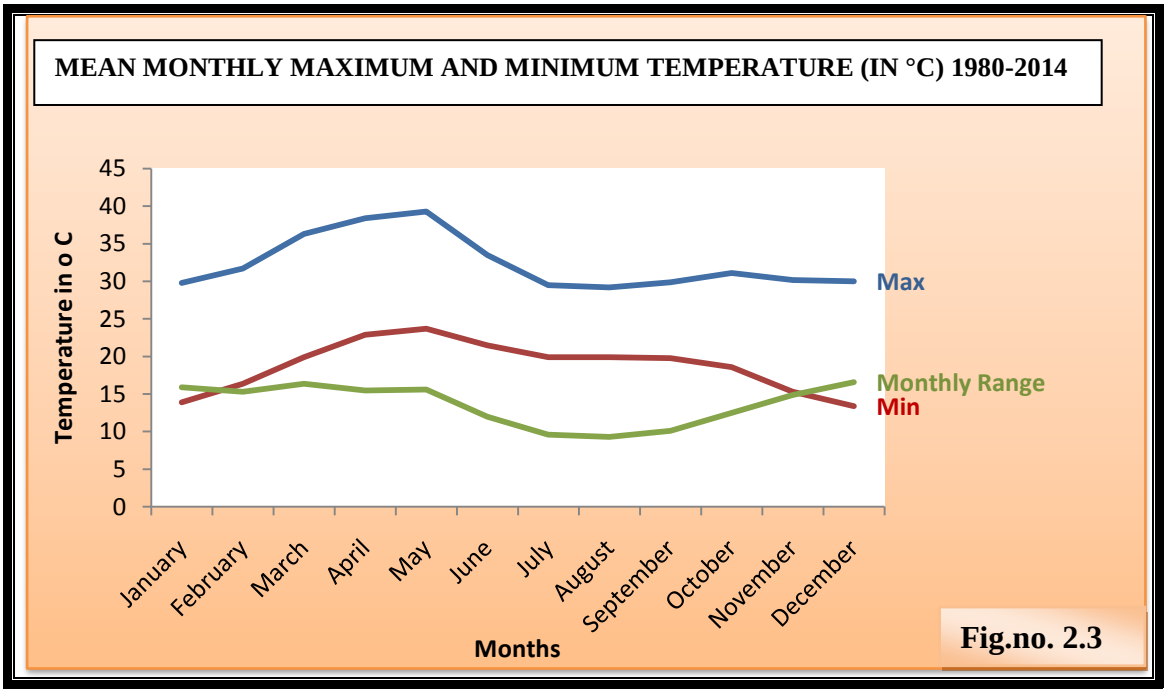


Fig.no. 2.3

2.5.2 Rainfall:

The amount of rainfall and its distribution in a particular region is very important in deciding the type of crop varieties which can be grown successfully (Nalawade D.B., 2011)**.** Rainfall is the most important factor of climate affecting farming activity in the region. Total rainfall and its month wise distribution is a significant factor considering agricultural production and land use intensity. Aberrant monsoon may lead to moisture deficit which may affect the crops (Malhotra S.K. 2012). Summer season is followed by the south west monsoon season from June to September. Region receives most of the rainfall from the south-west monsoon. In association with cyclonic storms in the Bay of Bengal in the post monsoon months and to a lesser extent in May, the district experience very strong winds and heavy rainfall occur. Occasionally these storms cross the some part of district and causing heavy damage to standing crops.

A) Average Annual Rainfall:

Osmanabad districts falls under the rain shadow of Sahyadri Mountains and therefore the beginning and end of the rainy season is quite uncertain in these parts. The rainfall is scanty and unreliable all over the district. Average annual rainfall is 729.32 mm in the region. The rainfall in the district varies from 609.9 mm in Paranda to 835.67 mm in Tuljapur. It is high in eastern part and low in western part of the study region. There are two peaks of rainfall pattern in June-July and September-October. In September the highest maximum rainfall is received when retreating monsoon and cyclonic rainfall occurs. At some times, the eastern winds during the end of monsoon cause precipitation here, which enables growing rabbi crops and vegetables after harvest of kharip crops on residual moisture. About 81.54 per cent of total rainfall is received in four months from June to September.

The above characteristics of rainfall have led to semi- arid condition in the region, which put limitation the quantity of surface as well as groundwater in the region. The region therefore has the problem of inadequate water hampering over all agricultural landscape.

B) Seasonal Distribution of Rainfall:

i) South-west Monsoon period:-

The period of this season is from June to September. During the south west monsoon season skies are overcast with clouds. During this season district as whole receives about 81.54 per cent of the total annual rainfall (Table No. 2.2), but spatial distribution varies ranging from 78 to 86 per cent. The low rainfall in south-west monsoon period is recorded in Omerga, Paranda and Bhum tehsils i.e. < 80 percent. The moderate rainfall is recorded in Kalam and Lohara tehsils i.e. 80 to 83 percent, where as it is high in Osmanabad, Tuljapur and Washi tehsils i.e. > 83 percent.

i) Post Monsoon Period:

During this season district as whole receives about 12.73 per cent of the total annual rainfall from retreating monsoon and cyclonic rainfall, but tehsilwise distribution varies ranging from 10 to 17 per cent of total rainfall. The low rainfall in post monsoon period is recorded in Osmanabad, Tuljapur and Washi tehsils i.e. < 12 percent. The moderate rainfall is recorded in Kalam, Omerga and Lohara tehsils i.e. 12 to 14 percent, where as it is high in Paranda and Bhum tehsils i.e. > 14 percent.

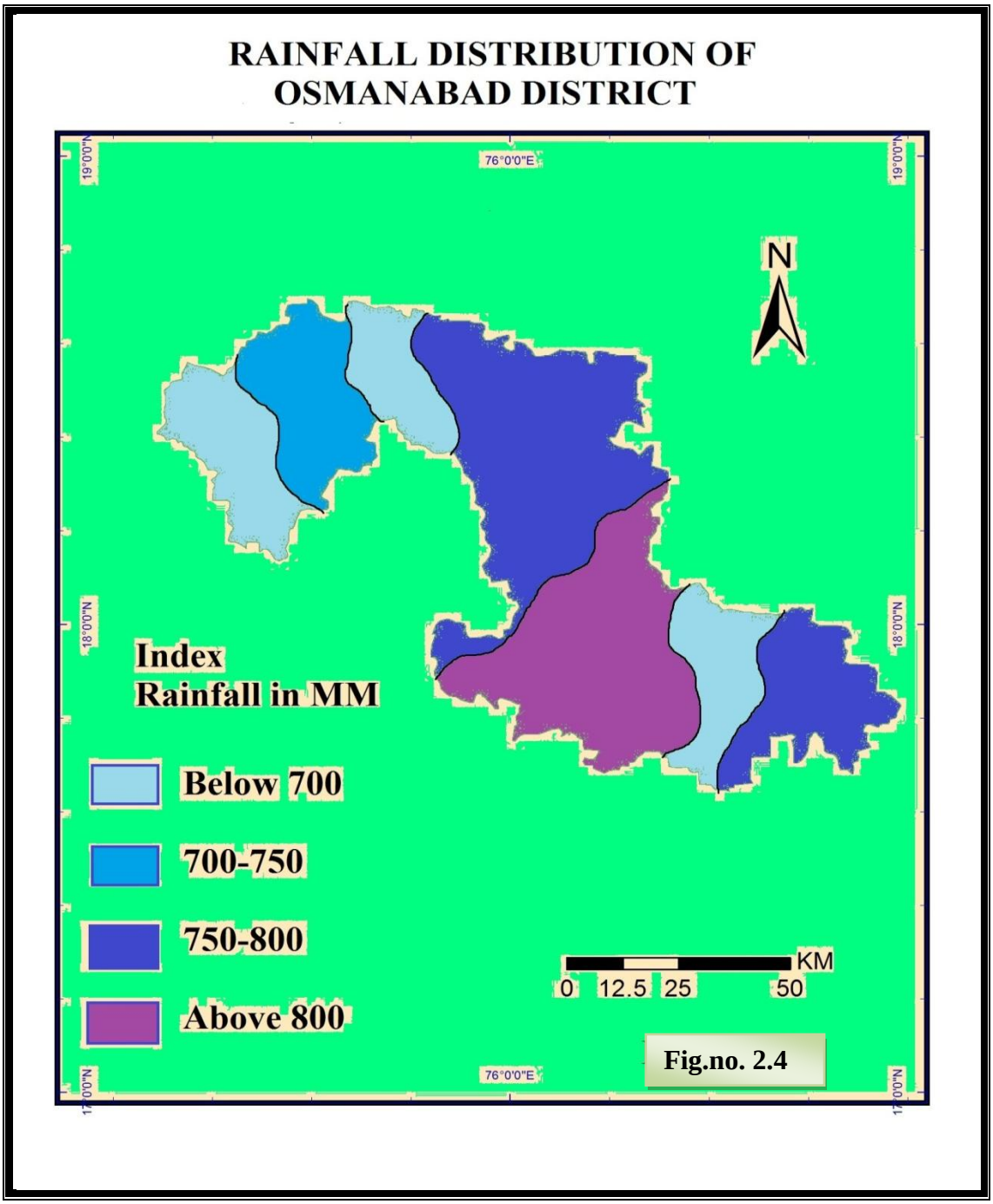
Table No.2.2: Seasonal Distribution of Rainfall (in mm)

Sr. No.	Tehsils	Monsoon June-Sept.	% to total rainfall	Post-Monsoon Oct-Nov.	% to total rainfall	Win-ter Season Dec-Feb	% to total rainfall	Hot Season Mar-May	% to total rainfall	Total Rainfall	% to total rainfall
1	Paranda	475.11	77.90	89	14.63	8.03	1.32	37.54	6.16	609.90	100
2	Bhum	562.03	77.85	120	16.62	6.70	0.93	33.21	4.60	721.93	100
3	Washi	586.93	84.62	70	10.11	6.00	0.87	30.55	4.40	693.62	100
4	Kallam	640.37	81.01	106	13.45	3.53	0.45	40.23	5.09	790.46	100
5	Osmanabad	664.10	85.78	74	9.52	11.09	1.43	25.34	3.27	774.23	100
6	Tuljapur	696.30	83.32	93	11.19	6.84	0.82	39.06	4.67	835.67	100
7	Lohara	525.93	81.46	84	13.09	3.93	0.61	31.27	4.84	645.62	100
8	Omerga	606.73	79.51	105	13.78	9.86	1.29	41.35	5.42	763.12	100
	District	594.7	81.54	92.8	12.73	7.00	0.96	34.82	4.77	729.32	100

Source: Socio-economic Review and District Statistical Abstract of Osmanabad District (1980-2014).

i) Winter Season:

During December to February district as whole receives only about 0.96 per cent of the total annual rainfall, but spatial distribution varies from 0.45 to 1.43 per cent of total annual rainfall. (Table 2.2) The low rainfall in winter is recorded in Kalam tehsil i.e. < 0.80 percent. The moderate rainfall is recorded in Tuljapur, Bhum and Washi i.e. 0.80 to 1.10 percent, where as it is high in Osmanabad, Omerga and Paranda tehsils i.e. > 1.10 percent. Sometimes cyclonic rainfall occurs in the month of February which is harmful to fruit crops such as grapes and mangoes.



i) Summer Season:

In summer season district as whole received 4.77 per cent of annual total rainfall. It varies from tehsil to tehsil ranging from 3.27 to 5.42 per cent of annual total rainfall. The low rainfall in summer season is recorded in Osmanabad tehsil i.e. < 4 percent. The moderate rainfall is recorded in Kalam, Tuljapur, Bhum, Lohara and Washi i.e. 4 to 5 percent, where as it is high in Omerga and Paranda tehsils i.e.> 5 per cent. Summer rainfall is largely limited by concentration in few days of the summer. This rainfall is not sufficient to meet annual water need for successful agricultural

production. It is also not well distributed spatially as well as temporally (Table No.2.2 and Fig.2.5).

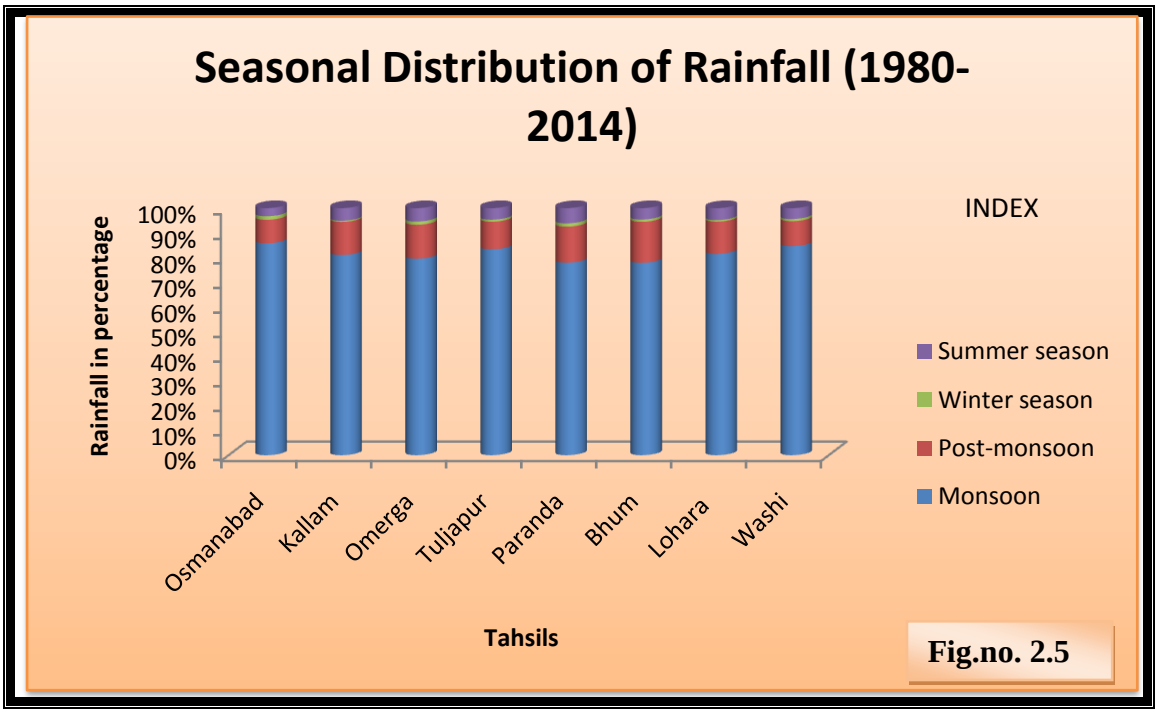


Fig.no. 2.5

2.5.3 Intensity of Rainfall:

The term intensity of rainfall is used in the context of rainfall received during 24 hours period. It is important as it determines the intensity of soil erosion. More ever the intensity of rainfall determines the water regime and thereby irrigation potentials of the region. In other words higher the intensity of rainfall higher is the degree of erosion, lower is the water regime and irrigation potentials, and vice versa (Nanaware A.H., 2007). The district as a whole has 13.42 intensity of rainfall, but the spatial distribution of intensity of rainfall varies from tehsil to tehsil. The low intensity of rainfall i.e. < 13 is found in Bhum, Paranda and Lohara. The moderate intensity of rainfall is observed in Osmanbad and Washi tehsils i.e.13 to 13.8, whereas it is high in Kallam, Omerga, and Tuljapur i.e. > 13.8(Fig. 2.6).

2.5.4 Rainfall Variability:

The intensity of agricultural operations, cropping pattern, irrigation and productivity are related to variability of rainfall. Variability of rainfall increases with decreasing mean annual rainfall. Variability in excess of 20 per cent implies great risk to farming (Williamson, 1925). Therefore in the absence of irrigation or dry farming practices, agriculture is a gamble and consequently famines can be expected any time.

In this situation, it is essential additional water supplies for successful agricultural practices.

Rainfall variability is measured by the co-efficient of variation of average rainfall of 34 years. The higher the co-efficient of variability, the lower is the assurance of rainfall. The Co-efficient of rainfall variability is calculated by the following formula.

$$\text{Co-efficient of Rainfall variability} = \frac{S.D}{\bar{X}} \times 100$$

Where,

S.D = Standard Deviation

$\bar{X}$ = the arithmetic mean of rainfall during the 31 years

The table No.2.3 and Fig. no. 2.6 show that the spatial pattern of average rainfall variability in the region. The district as a whole has 33.70 percent rainfall variability but the spatial distribution varies from tehsil to tehsil. The low rainfall variability is observed in Lohara and Washi tehsils i.e. < 31 percent. It is moderate in Osmanabad, Omerga and Tuljapur tehsils i.e. 31 to 35, whereas it is high in Kalam, Paranda and Bhum i.e. > 35 percent.

Table No.2.3: Intensity of Rainfall and Co-efficient of rainfall variability (1980-2014).

Sr.No.	Tehsils	Rainy Days	Average Annual Rainfall in M.M	Intensity Of Rainfall	Co-efficient of Rainfall Variability in %
1	Paranda	47.91	609.90	12.73	39.37
2	Bhum	57.41	721.93	12.58	36.61
3	Washi	52.27	693.62	13.27	26.69
4	Kallam	55.04	790.46	14.36	37.79
5	Osmanabad	57.87	774.23	13.38	33.80
6	Tuljapur	60.52	835.67	13.81	34.61
7	Lohara	50.18	645.62	12.87	28.01
8	Omerga	53.48	763.12	14.27	32.37
	Total District	54.34	729.32	13.42	33.70

Source:Compilled by Researcher on the basis of Socio-economic Review and District Statistical Abstract of Osmanabad District (1980-2014).

Generally, rainfall variability decreases from west to east in the study region. Therefore, rainfall reliability is low in western part in relation to eastern part of the

region. District as whole has over 33 per cent of rainfall variability so that agriculture without irrigation in the region becomes uneconomic.

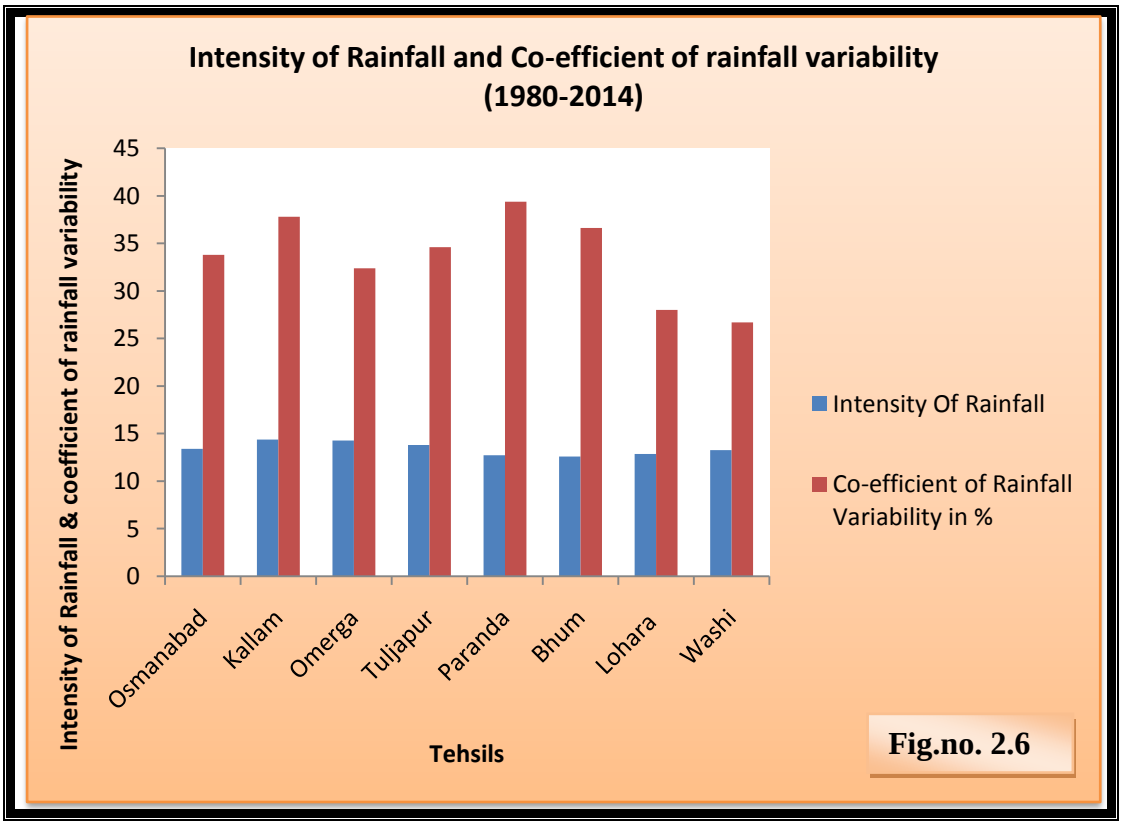


Fig.no. 2.6

The patterns of rainfall variability determine the areal extent of water balance. This in turn affects the cropping intensity and practices. No wonder that these rainfall characteristics deeply influence the traditional agriculture, which is depended on rainfall in the absence of irrigation facilities. But one important point to note is that fruit crops can withstand these rainfall variations and longer dry spells better.

2.5.5 Other Climatic Phenomena:

During the south west monsoon season sky is overcast with clouds. In May and October the sky is moderately clouded and during the rest of the year the sky is clear. The relative humidity in August is in between 82 per cent and 84 per cent but it is only 19% to 26% in April. High rate of relative humidity favors fast vegetative growth. Winds blow from North East to South West in winter season. In association with cyclonic storms in the Bay of Bengal in the post monsoon months and to a lesser extent in May. Occasionally these storms cross the some part of district and cause heavy damage to crops. Many times the eastern winds during the end of monsoon cause precipitation here.

2.6. DRAINAGE:

The district forms part of Godavari Basin and Bhima basin. Manjra, Sina, Terna, Bori, Benitura, Banganga are the main rivers flowing through the district. Manjara River is the main river which drains the district, except southern and western parts of the district, which are drained by the tributaries of the Bhima system. The river Terna, Bori and Benitura drains the Balaghat Plateau portion. The Osmanabad district is divided into three sub-basins viz., Manjra sub-basin in the Northern and Eastern parts covering 40 per cent of the district. Major rivers are Khatkali and Terna besides the Manjara and Sina sub- basin in the western parts covers 35 per cent of the area of district. Major rivers are Khari, Dudhan, Ulupa, Isrupa, Chandani and Sendas flowing in north South direction and the Bhima sub basin in the southern part covering 25 per cent of the district. Major rivers Benitura, Bori, and Palas are tributaries of the river Bhima.(Fig.no.2.7)

Manjara:-

The Manjara River rises above Gaurwadi near the northern edge of the Balaghat plateau in Bid district at the height of 823 meter from mean sea level and flows in a southeasterly direction towards Osmanabad district. The Manjra River flows along the northern boundary from west to east. The river has a length of 90 Kms. within the district, Manjra sub-basin in the Northern and Eastern parts covering 40 per cent of the district. The course of the river is generally westerly direction and river bed is about 100 to 200 meters wide. Major tributary of Manjara are Khatkali and Terna. The northern part of Washi and Kalam tehsils are drained by Manjara River.

Terna:-

The Terna River originates near Terkheda at the height of 685 meter above mean sea level, flows towards South-east direction in the district. The total length of the river is 150 kilometers from the source to its confluence with the Manjara, out of this 105 kilometers flow is in Osmanabad district. It has the longest course of all the rivers lying entirely within the district. Terna river valley is an important agricultural belt in the district (Babar Md. Et.al, 2011). The Terna project consists of an earthen dam on the river Terna at village Ter, south of Dhoki, with only one canal on the right bank. On account of the low relief of the adjoining divides the dam has to be very long and of low height giving rise to a storage covering a wide area but of shallow

DRAINAGE PATTERN OF OSMANABAD DISTRICT

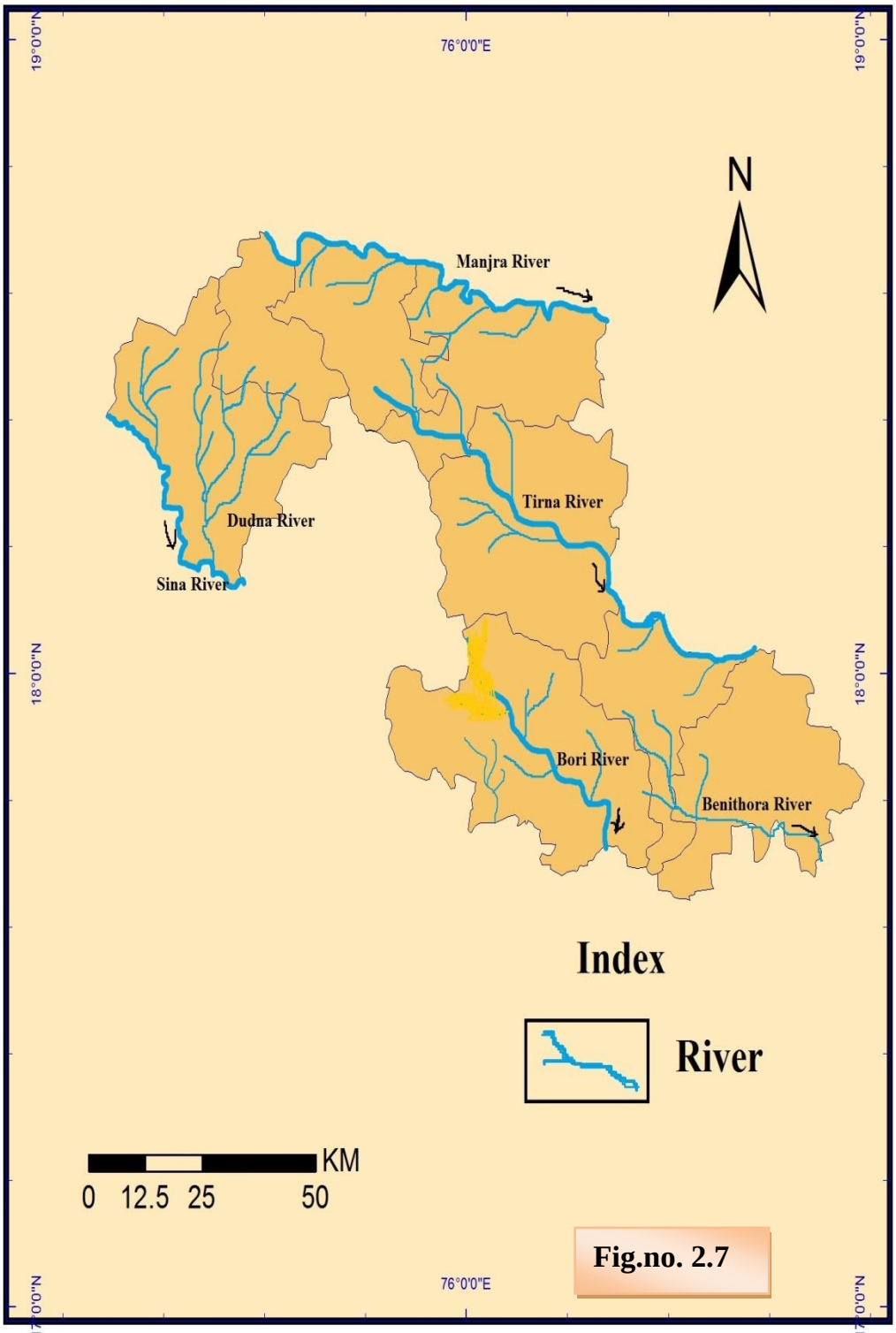


Fig.no. 2.7

depth. This river drains the Osmanabad tehsil and southern part of Washi and Kalam tehsils.

Benithora:-

The Benithura River, a tributary of the Bhima River, rises on the slopes of Deobet hill at the height of 668 meters above mean sea level and flows in a South-westerly direction passing by Jaoli, Yengur and Murum. At near about four kilometer south of Murum, it turns eastwards and receives number of tributaries like Ganjoti Nala and Omerga Nala. It then turns Southwards and passes outside the district. The river has a length of 70 kilometers within the district. This river drains Tuljapur, Lohara and Omerga tehsils of the district.

Bori:-

The Bori River originates on the South facing scarp land of Osmanabad plateau near Tuljapur to the west of Dharur at the height of 714 meter. It is a small left tributary of Bhima River. It flows in a South-easterly direction East of the ridge from Tuljapur to Naldurg. The river length is 59 Kms. within the district and enters in Akkalkot tehsil of Solapur district.

Harni:-

The Harni river, an important tributary of the Bori, flows West of Tuljapur-Naldurg ridge with a course of about 25 kilometers within the district and join the Bori about 10 kilometers North of Akkalkot.

Sina:

The Sina, a major tributary of the Bhima River, originates 22 km west of 'Torana' in Ahmednagar district and runs in south-east direction through Ahmednagar district and along the western boundary of Osmanabad district. The river has a length of 44 kms within the district. It receives many tributaries draining from the Bhum and Paranda tehsils. These are, beginning from north, the Kheri, the Dudhana with its tributary the Ulupa (the Banganga, being a tributary of the Ulupa) and the Chandani. All these are more or less parallel streams flowing in Southerly or South-westerly direction and having their sources on the western scarp faces of Kunthalgiri, Osmanabad, Tuljapur and Naldurg watershed. The river bed of Sina is about 100 to 200 meters wide with steep banks. Sina Sub basin stretches in the western part covering an area of 35per cent of the district.

All the rivers in the study region are seasonal and become dry in the summer season, therefore it necessary to built Kolhapur Types Bandhares on the rivers so that

more irrigational facilities will be provided to increase agricultural productivity. Deep and moderate deep soils developed along the banks of these rivers are too much favorable for the production of cash crops.

2.7 SOIL TYPES:

Soil is the product of parent rock, climate, vegetation and physiographic features. Soil is the basis or the foundation of farming. Without it we get nothing with poor soil, poor living, whereas with good soil, good farming and good living (De N.K., 1992). It plays an important role in the cultivation and production of crops in the study region. It nourishes and supports growth of plants. The growth of crops depends upon soil structure, colour, thickness and texture. Organic and inorganic matter, humidity and air are essential in soil for plant growth. The soil of the study region is basically derived from Deccan Trap Basalt and originated due to the decomposition of basaltic rock (Kumar Jainendra, 1986). The soil is underlined by partially decomposed basaltic rock, locally known as 'Murum'. Present analysis of soil is largely based on the report and data of Soil survey and Soil Testing Officer, soil survey and soil testing laboratory, Osmanabad and District Gazetteer.

The soil of the district are broadly classified into four groups- namely; (i) Very Shallow soil, (ii) Shallow Soil, (iii) Medium deep, (iv) Deep to Very Deep Soil. This exhibits a definite sequence i.e. very shallow soil and shallow soil on hills ridge and strong slope, medium and deep on gentle slope and deep soil at lower reaches of streams. (Fig.no.2.8)

(i) **Very Shallow Soil: -** These soils are coarse in texture and contain partially decomposed parent material, locally known as 'murmad' and 'malran soil'. This soil occurs on the tops and slope of hills. The depth of soil varies from 0 to 7.5 cm. These soils are light brown to dark grey in colour and loamy to clayey loamy in texture.

Very shallow soils occur in small patches in western and northwestern parts of the district. The table no. 2.4 exhibits that the district as a whole has 7.22 percent of very shallow soil. The highest proportion of very shallow soils is found in Bhum tehsil i.e. > 15 percent. It is moderate in Tuljapur tehsil i.e. 9 to 15 and low in Osmanabad, Omerga, Kalam, Paranda, Lohara and Washi i.e below < 9 percent of total geographical area of these tehsils.

Table No.2.4: Tehsilwise Distribution of Soil Types (As per depth)

Sr. No.	Tehsil	Area in %			
		Very shallow 0 - 7.5cm	Shallow 7.5-25 cm	Medium Deep 25-50cm	Deep to Very Deep 50-100 cm & >100 cm
1	Paranda	4.08	35.88	18.34	37.96
2	Bhum	21.11	41.60	12.07	20.85
3	Washi	4.56	41.41	15.06	36.55
4	Kalam	3.10	41.39	15.32	37.93
5	Osmanabad	6.85	40.69	13.87	35.55
6	Tuljapur	12.20	53.33	13.59	17.26
7	Lohara	2.57	30.31	19.70	35.43
8	Omerga	2.84	33.44	21.73	39.08
	District	7.22	41.91	16.30	30.50

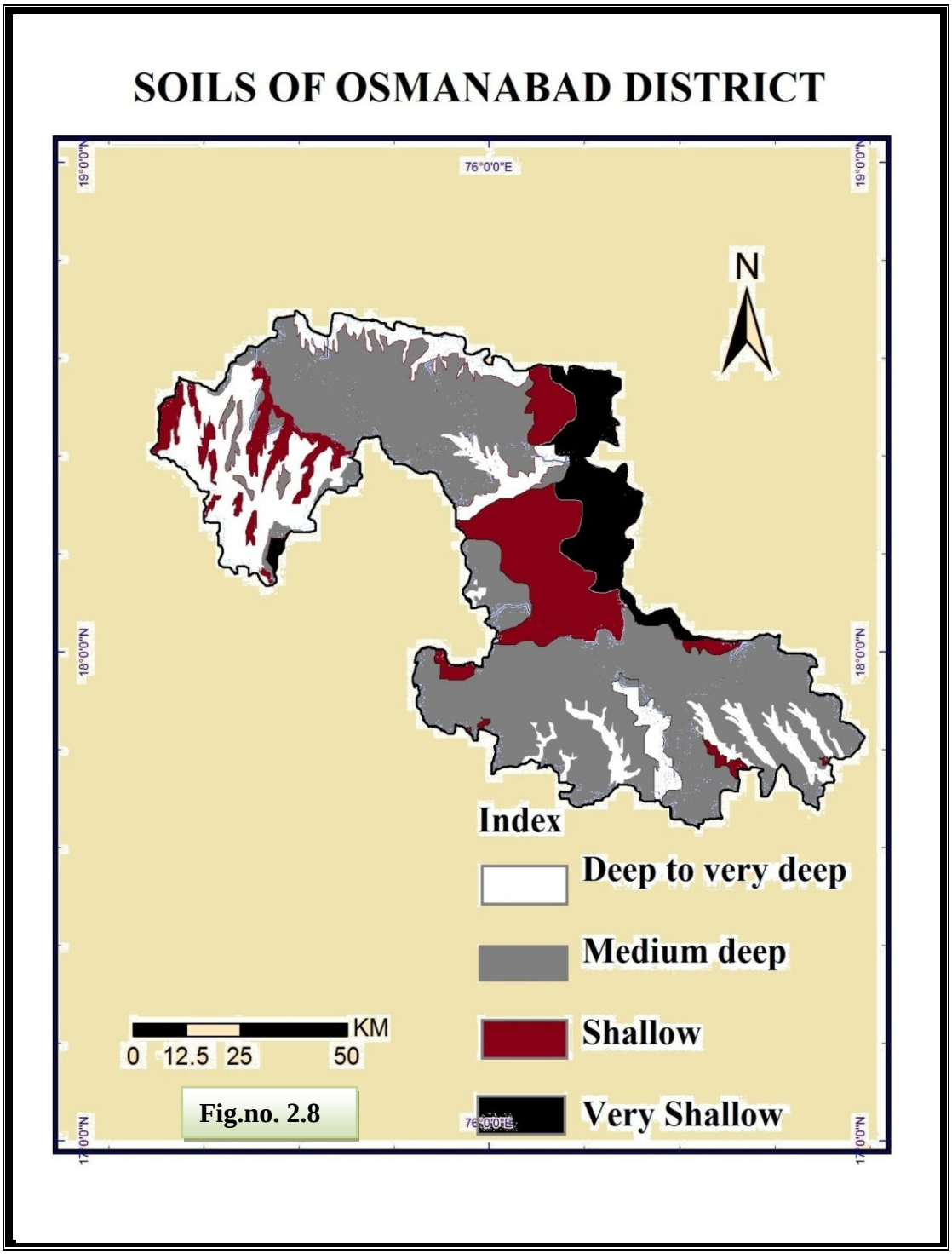
Source: Soil Survey and Soil Testing Laboratory, Osmanabad.

ii) Shallow Soils: - The depth of soil varies from 7.5 to 25 cm. They are dark brown to dark grey in colour. The district as a whole has 41.91 percent of shallow soil of the total geographical area. The solidity and porosity of these soils have posed a problem for the agricultultural development in the district.

The largest proportions of the district have shallow soils. The highest proportion of this category is confined to Tuljapur tehsil i.e.> 46 percent. It is moderate in Osmanabad, Kalam, Bhum and Washi tehsils i.e. 38 to 46 percent, whereas it is low in Paranda, Omerga and Lohara tehsils i.e. < 38 percent. (Table 2.4)

Low moisture retentively, low organic content, fairly fertile and being well drained are the salient features of these soils. Usually these soils with limited depth are cropped during kharif season, with crops like bajara, black gram and other pulses etc. as they are irretentive of soil moisture. These soils offer good prospectus for better productivity, if perennial water supply is available.

iii) Medium Deep Soil: - The depth of medium soil varies from 25-50 cm. This soil has developed along with drainage system of the district. It is also found on small plateau region located in isolated patches in various parts of the district. The capacity of internal drainage of such soil is medium. Such type soil contains high proportion of clay i.e. 20 to 70 percent and 5 to 15 percent lime. PH of this soil is in between 8 to 8.5, besides this high proportion of calcium, magnesium and potassium also found in such soil. However phosphorus is very low. This soil is dark brown in colour.



The table no. 2.4 indicates that the medium soil occupies 16.30 percent of total geographical area of the district. But the spatial distribution of this soil varies ranging from 12.07 to 21.73 percent of geographical area. The high proportion of this category is confined to Omerga and Lohara tehsils i.e. > 18.5 percent. It is medium in Kalam and Paranda tehsils i.e. 15 to 18.5 percent whereas it is low Osmanabad, Tuljapur, Bhum and Washi tehsils i.e. < 15 percent (Table no. 2.4).

Productivity of this soil is medium to good. It is cropped in both season i.e. kharif and Rabbi. The cereal crops, pulses and oilseeds are cultivated in this soil. The interesting features of this soil are medium moisture retentively, medium fertility and less availability of K (Potash), the horticultural crops can grow very well in this soil particularly onion crop.

iv) Deep to Very Deep Soil: - Deep to very deep soils are found in the banks of major rivers. These soils are developed in the form of strips. The colour of these soils varies from dark grey brown to very dark grey. They are clayey in texture. The depth of the soil is 50 to 100 cm and more than 100 cm. These soils have considerable moisture retaining capacity. Effective rooting depth in such soil is up to 70 cm and it is poorly drained. When wet swells and drying develops cracks up to 50 to 70 cm. Therefore it is supposed to be self-ploughing soil. This soil is low in porousity therefore; infiltration of water through this soil is low. Generally the soil is known as 'Kali' or 'Black Cotton Soil'. The proportion of clay in the soil is high with low quantity of lime. The process of erosion is also low.

This soil occupies 30.50 percent of total geographical area of the district. But the spatial distribution of soil varies ranging from 17.26 to 39.08. The high proportion of this category is confined into Osmanabad, Omerga, Kalam, Paranda, Washi and Lohara i.e. > 31 percent. It is low in Tuljapur and Bhum tehsil i.e. < 24.5 percent.

The crops like sugarcane, Jowar, wheat, gram cotton, tur, soyabean are cultivated in this soil. This soil is not favorable for fruit crops, but favorable for vegetable and spice. The soil contains magnesium carbonate, calcium carbonate and aluminum oxides whereas proportion of phosphorus and nitrogen is low. The productivity of this soil is high. Therefore soil is intensively cultivated. However, it is harmful to harrowing when it dries up.

Fertility (N P K) Status of the Soils:

Soil texture determines water holding capacity, retention of nutrients and aeration of soil. Generally soil fertility refers to the amount of nutrients available to plants in the soil. Soil fertility varied from place to place and macrobiotic, previous crop and addition of organic manure by farmers. Chemical elements are known to be important for plant's growth and survival. Plants use macro nutrients like Nitrogen (N), Phosphorus (P) and potash (K) in large amounts for their growth. Available quantities of NPK in the soil determine soil fertility.

The shallow soils of the district are relatively poor in phosphorus content. Hence their response for phosphorus fertilizers is good. However, the availability of potash (K) is relatively high, that is practically favorable for the quality production of fruits in western part of the region. The black soil of the district is moderate in nitrogen content. Its response for nitrogenous chemical fertilizers is moderate good.

The availability of phosphorus and potash content is relatively high in medium and deep black soils and it is poor in nitrogen. This soil has considerable potentials for other traditional crops by its virtue of high moisture holding capacity.

Table no.2.5: Tehsilwise Soil Fertility Index 2005-06 to 2009-10

Sr.No.	Tehsil	Total Analyzed Sample	Fertility status		
			N	P	K
1	Paranda	3064	L	L	H
2	Bhum	4684	L	VL	H
3	Washi	2782	L	L	H
4	Kalam	3397	M	L	H
5	Osmanabad	5837	M	VL	H
6	Tuljapur	3985	M	VL	H
7	Lohara	2218	L	VL	H
8	Omerga	1820	M	VL	H
	District	27787			

Source: Soil Survey and Soil Testing Laboratory, Osmanabad.

Tehsil-wise Fertility Status of the Soils:-

The table 2.5 indicates that percentage of nitrogen content in the soil is low in Paranda, Bhum, Washi and Lohara Tehsils. It is moderate in Osmanabad, Tuljapur, Kalam and Omerga tehsils. Phosphorus content is very low in tehsils of Osmanabad, Tuljapur, Bhum, Omerga and Lohara. It is low in Paranda, Washi and Kalam tehsils. Therefore, it is very essential to provide this content through chemical fertilizer or bio-fertilizer for better productivity. Potash content is high in each tehsils of Osmanabad district. Therefore, the soil of the district offers good future for production of agricultural commodities.

2.8 WATER RESOURCES:

इमा आप शिवतम ! हे पाणी अत्यंत पवित्र आहे. Water is very sacred

इमा सर्वस्य भेषिजी !! हे पाणी सर्वांचे संवर्धक आहे. Water is a life of all.

इमा राष्ट्रस्य वर्धिनी !! हे पाणी राष्ट्राची भरभराट आहे. Water makes prosperity of nation.

(Varun Sukta: Wrucha)

In the 'Yajurveda', (11: 50) water has been described as the elixir of life, the source of energy that sustains life on earth; water governs the evolution and functioning of the universe (Waldiya K.S., 1987). Water resources emerge from nature's gift of rain, wells, rivers, lakes and streams.

Water resources have tremendous important in drought prone area, in relation to agriculture. It is easily seen that abundant water is finite resource and scarce in the study region. Inadequate or poor supply of water may lead to dry farming manifesting inferior subsistence farming (Nanaware A.H., 2007). In such condition poor standard of peasant, which are compelled farmers to follow the traditional path of agriculture, thus inadequate water resources have forced the farmers of this region to find out alternative cropping system in given agro-climatic conditions. Farming without irrigation is uneconomic venture in Osmanabad district. It has become economic and prosperous by extending and improving irrigation facilities. Water for irrigation through Surface and subsurface are important assured source of agriculture i.e. rivers, canals, dams, tanks, wells, tube wells etc. Surface water resources are analyzed in the next chapter. In this chapter, attempt is made here to analyze ground water resources in relation to cropping pattern and agricultural productivity.

2.8.1 Groundwater Resources:

धर्म्यं यशस्यं च तदाभक्तोहं दकार्गलं येन जलोपलब्धिः।
पुंसा यताञ्डेषु शिरास्तथैव क्षितावपि प्रोन्नतनिम्नसंस्था
एकेन वर्णेन रसेन चाम्मश्च्युतं नभस्ता वसुधाविशेषांत ।
नाना रसत्वं बहुवर्णतां च गतं परिक्ष्यं क्षितितुल्यमेव ॥

(Slokas 1 and 2 of Dakargelam- chapter 54 of Vraht Samhita)

"The water veins beneath the earth are like veins in the human body, some higher and some lower. The rain water assumes various colures and tastes from differences in the nature of the Earth."

These slokas imply that the infiltration of rainwater through the veins into earth surface is the source of ground water.

Ground water is a natural resource with both ecological and economic value and is of vital importance of sustaining life, health and integrity of ecosystem. It provides drinking water to rural as well as urban community, supports irrigation and industry, sustains the flow of streams and rivers and maintains wetland ecosystem. This resource is increasingly threatened by over extraction which has insidious long-

term effects. Scarcity and misuse of groundwater pose a serious threat to sustainable development and livelihood.

In Osmanabad district the availability of ground water is extremely uneven, both in space, time and depth and so will the case in the future. The uneven distribution of groundwater in the study region is due to the highly heterogeneous lithology and regional variation of rainfall.

Table No.2.6: Tehsilwise Ground Water Recharge in Osmanabad District 2011-2012

Sr. No	Tehsil	Recharge from rainfall during monsoon season	Recharge from other sources during monsoon	Recharge from rainfall during non monsoon season	Recharge from other sources during non monsoon	Total Recharge from Rainfall	Total Recharge from other sources (Surface, subsurface Irrigation,	Total Annual ground water Recharge	Provision for natural discharge	Net ground water Availa-bility
1	Paranda	8209.99	984.41	974.69	2465.25	9184.68	3449.66	12634.34	631.72	12002.00
	%	64.98	7.79	7.71	19.51	72.70	27.30	100.00	5.00	95.00
2	Bhum	3841.71	428.74	453.51	1185.05	4295.22	1613.79	5909.41	295.47	5613.94
		65.01	7.26	7.67	20.05	72.68	27.31	100.00	5.00	95.00
3	Washi	5637.37	370.97	716.5	1765.34	6353.87	2136.31	8490.18	424.51	8065.67
	%	66.40	4.37	8.44	20.79	74.84	25.16	100.00	5.00	95.00
4	Kalam	7144.77	1021.92	1472.9	3539.59	8617.67	4561.51	13179.18	714.39	12464.79
	%	54.21	7.75	11.18	26.86	65.39	34.61	100.00	5.42	94.58
5	Osma-nabad	12394.97	1299.32	0	5147.86	12394.97	6447.18	18842.14	942.11	17900.04
	%	65.78	6.90	0.00	27.32	65.78	34.22	100.00	5.00	95.00
6	Tulja-pur	15106	1374.62	2022.94	4035.57	17128.94	5410.19	22539.41	1126.97	21412.44
	%	67.02	6.10	8.98	17.90	76.00	24.00	100.00	5.00	95.00
7	Lohara	5355.33	796.65	762.14	1918.92	6117.47	2715.57	8833.03	441.65	8391.38
	%	60.63	9.02	8.63	21.72	69.26	30.74	100.00	5.00	95.00
8	Omerga	9909.43	1310.63	1619.13	3405.91	11528.56	4716.54	16245.1	819.16	15425.94
	%	61.00	8.07	9.97	20.97	70.97	29.03	100.00	5.04	94.96
	District	67599.57	7587.26	8021.81	23463.49	75621.38	31050.75	106672.8	5395.98	**101276.2**
	%	**63.37**	**7.11**	**7.52**	**22.00**	**70.89**	**29.11**	**100.00**	**5.06**	**94.94**

Source: Compiled by researcher on the basis of "Report on the the Dynamic Ground Water Resources of Maharashtra (2011-12)" by GSDA, Govt, of Maharashtra & CGWB, Nagpur. Govt. of India.

Tehsilwise distribution of Groundwater recharge according to source:

The addition of water to the zone of saturation in aquifer is called groundwater recharge. The chief source of recharge in the study region is rainfall. Secondary source of recharge are groundwater irrigation, surface irrigation etc.

The table no. 2.6 indicates that the district as a whole have 107372.79 Hams. of total groundwater recharge. Out of these 70.89 percent ground water is recharged from rainfall. Next to rainfall are other sources viz., groundwater irrigation, surface irrigation and canals. Its share is about 29.11 percent.

The recharge by rainfall is high in Tuljapur tehsil i.e. < 75 percent. The reason for this is tehsil receives highest amount of rainfall. It is moderate in Paranda, Bhum, Washi and Omerga tehsils i.e. from 70 to 75 percent, whereas it is low in Lohara, Osmanabad and Kalam, tehsils (Table no. 2.6). Recharge from other sources is high in Lohara, Osmanabad and Kalam tehsils i.e. above 30 percent. It is moderate in Paranda, Bhum, Washi and Omerga tehsils i.e. from 25 to 30 percent, whereas it is low in Tuljapur tehsil i.e. >25.

The availability of Groundwater:

By subtracting natural discharge, the district as a whole has 101276.2 Hams. annual groundwater availability. The net annual availability is high in Osmanabad and Tuljapur tehsils i.e.> 16146.66 Hams. The net annual availability of groundwater is moderate in Omerga, Kalam and Paranda tehsils i.e. from 10880.27 to 16146.66 Hams, whereas it is low in Bhum, Washi, and Lohara tehsils i.e. < 108880.27 Hams.

Gross Draft of Groundwater:

The table no. 2.7 indicates that the district as a whole has about 63518.89 Hams. annual gross draft to net annual availability. Considering percentage of net annual groundwater availability, gross draft is high in Tuljapur, Osmanabad, Omerga and Paranda tehsils i.e. < 62.31 percent. It is medium in Lohara, Bhum and Kalam i.e. from51.81 to 62.31 percent, whereas it is low in Washi tehsil i.e. < 51.81 percent

Net Groundwater Balance:

As per the data available from the G.S.D.A., Govt. of Maharashtra, there is net annual availability of groundwater over the entire district 101276.82 Hams. and the gross draft for all uses are 63518.89 hams. So there remains net balance of 37757.93 hams. of groundwater for future development. Net balance of groundwater varies from tehsil to tehsil. The table no. 2.7 shows that the high balance of ground water is found in Washi, Kalam and Lohara tehsils i.e. > 41 percent of total recharge which indicates that there is high scope for digging wells for better agricultural production. It is moderate in Bhum tehsil i.e from 38 to 41percent whereas it is low in Osmanabad, Tuljapur, Omerga and Paranda tehsils i.e. below 38 percent.

Table No. 2.7: Tehsilwise Water Availability and existing groundwater draft in Osmanabad District 2011-12 (Ground water in ham)

Sr. No.	Tehsil	Net ground water Availability	Existing groundwater draft for irrigation	Existing groundwater draft for domestic	Gross groundwater draft for all uses	Net groundwater balance
1	Paranda	12002.62	7500.67	197.34	7698.01	4304.61
	%	100	62.49	1.64	64.14	35.86
2	Bhum	5613.94	3213.23	100.98	3314.21	2299.73
	%	100	57.24	1.80	59.04	40.96
3	Washi	8065.67	3181.89	150.17	3332.06	4733.61
	%	100	39.45	1.86	41.31	58.69
4	Kalam	12464.79	6933.13	294.97	7228.10	5236.69
	%	100	55.62	2.37	57.99	42.01
5	Osmanabad	17900.04	11379.97	323.58	11703.55	6196.49
	%	100	63.58	1.81	65.38	34.62
6	Tuljapur	21412.44	13983.48	377.33	14360.81	7051.63
	%	100	65.31	1.76	67.07	32.93
7	Lohara	8391.38	4498.89	149.37	4648.26	3743.12
	%	100	53.61	1.78	54.39	44.61
8	Omerga	15425.94	10955.32	278.57	11233.89	4192.05
	%	100	71.02	1.81	72.82	27.18
	District	101276.82	61646.58	1872.31	63518.89	37757.93
	%	100	60.87	1.85	62.72	37.28

Source: Compiled by researcher on the basis of "Report on the the Dynamic Ground Water Resources of Maharashtra (2011-12)" by GSDA, Govt, of Maharashtra & CGWB, Nagpur Govt. of India.

2.8.2 Spatial pattern of Water Table:

The spatial distribution of groundwater is uneven in the study region. The behavior of storage is not consistent and it varies from year to year and season to season causing widespread regional imbalances. In fact, the rise in water table is the fluctuating phenomena in the study region.

Table 2.8 shows that the five years average of water table of pre-monsoon and post-monsoon in Osmanabad district. In pre-monsoon period depth of water table is from 8.56 to 12.27 meter below the ground level in all over the study region. The highest depth of water table was found in Bhum tehsil i.e > 12.27 meter below the surface. It is medium in Paranda,Washi and Osmanabad, tehsils i.e. from 10 to 11

meter below the ground level, whereas it was very low in Kalam, Tuljapur. Omerga and Lohara Tehsils i.e. < 10 meter below the ground level.

Table No. 2.8: Tehsilwise Ground water level 2008-09 to 2011-12

Sr. No	Tehsil	No. of observation wells	5 year average Pre-monsoon Water Level (mbgl)	5 year average Post-monsoon Water Level (mbgl)	Average fluctuation (m)
1	Paranda	9	11.02	5.28	5.74
2	Bhum	5	12.27	5.20	7.07
3	Washi	1	10.85	4.35	6.51
4	Kalam	9	8.56	3.55	5.00
5	Osmanabad	16	10.47	4.98	5.49
6	Tuljapur	14	9.64	3.89	5.75
7	Lohara	3	9.78	4.75	5.03
8	Omerga	14	9.57	4.78	4.79

Source: Office of the Senior Geologist, GSD Osmanabad.

In post-monsoon period, district as a whole depth of water table is from 3.55 to 5.28 meter below the ground level. The highest depth of water table was found in Paranda , Bhum, Osmanabad, Omerga and Lohara tehsils i.e > 5 meter below the ground level. It is medium in Washi tehsil i.e. from 4 to 5 meter below the ground level, whereas it was very low in Kalam and Tuljapur Tehsil i.e. < 4 meter below the ground level.

In the study region, there is spatiotemporal variation in water table. The table no. 2.8 also indicates that the water table fluctuates from post-monsoon to pre-monsoon period due to the withdrawal by wells to rabbi crops. This decline in water table is in between from 4.79 to 7.07 meter below the ground level. The high fluctuation of water table was observed in Bhum and Washi tehsil i.e. > 6 meter below the ground level. It is medium in Tuljapur and Paranda tehsil i.e. from 5.5 to 6 meter below the ground level, whereas it is low in Lohara, Omerga, Kalam and Osmanabad tehsils i.e. < 5.5 meter below the ground level. The water table should at least remain in between 3.5 to 5 meter below the ground level, to be able for profitable irrigation (Singh & Dhillon, 1984). Since, these conditions are not found in most part of the region. The irrigation from underground water resources is more profitable to cash crops than the traditional crops like Jowar, bajra, Maize, wheat and pulses.

This has compelled the farmers of the region to find out drought tolerant crops to sustain and survive the agricultural enterprise in given conditions.

2.8.3 Decline of Water Table:

Decline of water table is a burning problem of Osmanabad district. Because of excess draft of groundwater due to increasing population, water table is declined by year to year.

The table no. 2.9 shows that in pre-monsoon (March) period of 2011-12 water tables is declined by 0.04 to 0.28 meter below the ground level from its backward 5 years average in all over the study region. High decline i.e. > 0.20 meter below the ground level was observed in Washi, Osmanabad, Omerga and Kalam tehsils. It is in between 0.12 to 0.20 meter below the ground level in Paranda and Lohara tehsils, whereas it is very low in Tuljapur tehsil i.e. 0.12 meter below the ground level.

Table No. 2.9: Decline of Groundwater Table 2008-09 & 2011-12 (mbgl.)

Sr.No.	Tehsil	Average water Table 2008-09 in Pre Monsoon	Average water Table 2011-12 in Pre Monsoon	Decline in meters.
1	Paranda	11.21	11.02	-0.19
2	Bhum	12.45	12.27	-0.18
3	Washi	11.13	10.85	-0.28
4	Kalam	8.78	8.56	-0.22
5	Osmanabad	10.74	10.465	-0.27
6	Tuljapur	9.68	9.64	-0.04
7	Lohara	9.93	9.775	-0.16
8	Omerga	9.82	9.565	-0.26

Source: Office of the Senior Geologist, GSD Osmanabad.

This picture is very horrible to agricultural activity and natural vegetation. Therefore it is very essential to increase groundwater recharge by artificial way to natural vegetations.

2.9 NATURAL VEGETATION:

The natural vegetation is commonly used to describe the natural plant's growth as distinct from the cultivated plants growth. The vegetation of any region is composed of a collection of number of plants belong to few or many different species. Natural vegetation is significant factors from the view point of rainfall distribution and the fertility of soil. It also checks the soil erosion to greater extent and keeps the

environmental balance (Anigunte V.S., 2006). Semi-natural vegetation in agricultural land mainly includes extensively managed grasslands, agro forestry areas and all vegetated features that are not used for crop production, such as hedgerows, buffer strips, field margins and woodlots. It plays a major role in the supply of ecosystem services such as pollination, pest control, water quality control and erosion prevention. The efficiency of ecosystem services for agriculture should therefore depend upon the spatial distribution of semi-natural vegetation (C Garcia-Feced et.al, 2014). For the environmental balance, the region should have 33 per cent of area under forest.

Water resources are highly depended on natural vegetation in terms of flow regulation. This is a crucial for providing a dependable water supply to crop areas, such as through retention of water in wetlands and forest buffering both droughts and floods (Bruinzeel E.C., 2005).

The natural vegetation is consisting of three- fold divisions from the view point of study i.e. the forest, grassland and desert. A Forest is a natural ecosystem having multispecies and multiage trees, as dominant community. Man for his very livelihood depends upon plants. Forest is the integral prior part of human life.

The natural vegetation of region depends upon the distribution of climatic elements over the region, edaphic or soil conditions, topography of terrain, natural drainage conditions, biotic factors and the extent of human interference.

The study region has negligible forest resources mainly concentrated in Tuljapur and Osmanabad tehsils. The forests are of thorny scrub type, common species found being Khair, Hivar, Hankal, Aroni, Karvand, Dikmali, Apta, Bor, Babhul and Neem. The forests have extensive grassy areas in undulating places. The major proportion of forest produce is consumed locally (Devarkar Vinod, 2012).

In Osmanabad district undulating hills of grass plains are unique feature to the Balaghat range of Southern Maharashtra. A substantial fraction of the grassland are found in Bhum Tehsil and referred to as Bhum. The grassland of Osmanabad district amounts to about 254.1 square kilometer. Dams and windmills are being commissioned in these areas, which would fragment the landscape (www.atree.org/research). The important species of grass found are Kusal, Sheda and Marvel.

PART-B: NON-PHYSICAL SETTING

2.10 DEMOGRAPHIC FACTORS:

Population plays a key role in the development of the agriculture in the region. The relation between population and land use is very close. For instance, changes in population pattern, influences on land use pattern (Singh and Dhillon, 1987). Growth of population, density of population, man-land ratio, sex ratio, age composition and literacy are the elements of population which are important in the social, cultural and economic development of the region (Nanaware A.H,. 2007 The total population of the district as per 2011census is 1657576 of which 83.04 per cent is rural and 16.96 per cent is urban population. So Osmanabad is well known as a district of villages.

A] Decadal Variation in Growth of Population:

During the 2011, the population of the district was 1657576 and decadal growth rate of population was about 11.50 percent. The growth rate of population of the district during last six decades is low as compared with the growth rate of population of the state.

Table No. 2.10: Growth of Rural and Urban Population and Decadal Variation (1951-2011)

Year	Rural Population	Urban Population	Rural Decadal variation	Urban Decadal Variation	Rate of Varia-tion of Rural Populat-ion in %	Rate of Varia-tion of Urban Populat-ion in %
1941-51	527745	75107	—	—	—	—
1951-61	655924	70149	128179	-4958	24.29	-6.60
1961-71	829742	98152	173818	28003	26.50	39.92
1971-81	896760	130961	67018	32809	8.08	33.43
1981-91	1082198	194129	185438	63168	20.68	48.23
1991-2001	1253330	233,256	171132	39127	15.81	20.16
2001-2011	1376519	281057	123189	47801	9.83	20.49

Source: Compiled by Researcher on the basis of 1) District Census Handbook of Osmanabad District 2011. 2) Data dissemination wing office of the Registrar General, India 2A. Mansingh road, New Delhi. 110011, India.

The table no. 2.10 shows the variation in growth rate of rural and urban population. During the 1951-61 the urban population is decreased by -6.60 per cent because in 1956 the district is separated from Hyderabad State and included in Bombay State. Due to this shift most of the urban population migrated to Hyderabad

state. Rural and urban population is increased in 1961-71 and 1981-91 decades, whereas decreased in 1971-81 decade because draught of 1972. During draught most of people suffered from insufficient food, fodder and drinking water. So many rural populations migrated with their livestock in other areas.

The growth rate of rural population had decreased in decades of 2001 and 2011 because of the family planning and out migration of rural population toward urban area due to the unemployment problem in rural area.

Table no. 2.11 and Fig. no. 2.9 give us an idea of tehsilwise growth rate of the population from 2001 to 2011. The district as a whole has 10.32 percent growth rate

Table No.2.11: Tehsilwise population growth rate (in %) during 2001-2011

Sr.No.	Tehsil	Population		Growth Rate in %
		2001	2011	
1	Paranda	125136	140148	10.71
2	Bhum	120844	136745	11.63
3	Washi	85896	92150	6.79
4	Kalam	193825	217687	10.96
5	Osmanabad	359234	405736	11.46
6	Tuljapur	250149	278879	10.30
7	Lohara	110163	116712	5.61
8	Omerga	241339	269519	10.46
	District	1486586	1657576	10.32

Source: Compiled by Researcher on the basis of 1) District Census Handbook of Osmanabad District 2011. 2) Data dissemination wing office of the Registrar General, India 2A. Mansingh road, New Delhi. 110011, India.

of population, but spatial distribution varies from tehsil to tehsil ranging from 5.61 to 11.63 percent. The tehsils of Bhum and Osmanabad having high growth rate i.e. > 11 percent. In Bhum it is high due to development of dairy farming and in Osmanabad it is high due to the agricultural and industrial development. The moderate growth rate of population is observed in Paranda, Kalam, Tuljapur and Omerga tehsils i.e. 9 to 11 percent, whereas the tehsils of Lohara and Washi have low growth rate i.e. < 9 percent.

B] Density of Population:

Population density refers to the population of a particular area per square mile or square kilometer (United Nation, 1979). The density of population in any region indicates the pressure on land. The concept of density of population is most revealing and useful tool in the analysis of the diversity of man's distribution in space

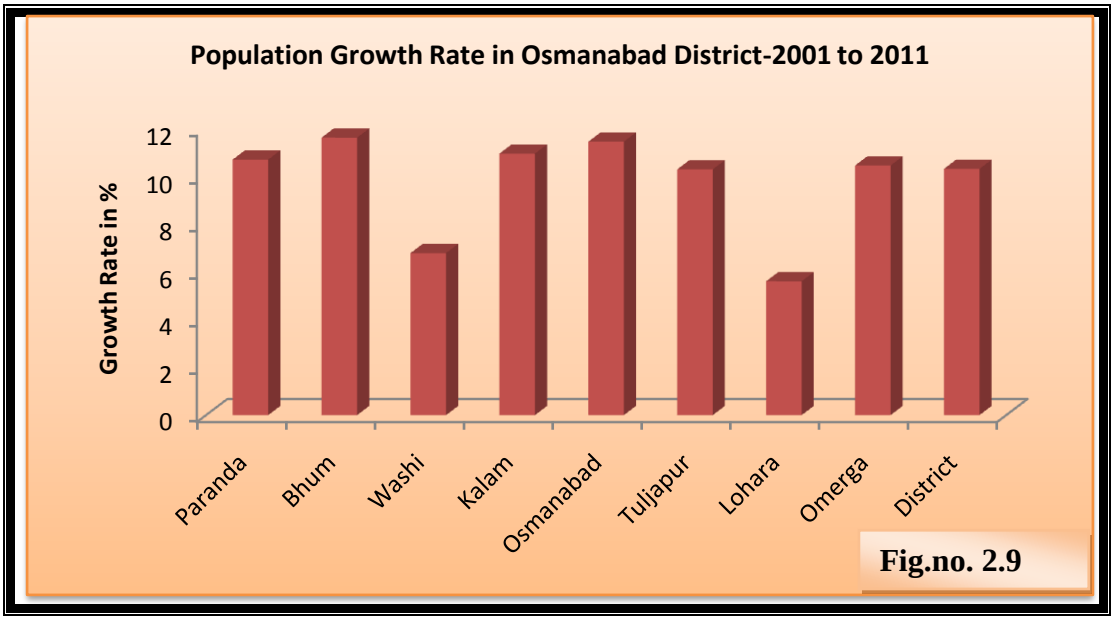


Fig.no. 2.9

(Chandana R.C., 2009). With the help of different types of densities viz., crude, physiological, agricultural and caloric, we can understand the pressure of the population on agricultural land. For physiological and agricultural density five years average of net sown area is taken into consideration and for caloric density average of food cropped area is taken into consideration.

I) Crude Density:

Crude density gives us general idea about the population pressure on land. It is computed by dividing total population by total geographical area. Table no. 2.12 and fig.no. 2.10 indicate that, the district as a whole has 214 crude density that of state is 365 per square kilometer as per 2011 census. The spatial distribution of crude density varies from tehsil to tehsil. The high Crude density is recorded in Osmanabad and Omerga tehsil i.e > 253 persons per square kilometer. In Osmanabad it was high because district head quarter is located in this tehsil which leads secondary and tertiary activities resulted into high urbanization whereas in Omerga it is high due to development of educational facilities. The moderate density is recorded in the tehsils of Kalam and Lohara ranging from 200 to 253 persons per square kilometer, while low crude density is found in the tehsils of Tuljapur, Paranda, Bhum and Washi i.e. < 200 persons per per square kilometer. It is low in Paranda due to low rainfall, while it is low in Tuljapur, Bhum and Washi as they are situated in rugged topography of Balaghat range (Table no. 2.12 & Fig. no. 2.10).

Table 2.12: Tehsilwise different types of population densities (2001-2011)

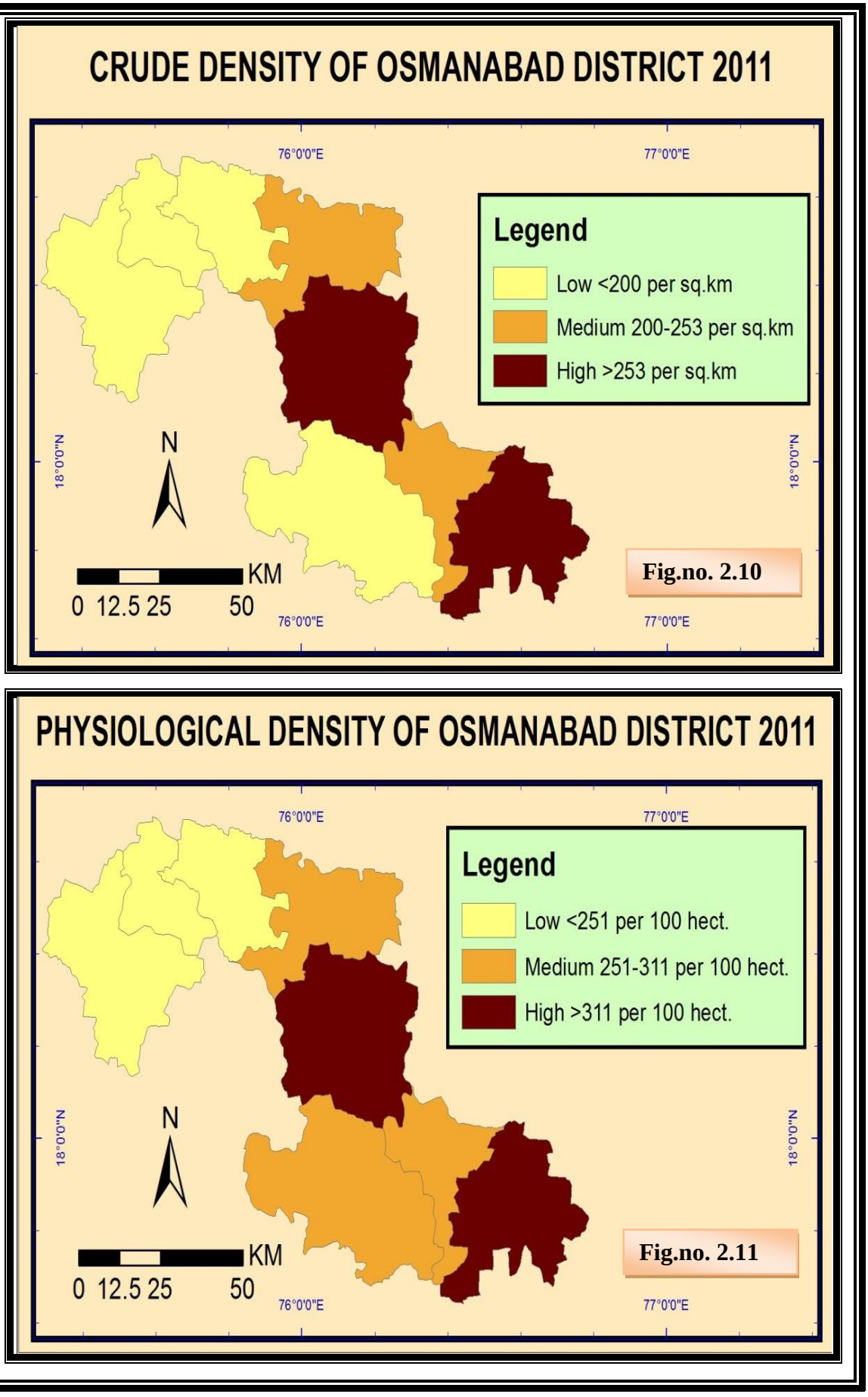
Sr.No.	Tehsil	2001 Density per sq.km.				2011 Density per sq.km.			
		Crude Density	Physiological Density	Agricultural Density	Caloric Density	Crude Density	Physiological Density	Agricultural Density	Caloric Density
1	Paranda	133	192	85	173	149	202	89	159
2	Bhum	146	192	75	167	166	227	101	194
3	Washi	137	185	80	180	147	190	90	218
4	Kalam	211	288	108	236	237	270	108	273
5	Osmanabad	271	355	105	269	307	372	115	292
6	Tuljapur	161	226	72	182	180	251	82	215
7	Lohara	206	237	87	243	218	263	97	280
8	Omerga	240	328	102	289	268	339	106	283
	District	192	259	89	220	214	275	99	240
	Maharashtra	315	543	101	249	365	646	150	266

Source: - *Compiled by Researcher.1) District Census Handbook of Osmanabad District 2011. 2) Data dissemination wing office of the Registrar General, India 2A. Mansingh road, New Delhi. 110011, India.*

During the period of investigation, positive changes in crude density are observed in all the tehsils of the district. District as a whole has 22 persons per per square kilometer increase in crude density. But it varies from tehsil to tehsil. The high positive change in crude density was observed in the tehsils of Osmanabad and Omerga i.e. > 27 persons per square kilometer, it was medium in Tuljapur, Kalam and Bhum tehsils i.e. from 19 to 27 persons per square kilometer whereas, it was low in Washi, Lohara and Paranda tehsils i.e. < 19 persons per square kilometer.

II) Physiological Density:-

Physiological density is hardly adequate for making a regional comparison in population burden on land and its impact on land-use. It gives rather, clearer picturebut fails to convey the true picture of population pressure (Singh Jasbir and Dhillon S.S, 1987).


CRUDE DENSITY OF OSMANABAD DISTRICT 2011
76°0'0"E
77°0'0"E
18°0'0"N
Legend
Low <200 per sq.km
Medium 200-253 per sq.km
High >253 per sq.km
N
KM
0 12.5 25 50
Fig.no. 2.10
PHYSIOLOGICAL DENSITY OF OSMANABAD DISTRICT 2011
Legend
Low <251 per 100 hect.
Medium 251-311 per 100 hect.
High >311 per 100 hect.
Fig.no. 2.11

Physiological density is calculated by using following formula.

$$\text{Physiological Density} = \frac{\text{Total Population}}{\text{Five years average of net sown area}} X\ 100$$

As per 2001 census, district as a whole has of 259 physiological density that of state as 543 per hundred hectare. There is spatial variation in physiological density from tehsil to tehsil. It ranges from 185 to 355 persons per hundred hectare net sown area. The high physiological density was recorded in Osmanabad, Kalam and Omerga tehsils i.e. > 283 persons per hundred hectare net sown area. It was medium in Lohara tehsil i.e. from 227 to 283 persons per hundred hectare net sown area, whereas it was low in tehsils of Tuljapur, Bhum, Paranda and Washi tehsils i.e. <227 persons per hundred hectare net sown area. (Table no. 2.12 & Fig. no. 2.11)

In 2011, physiological density of Osmanabad district was 275 that of state is 645.60 per hundred hectare. The spatial distribution is uneven ranges between 190 and 372 per hundred hectare net sown area. The high physiological density is recorded in Osmanabad and Omerga tehsils i.e. > 311 persons per hundred hectare net sown area due to the development of irrigation facilities and agricultural development. The medium physiological density is found in Tuljapur, Kalam and Lohara tehsils i.e. from 251 to 311 persons per hundred hectare net sown area, whereas it was low in tehsils of Bhum, Paranda and Washi i.e. <251 persons per hundred hectare net sown area. (Table no. 2.12 & Fig. no. 2.11)

During the period of investigation, positive changes in Physiological density are observed in all the tehsils of Osmanabad district except Kalam tehsil. District as a whole has positive change i.e. 16 persons per hundred hectare net sown area. But it varies from tehsil to tehsil. The high positive change in Physiological density is observed in the tehsils of Lohara and Bhum i.e. > 25 persons per hundred hectare net sown area. The medium positive change in physiological density is recorded in Tuljapur and Osmanabad tehsils i.e. from 15 to 25 persons per hundred hectare net sown area, whereas it was low in Washi, Omerga and Paranda tehsils i.e. < 15 persons per hectare net sown area.

III) Agricultural Density:

Agricultural density is a better approach to the question of land use in agricultural countries where heavy reliance is placed on farming (Singh Jasbir and Dhillon S.S, 1987). Agricultural density is calculated by using following formula.

$$\text{Agricultural density} = \frac{\text{(Agricultural labors + cultivators)}}{\text{Five years average of net sown area}} X\ 100$$

In 2011, agricultural density of Osmanabad district was 99 per hundred hectare net sown area that of state is 149.69 per hundred hectare net sown area. The spatial distribution ranges in between 82 and 115. The high agricultural density was recorded in Osmanabad, Kalam and Omerga tehsils i.e. > 104 persons per hundred hectare net sown area due to the high average annual rainfall and high proportion of deep soil. It was medium in Bhum and Lohara tehsils i.e. from 93 to 104 per hundred hectare net sown area, whereas it was low in tehsils of Tuljapur, Paranda and Washi i.e. < 93 per hundred hectare net sown area. (Table no. 2.12 & Fig. no. 2.12)

During the period of investigation, positive changes in agricultural density were observed in all the tehsils of Osmanabad district except Kalam tehsil. Agricultural density is increased by 10 per hundred hectare net sown area in the study region. The high positive change in agricultural density was observed in Bhum tehsil i.e. 26 per hundred hectare net sown area due to development of dairy farming. It was medium in Washi. Lohara, Tuljapur and Osmanabad tehsils i.e. from 9 to 18 per hectare net sown area. Whereas, it was low in Kalam, Omerga and Paranda tehsils i.e. < 9 persons per hectare net sown area.

IV) Caloric Density:

Caloric density is calculated by dividing total rural population by total food cropped area. The following formula is used to calculate caloric density.

$$\text{Caloric density} = \frac{\text{Total Rural Population}}{\text{Five years average of cropped area}} X\ 100$$

In 2011, the caloric density of Osmanabad district was 240 that of state is 266 per hundred hectare cropped area. The spatial distribution ranging from 159 to 292 persons per hundred hectare cropped area. The high caloric density was recorded in

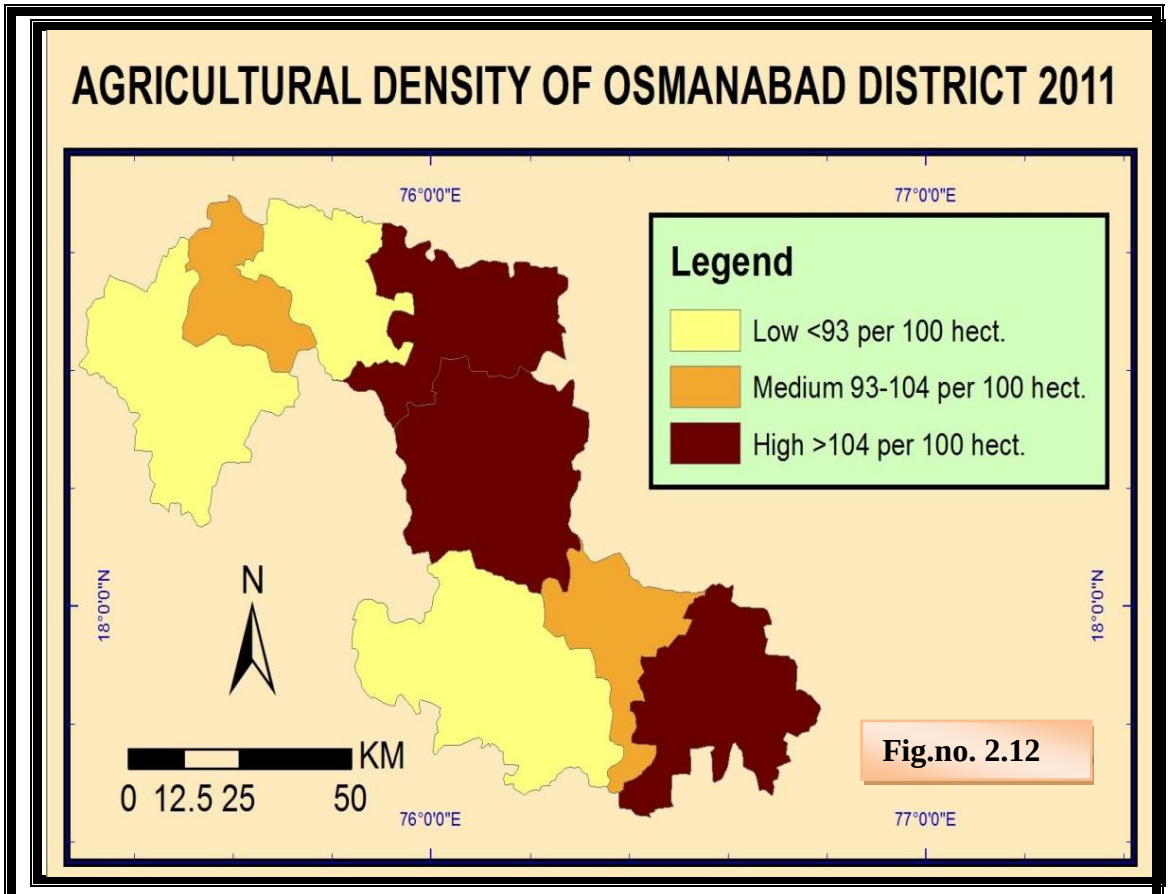


Fig.no. 2.12

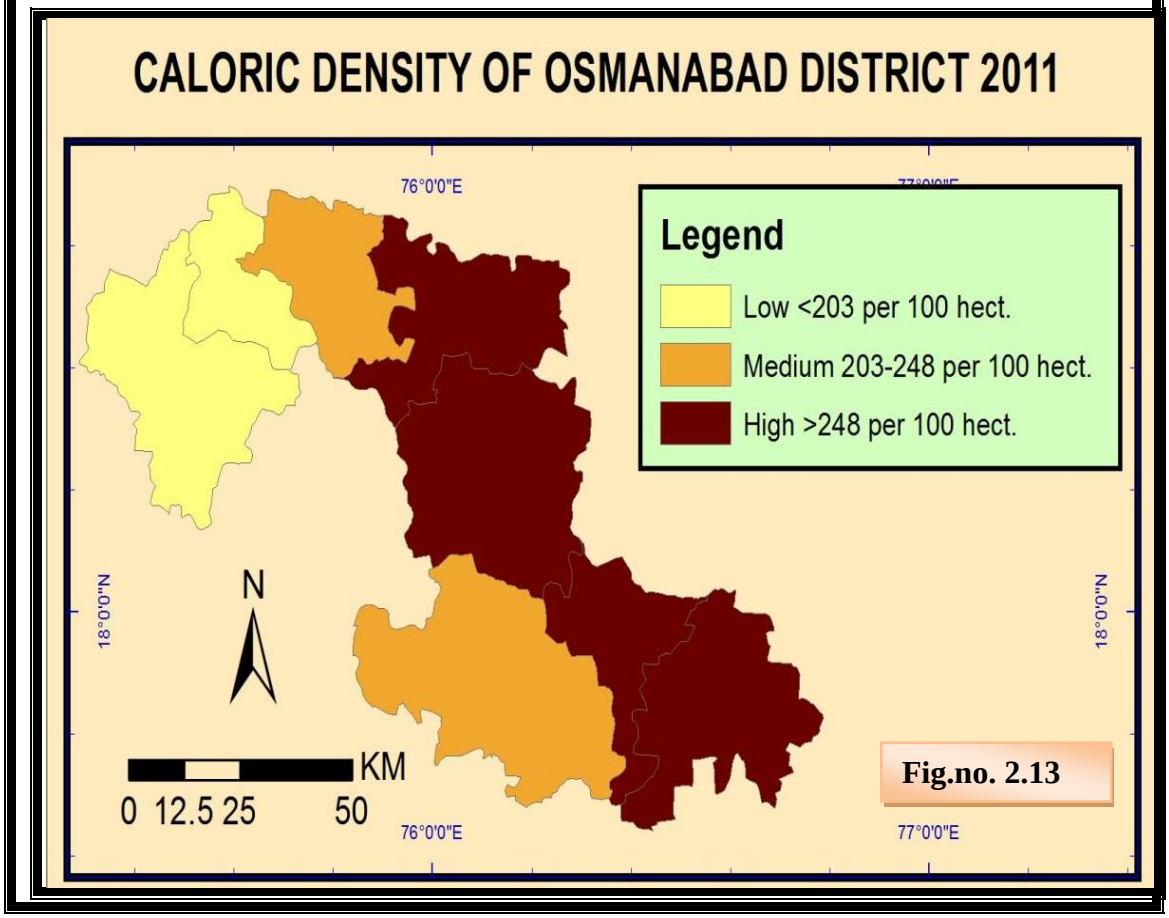


Fig.no. 2.13

Osmanabad, Kalam, Lohara and Omerga tehsils i.e. > 248 per hundred hectare cropped area. The medium caloric density is found in Washi and Tuljapur tehsils i.e. 203 to 248, whereas it was low in tehsils of, Paranda and Bhum i.e. < 203 per hundred hectare cropped area. (Table no. 2.12 & Fig. no. 2.13)

During the period of investigation, district as a whole has 20 persons positive change in caloric density but tehsil level distribution shows both positive and negative changes. The high positive change in caloric density was observed in Washi, Kalam and Lohara tehsils i.e. > 33 per hundred hectare cropped area. It was medium in Tuljapur tehsil i.e. 33 per hundred hectare cropped area. Whereas, it was low in Bhum and Osmanabad tehsils i.e. < 28 persons per hectare cropped area due to the industrial development. The high negative change in caloric density was observed in Paranda tehsil i.e. 14 per hundred hectare cropped area due to Sina Kolegaon Project causes increase in gross cropped area, whereas low negative change was found in Omerga tehsil i.e. 6 persons per hundred hectares cropped area.

C] Population Pressure on Agricultural Land:

For measuring the actual pressure of population on agricultural land the relative co-efficient of over population are computed by taking into consideration the standard hecterage namely 0.4047 hectare suggested by author of "Limits to Growth" and quoted by Swaminathan (1974). Using this as a criterion the unit 0.4047 of hectare is divided by per capita net sown area. The quotient thus obtained gives the relative coefficient of over population. Thus the greater the co-efficient, the higher would be the pressure of population on land, 1.10 may be considered as more or less marginal. It is only where this figure exceeds 1.10 that the area may be said to be over populated.

$$1.\ Per\ capita\ net\ sown\ area = \frac{5\ \text{Years average net sown area}}{\text{Rural Population}}$$

$$2.\ Relative\ coefficient\ of\ over\ population = \frac{\text{Criterion } 0.4074}{\text{Per capita Net sown area}}$$

During 2001 Osmanabad was only one over populated tehsil, which had 1.11 relative co-efficient of population.

Per Capita Net Sown Area:

The table 2.13 indicates that during 2001 there was 0.46 hectare per capita net sown area in the district; but it varies from tehsil to tehsil. Table no.2.13 reveals that per capita net sown area was low in Osmanabad, Omerga, Kalam and Lohara tehsils i.e <0.49 hectare, whereas it was high in Tuljapur, Paranda, Bhum and Washi tehsils i.e. > 0.49 hectare in 2001. (Fig.no.2.14 A)

During 2011, there was 0.43 hectare per capita net sown area in the district, but spatial distribution varies from tehsil to tehsil. The per capita net sown area is low in Omerga, Osmanabad, and Lohara Tehsils i.e. < 0.40 hectare. The per capita net sown area is moderate in Kalam and Tuljapur tehsils ranging 0.40 to 0.50 hectare, while it was high in Paranda, Bhum and Washi tehsils i.e. > 0.50 hectare. During the period under review, per capita net sown area decreased in all tehsils except Osmanabad tehsil. (Fig.no. 2.14 B)

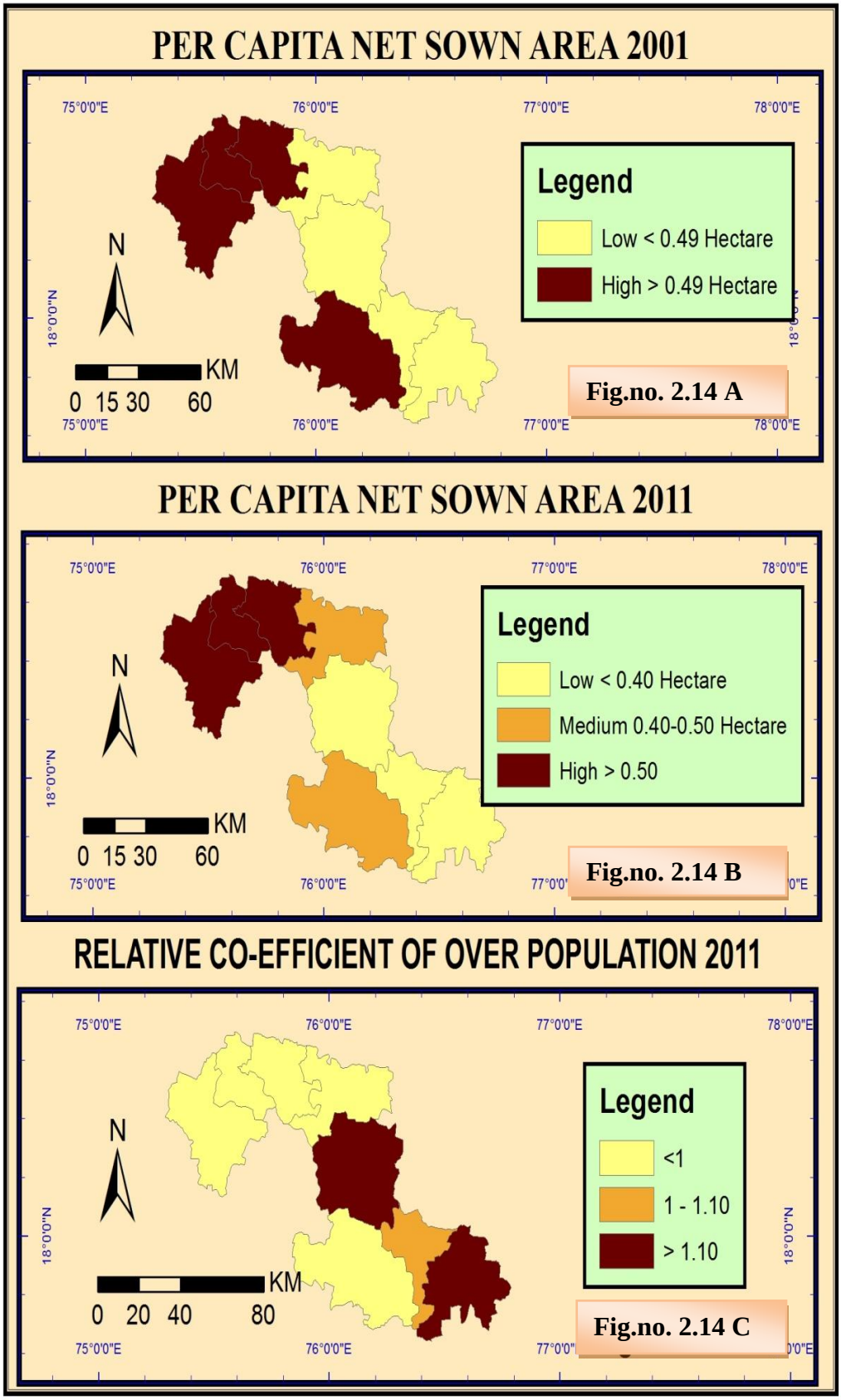
The Fig. no.2.14 C and table no. 2.13 exhibit that relative co-efficient of over population was less than 1 in Paranda, Bhum, Washi, Kalam, and Tuljapur tehsils.

Table No.2.13: Tehsilwise Per Capita Net Sown Area and Relative Co-efficient of Over population in Osmanabad district 2001 & 2011.

Sr.No.	Tehsil	Per Capita Net sown Area		Relative Co-efficient of over population	
		2001	2011	2001	2011
1	Paranda	0.60	0.57	0.67	0.71
2	Bhum	0.61	0.51	0.66	0.80
3	Washi	0.60	0.53	0.68	0.77
4	Kalam	0.40	0.42	1.02	0.96
5	Osmanabad	0.36	0.37	1.11	1.16
6	Tuljapur	0.55	0.45	0.74	0.89
7	Lohara	0.42	0.38	0.96	1.06
8	Omerga	0.38	0.34	1.07	1.19
	District	0.46	0.43	0.88	0.95

Source: Compiled by Researcher on the basis of Socio-Economic Review and District statistical abstract of Osmanabad district 2001-02 & 2011-12

It was 1.06 in Lohara tehsile, where as it was above 1.10 in Osmanabad and Omerga tehsils in 2011 which indicates that population pressure high in Omerga and


PER CAPITA NET SOWN AREA 2001
75°0'0"E
76°0'0"E
77°0'0"E
78°0'0"E
18°0'0"N
N
KM
0 15 30 60
Legend
Low < 0.49 Hectare
High > 0.49 Hectare
Fig.no. 2.14 A
PER CAPITA NET SOWN AREA 2011
Legend
Low < 0.40 Hectare
Medium 0.40-0.50 Hectare
High > 0.50
Fig.no. 2.14 B
RELATIVE CO-EFFICIENT OF OVER POPULATION 2011
0 20 40 80
Legend
<1
1 - 1.10
> 1.10
Fig.no. 2.14 C

Osmanabad tehsils. Table no. 2.13 shows that relative coefficient of population increased in every tehsils except Kalam and Osmanabad from 2001 to 2011.

D] Literacy:

As per 1991 census, a person aged seven and above who can both read and write with understanding in any language, is treated as literate (Census of India, 1991). Literacy plays the key role in the development of economic activities in any region. Literacy is necessity for all those who wish to practice the agricultural occupation on modern lines. Literacy and population growth are two factors which bring about a change in agriculture. Therefore, the worth of literacy has to assessed by its effectiveness as an instrument of agricultural development on progressive lines (Singh J and Dhillon S.S., 1997). Use of agricultural implements, fertilizers and pesticides and high yielding varieties are practiced by educated farmers. Literacy also affects on use of irrigation, non-fragmentation, agricultural loans which could change agricultural land use (Nanaware A.H, 2007). Literacy play very important role in agriculture because it requires techniques, use of pesticides and vermiculture for better production and literate person can use techniques easily.

The spatial distribution of literacy and volume of change in 2001and 2011 are shown in Table No. 2.14. As per 2001Census, literacy of Osmanabad district was 68.64 percent that of state is 82.3 percent. The spatial distribution varies from tehsil to tehsil ranging from 66.15 to70.72 percent. The high literacy was recorded in

Table No. 2.14: Tehsilwise Literacy in Osmanabad District during 2001& 2011

Sr.No.	Tehsil	Percent of Literacy		Volume of change in %
		2001	2011	
1	Paranda	54.41	66.15	11.74
2	Bhum	57.01	66.92	9.91
3	Washi	59.08	69.13	10.05
4	Kalam	60.75	70.52	9.77
5	Osmanabad	61.65	70.72	9.07
6	Tuljapur	57.49	67.51	10.02
7	Lohara	57.29	67.29	10.00
8	Omerga	57.24	67.76	10.52
	District	58.66	68.64	9.98

Source: *Compiled by Researcher on the basis of* ***(1)*** *District Census Handbook of Osmanabad Distric, 2001*

Osmanabad and Kalam tehsils i.e. >69 because of district headquarter lies in Osmanabad tehsil which leads to higher urbanization and in Kalam tehsil it is due to the development of educational facilities. The medium literacy is recorded in Washi tehsil i.e. 69.13 percent, whereas it was low in tehsils of, Tuljapur, Lohara, Paranda, Omerga and Bhum i.e. < 68 percent.

During the period of investigation, positive change in literacy is observed in all the tehsils of Osmanabad district. District as a whole has 9.98 percent positive change in literacy. The high positive change in literacy was observed in Paranda tehsils i.e. > 11 percent due to the growth of educational institute and positive attitude towards education. The positive change in literacy is medium in Washi, Omerga, Lohara and Tuljapur tehsils ranging from 10 to 11 percent, whereas, it was low in Bhum, Kalam and Osmanabad tehsils i.e.< 10 percent.

2.11 IRRIGATION:

Irrigation is the application of water to the soil for the purpose of supporting plant growth. Irrigation is treated as a mojor component in an integrated agricultural production scheme in which crop yields and or profits are maximized by considering the influence of crop variety, planting density, soil aeration, and other management practices on crop yields (George et.al, 1998). Irrigation is considered as one of the most important and basic factors in the process of transformation of agriculture, where rainfall is both inadequate and unpredictable. Irrigation is basic determinant of agriculture because its inadequacies are the most powerful constraints on the increase of agricultural production, particularly in the draught prone regions. It is recognized for its protective role of insurance against the vagaries of rainfall and drought (Pawar C.T., 1989). Irrigation plays a pre-eminent role in minimizing the adverse influence of scanty and highly unreliable rainfall. Such a role acquires an added significance in the dry lands where it becomes impossible to grow crops without irrigation (Singh J. and Dhillon S.S., 1987).

Farming without irrigation is very limited in the study region. Irrigation helps to the farmers to take two or more crops from the same field within a year and it increases the productivity of land by transforming the agriculture. The study region is suffered by scanty, erratic, uneven and uncertain rainfall. Therefore there is a great need of irrigation.

A] Surface Irrigation:

This category includes canal, lift and tank irrigation. Surface irrigation is very important in the study region due draught prone condition. Before analyzing the surface irrigated area, the sources of surface irrigation discussed in the light, these are the major, medium, minor irrigation projects, Kolhapur types bandhare's, percolation tanks and lift irrigation schemes.

I) Major Irrigation Project:

An irrigation project which covers more than 10000 hectares land as the culturable command area is called major irrigation project (Planning Commission, 1978). There are three major irrigation projects in the study region. They are the Manjara, Lower Terna and Sina-Kolegaon Joint canal Project which are completed.

A) Manjara Project:

The Manjara project has been constructed on the Manjara River near Dhanegaon in Beed district. It was completed in 1984 and about Rs. 17602 lakh was

Table no.2.15: Major Irrigation Project in Osmanabad District (as on 2012-13.)

Sr. No.	Particulars	Name of the project		
		Manjara Project	Lower Terna	Sina Kolegaon
1	Location of the project	Dhanegaon (Kej,Dist.Beed)	Lohara	Paranda
2	Year of completion	1984	1989	2007
3	Expenditure in Rs.Lakh	17602	16333	23783
4	Height in meter	25.5	26.3	26.1
5	Lenth of canal in killometers	168	154	112
6	Water storage capacity(in million cubic meters)	201.77	121.19	150.49
7	Water storage on 31.3.2013 (in million cubic meters)	110.98	49.05	89.34
8	Gross Benificiary area (in hect.)	26526	15600	15546
9	Cultivable land in benificiary area(in hect.)	23690	14513	14110
10	Area will be under irrigated after completion of project (in hect.)	18223	11610	12100
11	Area under irrigation (in hect.) in 2012-13	7599	5096	8573

Source:- District Socio-economic Review and Statistical Abstract of Osmanabad 2013

spent on its work. The wall height of dam is 25.5 meters. This project provides irrigation water to Beed, Latur and Osmanabad district. Total length of the canal is168 kms. The maximum storage capacity of the project is 201.77 million cubic meters and irrigation potentials are 26526 hectares. Total cultivable area due to this project is 23690 hectare; out of this 7599 hectare area was iriigated in 2012-13. This project provides water to 627 hectares of land of the study region and Kalam tehsil of Osmanabad district is benefited by this project.

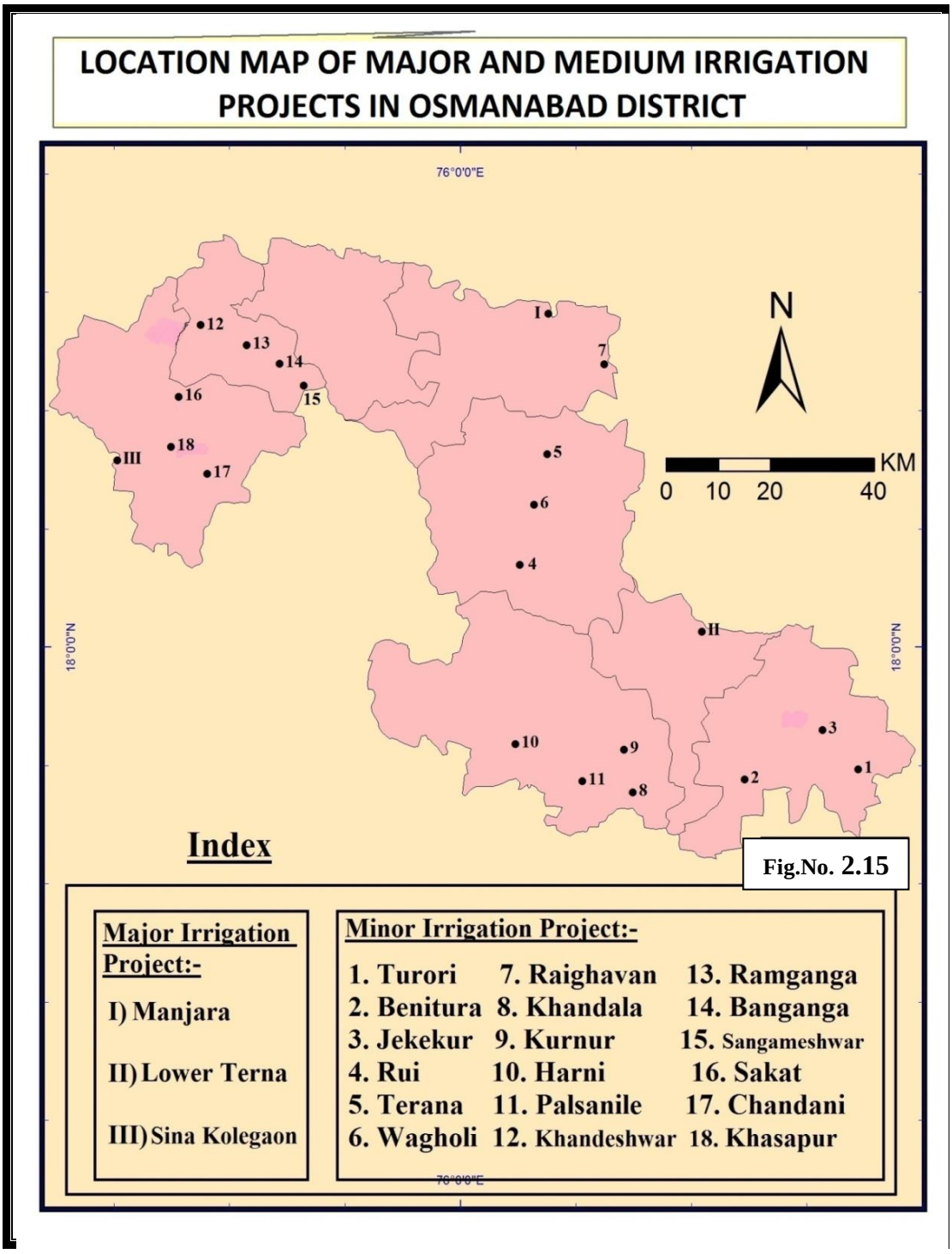


Fig.No. 2.15

B) Lower Terna Project:

It is constructed on river Terna near Makni village of Omerga tehsil. It was completed in 1989. The project provides irrigation water to Latur and Osmanabad district. The total length of the canal is 154 kms. The maximum storage capacity of project is about 121.19 million cubic meters and irrigation potentials are 15600 hectares. Total cultivable area due to this project is 14513 hectare; out of this 5096 hectare area was irrigated in 2012-13. This project provides water to 3649 hectares area of Osmanabad district; particularly Omerga and Lohara tehsils of Osmanabad districts are benefitted by this project.

B) Sina-Kolegaon Project:

It is constructed on river Sina near Domgaon village of Paranda tehsil. It was completed in 2007. Western Part of the Marathwada region, particularly Osmanabad District, is the most water scarce area. Therefore, Govt. of Maharashtra has proposed to transfer surplus water from Krishna sub basin and adjoining sub- basins.

Accordingly the Government of Maharashtra has proposed "Krishna Marathwada Irrigation project" for 23.66 TMC of surplus water available in Krishna, sub basin. Out of 23.66 TMC of water 17.98 TMC water is proposed to be utilized for Osmanabad District. The proposed project will enhance the income of the agriculture based activities and boost the social as well as economic conditions of the farmers. The proposed scheme intends to use 15.32 TMC of water from Ujani reservoir and 2.66 TMC water from free catchment of downstream of Sina Kolegaon Project.

The project provides irrigation water to Solapur and Osmanabad district. The maximum storage capacity of project is about 150.49 million cubic meters and irrigation potentials are 15546 hectares. Total cultivable area due to this project is 14110 hectare; out of this 8573 hectare area was irrigated in 2012-13. This project provides water to Paranda tehsil of Osmanabad district.

II) Medium Irrgation Project:

Medium irrigation project are those with culturable command areas between 2000 to 10000 hectares (Planning Commision of India, 1978-79). There are 18 medium projects in Osmanabad district. Table 2.16 also gives details of the medium irrigation projects. The all projects irrigate 5721 hectares during 2012-13 while the potential irrigated land was 37772 hectares. The water storage capacity of the said projects is 128.41 million cubic meters.

Table No. 2.16: Distribution of Medium Irrigation Project in Osmanabad District (As on 2013).

Sr. No.	Name of project	Year of comple-tion	Project Exp. In Rs.Lakh	Hei-ght in mts.	Len-gth of canal in kms.	Water stora-ge capa-city in M.C.M.	Irriga-tion potentials in hect.	Area under irriga-tion in 2012-13
1	Turori (Omerga)	1985	308.80	17.50	21.00	7.66	1250	60
2	Benitura (Omerga)	2000	202.60	13.38	44.00	12.84	2612	160
3	Jekekur(Omerga)	1977	175..95	14.80	22.51	10.17	1939	175
4	Rui (Osmanabad)	1994	910.36	11.75	29.00	8.94	2005	87
5	Terna (Osmanabad)	1994	259.09	15.08	33.00	11.00	2015	475
6	Wagholi(Osmanabad)	2009	1487.18	13.48	14.00	3.98	1942	85
7	Raigavhan (Kalam)	1992	95.00	13.23	19.70	12.70	2107	250
8	Khandala (Tuljapur)	1972	57.40	24.19	5.60	3.74	1205	212
9	Kurnur (Tuljapur)	1967	100.83	23.00	9.50	17.30	4117	829
10	Harni (Tuljapur)	1966	76.00	16.65	37.50	5.76	2112	504
11	Palsanile (Tuljapur)	1999	726.00	15.00	14.40	2.52	1040	124
12	Khandeshwar(Bhum)	1987	205.00	17.14	16.00	2.90	1815	317
13	Ramganga(Bhum)	1977	95.00	20.40	2.46	2.78	1217	252
14	Banganga(Bhum)	1975	51.06	18.82	3.50	2.69	1198	209
15	Sangmeshwar (Bhum)	1995	4404.61	15.22	43.00	8.76	3350	599
16	Sakat (Paranda)	1994	1664.00	14.77	24.50	3.21	2789	450
17	Chandani (Paranda)	1956	212.50	20.70	23.50	5.79	2470	193
18	Khasapur (Paranda)	1954	56.15	13.77	30.90	5.67	2589	740
	District	1954-2009	10911.58	16.60	394.07	128.41	37772	5721

Source :- District Socio- Economic Review and Statistical Abstract of Osmanabad 2013.

The table no. 2.17 indicates that the highest number of medium irrigation projects is situated in the tehsils of Bhum and Tuljapur i.e. 4 in each tehsil, as they are hilly tehsils and having favorable sites to develop medium irrigation project. The tehsils of Osmanabad, Paranda and Omerga have 3 medium irrigation projects in each tehsils whereas Kalam tehsil have one medium irrigation project. There is no single medium irrigation project in tehsils of Washi and Lohara. In Washi there is no any broad flow of drainage to develop site of medium irrigation project whereas Lohara is benefitted by the Lower Terna Major Project at Makni.

In 2013 district as a whole has 128.41million cubic meter water storage capacity by medium irrigation project. It varies from tehsil to tehsil. The low water storage capacity by medium irrigation project was found in Kalam, Bhum and Paranda tehsil i.e. < 19 million cubic meter. The medium water storage capacity was found in Osmanabad tehsil i.e. 19 to 25 million cubic meters where as the high water

storage capacity was found in Tuljapur and Omerga tehsils i.e. > 25 million cubic meters.

Table No. 2.17: The Number Of Medium Irrigation Project, Irrigation Potential and Area Under Irrigation in 2013

Sr.No.	Tehsil	No.of Medium Irrigation project	Length of canal in kms.	Water storage capacity in million C.M.	Irrigation potentials in hect.	Area under irrigation in 2012-13
1	Paranda	3	78.9	14.67	7848	1383
2	Bhum	4	64.96	17.13	7580	1377
3	Washi	0	0	0	0	0
4	Kalam	1	19.7	12.7	2107	250
5	Osmanabad	3	76	23.92	5962	647
6	Tuljapur	4	67	29.32	8474	1669
7	Lohara	0	0	0	0	0
8	Omerga	3	87.51	30.67	5801	395
	District	18	394.07	128.41	37772	5721

Source: Compiled by Researcher on the basis of Source: :- District Socio-Economic Review and Statistical Abstract of Osmanabad 2013.

In 2013 district as a whole has 394.07 kilometer total length of canals by medium irrigation project. It varies from tehsil to tehsil. The low length of canals by medium irrigation project was found only in Kalam tehsil i.e. 19.7 kilometer. The medium length of canals was found in Bhum tehsil i.e. 64.96 kilometer where as the high length of canals was found in Tuljapur, Osmanabad, Paranda and Omerga tehsils i.e. > 65 kilometer.

As on 2013, district as a whole has 37772 hectare irrigation potential. But tehsil level distribution is uneven. The low irrigation potential was observed in Kalam tehsil i.e. 2107 hectare area. It was medium in Osmanabad and Omerga tehsil i.e. 4229 to 6352 hectare area whereas it was high in the tehsils of Tuljapur, Paranda and Bhum i.e. > 6352 hectare.

In 2013 district as a whole has 5721 hectare area under irrigation by medium irrigation project. It varies from tehsil to tehsil. The low area under irrigation by medium irrigation project was found in Kalam, Osmanabad and Omerga tehsil i.e. < 723 hectare where as it is high in Bhum, Paranda and Tuljapur tehsils i.e. > 1196 hectare.

III) Minor Irrigation Projects:

An irrigation project which covers less than 2000 hectares as the culturable command area is called minor irrigation project (Planning Commision of India, 1978). It is observed from table no. 2.18 that district as a whole has 2040 minor irrigation work done through State, Zilla Parishad and local level as on 2013. The all minor

Table No.2.18: Distribution of Minor Irrigation Project, Irrigation Potential and Area Under Irrigation in 2013.

Sr.No.	Name of Tehsils	No.of minor projects				Irrigation potential in hectare	Area under irrigation in 2012-13
		State	Local level	Zilla Parishad	Total		
1	Paranda	3	123	158	284	9035	5024
2	Bhum	5	49	152	206	8247	5299
3	Washi	2	26	72	100	3455	1792
4	Kalam	6	57	228	291	11252	4133
5	Osmanabad	13	99	407	519	17517	13392
6	Tuljapur	14	150	225	389	12938	9958
7	Lohara	4	24	56	84	3281	1862
8	Omerga	7	34	126	167	4894	3565
	District	54	562	1424	2040	70619	45025

Source: Compiled by Researcher on the basis of Source: :- District Socio-Economic Review and Statistical Abstract of Osmanabad 2013.

irrigation projects irrigate 45025 hectares area during 2012-13 while the potential irrigated land was 70619 hectares. But spatial distribution of minor irrigation project varies from tehsil to tehsil. In 2013, the low number of irrigation work are found in Bhum, Omerga, Washi and Lohara tehsils i.e. <229. They are medium in Paranda and Kalam tehsils i.e. from 229 to 374, whereas they are high in Osmanabad and Tuljapur tehsils i.e. >374.

The table no. 2.18 indicates that in 2013 the low irrigated area by minor irrigation work is observed in Washi and Lohara tehsils i.e. < 2869 hectare. The medium irrigated area through minor irrigation work is found in Omerga tehsil i.e. 3565 hectare whereas it was high in Tuljapur, Osmanabad, Paranda, Bhum and Kalam tehsils i.e. > 3947 hectare.

In 2013 the low irrigation potential area was observed in Omerga, Washi and Lohara tehsils i.e. < 8026 hectare. The medium irrigation potential was found in

Bhum, Paranda and Kalam tehsils i.e. from 8026 to 12772 hectare whereas it was high in Tuljapur and Osmanabad tehsils i.e. > 12772 hectare.

Kolhapur Types Bandhare:

The Kolhapur types of Bandhare were introduced in the study region in 1989. Such type of bandhare helps to increase underground water table and results to increase the number of wells in the region.

The table no. 2.19 indicates that there are 1033 Kolhapur types of bandhare up to 2013 in the study the region. Out of these high percentage of KTB is found in Osmanabad tehsil i.e. 32.82 percent. The medium percentage of KTB is found in Kalam and Tuljapur tehsils i.e. from 13 to 23 percent, whereas it is low in Paranda, Bhum, Washi, Lohara and Omerga tehsils i.e. <13 percent.

The Table No. 2.19: Tehsilwise KTB and Percolation Tanks in Osmanabad District 2013.

Sr. No.	Tehsil	No. of KTB	% of KTB	No. of Percolation Tank	% of Percolation Tank	Density of Percolation Tank per 1000 hect
1	Paranda	54	5.23	187	14.20	2.70
2	Bhum	92	8.91	191	14.50	3.17
3	Washi	90	8.71	102	7.74	2.10
4	Kalam	138	13.36	194	14.73	2.40
5	Osmanabad	339	32.82	231	17.54	2.12
6	Tuljapur	177	17.13	276	20.96	2.51
7	Lohara	39	3.78	49	3.72	1.10
8	Omerga	104	10.07	87	6.61	1.09
	District	1033	100.00	1317	100.00	2.18

Source:- Compiled by Researcher on the basis of District Socio Economic Review & Statistical abstract of Osmanabad 2013.

Percolation Tanks:

It is an indirect irrigation project which helps to increase groundwater table in the study region. It causes to increase number of wells and bore wells in the district. Extent of command area of percolation tank is limited. It is 110 meter both side of nallah and maximum length of area is about 6.5 kms. from the tank or nala. The nearest percolation tanks are very useful for indirect irrigation in drought prone areas.

Table no. 2.19 indicates that the percolation tanks in 2013. District as a whole there are 1317 percolation tanks up to 2013. But the spatial distribution of these tanks varies from tehsil to tehsil. The high percentage of percolation tank is found in the tehsils of Tuljapur and Osmanabad i.e.>15 percent. The medium percentage of

percolation tanks is found in Paranda, Bhum and Kalam i.e. from 9 to 15 whereas it is low in Washi, Lohara and Omerga tehsils i.e. <9 percent.

Density of Percolation Tanks:

In 2013, district as a whole has 2.18 density of percolation tanks per 1000 hectare. It varies from tehsil to tehsil. The high density of percolation tanks is found in Tuljapur, Bhum and Paranda tehsils i.e. >2.5 tanks per 1000 hectare. It was high in Bhum and Tuljapur because as they are situated in rugged topography of Balaghat hilly region which give better site to percolation tanks. The moderate density of percolation tank was found in Washi, Kalam and Osmanabad tehsils i.e. 1.5 to 2.5 tanks per 1000 hectare, whereas it was low in Lohara and Omerga tehsils i.e. < 1.5 tanks per 1000 hectare.

Density of Irrigation Wells

Irrigation well is very vital, widespread, traditional means of irrigation (Phule B.R., 2015). In the study area wells are important for irrigation due to the paucity of other irrigation facilities and poor economic condition of farmer. The density of irrigation well is calculated by using following formula.

Density of well = (Total irrigation well ÷ Total net sown area) X 100 (Per 100 hectare)

The table 2.20 shows that during 2009-10 to 2013-14, the region as a whole has 9.02 density of irrigation wells per 100 hectare, but spatial distribution varies

Table no. 2.20 Tehsilwise Density of irrigation wells in Osmanabad District

Tehsil	1999-00 to 2003-04		2009-10 to 2013-14		1999-00 to 2003-04	2009-10 to 2013-14	Volume of Change
	No. of Wells	Net Sown Area	No. of Wells	Net Sown Area	Density per 100 hectors	Density per 100 hectors	
Paranda	6943	65248	8806	69381	10.64	12.69	2.05
Bhum	4785	60991	5490	60159	7.85	9.13	1.28
Washi	1933	51487	2531	48497	3.75	5.22	1.46
Kalam	5092	65351	10489	80756	7.79	12.99	5.20
Osmanabad	5141	101213	12293	109172	5.08	11.26	6.18
Tuljapur	4278	110442	7034	111032	3.87	6.34	2.46
Lohara	818	46444	1343	44367	1.76	3.03	1.27
Omerga	4788	73518	6427	79588	6.51	8.08	1.56
District	33778	574695	54413	602953	5.88	9.02	3.15

Source: Compiled by the Researcher on the basis of Socio-Economic Review and Statistical Abstract of Osmanabad District 1999-00 to 2003-04 & 2009-10 to 2013-14.

from tehsil to tehsil. The low density of wells is found in the tehsils of Tuljapur, Washi and Lohara i.e. below 6.5 per 100 hectare. It is moderate in Omerga and Bhum

tehsils i.e. 6.5 to 9.5, whereas it was high in Kalam, Paranda and Osmanabad tehsils i.e. > 9.5 per 100 hectares.

During the period of investigation well density is increased by 3.15 per 100 hectares. But spatial distribution varies ranging from 1.27 to 6.18. The high positive change is recorded in Osmanabad and Kalam tehsils i.e. above 5 wells per 100 hectares, while low positive change is found in Tuljapur, Paranda, Omerga, Washi, Bhum and Lohara tehsils i.e. below 3 well per 100 hectares.

Proportion of Surface and Well Irrigated Area to Net Sown area

I) Proportion of surface irrigated area to Net Sown Area:

The table no. 2.21 indicates that during the 1999-00 to 2003-04 the district as a whole has 1.93 percent surface irrigated area to net sown area. Their spatial distribution varies from tehsil to tehsil. The high proportion of surface irrigated area to net sown area was found in Bhum tehsils i.e. >3 percent due to high number of medium irrigation projects situated in the tehsil. It was medium in Paranda, Lohara and Kalam tehsils i.e. in between 2 to 3 percent, whereas it was low in Osmanabad, Tuljapur and Omerga tehsils i.e. <2 percent due to the decreasing of rainfall causes to low storage of water in medium irrigation project.

During the period 2009-2014, district as a whole has 0.95 percent surface irrigated area to net sown area. The spatial distribution varies from tehsil to tehsil. The high proportion of surface irrigated area to net sown area is observed only in Paranda tehsil i.e. 1.5 percent. It was high in Paranda tehsil due to Sina Kolegaon Irrigation project. The medium proportion of surface irrigated area to net sown area is found in Bhum and Kalam tehsils i.e. in between 1 to 1.5 percent whereas it was low in Osmanabad, Washi, Lohara, Tuljapur and Omerga tehsils i.e. < 1 percent due to the low rainfall. (Table no.2.21)

Table no. 2.21 indicates that during the period under review, surface irrigated area to net sown area is decreased by 0.98 per cent. All tehsils shows negative change in surface irrigated area to net sown area due to scarcity of rainfall. The high negative change is recorded in Bhum and Washi tehsils i.e. above 2 per cent. The moderate negative change is recorded in Kalam and Lohara tehsils i.e. 1 to 2 percent, while low negative change is found in Osmanabad, Omerga, Paranda and Tuljapur tehsils i.e. below 1 percent.

Table no. 2.21: Proportion of surface & well irrigated area to Net Sown Area area in District 1999-00 to 2003-04 & 2009-10 to 2013-14.

Sr.No.	Tehsil	1999-00 to 2003-04			2009-10 to 2013-14			Volume of change in %	
		Surface irriga-tion	Well irri- gation	Net Sown area	Surface irriga-tion	Well irriga- tion	Net Sown area	Surface irriga-tion	Well irrigation
1	Osmanabad	980	12963	101213	889	25999	109172	-0.15	11.01
	%	0.97	12.81	13.78	0.81	23.81	24.63		
2	Kalam	1565	10410	65351	1102	5858	80756	-1.03	-8.68
	%	2.39	15.93	18.32	1.36	7.25	8.62		
3	Omerga	850	14399	73518	710	20941	79588	-0.26	6.73
	%	1.16	19.59	20.74	0.89	26.31	27.20		
4	Tuljapur	1765	12707	110442	807	28826	111032	-0.87	14.46
	%	1.60	11.51	13.10	0.73	25.96	26.69		
5	Paranda	1313	9756	65248	1184	18995	69381	-0.31	12.43
	%	2.01	14.95	16.96	1.71	27.38	29.08		
6	Bhum	2204	9588	60991	618	8244	60159	-2.59	-2.02
	%	3.61	15.72	19.33	1.03	13.70	14.73		
7	Washi	1220	6249	51487	148	4285	48497	-2.06	-3.30
	%	2.37	12.14	14.51	0.31	8.84	9.14		
8	Lohara	1065	6646	46444	278	4484	44367	-1.67	-4.20
	%	2.29	14.31	16.60	0.63	10.11	10.73		
	District	11072	82717	574695	5736	117632	602953	-0.98	5.12
	%	1.93	14.39	16.32	0.95	19.51	20.46		

Source: - Compiled by Researcher on the basis of District Socioeconomic Review & District Statistical abstract of Osmanabad District 1999-2013-14

II) Proportion of Well Irrigated area to Net Sown area:

The table no. 2.21 shows that during the 1999-00 to 2003-04 the district as a whole has 14.39 percent well irrigated area to net sown area. The spatial distribution of well irrigated area to net sown area varies from tehsil to tehsil. The high proportion of well irrigated area to net sown area was found in Omerga tehsil i.e. 19.59 percent. The medium proportion of well irrigated area to net sown area was found in Kalam, Paranda, Bhum and Lohara tehsils i.e. in between 14 to 17 percent, whereas it was low in Osmanabad, Tuljapur and Washi tehsils i.e. <14 percent (Table no.2.21).

During the period 2009-10 to 2013-14, district as a whole has 19.51 percent well irrigated area to net sown area. The spatial distribution varies from tehsil to

tehsil. The high proportion of well irrigated area to net sown area is observed in Osmanabad, Omerga, Tuljapur and Paranda tehsils i.e. > 18 percent. The medium proportion of well irrigated area to net sown area was found only in Bhum tehsil i.e. 13.7 percent, whereas it was low in Kalam, Washi and Lohara tehsils i.e. < 13 percent.

Table no. 2.21 indicates that during the period of investigation, well irrigated area to net sown area is increased by 5.12 per cent. But the spatial analysis varies from tehsil to tehsil. Both positive as well as negative changes have been occurred in proportion of well irrigated area to net sown area. The high positive change is recorded in Paranda and Tuljapur tehsils i.e. above 12 per cent. The moderate positive change is recorded only in Osmanabad tehsil i.e. 11.01 percent, while low positive change is found only in Omerga tehsil i.e. 6.73 percent. The high negative change is recorded only in Kalam tehsil i.e. 8.68 per cent, whereas the low negative change is found in Lohara, Bhum and Washi tehsils i.e. < 4.24 percent.

Intensity of Irrigation:

The intensity of irrigation expresses man's dynamic attempts to overcome the environmental limitations in the transformation of many barren areas in to the agricultural areas. It is controlled by various factors such as source of irrigation, quantity and quality of water supply, intensity of network of water channels etc. the benefits of intense irrigation are reflected in the cropping patterns, land use efficiency and method of cultivation (Singh Jasbir and Dhillon S.S, 1987). The intensity of irrigation is calculated by using the following formula.

$$\text{Intensity of Irrigation} = \frac{\text{Net irrigated area of 'X' region}}{\text{Net Sown area of 'X' region}} \text{ X } 100$$

The table no. 2.22 indicates that during the 1999-00 to 2003-04, district as a whole has 16.32 percent of intensity of irrigation. But spatial distribution varies from tehsil to tehsil. The high intensity of irrigation was found in Kalam, Bhum and Omerga tehsils i.e. >18 percent. The medium intensity of irrigation was found in tehsils of Paranda and Lohara i.e. 16 to 18 percent, whereas it was low in Osmanabad, Tuljapur and Washi tehsils i.e. <16 percent.

Table No.2.22: Intensity of Irrigation in Osmanabad District 1999-2014

Sr.No.	Tehsil	1999-04	2009-14	Volume of change in %
		Intensity of Irrigation	Intensity of Irrigation	
1	Osmanabad	13.78	24.63	10.85
2	Kalam	18.32	8.62	-9.70
3	Omerga	20.74	27.20	6.46
4	Tuljapur	13.10	26.69	13.59
5	Paranda	16.96	29.08	12.12
6	Bhum	19.33	15.73	-4.60
7	Washi	14.51	9.14	-5.36
8	Lohara	16.60	10.73	-5.87
	District	16.32	20.46	4.14

Source: Compiled by Researcher

During the 2009-10 to 2013-14, district as a whole has 20.46 percent intensity of irrigation. The high intensity of irrigation was found in Paranda, Osmanabad,Tuljapur and Omerga tehsils i.e. > 22 percent. In Paranda and Omerga tehsils it was very high because tehsils benifited from Sina Kolegaon Project and Nimn Terna Project at Makhni respectively, in Osmanabad tehsil it is high due to Terna medium project, where as it is high in Tuljapur due to high concentration of medium irrigation project. The medium intensity of irrigation was found in Bhum tehsil i.e. 15.73 percent, whereas it was low in Lohara, Washi and Kalam tehsils i.e. <15 percent.

During the period of investigation, district as a whole has 4.14 percent positive change in intensity of irrigation. The table no. 2.22 indicates that the high positive change is observed in tehsils of Osmanabad, Tuljapur and Paranda i.e. >10 percent, whereas low positive change is observed in Omerga tehsil i.e. < 10 percent. The high negative change is found in Kalam tehsil i.e. >10 percent due to the scarcity of rainfall in recent year leads to low storage of water in Raigavhan medium irrigation project and Manjara major irrigation project. Low negative change was observed in Bhum, Washi and Lohara tehsil i.e. <10 percent.

2.12 AGRICULTURAL IMPLEMENTS:

Agricultural implements help the farmers to increase crop production and reduce labor force. It brings under the cultivation of land which could not be previously cultivated for technical reasons. Relief features, edaphic and climatic conditions largely controls the use of agricultural implement and machinery in an

area. Economic condition and social differences of farmers also determine the choice and use of agricultural implements (Jasbir Singh & S.S. Dhillon, 1987). Therefore attempt is made here to analyse agricultural implements namely; plough, bullock cart, oil engines, electric pumps and tractors etc.

2.12.1 DENSITY OF AGRICULTURAL IMPLEMENTS:

Density of agricultural implements is calculated simply to number each agricultural implements divided by net sown area.

Wooden Plough:

As per 2012 livestock census, density of wooden plough was 1.27 per hundred hectare net sown area in the study region. But spatial distribution varies from tehsil to tehsil ranging from 0.77 to 1.90 per hundred hectare net sown area. The low density of wooden plough is found in Bhum, Kalam and Paranda tehsils i.e. <1.14 per hundred hectare net sown area, whereas it was high in Omerga, Tuljapur and Lohara tehsils i.e. > 1.52 per hundred hectare net sown area (Table no. 2.23 A).

During the period of investigation, negative changes in wooden plough density were observed in all the tehsils of Osmanabad district. District as a whole has negative change in wooden plough density i.e. 0.70 per hundred hectare net sown area. But it varies from tehsil to tehsil. The high negative change in wooden plough density was observed in Bhum and Paranda tehsils i.e. > 1.00 per hundred hectare net sown area due to increase in iron plough, whereas it was low in Lohara and Washi tehsils i.e. < 0.50 per 100 hectare net sown area.

Iron Plough:

As per livestock Census 2012, density of iron plough is 5.16 per hundred hectare net sown area. But spatial distribution varies from tehsil to tehsil. The low density is found in Omerga, Washi and Lohara tehsils i.e. < 4 per hundred hectare net sown area. It is medium in Kalam tehsil i.e. 4.88 per hundred hectare net sown area, whereas it is high in Bhum, Paranda, Osmanabad and Tuljapur tehsils i.e. > 5 per hundred hectare net sown area.

Table no. 2.23 B exhibits that during the period of investigation, positive changes in density of iron plough are observed in all the tehsils of Osmanabad district. District as a whole has positive change i.e. 2.39 density of iron plough per hundred hectare net sown area. But it varies from tehsil to tehsil. The high positive change in density of iron plough is observed in Bhum and Paranda tehsils i.e. > 4 per hundred hectare net sown area. It is moderate in Osmanaba and Tuljapur tehsils i.e. ranging

Table No. 2.23 A: Density of Agricultural Implements in Osmanabad District during (2002 and 2012).

Year	2002 Density per 100 hect.						2012 Density per 100 hect.					
Tehsils/ Implements	Wooden Plough	Iron Plough	Bullock Cart	Oil Engines	Electric Pumps	Tractors	Wooden Plough	Iron Plough	Bullock Cart	Oil Engines	Electric Pumps	Tractors
Paranda	2.05	2.12	3.49	0.54	4.75	0.40	0.77	6.58	1.48	0.22	11.38	0.83
Bhum	2.16	1.53	4.91	0.79	4.30	0.17	1.06	6.91	4.31	0.42	12.52	0.37
Washi	1.72	2.70	5.14	0.38	3.55	0.21	1.32	3.23	4.72	0.26	4.37	0.40
Kalam	1.65	4.50	7.47	0.18	6.75	0.30	0.82	4.88	5.62	0.13	10.39	0.40
Osmanabad	1.87	2.34	5.57	0.46	4.60	0.27	1.15	5.99	2.66	0.35	7.99	0.78
Tuljapur	2.15	3.06	4.65	0.41	5.44	0.24	1.68	5.82	2.03	0.31	6.78	0.73
Lohara	1.95	2.15	5.29	0.48	6.84	0.25	1.90	2.83	4.93	0.44	10.01	0.39
Omerga	2.09	2.79	5.68	0.52	5.97	0.27	1.54	3.29	4.99	0.21	12.37	0.50
District	1.97	2.77	5.09	0.47	5.25	0.27	1.27	5.16	3.61	0.29	9.37	0.42

Source: Compiled by Researcher on the basis of Livestock Census Data 2002 & 2012

from 2 to 4 per hundred hectare net sown area, where as it is low in Lohara, Washi, Omerga and Kalam tehsils i.e. < 2 per hundred hectare net sown area.

Bullock Cart:

In 2012, density of bullock cart is 3.61 per hundred hectare net sown area. But spatial distribution varies from tehsil to tehsil. The low density of Bullock Carts is found in Osmanabad, Tuljapur and Paranda tehsils i.e. < 3.0 per hundred hectare net sown area due to increase in number of tractors in these tehsil. It is moderate only in

Table No.2.23 B: Volume of Change in Agricultural Implements in Osmanabad District during 1999-00 to 2013-14.

Tehsil	Agricultural Implements					
	Wooden Plough	Iron Plough	Bullock Cart	Oil Engines	Electric Pumps	Tractors
Paranda	-1.28	4.47	-2.01	-0.32	6.62	0.42
Bhum	-1.11	5.38	-0.59	-0.36	8.23	0.21
Washi	-0.41	0.53	-0.43	-0.12	0.82	0.18
Kalam	-0.83	0.38	-1.85	-0.04	3.65	0.10
Osmanabad	-0.72	3.65	-2.90	-0.11	3.38	0.51
Tuljapur	-0.47	2.76	-2.62	-0.11	1.34	0.49
Lohara	-0.05	0.68	-0.37	-0.05	3.17	0.14
Omerga	-0.55	0.50	-0.69	-0.31	6.40	0.23
District	-0.70	2.39	-1.48	-0.18	4.11	0.15

Source: Compiled by Researcher on the basis of Socio-economic Review and Statistical Abstract of Osmanabad District 1999-04 & 2009-14.

Bhum tehsils i.e. 4.31 per hundred hectare net sown areas, whereas it is high in Kalam,Omerga, Lohara and Washi tehsils i.e. > 4.5 per hundred hectare net sown area.

During the period of investigation, negative changes in density of bullock cart were observed in all the tehsils of Osmanabad district. District as a whole has negative change i.e. 1.48 per hundred hectare net sown area. But it varies from tehsil to tehsil. The high negative change in density of bullock cart was observed in Tuljapur and Osmanabad tehsil i.e. > 2 per hundred hectare net sown area due to increase in number of tractors and tempo. The moderate negative change was observed in Paranda and Kalam tehsil i.e. Kalam tehsil i.e. 1 to 2 per hundred net sown area, whereas it was low in Lohara, Washi and Bhum tehsils i.e. < 1.00 per hundred hectare net sown area.

Oil Engines Pumps:

As per livestock census 2012, density of oil engine was 0.29 per hundred hectare net sown area. But spatial distribution of varies from tehsil to tehsil. The low density of Oil Engines was found in Omerga, Kalam and Paranda tehsils i.e. <0.23 per hundred hectare net sown area. The medium density of Oil Engines is found in Washi and Tuljapur tehsils i.e. > 0.23 to 0.33 per hundred hectare net sown area, whereas it was high in Osmanabad, Bhum and Lohara tehsil i.e. >0.33 per hundred hectare net sown area.

Table no. 2.23 B indicates that during the period of investigation, district as a whole has 0.18 negative change in density of oil engine pumps per hundred hectare

net sown area. But it varies from tehsil to tehsil. All the tehsils of Osmanabad district shows negative changes in density of oil engine pumps. The high negative change in density of oil engines was observed in Omerga, Paranda and Bhum tehsils i.e. >0.26 per hundred hectare net sown area due to development of electricity, whereas it was low in Kalam, Lohara, Tuljapur, Osmanabad and Washi tehsils i.e. < 0.15 per hundred hectare net sown area.

Electric Pumps:

Table no. 2.23 A indicates that, density of electric pumps is 9.37 per hundred hectare net sown area in 2012. But spatial distribution is uneven from tehsil to tehsil. The low density of electric pumps is found in Tuljapur and Washi tehsils i.e. < 7 per hundred hectare net sown area. The medium density of Electric pumps is found only in Osmanabad tehsils i.e. 7.99 per hundred hectare net sown area, whereas it was high in Bhum, Omerga, Paranda, Kalam and Lohara tehsils i.e. > 10 per hundred hectare net sown area and causes is same as mention earlier.

During the period under review, all tehsils of the district shows positive changes in density of electric pumps. District as a whole has 4.11 percent positive change in density of electric pump per hundred hectare net sown area. But tehsil level analysis varies from tehsil to tehsil. The high positive change in density of electric pumps is observed in Bhum, Paranda and Omerga tehsils i.e. > 6 per hundred hectare net sown area. The medium positive change was observed in Kalam, Osmanabad and Lohara tehsils i.e. 3 to 6 per hundred hectare net sown area, whereas it was low in Tuljapur and Washi tehsils i.e. < 3 per hundred hectare net sown area.

Tractors:

During 2012, density of tractors is 0.42 per hundred hectare net sown area. But spatial distribution varies from tehsil to tehsil. The low density of tractors is found in Omerga, Kalam, Washi, Lohara and Bhum tehsils i.e. <0.52 per hundred hectare net sown area, whereas it was high in Tuljapur, Osmanabad and Paranda tehsils i.e. >0.68 per hundred net sown area.

Table no. 2.23 B indicates that during the period of investigation, district as a whole has 0.15 positive change in density of tractors per hundred hectare net sown area. All the tehsils of Osmanabad district shows positive changes in density of tractors. But spatial distribution varies from tehsil to tehsil. The high positive change in density of tractors is observed in Osmanabad, Tuljapur and Paranda tehsils i.e.

>0.37 per hundred hectare net sown area, whereas it is low in Omerga, Bhum, Washi, Lohara and Kalam tehsils i.e. < 0.24 per hundred hectare net sown area.

2.13 CHEMICAL FERTILIZERS:

Nutrients are very essential in soil for plant growth especially for cash crops. Balanced fertilization and soil fertility are factors, which affect crop yield and nitrogen use, that a farmer can control (Cassman et al., 2002). The significance of nutrient interactions increase as agriculture becomes more intensive, and that interaction between two or more nutrients can be positive or negative. A deficiency of any one of the other 16 essential plant nutrients can affect the absorption and function of nitrogen and reduce nitrogen use efficiency (Aulakh M.S and Mahli S.S., 2004). So attempt is made here, to analyze the use of chemical fertilizers in Osmanabad tehsil.

During 2009-10 to 2013-14, there were 94946 MT chemical fertilizers used in the district. The use of chemical fertilizer is low (< 10396 MT) in Paranda, Washi and Lohara tehsils i.e < 11 percent. The medium use of chemical fertilizer is found (10396 to 14970 MT) in Kalam, Bhum and Omerga tehsils i.e 11 to 16 percent whereas, use of chemical fertilizers is high (> 14970 MT) in Osmanabad and Tuljapur i.e. >16 percent due to development of irrigation facilities (Table no. 2.24).

Table No.2.24: Tehsilwise Consumption & Per Hectare Use of Chemical Fertilizers 1999-00 to 2003-04 & 2009-10 to 2013-14.

Sr. No.	Tehsils	1999-00 to 2003-04			2009-10 to 2013-14		
		Consum-ption in MT.	Consum-ption in %	Per Hect. Use (in kg.)	Consum-ption in MT.	Consum-ption in %	Per Hect. Use (in kg.)
1	Paranda	5947	11.38	91.14	9840	10.36	141.83
2	Bhum	6471	12.38	106.10	10780	11.35	179.19
3	Washi	3654	6.99	70.97	6820	7.18	140.63
4	Kalam	7954	15.22	121.71	14701	15.48	182.04
5	Osmanabad	10338	19.78	102.14	19543	20.58	179.01
6	Tuljapur	8212	15.71	74.36	16660	17.55	150.05
7	Lohara	3355	6.42	72.24	5822	6.13	131.22
8	Omerga	6346	12.14	86.32	10780	11.35	135.45
	District	52277	100.00	90.96	94946	100.00	157.47

Source:- Compiled by Researcher on the basis of District Socio Economic Review & statistical abstract of Osmanabad 2013.

Table no 2.24 also indicates that during the period of investigation, per hectare use of chemical fertilizers is increased year by year. In 1999-00 to 2003-04, district as a whole use of chemical fertilizers was 90.96 kg/ hectare. It varies from tehsil to tehsil. The high per hectare consumption of chemical fertilizers observed in Kalam and Bhum tehsils i.e. > 105 kg/hectare. The medium per hectare use of chemical fertilizer is found in Paranda and Osmanabad tehsils i.e. 88 to 105 Kg/hectare whereas, it was low in Washi, Lohara, Omerga and Tuljapur tehsils i.e. < 88 kg/hectare.

During 2009-10 to 2013-14, district as a whole has 157.47 kg/per hectare use of chemical fertilizer but spatial distribution varies from tehsil to tehsil. The high per hectare use of chemical fertilizer is found in Bhum, Kalam and Osmanabad tehsils i.e. > 165 kg/hectare. It is high in Bhum due to development of irrigation facilities by medium irrigation project and in Kalam and Osmanabad due to development of minor irrigation facilities. The medium per hectare use of chemical fertilizer is recorded in Tuljapur tehsil i.e. 150 kg/hectare whereas it is low in Paranda, Washi, Lohara and Omerga tehsils i.e. < 148 kg/hectare.

2.14 SOCIO-CULTURAL FACTORS:

Agricultural development is not only depending on the modern techniques and agricultural requisites but also depend on cultural and social factors. The size of holdings and the size of farm decide the degree of risk that a farm operator may bear. In general, larger the size of the farm, greater the capacity of the farmer to take the risk and vice versa (Majid Hussain, 1996).An operational holding is defined as “all land which is used wholly or partly for Agriculture production and is operated as one Technical Unit by one person alone or with others without regard to title, legal form size or location”. It is the operational holding which is the fundamental unit of decision making in agriculture and consequently for development programmes aimed at improving the condition of the individual cultivators and also the production. According to major size-groups of operational holdings, viz., marginal (below 1 ha.), small (1- 1.99 ha.), semi-medium (2- 3.99 ha.), medium (4- 9.99 ha.) and large (10 ha. and above), for getting an insight into the consumption pattern of inputs by various categories of farmers (http://agcensus.nic.in/). This information is vital for planning the production, imports and distribution of fertilizers.

Operational Holding by Size Class:

The table no. 2.25 also indicates that during the year 2010-11, the total number of holdings in all the classes of size in the study region was 356579. Out of these, 31.18 percent holding was marginal farmers (less than 1 hectare in size) and covers only 9.57 percent of the cultivated area. The percent of small farmers (i.e. 1 to 2 hectare in size) was 36.46 percent and covers 26.92 percent of the cultivated area, 22.49 percent holding were semi medium (i.e. 2 to 4 hectare in size) and covers 31.09 percent of the area, 9.09 percent holding were medium farmers (i.e. 4 to 10 hectares in size) and covers 26.56 percent of the cultivated area, whereas 0.78 percent holding were large farmers (10-20 and more than 20 hectare in size) and covers 5.87 percent of the cultivated area.

During the period of investigation, considerable change in percentage of number of holding and in percentage of area in different size of farm occurred in study region from 2000-01 to 2010-11. The number of holding having less than 1 hectare in size (i.e. marginal farmers) is increased by 5.74 percent. The number of holding having 1 to 2 hectare in size (i.e. small farmers) is also increased by 2.17 percent. The number of holdings having 2 to 4 hectare (i.e. semi-medium farmers) decreased by 3.76 percent, the number of holding of medium farmers (i.e. 4 to 10

Table No.2.25: Number and Area of Operational Holding by Size class 2000-01 & 2010-11.

Sr. No	Size of Holding (in Ha.)	2000-01				2010-11				Volume Change in %	
		Number	% of holding	Area	%of Area	Number	% of holding	Area	%of Area	% of holding	%of Area
1	Marginal Below 1	74185	25.45	41966	6.44	111194	31.18	66338	9.57	5.74	3.13
2	Small 1-2	99966	34.29	133354	20.47	130022	36.46	186696	26.92	2.17	6.46
3	Semi-medium 2-4	76538	26.25	200803	30.82	80191	22.49	215585	31.09	-3.76	0.27
4	Medium 4-10	37104	12.73	211310	32.43	32406	9.09	184176	26.56	-3.64	-5.87
5	Large 10-20 & Above	3740	1.28	64182	9.85	2766	0.78	40721	5.87	-0.51	-3.98
6	All Classes	291533	100	651615	100	356579	100	693516	100	0.00	0.00

Source:- Compiled by Researcher on the basis of Agricultural Census, 2000-01 & 2010- 2011.

hectare in size) was decreased by 3.64 percent whereas the number of holding of large farmers (i.e. 10 to 20 and above hectare size class) decreased by 0.51 percent.

Taken into consideration the cultivated area in size class, 3.13 percent increase in cultivated area was observed in below 1 hectare class (i.e. marginal farmers), 6.46 percent increase in cultivated area is found in 1 to 2 hectare size class (i.e. small farmers), 0.27 percent increase in cultivated area is found in 2 to 4 hectare size class (i.e. semi-medium farmers). On the other hand, 5.87 percent decrease is observed in cultivated area of 4 to 10 hectare size class (i.e. medium farmers). Cultivated area is decreased by 3.98 percent in 10 to 20 and above hectare size class (i.e. large farmers) from 2000-01 to 2010-11.

2.15 FARM WORKERS:

The term farm worker includes cultivators and agricultural laborers. Attempt is made here, to analyze percentage of farm workers to total workers in Osmanabad district during the period from 2001 to 2011.

2.15.1 Cultivators:

The table no. 2.26 exhibits that the share of cultivators was 34.07 percent of total working population in the district during 2011. But spatial distribution varies from tehsil to tehsil. The low percentage of cultivators were found in Osmanabad, Tuljapur, Lohara and Omerga tehsils i.e. <35 percent, whereas they were high in Paranda, Bhum, Kalam and Washi tehsils i.e.>43 percent of total working population. Very low concentration of cultivators is found in Osmanabad tehsil due to the effect of Osmanabad city. In this urban area most of the working population is engaged in secondary and tertiary activities. The high concentration of cultivators were found in north- western part of the study region, particularly Paranda, Bhum and Washi tehsils due to the less development of secondary and tertiary activities.

During the period under observation district as a whole has 2.72 percent negative change in cultivators to total workers. But spatial distribution in change in cultivators varies from tehsil to tehsil. Both positive as well as negative change is observed. The high positive change of 3.88 percent was observed in Paranda tehsil due to bifurcation of families in last decade, whereas the low positive change of 1.06 percent was observed in Washi tehsil during 2001 to 2011. The high negative change was observed in Osmanabad and Lohara tehsils i.e > 3.5 percent. In Osmanabad tehsil it is high negative due to the development of secondary and tertiary activities in urban area. The low negative change was observed only in Bhum tehsil i.e. 0.85 percent.

Table No.2.26: Percentage of Farmworkers to Total workers in Osmanabad district 2001 & 2011.

Sr.No.	Tehsil	Year	Total Workers	Cultivaters	% to total workers	Agricul-tural Labourers	% to total workers	Total CL+AL	% to Tot. Workers
1	Paranda	2001	64603	29141	45.11	18747	29.02	47933	74.20
		2011	79923	39154	48.99	24624	30.81	63778	79.80
	Volume change		15320	10013	3.88	5877	1.79	15845	5.60
2	Bhum	2001	55511	27701	49.90	18211	32.81	45962	82.80
		2011	78517	38513	49.05	24000	30.57	62513	79.62
	Volume change		23006	10812	-0.85	5789	-2.24	16551	-3.18
3	Washi	2001	48962	24467	49.97	16746	34.20	41263	84.28
		2011	50930	25990	51.03	17889	35.12	43879	86.16
	Volume change		1968	1523	1.06	1143	0.92	2616	1.88
4	Kalam	2001	85801	40333	47.01	29954	34.91	70334	81.97
		2011	115913	50931	43.94	37746	32.56	88677	76.50
	Volume change		30112	10598	-3.07	7792	-2.35	18343	-5.47
5	Osmanabad	2001	149583	48030	32.11	58576	39.16	106638	71.29
		2011	214744	57674	26.86	71760	33.42	129434	60.27
	Volume change		65161	9644	-5.25	13184	-5.74	22796	-11.02
6	Tuljapur	2001	105345	33986	32.26	45386	43.08	79404	75.38
		2011	137880	40156	29.12	51916	37.65	92072	66.78
	Volume change		32535	6170	-3.14	6530	-5.43	12668	-8.60
7	Lohara	2001	47128	16403	34.81	23894	50.70	40332	85.58
		2011	54239	16470	30.37	26352	48.58	42822	78.95
	Volume change		7111	67	-4.44	2458	-2.12	2490	-6.63
8	Omerga	2001	96589	29141	30.17	45611	47.22	74782	77.42
		2011	120423	33018	27.42	55099	45.75	88117	73.17
	Volume change		23834	3877	-2.75	9488	-1.47	13335	-4.25
	Total District	2001	567721	208869	36.79	227171	40.01	436077	76.81
		2011	736656	250975	34.07	271640	36.87	522615	70.94
	Volume change		168935	42106	-2.72	44469	-3.14	86538	-5.87

Source: - Compiled by Researcher on the basis of Census of India.

2.15.2 Agricultural Labors:

The availability of labor is also major constraint in the agricultural productivity, land use and cropping patterns of a region. Labor represents all human services other than decision making and capital. The requirement of labor force varies in different season with the agricultural operation in the study region.

The table no. 2.26 indicates that the share of agricultural labors was 36.87 percent of total working population in the district during 2011. But spatial distribution varies from tehsil to tehsil. The low percentage of agricultural labors is found in Bhum, Paranda, Washi, Kalam and Osmanabad tehsils i.e. < 36.5 percent, whereas high percentage is found in Lohara and Omerga tehsils i.e. > 42.5 percent of total working population.

During the period of investigation, the table no. 2.27 shows both positive and negative changes in the percentage of agricultural labors to total workers. District as a whole has 3.14 percent negative change. The high positive change of 1.79 percent was observed only in Paranda tehsil, whereas low positive change of 0.92 percent was observed only in Washi tehsil. The high negative change in agricultural laboures is observed in Osmanabad andTuljapur tehsils i.e. >5 percent because Osmanabad is district headquarter and Tuljapur is famous religious tourist center, whereas low negative changes in agricultural laboures is found in Bhum, Kalam, Lohara and Omerga tehsils i.e. < 3 percent (Table no. 2.26).

2.16 LIVESTOCK:

Human and animal constitute the main source of power for the farms. Livestock are the part of our farming society. Livestock are the keystone in our farming as they are the chief source of power and manure. The entire field operation from ploughing to the harvesting of crops is carried out by the draught animals mainly bullocks, male and female buffaloes and they are chief source of power and manure (Kaysthan A.L, 1961). Livestock is an important source of supplementary income. Mixed farming has been serving as an insurance against natural calamities, while supporting food security and nutrient recycling (Pawar S.E. et.al. 2010). Dairy farming, which helps farmers economically depends on livestock, therefore an attempt is made here to analyse livestock distributional pattern and changes therein.

The number of different classes of livestock in Osmanabad district derived from agricultural and livestock census (2003 & 2012) are classified into broad five classes i.e. cattle, buffaloes, sheep, goat and other livestock.

2.16.1 Tehsilwise Distribution of livestock:

Cattle:

This group includes all types of cow and bullocks and young stock, cattle ranks second next to goat. The table no.2.27 shows that proportion of cattle 46.10

Table No.2.27: Tehsilwise Distribution of Livestck: According to Livestock Census livestock in the district during 1997 & 2007.

Sr. No.	Tehsil	Year & %	Cattle	Buffalloes	Sheep	Goat	Other Livestocks	Total Livestocks	Total Poultry
1	Paranda	2002	51232	10758	8815	44924	8887	124616	73314
		%	41.11	8.63	7.07	36.05	7.13	100.00	13.11
		2012	40289	9208	6083	35775	1157	92512	51402
		%	43.55	9.95	6.58	38.67	1.25	100.00	21.48
		V.C.%	2.44	1.32	-0.50	2.62	-5.88	0.00	8.36
2	Bhum	2002	52062	10756	3933	35027	5831	107609	68999
		%	48.38	10.00	3.65	32.55	5.42	100.00	12.34
		2012	54398	12515	5185	25333	1399	98830	33500
		%	55.04	12.66	5.25	25.63	1.42	100.00	14.00
		V.C.%	6.66	2.67	1.59	-6.92	-4.00	0.00	1.65
3	Washi	2002	*	*	*	*	*	*	*
		%							
		2012	34452	10000	2796	15771	62	63081	11333
		%	54.62	15.85	4.43	25.00	0.10	100.00	4.74
		V.C.%	54.62	15.85	4.43	25.00	0.10	100.00	4.74
4	Kalam	2002	64599	18410	6183	36387	8999	134578	41819
		%	48.00	13.68	4.59	27.04	6.69	100.00	7.48
		2012	59821	18285	3924	26552	740	109322	30143
		%	54.72	16.73	3.59	24.29	0.68	100.00	12.59
		V.C.%	6.72	3.05	-1.00	-2.75	-6.01	0.00	5.11
5	Osmana-bad	2002	66187	27695	6355	50806	12381	163424	64509
		%	40.50	16.95	3.89	31.09	7.58	100.00	11.54
		2012	75775	40280	2426	39228	5308	163017	42528
		%	46.48	24.71	1.49	24.06	3.26	100.00	17.77
		V.C.%	5.98	7.76	-2.40	-7.02	-4.32	0.00	6.23
6	Tuljapur	2002	73090	42179	14886	72853	13126	216134	78916
		%	33.82	19.52	6.89	33.71	6.07	100.00	14.12
		2012	48591	37767	7098	47198	3891	144545	52985
		%	33.62	26.13	4.91	32.65	2.69	100.00	22.14
		V.C.%	-0.20	6.61	-1.98	-1.05	-3.38	0.00	8.02
7	Lohara	2002	*	*	*	*	*	*	*
		%							
		2012	20919	14622	5296	11608	116	52561	8864
		%	39.799	27.819	10.08	22.085	0.221	100.000	3.704
		V.C.%	39.80	27.82	10.08	22.08	0.22	100.00	3.70
8	Omerga	2002	71718	37677	14746	49784	14118	188043	231474
		%	38.14	20.04	7.84	26.47	7.51	100.00	41.41
		2012	39694	25097	4899	16803	815	87308	8580
		%	45.46	28.75	5.61	19.25	0.93	100.00	3.58
		V.C.%	7.33	8.71	-2.23	-7.23	-6.57	0.00	-37.82
	Total District	2002	378888	147475	54918	289781	63342	934404	559031
		%	40.55	15.78	5.88	31.01	6.78	100.00	100.00
		2012	373939	167774	37707	218268	13488	811176	239335
		%	46.10	20.68	4.65	26.91	1.66	100.00	100.00

Source:- Compiled by Researcher on the basis of District Socio Economic Review & Statistical Abstract of Osmanabad 1999-00 & 2013-14.

percent of the total livestock in the district during 2012. The proportion of cattle is low in Tuljapur and Lohara tehsil i.e. < 41 percent, whereas it is high in Bhum Washi and Kalam tehsils i.e. > 48 percent because natural grasses grow luxuriously in these tehsil.

During the period under review, the district as a whole has 5.65 percent positive change in proportion of cattle. The share of cattle was increased in the entire study region except Tuljapur tehsil. The high positive change was observed in Bhum, Kalam and Omerga tehsil i.e. > 6 percent due to development of dairy farming. The low positive change was found in Osmanabad and Paranda tehsil i.e. < 6 percent. The negligible negative change in cattle i.e. 0.20 percent was found in Tuljapur tehsil.

Buffaloes:

Table no.2.27 indicates that the proportion of Bufalloes was 20.68 percent of the total livestock in the district during 2012. The proportion of buffaloes is low in Paranda, Washi and Bhum tehsils i.e. < 16 percent, whereas it is high in Osmanabad, Tuljapur, Lohara and Omerga tehsils i.e. > 22 percent. In Osmanabad and Tuljapur tehsils it is high due to market of urban and tourist center while it is high in Lohara and Omerga because the farmers in these tehsils economically depends on dairy farming as secondary occupation.

During the period under review, the district as a whole has 4.9 percent positive change in buffaloes. The share of buffaloes was increased in the entire study region. The low positive change in buffaloes i.e. <4 percent was observed in Paranda, Bhum and Kalam tehsils, whereas the high positive change was observed in Osmanabad, Tuljapur and Omerga tehsil i.e. >6 percent due to growth of urbanization (Table no. 2.27).

Sheep:

The Table no. 2.27 shows that the proportion of sheep was 4.65 percent of the total livestock in the district during 2012. The low proportion of sheep is found in Kalam and Osmanabad tehsils i.e. < 4 percent, whereas it is high in Lohara tehsil i.e. 10.08 percent due to the scarcity and uncertainity of rainfall leads to paucity of pastures. These conditions are best suited for sheep as they can survive even under the draught conditions and poor pastures for some time.

During the period under review, the negative change in proportion of sheep is observed in the entire study region except Bhum tehsil. The table 2.27 indicates that high positive change in sheep was observed in Bhum tehsil i.e. 1.59 percent. The low negative change in proportion of sheep is observed in Paranda and Kalam tehsils i.e. < 1 percent whereas the high negative change was observed in Osmanabad, Tuljapur and Omerga tehsil i.e.>1.5 percent in the total livestock.

Goat:

The Osmanabad district is famous for goat in the state and country due to the taste of meat. During 2012, the proportion of goats was 26.91 percent of the total livestock in the district. The low proportion of goats is found in Bhum, Washi, Kalam, Osmanabad, Lohara and Omerga tehsils i.e. < 26 percent, whereas it is high in Paranda and Tuljapur tehsils i.e. > 32 percent (Table no. 2.27).

During the period under review, the district as a whole has 4.10 percent negative change in proportion of goats. All the tehsils exhibits negative change in goats except Paranda tehsil. The high positive change was observed only in Paranda tehsil i.e. 2.62 percent. The high negative change in proportion of goat is observed in Bhum, Osmanabad and Omerga tehsils i.e. > 5 percent due to climate change which leads to decrease in area under grazing pastures, whereas the low negative change was observed in Kalam and Tuljapur tehsils i.e. < 3 percent.

Other Livestock:

The other livestock consists of horse, pigs, donkey, and dog etc. animals. During 2012, the proportion of other livestock is 1.66 percent of the total livestock in the district. The proportion of other livestock is high in Tuljapur and Osmanabad tehsils i.e. > 2 percent. The medium proportion of other livestock is recorded in Paranda and Bhum tehsils i.e. 1 to 2 percent of total livestock whereas it was low in Washi, Kalam, Lohara and Omerga tehsils i.e. <1 percent of total livestock.

During the period under review, the district as a whole has 5.12 percent negative change in proportion of other livestock. All tehsils exhibits negative changes in other livestock. The high negative change was observed in Paranda, Kalam and Omerga i.e. >5.5 percent, whereas low negative change was observed in Bhum, Osmanabad and Tuljapur tehsils i.e. < 5.5 percent of total livestock (Table no. 2.27).

2.16.2 Density of Livestock:

Density of livestock per sq.km is calculated simply to number of livestock divided by total geographical area in sq.km. The table no. 2.28 indicates that during 2002, density of livestock was124.38 per sq.km in the study region. The low density of livestock was found in Osmanabad, Tuljapur and Bhum tehsil i.e. < 145 per sq.km whereas it was high in Paranda, Kalam and Omerga tehsils i.e. > 145 per sq.km.

During 2012, density of livestock was 107.98 per sq.km in the study region. The low density of livestock was found in Omerga, Tuljapur, Washi and Lohara tehsil

Table No.2.28: Tehsilwise density of Livestock in Osmanabad district 2002 and 2012

Sr.No.	Tehsil	Density of livestock per sq.km		Change per sq.km.
		2002	2012	
1	Paranda	148.78	110.45	-38.33
2	Bhum	141.39	129.86	-11.54
3	Washi	*	97.25	*
4	Kalam	147.82	120.08	-27.74
5	Osmanabad	126.21	125.89	-0.31
6	Tuljapur	140.01	93.63	-46.37
7	Lohara	*	97.57	*
8	Omerga	192.40	89.33	-103.07
	District	124.38	107.98	-16.40

Source:- Compiled by Researcher on the basis of Livestock Census 2002 & 2012..

i.e. < 100 per sq.km, whereas it was high in Paranda, Bhum, Kalam and Osmanabad tehsils i.e. > 100 per sq.km.

The table no. 2.28 also indicates that district as a whole has negative change in density of livestock i.e. 16.40 per sq.km. Because numbers of tractors were increased and uncertain rainfall causes unavailability of grazing crops in the region. The high negative change in density of livestock per sq.km was found in Omerga tehsil i.e. 103.07. The medium negative change in density of livestock is observed in Paranda and Tuljapur tehsil i.e. 35 to 70 per sq.km whereas low negative change in density of livestock is found in Kalam, Osmanabad and Bhum tehsils i.e. < 35 per sq.km.

2.17 INFRASTRUCTURAL SERVICES:

These are the basic services, which are provided by government, public and private agencies. These consists marketing facilities, transport costs, accessibility to roads; price incentives credit societies, federation and political policies. These factors individually or collectively influence farming system in the study region. For the present analysis the following infrastructural services are taken into consideration.

2.17.1 Marketing facilities:

Marketing can be defined as the performance of business activities that direct the flow of goods and services from the producer to the consumer so that they may reach the consumer at the time, place and in the form he wishes and at a price he is willing to pay **(**Koul L., 1958**).** Due to the market system goods and services reaches to consumer from producer. The accessibility to the market is major consideration in

the decision making of the farmer. In most of the countries, the prices of agricultural commodity and agricultural commodity markets are controlled by buyers rather than seller. The fluctuations in prices of agricultural produce many a times compel the farmers to change the cropping pattern.

The table no. 2.29 shows that during 2000 there were 6 regular markets in the study region. The distribution of regulated market is uneven in the district. The tehsils of Osmanabad, Omerga and Kalam have 2 regulated markets. The tehsils of Paranda, Bhum, Washi, Tuljapur and Lohara, did not have regulated market in 2000. It means that the farmers of Bhum and Paranda have to send their agricultural products to the Barshi market in Solapur district, the farmers of Washi have to send their agricultural commodity to Kalam market as it is adjoining market.

Table No. 2.29: Number, Percentage and Density of Regulated Market 2000 and 2013

Sr. No.	Tehsil	As on 31 March 2000			As on 31 March 2013		
		No. of Regu-lated market	% of R.M.	Density per 100 Hect.	No. of Regu-lated market	% of R.M.	Density per 100 Hect.
1	Paranda	0	0.00	0	1	11.11	0.00144
2	Bhum	0	0.00	0	1	11.11	0.00166
3	Washi	0	0.00	0	1	11.11	0.00206
4	Kalam	2	33.3	0.00306	1	11.1	0.00124
5	Osmanabad	2	33.3	0.00198	1	11.1	0.00092
6	Tuljapur	0	0.0	0	1	11.1	0.00090
7	Lohara	0	0.0	0	1	11.1	0.00225
8	Omerga	2	33.3	0.00272	2	22.2	0.00251
	District	6	100.0	0.00104	9	100.0	0.00149

Source:- Compiled by Researcher on the basis of District Socio Economic Review & Statistical Abstract of Osmanabad 1999-00 & 2013.

The farmers from the tehsils of Tuljapur and Lohara have to send their agricultural products to Osmanabad and Omerga market respectively. In 2013, there are 9 regulated markets in the study region. Out of these maximum 2 markets were in Omerga tehsil and other each tehsil have only one market for each.

2.17.2 Agricultural Credit societies:-

Capital play an important role in the selection of crops, therefore the analysis of credit societies and capital is taken into consideration in the study of irrigation and agricultural productivity. All inputs for better production require capital. Finance is

one of the motivations to improve production, adopt new techniques and new cropping pattern. Credit societies play an important role in the provision of finance to farmers.

The Table no. 2.30 indicates that during 2012-13, district as whole has 469 primary agricultural societies in the district during 2000. The high number of agricultural socities are observed in Osmanabad, Kalam and Tuljapur tehsils i.e.> 70. The medium number of agricultural societies is found in Bhum, Paranda and Omerga tehsils i.e. 50 to 70 whereas they are low in Washi and Lohara tehsils i.e. 50.

During the period of investigation, district as a whole has positive change in primary agricultural societies i.e. +7. The high positive change in number of agricultural societies was observed in Bhum and Kalam i.e. 5 and 7 respectively

Table No. 2.30: Primary Agricultural Societies in Osmanabad district 2000 & 2013

Tehsil	As on 31 March 2000				As on 31 March 2013			
	No. of Agricul-tural society	% of Agricul-tural society	Loan advan-ced in '000'	% of loan adva-nced	No. of Agricul-tural society	% of Agricul-tural society	Loan advan-ced in '000'	% of loan advan-ced
Paranda	56	12.12	112285	6.36	56	11.94	12576	1.26
Bhum	47	10.17	97122	5.50	52	11.09	16982	1.71
Washi	36	7.79	101268	5.73	30	6.40	37976	3.82
Kalam	64	13.85	304161	17.22	71	15.14	95993	9.65
Osmanabad	89	19.26	557343	31.55	89	18.98	189854	19.08
Tuljapur	70	15.15	252470	14.29	70	14.93	512978	51.56
Lohara	40	8.66	126726	7.17	40	8.53	82994	8.34
Omerga	60	12.99	215344	12.19	61	13.01	45537	4.58
District	462	100.00	1766719	100	469	100.00	994890	100

Source:- Compiled by Researcher on the basis of District Socio Economi Review & Statistical Abstract of Osmanabad 1999-00 & 2013.

whereas the low positive change was observed in Omerga tehsil i.e. 1 agricultural society. In tehsils of Paranda, Osmanabad, Tuljapur and Lohara, no changes occurred in number of agricultural societies. The tehsil of Washi exhibits negative change i.e. 6 agricultural societies.

Table no. 2.30 also indicates that during the period 2012-13, the primary agricultural societies were advanced Rs. 99, 48, 90,000/- loan in entire study region. Out of these, highest loan advances (> 40, 00, 00, 000) was observed in Tuljapur, Osmanabad, Kalam Lohara and Omerga tehsils co-operative societies i.e. > 4 percent

of the district total. It was medium (17, 00, 00,000 to 40, 00, 00,000) only in Washi tehsil i.e. 2 to 4 percent, whereas it was low (< 17, 00, 00,000) in Paranda and Bhum tehsils i.e. < 2 percent.

During the period of investigation, all tahasils of the district have decreasing trend in the loan advances except Tuljapur and Lohara. More than half of the loan advance of the district is observed in Tuljapur tehsil. The high positive change is observed in Tuljapur tehsil i.e.37.27 percent, whereas the low positive change is observed in Lohara tehsil i.e. 1.17 percent of the district. The high negative change is observed in Paranda, Kalam and Omerga i.e. > 5.50 percent, whereas low negative change is observed in Osmanabad tehsil i.e. >8.95 percent. The medium negative change is observed in Kalam and Omerga tehsil i.e. 5.43 to 8.95 percent whereas low negative change is observed in the tehsils of Paranda, Bhum and Washi tehsil.

2.17.3 Transportation:

Without transportation, any economic activity could not be developed in the region. Roads are the lifeline or the arteries of each economic region. These vital channels promote agricultural development and According to the recommendation of the Chief Engineers (1958) responsible for the second development plan for roads in India (popularly known as Nagpur Report), areas lying within four km. from transport point treated as 'fairly accessible' and those within 8 km. as 'simply accessible'. In contrast places beyond 8 km, from transport point have been declared inaccessible (Singh J and Dhillon S.S., 2004).

The speed of the means of transportation and cost of transportation affect the cropping pattern because they (fruits, vegetables and flowers) are perishable crops. Better transport linkages are advantageous to the farmer as he able to supply his perishable crops to the distant markets within a short period of time. There are only two means of transportation i.e. road transportation and railway transportation in study area.

The table no. 2.31 indicates that the total length of the road in the district is 6746.08 kilometer and density is 89.80 per 100 Sq.km during the period of 2012-13. It also indicates tehsilwise spatial distribution of types, length and density of roads in 2013. The spatial distribution in length of National highway varies from tehsil to tehsil. The high length of National highway is found in Omerga and Tuljapur tehsils i.e. > 44 kilometer because NH-7 Pune to Hyderabad passes into these tehsil. The medium length of National highway was observed in Osmanabad and Washi tehsil

Table no. 2.31 : Tehsilwise Types, length & Density of Roads and Railways in Osmanabad Dstrict in 2013.

Sr. No.	Tehsils	Length of Roads (in K.M)				Total Length	Density per 100 sq.km	Railway	Density per 100 sq.km
		National Highway	State Highway	District Highway	Village Roads			Broad Guage single	
1	Paranda	0	79	287.15	352.11	718.26	85.75	0	0
2	Bhum	0	96	332.5	237.27	665.77	87.48	0	0
3	Washi	32	27	240.1	207.22	506.32	78.06	0	0
4	Kalam	21	137	300.8	337.38	796.18	87.45	0	0
5	Osmanabad	37	276.9	612	388.72	1314.62	101.52	50	3.86
6	Tuljapur	66	137	558.7	491.2	1252.9	81.16	0	0
7	Lohara	5	102	240.45	209.53	556.98	103.39	0	0
8	Omerga	49	45.4	377	463.65	935.05	95.67	0	0
	District	210	900.3	2948.7	2687.08	6746.08	89.80	50	0.67

Source:- Compiled by Researcher on the basis of District Socio Economic Review & Statistical Abstract of Osmanabad 2013.

i.e. 22 to 44 kilometer whereas low length of National highway was found in Lohara and Kalam tehsil i.e. <22 kilometer. There is no National highway in Paranda and Bhum tehsil.

In 2013, the highest length of State highway is observed only in Osmanabad tehsil i.e. 276.9 kilometer. The medium length of State highway was found in Tuljapur and Kalam tehsil i.e. 110 to 194 kilometer whereas the low length of State highway is found in Washi, Omerga, Paranda, Bhum and Lohara tehsils i.e. <110 kilometer.

The high length of District roads is observed in Tuljapur and Osmanabad tehsils i.e. >488 kilometer. The medium length of district roads is found only in Omerga tehsils i.e. 377 kilometer, whereas the low length of District roads is observed in Washi, Lohara, Paranda, Kalam and Bhum tehsils i.e. < 364 kilometer.

The high length of Village roads is observed in Tuljapur and Omerga tehsils i.e. > 397 kilometer. The medium length of village roads is found in Kalam, Paranda and Osmanabad tehsils i.e. 302 to 397 kilometer, whereas the low length of Village roads is observed in Washi, Lohara and Bhum tehsils i.e. < 302 kilometer.

Taking into consideration tehsilwise total length of all types of roads, it varies from tehsil to tehsil during 2012-13. The high length of all types of road is observed in Osmanabad and Tuljapur tehsils i.e. > 1045 kilometer. It is medium in Kalam and

Omerga tehsils i.e. 776 to 1045 kilometer, whereas the low length of all types of road is observed in Washi, Lohara, Bhum and Paranda tehsils i.e. <776 kilometer.

Tehsilwise Density of Roads and Railway in Osmanabad District:

During 2012-13, district as a whole has 89.80 density of all types of road per 100 square kilometers. But spatial distribution varies from tehsil to tehsil. The high density of all types of road is observed in Osmanabad, Omerga and Lohara tehsils i.e. >95 kilometer per 100 square kilometer. The moderate density of all types of road is found in Kalam and Bhum tehsils i.e. 86.5 to 95 kilometer per 100 square kilometer, whereas it is low in Washi, Tuljapur and Paranda tehsils i.e. < 86.5 kilometer per 100 square kilometer.

The density of National highway is only 2.80 kilometer per 100 square kilometer in 2013. The density of State highway is 11.98 kilometer per 100 square kilometer in the study region. The density of major district roads is 39.25 kilometer per 100 square kilometer whereas the density of village road is 35.77 kilometer per 100 square kilometer in the study region in 2013.

Table No. 2.31 also shows the length of railway in the study region. During the period of 2012-13, there is only one single broad gauge railway route having length of 50 Km. and negligible density of 0.67 per 100 Sq.km. only the Osmanabad tehsil have railway line of 50 kms and density of 3.86 kilometer per 100 square kilometer. Rests of tehsils are deprived from the rail transport. In these circumstances, the entire burden of passenger and cargo traffic is on road transport in the study region.

2.18 SUMMARY:

The forgoing analysis reveals the Balaghat rangeis prominent physical feature in the study area. The high proportion of hilly area in Bhum and Tuljapur tehsils and northern bounding scrap of balghat range is not favorable for better agricultural productivity. The western part of the district is characterized by irregular hard rock terrain with flat-topped Deccan basaltic plateau surfaces. The eastern part of the district is gently sloping to flat terrain consisting of alluvial material of the Terna River and east west trending escarpment. This plateau and plain area comprises 88.65 percent of total area of district which is favorable for better agricultural productivity.

The district lies in the Deccan Trap system of Peninsular India and is made up of a pile of black, compact, aphanites' basalt flows. The geology of district leads to regur soils but it is unfavorable of ground water resources.

The Osmanabad district has hot and dry climate. It falls under the rain shadow of Sahyadri Mountains and therefore the beginning and end of the rainy season is quite uncertain in these parts. The rainfall is scanty and unreliable all over the district. It is high in Eastern part, while low in western part. These conditions led to semi- arid condition in the region, which puts limitation the quantity of surface as well as groundwater in the region. The region therefore has the problem of inadequate water which adversely affects on agricultural productivity.

The district drained by Manjra, Sina, Terna, Bori, Benitura and Banganga rivers which are fordable through out the year except rainy season.

The district has high proportion of shallow soils and medium deep soil collectively. These soils offer good prospect for agricultural productivity, if perennial water supply is available. The deep to very deep soils are found in the banks of major rivers which have moisture retaining capacity indicates favorable for agricultural productivity. The percentage of nitrogen content in the soil is low in Paranda, Bhum, Washi and Lohara Tehsils. The Phosphorus content is very low in tehsils of Osmanabad, Tuljapur, Bhum, Omerga and Lohara, which indicates that needs to provide this content through chemical fertilizer or bio-fertilizer for better productivity. Potash content is high in each tehsils of Osmanabad district which states that the soil of the district offers good future for fruit crops.

The high balance of ground water in Washi, Kalam and Lohara tehsils indicates that there is high scope for digging wells for better agricultural production. The Decline of water table is a burning problem of Osmanabad district with increasing population and development of water lifting technology so it is very essential to increase groundwater recharge by artificial way to develop and survive agriculture and natural vegetations.

The study region has negligible forest resources mainly concentrated in Tuljapur and Osmanabad tehsils, therefore it is very essential to increase forest area by artificial way i.e. plantation of trees for survival of ecosystem and keep the environmental balance in the study region.

The forgoing analysis reveals that during last six decades, the growth rate of population of Osmanabad district is low as compare to state. The high growth rate of population in Osmanabad tehsil is mainly due to industrial and agricultural development, however it is high in Bhum tehsil due to Dairy farming. The high Crude density in Osmanabad tehsil is because of district head quarter is located in this tehsil

which leads secondary and tertiary activities resulted into high urbanization, whereas it is high in Omerga tehsil due to development of educational facilities. Agricultural and caloric density is high in Osmanabad, Kalam and Omerga Tehsil due to lower development of mechanical implements of agriculture. Osmanbad, Lohara and Omerga tehsil have high co-efficient of over population indicates high pressure of population on agricultural land. Per capita net sown area is decreased highly in all most all tehsils of study region. There is a considerable positive change in literacy in all over the region; particularly it is high in the Paranda tehsil. This increasing pressure of population, decrease in net area sown and increases in literacy, has brought change in cropping pattern.

Study region benefited by three major irrigation projects. The Manjara, Lower Terna and Sina Kolegaon Joint canal irrigation projects play a very important role in the development of agriculture as well as agricultural productivity. Irrigation potential of Manjara Dam, Lower Terna dam and Sina-Kolegaon Joint canal is favorable to increase agricultural productivity of Kalam, Lohara, Omerga and Paranda tehsils. This project has changed the agricultural productivity of the study region largely. There are 18 medium irrigation projects in the study region but high concentration medium projects in Bhum and Tuljapur tehsil is mainly due to favorable physiography. In the study region there are 54 minor irrigation works. Maximum proportion of irrigated potential by minor irrigation works is found in Osmanabad tehsil followed by Tuljapur and Kalam. Most of the minor irrigation schemes become dry in summer season due to rate and distribution of the monsoon rainfall which effects on the water storage capacity of the project. In the study region there are 1033 Kohapur type Bandhare but maximum concentration is in Osmanabad tehsil. There are 1317 percolation tanks in the study area. The density of percolation tanks is high in Tuljapur, Bhum and Paranda tehsil. Evidences shows that the Osmanabad district as a whole has only 4.65 percent surface irrigated area to net sown area indicates that there is dire need to develop surface irrigation facility for better agricultural productivity. The high surface irrigated area to net irrigated area in Kalam tehsil is mainly due Manjara irrigation project and Raigavhan medium irrigation project. The high surface irrigated area to net sown area in paranda tehsil is a result of Sina-Kolegaon project.

The high density of irrigation wells in Kalam, Paranda and Osmanabad tehsils is due to physiography and geology. The proportion of well irrigated area to net irrigated area is high in Osmanabad and Omerga tehsil. During the period of under

review, well-irrigated area is increased in Osmmanabad, Omerga, Tuljapur and Paranda Tehsils. The high well irrigated area and remarkable increase in Tuljapur and Paranda tehsils is mainly due to recharge from surface irrigation. The negative change in well irrigated area in Kalam, Bhum, washi and Lohara tehsil is mainly due to scarcity of rainfall and lowing of ground water. The high intensity of irrigation in Paranda and Omerga tehsils is mainly due to Sina Kolegaon Project and Nimn Terna Project at Makhni respectively, in Osmanabad and Tuljapur tehsil it is high due to medium project, which is favorable for agricultural production.

With the availability of iron ploughs, the density of wooden ploughs is decreased in almost all tehsils. The considerable decrease in oil engine in all over the region is due to increase in electric pumps at greater level. The high increasing density of electric pumps in Bhum, Paranda and Omerga tehsilis mainly is due to growth and development of electricity. The density of bullock carts decreased in all over the study region with an increase in number of tractors. However, spatial distribution of tractor is very uneven. High density of tractors in Paranda, Tuljapur and Osmanabad tehsils states that the association of tractor with irrigated areas.

The region as a whole has increased per hectare use of chemical fertilizer by more than two times during the period of investigation.

The most of land tenure is individual peasant farming and majority of farmers are owner cultivators. The proportion of Joint holding and Institutional holdings is negligible. So far as the land holding is concerned Osmanabad district is an area of small size holdings.

The low percentage of agricultural labors in Paranda, Kalam and Osmanabad tehsils indicates high use of Mechnical implements mainly due to development of surface irrigation facilities.

The high increase in density of Buffaloes in Osmanabad, Omerga and Tuljapur is due to development of surface irrigation and high urbanization. During the period of investigation, the high proportion of Catteles in Bhum, Washi and Kalam tehsils is due to the growth of dairy industry. The high proportion of sheep in Lohara Tehsil and high proportion of goats in Paranda, and Tuljapur tehsils is result of favorable of physiography and uncertain rainfall leads paucity of pastures.

The number of agricultural societies is high in Eastern the part of region, which are mostly irrigated area. There are only 9 regulated markets in the study area

and each tehsil have only one market except omerga. It indicates that there is need to increase number of regulated markets.

The high loan advancement in Tuljapur and Osmanbad tehsil is mainy due to develoment of well and surface irrigation facilities. The low state highway length in Washi Omerga Paranda, Bhum and Lohara tehsil is mainly due to adverse physiographic condition. All most all tehsils are deprived from railway transportation except Osmanabad tehsil, which adversely affects on agricultural marketing.

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CHAPTER– III

GENERAL AND AGRICULTURAL LANDUSE PATTERN

3.1 INTRODUCTION:

The physical and socio-economic setting of the Osmanabad district is discussed in the previous chapter. This chapter aims at nice telling general land use pattern and agricultural land use pattern, changes therein in the light of preceding discussion and indicating the areas of potentially for future agricultural development.

Land use pattern of a region can not the actual and specific use of land for which its surface uses of land, for which its surface area is put in terms of use. The aim of the study is to suggest proper land use for the land which otherwise has been put to some other use for which the same is unsuitable (White R.O., 1961). The land utilization in a region is a picture of an adjustment between the land resources and the human capabilities at certain period (Wise M.J., 1969). The nature of their utilization depends upon and in turn reflects the nature of economic development that is taking place within society (Tawade M.D., 1976). Land use is a function of four variables i.e. land, water, air and man. Each plays its own role along with other. The pattern of land use of a country at any particular time is determined by the physical, economic and institutional framework taken together. The existing land use pattern in different region has been evolved as the result of the action and interaction of various factors. These are the physical characteristics of land, the institutional framework, the structure of other resources (capital, Labor etc.) available and the location of the region in relation to other aspects of economic development (Handbook of Agriculture, 2003). A physical limitation of site has a direct expression in land use.

Land use is a geographical concept since it involves specific areas. Land use is an important aspect of geographic studies, particularly in agricultural geography. Generally land is used for agriculture, gardening, residential, commercial, transportation, mining, pastures, forests etc. uses of land two or more purpose are not normally possible. Systematic utilization of land is able to promote economic and cultural development. Efficient use of land depends on the capacity of man to utilize the land and manage it in proper perspective. Thus, the study of land utilization is of immense value in tracing out the use of land in the past and its future trends. Only

through the study of the past land utilization, one can predict its future use and evolve land use planning of a particular region (Mandal R.B., 1982).

In this context the changes that have taken place in the agriculture land use of the Osmanabad district in the last two decades with regard to the land use pattern and the cropping pattern are worth noting.

3.2 GENERAL LAND-USE PATTERN:

General land use pattern of the district is typical due to its location and physical setting. The land use pattern of first quinquennial average for the 1999-00 to 2003-04 and second quinquennial average for 2009-10 to 2013-14 is depicted in Fig. no. 3.1 A and 3.1B. It is modified by the expansion of irrigation and the growth of population. (Table no. 3.2)

Table No. 3.1: General Land-use Pattern of Osmanabad district 1999-04 & 2009-2014

(Area in %)

Land use Categories	1999-00 to 2003-04	2009-10 to 2013-14	Change in %
Total Geographical area	100	100	
(1) Area under forest	0.72	0.85	0.13
(2) Area not available for cultivation	5.00	5.21	0.21
(3) Other uncultivable land	5.73	4.87	-0.85
(4) Current fallow	6.39	5.43	-0.95
(5) Other fallow	5.67	5.37	-0.30
(6) Net sown area	76.50	78.26	3.76
(7) Area sown more than one cropped	20.32	22.84	2.52
(8) Gross cropped area	96.81	103.10	6.29
(9) Total cultivable area	94.28	95.94	1.66

Source: Compiled by researcher on the basis of Socio-economic Review and District & Statistical Abstract of Osmanabad 1999-00 to 2003-04 & 2009-10 to 13-14.

The said category includes all land classed as forest under any legal enactment dealing with forest or administered as forests whether state owned or private, and whether wooded or maintained as potential forest land. The area of crops grows in the forest and grazing lands or the area open for grazing within the forest should remain included under the forest area (Ministry of Food & Agriculture, 1948).

A) General Landuse-1999-00 to 2003-04

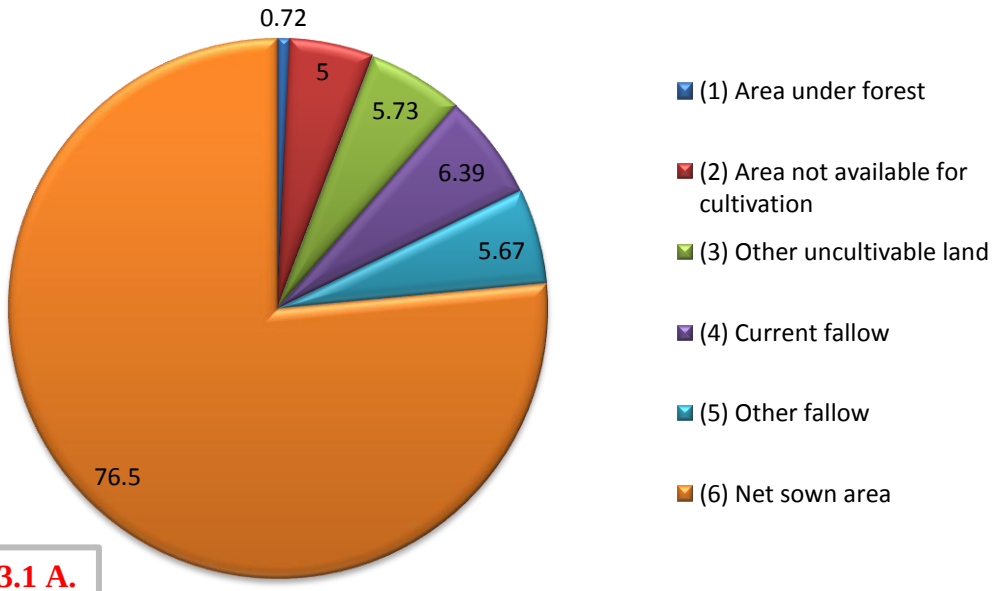

Fig.3.1 A.

B) General Landuse-2009-10 to 2013-14

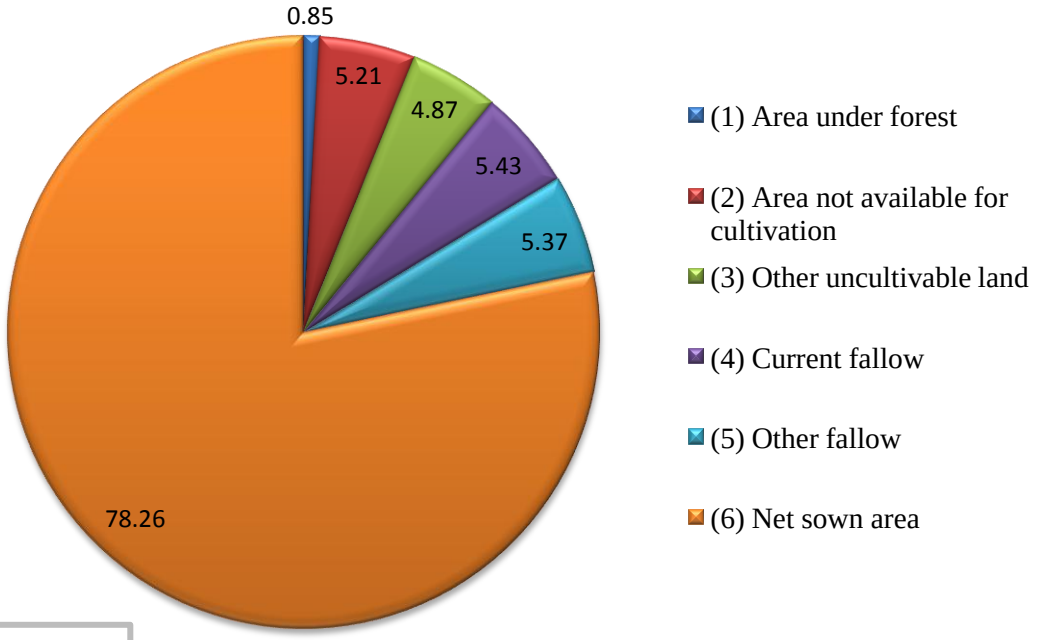

Fig.3.1B

3.2.1 Tehsil Level General Land Use and Changes:

I) Area under Forest:

The study region has very little portion under forest, mostly arid and scrub patches are recorded. The forest area is observed in ranges and upland areas. Old as well as newly planted forests are found in the Osmanabad, Tuljapur, Kalam and Omerga tehsils.

During 1999-04, out of total geographical area only 0.72 percent was under forest in the Osmanabad district. The tehsil level analysis varies from 0.12 to 1.62 percent. The table No. 3.2 shows that the low area under forest was found in Paranda, Bhum and Omerga tehsils i.e. < 0.60 percent. The medium proportion of area under forest was recorded in Osmanabad, Tuljapur, Washi and Lohara tehsils i.e. 0.60 to 1.10 percent, whereas it was high in Kalam tehsil i.e. >1.10 percent due to hilly area of Balaghat range near Yermala.

During 2009-14, out of total geographical area only 0.85 percent area was under forest in Osmanabad district that of state is 16.95. The area under forest is too much low as compare to the state due to cutting of trees for domestic fuel, agricultural implements and sale due to poverty of farmers, frequency of scarcity and famine condition. The tehsil level analysis reveals that great variations ranging from 0.10 to 1.54 percent. Table No. 3.2 and Fig. no. 3.2 A show that the low proportion of area under forest is observed in Paranda, Bhum, Kallam and Lohara tehsils i.e. < 0.60 percent. The medium proportion of area under forest is found in Washi and Omerga tehsils i.e. 0.60 to 1.10 percent, whereas it is high in the Osmanabad and Tuljapur tehsils i.e. >1.10 percent due to the newly planted forest in the hilly area of both tehsils.

Changes in Area under Forests:

During the period of investigation, district as a whole has 0.13 percent positive change. But taking into consideration of tehsil to tehsil analysis, there were both positive as well as negative changes occurred. The Table no. 3.2 indicates that the low positive change in area under forest is observed in Bhum and Washi tehsils i.e. < 0.25 percent. The medium positive change is observed only in Tuljapur tehsil i.e0.32 percent, whereas it is high in Osmanabad and Omerga tehsils i.e. >0.50 percent due to newly planted forest. (Fig.no. 3.2 B)

AREA UNDER FOREST OF OSMANABAD DISTRICT (2009-10 TO 2013-14)

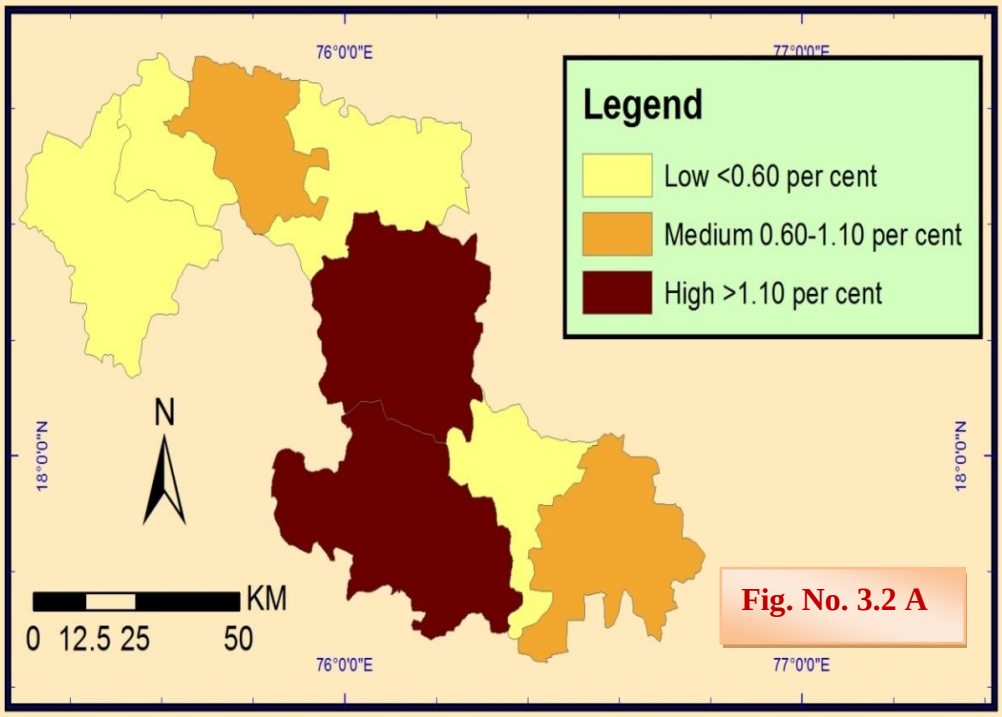

Fig. No. 3.2 A

VOLUME OF CHANGE IN AREA UNDER FOREST (1999-00 to 2013-14)

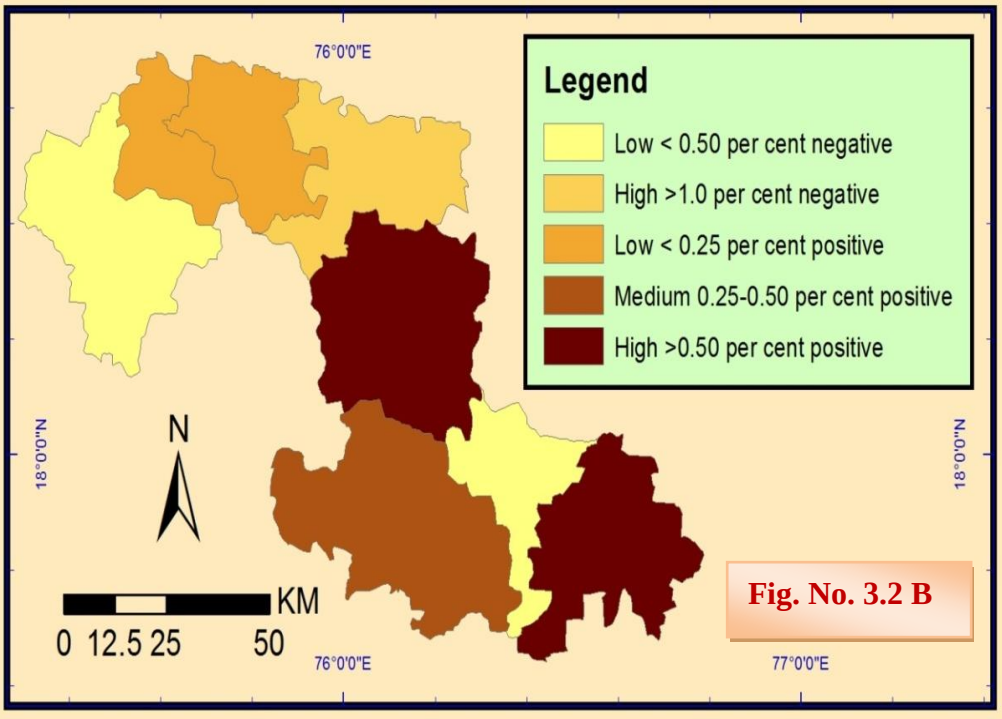

Fig. No. 3.2 B

The low negative change is seen in Paranda and Lohara tehsils i.e. < 0.50 percent. The high negative change is observed in the Kalam tehsil i.e > 1.00 percent due to the cutting of trees to bring land under cultivation.

II) Area not Available for cultivation:

The said category includes area under non-agricultural use (i.e. under settlement, roads, railway, rivers, tanks, canals etc.) and barren, uncultivable land. These are bare, rocky outcrops of hills, stony waste and mountains. These areas show a close association with other uncultivated land and net sown area. It means, if there is a change at all, more net sown area will be converted into the category and this may happen particularly due to the increasing urbanization and construction of roads and canals.

The Table no. 3.2 indicates that, during 1999-04, out of total geographical area 5.0 percent area was under area not available for cultivation in the Osmanabad district. The tehsil level analysis varies from 2.45 to 7.81 percent. The table No. 3.2 shows that low area under area not available for cultivation was in the Osmanabad, Lohara, Washi and Omerga tehsils i.e. < 4 percent. The medium proportion of area under this category was found in the Bhum and Paranda tehsils i.e. 4 to 6 percent, whereas it was high in the Kalam, Tuljapur tehsil i.e. > 6 percent.

During 2009-14, out of total geographical area 5.21 was under the area not available for cultivation in the Osmanabad district that of state is 10.33 percent. The tehsil level analysis reveals great variations ranging from 1.64 to 6.24 percent. The table No. 3.2 shows that low proportion of area not available for cultivation was in the Omerga Tuljapur and Kalam tehsils i.e. < 3 percent. The medium proportion of this category is recorded in Osmanabad, Lohara, Washi and Paranda tehsils i.e. 3 to 5 percent, whereas it was high only in Bhum tehsil i.e. > 6.24 percent due to hilly area which cannot be brought under cultivation without incurring cost on their development.

Changes in Area not Available for cultivation:

During the period of investigation, district as a whole has 0.21 percent positive change in area not available for cultivation. Considering tehsil level analysis, both positive and negative changes are observed. The Table no. 3.2 indicates that low positive change in area not available for cultivation is observed in Washi i.e. <0.20 percent. The medium positive change is found only in Osmanabad tehsil i.e. 0.55

Table No. 3.2: Tehsilwise General Landuse in Osmanabad District-1999- 00 to 2013-14.

Taluka	Year/ Volume change (%)	Total Geogra-phical area	Area under forest	Area not availab le for culti-vation	Poten-tial agricu-ltural land	Other fallow land	Curr-ent fallow land	Net sown area	More than one cropped area	Gross cropped area	Total cultiv-able area
Paranda	1999-00 to 2003-04	83760	101	4379	2112	5200	6720	65248	12106	77354	79280
	% Area	100	0.12	5.23	2.52	6.21	8.02	77.9	14.45	92.35	94.65
	2004-05 to 2008-09	83760	113	4014	2527	4508	5078	67282	16937	84219	79395
	% Area	100	0.13	4.79	3.02	5.38	6.06	80.33	20.22	100.55	94.79
	2009-10 to 2013-14	83760	85	3888	3043.75	3353	4009.04	69381.21	20995.42	90376.63	79787
	% Area	100	0.1	4.64	3.63	4	4.79	82.83	25.07	107.9	95.26
	V.C%	0	-0.02	-0.59	1.11	-2.21	-3.24	4.93	10.61	15.55	0.61
Bhum	1999-00 to 2003-04	76107	201	4185	3143	3260	4327	60991	12760	73751	71721
	% Area	100	0.26	5.5	4.13	4.28	5.69	80.14	16.77	96.9	94.24
	2004-05 to 2008-09	76107	256	4351	3211	2906	4649	60542	13100	73642	71308
	% Area	100	0.34	5.72	4.22	3.82	6.11	79.55	17.21	96.76	93.69
	2009-10 to 2013-14	76107	383	4746	3242	2680	4897	60159	13277	73436	70978
	% Area	100	0.5	6.24	4.26	3.52	6.43	79.05	17.45	96.49	93.26
	V.C%	0	0.24	0.74	0.13	-0.76	0.75	-1.09	0.68	-0.41	-0.98
Washi	1999-00 to 2003-04	64863	395	2271	2112	4565	4033	51487	7854	59341	62197
	% Area	100	0.61	3.5	3.26	7.04	6.22	79.38	12.11	91.49	95.89
	2004-05 to 2008-09	64863	402	2349	2581	4756	4612	50312	9043	59355	62261
	% Area	100	0.62	3.62	3.98	7.33	7.11	77.57	13.94	91.51	95.99
	2009-10 to 2013-14	64863	411	2400	2944	5395.04	5215.8	48497.16	10159	58656.16	62052
	% Area	100	0.63	3.7	4.54	8.32	8.04	74.77	15.66	90.43	95.67
	V.C%	0	0.02	0.2	1.28	1.28	1.82	-4.61	3.55	-1.06	-0.22
Kalam	1999-00 to 2003-04	91040	1475	5481	3770	8735	6228	65351	23675.28	89026.28	84084
	% Area	100	1.62	6.02	4.14	9.59	6.84	71.78	26.01	97.79	92.36
	2004-05 to 2008-09	91040	854	3318	2719	5557	4212	75467	20157	95624	87955
	% Area	100	0.94	3.64	2.99	6.10	4.63	82.89	22.14	105.04	96.61
	2009-10 to 2013-14	91040	498	1627	2010	3330.1	2818.88	80756.02	19551.16	100307.18	88915
	% Area	100	0.55	1.79	2.21	3.66	3.1	88.7	21.48	110.18	97.67
	V.C%	0	-1.07	-4.23	-1.93	-5.94	-3.74	16.92	-4.53	12.39	5.31
Osmanabad	1999-00 to 2003-04	129490	1120	4250	3653	7425	11829	101213	34133.25	135346.25	124120
	% Area	100	0.86	3.28	2.82	5.73	9.14	78.16	26.36	104.52	
	2004-05 to 2008-09	129490	1581	4480	4318	6052	5067	104312	33343	137655	119749
	% Area	100	1.22	3.46	3.33	4.67	3.91	80.56	25.75	106.31	92.48
	2009-10 to 2013-14	129490	2000	4965	4830.81	5218.91	3303.19	109172.09	32450	141622.09	122525
	% Area	100	1.54	3.83	3.73	4.03	2.55	84.31	25.06	109.37	94.62
	V.C%	0	0.68	0.55	0.91	-1.7	-6.58	6.15	-1.3	4.85	94.62

Table No. 3.2 Continue…

Tuljapur	1999-00 to 2003-04	154375	1219	12059	18554	6560	5541	110442	32957.58	143399.58	141097
	% Area	100	0.79	7.81	12.02	4.25	3.59	71.54	21.35	92.89	91.4
	2004-05 to 2008-09	154375	1511	7729	16357	9027	8209	110159	34791	144950	143752
	% Area	100	0.98	5.01	10.60	5.85	5.32	71.36	22.54	93.89	93.12
	2009-10 to 2013-14	154375	1708	3115	14302	12381.1	11837	111031.92	37145.25	148177.17	149552
	% Area	100	1.11	2.02	9.26	8.02	7.67	71.92	24.06	95.99	96.88
	V.C%	0	0.32	-5.79	-2.75	3.77	4.08	0.38	2.71	3.09	5.48
Lohara	1999-00 to 2003-04	53872	397	1318	1611	1835.42	2266	46444.58	9715	56159.58	52157
	% Area	100	0.74	2.45	2.99	3.41	4.21	86.21	18.03	104.25	96.82
	2004-05 to 2008-09	53872	319	1537	1729	2717	2308	45371	10125	55496	52125
	% Area	100	0.59	2.85	3.21	5.04	4.28	84.22	18.79	103.01	96.76
	2009-10 to 2013-14	53872	227	1770.32	1826	3314.33	2367	44367.35	10207	54574.35	51874.68
	% Area	100	0.42	3.29	3.39	6.15	4.39	82.36	18.95	101.3	96.29
	V.C%	0	-0.32	0.84	0.4	2.75	0.19	-3.86	0.91	-2.94	-0.52
Omerga	1999-00 to 2003-04	97733	521	3604	8066.79	4999	7024.37	73517.84	19416	92933.84	93608
	% Area	100	0.53	3.69	8.25	5.11	7.19	75.22	19.87	95.09	95.78
	2004-05 to 2008-09	97733	776	2540	6097	4731	6718	76487	22582	99069	94033
	% Area	100	0.79	2.60	6.24	4.84	6.87	78.26	23.11	101.37	96.21
	2009-10 to 2013-14	97733	1074	1605	4418	4668.75	6379.22	79588.33	27791.75	107380.08	95054.3
	% Area	100	1.1	1.64	4.52	4.78	6.53	81.43	28.44	109.87	97.26
	V.C%	0	0.57	-2.05	-3.73	-0.34	-0.66	6.21	8.57	14.78	1.48
District	1999-00 to 2003-04	751240	5429	37547	43021.8	42579.4	47968.4	574694.42	152617.11	727311.53	708264
	% Area	100	0.72	5	5.73	5.67	6.39	76.5	20.32	96.81	94.28
	2004-05 to 2008-09	751240	5812	30318	39539	40254	40853	589932	160078	750010	710578
	% Area	100	0.77	4.04	5.26	5.36	5.44	78.53	21.31	99.84	94.59
	2009-10 to 2013-14	751240	6386	24116.3	36616.6	40341.2	40827.1	602953.08	171576.58	774529.66	720737.98
	% Area	100	0.85	5.21	4.87	5.37	5.43	78.26	22.84	103.1	95.94
	V.C%	0	0.13	0.21	-0.85	-0.3	-0.95	1.76	2.52	6.29	1.66

Source: Compiled by the Researcher on the basis on District Socioeconomic Review and Statistical Abstract of Osmanabad 1999-2004 & 2009-14

percent, whereas high positive change was observed in Bhum and Lohara tehsil i.e. > 0.60 percent due to the increase of urbanization. The low negative change was seen

in Paranda and Omerga tehsils i.e. < 2.6 percent whereas the high negative change was found in Tuljapur and Kalam tehsils i.e. > 4 percent due to farmers in these tehsil brought barren land under cultivation.

III) Other Uncultivable Land (Potential Agricultural Land):

This category includes three types of nine-fold classification i.e. (i) cultivable waste, (ii) permanent pasture and (iii) land under miscellaneous tree crops and groves.

The Table no. 3.2 indicates that, during 1999-04, out of total geographical area 5.73 percent was under other uncultivable land in the Osmanabad district. The tehsil level analysis varies from 2.52 to 12.02 percent. The table No. 3.2 shows that low area under other cultivable land was observed in the Paranda, Bhum, Washi, Kalam, Osmanabad and Lohara tehsils i.e. < 6 percent. The medium proportion of area under other uncultivable land was found in the Omerga tehsil i.e. 8.25 percent, whereas it was high in Tuljapur tehsil i.e. > 9 percent.

During 2009-14, out of total geographical area 4.87 percent area was under the other uncultivable land in the Osmanabad district that of state is 2.98 percent. The tehsil level analysis reveals great variations ranging from 2.21 to 9.26 percent. The table No. 3.2 indicates that low proportion of area under uncultivable land is recorded in the Paranda, Bhum, Washi, Kalam, Osmanabad, Omerga and Lohara tehsils i.e. below district average, whereas it was high only in the Tuljapur tehsil i.e. 9.26 percent due to hilly area of Balaghat resulted into permanent pasture.

Changes in Area under other uncultivable land:

During the period of investigation, district as a whole has 0.85 percent negative change in uncultivable land. The Table no. 3.2 indicates that low positive change in area under other uncultivable land is observed in the Bhum and Lohara tehsils i.e. <0.5 percent whereas it was high in the Paranda, Washi and Osmanabad tehsils i.e. >0.9 percent.

The low negative change in area under other uncultivable land is seen in Kalam tehsil i.e. < 1.93 percent. The medium negative change is found in the Tuljapur tehsil i.e. 2.75 percent whereas it was high in the Omerga tehsil i.e. > 3.73 percent, due to proportion of other uncultivable land, which has gone to agricultural land.

IV) Other Fallow Land:

This category includes all land, which were taken up for cultivation but are temporarily out of cultivation for a period of not less than one year and not more than five year.

The Table no. 3.2 indicates that, during 1999-04, out of total geographical area. 5.67 percent area was under other fallow land in the Osmanabad district. The tehsil level analysis varies from 3.41 to 9.59 percent. The table No. 3.2 shows that low area under other fallow land was observed in Bhum, Tuljapur Lohara and Omerga tehsils i.e. < 5.5 percent. The medium area under other fallow land was found in Paranda, Washi and Osmanabad tehsils i.e. 5.5 to 7.5 percent, whereas it was high in Kalam tehsil i.e. 9.59 percent.

During 2009-14, out of total geographical area 5.37 percent area is under other fallow land in Osmanabad district that of state is 3.83 percent. The tehsil level analysis reveals great variations ranging from 3.52 to 8.32 percent. The table No. 3.2 indicates that low proportion of area under other fallow land is in the Osmanabad, Omerga, Paranda,Bhum and Kalam tehsils i.e. < 5 percent. The medium area under this category is recorded in the Lohara tehsil i.e. 6.15 percent, whereas it was high in the Washi and Tuljapur tehsils i.e. > 7 percent due to the adverse climatic conditions i.e. drought in recent year and lower development of irrigation. (Fig.no. 3.3A)

Changes in Other Fallow Land:

During the period of investigation, district as a whole has 0.30 percent negative change in other fallow land. Considering tehsil level analysis, both positive and negative changes are observed. The Table no. 3.2 and figure no. 3.3 B indicates that low positive change in area under other fallow land was observed in the Washi tehsil i.e. <2 percent. The medium positive change was observed in the Lohara tehsil i.e. 2.75 percent whereas it was high in the Tuljapur tehsil i.e. > 3.77 percent due to inadequate rainfall and poor irrigation facilities. The low negative change was seen in the Bhum, Osmanabad and Omerga tehsils i.e. < 2 percent. The medium negative change in other fallow land is recorded only in the Paranda tehsil i.e. 2.21 percent whereas the high negative change was found in the Kalam tehsil i.e. 5.94 percent due to increase in minor irrigation project.

OTHER FALLOW LAND IN OSMANABAD DISTRICT (2009-10 TO 2013-14)

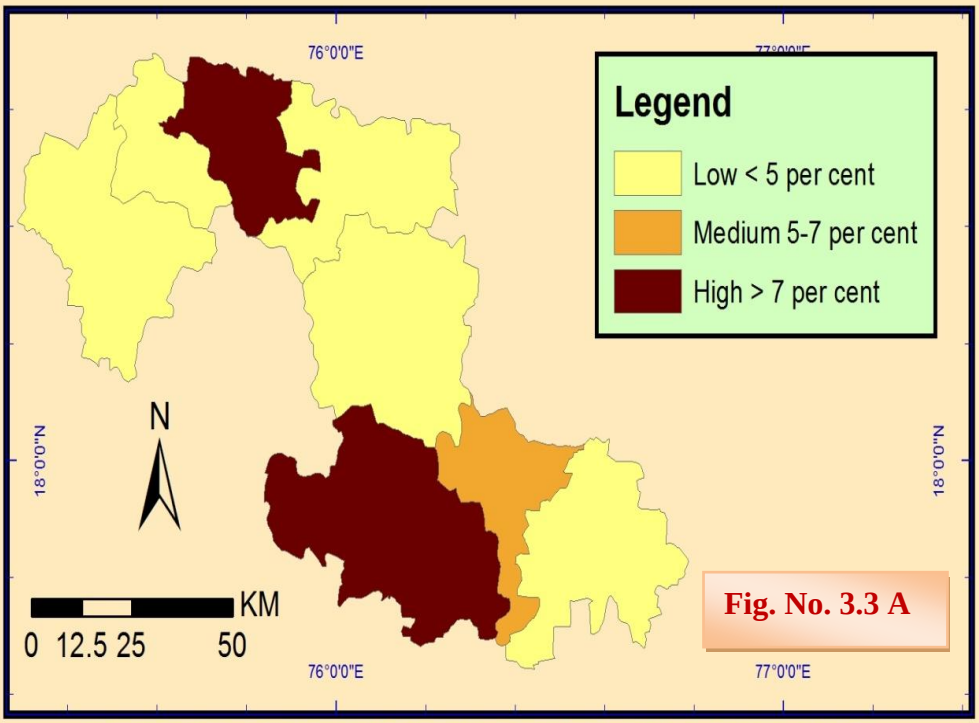

Fig. No. 3.3 A

VOLUME OF CHANGE IN OTHER FALLOW LAND (1999-00 to 2013-14)

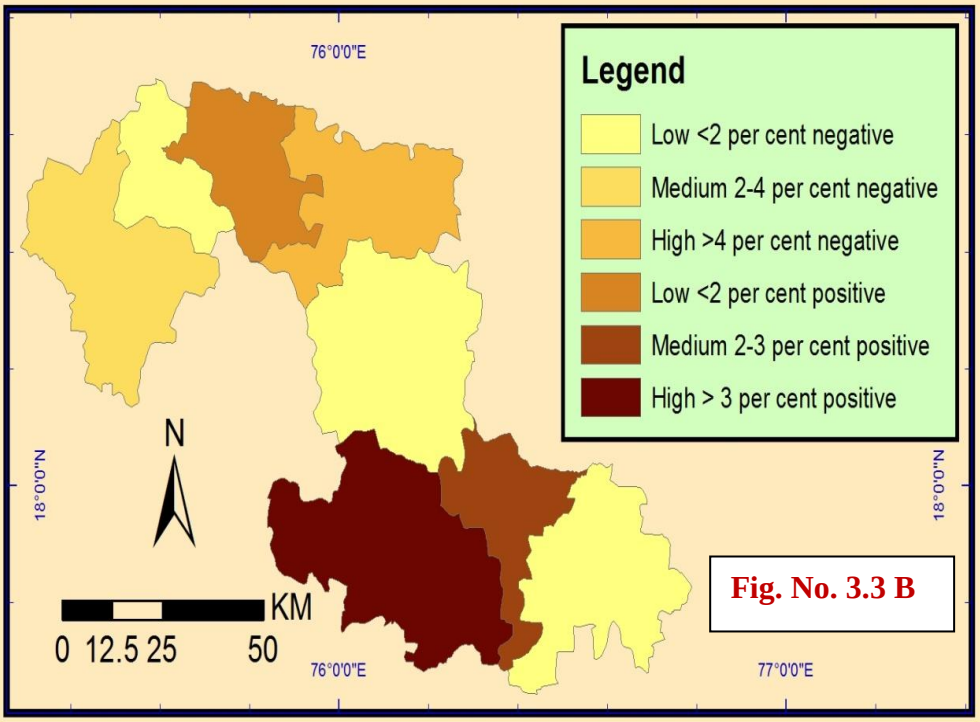

Fig. No. 3.3 B

V) Current Fallow Land:

This class comprises the cropped area which is kept fallow during the current year only. The Table no. 3.2 indicates that, during 1999-04, out of total geographical area. 6.39 percent area was under current fallow land in the Osmanabad district. The tehsil level analysis varies from 3.59 to 9.14 percent. The table No. 3.2 also shows that low proportion of area under current fallow land was observed in the Tuljapur and Lohara tehsils i.e. < 5 percent. The medium area under current fallow land was found in the Bhum, Washi and Kallam tehsils i.e. 5 to 7 percent, whereas it was high in the Paranda and Osmanabad tehsils i.e. > 7 percent.

During 2009-14, the district as a whole has 5.43 percent was area under current fallow land that of state is 4.44 percent. The tehsil level analysis reveals great variation ranging from 2.55 to 8.04 percent. The table no. 3.2 and Fig.no. 3.4 A exhibits that low proportion of area under current fallow land was in the Osmanabad and Kalam tehsils i.e. < 4 percent. The medium area under current fallow land is recorded in the Paranda and Lohara tehsil i.e. 4 to 6 percent, whereas it was high in the Bhum, Washi, Omerga and Tuljapur tehsils i.e. > 6 percent because of adverse condition of rainfall and poor irrigation facilities, therefore farmers think that it is better to keep fallow land instead of accepting risk.

Changes in Current fallow land:

During the period of investigation, district as a whole has 0.95 percent negative change in current fallow land. Considering tehsil level analysis, both positive and negative changes are observed. The Table no. 3.2 and Fig. no. 3.4 B indicates that low positive change in area under current fallow land was observed in Bhum and Lohara tehsils i.e. <1.5 percent. The medium positive change in area under current fallow land was observed in Washi tehsil i.e. 1.82 percent, whereas it was high in Tuljapur tehsil i.e. 4.08 percent due to adverse climatic condition.

The low negative change is seen in Omerga tehsil i.e. 0.66 percent. The medium negative change in this category is found in Paranda and Kalam tehsils i.e. from 2.5 to 5 percent, whereas the high negative change was found in Osmanabad tehsil i.e. > 6.58 percent due to development of surface irrigation facilities.

CURRENT FALLOW LAND IN OSMANABAD DISTRICT (2009-10 TO 2013-14)

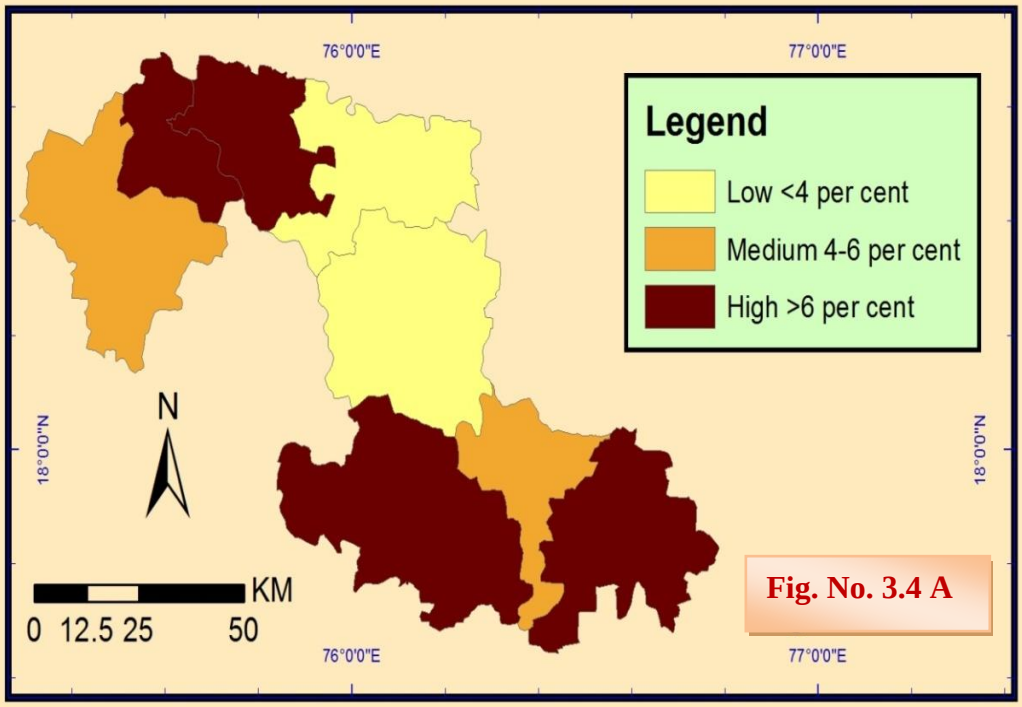

Fig. No. 3.4 A

VOLUME OF CHANGE IN CURRENT FALLOW LAND (1999-00 to 2013-14)

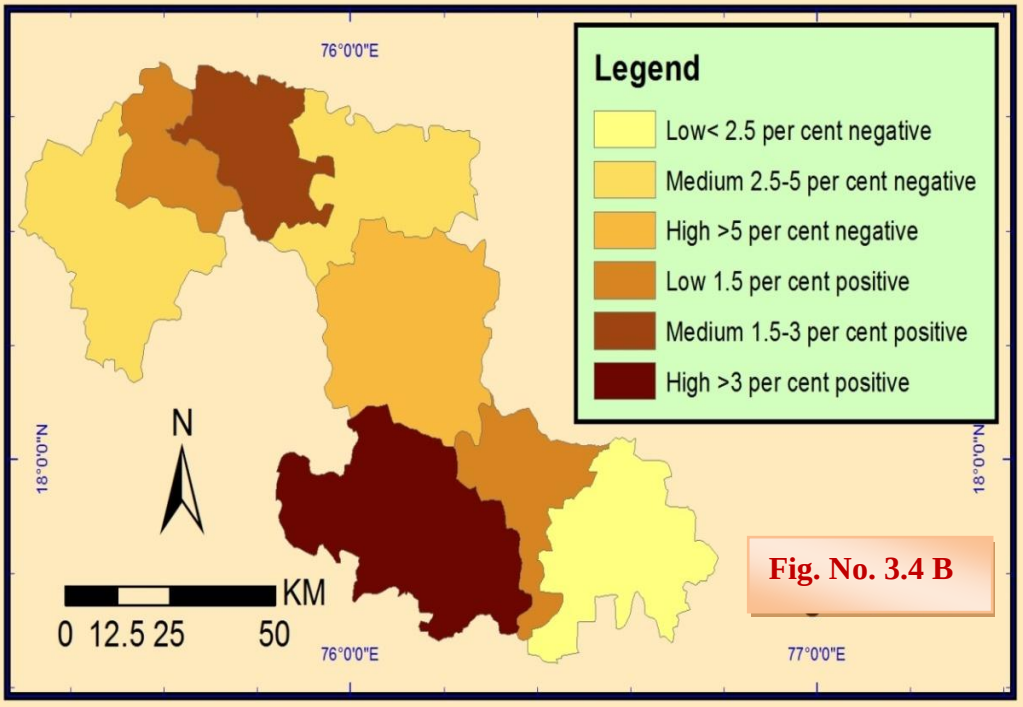

Fig. No. 3.4 B

VI) Net Sown Area:

The net sown area is the actual area under crops sown once in the same year. This category constitutes the extent of the cropped land in any region, which is of vital significance in studies regarding to agricultural geography (Shinde S.D., 1974).

During 1999-04, out of total geographical area 76.50 percent area was net sown area in the study region. The tehsil level analysis varies from 71.54 to 86.21 percent. The table No. 3.2 also shows that low proportion of net sown area was observed in Kalam, Tuljapur and Omerga tehsils i.e. < 76 percent. The medium proportion of net sown area was found in Paranda, Bhum, Washi and Osmanabad tehsils i.e. 76 to 81 percent, whereas it was high in Lohara tehsil i.e. > 81 percent.

During 2009-14, district as a whole has 78.26 percent net sown area out of total geographical area that of state is 56.45 percent. The tehsil level analysis reveals great variation ranging from 71.92 to 88.70 percent. The table No. 3.2 and Fig. no. 3.5 A indicates that low proportion of net sown area is observed in Washi and Tuljapur tehsils i.e. < 77.5 percent. The medium proportion of this category is recorded in Paranda, Bhum Omerga and Lohara tehsil i.e. 77.5 to 83 percent, whereas it was high in Kalam and Osmanabad tehsils i.e. > 83 percent due to the shifting of land in the other categories such as land for housing, industrial establishment and various other purposes.

Changes in Net Sown Area:

During the period of investigation, the net sown area was increased by 1.76 percent in Osmanabad district. Considering tehsil level analysis, both positive and negative changes are observed in net sown area. The Table no. 3.2 and Fig. no. 3.5 B indicates that low positive change in net sown is observed in Paranda and Tuljapur tehsils i.e. <6 percent. The medium positive change in net sown area is observed in Osmanabad and Omerga tehsils i.e. from 6 to 11 percent whereas it is high in Kalam tehsil i.e. 16.92 percent because of other uncultivable land is brought under cultivation with the growth of population.

The low negative change was seen in Bhum tehsil i.e. 1.09 percent whereas the high negative change was found in Washi and Lohara tehsils tehsil i.e. > 3 percent as they are fall into the high scarcity condition.

NET SOWN AREA OF OSMANABAD DISTRICT
(2009-10 TO 2013-14)

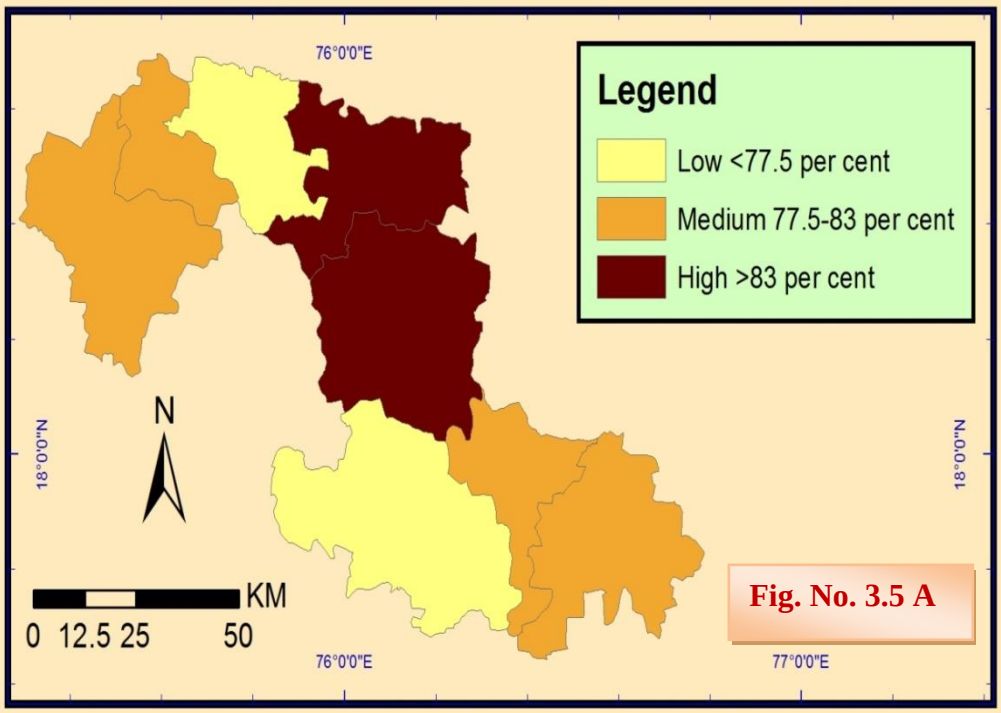

Fig. No. 3.5 A

VOLUME OF CHANGE IN NET SOWN AREA
(1999-00 to 2013-14)

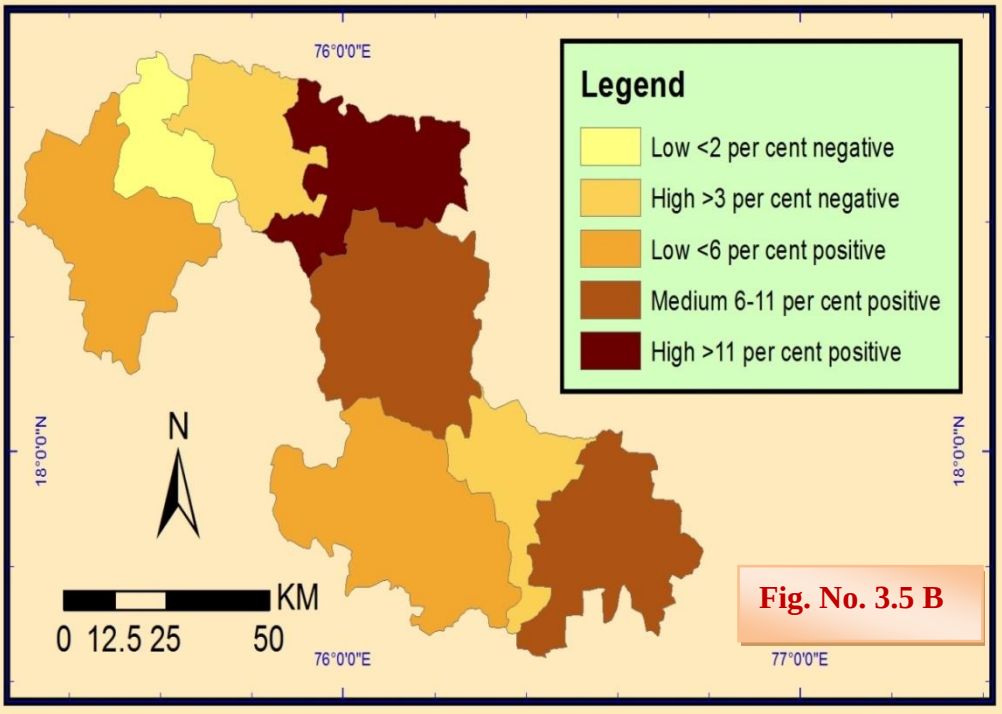

Fig. No. 3.5 B

3.2.2 Correlation and Transformation of General Land Use:

Transformation means the process of transforming (Webster's Collegiate Dictionary, 2004). The transformation of general land use means alternation in land use category due to cultural factors. Land use / land cover study has key role in scientific study. Throughout the world, emphasis has been given on such study due to increasing demand for land as its limited availability (Vaidya & Nannaware, 2013). Systematic utilization of land is able to promote economic and cultural development. Without utilization of land, one cannot think of any progress. With a shift towards modernization and globalization, land use land cover has been changing remarkably all over world (Rath P. K. etc., 2009). Due to the growth of population, many changes in land-use have taken place. Forest and grassland are converted into agricultural, industrial, settlement, and transportation and mining land. Because of ever increasing population pressure on land, the land resources are depleting rapidly.

The study of transformation of land utilization is of immense value in tracing out the use of land in the past and its future trends. Through the study of transformation of land utilization, one can predict its future use and evolve land-use planning of a particular region. Therefore attempt is made here to study the transformation of land use in Osmanabad district.

To determine correlation and transformation of agricultural land use, the Karl Pearson's formula i. e.

$$r = \frac{\Sigma xy}{\sqrt{\Sigma x^2 \Sigma y^2}}$$

is used and the value of coefficient of correlation is calculated. Correlation between different land use categories gives idea about mutual transfer of area between different land use categories. The total geographical area has been divided in to five categories Viz. Area under forest, Area not available for cultivation, Other uncultivable land, Fallow land and Net area sown naturally a change in one followed by a change in another or all the reaming categories. The co-efficient of correlation of each of the category with rest of the categories have been calculated. On the basis of value of negative correlation the transformation of land use is determined and conclusions are drawn.

A] Positive Correlation between Different Land-Use Categories:

1. Positive correlation of area under forest to other categories:

The table no. 3.3 A indicates that the district as a whole has high positive correlation between area under forest to net sown area which is amounted at + 0.8562 co-efficient of correlation.

I. The table no. 3.3 B reveals that high positive correlation between area under forest and area not available for cultivation is found in Kalam and Osmanabad tehsils which amounted at + 0.9534 and 0.8081 co-efficient of correlation respectively.

II. The high positive correlation between area under forest and other uncultivable land is recorded only in Kalam tehsil which is amounted at + 0.8837.

III. The high positive correlation between area under forest with fallow land is found in Paranda,Tuljapur and Kalam tehsil which is amounted from +0.7850 to +0.9382 coefficient of correlation.

Table 3.3 A : Matrix of co-efficient of correlation between different categories of General land-use of Osmanabad District.

Region	Categories	A	B	C	D	E
Osmanabad District	A	-	0.55125	-0.9181	-0.77818	0.85626
	B		-	0.20553	0.26622	-0.80404
	C			-	0.84361	-0.6529
	D				-	-0.75403
	E					-

Source: Compiled by Researcher

Note : Where,

A = Area under forest, **B** = Area not available for cultivation,

C = Other uncultivable land, **D** = Fallow land, **E** = Net area sown

Source: Compiled by Researcher on the basis of Socio Economic Review and Distric Statistical Abstract of Osmanabad District 1999-2004 to 2009-14.

IV. The high positive correlation between area under forest to net sown area is recorded in Osmanabad (+0.8105) and Omerga (+0.8857) tehsils which is very better sign for human being and environment.

2. Positive Correlation Of Area Not Available For Cultivation To Other Categories:

I. The high positive correlation between area not available for cultivation to other uncultivable land is found in Kalam tehsil which amounted at + 0.7747 coefficient of correlation.

II. The high positive correlation between area not available for cultivation with fallow land is recorded in Kalam tehsil which amounted at + 0.8542 coefficient of correlation.

3. Positive correlation of other uncultivable land to other categories:

I. The high positive correlation of other uncultivable land with fallow land is found in Washi and Kalam tehsils which amounted by + 0.7731 and + 0.9636 respectively.

B] Negative Correlation between Different Land-Use Categories and Transformation of land use:

1. Transformation of area under forest into rest of categories:

The table no. 3.3 A exhibits that the district as a whole, area under forest have high negative correlation with other uncultivable land and fallow land amounted by -0.77 and -0.91respectively during the period of investigation. However, tehshil level analysis varies, which is as following.

I. During the period of investigation, very high negative correlation between area under forest and area not available for cultivation is found in Tuljapur, Omerga and Lohara tehsils, which ranges from -0.68 to -0.84 coefficient of correlation. In Lohara tehsil area under forest is decreased indicates that it is converted into area not available for cultivation. Whereas in Tuljapur and Omerga tehsils area under forest is increased due to the afforestation, it indicates that area not available for cultivation is converted into forest area.

II. During the period of investigation, high negative correlation between area under forest and other uncultivable land is found in Tuljapur and Omerga tehsils(r = - 0.82, -0.93). In both tehsils the area under forest is increased which indicates that the other uncultivable land is converted into forest area due to afforestation.

III. High negative correlation between area under forest and fallow land is found Osmanabad tehsil amounted by-0.91 coeeficient of correlation which indicates that fallow land is transferred into forest area due to afforestation.

IV. High negative correlation between area under forest and net sown area is observed in Paranda and Kalam tehsils amounted by -0.68 to -0.98, area under forest is decreased and increase in net sown area indicates that area under forest is converted into net sown area.

2. Transformation of Area not available for cultivation into other Categories:

I. During the period of under review, high negative correlation between area not available for cultivation and net sown area is found Kalam tehsil, which is amounted by -0.94. The area not available for cultivation is decreased which is converted into net sown area due to the man made siltation of alluvial soil on barren lands.

II. High negative correlation between area not available for cultivation and fallow land is recorded in Tuljapur tehsil, which is amounted by -0.85 co-efficient of correlation. The fallow land is increased while area not available for cultivation is decreased which reveals that the the land put to non agricultural uses and barren land is converted into fallow land.

3. Transformation of other uncultivable land to other Categories:

I. The table 3.3 B reveals that other uncultivable land has high negative correlation with fallow land only in Paranda tehshil, which is amounted by -0.76 co-efficient of correlation, which indicates that fallow land is converted into cultivable waste, permanent pasture and groves.

II. High negative correlation between other uncultivable land and net area sown is found in Washi, Kalam and Omerga tehsils, which is amounted by -0.67 to 0.91 co-efficient of correlation. During the period of investigation the net sown area is decreased in Washi, which is transferred in other uncultivable land i.e. cultivable waste, permanent pasture and groves in this tehsil. In Kalam and Omergatehsils, other uncultivable land is decreased which is converted into net sown area.

4. Transformation of Fallow Land into Net area sown:

The table 3.3 B indicates that the district as whole has high negative correlation between fallow land and Net area sown during the period of investigation. The spatial analysis also reveals that, there is high negative correlation between fallow land and net area sown is found in all tehsils of study region except Tuljapur tehsil ranging from -0.83 to-0.97. In Washi and Lohara fallow land is increased which indicates that much of the net sown area is converted into fallow land due to inadequate insufficient and unpredictable rainfall and lack of perennial irrigation facilities. In Omerga, Osmanabad, Kalam and Paranda tehsils fallow land is

decreased which is converted into net sown area due to development of irrigation facilities.

Table 3.3 B : Matrix of Co-efficient of Correlation between different categories of General Landuse at tehsil level.

Tehsil	Category	A	B	C	D	E
1.Paranda	A	-	0.59955	-0.664205	0.861492	-0.683073
	B		-	-0.437222	0.696977	-0.66319
	C			-	-0.765863	0.625182
	D				-	-0.944455
	E					-
2. Bhum	A	-	0.564153	0.172404	0.099595	-0.296758
	B		-	0.468898	-0.604518	0.327678
	C			-	-0.466714	0.324025
	D				-	-0.905963
	E					-
3.Washi	A	-	-0.40368	0.677975	0.202225	-0.348628
	B		-	0.206959	0.57895	-0.41886
	C			-	0.773145	-0.828775
	D				-	-0.945342
	E					-
4.Kalam	A	-	0.953448	0.883701	0.938289	-0.984431
	B		-	0.774763	0.854275	-0.943291
	C			-	0.963639	-0.916558
	D				-	-0.975203
	E					-
5. Osmanabad	A	-	0.808811	0.445644	-0.912401	0.810915
	B		-	-0.121389	-0.567189	0.407893
	C			-	-0.580344	0.658676
	D				-	-0.966172
	E					-
6.Tuljapur	A	-	-0.68348	-0.939423	0.785051	-0.19585
	B		-	0.442886	-0.850532	-0.218006
	C			-	-0.59363	0.328517
	D				-	-0.251783
	E					-
7. Lohara	A	-	-0.84817	-0.125355	-0.654365	0.48049
	B		-	-0.353491	0.260413	-0.162299
	C			-	0.602854	-0.66518
	D				-	-0.893467
	E					-
8. Omerga	A	-	-0.81297	-0.822857	-0.583512	0.885743
	B		-	0.668444	0.111914	-0.609652
	C			-	0.59513	-0.89607
	D				-	-0.837236
	E					-

Source: Compiled by Researcher

3.3 AGRICULTURAL LAND USE:

3.3.1 Introduction:

Agricultural land use is a portion of area used to grow different crops during the agricultural year. In other words cropping patterns are the extent to which the arable land under different agricultural activities can be put to use (Singh and Dhillon, 1987). Cropping pattern is, however, a dynamic concept as it changes over space and time because of it is a combine effect of physical, social, economic and technological factors at the particular time (Husain M, 1996).

The crop association provides an adequate understanding of land and integrative reality that demands distributional analysis (Mohammad Ali, 1978). The study of agricultural land use not only provides base for understanding the complex structure of agricultural landscape of the region, but also helps for better planning. In this context effort is made to study the cropping pattern and overall changes in cropping pattern and crop combinations changes.

Cropping pattern of study region is typical of an underdeveloped agricultural economy. Varieties of crops are grown in the study region. The overall cropping pattern of the study region is outlined and it is followed by a discussion of the individual crop, calculating the percentage of strength for each tehsil derives the relative strength of the crop grown.

There is spatial variation in cropping pattern upon rainfall and soil condition therefore detailed analysis of each tillage crop based on quinquiennial average and respective changes therein as follow.

3.3.2 Cropping Pattern:

The most of the area of study region comes under the drought prone area, where seasonal and uncertain rainfall is the main characteristics. Therefore, agricultural of the area depend on irrigation. Implementation of new technological inputs, machineries, high yielding varieties of seeds, commercial crops, chemical fertilizers and irrigation facilities supported to the agriculture and agricultural pattern. The cropping patterns of the study region is very typical because both dry land culture and irrigated culture are directly governed by other geographical factors and modified by the emergent social and economic circumstances. Therefore present section deals with cropping pattern and changes of crops in the Osmanabad district. The crops of the region are classified into A) Food crops and B) Non-food crops.

A) Food crops:

Food crops are very dominant in cropping pattern of the study region. During 2009-10 to 2013-14, the district as a whole has 75.91 percent area under food crops that of state is 64.92 percent. The Table no. 3.4 shows the regional variation of food crops ranging from 70.16 to 84.48 percent of the total cropped area. The high proportion of the area under food crop is found in Paranda and Bhum tehsils i.e. > 80 percent. The moderate proportion of area under food crops is found in Lohara, Omerga and Tuljapur tehsil i.e. from 75 to 80 percent whereas it is low in Washi, Kalam and Osmanabad tehsil i.e. < 75 percent due to the development of irrigation facilities the farmers have change their trend from food crop to cash crops (Fig. no. 3.6 A).

The change that has occurred in food crops distribution during the period of investigation is shown in the Fig. no. 3.6 B. The district as a whole has negative change in area under food crops i.e. 1.97 percent. However tehsil level analysis reveals both positive and negative changes; the low negative change was observed in the tehsil of Tuljapur i.e. 0.73 percent. The moderate negative change is recorded in Osmanabad and Lohara tehsils i.e. from 3 to 6 percent, whereas remarkable decrease is found in tehsils of Washi and Kalam i.e. > 6 percent due to the tendency of farmers is to grow oilseed like soyabean as a cashcrop. The low positive change was observed in Bhum tehsil i.e. 2.21 percent. It is moderate in Paranda tehsil i.e. from 3.80 percent whereas the high positive change was observed in Omerga tehsil i.e. 4.77 percent.

1. Cereals:

In this category Jowar, Wheat, Bajara and Maize are important food grain crops. Jowar is the major cereal crop of the study region. During 2009-2014, the district as a whole has 43.49 percent of area under cereal crops. The Fig. no. 3.7 A and B shows the regional variation in cereal crops ranging from 35 to 54 percent of the total cropped area. The high proportion of the area under cereal crop was in Paranda and Bhum tehsils i.e. > 48 percent. The moderate area under cereal crop was found in Washi, Kalam and Tuljapur tehsil i.e. from 41 to 48 percent whereas it is low in Lohara, Omerga and Osmanabad tehsil i.e. < 41 percent. During the period of investigation, the district as a whole has 5.14 percent decrease in the area under cereal crops. However tehsil level analysis reveals considerable changes; the low negative change was observed in the tehsil of Bhum i.e. 0.72 percent, whereas remarkable decrease was found in tehsils of Kalam, Osmanabad, Lohara and Omerga i.e. > 6

Table no. 3.4: Agricultural Land use Pattern in Osmanabad District (1999-00 to 2003-04 and 2009-10 to 2013-14)

Tehsil	Paranda			Bhum			Washi			Kalam		
Crops	% area to gross cropped area		% of volume change	% area to gross cropped area		% of volume change	% area to gross cropped area		% of volume change	% area to gross cropped area		% of volume change
	1999-00 to 2003-0404	2009-10 to 2013-14		1999-00 to 2003-0404	2009-10 to 2013-14		1999-00 to 2003-0404	2009-10 to 2013-14		1999-00 to 2003-0404	2009-10 to 2013-14	
Rice	0.42	0.17	-0.25	1.86	0.32	-1.55	0.77	1.09	0.32	0.86	0.44	-0.41
Wheat	2.7	1.98	-0.72	2.6	6.76	4.16	2.97	3.8	0.83	1.73	1.09	-0.64
Jowar	47.32	47.83	0.51	42.61	38.03	-4.59	40.5	35.78	-4.71	45.41	38.92	-6.49
Bajri	2.77	1.44	-1.33	3.27	3.68	0.41	4.13	1.96	-2.17	1.23	1.29	0.06
Maize-MAKA	0.74	2.53	1.79	1.9	2.62	0.72	1.11	3.03	1.91	1.41	1.31	-0.1
Other Cereals	0.1	0.14	0.04	0.12	0.27	0.14	0.08	0.23	0.15	0.12	0.13	0.01
Total Cereals	**54.07**	**54.08**	**0.02**	**52.39**	**51.67**	**-0.72**	**49.56**	**45.88**	**-3.68**	**50.8**	**43.28**	**-7.53**
Mung	1.44	1.06	-0.37	1.95	1.67	-0.28	2.63	0.96	-1.67	3.48	2.17	-1.31
Gram	9.08	10.55	1.47	8.28	6.54	-1.74	7.03	6.35	-0.68	6.21	6.77	0.56
Tur	8.49	7.72	-0.77	8.2	10.86	2.66	10.78	7.97	-2.81	7.74	8.95	1.2
Urid	2.19	0.66	-1.53	5.34	6.23	0.89	5.17	3.28	-1.89	3.98	1.82	-2.16
Other Pulses	0.76	0.19	-0.57	0.62	0.38	-0.24	0.76	0.26	-0.51	0.67	0.47	-0.2
Total Pulses	**21.96**	**20.19**	**-1.77**	**24.39**	**25.67**	**1.29**	**26.37**	**18.82**	**-7.55**	**22.07**	**20.17**	**-1.9**
Total Food Grains	**76.03**	**74.28**	**-1.75**	**76.77**	**77.34**	**0.56**	**75.93**	**64.7**	**-11.23**	**72.87**	**63.45**	**-9.43**
Sugarcane	2.73	6.76	4.04	2.26	3.27	1.01	2.1	4.49	2.39	4.13	5.05	0.92
Total Fruits	**0.68**	**1.59**	**0.9**	**0.59**	**1.14**	**0.55**	**1.08**	**1.15**	**0.07**	**0.46**	**0.57**	**0.11**
Total fiber crops	**0.96**	**0.91**	**-0.05**	**1.56**	**6.03**	**4.46**	**2.62**	**7.63**	**5**	**2.52**	**3.56**	**1.04**
Groundnut	0.81	0.91	0.11	0.78	0.22	-0.56	2.01	0.32	-1.69	1.45	0.57	-0.88
Total Vegetables	**0.44**	**1.22**	**0.78**	**0.33**	**0.78**	**0.44**	**0.58**	**1.4**	**0.82**	**0.7**	**0.87**	**0.17**
Total veg.Fruit crops	**1.13**	**2.8**	**1.68**	**0.92**	**1.91**	**0.99**	**1.66**	**2.55**	**0.89**	**1.16**	**1.44**	**0.28**
Other fiber crops	0.72	0	-0.72	0.97	0	-0.97	0.6	0	-0.6	0.57	0	-0.57
Sunflower	7.5	0.26	-7.24	8.1	2.23	-5.87	4.83	1.45	-3.38	8.43	1.69	-6.74
Seasamum (Til)	0.39	5.35	4.96	0.73	0.23	-0.51	0.55	0.34	-0.21	0.96	0.95	0
Safflower	5.81	0.26	-5.55	1.98	1.19	-0.78	2.74	0.95	-1.79	2.74	2.65	-0.08
Linseed (Jawas)	0.83	3.77	2.93	1.34	0.45	-0.89	1.23	0.28	-0.94	1.12	0.76	-0.35
Soyabeen	0.19	0.18	-0.01	0.61	3.85	3.23	0.76	15.09	14.33	0.97	17.97	17
Other oil seeds	1.43	1.05	-0.38	2.23	0.17	-2.06	3.14	0.45	-2.69	2.44	0.42	-2.02
Total oil seeds	**16.96**	**11.78**	**-5.18**	**15.77**	**8.34**	**-7.44**	**15.26**	**18.89**	**3.63**	**18.1**	**25.03**	**6.93**
Grazing crops	1.38	1.03	-0.35	1.88	2.64	0.76	1.81	1.24	-0.57	0.82	1.23	0.42
Total non food crops	**19.32**	**13.82**	**-5.5**	**19.23**	**17.02**	**-2.21**	**19.7**	**27.79**	**8.09**	**21.45**	**29.84**	**8.39**
Total Food crops	**80.68**	**84.48**	**3.8**	**80.77**	**82.98**	**2.21**	**80.3**	**72.21**	**-8.09**	**78.55**	**70.16**	**-8.39**

Table No. 3.4 Continue…..

Tehsil	Osmanabad			Tuljapur			Lohara			Omerga			District		
	% area to gross cropped area		% of volume change	% area to gross cropped area		% of volume change	% area to gross cropped area		% of volume change	% area to gross cropped area		% of volume change	% area to gross cropped area		% of volume change
Crops	**1999-00 to 2003-0404**	**2009-10 to 2013-14**		**1999-00 to 2003-0404**	**2009-10 to 2013-14**		**1999-00 to 2003-0404**	**2009-10 to 2013-14**		**1999-00 to 2003-0404**	**2009-10 to 2013-14**		**1999-00 to 2003-0404**	**2009-10 to 2013-14**	
Rice	1.01	0.53	-0.48	2.4	2.51	0.12	1.01	1.08	0.07	3.07	2.38	-0.69	1.42	1.17	-0.25
Wheat	3.74	4.17	0.42	2.99	3.1	0.12	2.79	3.36	0.57	2.85	2.15	-0.7	2.87	3.19	0.32
Jowar	41.42	31.76	-9.67	36.51	33.2	-3.31	43.48	28.78	-14.7	32.42	25.03	-7.38	40.62	34.59	-6.04
Bajri	0.97	0.37	-0.6	1.17	1.23	0.06	2.13	3.24	1.11	3.02	3.56	0.54	2.08	1.86	-0.22
Maize-MAKA	1.13	1.5	0.37	2.1	5.14	3.04	0.94	0.9	-0.04	1.01	1.18	0.17	1.36	2.42	1.07
Other Cereals	0.11	0.11	0	0.19	0.2	0.01	0.15	0.58	0.43	0.25	0.28	0.03	0.15	0.21	0.07
Total Cereals	**48.42**	**38.43**	**-9.99**	**45.36**	**45.46**	**0.1**	**50.51**	**38.12**	**-12.39**	**42.62**	**34.58**	**-8.04**	**48.62**	**43.49**	**-5.14**
Mung	2.33	1.61	-0.72	3.77	2.73	-1.03	2.51	1.84	-0.66	2.73	2.12	-0.61	2.71	1.88	-0.83
Gram	5.31	8.3	2.99	5.15	4.81	-0.33	8.88	7.1	-1.78	6.61	10.24	3.63	6.67	7.57	0.89
Tur	8.74	8.63	-0.1	12.67	12.2	-0.48	8.61	9.4	0.79	7	10.78	3.78	9.25	9.76	0.52
Urid	5.98	5.05	-0.93	4.54	5.23	0.69	5.89	8.37	2.48	6.16	11.22	5.07	4.93	5.23	0.29
Other Pulses	0.6	0.23	-0.37	0.76	0.24	-0.53	0.81	0.4	-0.41	0.72	0.28	-0.44	0.7	0.29	-0.41
Total Pulses	**22.95**	**23.82**	**0.87**	**26.89**	**25.21**	**-1.68**	**26.69**	**27.11**	**0.41**	**23.21**	**34.64**	**11.43**	**24.26**	**24.72**	**0.46**
Total Food Grains	**71.36**	**62.24**	**-9.12**	**72.25**	**70.67**	**-1.58**	**77.2**	**65.22**	**-11.98**	**65.83**	**69.23**	**3.39**	**72.89**	**68.21**	**-4.68**
Sugarcane	2.77	5.88	3.11	3.21	3.71	0.5	1.3	5.94	4.63	4.32	4.81	0.5	3	4.96	1.97
Total Fruits	**0.99**	**1.39**	**0.4**	**0.78**	**1.04**	**0.26**	**0.75**	**1.1**	**0.35**	**0.61**	**0.71**	**0.1**	**0.75**	**1.08**	**0.33**
Total fiber crops	**0.34**	**0.26**	**-0.07**	**0.15**	**0.02**	**-0.13**	**0.73**	**0.35**	**-0.38**	**1.42**	**2.44**	**1.02**	**1.11**	**2.13**	**1.02**
Groundnut	1.17	0.49	-0.68	2.12	1.23	-0.89	2.15	2.7	0.55	1.97	0.65	-1.32	1.56	0.83	-0.73
Total Vegetables	**0.77**	**1.17**	**0.39**	**0.63**	**0.84**	**0.21**	**0.61**	**1.44**	**0.83**	**0.54**	**1.82**	**1.27**	**0.6**	**1.16**	**0.56**

Total veg.Fruit crops	**1.77**	**2.56**	**0.79**	**1.41**	**1.88**	**0.47**	**1.36**	**2.54**	**1.19**	**1.15**	**2.52**	**1.37**	**1.35**	**2.25**	**0.9**
Other fiber crops	0.18	0	-0.18	0.12	0	-0.12	0.31	0	-0.31	1.05	0	-1.05	0.51	0	-0.51
Sunflower	8.27	3.09	-5.18	8.52	7.87	-0.65	7.68	3.82	-3.86	8.71	5.78	-2.93	7.97	3.71	-4.26
Seasamum (Til)	0.72	0.4	-0.32	0.61	0.31	-0.3	0.64	0.36	-0.28	1.43	1.21	-0.22	0.77	1.12	0.36
Safflower	2.58	2.28	-0.31	2.7	3.48	0.78	2.4	3.19	0.79	4.34	3.98	-0.35	3.13	2.42	-0.71
Linseed (Jawas)	2	0.54	-1.46	1.33	0.65	-0.68	1.55	1.5	-0.05	2.1	1.58	-0.52	1.48	1.15	-0.33
Soyabeen	3.27	20.15	16.88	2.03	7.2	5.17	1.27	9.22	7.95	2.04	5.98	3.95	1.63	10.4	8.77
Other oil seeds	2.97	0.23	-2.74	3.07	0.74	-2.33	1.29	2.69	1.4	4.41	0.73	-3.68	2.75	0.71	-2.05
Total oil seeds	**20.98**	**27.18**	**6.2**	**20.4**	**21.49**	**1.1**	**16.98**	**23.48**	**6.5**	**25**	**19.93**	**-5.07**	**19.3**	**20.34**	1.05
Grazing crops	2.25	1.48	-0.77	1.93	1.69	-0.24	1.72	1.2	-0.52	1.32	0.61	-0.71	1.69	1.39	-0.3
Total non food crops	**23.59**	**28.95**	**5.36**	**22.49**	**23.23**	**0.73**	**19.44**	**25.05**	**5.62**	**27.76**	**22.99**	**-4.77**	**22.11**	**23.89**	**1.78**
Total Food crops	**76.41**	**71.05**	**-5.36**	**77.51**	**76.77**	**-0.73**	**80.56**	**74.95**	**-5.62**	**72.24**	**77.01**	**4.77**	**77.89**	**75.91**	**-1.97**

Source: *Compilled by Researcher on the basis of Crops and Season Reports & District Socioeconomic Review and District Statistical abstract of Osmanabad District (1999-00 to 2003-04 and 2009-10 to 2013)*

percent due to the farmer turn toward soyabean crop as cash crop which is more profitable than cereal crops. The negligible positive change was observed in Paranda and Tuljapur tehsils i.e. 0.10 and 0.02 percent respectively.

Jowar:

Jowar ranks first in the cropping pattern of the study region. Being a drought resistance crop, it is grown rain fed as well as irrigated crop. It requires 27˚C to 32˚C temperature and 50 to 100 cm rainfall. It is sown in both kharif and rabbi seasons. However in the study region it is sown mainly in rabbi season during September to October and harvested during March to April. The very low percentage of kharif Jowar was seen in the study region.

AREA UNDER FOOD CROPS OF OSMANABAD DISTRICT (2009-10 TO 2013-14)

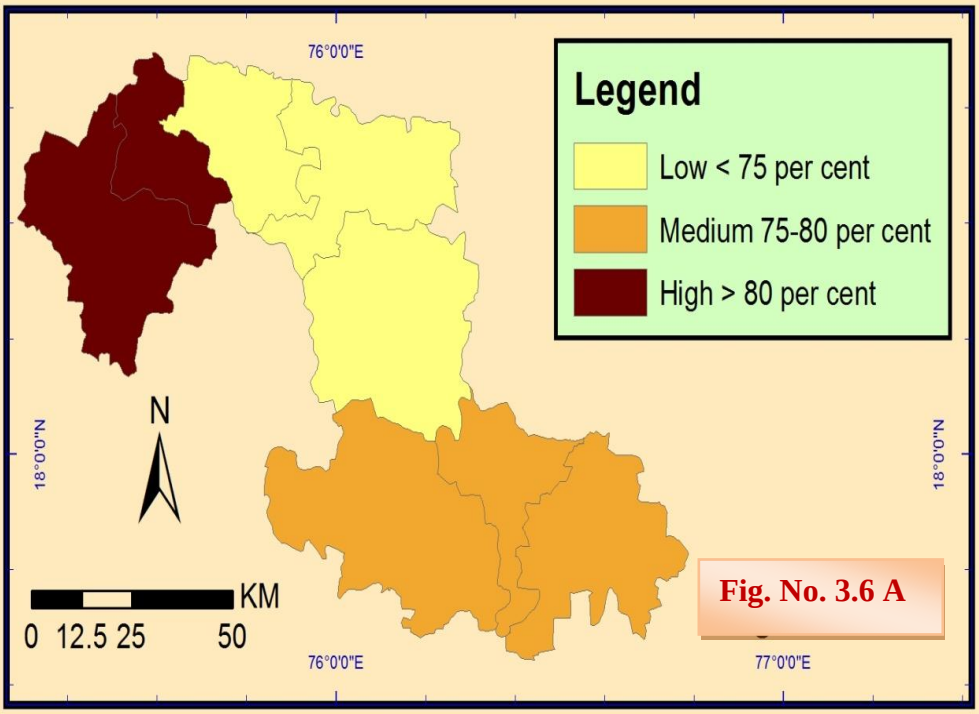

Fig. No. 3.6 A

VOLUME OF CHANGE IN AREA UNDER FOOD CROPS (1999-00 TO 2013-14)

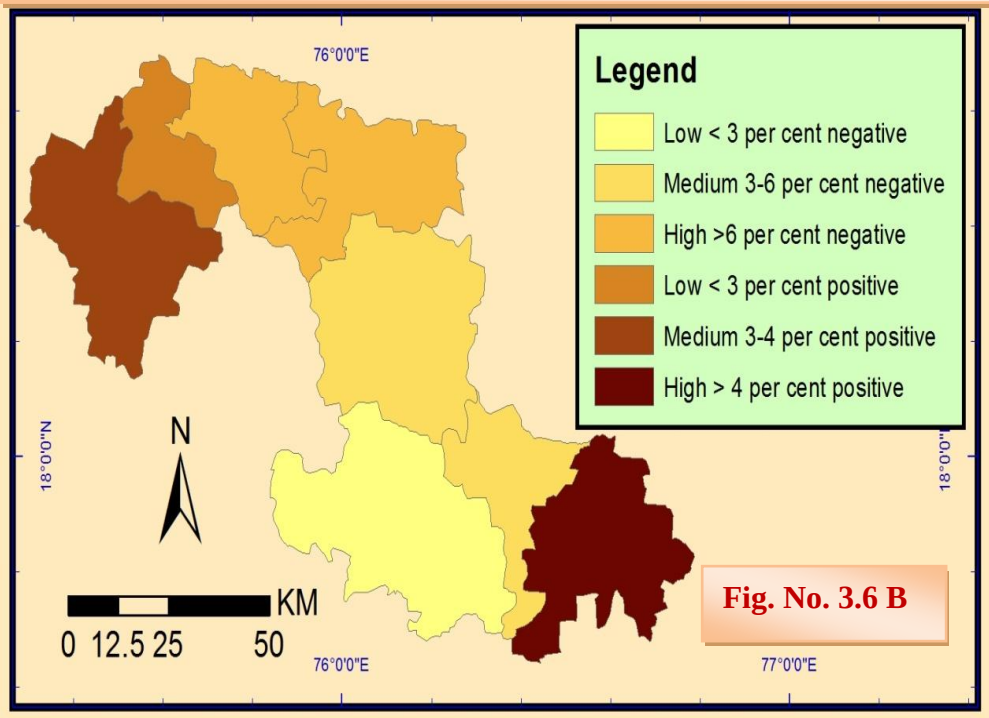

Fig. No. 3.6 B

During 2009-10 to 2013-14, the district as a whole has 34.59 percent of area under Jowar crop that of state is 16.15 percent. The high proportion of the area under Jowar crop was in Paranda tehsil i.e. > 47.83 percent due to low rainfall as Jowar is drought registance. The moderate proportion is found in Bhum, Washi, Kalam and Tuljapur tehsil i.e. from 33 to 40 percent whereas low proportion of Jowar crop was recorded in Lohara, Omerga and Osmanabad tehsil i.e. <33 percent.

During the period of investigation, the district as a whole has gradually decrease in the area under Jowar crop about 6.04 percent. However tehsil level analysis reveals that both positive and negative changes; the low negative change was observed in the tehsils of Bhum, Washi, Kalam and Tuljapur i.e. < 7 percent. The moderate negative change is occurred in Osmanabad and Omerga tehsils i.e. from 7 to 11 percent whereas high negative change was found in Lohara tehsil i.e. > 14.70 percent due to the increase in area under sugarcane with development of surface irrigation facilities. The negligible positive change was observed in Paranda tehsil i.e. 0.51 percent.

Wheat:

Wheat ranks second among the cereals in the cropping pattern of the study region during 2009-14. Wheat is a rabbi crop and requires winter temperature between 10˚C to 20˚C. It can also be grown in areas where rainfall is less than 50 cm with the help of irrigation. In the study region, post monsoon rainfall is not sufficient for maximum production. The extent of irrigation provided to this crop determines its areal extent and yielding capacity. Wheat is generally sown in October and harvested in the month of February.

During 2009-10 to 2013-14, the district as a whole has 3.19 percent of area under Wheat crop that of state is 4.43 percent. However, within the district the proportion of Wheat varies from 1.09 to 6.76 percent of total cropped area. The high concentration of Wheat is observed in Osmanabad and Bhum tehsils i.e. > 4 percent due to development of irrigation facilities and high yielding seeds. The moderate proportion is found in Washi, Lohara and Tuljapur tehsil i.e. from 3 to 4 percent whereas low proportion of Wheat was recorded in Paranda, Kalam and Omerga tehsils i.e. < 3 percent.

During the period of investigation, the district as a whole has negligible positive change about 0.32 percent. The low positive change was found in Washi,

AREA UNDER CEREAL CROPS OF OSMANABAD DISTRICT (2009-10 TO 2013-14)

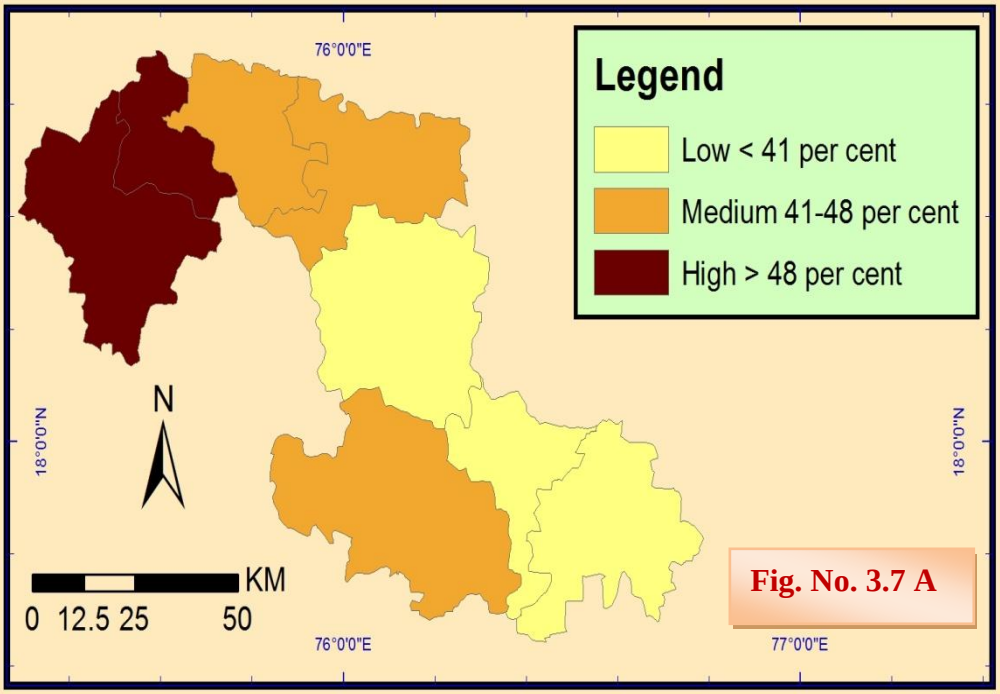

Fig. No. 3.7 A

VOLUME OF CHANGE IN AREA UNDER CEREAL CROPS (1999-00 TO 2013-14)

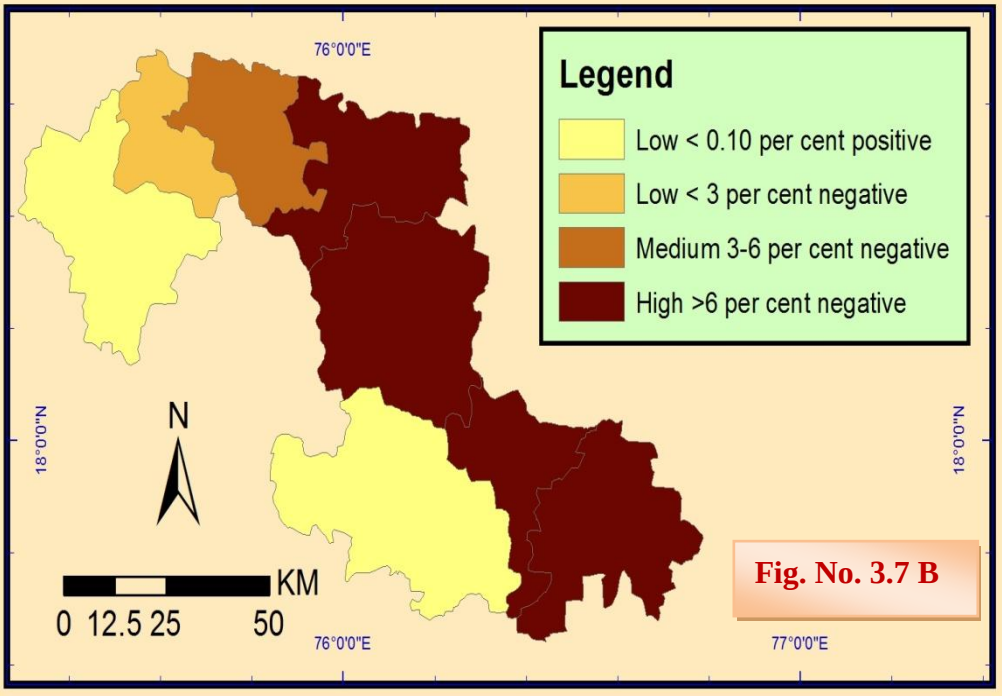

Fig. No. 3.7 B

Osmanabad, Tuljapur and Lohara tehsils i.e. < 1.5 percent whereas the high positive change was found only in Bhum tehsil i.e. 4.16 percent due to the high availability of groundwater. The low negative change was observed in Kalam tehsil i.e. < 0.65 percent. The negligible negative change is observed in Paranda, Kalam and Omerga tehsil i.e. < 1 percent.

Bajara:

It is inferior kharif foodgrain and rank fourth among cereals in the region. Bajara is the most drought resistant crop requires less amount of rainfall i.e. 50 cm and sustains on shallow, black lighter soil or inferior land. Generally it is sown in the June-July and harvested in the September.

During 2009-10 to 2013-14, the district as a whole has 1.86 percent of area under Bajara that of state is 4.05 percent. However, within the district the proportion of Bajara varies from 0.37 to 3.68 percent of total cropped area. The high proportion of Bajara is observed in Omerga, Lohara and Bhum tehsils i.e. > 2.5 percent due to favorable soils and development of seasonal irrigation facilities, whereas low proportion of Bajara was recorded in Paranda, Kalam, Tuljapur and Osmanabad tehsils i.e. < 1.5 percent.

During the period of investigation, the district as a whole has negligible negative change about 0.22 percent. The low negative change was observed in the Osmanabad tehsil i.e. < 0.60 percent, whereas high negative change was found in Washi tehsil i.e. > 2.17 percent. The low positive change was found in Bhum, Kalam, Omerga and Tuljapur tehsils i.e. < 1.0 percent, whereas high positive change was found in Lohara tehsil i.e. 1.11 percent.

Maize:

Maize is mostly irrigated crop and ranks third among the cereal crops in the study region. It requires 75 cm rainfall and medium to high quality soil. It is an important crop as it provides food for human being as well as fodder (both wet and dry) to milch animals. It is grown in both kharif and rabbi season.

During 2009-10 to 2013-14, the district as a whole has 2.42 percent of area under Maize. However, within the district the proportion of Maize varies from 0.90 to 5.14 percent of total cropped area. The high proportion of Maize is observed in Tuljapur tehsil i.e. > 5.14 percent due to development of dairy farming as Tuljapur is religious tourist center. The moderate proportion is found in Bhum, Paranda and

Washi tehsils i.e. from 2 to 4 percent whereas low proportion of Maize was recorded in Osmanabad, Kalam, Lohara and Omerga tehsils i.e. < 2 percent.

During the period of investigation, the district as a whole has 1.07 percent positive change. The low positive change was found in Bhum, Osmanabad and Omerga tehsils i.e. < 1 percent. The moderate positive change in area under Maize is observed in Paranda and Washi tehsils i.e. from 1 to 2 percent, whereas high positive change is found only in Tuljapur tehsil i.e. 3.04 percent due to market of Tuljapur tehsils as Tuljapur is tourist center. The neglegible negative change was observed in the tehsils of Lohara and Kalam i.e. < 0.10 percent respectively.

Pulses:

The variety of pulses i.e. Tur, Gram, Udid, Mung, Matki and Hulga etc. are cultivated in the study region. Normally pulses are grown in kharif season. The soil and moisture requirement varies from pulses to pulses but generally, Tur is grown on fertile soil and Hulga on shallow soil.

During 2009-10 to 2013-14, the district as a whole has 24.72 percent of area under pulses that of state is 15.36 percent. The spatial distribution and changes in the area under pulses is depicted in fig. no. 3.8 A and B. However, within the district the proportion of pulses varies from 18.82 to 34.64 percent of total cropped area. The high proportion of pulses is observed in Omerga tehsil i.e. 34.64 percent due to favorable soil and the local availability of market i.e. Murum and Omerga. The moderate proportion is found in Bhum, Tuljapur and Lohara tehsils i.e. from 24.09 to 29.36 percent, whereas low proportion of pulses was recorded in Paranda, Washi Osmanabad and Kalam, tehsils i.e. < 24.09 percent.

During the period of investigation, the district as a whole has 0.46 percent positive change. The low positive change was found in Bhum, Osmanabad and Lohara tehsils i.e. < 4 percent whereas high positive change was found in Omerga tehsil i.e. > 8 percent. The low negative change was observed in Paranda, Kalam and Tuljapur tehsils i.e. < 4 percent whereas the high negative change was found in Washi tehsil i.e. >5.5 percent. (Fig. no. 3.8 B)

Tur:

For human being and livestock, Tur is an important pulse crop as a nutritive food. It also constitutes important chain in rotation system of crops from the viewpoint of soil management (Pawar C.T, 1989). It is sown in June-July and

AREA UNDER PULSES OF OSMANABAD DISTRICT (2009-10 TO 2013-14)

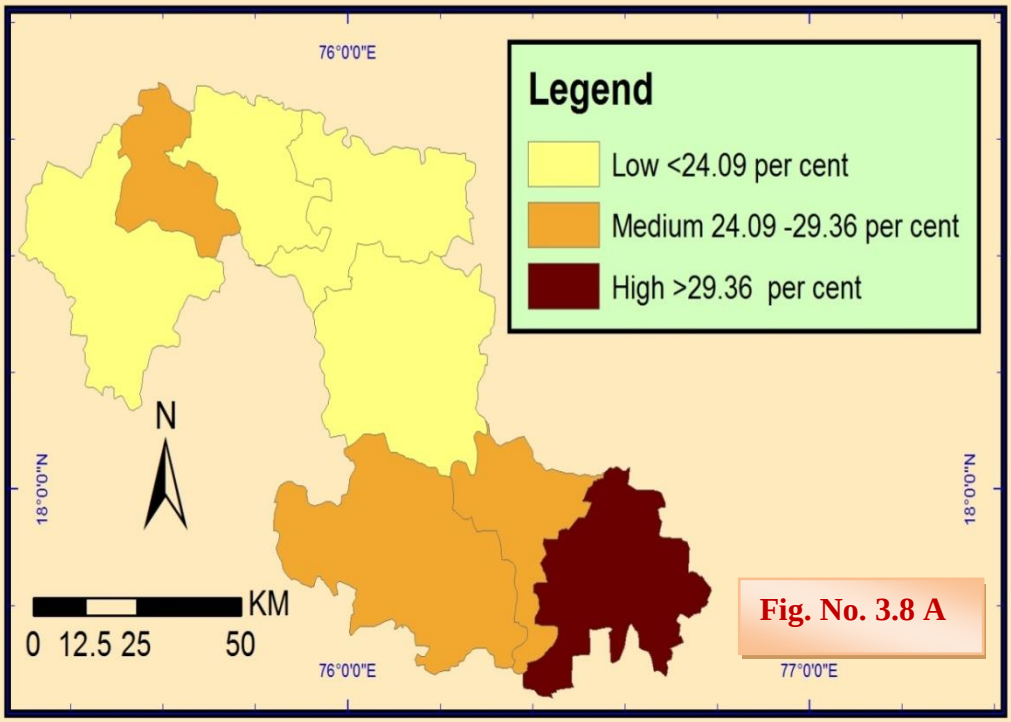

Fig. No. 3.8 A

VOLUME OF CHANGE IN AREA UNDER PULSES (1999-00 TO 2013-14)

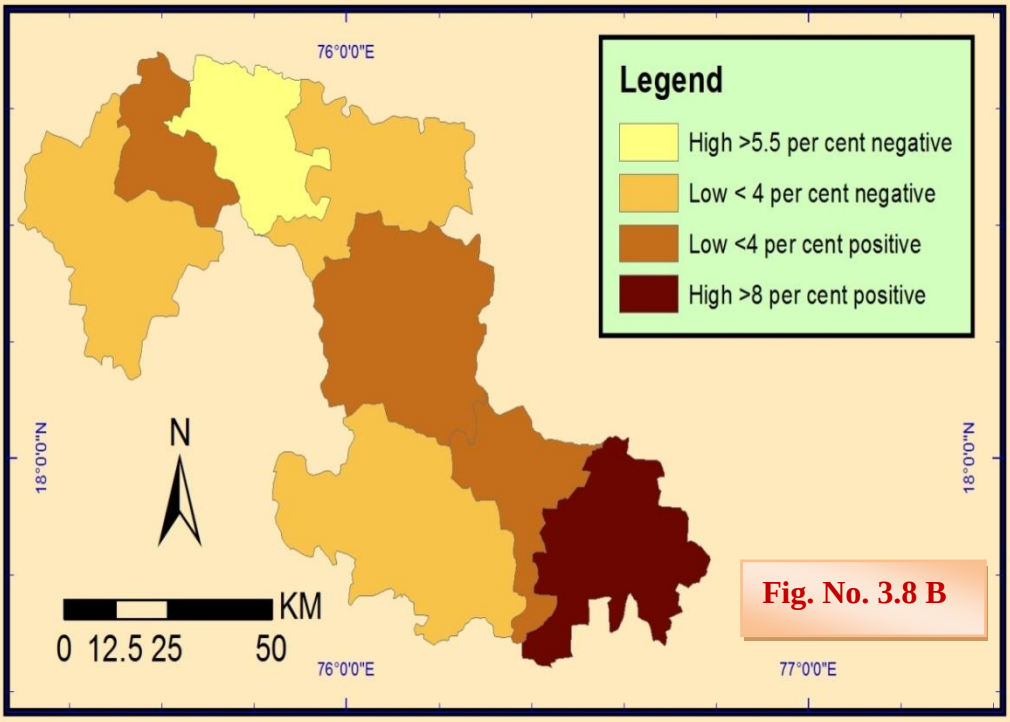

Fig. No. 3.8 B

harvested in December-January. It requires moderate amount of rainfall and black to brown soil. Generally this crop is grown as a rain fed crop and rarely supplemented by irrigation.

During 2009-10 to 2013-14, the district as a whole has 9.76 percent of area under Tur out of total cropped area that of state is 5.30 percent. However, within the district the proportion of area under Tur varies from 7.72 to 12.20 percent of total cropped area. The high proportion of area under Tur is observed in Bhum, Tuljapur and Omerga tehsils i.e. > 10.5 percent due to the assure rainfall and availability of market in adjoining Barshi and Latur towns. The moderate proportion of area under Tur is found

only in Lohara tehsil i.e. 9.40 percent whereas low proportion of Tur was recorded in Paranda, Washi, Osmanabad and Kalam, tehsils i.e. < 9 percent.

During the period of investigation, the district as a whole has 0.52 percent positive change in area under Tur cultivation. The low positive change was found in Kalam and Lohara tehsils i.e. < 2 percent. The moderate positive change is observed in Bhum tehsil i.e. 2.66 percent whereas high positive change is found in Omerga tehsil i.e. 3.78 percent. The low negative change is observed in Paranda, Osmanabad and Tuljapur tehsils i.e. <1.00 percent whereas the high negative change was found in Washi tehsil i.e. 2.81 percent.

Gram:

Gram is also an important crop for human being and helpful in increase fertility by dropping its leaves after maturity. It is rabbi crop among pulses. It requires medium to high quality and well discharging soil as well as cool climate of winter season. It is sown in October- November and harvested in February-March and grown as rain fed as well as irrigated.

During 2009-10 to 2013-14, the district as a whole has 7.57 percent of area under Gram out of total cropped area that of state is 5.41 percent. However, within the district the proportion of Gram varies from 4.81 to 10.55 percent of total cropped area. The high proportion of Gram is observed in Paranda and Omerga tehsil i.e. > 9 percent. The moderate proportion of Gram is found in Kalam, Osmanabad and Lohara tehsils i.e. from 7 to 9 percent whereas low proportion of Gram is recorded in Bhum, Washi, and Tuljapur tehsils i.e. < 7 percent due to assure rainfall farmer prefer Tur than Gram because Tur is more profitable than Gram.

During the period of investigation, the district as a whole has 0.89 percent positive change in area under Gram cultivation. The low positive change is found in Kalam and Paranda tehsils i.e. < 1.5 percent, whereas high positive change was found in Osmanabad and Omerga tehsils i.e. > 2.5 percent. The low negative change is observed in Washi and Tuljapur tehsils i.e. < 0.75 percent, whereas the high negative change was found in Bhum and Lohara tehsils i.e. >1.5 percent.

Non-food grains:

Sugarcane:

Sugarcane locally called as 'oos' is the second leading cash crop after soyabean in the study region. It occupies an important place in the economy of the district. There are nine Sugar factories in the study region. Sugarcane requires twelve month to mature and is planted in the month of December-January. Besides Adsali cane cultivation is also practiced in the study region. Sugarcane is water loving tropical crop and requires high temperature, maximum moisture. It is grown well in areas of black cotton soil (regur) which has high moisture retaining power and where perennial sources of irrigation are available; these factors collectively determine the intensity of Sugarcane cropping, despite the competition from food grains and other cash crop.

During 2009-2014, the share of Sugarcane is 4.96 percent in the total cropped area of the study region that of state is 4.49 percent. The spatial distribution of area under Sugarcane varies from tehsil to tehsil due to uneven distribution of irrigation facilities. The high proportion of area under Sugarcane is observed in Paranda, Osmanabad and Lohara tehsils i.e. > 5.5 percent. In Paranda it is high due to Bhima-Sina Joint canal and Sina-Kolegaon project, whereas it is high in Osmanabad and Lohara due to Upper Terna and Lower Terna irrigation project respectively. The moderate proportion was found in Kalam and Omerga tehsils i.e. from 4.5 to 5.5 percent whereas low proportion of Sugarcane was observed in Bhum, Washi and Tuljapur tehsils i.e. < 4.5 percent.

During the period of investigation, there is positive change in area under Sugarcane. The district as a whole has 1.97 percent positive change in area under Sugarcane cultivation. All tehsils of the study region show the positive change but it varies from tehsil to tehsil. The low positive change is found in Bhum, Kalam, Tuljapur and Omerga tehsils i.e. < 2 percent. The moderate positive change is in

AREA UNDER FRUITS & VEGETABLES OF OSMANABAD DISTRICT (2009-10 TO 2013-14)

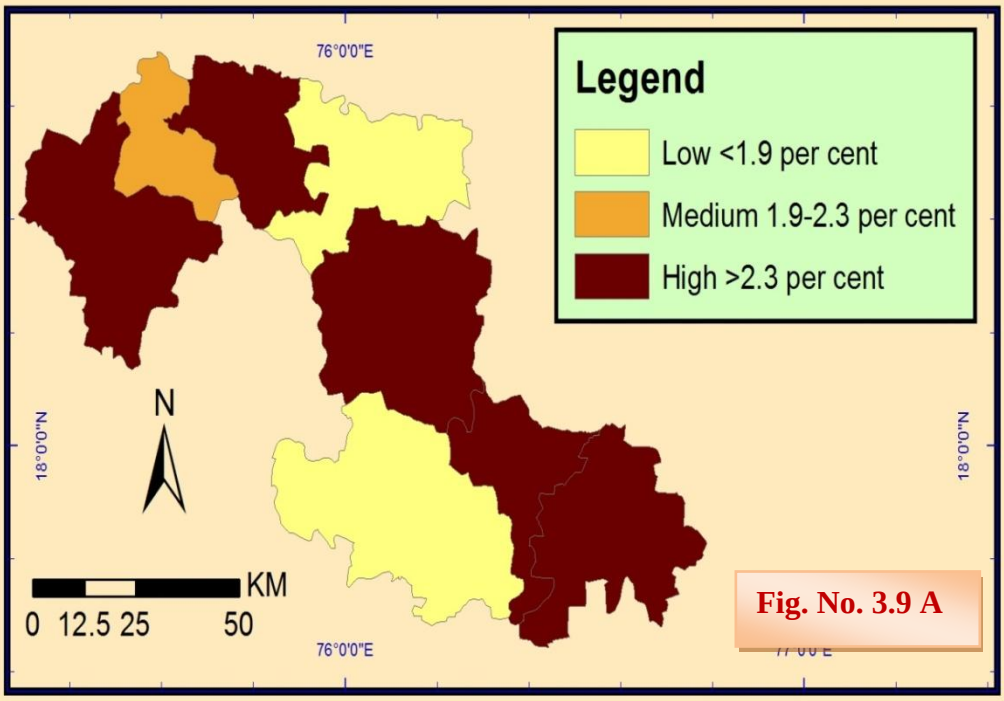

Fig. No. 3.9 A

VOLUME OF CHANGE IN AREA UNDER FRUITS & VEGETABLES (1999-00 TO 2013-14)

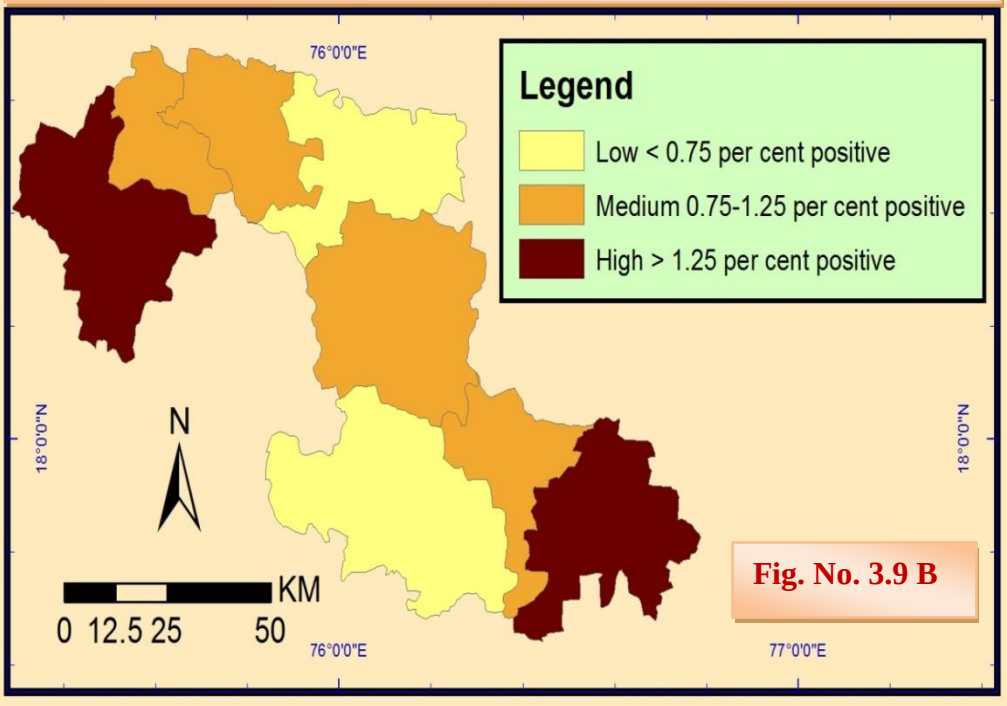

Fig. No. 3.9 B

Washi and Osmanabad tehsils i.e. from 2 to 3.5 percent whereas, high positive change was found in Paranda and Lohara tehsils i.e. > 3.5 percent due to the development of surface irrigation facilities.

Fruits and Vegetables:

Fruits are grown in dry climate; rain fed conditions and need comparatively less water than other field crop. They produce higher biomass than field crops per unit area resulting in efficient utilization of natural resources and are important for nutritional security (GOI, Planning Commission, 2001). The scarcity of rainfall compel to the farmers to cultivate fruits and vegetables. The variety of fruits and vegetables are grown in the study region such as pomegranate, ber, grapes, mango guava, lemon, chikku, banana, custard apple etc.

During 2009-2014, the share of fruits and vegetable is 2.25 percent in the total cropped area of the study region that of state is 10.42 percent. The fig. 3.9 A reveals that the spatial distribution of area under fruits and vegetables varies from tehsil to tehsil. High proportion of area under fruits and vegetable is observed in Paranda, Osmanabad, Washi, Omerga and Lohara tehsils i.e. > 2.5 percent due to favorable climate. The moderate proportion was found in Bhum tehsil i.e. 1.91 percent whereas low proportion was found in Kalam and Tuljapur tehsils i.e. < 1.9 percent.

During the period of investigation, there is increase in area under fruits and vegetables. The district as a whole has 0.90 percent positive change in area under fruits and vegetables. All tehsils of the study region show the positive change in area under fruits and vegetables, ranging from 0.28 to 1.68 percent. The low positive change was found in Kalam and Tuljapur tehsils i.e. < 0.75 percent. The moderate positive change was in Bhum, Washi and Lohara tehsils i.e. from 0.75 to 1.25 percent, whereas high positive change was found in Paranda, Osmanabad and Omerga tehsils i.e. > 1.25 percent as the farmers have adopted fruit crops because of suitable climatic and edaphic conditions, apart from government policy to give subsidy to fruit cultivation and drip irrigation. (Fig. no. 3.9 B)

Non- Food Crops:

In the previous analysis the food crops are considered. This category of agricultural land use consist the oil seeds and fiber, drugs narcotics, miscellaneous non-food crops which occupy very negligible area, hence they are not analysed separately.

AREA UNDER NON FOOD CROPS OF OSMANABAD DISTRICT (2009-10 TO 2013-14)

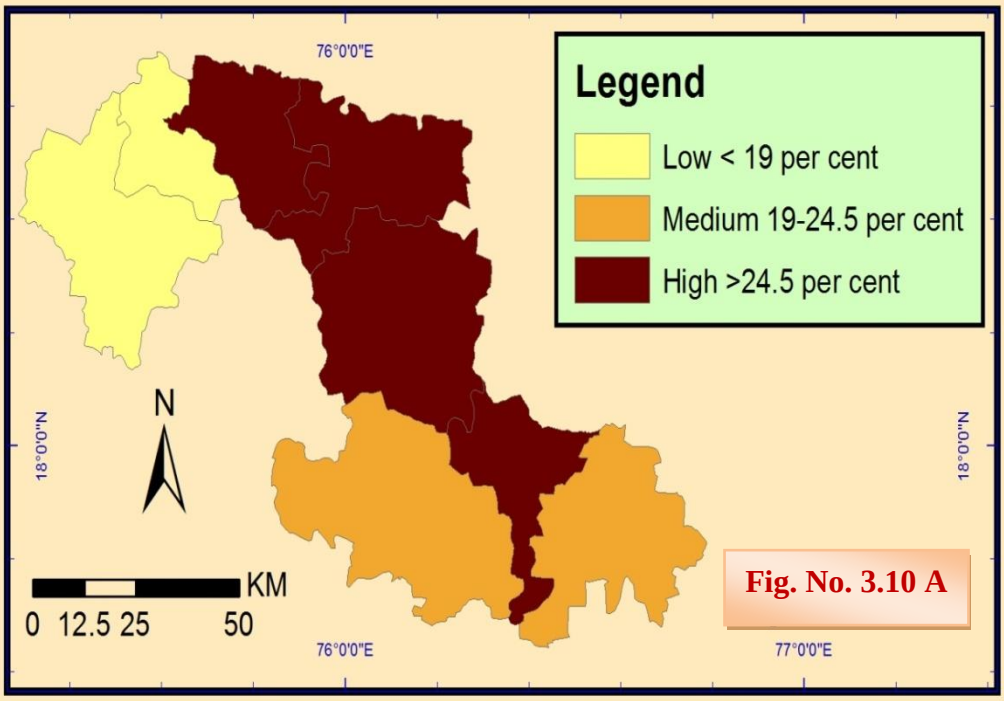

Fig. No. 3.10 A

VOLUME OF CHANGE IN AREA UNDER NON FOOD CROPS (1999-00 TO 2013-14)

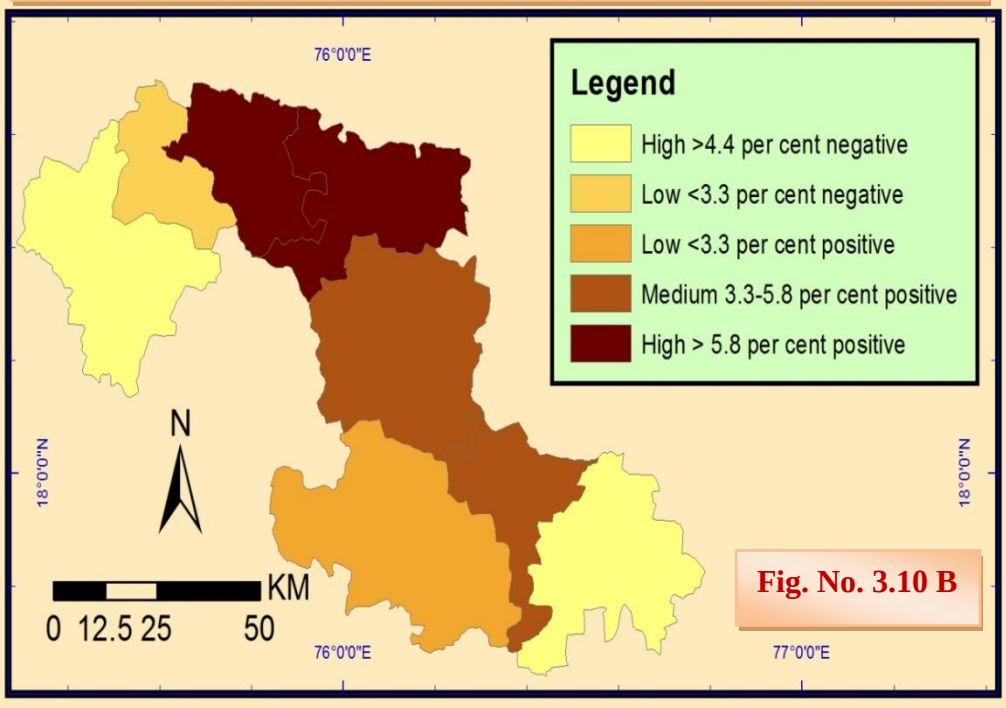

Fig. No. 3.10 B

During 2009-10 to 2013-14, the share of non-food crops is 23.89 percent in the total cropped area of the study region. The Fig. no. 3.10 A reveals that the spatial distribution of area under non-food crops. Spatial distribution of area under non-food crops exhibits considerable variation ranging from 13.82 to 29.84 percent. The high proportion of area under non-food crops is observed in Washi, Kalam, Osmanabad and Lohara tehsils i.e. > 24.5 percent due to favorable soil and climate for cultivation of oil seeds. The moderate proportion of area under Non-food crop is found in Tuljapur and Omerga tehsils i.e. from 19 to 24.5 percent whereas low proportion was found in Paranda and Bhum tehsils i.e. < 19 percent.

During the period of investigation, the district as a whole has seen 1.78 percent positive change in area under non-food crops. However, tehsil level change varies and both positive as well as negative. The low positive change in area under non food crop is found in Tuljapur tehsil i.e. 0.73 percent. The moderate positive change in area under non-food crop is recorded in Lohara and Osmanabad tehsils i.e. from 3.3 to 5.8 percent whereas it is high in Washi and Kalam tehsils i.e. > 5.8 percent because farmer cultivate oil seed as a cash crop. The low negative change is observed in Bhum tehsil i.e. 2.21 percent whereas high negative change was observed in Paranda and Omerga tehsils i.e. >4.4 percent because they loosed area under fiber and oil seeds due to other cash crops such as sugarcane, fruits and vegetables.

Oilseeds:

The Oilseeds are very important in different ways as they are used both edible and industrial purposes. It is to be seen that, the edible oil seed occupies most of the cultivated area. Some oil seeds are grown in kharif season e.g. seasamum, some are in both kharif and rabbi e.g. sunflower, groundnut, soybean (Nanaware A.H., 2007). Soyabean, sunlower and safflower are important oilseed in the study region, as they are cash crops. The other oilseed such as seasamum, linseed etc. is meagre in the study region.

During 2009-10 to 2013-14, the share of Oilseeds is 20.34 percent in the total cropped area of the study region that of state is 16.27 percent. The fig. 3.11 A reveals that the spatial distribution of area under Oilseeds. The spatial distribution of area under Oilseeds reveals considerable variation ranging from 8.34 to 27.18 percent. The high proportion of area under oil seeds was observed in Kalam, Osmanabad, Tuljapur and Lohara tehsils i.e. > 21 percent due to the favorable soil condition and availability of market like Barshi and Latur. The moderate proportion of oilseed is found in Washi

AREA UNDER OIL SEEDS CROPS OF OSMANABAD DISTRICT (2009-10 TO 2013-14)

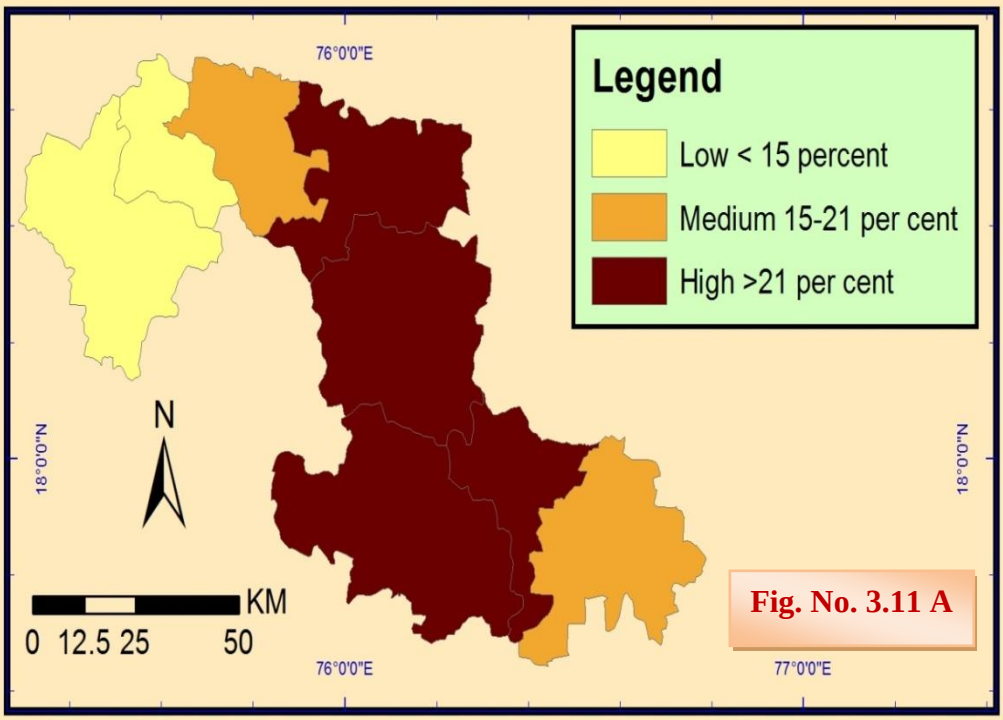

Fig. No. 3.11 A

VOLUME OF CHANGE IN AREA UNDER NON FOOD CROPS (1999-00 TO 2013-14)

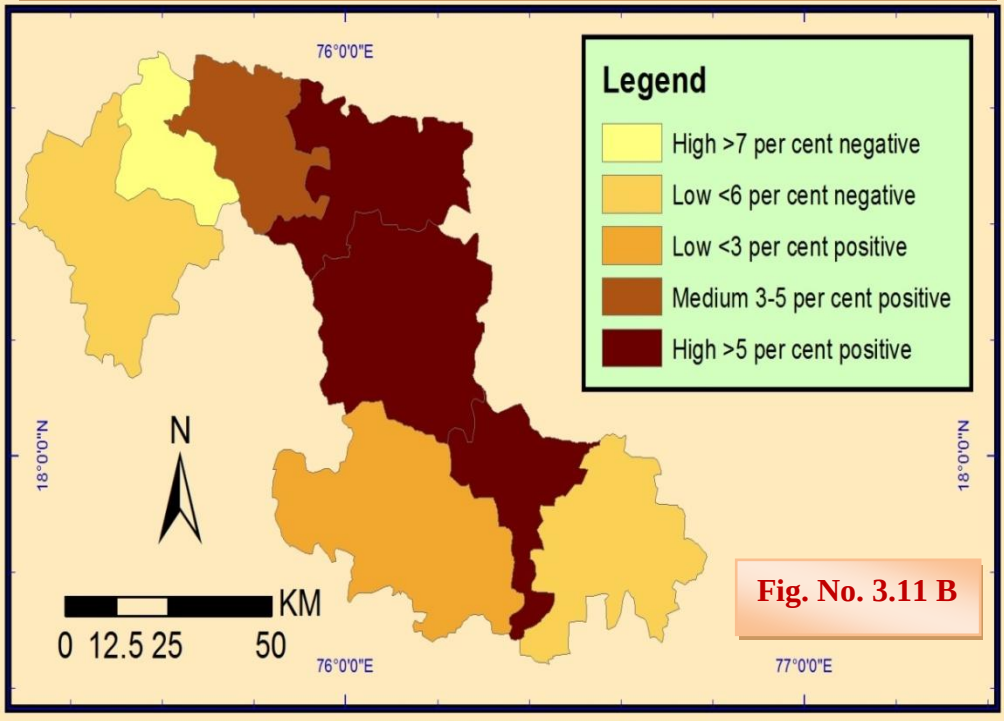

Fig. No. 3.11 B

and Omerga tehsils i.e. from 15 to 21 percent whereas low proportion was found in Paranda and Bhum tehsils i.e. <15 percent.

During the period of investigation, the district as a whole has 1.05 percent positive change in area under Oilseeds. However, tehsil level change varies and both positive as well as negative change. The low positive change was found in Tuljapur tehsil i.e. 1.10 percent. The moderate positive change is in Washi tehsil i.e. from 3.63 percent, whereas high positive change is found in Osmanabad, Kalam and Lohara tehsils i.e. > 5 percent because of high yielding variety of soybean as a cash crop. The low negative change was observed in Paranda and Omerga tehsils i.e. < 6 percent whereas high negative change was observed in Bhum tehsil i.e. 7.44 percent. (Fig. no. 3.11 B)

Soybean:

Soybean is the leading cash crop among Oilseeds in recent years. Soybean thrives well in warm and moist climate. A temperature of 26 ^{0} C to 32 ^{0} C appears to be the ideal for the most of the varieties of of soybean. Extreme temperatures above 40°C are harmful for seed production. Soybean requires 400 to 500 mm rainfall in a season for a good crop. The high moisture requirement is critical at the time of germination, flowering and pod forming stage. However dry weather is necessary for ripening. It requires well drained and fertile loamy soil with pH range between 6.0 and 7.5 are most favorable the cultivation. Saline soils and sodic inhibit germination of Soybean seeds. Water logging damages the crop, so it is mandatory to have good soil drainage in rainy season. Soybean is a short-day plant (flowering in brief periods of sunlight). Shorter duration of the crop (i.e.3 to 3.5 months) allows cultivators to take the second crop on the same piece of land and add to their income which is not possible for a kharif crop like cotton. Easy cultivation of the crop and benefits in terms of improvement in fertility also prompted farmers to cultivate soybean in the study region (Kajale Jayantee and Shroff Sangeeta, 2013).

During 2009-10 to 2013-14, the share of soybean is 10.40 percent in the total cropped area of the study region. The spatial distribution of area under soybean reveals considerable variation ranging from 0.18 to 20.15 percent. The high proportion of area under Soybean is observed in Osmanabad, Kalam and Washi tehsils i.e. >13.50 percent due to favorable climate and well drained and fertile soil. The moderate proportion of area under Soybean is found in Tuljapur and Lohara

tehsils i.e. from 7 to 13.50 percent, whereas the low proportion is found in Paranda, Bhum and Omerga tehsils i.e. < 7 percent.

During the period of investigation, the district as a whole has 8.77 percent positive change in area under Soybean. All the tehsil shows positive change in area under soybean except Paranda. The low positive change in area under Soybean is found in Bhum, Tuljapur and Omerga tehsils i.e. < 7.5 percent. The moderate positive change in area under Soybean is found only in Lohara tehsil i.e. 7.95 percent whereas high positive change is found in Osmanabad, Kalam and Washi tehsils i.e. > 12.5 percent. The negligible negative change was observed in Paranda tehsil i.e. < 0.01 percent.

Sunflower:

Sunflower requires dry and hot climate and medium to high quality soil. Sunflower is cultivated in both rabbi and kharif season. It is mostly rain fed crop. It diminishes the quality of soil.

During 2009-2014, the share of sunflower is 3.71 percent in the total cropped area of the study region. The table no. 3.4 indicates that the spatial distribution of area under sunflower. Spatial distribution of area under sunflower reveals considerable variation ranging from 0.26 to 7.87 percent. The high proportion of area under sunflower is observed in Tuljapur and Omerga tehsils i.e. > 5 percent because it is cultivated as cash crop. The moderate proportion of area under Sunflower is found in Osmanabad and Lohara tehsils i.e. from 3 to 5 percent, whereas it is low in Paranda, Bhum, Kalam and Washi tehsils i.e. < 3 percent due to rain fed condition as sunflower is rain fed crop.

During the period of investigation, the district as a whole has 4.26 percent negative change in area under sunflower. All tehsils exhibits negative change in area under sunflower because farmer's trend to cultivate soybean crop as a cash crop. The low negative change in area under Sunflower is found in Tuljapur tehsil i.e. <2.85percent. The medium negative change in area under Sunflower is observed in Washi, Lohara and Omerga tehsils i.e. from 2.85 to 5.05 percent, whereas it is high in Paranda, Bhum, Kalam and Osmanabad tehsils i.e. >5.05 percent.

Safflower:

Safflower is best grown in cool season of tropical and subtropical region and rarely in temperate region. It requires cool climate in the initial stage (15^0

C), but warm temperatures between 24^0 C to 32^0 C and dry and hot climates during maturity (30^0 C to 35^0 C). Freezing temperatures of flowering may result into sterility. Continuous rains at flowering or even in the initial stages may damage the crop. It can be grown in any well drained soil, but it is preferred to grow in clay rich soil with high water holding capacity. It can tolerate mild salinity (Joshi Mukund, 2015).

During 2009-2014, the share of safflower is 2.42 percent in the total cropped area of the study region that of state is 0.65 percent. The table no. 3.4 reveals that the spatial distribution of area under safflower. Spatial distribution of area under safflower reveals considerable variation ranging from 0.26 to 3.98 percent. The high proportion of area under safflower was observed in Tuljapur, Lohara and Omerga tehsils i.e. > 3 percent due to favorable soil. The moderate proportion of Safflower is found in Kalam and Osmanabad tehsils i.e. from 1.50 to 3 percent, whereas it is low in Paranda, Bhum and Washi tehsils i.e. < 1.50 percent.

During the period of investigation, the district as a whole has seen 0.71 percent negative change in area under safflower. However, tehsil level analysis reveals both positive as well as negative change in area under Safflower. The negligible positive change in area under Safflower is found in Tuljapur and Lohara tehsils i.e. 0.78 and 0.79 percent respectively. The low negative change in area under Safflower is observed in Bhum, Washi, Kalam, Osmanabad and Omerga tehsils i.e. < 2 percent, whereas it is high in Paranda tehsil i.e. 5.55 percent.

Other Oilseeds:

This category consist seassum, groundnut and linseed etc. oilseed. Among the other oilseed, it requires well drained medium to deep soil and cultivated throughout the year.

During 2009-2014, the share of Other Oilseeds is 0.71 percent in the total cropped area of the study region. The table no. 3.4 reveals that the spatial distribution of area under Other Oilseeds. Spatial distribution of area under Other Oilseeds reveals considerable variation ranging from 0.17 to 2.69 percent. The high proportion of area under Other Oilseeds is observed only in Lohara tehsil i.e. 2.69 percent due to well drained medium to deep soil conditions. The moderate proportion of area under Other oilseeds is found in Paranda tehsil i.e. 1.05 percent, whereas it is low in Bhum, Washi, Kalam, Osmanabad, Tuljapur and Omerga tehsils i.e. < 1 percent.

During the period of investigation, the district as a whole has 2.05 percent negative change in area under other Oilseeds. All the tehsil shows negative change in area under Other Oilseeds except Lohara tehsil. The low negative change in area under other oilseeds is found in Paranda tehsil i.e. 0.38 percent. The moderate negative change in area under other oilseeds is found in Bhum, Kalam and Tuljapur tehsils i.e. from 1.5 to 2.5 percent, whereas high negative change in area under other oilseeds is found in Washi, Osmanabad and Omerga tehsils i.e. > 2.5 percent.

3.4 AGRICULTURAL REGION:

Region is one of the basic concepts of geography. A widely accepted definition of region is 'an area that is differentiated from other areas, according to the specified criteria'. In other words 'region' is differentiated segment of the earth surface (Whittlesey D, 1936). Among the different types of region, agricultural region is very important to the point of agricultural geographer. Any segment of the earth's surface possessing a distinctive form of agricultural is an agricultural region (Singh J & Dhillon S.S., 1987). The agriculture region is a device for selection and investigating regional grouping of the complex agricultural phenomena. According to Buchana (1959) agricultural region must be defined in terms of agricultural element, that is by crop, livestock or enterprises data, so that attempt is made here to define agricultural region of Osmanabad district based on crops.

3.4.1 Crop Combination Region and changes

The study of crop combination region constitutes an important aspect of agricultural geography as it provides a good basis for agricultural regionalization (Hussain M, 1996). It is fruitful in many ways such as to understand the cropping pattern and crop concentration, in a given area. The crop combinations give an idea about the agricultural typology and agricultural income of a region. Such region provides a real significance and strength of individual crops, to advocate suitable device for planning improvements in the under development regions. The principle of combination analysis thus promises to be an important tool of statistical studies in various fields of geography, particularly in agricultural geography. The crop combination regions thus delineated would emphasis the regional framework of agricultural activities and specialization of crops in the area. The pattern of crop combination regions that will emerge from the delineated might also serve the

meaningful purpose in a balanced regional agricultural planning. Different approaches have been applied for the delineation of crop combination. The crop combination analysis was originally introduced in geographical research by Weaver in his outstanding study of crop combinations in mid western United States (Singh J & Dhillon S.S., 1987). A simple scale of gradation was derived by Johnson (1958) on the basis of the scale of the level of importance for each of the crop in East Pakistan. Rafiullah (1956) has used maximum positive deviation method for the functional classification of towns. The crop combination regions demarcated by Weaver's method has included all the crops in the combinations those have occupied about 1 percent of the total cropped area, hence the combination become over generalized and did not show any difference from the gradation method (Hussain Majid, 1996). Therefore, this method fails to give precise crop combinations of the region under investigation. Moreover, these regions are improper.

For the present study an attempt is made to delineate the crop combination regions by applying two methods of crop combination i.e. minimum standard deviation method as introduced by Doi(1959) and maximum positive deviation method by Rafiullah (1956).

A) Crop Combination Method of Doi's

The Weaver's technique was subsequently modified by Doi (1959). Doi's technique is used for combination analysis prior to the application of computer programming facilities. The Doi's formula may be expressed as…..

$$(\sum \mathbf{d^2})$$

The combination having the lowest ($\sum d^2$) will be the crop combination.

In Doi's technique, it is not require to calculate **($\sum \mathbf{d^2}$)** for each combinations but the crop combination is actually established by one sheet table (table no.3.5), which represents critical values for various elements at different ranks against cumulative percentage of elements at higher ranks (Hussain Majid, 1996).

During 2009-14, as per Doi's method monoculture, two and three crop combinations are absent in Osmanabad district.

Four Crop Combinations:

The table no. 4.6 indicates that during 2009-14, as per Doi's method (1959) four crop combination is practiced in three tehsils of the study region i.e. Paranda,Kalam and Osmanabad tehsils. In Paranda tehsil Jowar, Gram, Tur and Sugarcane constitute the combination due to the development of irrigation facility

Table no. 3.5: Crop Combination Region by Doi's Method 1999-00 to 2003-04 and 2009-10 to 2013-14

Sr. No	Tehsil	Year	Three Crop	Four Crop	Five Crop	Six Crop	Seven Crop	Eight Crop
1	Paranda	1999-00 to 2003-04		J+Gr+T +Snf				
		2009-10 to 2013-14		J+Gr+T +Sgr				
2	Bhum	1999-00 to 2003-04			J+Gr+T+ Snf+U			
		2009-10 to 2013-14				J+T+W+ Gr+U+C		
3	Washi	1999-00 to 2003-04	J+T+Gr					
		2009-10 to 2013-14			J+Sy+T+C+ Gr			
4	Kalam	1999-00 to 2003-04		J+snf+T +Gr				
		2009-10 to 2013-14		J+Sy+T +Gr				
5	Osmanabad	1999-00 to 2003-04			J+T+Snf+U +Gr			
		2009-10 to 2013-14		J+Sy+T +Gr				
6	Tuljapur	1999-00 to 2003-04				J+T+Snf+ Gr+U+Mg		
		2009-10 to 2013-14					J+T+Snf+S y+ U+Mz+Gr	
7	Lohara	1999-00 to 2003-04		J+Gr+T +Snf				
		2009-10 to 2013-14				J+T+Sy+U +Gr+Sgr		
8	Omerga	1999-00 to 2003-04						J+Snf+T+ Gr+ U+O.o+S fl+Sgr
		2009-10 to 2013-14					J+U+T+Gr + Sy+Snf+Sg r	
	District	1999-00 to 2003-04			J+T+Snf+Gr +U			
		2009-10 to 2013-14				J+Sy+T+ Gr+U+Sgr		

Source: *Compiled by Researcher*

Note: J=Jowar, T=Tur, W=Wheat, Sgr=Sugarcane, Gr=Gram, Sy=Soybean, Snf= Sunflower, Sfl= Safflower, U= Udid, M= Mung, C= Cotton, O.o= Other Oilseeds

whereas Kalam and Osmanabad tehsils Jowar, Tur, Gram and Soybean are entered in the crop combination.

Five Crop Combinations:

The five crop combination is observed only in Washi tehsil of the study region. The Jowar is the dominant crop; the largest coverage of Jowar stands as first, followed by Soyabean, Tur, Cotton and Gram. The favorable environmental condition has been found to be suitable for this pre-dominant crop. The medium deep to very deep type of soil is also favorable for the cultivation of Jowar, Soyabean, Tur, Cotton and Gram in this tehsil. The topography of this region is more or less uniform.

Six Crop Combinations:

During 2009-14, six crop combinations are practiced in two tehsils of the study region i.e. Bhum and Lohara tehsils. In Bhum tehsil Jowar, Tur, Wheat, Gram, Udid, and Cotton constitute the combination because tehsil lie in high rainfall variability region. Whereas in Lohara tehsil Jowar, Tur, Soybean, Udid, Gram and Sugarcane entered in the crop combination due to the fertile soil and irrigation facilities by lower Terna irrigation project.

Seven Crop Combinations:

During 2009-14, seven crop combinations are practiced in two tehsils of the study region i.e. Tuljapur and Omerga tehsils. In Tuljapur tehsil Jowar, Tur, Sunflower, Soybean, Udid Maize and Gram entered in the combination whereas in Omerga tehsil Jowar, Udid, Tur, Gram, Soybean, Sunflower and Sugarcane entered in the crop combination.

The table 3.5 exhibits the change in crop combination region based on Doi's method. Six tehsils show the change in crop combination. Three crops to five crops change is recorded in Washi tehsils, soybean and cotton are entered as new crop. Four crops to six crops change is recorded in Lohara tehsil. Soybean, Sugarcane and Udid are entered in crop combination instead of Sunflower. Five crops to six crops change is recorded in Bhum tehsil. Instead of sunflower Wheat and cotton are entered in crop combination in Bhum tehsil. Five crops to four crops change is recorded in Osmanabad tehsil. In place of sunflower and Udid, Soybean is entered in crop combination. Six crops to seven crops change is recorded in Tuljapur tehsil. Instead of Mung, Soybean and Maize are entered in crop combination in Tuljapur tehsil.

B) Crop Combination Method of Rafiullah:

Rafiullah's maximum positive deviation method gives such combinations that are representative of the primary crops further crop combinations are conformity with the soil and rainfall distribution. Therefore maximum positive deviation method has an advantage over Weaver's method (Hussain Majid, 1996). The Rafiullah's formula is expressed as fallow.

$$d = \frac{\sum D^2 p \quad D^2 n}{N^2}$$

Where,
D = Deviation
Dp = Positive difference from the median value of theoretical curve value of combination.
Dn = Negative difference from the median value of theoretical curve value of combination.
N = Number of crops in the combination.

The resultant of crop combination region by Rafiullah's method is as following.

Table No. 3.6: Crop Combination by Rafullah Method 1999-04 and 2009-14

Sr.No	Tehsil	Year	Monoculture	2 Crop
1	Paranda	1999-04		J+T
		2009-14		J+Gr
2	Bhum	1999-04		J+Gr
		2009-14	J	
3	Washi	1999-04		J+T
		2009-14	J	
4	Kalam	1999-04		J+snf
		2009-14	J	
5	Osmanabad	1999-04		J+T
		2009-14	J	
6	Tuljapur	1999-04	J	
		2009-14	J	
7	Lohara	1999-04		J+Gr
		2009-14	J	
8	Omerga	1999-04	J	
		2009-14	J	
	District	1999-04		J+T
		2009-14	J	

Source: *Compiled by Researcher*

Note: J=Jowar, T=Tur, Gr=Gram, Snf= Sunflower.

Monoculture:

During 2009-14, the seven tehsils of Osmanabad district have monoculture crop combination i.e. Bhum, Washi, Kalam, Osmanabad, Tuljapur, Lohara and Omerga tehsils. Monoculture crop is Jowar. Due to the regur soil and drought resistance nature of Jowar, the farmers devote most of their arable land to this crop.

Two Crops Combination:

Two crop combinations is recorded only in Paranda tehsils of the study region. The crop combination of Paranda tehsil is Jowar and Gram because it is very well suited in agro climatic conditions and soil fertility.

The table no. 3.6 exhibits the change in crop combination regions based on maximum deviation method. Five tehsils i.e. Bhum, Washi, Kalam, Osmanabad and Lohara tehsils recorded the changes in crop association pattern; two to one crop combination change is observed in these tehsils. There is no change in number of crops in Paranda, Tuljapur and Omerga tehsils, during the period under review. But association is changed in Paranda tehsil i.e. Gram is entered in place of Tur.

3.5 SUMMARY:

The forgoing analysis of general land use indicates that the low proportion of area under forest in the Osmanabad district (0.72 per cent to total geographical area) is result of frequency of droughts and cutting of trees for different purposes due poverty of farmers. The high proportion of area not available for cultivation only in Bhum tehsil; is mainly due to hilly area which cannot be brought under cultivation without incurring cost on their development.

The high other uncultivable land in Tuljapur tehsil is because of hilly area of Balaghat range leads to permanent patures. The negative change in other uncultivable land in Kalam, Tuljapur and Omerga tehsils is mainly due to the availability of irrigation facilities, farmer brought this land under cultivation.

The high proportion of other fallow land and high positive change in Tuljapur Tehsil is a result of inadequate supply of water and inadequate rainfall. Negative change in fallow land in Kalam tehsil is due to development of minor irrigation projects. The high proportion of current fallow land in Bhum, Washi, Omerga and Tuljapur tehsils is because of adverse condition of rainfall and poor irrigation facilities.

The high proportion of net sown area in Kalam and Osmanabad tehsil is a result of major and medium irrigation project. While it is low in Washi and Tuljaur Tehsil is due to adverse physiographyi.e. rugged topography of Balaghat range.The high positive change in netsown area in Kalam Tehsil is because of other un cultivale land is brought under cultivation with the growth of population and development of irrigation.

During the period of investigation, very high negative correlation between area under forest and area not available for cultivation is found in Tuljapur and Omerga tehsils and area under forest is increased due to afforestation indicates that area not available for cultivation is converted into forest area.

The high negative correlation between fallow land and net sown area in all most all tehsil except Tuljapur ranging from -0.83 to -0.97 and decrease in net sown area in Washi and Lohara indicates that the net sown area has been converted into fallow land due to inadequate and unpredictable rainfall and lack of irrigation facilities. High negative correlation between area under forest and net sown area is observed in Paranda and Kalam tehsils and decrease in area under forest indicates that area under forest is converted into net sown area.

High negative correlation between area not available for cultivation and fallow land is recorded in Tuljapur tehsil, and increase in fallow land reveals that the the land put to non agricultural uses and barren land is converted into fallow land.

High negative correlation between other uncultivable land and net area sown in Kalam and Omerga tehsils and decrease in other uncultivable land indicates that it is converted into net sown area.

The high negative correlation between area not available for cultivation and other uncultivated land i.e. -0.69 and increase in area not available for cultivation indicates that other uncultivable land is converted into area not available for cultivation during the period of investigation.

The foregoing analysis clearly indicates that there is dominance of food crops, which occupy 75.91 percent of gross cropped area. The Jowar, Wheat, Maize, are dominant cereals in cropping pattern, while Bajara and other cereals are insignificant in the cropping pattern of the region. The high proportion of Jowar in Paranda Tehsil is mainly due to low rainfall. Among the Pulses,Tur and Gram are the important pulses, whereas Mung, Udid etc. are ancillary in the cropping pattern of the region.

Sugarcane and Fruit-Vegetables are important cash crop of study region occupies 4.96 and 2.25 percent total cropped area respectively, mainly due to favorable climate and soil in Sina, Manjra basin. Soybin and Safflower are the two important non-food crops occupying significant position in the cropping pattern of study region.

Crop combination analysis reveals that as per Doi's method six tehsils shows the change in crop combination i.e. Washi, Lohara, Bhum, Osmanabad, Tuljapur and Omerga tehsils. Three crops to five crops change is recorded in Washi tehsils, soybean and cotton are entered as new crop. Four crops to six crops change is recorded in Lohara tehsil. Soybean, Sugarcane and Udid are entered in crop combination instead of Sunflower. Five crops to six crops change is recorded in Bhum tehsil. Instead of sunflower Wheat and cotton are entered in crop combination in Bhum tehsil. Five crops to four crops change is recorded in Osmanabad tehsil. In place of sunflower and Udid, Soybean is entered in crop combination. Six crops to seven crops change is recorded in Tuljapur tehsil, instead of Mung, Soybean and Maize are entered in crop combination.

As per Rafiulla's method Jowar crop is the monoculture crop in the seven tehsils of the Osmanabad district i.e. Bhum, Washi, Kalam, Osmanabad, Tuljapur, Lohara and Omerga tehsils due to the regur soil and drought resistance nature of Jowar, the farmers devote most of their arable land to this crop. The change in crop combination region based on maximum deviation method is recorded in five tehsils, i.e. Bhum, Washi, Kalam, Osmanabad and Lohara tehsils and it is two crops to one crop.

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CHAPTER-IV
AGRICULTURAL PRODUCTIVITY

4.1 INTRODUCTION:

In the previous chapter the general land use and agricultural land use of the Osmanabad district are discussed. This chapter accordingly examines agricultural productivity, changes therein and impact of irrigation on agricultural productivity of the study region in the light of the preceding discussion.

The concept of productivity is a relative and cannot be uniformly applied all over the world some have viewed productivity as the overall effectiveness of productive unit, while some have confined use of the term productivity to denote the ratio of output to the corresponding input of labor. However, all these apparently conflicting the different interpretations have one common characteristic i.e. productivity is some one's ability to produce more economically and efficiently. Therefore, agricultural productivity could be defined as the ratio of output to input in relation to land, capital, and overall resources employed in agriculture (Noor Mohmad, 1995). Productivity is defined as the ratio of output to input. Agricultural productivity is a measure of the efficiency with which inputs are used in agriculture to produce an output. A precise measure of productivity is the ratio of output to all inputs used in the production process. The computation of such a ratio therefore involves the problem of aggregating a variety of output and inputs into single indexes (Christensen, 1975). Agricultural productivity is the function of a number of factors including physical, socio-economic and technological organization (Noor Mohamd and Majeed Abdul, 1995).

Agricultural productivity is defined as efficiency of various inputs used in productive operations. The productivity is thus bound to vary from region to region with the variation in various physical, technological and institutional factors operating in the region (Siddiqul, 1987). Productivity of crop sector per unit of area and per worker is affected by several factors; the most important are rainfall, levels of irrigation, fertilizer use and diversification towards high value crops (Chand Ramesh et.al, 2009). Agricultural productivity exhibits wide regional disparities with the result of very divers set of condition. Broadly, variation in the agricultural productivity can be attributed to the environmental institutional and technological factors. All these

factors are highly variable and dynamic in nature therefore productivity is dynamic in nature (Munir Abdul et.al., 1989).

Increase in agricultural production and productivity leads to increase in the income of the farmers. This increased income of the rural community will lead to more savings, which can be used for either further development of non-agricultural occupations, as well as industry (Thenmozhia and P.Thilagavathib, 2014). The methods of mapping of spatio-temporal characteristics of the level of agricultural productivity provides rational base for further orientation in agricultural planning. The determination of variations in agricultural productivity and there probable causes will make it possible to demarcate the regions of agricultural productivity. It will be immense help in appropriate planning of development of each region according to its physio-socio-economic conditions (Noor Mohamd and Thakur Rameshwar, 1995).Agricultural productivity is essential to identify sure or weaker areas in order to do rational and scientific planning for the agricultural development (Nanaware A. H, 2007).

Therefore an attempt is made here to analyze the agricultural productivity. This chapter comprises per hectare yield, trends in per hectare yield and production, irrigated area and per hectare yield, variation in per hectare yield and production, agricultural productivity, composite index of agricultural productivity and impact of irrigation on agricultural productivity

4.2 PER HECTARE YIELD OF SELECTED CROPS IN OSMANABAD DISTRICT:

4.2.1. Jowar

The region as a whole has 788.57 Metric ton per hectare yield of Jowar that of state is 830.4 kg, but the tehsil level analysis reveals uneven distribution. The table no. 4.1 indicates that high per hectare yield of Jowar is found in Paranda and Washi tehsils i.e. above 870 kgs., due to the development of surface irrigation, high use of high yield variety seeds and chemical fertiliser. The moderate per hectare yield of Jowar is registered in Kalam and Lohara tehsils i.e. 760 to 870 kgs., whereas, it is low in Osmanabad, Tuljapur, Bhum and Omerga tehsils i.e. below 760 kgs. during 2013-2014.

Table 4.1: Per Hectare Yield of Selected Crops in Osmanabad District –1999-00 to 2003-04 & 2009-10 to 2013-14

(Per Hectare yield in kgs.)

Crops	Year	Paranda	Bhum	Washi	Kalam	Osmana-bad	Tulja-pur	Lohara	Omerga	District Average
Jowar	1999-00 to 2003-04	517.02	592.78	370.58	760.52	779.85	748.88	743.17	786.20	662.38
	2009-10 to 2013-14	881.93	646.70	650.70	747.10	735.50	695.40	797.70	653.50	726.07
	Change	364.91	53.92	280.12	-13.42	-44.35	-53.48	54.53	-132.70	63.69
Wheat	1999-00 to 2003-04	1005.00	850.67	435.50	772.17	919.33	850.00	818.50	1008.83	832.50
	2009-10 to 2013-14	1084.40	920.60	928.20	584.80	1011.40	770.60	1126.00	840.80	908.35
	Change	79.40	69.93	492.70	-187.37	92.07	-79.40	307.50	-168.03	75.85
Bajra	1999-00 to 2003-04	335.40	420.67	353.00	426.67	253.00	318.67	564.67	365.67	379.72
	2009-10 to 2013-14	580.20	536.80	384.40	358.60	285.40	353.20	328.60	431.60	407.35
	Change	244.80	116.13	31.40	-68.07	32.40	34.53	-236.07	65.93	27.63
Tur	1999-00 to 2003-04	453.33	440.50	372.33	517.67	551.33	577.83	409.33	589.00	488.92
	2009-10 to 2013-14	704.80	629.60	594.00	793.20	575.00	544.20	601.60	687.60	641.25
	Change	251.47	189.10	221.67	275.53	23.67	-33.63	192.27	98.60	152.33
Gram	1999-00 to 2003-04	374.33	460.80	248.50	482.00	480.17	443.67	408.50	522.40	427.55
	2009-10 to 2013-14	640.20	622.20	844.00	979.00	598.00	615.80	875.80	651.80	728.35
	Change	265.87	161.40	595.50	497.00	117.83	172.13	467.30	129.40	300.80
Groundnut	1999-00 to 2003-04	678.50	1026.9	376.33	1013.25	753.33	757.00	1526.33	791.08	865.34
	2009-10 to 2013-14	811.20	439.80	618.80	1036.73	757.33	762.90	1184.53	1025.30	829.58
	Change	132.70	-587.07	242.47	23.48	4.00	5.90	-341.80	234.22	-35.76
Soybean	1999-00 to 2003-04	460.00	864.00	1401.00	939.50	892.00	569.67	881.33	604.67	826.52
	2009-10 to 2013-14	951.80	936.00	1020.40	962.60	1019.40	886.00	952.80	1013.80	967.85
	Change	491.80	72.00	-380.60	23.10	127.40	316.33	71.47	409.13	141.33
Sugarcane	1999-00 to 2003-04	56.40	51.00	45.00	46.60	58.00	55.80	45.00	51.67	51.18
	2009-10 to 2013-14	80.75	71.00	67.50	73.25	79.25	86.00	70.50	63.75	74.00
	Change	24.35	20.00	22.50	26.65	21.25	30.20	25.50	12.08	22.82

Source: Compiled by Researcher on the basis of Statistical officer, Divisional Joint Director Office of Agriculture, Latur Division, Latur.

During the period of investigation, Osmanabad district as a whole has 126.19 kilogram positive change in per hectare yield of Jowar. However tehsil level analysis varies from tehsil to tehsil. Both positive as well as negative change was observed in per hectare yield of Jowar. The high positive change in per hectare yield of Jowar was

recorded in Paranda and Washi tehsils i. e. above 400 kilogram, during 1999-04 and 2009-14. The low positive change is found in Kalam, Lohara and Bhum tehsils i.e. below 100 kilogram.

The low negative change in per hectare yield of Jowar is noticed in Osmanabad and Tuljapur tehsils i. e. below 75 kilogram, during 1999-04 and 2009-2014. The high negative change is observed only in Omerga tehsils i.e. 132.7 kilogram during the period of investigation.

4.2.2. Wheat

The region as whole has 959.48 kgs. per hectare yield of Wheat during 2013-14, that of state was 1126.8 kgs., but spatial distribution varies from tehsil to tehsil. The table no. 4.1 shows that the low per hectare yield of Wheat was recorded only in Kalam tehsil i.e. 584.8 kgs. during 2013-14. It was moderate in Omerga and Washi tehsils i.e. in between 765 to 945 kgs., whereas high per hectare yield of wheat is found in Paranda, Tuljapur, Bhum, Osmanabad and Lohara tehsils i.e. above 945 kgs., because of development of irrigation facilities and high use of high yield variety seeds and chemical fertilizers.

During the period of investigation, district as a whole has 126.97 kilogram positive change. All tehsils show positive as well as negative change in per hectare yield of Wheat. The high positive change is found only in Washi tehsil i.e. 492.7 kilogram. The moderate positive change is observed in Tuljapur and Lohara tehsils i.e. 170 to 330 kilogram whereas it is low in Bhum, Osmanabad and Paranda tehsils i.e. below 170 kilogram during 1999-04 to 2009-14.

The low negative change in per hectare yield of Wheat is observed in Omerga tehsil i. e. 68.03 kilogram, during 1999-04 and 2009-2014. The high negative change is observed only in Kalam tehsil i.e. 187.37 kilogram during the period of investigation.

4.2.3. Bajara

The district as whole has 444.85 kgs. per hectare yield of Bajra during 2013-14. However, spatial distribution is very uneven; the low per hectare yield of Bajara was found in Tuljapur, Lohara and Osmanabad tehsils i. e. below 385 kilogram during 2009-14. It was moderate in Paranda and Omerga tehsils i.e. 385 to 485 kilogram;

whereas it is high in Washi, Kalam and Bhum tehsils i.e. above 485 kilogram per hectare, due to suitable climate and soil.

During the period of investigation, district as a whole has 65.13 kilogram positive change in per hectare yield of Bajra, but it varies from tehsil to tehsil. The high positive change is recorded only in Washi tehsil i.e. 231.4 kilogram, due to the use of high yielding variety. The moderate increase is found in Bhum, Kalam and Paranda tehsils i.e. 100 to 165 kilogram, whereas it is low in Osmanabad, Tuljapur and Omerga tehsils i.e. below 100 kilogram.

4.2.4. Tur

District as a whole has 641.25 kilogram per hectare of Tur, that of state is 717.4 kilogram, but the tehsil level analysis reveals uneven distribution. The high per hectare yield of Tur is found only in Kalam tehsil i.e. 793.20 kilogram, due to suitable soil and use of high yielding variety. The moderate per hectare yield of Tur is registered in Paranda, Omerga and Bhum tehsils i.e. 627 to 710 kilogram, whereas it is low in Lohara, Washi, Osmanabad and Tuljapur tehsils i.e. below 627 kilogram during 2009-14.

The region as a whole has 152.33 kilogram positive change in per hectare yield of Tur. All tehsils show positive change in per hectare yield of Tur except Tuljapur tehsil. The high positive change in per hectare yield of Tur is found in Kalam, Paranda and Washi tehsils i.e. above 200 kilogram, due to high yielding variety and availability of market of Dal mills. The moderate increase in per hectare yield of Tur is recorded in Bhum and Lohara i.e. 100 to 200 kilogram, whereas it is low in Osmanabad and Omerga tehsils i.e. below 100 kilogram.

During the period of investigation per hectare yield of Tur decreased only in Tuljapur tehsil i.e. 33.63 kilogram.

4.2.5. Gram

The region as whole has 778.35 kilogram per hectare yield of Gram during 2009-14, that of state was 692 kilogram, but spatial distribution varies from tehsil to tehsil. The low per hectare yield of Gram was recorded in Washi and Kalam tehsils i.e. below 700 kilogram. It was moderate in Paranda and Bhum tehsils i. e. 700 to 800 kilograms, whereas high per hectare yield of Tur is found in Tuljapur, Osmanabad,

Lohara and Omerga tehsils i.e. above 800 kilogram, because of fertile soil, use of high yielding Variety seeds, chemical fertilizer and development of irrigation.

During the period of investigation the region as a whole has 350.80 kilogram positive change in per hectare yield of Gram, but spatial distribution varies from districts to district, due to variation in use of high yield variety seeds, chemical fertilizer and development of irrigation. The High positive change in per hectare yield of gram is recorded in Paranda, Washi, Osmanabad, Lohara and Tuljapur tehsils i.e. above 350 kilogram. The moderate increase is found in Bhum and Omerga tehsils i.e. 100 to 350 kilogram, whereas it is low only in Kalam tehsil i.e. 97 kilogram.

4.2.6. Groundnut

During the period of 2009-14 the region as a whole has 892.07 per hectare yield of Groundnut that of state is 1164.6. However spatial distribution of per hectare yield of groundnut is uneven in the study region. Per hectare yield of Groundnut is high in Lohara and Omerga tehsils i.e. 1000 kilogram, due to development of irrigation facility. The moderate per hectare yield of Groundnut is recorded in Tuljapur, Bhum, Osmanabad and Paranda tehsils ranging from 800 to 1000 kilogram, whereas it was low in tehsils of Kalam and Washi i.e. below 800 kilogram.

The region as a whole has 26.74 kilogram positive change in per hectare yield of Groundnut. However, tehsil level analysis reveals both positive and negative change. The High positive change in per hectare yield of groundnut is recorded in Tuljapur, Omerga and Washi tehsils i.e. above 200 kilogram, whereas it is low in Paranda and Osmanabad tehsils i. e. below 150 kilogram, from 1999-04 to 2009-14.

The low negative change of per hectare yield of Groundnut is noticed only in Bhum tehsil i. e. 87.07 kilogram, whereas the high negative change is observed in Kalam and Lohara tehsils i.e. above 250 kilogram during the period of investigation.

4.2.7. Soybean

The region as a whole has 967.85 kilogram per hectare yield of Soybean in 2009-14 but spatial distribution of per hectare yield of Soybean is very uneven in the study region. High per hectare yield of Soybean is recorded in Washi, Osmanabad and Omerga tehsils i. e. above 975 kilogram. The moderate per hectare yield of Soybean is found in Kalam, Lohara, Paranda and Bhum tehsils ranging from 930 to 975

kilogram whereas it was low only in Tuljapur tehsil i.e. below 886 kilogram per hectare.

Per hectare yield of Soybean is increased by 141.33 kilogram in the study region during 2009-14, but spatial distribution varies from tehsil to tehsil. The high increase of per hectare yield of Soybean is found in Tuljapur, Omerga and Paranda tehsils i.e. above 300 kilogram, whereas the low increase is observed in Kalam, Lohara, Bhum and Osmanabad tehsils i.e. below 150 kilogram during the period of investigation. The high decrease of per hectare yield of Soybean is observed only in Washi tehsil i.e. 380.6 kilogram during the period of investigation.

4.2.8. Sugarcane

The region as a whole has 73.84 M.T. per hectare yield of Sugarcane that of state is 77.69 ton in 2009-14, but the spatial distribution is very uneven. The high per hectare yield of Sugarcane is found in Tuljapur, Omerga, Osmanabad, Lohara and Paranda tehsils i.e. above 75 M.T. because of development of irrigation facility, the use of high yielding variety and regur soil in river basin. It was moderate only in Bhum tehsil, whereas it is low in Kalam and Washi tehsils i.e. below 70 M.T. during the period of investigation.

The region as a whole has 22.63 M.T. positive change in per hectare yield of Sugarcane. Per hectare yield of Sugarcane increased in the all tehsils of the study region. The high increase is observed only in Lohara tehsil i.e. 30.50 M.T. per hectare, due to development of surface irrigation. The moderate increase is observed in Washi, Tuljapur and Omerga tehsils i.e. 22.30 to 26.40 M.T., whereas it is low in Kalam, Bhum, Paranda and Osmanabad tehsils i.e. below 22.30 M.T. during the period of investigation.

4.3 IRRIGATED AREA AND PER HECTARE YIELD OF SELECTED CROPS IN OSMANABAD DISTRICT:

Rainfall is uncertain, unpredictable and inadequate rainfall. Rainfall variability is more than 33 per cent in region therefore role of irrigation is very important. So attempt is made here to find out correlation and coefficient of determination between irrigated area and per hectare yield of selected crops.

The table 4.2 indicates that there is positive as well as negative correlation between Net irrigated area and per hectare yield of selected crops in Osmanabad district during 2009-10 to 2013-14. The high positive correlation is found in case of Sugarcane, Gram and Wheat, the coefficient of correlation in this regard is + 0.837, + 0.794 and + 0.700 respectively. The coefficient of determination (r2) is found to be at 0.701, 0.631 and 0.490 respectively, which reveals that the independent variable (X) i.e. net irrigated area are explaining 83.70 , 79.40 and 70.00 per cent of the total variations in dependant variable (Y) i.e. average per hectare yield of Sugarcane, Gram and Wheat respectively. The moderate positive correlation is found only in case of Groundnut, the coefficient of correlation in this regard is at +0.528. The coefficient of determination (r2) is found to be at 0.278, which reveals that the independent variable (X) i.e. net irrigated area are explaining 27.80 per cent of the total variations in

Table No. 4.2: Correlation and Coefficient of Determination between Irrigated area and per hectare Yield of Selected Crops – 2009-10 to 2013-14.

Tehsil	% of NIA	Selected Crops							
		Jowar	Wheat	Bajara	Tur	Gram	Ground-nut	Soy-bean	Sugar-cane
Paranda	20.18	981.9	1014	480.2	704.8	740.2	811.2	951.8	75750
Bhum	21.1	646.7	999.6	536.8	629.6	722.2	939.8	936	71750
Washi	12.39	950.7	928.2	584.4	594	644	618.8	1020.4	67500
Kalam	8.76	847.1	584.8	558.6	793.2	579	736.73	962.6	68250
Osman-abad	20.66	735.5	1011	285.4	575	898	857.33	1019.4	76250
Tuljapur	35.83	695.4	1071	353.2	544.2	915.8	962.9	886	79000
Lohara	20.45	797.7	1126	328.6	601.6	875.8	1184.5	952.8	75500
Omerga	20.34	653.5	940.8	431.6	687.6	851.8	1025.3	1013.8	76750
r=		-0.499	0.700	-0.615	-0.647	0.794	0.528	-0.622	0.837
r2=		0.249	0.490	0.378	0.418	0.631	0.278	0.387	0.701

Source: Compiled by Researcher on the basis of District Socio-Economic Review & Statistical Abstract of Osmanabad and Statistical officer, Divisional Joint Director Office of Agriculture, Latur Division, Latur.

dependant variable (Y) i.e. average per hectare yield of Groundnut. The negative correlation is found in case of Jowar, Bajra, Tur and Soybean as they are mostly cultivated as rain fed.

4.4 IMPACT OF IRRIGATED AREA ON AVERAGE PER HECTARE YIELD OF SELECTED CROPS:

Attempt is made here to assess the impact of percentage of net irrigated area to net sown area on average per hectare yield of all selected crops of tehsils in Osmanabad district. In the context of objective the following findings has come to light**.**

Table no. 4.3 A: Percentage of Net Irrigated Area and average per hectare yield of selected crops in tehsils of the Osmanabad District

Sr. No	Tehsils	X (% of Net irrigated area to net area sown)	Y (Average PHY of Selected Crops
1	Paranda	20.18	10179.32
2	Bhum	21.20	9645.09
3	washi	12.39	9105.06
4	Kalam	8.76	9164.00
5	O. bad	20.66	10204.00
6	Tuljapur	35.83	10553.51
7	Lohara	20.45	10170.88
8	Omerga	20.34	10294.30
Coefficient of correlation			0.828215
Coefficient of determination			0.685940

Source: Compiled by researcher on the basis of Socio economicc Review and district Statistical Abstract of Osmanabad District 2009-10 to 2013-14, Statistical officer, Divisional Joint Director Office of Agriculture, Latur Division, Latur.

1. The high positive correlation is observed in between percentage of net irrigated area and average per hectare yield of selected crops in the tehsils of Osmanabad District. The coefficient of correlation in this regard is +0.828215. The degree of linear association between these two variable obtained by using the coefficient of determination (r^2) is found to be at 0.685940, which reveals that the independent variable (X) i.e. net irrigated area are explaining 68.59 per cent of the total variations in dependant variable (Y) i.e. average per hectare yield of selected crops in the tehsils of Osmanabad District.

It is a good explanation because 68.59 per cent of variation in 'Y' average per hectare yield of selected crops in the tehsils of Osmanabad District to be influenced by the variable 'X' i.e. net irrigated area and about 31.41 percent of variation is left to be influenced by other variables.

2) The functional form of linear relationship of 'Y' on 'X' found to be at y = 8777.77 + 56.91x. The line of best fist is shown in figure no. 4.1. The regression coefficient indicates that increase of one percent net irrigated area causes for increase of 56.91 kilogram average per hectare yield of selected crops in the tehsils of Osmanabad District. By testing the significance of regression coefficient (a test of significance), the validity of this causal relationship has been confirmed.

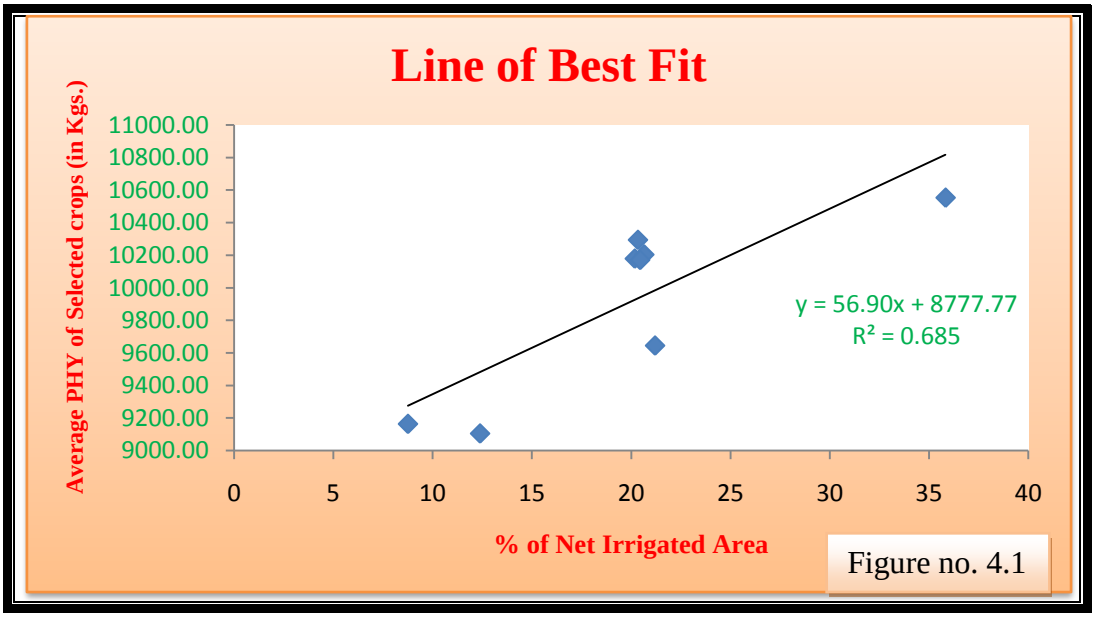

Figure no. 4.1

The calculated value of 't' in this exercise is found at 3.62. It is observed that this calculated value is higher than the tabulated value of 't' (3.14) at the 6 degree of freedom (df = n –2, where 'n' is 8) at 2 per cent level of significance.

3) In order to understand the degree of fit of regression equation and the accuracy level of predicted values (y) average per hectare yield of selected crops in the tehsils of Osmanabad district the standard error (SE) of estimate is being done with the equation SE (Y) = SY $\sqrt{1-r^2}$, where SE (Y) is the standard deviation of residuals (Y-y); and 'SY' is the standard deviation of 'Y'.

The confidence intervals of the predicted values are worked out at Y ± SE (Y) (The SE (Y) for the present exercise is 328.6 and SY is the 542.91). Thus it is assumed that if the values of 'Y' (Y-y) lie within the range of Zero to ± SE, the

prediction could be expected to be accurate. In other words, the role of independent variables in explaining the change in dependent variable can be accepted as correct.

The equation used $t = (b-\beta) \sqrt{(n-2)\Sigma(Xi-\bar{X})^2 \div \Sigma (Yi-yi)^2}$

In this context it has been observed that the predicted values (given in table-4.3 B) of 5 out of 8 tehsils in the present study lie within the range of ± SE, 3 within ± SE to ± 2 SE. Now the obvious inference is that the 62.5 per cent of the total number of observation (n is 8) the regression is a good indicator meaning thereby that the variations in average per hectare yield of

Table No.4.3 B: Residuals from Regression of average per hectare yield of selected Crops.

Sr. No,	Tehsils	yi	Yi-yi
1	Paranda	9926.114	253.2056
2	Bhum	9984.158	-339.0676
3	washi	9482.824	-377.7639
4	Kalam	9276.259	-112.2585
5	Osmanabad	9953.429	250.5712
6	Tuljapur	10816.679	-263.1687
7	Lohara	9941.479	229.4012
8	Omerga	9935.219	359.0808

Source: compiled by researcher.

selected crops is the function of the variations in net irrigated area. In the case of other tehsils with residuals between ± SE to ± 2 SE the situation is different because here the regression is a poor indicator. It clearly indicates that these are the tehsils whom the influence of variables other than the independent one. The variations in average per hectare yield of selected crops in the tehsils of Osmanabad district in the later case may be due to the variation in climatic condition, variation in soil, variation in use of fertilizer and pesticides, and variation in consciousness of farmers.

4.5 TEHSIL-WISE PRODUCTION OF SELECTED CROPS IN OSMANABAD DISTRICT

4.5.1. Jowar

The Table 4.4 indicates that during the 2009-10 to 2013-14, the average production of Jowar is 194521.4 M. T. in Osmanabad district. The low production of Jowar is recorded in Bhum, Omerga, Washi and Lohara tehsils i.e. below 21000 M. T. during 2009-10 to 2013-14. It was moderate only in Kalam tehsil i.e. 29166 M.T., whereas it was high in Paranda, Tuljapur and Osmanabad tehsils i.e. above 30000 M.T., due to the favorable soil, rainfall and temperature.

During the period of investigation, the region as a whole has negative change in production of Jowar i.e. 1168 M. T. However tehsil level analysis reveals both positive as well as negative change in the production of Jowar. The high positive change i.e. above 19198 is recorded only in Paranda tehsil, while low positive change is found only in Washi tehsil i.e. 4750 M.T.

The high negative change in Jowar production is observed in Osmanabad tehsil i.e. 10636.5 M. T. The moderate positive change is found in Tuljapur, Lohara and Omerga tehsils which is ranging from 4000 to 7000 M.T., while it is low in Bhum and Kalam tehsils i.e. < 4000 M.T.

4.5.2. Wheat

Wheat as a rabbi crop is cultivated over medium to deep black soil with moisture and hence hardly requires irrigation facility. During the 2009-10 to 2013-14, the average production of Wheat is 22443 M. T. in Osmanabad district. The table no. 4.4 indicates that the spatial distribution varies from tehsil to tehsil. The high production of wheat is recorded in Bhum and Osmanabad tehsils i.e. above 4000 M. T., because of development of irrigation facilities and use of high yielding varieties. It is moderate only in Tuljapur tehsil i.e. 3540 M.T. The low production of wheat is recorded in Kalam, Paranda, Omerga, Lohara and Washi tehsils i.e. below 2500 M. T., due to dominance of jowar the area under wheat is low.

The region as a whole has 5065 M.T. positive change in Wheat production, but spatial distribution varies from tehsil to tehsil. The low positive change in wheat production was noticed in Osmanabad, Washi and Lohara tehsils i.e. below 1500 M.

Table No. 4.4: Tehsil-wise Production of Selected Crops [1999-00 to 2003-04 and 2009-10 to 2013-14

Production in M.T

Tehsil	Crops	Jowar	Wheat	Bajra	Gram	Tur	Groundnut	Soybean	Sugarcane
Paranda	**1999-00 to 2003-04**	18924.95	2099.00	718.66	2629.20	2977.18	425.13	67.61	119103.50
	1999-00 to 2003-04	38123.05	1940.47	755.08	6133.02	4917.41	667.15	154.84	493335.47
	2009-10 to 2013-14	19198.09	-158.53	36.42	3503.83	1940.23	242.02	87.23	374231.97
	% of volume change	19198.09	-158.53	36.42	3503.83	1940.23	242.02	87.23	374231.97
Bhum	**1999-00 to 2003-04**	18628.29	1631.18	1014.51	2813.91	2663.96	590.73	388.70	85005.40
	2009-10 to 2013-14	18060.85	4570.11	1450.67	2991.90	5021.15	71.05	2646.34	170496.36
	% of volume change	-567.44	2938.93	436.16	177.99	2357.19	-519.68	2257.64	85490.96
Washi	**1999-00 to 2003-04**	8906.19	767.54	865.13	1036.66	2381.78	448.87	631.84	56077.25
	2009-10 to 2013-14	13656.32	2068.89	441.93	3143.61	2776.88	116.15	9031.75	177771.67
	% of volume change	4750.13	1301.35	-423.20	2106.95	395.10	-332.72	8399.92	121694.43
Kalam	**1999-00 to 2003-04**	30745.32	1189.26	467.21	2664.74	3567.06	1307.98	811.31	171337.66
	2009-10 to 2013-14	29166.40	639.39	464.01	6648.18	7120.93	592.75	17351.03	371048.13
	% of volume change	-1578.92	-549.87	-3.20	3983.43	3553.87	-715.23	16539.72	199710.47
Osmanabad	**1999-00 to 2003-04**	43718.64	4653.59	332.15	3450.92	6521.82	1192.93	3947.83	217446.88
	2009-10 to 2013-14	33082.16	5972.96	149.55	7029.27	7027.64	525.55	29090.45	659944.36
	% of volume change	-10636.47	1319.37	-182.60	3578.35	505.82	-667.39	25142.62	442497.47
Tuljapur	**1999-00 to 2003-04**	39207.87	3644.51	534.66	3276.55	10498.47	2301.34	1658.32	256855.21
	2009-10 to 2013-14	34210.04	3539.74	643.73	4389.00	9837.83	1390.44	9452.51	472773.54
	% of volume change	-4997.83	-104.77	109.08	1112.45	-660.64	-910.90	7794.19	215918.32
Lohara	**1999-00 to 2003-04**	18146.68	1282.46	675.45	2037.16	1979.23	2100.07	628.58	32853.02
	2009-10 to 2013-14	12528.99	2064.73	581.03	3393.51	3086.18	1745.40	4794.23	228539.54
	% of volume change	-5617.68	782.28	-94.42	1356.35	1106.95	-354.67	4165.64	195686.52
Omerga	**1999-00 to 2003-04**	23687.58	2672.01	1026.29	3209.07	3831.67	1448.31	1146.37	207442.07
	2009-10 to 2013-14	17564.26	1941.13	1649.89	7139.01	7959.36	715.63	6509.94	329267.35
	% of volume change	-6123.32	-730.88	623.60	3929.94	4127.69	-732.68	5363.57	121825.28
District	**1999-00 to 2003-04**	195689.39	17377.46	5744.43	20741.15	32892.71	9818.19	9798.53	1116713.31
	2009-10 to 2013-14	194521.36	22443.06	5868.39	42704.56	48474.73	5333.04	77961.40	2842834.91
	% of volume change	-1168.03	5065.60	23.96	21963.41	15582.02	-4485.16	68162.87	1726121.60

T. during 1999-00 to 2003-04 and 2009-10 to 2013-14. The high positive change is found only in Bhum tehsil i.e. 2939 M.T. during the period of investigation, due to the development of irrigation facilities and technological factor. The high negative change in Wheat production is noticed in Kalam and Omerga tehsils i.e. > 500 M.T., whereas the low negative change was observed in Paranda and Tuljapur tehsils i.e. below 300 M.T.

4.5.3. Bajara

Bajara, a drought resistant crop of kharif season, is grown on inferior quality of soil and having less commercial value. During the 2009-10 to 2013-14, the average production of Bajara is 5668.39 M. T. in the study region. The low production of Bajara is found in Osmanabad, Washi, Kalam, Lohara and Tuljapur tehsils i. e. below 650 M. T. during 2009-10 to 2013-14, due to increase of area under Sugarcane and Soybean. It was moderate in Paranda tehsil i. e. 755.08 M. T., whereas it was high in Bhum and Omerga tehsils i.e. above 1150 M. T. due to inferior soil in Bhum tehsil and use of high yield variety Seeds in Omerga tehsil.

During the period of investigation, the region as a whole has negligible i.e. 123.96 M.T. positive change in Bajara production, but tehsil level analysis reveals both positive and negative changes. The high positive change in Bajara production is recorded in Omerga and Bhum tehsils i.e. above 430 M.T., whereas it is low in Tuljapur and Paranda tehsils i.e. below 230 M.T.

During the period of investigation, high negative change in Bajara production is found in Washi tehsil i.e. 423.20 M.T.; due to development of irrigation facilities the area under Bajara is converted into cash crop like sugarcane and soybean. The moderate negative change was observed in Osmanabad tehsil i.e. 182.60 M.T., whereas low negative change was observed in Kalam and Lohara tehsuls i.e. < 140 M.T.

4.5.4. Gram

During the 2009-10 to 2013-14, the average production of gram is 42707 M.T. in Osmanabad district. The table no. 4.4 exhibits that the low production of Gram was recorded in Bhum, Washi, Lohara and Tuljapur tehsils i.e. below 4500 M. T. during 2009-10 to 2013-14., whereas it is high in the tehsils of Paranda, Kalam, Osmanabad and Omerga tehsils i.e. above 6000 Metric Tonns because of use of high yielding variety seeds.

During the period of investigation, the region as a whole has 21963 M. T. positive change in Gram production. The table no. 4.4 reveals that high positive change in Gram production is recorded in Paranda, Osmanabad, Omerga and Kalam tehsils i.e. above 2700 M. T. The moderate change in Gram production is observed in Washi tehsil i.e. 2106.95 M.T., whereas it is low in Bhum, Tuljapur and Lohara tehsils i.e. below 1450 M. T.

4.5.5. Tur

During 2009-10 to 2013-14, the region as has 48474 M. T. average production of Tur. The tehsil level analysis reveals uneven distribution. The table no. 4.4 indicates that the production of Tur was high in Omrga and Tuljapur tehsils i.e. > 7500 M.T., due to the suitable climate and soil. It is Moderate in Osmanabad and Kalam tehsils i.e. ranging from 5100 to 7500 M.T. Whereas it is low in Washi, Lohara, Paranda and Bhum tehsils i.e. below 5100 M. T.

During the period of investigation, production of Tur increased by 15582 M. T. in the study region. High increase in production of Tur is found in Kalam and Omerga tehsils i.e. > 2900 M.T., due to the high yielding varieties and availability of market. The moderate positive change in Tur production is in Paranda and Bhum tehsils i.e. 1600 to 2900 M.T., whereas it is low in Washi, Osmanabad and Lohara tehsils i.e. below 1600 metric tons due to dominance of Soybean. The negligible negative change in Tur production is found only in Tuljapur tehsil i.e. 660 M.T.

4.5.6. Groundnut

During the 2009-10 to 2013-14, the region has 5333 M.T. average production of Groundnut. The spatial distribution of Groundnut production is very uneven in the study region. The table no. 4.4 indicates that the high production of Groundnut is found in Tuljapur and Lohara tehsils i.e. > 1200 M.T., due to the development of irrigation facility. It is moderate in Paranda and Omerga tehsils i.e. Paranda and Omerga tehsils i.e. ranging from 600 to 1200 M.T., whereas it is low in Bhum, Washi, Osmanabad and Kalam tehsils i.e. below 600 M.T

During the period under review the study region have negative change in average production of Groundnut i.e. 4485 M.T. The table no. 4.4 indicates that the high negative change in Groundnut production was recorded in Omerga and Tuljapur tehsils i.e. 720 M.T. The moderate negatve change is observed in Osmanabad and Kalam tehsils ranging from 525 to 720 M.T, where as low negative change in

Groundnut production is recorded in Washi, Lohara and Bhum tehsils i.e. < 525 M.T. The negligible positive change of 242 M.T. Is observed in Paranda tehsil.

4.5.7. Soybean

During 2009-10 to 2013-14, the region as has 77961 M. T. average production of Soybean. The tehsil level analysis reveals uneven distribution. The table no. 4.4 indicates that the production of Soybean was high in Kalam and Osmanabad tehsils i.e. > 17000 M.T., whereas it is low in Tuljapur, Omerga, Washi, Lohara, Paranda and Bhum tehsils i.e. below 10000 M. T.

During the period of investigation, production of Soybean is increased by 68162 M. T. in the study region. High increase in production of Soybean is found in Kalam and Osmanabad tehsils i.e. > 16500 M.T., due to the high yielding varieties and availability of market., whereas low positive change in Soybean production is recorded in Paranda, Bhum, Omerga, Washi, Tuljapur and Lohara tehsils i.e. below 8500 metric tons.

4.5.8. Sugarcane

Sugarcane is a long duration crop grown in medium black and deep black soil with assured supply of irrigation. In study region, there was a 2842835 M.T. average production of Sugarcane during 2009-10 to 2013-14. The high production of Sugarcane was found only in Osmanabad tehsil i.e. 500000 M.T., because of irrigation facility. It was moderate in Kalam, Tuljapur and Paranda tehsils i.e. ranging 350000 to 500000 M.T. whereas it was low in Bhum, Washi, Lohara and Omerga tehsils i.e. below 350000 M.T. during the period of investigation, due to high percentage of black cotton soil farmer choose Cotton rather than Sugarcane.

During the period of investigation the study region as a whole has 1726122 M.T. positive change in the production of Sugarcane. All the tehsils of the study region shows positive changes in Sugarcane production. The high increase in sugarcane production is observed in Osmanabad and Paranda tehsils i.e. > 325000 Metric Tonnes, due to fertile soil, high yield variety and surface irrigation facilities. It is moderate only in Tuljapur tehsil i.e. 200000 to 325000 Metric Tones', whereas it is low in Bhum, Washi, Omerga, Lohara and Kalam tehsils i.e. below 200000 M.T.

4.6 COEFFICIENT OF VARIATION IN PER HECTARE YIELD AND PRODUCTION OF SELECTED CROPS:

In the previous point per hectare yield and production of selected crops have been explained on the basis five year's averages i.e. 1999-00 to 2003-04 and 2009-10 to 2013-14. In this point, an attempt has been made to analyze total magnitude of fluctuations that may be resulted due to the positive deviation and may reflect to a great extent the degree at stability in phenomena over the period under review.

The magnitude of variability has been determined by applying the Karl Person's formula of coefficient of variation, which is as below.

$$\text{Coefficient of Variation} = \frac{\text{S.D}}{\text{Mean}} \times 100$$

4.6.1 Coefficient of Variation in Per Hectare Yield:

The table 4.5 shows the variability in per hectare yield of selected crops in the study region. During 2009-10 to 2013-14, crop wise analysis of variability varies ranging in between 4.90 and 29.30 percent. The high degree of variability is found in Groundnut and Bajra crops i.e. above 21 per cent of coefficient of variation, because most of irrigated area is devoted to other cash crops such as Soybean and Sugarcane etc. The moderate degree of variability is found in Wheat and Gram i.e. ranging from 13 to 21 per cent, whereas the low degree of variability is recorded in Jowar, Soybean, Sugarcane and Tur crop i.e. below 13percent as these are seasonal crops except Sugarcane.

During the period of investigation, both negative as well as positive change in coefficient of variation of selected crops has been observed in the study region. The high negative change is observed in Soybean crop i.e. > 20 per cent because farmers attracted towards the Soybean as a cash crop and they cultivate it very cautiously. The moderate negative change is found in Jowar crop as Jowar is dominant and traditional crop in the study region. Whereas the low negative change in variation of per hectare yield of selected crops is found in Sugarcane, Wheat and Tur. The negligible positive change is noticed in Bajra and Gram i.e. 0.73 and 0.23 per cent respectively.

Table No. 4.5: Coefficient of Variation of per Hectare Yield and Production of Selected Crops in Osmanabad district during 1999-00 to 2003-04 & 2009-10-201314.

Crop	Co-efficient of Variation in PHY			Co-efficient of Variation in Production		
	1999-00 to 2013-14	2009-10 to 2013-14	Change	1999-00 to 2013-14	2009-10 to 2013-14	Change
Jowar	23.10	11.42	-11.68	46.628	41.48	-5.15
Wheat	21.80	19.42	-2.38	59.745	60.87	1.13
Bajra	24.53	25.26	0.73	36.014	67.49	31.47
Gram	20.03	20.26	0.23	29.869	35.51	5.64
Tur	16.61	12.78	-3.83	66.673	40.98	-25.69
Ground-nut	38.79	29.30	-9.49	58.665	79.47	20.80
Soya-bean	35.45	4.90	-30.55	105.533	94.49	-11.05
Sugar-cane	10.25	10.04	-0.21	57.246	47.48	-9.76

4.6.2 Coefficient of Variation in Production:

During 2009-10 to 2013-14, the variability in production of selected crops in the study region varies ranging from 35.51 and 94.49 percent. The high degree of variability is found in case of Soybean and Groundnut production i.e. > 75 per cent of coefficient of variation, due to the uncertain monsoon. The moderate degree of variability is found in case of Bajra and Wheat i.e. 55 to 75 per cent, whereas the low degree of variability is recorded in Gram, Tur, Jowar and Sugarcane i.e. below 55 per cent. The analysis of variation in production reveals that uncertain and erratic nature of Monsoon as well as unsure irrigation facilities.

During the period of investigation, both negative as well as positive change in coefficient of variation in production of selected crops has been observed in the study region. The high negative change is observed in case of Tur i.e. > 19 per cent because Tur is traditional crop in the study region. Whereas the low negative change in variation of production of selected crops is found in Jowar, Sugarcane and Soybean. The table no. 4.5 also indicates that the high positive change is noticed in case of Groundnut and Bajra i.e. > 20 per cent because most of the farmers preferred Soybean instead of Groundnut and Bajra as a cash crop, whereas the low positive change is observed in Wheat and Gram i.e. < 10 per cent.

4.7. AGRICULTURAL PRODUCTIVITY:

Productivity as defined in economic or agricultural geography means output per unit of input or per unit of area respectively and the important in agricultural productivity is generally the result of a more efficient use of factors of production viz. environment, arable land, labour and capital (Singh Jasbir & Dhillon S.S.1997).Bhatia (1967) defined "Agricultural efficiency as the aggregate performance of various crops in regard to their output per acre but the contribution of each crop to the agricultural efficiency would be relative to its share of the crop land".

Agricultural productivity is a measure of efficiency with which inputs are used to provide an output. When a given combination of inputs produces a maximum output, the productivity is said to be at its maximum. The measurements of agricultural productivity enable a comparison of the relative performance of farmers between farm, between types of farming and between geographical areas. The study of agricultural productivity is essential for differentiating and delimiting the areas whose performance and accomplishments are diverse. The studies on agricultural productivity are helpful in involving a future oriented strategy for agricultural planning (Ahmed P, 2007). The measurement of agricultural productivity helps in knowing the area that is performing rather less efficiency in comparison to the neighboring areas. By delimiting the areas of low, medium and high productivity, agricultural plans may be formulated to remove and minimize for the regional inequalities. It is also provides an opportunity to ascertain the ground reality, the real cause of agricultural backwardness of a region. (Husain, Majid 2010)

In the recent decades geographers and economists have developed sophisticated tools and techniques to determine the agricultural productivity. Some of the well known techniques developed and used for the measurement of agricultural productivity and agricultural efficiency per unit area per unit of time are given below.

1. Output per unit area.

2. Production per unit of farm labour.

3. To assess agricultural production as grain equivalents (Buckn1967).

4. Input- output ratio (Khusro, 1964).

5. Ranking coefficient method (Kendall, 1939; Stamp, 1960; Shafi, 1990).

6. Giving weight to the ranking order of the output per unit area with the percentage share under each crop (Sapre and Deshpande, 1964; Bhatia, 1967).

7. Carrying capacity of land in terms of population (Stamp, 1958).

8. Determining an index of productivity (Enyedi, 1964; Shafi, 1972).

9. Computing the crop yield and concentration indices ranking coefficient (Jasbir Singh 1976).

10. Involving the area, production and price of each cultivated crop in each of the constituent areal units of the region, and then relating the out term in terms of money of the unit to the corresponding productivity of the region (Husain, 1976).

11. To assess agricultural production in terms of money.

12. Assessing the net income in rupees per hectare of cropped area (Jasbir Singh 1976). (Husain, Majid., 2010)

These first three techniques seen to require such statistics as are not readily available and even easily accessible in the region. Technique fourth which advocates measuring agricultural progress in term of grain equivalents per head population was used for the first time by Buck (1967). He had used grain equivalents per head of population in China. According to him in a subsistence agricultural economy, grain equivalent is more varied than any other measure e.g. monetary. He considered all grains to be equal in food value. He converted the crops other than food grains in grain equivalents according to local market price at which they are exchanged against the predominant food grains of the region. This method was attempted by clerk and Has Well (1967) by expressing the output in terms of kilograms of "Wheat Equivalent" per head of population.

Fifth technique was developed by Kendall (1939). He had considered output per unit area after grading them in ranking order, there by deriving the ranking order, and there by deriving the ranking coefficient. Kendall took into account only the rank of the crop according to per hectare yield, neglecting its areal strength. He took the per unity area yields of ten leading crops in forty-eight administrative counties of England. Ranks were given to each of the ten crops. Their average was worked out and an average rank was given to each county. This he called ranking coefficient of agricultural efficiency of each county. In this way he measured agriculture productivity or efficiency. Stamp (1960) applied the Kendall's ranking coefficient

technique for international comparisons by selecting twenty countries and nine major crops. Shafi Mohmmad (1960) used this technique of Kendall for determining the efficiency of the districts comprising the state of Uttar Pradesh by considering the hectare yield of eight crops.

Sixth technique has been introduced by Sapre and Deshpande (1964). They tried to overcome the weakness of Kendalls method to some extent by bringing into picture the regional strength of crops. They multiplied the rank value of all crops in an aerial unit by the percentage of cropland share and divided the percentage share of the total cropped area. They applied this modified method for Maharashtra. But their method also suffered from another weakness i.e. hectare yield itself does not come up but instead only came the weight age average of ranks. Between each rank the difference remains one only.

The technique seventh of carrying capacity, of land (in terms of population) was suggested by Stamp (1958) in his presidential Address to the International Geographical Congress at Rio de Janerio in 1956. Stamp L. D. calculated agricultural productivity by converting the total agricultural production of different crops in calorie value. Stamp called it is a "Standard Nutrition Unit" (SNU). Taking into consideration the age structure of the population the range of occupation the weight and height of people living under climatic condition varies from region to region also considers the average calories varies per day and per year published by the British Medical Association".

The eighth technique was advocated by Enyedi (1964) for determining an index of productivity coefficient. He described geographical types of agriculture in Hungary referred to a formula for determining agricultural productivity. Shafi (1972 and 1974) also adopted this technique to determine the productivity indices in respect of twelve food crops of India.

The ninth is a modification form of technique seventh and is considered the most useful for measuring agricultural efficiency used by Jasbir Singh (1974). Technique tenth has been introduced by Hussain (1976) for establishing agricultural productivity of the Sutlej Ganga plains of India; he converted the agricultural production into money value of a regional unit proportion to the whole region. Technique eleventh was advocated by Singh V. R. (1979) he tried to present two-dimensional picture of agriculture productivity consisting the intensity and spread. He considered three variables i.e. i) yield ii) grain equivalents iii) cropping system

formulated agricultural productivity regions. Twelve techniques was used by Jasbir Singh (1985) studies on Hariyana.

For the present study, the technique has been introduced by Jasbir Singh (1976), Bhatia (1967), Shafi (1972) is used.

4.7.1. MEASUREMENT OF PRODUCTIVITY BY JASBIR SINGH'S METHOD

An attempt is made here to measure agricultural productivity by Jasbir Singh et.al. (1976) in order to assess the regional differences in the level of agricultural production and to delimit the weaker areas from the point of view of agricultural productivity the relative crop yield and concentration indices in ranking order and computed into average ranking coefficient. It may be called the crop yield and concentration indices ranking coefficient.

The procedure explained as follows.

$$Yi = \frac{Ya_e}{Ya_r} X\ 100$$

Where,

Yi = is the crop yield index.

Yae = is the average yield per hectare of crop 'a' in the component enumeration unit.

Yar = is the average yield of the crop 'a' in the entire region.

$$Ci = \frac{Pae}{Par} X\ 100$$

Where,

Ci = is the crop concentration index.

Pae = is the percentage strength of crop 'a' in the total copped area in the component enumeration unit.

Par = is the percentage strength of crop 'a' in the total cropped area in the entire region.

The derived crop yields and concentration indices for crops are ranked separately, yield and concentration ranks for individual crops are added and there after divided by two thus giving the crop yield and concentration indices ranking coefficient. The equation is as follows.

$$\text{Crop Yield \& Concentration Indices Ranking Coefficient For Crop-A} = \frac{\text{Crop Yield Index Ranking crop 'A'} + \text{Crop Concentration Index Ranking Crop 'A'}}{2}$$

This will give an idea of the level of agricultural productivity the lower the ranking coefficient, the higher the level of agricultural productivity and vice versa. This technique helps to identify the crop of good level of productivity in the region. The ranking coefficients for individual crops thus derived are arranged in order and coefficients are grouped in to three efficiency grade viz. high grade, moderate grade and low grade for discussing the spatial variations in the region.

LEVEL OF PRODUCTIVITY

Jowar

The table 4.6 reveals that during 2009-10 to 2013-14, high productivity of Jowar was observed in Paranda and Kalam tehsils, due to high percentage of medium to deep black soil and favourable climate. The moderate productivity is recorded in Lohara, Osmanabad and Tuljapur tehsils. It is low in Washi, Bhum and Omerga tehsils.

During the period of investigation the productivity of Jowar decreased in Osmanabad and Omerga tehsils, as per gradation in high to low change in Osmanabad and Omerga tehsils, because area under Kharip Jowar is devoted to cash crops, i.e. Soybean.

Wheat

The table 4.6 indicates that during the period of 2009-10 to 2013-14, Lohara, Osmanabad, Bhum and Washi tehsils, it is high in Lohara, Osmanabad and Bhum tehsils, due to increase in irrigated area, while it is high in Washi, due to use of high yield varieties. The moderate productivity of Wheat is found in Paranda, Omerga and Tuljapur tehsils, while it is low only in Kalam tehsil.

During the period of investigation the productivity of Wheat is increased in Tuljapur and Omerga tehsils, due to increase in irrigated area and use of high yielding varieties.

Table No.4. 6: Agricultural Productivity by Jasbir Singh (1976)

Tehsil	Year	Crop Yield & Concentration Indices Ranking Coefficient of Selected Crops							
		Jowar	Wheat	Bajra	Gram	Tur	Ground-nut	Soybean	Sugar-cane
Paranda	1999-00 to 2003-04	4	4	5	4	5	7	8	3.5
	2009-10 to 2013-14	1	4.5	3	3	5	3.5	7	1.5
Bhum	1999-00 to 2003-04	5	5.5	2.5	3.5	6	5	6	5.5
	2009-10 to 2013-14	5.5	3	1.5	6	3	8	7	6.5
Washi	1999-00 to 2003-04	7	5.5	3	6	5	5.5	3.5	7
	2009-10 to 2013-14	5.5	3.5	4	5	6.5	7	2	6.5
Kalam	1999-00 to 2003-04	2.5	7.5	4	4	5.5	4	3.5	4
	2009-10 to 2013-14	2.5	8	5.5	3	3	3.5	3	4
Osmanabad	1999-00 to 2003-04	3.5	2	8	5	3	6	2	2.5
	2009-10 to 2013-14	5	2.5	8	5.5	6.5	6	1.5	3
Tuljapur	1999-00 to 2003-04	5.5	3.5	7	6.5	1.5	3.5	5	3
	2009-10 to 2013-14	5	6	6.5	7.5	4.5	3.5	6.5	4
Lohara	1999-00 to 2003-04	4	5.5	3	4	5.5	1	4	8
	2009-10 to 2013-14	4.5	2.5	5	3	4.5	1	4.5	4
Omerga	1999-00 to 2003-04	4.5	2.5	3.5	3	4.5	4	4	2.5
	2009-10 to 2013-14	7	6	2.5	3	3	3.5	4.5	6.5

*Source**:** Complied by Researcher, on the basis of Socio economicc Review and district Statistical Abstract of Osmanabad 1999-00 to 2013-14, Statistical Officer, Divisional Joint Director Office of Agriculture, Latur Division, Latur*

Bajara

The table 4.6 indicates that as per Jasbir Singh method, high productivity of Bajara is recorded in Bhum, Omerga, Paranda and Washi tehsils, it is high in Bhum

and Washi, due to suitable soil and climate. The moderate productivity of Bajara is recorded in Lohara and Kalam tehsils, while low in Tuljapur and Osmanabad tehsils i.e. above 6 ranks co-efficient.

During the period of under view the productivity of Bajara decreased in Kalam and Lohara tehsils, as per gradation low to moderate change is recorded in Washi tehsil, due to unfavourable climate and decrease of rainfall.

Gram

The table 4.6 reveals that during the 2009-10 to 2013-14, the high productivity of Gram is found in Omerga, Lohara, Kalam and Paranda tehsils, due to fertile soil in Benithura, Manjara and Sina river basins, development of irrigation facility and use of improved seeds. The moderate productivity of Gram is found in Washi, Osmanabad and Bhum tehsils, while it is low in Tuljapur tehsil, due to low proportion of fertile soil.

During the period of investigation Gram productivity in decreased in Bhum tehsil, due to adverse effect of soil and climate.

Tur

The table 4.6 indicates that the high productivity of Tur is recorded in Omerga, kalam and Bhum tehsils during 2009-10 to 2013-14. It is high in Omerga and Kalam due to the high proportion of medium deep soils and suitable rainfall. The moderate productivity of Tur is observed in Lohara, Tuljapur and Paranda tehsils, while it is low in Washi and Osmanabad tehsils i.e. above 5 ranking coefficient.

During the period of investigation Tur productivity is increased in Bhum, Kalam and Omerga tehsils due to use of high yielding varieties and increase in irrigated area.

Groundnut

The table 4.6 indicates that the high productivity of Groundnut is found in Lohara, Omerga, Tuljapur, Kalam and Paranda tehsils during 2009-10 to 2013-14. It is high in Lohara, Omerga, Paranda and Kalam tehsils, due to development of surface irrigation facilities and suitable shallow soil, while it is low in Osmanabad, Washi and Bhum tehsils i.e. above 5 ranking co-efficient.

During the period of investigation low to high change is observed in Paranda tehsil, due to development of irrigation facility.

Soybean

During the period of 2009-10 to 2013-14, high productivity of Soybean is found in Osmanabad, Washi and Kalam tehsils. The moderate productivity of Soybean is recorded in Omerga and Lohara tehsils, while it is low in Tuljapur, Paranda and Bhum tehsils i.e. above 5 ranking coefficient.

During the period of investigation moderate to high change in Paranda and Washi tehsil, is due to use of high yielding varieties of Soybean and farmers trends toward Soybean as a cash crop.

Sugarcane

During the period of 2009-10 to 2013-14, as per Jasbir Singh method high productivity of Sugarcane is found in Osmanabad and Paranda tehsils i.e. below 3 ranking co-efficient, due to development of surface irrigation facility. The moderate productivity of Sugarcane is recorded in Lohara, Tuljapur and Kalam tehsils, while it is low in Omerga, Washi and Bhum tehsils, due to lower development of surface irrigation facility and other technological factors.

During the period of investigation low to high change is recorded in Paranda and Lohara tehsils, mainly due to considerable development of surface irrigation facility.

Overall Productivity By Jasbir Singh Method (1976)

During 2009-10 to 2013-14, the high level of productivity is found in Paranda, Lohara and Kalam tehsils, due to high development of surface irrigation facilities and fertile soil. Paranda tehsil is benefited by Sina-Kolegaon Joint Canal irrigation project and having fertile soil of Sina basin, Lohara is benefited by Lower Terna Major irrigation Project while Kalam is benifited by Manjara major irrigation project. The moderate overall productivity is recorded in Osmanabad and Omerga tehsils, while it is low in Washi, Bhum and Tuljapur tehsils as per Jasbir Singh's method.

4.7.2 MEASUREMENT OF PRODUCTIVITY BY THE BHATIA'S METHOD (1967)

To identify the regional difference in levels of agricultural productivity here the Bhatia's method of weighted average yield index is used. Eight crops are selected for this purpose and weights are given by taking cropland devoted to each crop. This may be expressed as below.

$$Iya = \frac{Ye}{Yr} \times 100$$

Where,

Iya= the Yield index of crop 'a'

Ye= the hectare Yield of crop 'a' in the areal unit.

Yr= the hectare yield of crop 'a' in the entire region

$$Ap\ (Ei) = \frac{Iya \times Ca + Iyb \times Cb + \ldots\ldots\ldots\ldots Iyn \times Cn}{Ca + Cb + \ldots\ldots\ldots\ldots\ldots Cn}$$

Where,

Ap = the agricultural productivity (Efficiency index)

Iya, Iyb, Iyn = the area yield indices of various crops.

Ca, Cb, Cn = the percentage of cropland under difference crops.

On the basis this, agricultural productivity of each tehsil of study region has been computed and for discussion the tehsils of the Osmanabad district are grouped into three categories i.e. area of high productivity, Areas of moderate productivity and area of low productivity.

Area Of High Productivity (Ei. > 105)

The The table 4.7 indicates that during 2009-10 to 2013-14, the high productivity is observed in the Western, North-eastern and South eastern part of the study region which comprises Paranda, Kalam and Lohara tehsils these tehsils cover 30.43 per cent of total reported area and contributes 32.25 net sown area of the Osmanabad district. The agricultural productivity is high in Paranda, Kalam and

Table no. 4.7: Agricultural Productivity Index (Ei) by Bhatia's Method (1967)

Sr.No.	Taluka	Agricultural Productivity Efficiency Index (Ei)		
		1999-00 to 2003-04	2009-10 to 2013-14	Change
1	Paranda	83.97	114.66	30.69
2	Bhum	94.07	93.98	-0.09
3	Washi	63.11	96.07	32.96
4	Kalam	111.63	106.24	-5.39
5	Osmanabad	114.33	99.81	-14.53
6	Tuljapur	109.92	92.90	-17.02
7	Lohara	108.59	106.60	-1.99
8	Omerga	114.57	95.29	-19.28

Source: Complied by Researcher, on the basis of Socio economicc Review and district Statistical Abstract of Osmanabad 1999-00 to 2013-14, & Statistical Officer, Divisional Joint Director Office of Agriculture, Latur Division, Latur

Lohara tehsils, due to fertile soil in Sina, Manjara and Terna river basin and they benefited by surface irrigation facilities i.e. Sina Kolegaon, Manjara and Lower Terna Irrigation Projects respectively.

Areas Of Moderate Productivity (Ei. 95 To 105)

The moderate agricultural productivity is recorded in Osmanabad, Omerga and Washi tehsils, which covers 38.88 per cent of geographical area and contribute 39.35 per cent of net sown area of study region. In Osmanabad and Omerga tehsils, it is moderate due to the development of surface irrigation facility and high proportion of medium deep soil.

Area Of Low Productivity (Ei. < **99)**

During 2009-10 to 2013-14, the low level of productivity is found in Bhum and Tuljapur tehsils, which covers 30.68 per cent of geographical area and contributes 28.39 per cent of net sown area of Osmanabad district. Most part of these tehsils covered by Balaghat hilly area and having high percentage of shallow soils. Therefore agricultural productivity is lower in these tehsils as per Bhatia's method.

Change In Level Of Prductivity

During the period of investigation, both positive as well as negative change in level of productivity is observed in the study region. The high positive change is recorded in Paranda and Washi tehsils, due to development of irrigation facility and use of high yielding varieties. The high negative change in level of productivity is

found in Omerga, Tuljapur and Osmanabad tehsils while low negative change is observed in Kalam, Lohara and Bhum tehsils.

4.7.3 MEASUREMENT OF PRODUCTIVITY BY THE SHAFI'S METHOD

After measurement of productivity by the Bhatia's method, efforts is made here to find out regional imbalance in agricultural productivity of Osmanabad district by using the Shafi's method (1972), because this technique helps to examine overall yield in relation to the region. While using this method eight crops of each tehsils are selected. To measure agricultural productivity the following formula is used.

$$\sum \frac{y1}{t1} + \frac{Y2}{T2} + \ldots n \;:\; \sum \frac{y1}{t1} + \frac{Y2}{T2} + \ldots n$$

Where,

y1, y2 …… n = Total production of the selected crops in the tehsil.

t1, t2 ……..n = Total cropped area under those crops in the tehsil.

$$\sum \frac{yn}{tn} \;:\; \sum \frac{YN}{TN}$$

Y1, Y2 ….. n = Total production of the selected crops in the district.

t1, t2 ……..n = Total cropped area under those crops in the district.

Area Of High Productivity

The table 4.8 indicates that the high productivity is confined in Western, Central part and South Western part of the district, which consist of Paranda, Osmanabad and Tuljapur tehsils during the 2009-10 to 2013-14. These tehsils cover 48.94 per cent of total reported area of the study region and share 48.02 per cent of the total net sown area. These tehsils having high overall yield index relation to other tehsils, because of development of surface irrigation facilities and high development of technological factrors.

Area Of Moderate Productivity

The moderate productivity is confined in Lohara and Kalam tehsils. These tehsils covers 19.29 percent of total reported area of Marathwada region and shares 20.75 percent of the total net sown area of region.

Table No. 4.8: Overall Yield Index by Shafi's Method (1972)

Sr.No	Tehsils	Index Value 1999-00 to 2003-04	Index Value 2009-10 to 2013-14
1	Paranda	60.22 : 55.66	86.40 : 79.21
2	Bhum	55.65 : 55.66	75.73 : 79.21
3	Washi	48.55 : 55.66	72.54 : 79.21
4	Kalam	51.51 : 55.66	78.71 : 79.21
5	Osmanabad	62.63 : 55.66	84.23 : 79.21
6	Tuljapur	60.06 : 55.66	90.62 : 79.21
7	Lohara	50.35 : 55.66	76.36 : 79.21
8	Omerga	56.33 : 55.66	69.05 : 79.21

Source: Compiled by Researcher on the basis of Socio economicc Review and district Statistical Abstract of Osmanabad 1999-00 to 2013-14, & Statistical Officer, Divisional Joint Director Office of Agriculture, Latur Division, Latur

Area Of Low Producticity

The table 4.8 indicates that low productivity is recorded in Bhum, Washi and Omerga tehsils in 2009-10 to 2013-14, which covers 31.77 percent of total geographical area of study region and 31.22 of total net sown area of region.

Changes In Prodctivity As Shafi's Method

During the period of investigation, agricultural productivity increased in all tehsils of the study region. As per gradation low to high productivity change is obseved only in Washi tehsil, due to the high yielding varieties and technological development. Moderate to high change is found in Bhum tehsil. Low to moderate

productivity change is observed in Kalam and Lohara tehsils due to development of surface irrigation facilities.

4.7.4 COMPOSITE INDEX OF AGRICULTURAL PRODUCTIVITY

To find out of aggregate productivity attempt is made here to calculate composite index of agricultural productivity. The index value of Bhatia's method and Shafi's method is taken into consideration for the calculation of composite index.

Table No. 4.9: Composite Index of Agricultural Productivity in Osmanabad District1999-00 to 2003-04 and 2009-10 to 2013-14.

Tehsils	1999-00 to 2003-04			2009-10 to 2013-14		
	PI Shaffi's	Ei Bhatia's	Composite Index	PI Shaffi's	Ei Bhatia's	Composite Index
Paranda	60.22	83.97	72.10	86.40	114.66	100.53
Bhum	55.66	94.07	74.86	75.73	93.98	84.85
Washi	48.56	63.11	55.83	72.54	96.07	84.31
Kalam	51.51	111.63	81.57	78.71	106.24	92.48
Osmanabad	62.63	114.33	88.48	84.23	99.81	92.02
Tuljapur	60.07	109.92	84.99	90.63	92.90	91.77
Lohara	50.35	108.59	79.47	76.37	106.60	91.49
Omerga	56.34	114.57	85.45	69.05	95.29	82.17

Source: Compiled by Researcher on the basis of Socio economicc Review and district Statistical Abstract of Osmanabad 1999-00 to 2013-14, Statistical Officer, Divisional Joint Director Office of Agriculture, Latur Division, Latur

The composite index indicates that high level of agricultural productivity is observed only in Paranda tehsil, due to fertile soil, development of irrigation facility and other technological factors. This tehsil covers 11.15 percent of total geographical area of the study region and shares 11.50 per cent of net sown area. The modetate level of productivity is found in Osmanabad, Tuljapur, Lohara and Kalam tehsils, which covers 57.08 percent of total geographical area, contribute 57.27 percent of net sown area. The low aggregate productivity is found in Bhum, Washi and Omerga tehsils. These tehsils covers 31.77 percent of total geographical area of the district and share 31.52 per cent of net sown area, it is low in Washi tehsil, due to the inadequate, rainfall.

4.8 SUMMARY:

Per hectare yield of Gram of the study region is higher than the Maharashtra state suggest that agro climatic condition of the Osmanabad district is suitable for Gram crop. The high per hectare yield of Jowar is found in Paranda and Washi tehsils and the high per hectare yield of wheat is found in Paranda, Tuljapur, Bhum, Osmanabad and Lohara tehsils is due to the development of surface irrigation, high use of high yield variety seeds and chemical fertiliser. The highest per hectare yield of Bajara in Washi, Kalam and Bhum tehsils due to suitable climate and soil. The high per hectare yield of Tur is found only in Kalam tehsil is mainly due to suitable climate and soil. The high per hectare yield of Gram in Tuljapur, Osmanabad, Lohara and Omerga tehsils is a result of fertile soil, use of high yielding Variety seeds, chemical fertilizer and development of irrigation. The highest decline of per hectare Yield Groundnut in in Kalam and Lohara tehsils is mainly due to scanty and uncertain rainfall. High per hectare yield of Soybean is recorded in Washi, Osmanabad and Omerga tehsils because of suitable soil, favorable climate and high yielding varieties. The high per hectare yield of Sugarcane in Tuljapur, Omerga, Osmanabad, Lohara and Paranda tehsils because of development of irrigation facility, the use of high yielding variety and regur soil in river basin.

There is positive as well as negative correlation between Net irrigated area and per hectare yield of selected crops in the study region. The negative correlation is found in case of Jowar, Bajra, Tur and Soybean as they are mostly rain fed crops in the study region. The high positive correlation is found in case of Sugarcane, Gram and Wheat as it depend on perennial irrigation, the coefficient of determination (r2) is found to be at 0.701, 0.631 and 0.490 respectively, which reveals that the independent variable (X) i.e. net irrigated area are explaining 70.10, 63.10 and 49 per cent of the total variations in dependant variable (Y) respectively.

The analysis of impact of percentage of net irrigated area on average per hectare yield of all selected crops of Osmanabad district reveals that there is high positive correlation (+0.828215) between net irrigated area and average per hectare yield of selected crops of districts. The degree of linear association between these two variable is found to be at 0.685940 (r2), which indicates that the independent variable (X) i.e. net irrigated area are explaining 68.59 per cent of the total variations in dependant variable (Y) i.e. average per hectare yield of selected crops and about 31.41

percent of variation is left to be influenced by other variables. The regression coefficient indicates that increase of one percent net irrigated area causes for increase of average per hectare yield of district by 56.91 Kilogram average per hectare yield in tehsils of Osmanabad district.

The high production of Jowar in Paranda, Tuljapur and Osmanabad tehsils is result of the favorable soil, rainfall and temperature. Decline of Jowar production in Osmanabad tehsil is mainly due to most of the irrigated land goes under commercial crops. The high positive change in Wheat Production in Bhum tehsil is mainly due to the development of irrigation facilities and technological factors. The high production of Bajara in Bhum and Omerga tehsils due to inferior soil in Bhum tehsil whereas use of high yield variety Seeds in Omerga tehsil. High per hectare yield of Groundnut in Lohara and Omerga tehsils is due to development of irrigation facility. High increase in production of Tur in Kalam tehsil is mainly due to the High Yielding varieties and availability of market. High per hectare yield of Gram in Tuljapur, Osmanabad, Lohara and Omerga tehsils is because of fertile soil, use of high yielding Variety seeds, chemical fertilizer and development of irrigation. Sugarcane production increased in the all tehsils of Osmanabad district, but high increase in Lohara tehsil is result of fertile soil, which is supported by High Yielding Varieties, perennial irrigation and growth of sugar industries.

The analysis of coefficient of variation reveals that high fluctuation in yield of Groundnut and Bajra crops, because most of irrigated area is devoted to other cash crops such as Soybean and Sugarcane etc. The high degree of variability is found in case of Soybean and Groundnut production due to the unreliable monsoon and decreasing water table in the study region.

As per Jasbir Singh's method highest productivity of Jowar in Paranda and Kalam tehsils, is result of high percentage of medium to deep black soil and favourable climate. The high productivity of Wheat was found in Lohara, Osmanabad, Bhum and Washi tehsils, it is high in Lohara, Osmanabad and Bhum tehsils, due to increase in irrigated area, while it is high in Washi, due to use of high yield varieties.

The high productivity of Tur in Omerga and Kalam is due to the high proportion of medium deep soils and suitable rainfall. The high productivity of Groundnut is found in Lohara, Omerga, Tuljapur, Kalam and Paranda tehsils. It is high in Lohara, Omerga, Paranda and Kalam tehsils, due to development of surface irrigation facilities and suitable shallow soil. The high productivity of Sugarcane is found in

Osmanabad and Paranda tehsils due to development of surface irrigation facility. Considering overall productivity by Jasbir Singh's method, the high level of productivity in Paranda, Lohara and Kalam tehsils, is result of high development of surface irrigation facilities and fertile soil.

As per Bhatia's method high productivity is in the Western, North-eastern and South eastern part of the study region which comprises Paranda, Kalam and Lohara tehsils these tehsils. The agricultural productivity is high in Paranda, Kalam and Lohara tehsils, due to fertile soil in Sina, Manjara and Terna river basin and they benefited by surface irrigation facilities i.e. Sina Kolegaon, Manjara and Lower Terna Irrigation Projects respectively.

As per Shafi's method the level of agricultural productivity is high in Western, Central part and South Western part of the district, which consist of Paranda, Osmanabad and Tuljapur tehsils, which contribute 48.02 per cent of the total net sown area. These tehsils are benifited by irrigation facilities, fertile soil in Sina, Benithura and Terna river basin and high development of technological factrors. During the period under review all tehsils shows positive change in level of agricultural productivity by Shafi's method. Low to high productivity change in Washi tehsil, is a result of high yielding varieties and technological development.

Composite index of agricultural productivity reveals that productivity is high only in Paranda tehsil, due to fertile soil, development of irrigation facility and other technological factors, whereas it is low in Bhum, Washi and Omerga tehsils. These tehsils covers 31.77 percent of total geographical area of the district and share 31.52 per cent of net sown area, it is low in Washi tehsil, due to the inadequate, rainfall.

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CHAPTER–V
CASE STUDIES OF SELECTED VILLAGES

5.1 INTRODUCTION:

In the previous chapters, the impact of physical and non physical determinants on land use, agricultural land use, agricultural cropping pattern and productivity at the tehsil level in the region has been described. The agricultural cropping pattern in the study region is a reflection of physiography, soil types, slope, irrigation and other socio-economic factors. The purpose of this chapter is to highlight the agricultural productivity at micro level. The observation and findings in this chapter are based on primary data which has been collected during field survey in 2013-14. Twenty four villages were selected from eight tehsils of Osmanabad district by Stratified Random Sampling Technique. The stratas are made on the basis of physiography. From each village 10 farmers with agricultural practices are selected and assessed.

A questionnaire (schedule) is prepared for farmers to get the information regarding non-physical determinants such as irrigation, use of fertilizers, pesticides, agricultural implements, high yielding variety, live stock, general land use, agricultural land use, cropping pattern, agricultural productivity and agricultural problems. The farmers are interviewed for the same. During the field survey, exhaustive field notes also prepared, which have been used for the subsequent micro-level analysis. In order to access the agricultural productivity, a brief account of the agricultural structure of the respondents is present here.This chapter deals with agricultural land use and agricultural productivity at micro level.

5.2 SITE AND SITUATIONS OF SELECTED VILLAGES:

1. Shirala:

The village Shiralla is located on the left bank of Sina River in Paranda tehsil of Osmanabad district. The absolute location of village is 18^0 10’ 26” North latitude and 75^0 29’ 24” East longitudes with an altitude of 490 metre from mean sea level. The village is situated in 600 to 700 Milimeters rainfall zone and in plateau region having plane area. The village is just 11 Kilomiters away from Paranda, a tahasil head quarter and well connected by road. It has an area of 1668 hectares with 2492 population as per 2011 census.

LOCATION MAP OF SELECTED VILLAGES IN OSMANABAD DISTRICT

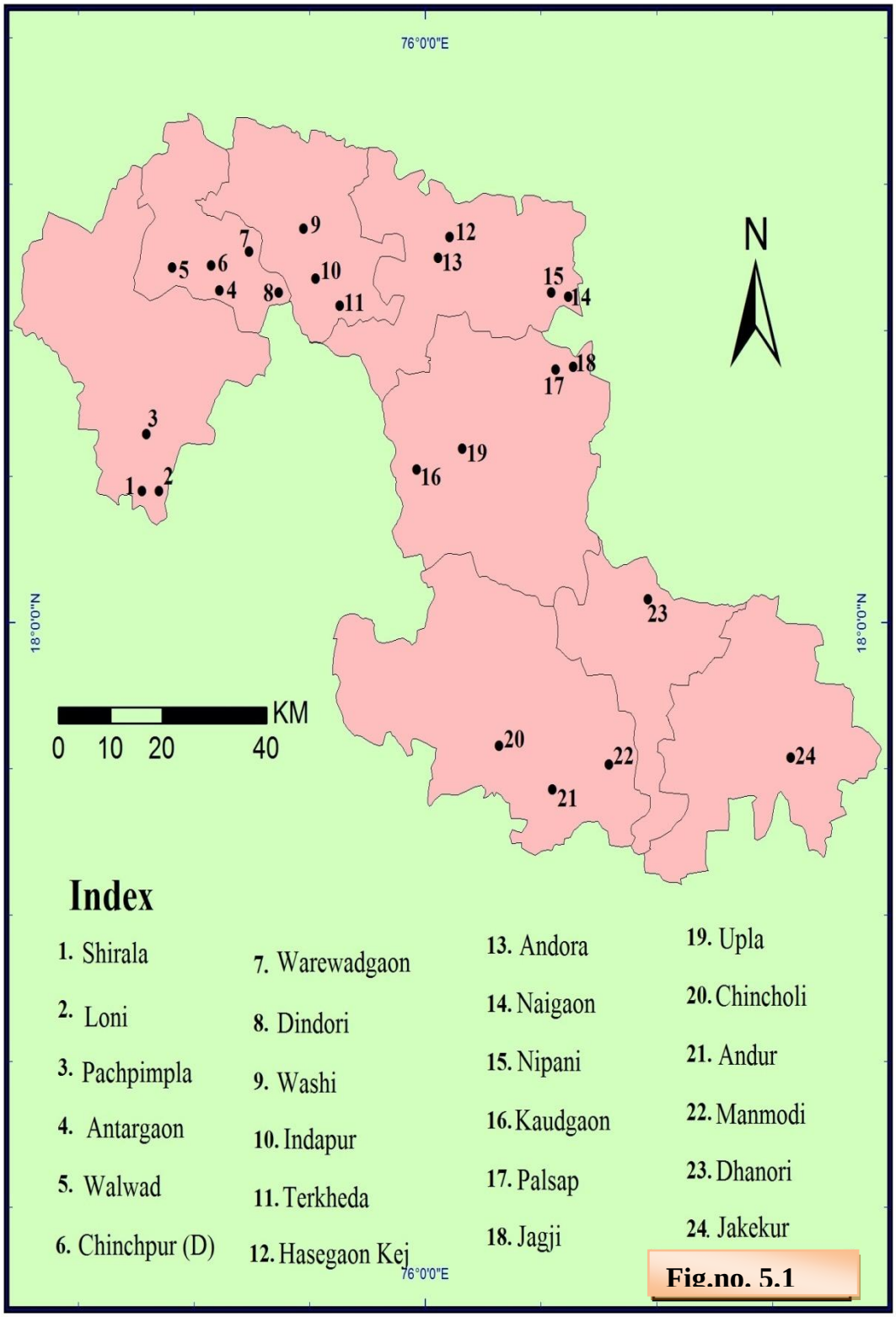

Fig.no. 5.1

2. Loni:

The absolute location of the village is 18^0 11' 13" North latitude and 75^0 31' 56" East longitudes. The village Loni is 14 kilometer away from Paranda as a tehsil headquarter to the south east and connected by road, an average altitude of village is 502 meters from mean sea level. The village is situated in the Sina river basin in 600 to 700 Milimeters rainfall zone and in plateau region having plane area. It has an area of 1641 hectares with 2472 population as per 2011 census.

3. Panchpimpala:

The village Pachpimpla is situated at 18^0 21' 01" North latitude and 75^0 29' 24" East longitudes with an average altitude of 522 meters from mean sea level. The village is located 11 kilometer away to the North-East from Paranda a tehsil headquarter and connected by road. The village is situated in 600 to 700 Milimeters rainfall zone and in plateau region having plane area. The river Dudhana flow Southerly direction through this village. The village extends 1707 hectares land with 1747 population as per 2011 census.

4. Antargaon:

The absolute location of village is 18^0 23' 43" North latitude and 75^0 32' 54" East longitudes. The Village Antargaon is located in the Bhum tehsil of Osmanabad district with an altitude of 534 meters from mean sea level. The nearest town to the village is Bhum a tehsil head quarter 19 kilometer away. The village is situated in 700 to 800 Milimeters rainfall zone and in plateau region having plane area. The river Banganga flow Southerly direction through the village. It has an area of 771.2 hectares with 1780 population as per 2011 census.

5. Walwad:

The village Walwad lies in Bhum tehsil of Osmanabad district. The absolute location of village is at 18^0 27' 25" North latitude and 75^0 31' 17" East longitudes with an altitude of 556 meters from mean sea level. The village is situated in 700 to 800 Milimeters rainfall zone and in plateau region having plane area. The river Dudhana flow South-Westerly direction through this village.The village is 20 kilometer away from the Bhum town a taluka head quarter. The village extends 2592 hectares area with 3658 populations as per 2011 census.

6. Chinchpur (D):

The absolute location of village is 18^0 25’ 54” North latitude and 75^0 34’ 11” East longitudes. The village Chinchpur (D) lies in the Bhum tehsil of Osmanabad district and just 13 kilometers away from Bhum town. The village is situated in 700 to 800 Milimeters rainfall zone and in plateau region having plane area. The river Banganga flow Southerly direction through this village. It has an area of 1694.7 hectares; the average height of village is 548 meters from mean sea level and population is 2405 in 2011.

7. Warewadgaon:

The absolute location of village is 18^0 28’ 05” North latitude and 75^0 37’ 13” East longitudes. The Village Warewadgaon is located in Bhum tehsil of Osmanabad district. The nearest town to the village is Bhum just 5 kilometer away. The village Warewadgaon is situated in 700 to 800 Milimeters rainfall zone and in plateau region having plane area. The river Banganga flow South-Westerly direction through this village. It has an area of 652 hectares and average height of village is 572 Meters from mean sea level. The population of village is 1021 in 2011.

8. Dindori:

The absolute location of village is 18^0 26’ 58” North latitude and 75^0 44’ 58” East longitudes. Dindori village is 10 kilometer to the west from Bhum tehsil headquarter and connected by road. It surrounded by hilly area of Balaghat range with an altitude of 648 meter from mean sea level. The village Dindori is situated in 700 to 800 Milimeters rainfall zone. The river Chandani, tributary of the Sina originates near this village and flow westerly direction. The village has 913 hectares area with 871 populations in 2011.

9. Washi:

The Village Washi is a headquarter place of the Washi tehsil of Osmanabad district. The absolute location is 18^0 32’ 32” North latitude and 75^0 46’ 44” East longitudes. The village is situated in the Balaghat plateau having undulating topography with an altitude of 724 meter from mean sea level. It is situated in Manjara river basin in less than 700 Milimeters rainfall zone. It has an area of 5303 hectares and the population of village is 15431 in 2011.

10. Terkheda:

The absolute location of village is 18^0 26’ 43” North latitude and 75^0 50’ 11” East longitudes. The village Terkheda lies in the Washi tehsil of Osmanabad district and 18 kilometer away from Washi, a tehsil headquarter. The village is situated in less than 700 Millimeters rainfall zone and in the Balaghat plateau region having plane area. The river Terna originates near the village and flow South-Easterly direction through this village. It has an area of 2516 hectares; the average height of village is 722 meters from mean sea level and population is 6626 in 2011.

11. Indapur:

The village Indapur lies in Washi tehsil of Osmanabad district, situted at 18^0 29’ 54” North latitude and 75^0 48’ 52” East longitudes with an altitude of 720 meter from mean sea level. The village has 1994 hectares geographical area with 3442 populations as per 2011 census. The village is situated in the Manjara river basin in less than 700 Milimeters rainfall zone and in plateau region having plane area. The village is 8 kilometer away from Washi a taluka head quarter.

12. Hasegaon:

The Village Hasegaon is located in Kalam tehsil of Osmanabad district. The nearest town to the village is Kalam just 5 Kilomiters away. The absolute location of village is 18^0 32’ 50” North latitude and 75^0 59’ 33” East longitudes with an altitude of 673 meter from mean sea level. The village is situated in the Manjara river basin in 700 to 800 rainfall zone. It has an area of 1287 hectares and the population of the village is 2477 as per 2011 census.

13. Andora:

The village Andora is located in the Kalam tehsil of Osmanabad district. The absolute location of village is 18^0 21’ 23” North latitude and 75^0 58’ 13” East longitudes. The village is situated in the Manjara river basin in 700 to 800 Milimeters rainfall zone having plane area with an average altitude of 685 meters from mean sea level. The village is just 9 kms. away from Kalam town, a tehsil head quarter. The village has an area of 1959 hectares with the population of 3721 in 2011.

14. Naigaon:

The village Naigaon lies in Kalam tehsil, 33 Kms. away from Kalam town the taluka head quarter. The absolute location of village is 18^0 27' 09" North latitude and 76^0 14' 58" East longitudes. The nearest market center to the village is Murud in the Latur district. The village is situated in 700 to 800 Milimeters rainfall zone. The river Muruda, a tributary of Manjara passes North Easterly direction through this village. The total geographical area of village is 1678 hectares. The average height of village is 654 meters from mean sea level and population is 4153 in 2011.

15. Nipani:

The absolute location of village is 18^0 27' 10" North latitude and 76^0 10' 37" East longitudes. The Village Nipani is located in Kalam tehsil of Osmanabad district. The nearest town to the village is Murud just 7 kms. away. The village is situated in the Manjara river basin 700 to 800 Milimeters rainfall zone. It has an area of 865 hectares and average height of village is 678 Meters from mean sea levels. The population of village is 1522 in 2011.

16. Kaudgaon:

The absolute location of village is 18^0 11' 38" North latitude and 75^0 57' 17" East longitudes. The village Kaudgaon is located in Osmanabad tehsil of Osmanabad district occupying 1389 hectares area with 2460 populations in 2011. The village is situated in Sina river basin in 700 to 800 Milimeters Rainfall zone with an altitude of 546 meters from mean sea level. The village is just 10 kms. away from Osmanabad, a tehsil and district head quarter.

17. Palsap:

The absolute location of village is 18^0 22' 01" North latitude and 76^0 11' 06" East longitudes. The village Palsap lies in the Osmanabad tehsil of Osmanabad district. The village is 30 kms. away from Osmanabad district head quarter. The nearest town to the village is Murud just 5 kms away, which is the famous market center for agricultural production. The average height of village is 667 meters from mean sea level. The village is situated in Terna river basin in 700 to 800 M.M rainfall zone. The village has an area of 2160 hectares; and population is 4858 in 2011.

18. Jagji:

The Village Jagji is located in Osmanabad tehsil of the district. The absolute location of village is 18^0 20' 35" North latitude and 76^0 13' 53" East longitudes. The nearest town to the village is Murud just 7 kms. away. The village is situated in the

Terna river basin in 700 to 800 Milimeters rainfall zone and average height of village is 667 meters from mean sea levels. It has an area of 3830 hectares and the population of village is 5586 in 2011.

19. Upla:

The absolute location of village is 18^0 15' 08" North latitude and 76^0 03' 26" East longitudes. The village Upla is located in the Osmanabad tehsil occupying 2768 hectares area with 5292 population in 2011. The village is situated in Terna river basin in 700 to 800 Milimeters rainfall zone having plane area of Maharashtra plateau. The average height of the village is 665 meters from mean sea level. The village is just 11 kms. away from Osmanabad, a taluka and district head quarter.

20. Andur:

The absolute location of village is 17^0 48' 56" North latitude and 76^0 14' 30" East longitudes. The village Andur lies in the Tuljapur tehsil of Osmanabad district and 33 kms. away from Tuljapur town. The nearest town to the village is Naldurg, an old district headquarter of Hyderabad state just 3 kms. away. The village is situated in the Bori river basin in more than 800 Milimeters rainfall zone. The geographical area of village is 6641 hectares. The average height of village is 548 meters from mean sea level and population is 11630 in 2011.

21. Chincholi:

The Village Chincholi is located in Tuljapur tehsil of Osmanabad district. The absolute location of village is $17^0$54' 25" North latitude and $76^0$07' 59" East longitudes.The nearest town to the village is Tuljapur 16 kms. away. The village is situated in Bori river basin above 800 Milimeters rainfall zone in plateau having plain area. The geographical area of villahe is 671 hectares and average height of village is 551 Meters from mean sea levels. The population of village is 1459 in 2011.

22. Manmodi:

The absolute location of village is 17^0 51' 57" North latitude and 76^0 19' 47" East longitudes. The village Manmodi is located in Tuljapur tehsil of Osmanabad district, occupying 1124 hectares area with 1160 population in 2011. The village is situated in the Benithura river basin in more than 800 Milimeters rainfall zone and having undulating topography with an altitude of 606 meters from mean sea level. The village is 44 kms. away from Tuljapur, a tehsil head quarter and nearest town to the village is Lohara 24 kms. away.

23. Dhanori:

The Village Dhanori is located in Lohara tehsil of Osmanabad district. The absolute location of village is 17^0 58' 07" North latitude and 76^0 24' 28" East longitudes. The nearest town to the village is Lohara a tehsil head quarter just 11kms. away. The village is situated in Terna river basin in more than 700 Milimeters rainfall zone. Average height of village is 629 Meters from mean sea levels. It has an area of 2821 hectares and the population of village is 3882 in 2011.

24. Jakekur:

The absolute location of village is 17^0 51' 19" North latitude and 76^0 34' 12" East longitudes. The village Jakekur is located in the Omerga tehsil of Osmanabad district occupying 2408 hectares area with 3509 populations in 2011. The village is situated in lower Bhima sub basin in 700 to 800 Milimeters rainfall zone in plane area of plateau. The average height of village is 586 meters from mean sea level. The village is just 6 kms. away from Omerga town a tehsil head quarter.

5.3 NON PHYSICAL DETERMINANTS:

The diversifying physical conditions are definitely responsible for variations in the regional pattern of agricultural phenomena. However, role of non physical determinants is also important. Among the non physical determinants, cultivators, agricultural laborers, irrigation area, irrigation wells, agricultural implements, livestock, use of fertilizer, draught force influences the agricultural patterns. These determinants are useful and essential in the study of agricultural land use and productivity. These are conspicuous because the combination of these circumstances furnished the basic material essential for explaining the modifications brought in agricultural activities, which are the primary creation of natural forces. Notwithstanding this, the quality and quantity of human effort and their caliber modify farm practice, crop grown and the economy prevailing at the farm as well as at the regional level (Ahmed N, 2010).

Considering importance of non physical determinants, here attempt is made to analyze growth of population, density of farm worker and literacy of selected villages.

5.3.1 DEMOGRAPHIC FACTORS

5.3.1.1. Density of Population

The concept of density of population is the most rarely and useful tool in the analysis of the diversity of man's distribution in space (Clarke, 1972) Table No 5.1 reveals that the high density of population area is found in Washi, Terkheda, Naigaon and Antargaon villages i.e. above 225 per 100 hectares (per square kilometer) area because these villages are situated in plane area and well connected with roads. The low density of population is recorded in Dindori, Panchpimpala, Manmodi, Dhanori, Walwad, Chinchpur (D), Jakekur, Jagji, Shiralla, Loni, Warewadgaon villages i.e. below 160 per 100 hectares area.

5.3.1.2. Literacy

According to 2011 Census a person aged 7 years and above who can both read and write with understanding in any language has to be considered as literate. On an average the literacy of selected village is 67.96 per cent but spatial distribution varies from village to village. The table-5.1 reveals that the high literacy is experienced in Nipani, Washi, Hasegaon (K), Terkheda, Upla, Indapur and Chinchpur i.e above 70 per cent. The low literacy is experienced in Manmodi, Kaudgaon, Chincholi, Dhanori, Walwad and Jakekur i. e. below 66 per cent due to the less accessibility and lower parantal income.

5.3.1.3. Density of Farm Workers

The farm workers include both cultivator and agricultural labors. During 2013-14, the region as whole has 69.90 density of farm workers in selected villages, but spatial distribution varies from village to village. The table 5.1 indicates that high density of farm workers is in Naigaon, Palsap, Chincholi, Hasegaon (K), Kaudgaon, Andora, Terkheda and Washi villeges i.e. above 80 per 100 hectares due to the lower mechanization. The low density of farmworkers is found in Manmodi, Andur, Warewadgaon and Jakekur villages i.e. below 50 per 100 hectares.

5.3.2. Irrigation

Irrigation is an artificial application of water to the land or soil. It is used to assist in the growing of agricultural crops, maintenance of landscapes, and revegetation of disturbed soil in dry areas and during periods of inadequate rainfall (Snyder R.L et.al, 2005). Irrigation plays an important role in those areas where

Table No. 5.1: Density of Population, Literacy Rate and Density of Farm workers in Selected Villages of Osmanabad District-2014.

Sr.No.	Village Name	Population 2011	Density per 100 Hectares	Per centage of Literacy	Density of farmworkers per 100 hectares
1	Shirala	2492	149.40	67.74	75.30
2	Loni	2472	150.64	66.63	66.85
3	Pachpimpla	1747	102.34	66.97	55.48
4	Antargaon	1780	235.76	68.93	73.11
5	Walwad	3658	141.13	65.75	56.64
6	Chinchpur (D)	2405	141.89	70.35	73.10
7	Warewadgaon	1021	157.81	67.19	27.82
8	Dindori	871	95.40	68.89	58.27
9	Washi	15431	290.99	72.73	80.92
10	Indapur	3442	172.63	70.37	77.19
11	Terkheda	6626	263.35	71.69	83.19
12	Hasegaon Kej	2477	192.46	72.59	94.56
13	Andora	3721	189.94	68.34	84.12
14	Naigaon	4153	247.50	68.41	110.19
15	Nipani	1522	175.95	74.70	74.45
16	Kaudgaon	2460	177.11	63.82	88.34
17	Palsap	4858	224.91	66.55	103.89
18	Jagji	5586	145.85	66.42	73.99
19	Upla	5292	191.18	70.65	60.19
20	Andur	11630	175.12	66.51	43.40
21	Chincholi	1459	217.44	64.15	96.27
22	Manmodi	1160	103.20	61.47	46.80
23	Dhanori	3882	137.61	64.30	54.27
24	Jakekur	3509	145.72	65.86	19.23

Source: Compiled by researcher on the basis of field survey

rainfall is uncertain and adequate; therefore attempt is made here to analysis irrigation facilities in the selected villages.

5.3.2.1. Density of Irrigation Wells

The table No. 5.2 reveals that during the year 2013-14, the density of irrigation wells is high in Palsap, Loni, Dindori, Indapur, Antargaon, Terkheda, Jagji, Upla(M), Washi, Walwad and Chincholi villages i.e. above 16 wells per 100 hectares because all these villages are benefitted by percolation tanks, development of minor irrigation projects and have little development of surface irrigation facilities. The low density of irrigation wells is found in Shiralla, Jakekur, Andur and Warewadgaon i. e. below 11 due to high development of surface irrigation.

Table No.5.2 Density of Irrigation Wells per 100 hectare in Selected Villages (2014)

Sr. No.	Village Name	Density of Irrigation Wells	Sr.No.	Village Name	Density of Irrigation Wells
1	Shirala	7.86	13	Andora	12.19
2	Loni	19.25	14	Naigaon	11.27
3	Pachpimpla	13.19	15	Nipani	13.78
4	Antargaon	17.16	16	Kaudgaon	13.11
5	Walwad	16.01	17	Palsap	20.08
6	Chinchpur (D)	13.42	18	Jagji	16.72
7	Warewadgaon	6.28	19	Upla	16.29
8	Dindori	19.24	20	Chincholi	16.37
9	Washi	16.15	21	Andur	10.49
10	Indapur	18.17	22	Manmodi	14.49
11	Terkheda	17.11	23	Dhanori	13.94
12	Hasegaon Kej	11.73	24	Jakekur	8.24

Source: Compiled by researcher on the basis of field survey

Table No. 5.3: Percentage of Irrigated Area to Net Sown Area in the Selected Villages (2014).

Sr.No.	Villages	Well Irrigated Area to Net Sown Area (%)	Surface Irrigated Area to Net Sown Area (%)	Net Irrigated Area to Net Sown Area (%)
1	Shirala	3.65	42.47	46.12
2	Loni	17.69	2.08	19.77
3	Pachpimpla	2.72	17.02	19.74
4	Antargaon	19.53	3.38	22.91
5	Walwad	16.23	3.12	19.35
6	Chinchpur (D)	18.79	3.97	22.76
7	Warewadgaon	9.78	29.05	38.83
8	Dindori	11.88	8.88	20.76
9	Washi	16.91	3.42	20.33
10	Indapur	15.72	4.48	20.2
11	Terkheda	19.23	1.12	20.35
12	Hasegaon Kej	10.05	0	10.05
13	Andora	9.98	0	9.98
14	Naigaon	11.68	13.9	25.58
15	Nipani	13.67	2.22	15.89
16	Kaudgaon	12.18	15.18	27.36
17	Palsap	21.02	4.44	25.46
18	Jagji	15.37	2.06	17.43
19	Upla	17.1	3.63	20.73
20	Chincholi	20.01	2.42	22.43
21	Andur	8.44	33.7	42.14
22	Manmodi	13.56	28.77	42.33
23	Dhanori	15.37	5.08	20.45
24	Jakekur	7.97	29.37	37.34
Region Average		13.69	10.82	24.51

Source: Compiled by researcher on the basis of field survey

5.3.2.2 Well Irrigated Area

Table no. 5.3 indicates that study region as a whole has 13.69 per cent average well irrigated area to net sown area in selected villages in 2010, but spatial distribution varies from Village to village.

The high well irrigated area is recorded in Palsap, Chincholi, Antargaon, Terkheda, Chinchpur (D), Loni, Upla(M), Washi, Walwad, Indapur, Jagji, and Dhanori i.e. above 15 per cent to net sown area because these villages are deprived from surface irrigation facilities. The low well irrigated area is found in Shiralla, Andur, Jakekur and Panchpimpalavillages i.e. below 9 per cent to total net sown area.

5.3.2.3 Surface Irrigated Area

Table no. 5.3 indicates that study region as a whole has 10.82 per cent surface irrigated area to net sown area in selected villages in 2010, but spatial distribution varies from Village to village. The high Surface irrigated area is recorded in Shirala, Andur, Jakekur, Warewadgaon and Manmodi villages i.e. above 28 per cent. Because Shirala is benifited from the Bhima-Sina joint tunnel project, Bori dam provides water to Andur, while Warewadgaon is drained by Banganga medium project near Bhum. The low surface irrigated area is found in Dindori, Dhanori, Indapur, Palsap, Chinchpur(D), Upla(M), Washi, Antargaon, Walwad, Chincholi, Nipani, Loni, Jagji, Terkheda, Andora and Hasegaon (Keij) villages i.e below 10 per cent.

5.3.2.4. Net Irrigated Area

Table no. 5.3 indicates that study region as a whole has 24.51 per cent net irrigated area to net sown area in the selected villages in 2013-14, but spatial distribution is uneven it varies from village to village. The high net irrigated area is recorded in Shirala, Manmodi, Andur, Warewadgaon and Jakekur villages i.e. above 34 per cent to total net sown area. The low net irrigated area to net sown area is found in Dindori, Upla, Dhanori, Terkheda, Washi, Indapur, Loni, Panchpimpla, Walwad, Jagji, Nipani, Hasegaon (Keij), Andora i.e. below 22 per cent.

5.4 USE OF FERTILIZER:

5.4.1. Chemical Fertilizer

The case study reveals that per hectares average use of chemical fertilizer is 160.68 kilogram in the study region, but spatial distribution varies from village to village. The table 5.4 indicates that during 2013-14, high use of chemical fertilizer per

Table No. 5.4: Per Hectares Use of Chemical Fertilizers in Selected Villages (2014)

Sr.No.	Villages	Chemical Fertilizer in Kg.	Compost Fertilizer in tons.	Sr.No.	Villages	Chemical Fertilizer in Kg.	Compost Fertilizer in tons.
1	Shirala	231.45	6	13	Andora	111.37	2
2	Loni	90.41	2.5	14	Naigaon	150.34	3
3	Pachpimpla	115.37	5	15	Nipani	99.19	4
4	Antargaon	140.61	4	16	Kaudgaon	220.73	5
5	Walwad	200.14	4	17	Palsap	229.17	4
6	Chinchpur (D)	225.73	6	18	Jagji	105.82	4
7	Warewadgaon	169.72	5	19	Upla	159.95	5
8	Dindori	200.25	5	20	Chincholi	140.17	3
9	Washi	175.46	3	21	Andur	165.31	5
10	Indapur	188.27	4	22	Manmodi	242.33	6
11	Terkheda	100.37	2.5	23	Dhanori	129.32	4
12	Hasegaon Kej	124.52	2	24	Jakekur	140.37	5
Region Average						160.68	4.13

Source: Compiled by researcher on the basis of field survey

hectares is found in Manmodi, Shirala, Palsap, Chinchpur (D), Kaudgaon, Dindori and Walwad i.e. above 192 kilogram chemical fertilizer, because these villages have surface irrigation facility. The low use of chemical fertilizer is noticed Antargaon, Jakekur, Chincholi, Dhanori, Hasegaon (Keij), Pachpimpala, Andora, Jagji, Terkheda, Nipani and Loni Villages i.e. below 141 kilogram.

5.4.2. Compost Fertilizer

On an average the study region as whole has 4.13 tons per hectares use of compost fertilizer selected villages in 2013-14 but spatial distribution is uneven. Compost fertilizer is used in all selected villages, as it is locally available. The table

5.4 reveals that during 2013-14, the high use of compost fertilizer is found in Shirala, Chinchpur (D) and Manmodi i.e. above 5 tones per hectares, due to development of irrigation. The low use of compost fertilizer is observed in Washi, Naigaon, Chincholi, Loni, Terkheda, Hasegaon (Keij) and Andora i.e. below 3 tones.

5.5. AGRICULTURAL IMPLEMENT IN SELECTED VILLAGES:

Agricultural implements are simple extension of the human bodywork aids designed to enhance performance and reduce wear and tear on the body. The prime attributes of good implements are functionality and durability. Agricultural implements work in the soil-stirring, turning, planting, incorporating, loosening, digging, grafting, spraying, cutting, beating, picking, separating, cleaning, holding, cooling, heating, processing, conveying, lifting, packing and wrapping (Jay B. Agness, 2003). Agricultural implements are very important tools of farming and better implements exhilarate farmers to agricultural activity. Therefore, attempt is made here to study agricultural implements in the selected villages.

5.5.1. Iron Ploghs

On an average the density of iron plough is 3.53 per 100 hectares net sown area in selected villages of the study region but spatial distribution varies from village to village. The table 5.5 indicates that the high density of iron ploughs is found in Dhanori, Hasegaon (Keij), Andur, Naigaon, Jakekur, Chincholi and Nipani i.e. above 5 per 100 hectare net sown area in 2013-14. The low density of iron ploughs is recorded in Palsap, Chinchpur (D), Manmodi, Shirala, Upla, Jagji and Kaudgaoni.e. below 3 density, due to higher number of tractors.

5.5.2. Wooden Plough

The study region as a whole has 10.72 density of wooden plough per 100 hectares considering selected villages, but spatial distribution varies from village to village. The table 5.5 indicates that the high density of wooden ploughs is found in Dhanori, Terkheda, Antargaon, Indapur and Washi villages i.e. above 18 per 100 hectares net sown area. The low density of wooden ploughs is recorded in Loni, Dindori, Andora, Panchpimpla, Hasegaon (Keij), Kaudgaon, Andur, Jagji, Chinchpur (D), Naigaon, Upla, Nipani, Shirala and Chincholi villages i.e. below 9 per 100 hectare net sown area.

5.5.3. Bullock Cart

The study region as a whole has 5.85 density of bullock cart per 100 hectares considering selected villages, but spatial distribution varies from village to village. The table 5.5 indicates that the high density of bullock carts is found in Kaudgaon, Dhanori, Jagji, Shirala, Palsap, Upla, Manmodi and Loni villages i.e. above 6 per 100

Table-5.5: Density of Agricultural Implement in Selected Villages - 2014

(density per 100 hectares Cultivated Area)

Sr.No.	Villages	Iron Plough	Wooden Plough	Bullock carts	Oil Engine	Electric Pump	Tractors
1	Shirala	1.18	1.68	9.12	0.25	10.82	2.52
2	Loni	3.75	8.87	6.37	0.19	15.87	0.44
3	Pachpimpla	3.55	8.01	5.56	0.15	8.29	0.68
4	Antargaon	3.12	20.65	4.83	0.55	15.37	0.47
5	Walwad	3.19	9.57	3.21	0.43	10.72	0.55
6	Chinchpur (D)	1.32	6.73	4.77	1.01	9.94	2.19
7	Warewadgaon	3.60	11.08	3.71	0.75	5.68	0.33
8	Dindori	3.49	8.78	3.91	0.30	8.86	0.49
9	Washi	3.25	18.55	3.14	0.10	5.42	0.58
10	Indapur	3.12	20.42	4.83	0.04	15.81	0.49
11	Terkheda	3.37	21.53	5.01	0.07	4.44	0.57
12	Hasegaon Kej	6.48	7.76	3.83	0.05	11.97	0.33
13	Andora	4.37	8.52	4.76	0.09	9.75	0.41
14	Naigaon	5.61	6.73	5.08	0.07	11.88	0.57
15	Nipani	4.99	5.43	3.97	0.02	10.93	0.59
16	Kaudgaon	1.05	7.43	10.81	0.25	12.74	2.34
17	Palsap	1.40	10.87	8.61	0.19	19.94	2.17
18	Jagji	1.12	7.19	10.43	0.15	13.19	2.35
19	Upla	1.15	5.71	7.71	0.11	12.37	2.31
20	Chincholi	5.28	4.28	4.13	1.25	5.82	0.15
21	Andur	6.41	7.39	5.17	0.96	9.73	0.26
22	Manmodi	1.25	9.81	6.73	0.77	5.21	2.54
23	Dhanori	7.07	25.67	10.66	0.55	11.37	0.55
24	Jakekur	5.55	14.73	4.09	0.31	10.86	0.33
Region Average		3.53	10.72	5.85	0.36	10.71	1.00

Source: Compiled by Researcher.

hectares. The low density of bullock carts is recorded in Antargaon, Indapur, Chinchpur (D), Jakekur, Andora, Chincholi, Nipani, Dindori, Hasegaon (Keij), Warewadgaon, Walwad and Washi villages i.e. below 5 per 100 hectares because

farmers in these villages trends to carry their agricultural production through rental vehicle i.e. pickup or small Appe.

5.5.4. Oil Engine Pumps

Oil engines are not significant, due to the development of electricity; these are used only in that area, which are deprived from electricity. The density of Oil engines is 0.36 per 100 hectares in the study region in 2013-14, but it varies from village to village. The table 5.5 reveals that the high density of Oil Engine is found in Chincholi, Chinchpur (D) and Andur i.e. 0.84 per 100 hectares. The low density of Oil Engine is recorded in Jakekur, Dindori, Shirala, Kaudgaon, Loni, Palsap, Panchpimpla, Jagji, Upla, Washi, Andora, Terkheda, Naigaon, Hasegaon(Keij), Indapur and Nipani villages i.e. below 0.33 per 100 hectares.

5.5.5. Electric Pump

On an average **t**he density of electric pump is 10.71 per 100 hectares in the selected villages, but spatial distribution varies from village to village. The table 5.5 indicates that the high density of Electrical pump is found in Palsap, Loni, Indapur, Antargaon i.e. above 15 per 100 hectares, because these villages have high density of irrigation well due to inadequate surface irrigation facilities. The low density of Electrical pump is recorded in Chinchpur (D), Andora, Andur, Dindori, Pachpimpla, Chincholi, Warewadgaon, Washi, Manmodi, Terkheda i.e. below 10 per 100 hectares.

5.5.6. Tractor

On an average there is 1 tractor per 100 hectares in the selected villages, but spatial distribution varies from village to village. During 2013-14**,** the high density of Tractor is found in Manmodi, Shirala, Jagji, Kaudgaon , Upla, Chinchpur (D), Palsap i.e. above 2 per 100 hectares, because of development of irrigation leads better production which resulted into purchasing power of farmers. The low density of Tractor is recorded Pachpimpla,Nipani, Washi, Terkheda, Naigaon, Walwad, Dhanori, Dindori, Indapur, Antargaon, Loni, Andora, Warewadgaon, Hasegaon Kej, Jakekur, Andur, Chincholi i.e. below 1 per 100 hectares.

5.6 LIVE STOCK IN SELECTED VILLAGE

The varying physio-socio-economic and infrastructural conditions encourage farmers to grow crops and to raise live stock (Singh and Dhillon, 1987). Live stock constitutes important aspect of agriculture system as they provide draught force for agricultural operations. For the present study total Cattle, buffaloes, bullocks, sheep and goat are considered.

5.6.1. Cattle

On an average, there are a 48 per cent proportion of cattle in selected villages, but spatial distribution varies from village to village. The table 5.6 reveals that the low proportion of cattle is noticed in Dhanori,Shirala, Andur, Chincholi, Manmodi i.e. below 41 per cent. The high Proportion of Cattles is found in Dindori, Warewadgaon, Walwad, Terkheda, Andora, Nipani, Indapur, Chinchpur (D), Hasegaon Kej, Naigaon, Washi, Antargaon, Jagji villages i.e. above 50 per cent in 2014.

5.6.2. Buffaloes

On an average there is 17.76 per cent Buffaloes in the selected villages to total livestock, but spatial distribution is uneven. The table 5.6 indicates that low proportion of Buffaloes is noticed in Walwad, Warewadgaon, Dindori, Pachpimpla, Loni i.e. below 14 per cent as they have less accessibility which adversely affect on dairy farming. The high proportion of Buffaloes is found in Manmodi, Jakekur, Dhanori, Chincholi, Palsap, Upla, Kaudgaon, Jagji i.e. above 21 per cent, due to the availability of green fodder with the development of irrigation.

5.6.3. Goats

On an average, there is a 26.81 per cent of Goats to total livestock in selected villages, but spatial distribution varies from village to village. The table 5.6 reveals that the low per cent of Goats is noticed in Nipani, Washi, Palsap, Andora, Terkheda, Indapur, Walwad, Jagji, Upla, Warewadgaon, Jakekur, Dhanori, Dindori i.e. below26 per cent due to the plane topography and farmers are more interested in farming rather than Goat raring. The high per cent of Goats is recorded in Shirala, Loni, Manmodi, and Andur i.e. above32 per cent. The high proportion of Goat is found in Andur and Manmodi

Table No. 5.6: Live Stock in Selected Villages (2014)

(in Per cent to total livestock)

Sr.No.	Villages	Cattle	Buffaloes	Sheep	Goat	Other Livestock	Total Livestock
1	Shirala	36.94	14.88	7.77	37.89	2.52	100
2	Loni	44.67	7.24	8.24	35.18	4.67	100
3	Pachpimpla	42.54	10.41	9.85	31.91	5.29	100
4	Antargaon	50.41	16.33	4.37	27.36	1.53	100
5	Walwad	56.91	13.82	4.19	23.91	1.17	100
6	Chinchpur (D)	53.18	14.67	3.74	26.37	2.04	100
7	Warewadgaon	57.38	13.78	2.39	22.17	4.28	100
8	Dindori	58.19	11.58	6.37	20.37	3.49	100
9	Washi	51.04	18.82	3.34	25.91	0.89	100
10	Indapur	53.26	17.53	4.06	23.94	1.21	100
11	Terkheda	56.03	14.85	3.94	24.33	0.85	100
12	Hasegaon Kej	51.27	17.96	2.81	26.28	1.68	100
13	Andora	55.63	14.25	3.77	25.34	1.01	100
14	Naigaon	51.18	14.36	5.31	27.82	1.33	100
15	Nipani	55.04	14.03	3.89	25.99	1.05	100
16	Kaudgaon	44.84	21.03	2.91	26.60	4.62	100
17	Palsap	46.25	23.17	2.04	25.66	2.88	100
18	Jagji	50.18	21.01	2.22	23.73	2.86	100
19	Upla	48.09	22.16	1.71	22.37	5.67	100
20	Chincholi	35.58	24.13	5.92	31.56	2.81	100
21	Andur	36.26	19.21	8.19	32.55	3.79	100
22	Manmodi	32.59	28.13	3.12	33.65	2.51	100
23	Dhanori	40.48	25.68	11.84	21.06	0.94	100
24	Jakekur	43.88	27.15	6.34	21.52	1.11	100
Region Average		48.00	17.76	4.93	26.81	2.50	100

Source: Compiled by researcher on the basis of field survey.

due to the favorable physiography i.e. rugged topography and barren land while it is high in Shirala and Loni due to higher number of Nomadic tribes i.e. Dhangar social group.

5.6.4. Sheep

On an average there is a 4.93 per cent of Sheep to total livestock in the selected villages, but spatial distribution varies from village to village. The table 5.6 indicates that the low proportion of Sheep is noticed in Terkheda, Nipani, Andora, Chinchpur (D), Washi, Manmodi, Kaudgaon, Hasegaon (Keij), Warewadgaon, Jagji, Palsap, Upla villages i.e. below 4 per cent. The proportion of sheep is high in Dhanori, Pachpimpla, Loni and Andur i.e. above 8 per cent due to the scarcity and uncertainity of rainfall leads to paucity of pastures which leads sheep raring as sheep can survive even under the draught conditions and poor pastures for some time.

5.6.5. Other Livestock:

On an average there is a 2.50 per cent of Other livestock to total livestock in selected villages, but spatial distribution varies from village to village. The table 5.6 indicates that the high proportion of other livestock is noticed in Upla, Panchpimpala, Loni, Kaudgaon and Warewadgaon villages i.e. above 4 per cent. The low proportion of other livestock is found in Antargaon, Walwad, Washi, Indapur, Terkheda, Hasegaon, Andora, Naigaon, Nipani, Dhanori and Jakekur i.e. below 2 per cent.

5.7. GENERAL LAND USE PATTERN:

5.7.1. Area under Forest

The region as a whole has 2.09 per cent area under forest in selected villages, but spatial distribution varies from village to village. The table 5.7 indicates that the low area under forest is found in Washi, Nipani, Chinchpur (D), Shirala, Indapur, Jagji, Chincholi, Andora, Terkheda, Warewadgaon, Hasegaon (Keij), Dhanori, Naigaon, Panchpimpala and Jakekur villages i.e. below 2 per cent. The high area under forest is observed in Kaudgaon, Walwad, Manmodi and Dindori villages i. e. above 4 per cent, because of newly plantation.

5.7.2. Area Not Available For Cultivation

On an average there is 2.96 per cent area not available for cultivation is in selected villages, but spatial distribution is uneven. The table 5.7 indicates that the low area not available for cultivation is found in Dhanori, Andur, Shirala, Walwad,

Table No 5.7: General Land use in Selected Village (2014)

Sr. No.	Villages	Forest	Area Not Available for Cultivation	Un-cultivable Land	Fallow Land	Net Area Sown	Total Geogra-phical Area (%)
1	Shirala	1.27	1.19	7.52	0.21	89.81	100
2	Loni	2.72	2.95	1.1	0.51	92.71	100
3	Pachpimpla	0.6	0.12	4.05	3.91	91.32	100
4	Antargaon	3.4	4.84	0.69	0.7	90.38	100
5	Walwad	4.83	1.17	4.32	0.64	89.04	100
6	Chinchpur (D)	1.71	8.27	2.51	0.21	87.29	100
7	Warewadgaon	0.89	2.64	0.75	0.02	95.7	100
8	Dindori	4.44	8.95	31.23	0.09	55.29	100
9	Washi	1.77	0.04	3.72	1.42	93.05	100
10	Indapur	1.22	3.11	2.27	1.07	92.33	100
11	Terkheda	0.91	1.07	4.25	0.76	93.01	100
12	Hasegaon Kej	0.8	0.44	1.73	0.58	96.45	100
13	Andora	1.01	0.43	0	0.77	97.79	100
14	Naigaon	0.67	9.83	1.01	0.34	88.14	100
15	Nipani	1.77	8.27	3.33	0.31	86.32	100
16	Kaudgaon	5.64	3.31	4.42	2.77	83.86	100
17	Palsap	2.41	4.44	5.9	0.11	87.14	100
18	Jagji	1.1	2.04	4.51	1.86	90.49	100
19	Upla	3.71	0.91	0.41	0.4	94.57	100
20	Chincholi	1.08	3.05	1.24	3.04	91.59	100
21	Andur	2.23	1.39	3.99	0.09	92.3	100
22	Manmodi	4.76	0.18	0.89	0.17	94	100
23	Dhanori	0.77	1.41	5.86	2.06	89.91	100
24	Jakekur	0.54	1.11	0.66	0.22	97.47	100
Region Average		2.09	2.96	4.02	0.93	73	100

Source: Compiled by researcher on the basis of field survey.

Jakekur, Terkheda, Upla, Hasegaon Kej, Andora, Manmodi, Pachpimpla and Washi villages i.e. below 2 per cent, whereas it is high in Naigaon, Dindori, Chinchpur (D), Nipani villages i.e. above 7 per cent.

5.7.3 Uncultivable Land

On an average there is 4.02 per cent uncultivable land in selected villages, but spatial distribution varies from village to village. The table 5.7 exhibits low uncultivable land is found Andur, Washi, Nipani, Chinchpur (D), Indapur, Hasegaon (Keij), Chincholi, Loni, Naigaon, Manmodi, Warewadgaon, Antargaon, Upla and Andora villages i.e. below 4 per cent. The very high uncultivable land is noticed only in Dindori village i.e. above 31.23 per cent because this vellage is situated in the rugged topography and rocky hills of Balaghat range.

5.7.4 Fallow Land

On an average there is 0.93 per cent of fallow land in selected villages, but spatial distribution varies from village to village. The table 5.7 indicates that the low fallow land is found in Washi, Indapur, Andora, Terkheda, Antargaon, Walwad, Hasegaon Kej, Loni, Upla, Naigaon, Nipani, Jakekur, Shirala, Chinchpur (D), Manmodi, Palsap, Dindori, Andur and Warewadgaon villages i.e. below 0.90 per cent. The high fallows land is noticed in Panchpimpala and Chincholi villages i.e. above 3 per cent, due to uncertain and low rainfall.

5.7.5 Net Sown Area

On an average there is a 73 per cent of Net Sown Area in selected villages, but spatial distribution varies from village to village. The table 5.7 indicates that the low Net Sown area is found only in Dindori village i.e. below 70 per cent to total geographical area, due to unfavorable physiography. The high Net Sown area is noticed in Shirala, Palsap, Dhanori, Jagji, Indapur, Walwad, Terkheda, Pachpimpla, Andur, Washi, Nipani, Chinchpur (D), Indapur, Hasegaon Kej, Chincholi, Loni, Naigaon, Manmodi, Warewadgaon, Antargaon, Jakekur, Upla and Andora i.e. 84 per cent due plain topography and development of irrigation facilities.

5.8 AGRICULTURAL LAND USE PATTERN:

A) Food Crops

The region as a whole has 80.14 per cent area under food crops to total geographical area in selected villages, but village level distribution varies. The table No. 5.8 reveals that, the high per cent area under food crops is found in Shirala, Walwad, Kaudgaon, Pachpimpla, Antargaon, Manmodi villages i.e. above 84 per cent. Whereas it is low in Dhanori, Upla, Naigaon, Nipani, Hasegaon Kej, Jakekur,

Chinchpur (D) and Terkheda villages i. e. below 78 per cent to total gross cropped area.

Cereals Crops

The region as a whole has 42 per cent area under cereals crops in selected villages. The table 5.8 indicates that low area under Cereals Crops is found in Jagji, Dindori, Terkheda, Jakekur, Chinchpur (D), Upla, Dhanori, Palsap and Shirala i.e. below 40 per cent because of development of irrigation farmers turn toward cash crops. The high area under cereals is recorded in Warewadgaon, Loni, Pachpimpla and Walwad villages i.e. above 46 per cent, due to low rainfall the farmers prefer cereals rather than cash crops.

1. Jowar

The region as a whole has 32.38 per cent area under Jowar crop in selected villages, but village level distribution varies. Jowar is dominant in Cereals. The table 5.8 reveals that low proportion of area under Jowar is noticed in Manmodi, Dindori, Jakekur and Shirala villages i.e. below 28 per cent. The high proportion of Jowar is found in Loni, Pachpimpla, Andora and Nipani villages i.e. above 37 per cent, due to lower development of irrigation and drought- registrant nature of Jowar.

2. Wheat

The region as a whole has 3.78 per cent area under Wheat crop in selected villages, but spatial distribution varies from village to village. The table 5.8 indicates that the low proportion of Wheat is noticed in Jakekur, Dindori, Upla, Palsap, Andur, Antargaon, Hasegaon (Keij), Walwad, Terkheda, Naigaon, Indapur, Washi, Andora, Chinchpur (D), Dhanori, Pachpimpla, Nipani and Loni villages i.e. below 4 per cent. The high area under Wheat is found in Manmodi and Shirala villages' i.e. above 7 per cent due to high development of seasonal irrigation.

3. Bajara

The region as a whole has 5.49 per cent area under Bajara in selected villages, but spatial distribution varies from village to village. The table 5.8 indicates that low proportion under Bajara is noticed in Dhanori, Chincholi, Hasegaon Kej, Loni, Terkheda, Pachpimpla, Shirala, Kaudgaon, Chinchpur (D), Manmodi, Jagji, Upla, Naigaon, Nipani and Palsap villages i.e. below 2.5 per cent. The high proportion of Bajara is recorded in Walwad and Warewadgaon villages i.e. above 6 per cent, due to the low rainfall as Bajara is drought- registrant crop.

Table No. 5.8 : Agricultural Land use of Selected Village- 2014

Sr.No.	Villages	Jowar	Wheat	Bajri	Maize	Other Cereal	Total Cereal	Tur	Gram	Udid	Mung	Other Pulses	Total Pulses
1	Shirala	20.01	9.17	1.02	2.64	0.89	33.73	7.93	0.88	1.27	0.99	1.03	12.1
2	Loni	45.12	1.25	1.87	1.7	1.02	50.96	11.04	2.77	1.31	2.33	1.47	18.92
3	Pachpimpla	44.35	2.01	1.11	2.09	0.23	49.79	10.82	2.06	2.58	2.06	0.11	17.63
4	Antargaon	34.9	3.49	5.39	1.27	0.72	45.77	11.74	6.35	3.28	1.77	0.51	23.65
5	Walwad	36.47	3.09	6.94	1.39	1.02	48.91	12.24	2.78	5.53	3.17	2.74	26.46
6	Chinchpur (D)	31.79	2.11	0.8	2.11	0.79	37.59	8.42	2.99	3.33	1.72	1.22	17.68
7	Warewadgaon	30.49	5.45	6.44	5.92	4.21	52.5	3.47	1.03	2.14	1.64	0.98	9.26
8	Dindori	26.67	3.75	3.33	2.92	1.71	38.38	9.17	2.92	5.83	0.83	3.31	22.06
9	Washi	30.56	2.43	4.61	1.65	5.96	45.21	10.09	4.3	1.12	3.19	2.47	21.17
10	Indapur	31.31	2.75	4.44	2.04	1.29	41.83	9.82	4.52	2.16	2.76	1.21	20.47
11	Terkheda	30.09	2.96	1.24	1.79	2.28	38.36	8.07	3.79	2.57	3.19	3.03	20.65
12	Hasegaon K	33.2	3.46	2.07	1.38	2.31	42.42	12.52	3.46	1.05	0.8	2.69	20.52
13	Andora	38.93	2.36	2.76	0.55	1.2	45.8	12.94	5.52	1.28	0.93	1.27	21.94
14	Naigaon	34.14	2.89	0	1.97	1.13	40.13	8.96	8.83	1.34	0.73	1.09	20.95
15	Nipani	37.08	1.82	0	1.64	0.81	41.35	13.1	5.55	0.97	0.56	1.32	21.5
16	Kaudgaon	33.1	6.71	1.02	1.46	0.89	43.18	9.42	1.42	2.72	1.34	1.3	16.2
17	Palsap	29.53	3.65	0	2.6	0	35.78	8.46	7.16	6.51	1.28	2.21	25.63
18	Jagji	31.22	4.44	0.56	1.37	1.42	39.01	8.45	8.15	2.73	2.83	2.21	24.37
19	Upla	30.33	3.72	0.34	2.26	0.73	37.38	9.95	6.37	4.44	1.16	0.91	22.83
20	Chincholi	35.19	4.25	2.28	1.92	0.28	43.92	11.47	5.21	5.27	1.32	1.11	24.38
21	Andur	31.1	3.52	3.42	2.29	0.82	41.15	8.48	4.41	4.52	2.23	0.99	20.63
22	Manmodi	26.69	9.54	0.73	2.54	0.96	40.46	5	3.33	2.21	1.13	1.09	12.76
23	Dhanori	28.66	2.05	2.48	1.37	1.83	36.39	8.47	6.78	4.44	3.21	1.86	24.76
24	Jakekur	26.3	3.96	4.72	1.44	1.66	38.08	9.45	2.21	4.05	1.34		17.05
Region Average		32.38	3.78	2.4	2.01	1.42	42	9.56	4.28	3.03	1.77	1.57	20.15

Table No. 5.8 Continue…

Sr.No.	Villages	Sugar-cane	Spices	Fruits & Vegeta-bles	Ground-nut	Soya-bean	Saff-lower	Other Oil-seed	Cotton	Total Cropp-ed Area	Total Food grain	Total Food-crop	Total Non Food Crop
1	Shirala	21.55	1.01	22.18	5.44	1.58	1.32	0.66	0.43	100	45.83	90.57	9.43
2	Loni	3.41	0.43	8.27	2.14	1.98	2.42	2.97	8.49	100	69.88	81.99	18.01
3	Pachpimpla	4.15	0.53	12.88	1.11	0.21	0.42	5.06	8.25	100	67.42	84.98	15.05
4	Antargaon	2.72	1.41	11.03	0.31	2.12	1.21	0.99	10.79	100	69.42	84.58	15.42
5	Walwad	2.36	1.73	10.04	1.07	0.87	3.37	3	2.19	100	75.37	89.5	10.5
6	Chinchpur (D)	3.94	1.24	12.26	2.11	0.22	3	1.96	20	100	55.27	72.71	27.29
7	Warewadgaon	4.46	2.65	9.68	5.94	2.77	3.05	2.77	6.93	100	61.76	78.54	21.46
8	Dindori	1.27	1.13	17.29	0.43	18.1	0.22	0.82	0.31	100	60.44	80.13	19.87
9	Washi	3.04	2.23	8.41	2.11	13.8	0.71	1.06	2.22	100	66.38	80.06	19.93
#	Indapur	4.43	1.99	10.17	2.08	14.9	1.21	1.15	1.74	100	62.3	78.89	21.11
#	Terkheda	4.04	2.32	6.88	2.42	20.6	2.17	1.08	1.45	100	59.01	72.25	27.75
#	Hasegaon Kej	2.07	1.82	8.01	0.35	14.5	0.76	0.61	8.99	100	62.94	74.84	25.16
#	Andora	2.21	1.1	7.42	0.44	11.1	0.69	1.05	8.29	100	67.75	78.48	21.52
#	Naigaon	5.09	1.96	7.85	0.54	20.2	0.33	1.11	1.83	100	61.08	75.98	24.02
#	Nipani	3.37	0.91	7.77	0.71	19.9	0	2.84	1.64	100	62.84	74.89	25.11
#	Kaudgaon	8.41	1.65	17.49	1.11	10.9	0.37	0.66	0	100	59.38	86.93	13.07
#	Palsap	3.23	1.15	16.38	0.47	15	1.28	0.89	0.22	100	61.41	82.17	17.83
#	Jagji	4.39	1.41	10.8	0.47	18.4	0.27	0.67	0.22	100	63.38	79.98	20.02
#	Upla	3.72	0.84	12.26	0.33	14.7	2.22	5.58	0.11	100	60.21	77.03	22.97
#	Chincholi	4.33	3.01	4.69	2.39	12.9	1.91	1.67	0.76	100	68.3	80.33	19.67
#	Andur	8.14	3.27	9.48	4.45	8.19	3.69	0.88	0.12	100	61.78	82.67	17.33
#	Manmodi	8.61	2.81	19.83	3.81	10.5	0	1.25	0	100	53.22	84.47	15.53
#	Dhanori	3.91	1.99	10.6	1.96	15.1	0.72	2.41	2.22	100	61.15	77.65	22.36
#	Jakekur	7.41	4.49	6.65	3.28	14.8	0.36	5.04	2.82	100	55.13	73.68	26.31
Region Average		5.01	1.8	11.18	1.89	11	1.32	1.92	3.75	100	62.15	80.14	19.86

Source: Compiled by Researcher on the basis of Field Survey

4. Maize

The region as a whole has 2.01 per cent area under Maize crops in selected villages, but spatial distribution varies from village to village. The table 5.8 indicates that low proportion of area under Maize is noticed in Naigaon,Chincholi, Terkheda, Loni, Washi, Nipani, Kaudgaon, Jakekur, Walwad, Hasegaon Kej, Jagji, Dhanori, Antargaon and Andora villages i.e. below 2 per cent. The high proportion of Maize is observed only in Warewadgaon village i.e. above 5.92 per cent, due to the development of dairy farming.

Total Pulses

The region as a whole has 20.15 per cent area under total pulses in selected villages, but spatial distribution varies from village to village. The low proportion of total Pulses is noticed in Manmodi, Shirala, and Warewadgaon villages i.e. below 15 per cent, whereas it is high in Walwad, Palsap, Dhanori, Chincholi, Jagji and Antargaon i.e. above 23 per cent.

5. Tur

Tur is important pulse crop, and cultivated in all selected villages. The region as a whole has 9.56 per cent area under Tur crops in the selected villages, but spatial distribution is uneven. The table 5.8 indicates that the low proportion of Tur is noticed in Manmodi and Warewadgaon villages i.e. below 7 per cent. The high proportion of Tur is recorded in the villages of Nipani, Andora, Hasegaon Kej, Walwad, Antargaon, Chincholi, Loni, Pachpimpla and Washi i. e. 10 per cent due to favorable soil and lower development of irrigation.

6. Gram

Gram is important pulse crop, and cultivated in all selected villages. The region as a whole has 4.28 per cent area under Gram crops in selected villages, but spatial distribution varies from village to village. The low proportion of Gram is noticed Hasegaon Kej, Manmodi, Chinchpur (D), Dindori, Walwad, Loni, Jakekur, Pachpimpla, Kaudgaon, Warewadgaon and Shirala villages i. e. below 3.5 per cent.Whereas, it is high in Naigaon, Jagji, Palsap, Dhanori, Upla and Antargaon, i. e. above 6 per cent, due to suitable soil and climate.

7. Sugarcane

The region as a whole has 5.01 per cent area under Sugarcane in selected villages, but spatial distribution varies from village to village. The table 5.8 indicates that the low proportion of area under Sugarcane is found in Jakekur,Naigaon,

Warewadgaon, Indapur, Jagji, Chincholi, Pachpimpla, Terkheda, Chinchpur (D), Dhanori, Upla, Loni, Nipani, Palsap, Washi, Antargaon, Walwad, Andora, Hasegaon Kej and Dindori villages i.e. below 8 per cent. The high proportion of Sugarcane is found only in Shirala village i.e. 21.55 per cent, due to high development of surface irrigation facility and fertile soil in river basin.

8. Spices

The region as a whole has 1.80 per cent area of Spices crops in the selected villages, but spatial distribution varies from village to village. The table 5.8 indicates that the low proportion of area under Spices is found in Nipani, Upla, Panchpimpala and Loni villages i.e. below 1 per cent, whereas it is high in Jakekur, Andur and Chincholi villages i.e. above 3 per cent, due to the development of irrigation facilities.

9. Fruist and Vegetable

The region as a whole has 11.18 per cent area of Fruit and Vegetable crops in selected villages, but spatial distribution varies from village to village. The table 5.8 reveals that the low proportion of area under Fruit and Vegetable is found in Indapur,Walwad, Warewadgaon, Andur, Washi, Loni, Hasegaon Kej, Naigaon, Nipani, Andora, Terkheda, Jakekur and Chincholi villages i.e. below 10.5 per cent. Whereas it is high in Shirala, Manmodi, Kaudgaon, Dindori and Palsap villages i.e. above 16 per cent, due to development of irrigation facilities and other technological factors.

B) Non Food Crop

The region as a whole has 19.86 per cent area under Non Food crops in selected villages, but spatial distribution varies from village to village. The table 5.8 reveals that the low proportion of area under Non food Crop is found Manmodi, Antargaon, Pachpimpla, Kaudgaon, Walwad and Shirala i.e. below 16 per cent due to the high development of irrigation farmer devoted their land to Sugarcane and fruits and vegetables. The high per centage of area under nonfood crops is noticed in Terkheda, Chinchpur (D), Jakekur, Hasegaon Kej, Nipani, Naigaon, Upla and Dhanori villages i.e. above 22 per cent.

10. Groundnut

The region as a whole has 1.89 per cent area under Groundnut in selected villages, but spatial distribution varies from village to village. The table 5.8 indicates that the low proportion of area under Groundnut is found in Pachpimpla, Kaudgaon, Walwad, Nipani, Naigaon, Palsap, Jagji, Andora, Dindori, Hasegaon(Keij), Upla and Antargaon villages i. e. below 1.5 per cent. The high proportion of groundnut is registered in Warewadgaon, Shirala, and Andur villages i.e. above 4 per cent due to the development of irrigation facilities.

11. Soybean

The region as a whole has 10.97 per cent area under Soybean crops in selected villages, but spatial distribution varies from village to village. The low proportion of area under Soybean is found in Warewadgaon, Antargaon, Loni, Shirala, Walwad, Chinchpur (D) and Pachpimpla villages i.e. below 7 per cent. The high proportion of Soybean is found in Terkheda, Naigaon,Nipani Jagji, Dindori, Dhanori, Palsap, Indapur, Jakekur, Upla and Hasegaon(Ke)j villages i.e. above 14 per cent, due to suitable soil as it is Kharif crop and farmer's increasing trend, which is now fetching better price.

12. Safflower

The region as a whole has 1.32 per cent area under Safflower crops in selected villages, but spatial distribution varies from village to village. The low proportion of area under Safflower is found in Antargaon, Indapur, Hasegaon Kej, Dhanori, Washi, Andora, Pachpimpla, Kaudgaon, Jakekur, Naigaon, Jagji, Dindori, Nipani and Manmodi villages i.e. below 1.25 per cent. The high proportion of Safflower is found Andur, Walwad, Warewadgaon and Chinchpur (D) villages i.e. above 2.5 per cent, due to suitable soil and climate.

13. Cotton

Cotton is important cash crop in selected villages. The region as a whole has 3.75 per cent area under Cotton crop in selected villages. The low proportion of area under Cotton is found in Jakekur, Washi, Dhanori, Walwad, Naigaon, Indapur, Nipani, Terkheda, Chincholi, Shirala, Dindori, Palsap, Jagji, Andur, Upla, Kaudgaon and Manmodi villages i.e. below 3 per cent. Whereas the very high proportion of Cotton is noticed only in Chinchpur (D) village i.e. 20.00 per cent due to high proportion of Regur Soil.

5.9. AGRICULTURAL PRODUCTIVITY IN THE SELECTED VILLAGES:

5.9.1 Per Hectares Yield of Selected Crop in the Selected Villages

Measurement and evaluation of agricultural productivity forms a basis for improving productivity at various levels (Noor Mohammad, 1995) therefore attempt is made here to study agricultural productivity at micro level.

1. Jowar

The region as a whole has 1055.21 kgs. per hectare yield of Jowar crops in selected villages, but spatial distribution is uneven. In 2014, the high per hectare yield of Jowar is observed in Shirala, Manmodi, Andur, Warewadgaon, Kaudgaon, Jakekur, Naigaon and Palsap villages i.e. above 1250 kgs., due to suitable soil for Jowar and development of irrigation facilities.

The low per hectare yield of Jowar is noticed in Dindori, Upla, Dhanori, Terkheda, Washi, Indapur, Loni, Pachpimpla, Walwad, Jagji, Nipani, Hasegaon Kej and Andora villages i.e. below 1000 kgs.

2. Wheat

The region as a whole has 1194.04 kgs. per hectare yield of Wheat crops in selected villages, but spatial distribution varies from village to village. During 2014, the high per hectare yield of Wheat is observed in Shirala, Manmodi, Andur, Jakekur and Warewadgaon villages i.e. above 1400 kgs, due to the development of irrigation facilities and high rainfall.

The low per hectare yield of Wheat is noticed in Antargaon,Upla , Dindori, Dhanori, Chinchpur (D), Terkheda, Washi, Loni, Indapur, Pachpimpla, Jagji, Walwad, Nipani, Hasegaon Kej and Andora villages i.e. below 1150 kgs.

3. Bajara

The region as a whole has 480 kgs. per hectare yield of Bajara crops in selected villages, but spatial distribution varies from village to village. The Low per hectare yield of Bajara is observed in Kaudgaon, Palsap, Dhanori, Jagji, Chincholi and Upla villages i.e. below 400 kgs., in the year of 2014.

The high per hectare yield of Bajara is noticed in Warewadgaon, Antargaon, Terkheda, Chinchpur (D), Naigaon, Dindori, Shirala, Nipani, Washi, Manmodi, Hasegaon Kej, Walwad and Indapur villages i.e. above 500 kgs., due to suitable soil and climate.

Table-5.9: Per Hectares Yields of Selected Crops in Selected Villages (2014).
(Yield in Kgs. * Sugarcane in M.T)

Villages	Jowar	Wheat	Bajra	Gram	Tur	Ground nut	Soy-bean	Sugar-cane
Shirala	1518	1681	532	1150	1484	1242	1015	175
Loni	827	1079	487	873	918	797	740	100
Pachpimpla	816	1056	492	842	910	790	715	100
Antargaon	1209	1110	578	919	1196	964	909	125
Walwad	806	994	516	822	825	937	691	75
Chinchpur (D)	1166	1094	555	925	1185	952	888	125
Warewadgaon	1412	1413	598	1088	1315	1059	987	150
Dindori	886	1102	541	891	952	817	842	100
Washi	855	1088	519	888	948	799	811	100
Indapur	828	1076	515	876	930	761	826	100
Terkheda	862	1092	568	890	953	788	856	100
Hasegaon Kej	717	891	517	615	898	642	973	75
Andora	711	877	497	607	890	630	956	75
Naigaon	1312	1324	550	942	1271	1012	1042	100
Nipani	776	984	521	777	915	866	1004	100
Kaudgaon	1381	1392	372	952	1471	908	992	150
Palsap	1302	1312	360	941	1312	899	969	125
Jagji	803	1003	339	795	965	766	854	100
Upla	879	1108	311	878	978	795	861	100
Chincholi	1067	1212	325	902	1087	824	893	100
Andur	1463	1549	467	1115	1409	1177	1012	150
Manmodi	1482	1623	519	1132	1465	1189	1028	166
Dhanori	878	1098	351	891	1050	771	850	113
Jakekur	1369	1499	490	1079	1391	1019	999	150
Region	1055.21	1194.04	480.00	907.92	1113.25	891.83	904.71	114.75

Source: Compiled by Researcher on the basis of Field Survey during 2014

4. Gram

The region as a whole has 907.92 kgs. per hectare yield of Gram crops in selected villages, but spatial distribution is uneven from village to village. The table 5.9 exhibits that the low per hectare yield of Gram is observed in Jagji, Nipani, Hasegaon Kej and Andora villages i. e. below 800 kgs., because inadequate rainfall. The high per hectare yield of Gram is noticed in Shirala, Manmodi, Andur, Warewadgaon and Jakekur villages i.e. above 1000 kgs.

5. Tur

The region as a whole has 1113.25 kgs. per hectare yield of Tur crops in selected villages, but spatial distribution is uneven. The table 5.9 indicates that the high per hectare yield of Tur is observed in Shirala, Kaudgaon, Manmodi, Andur, Jakekur, Warewadgaon, Palsap and Naigaon villages i.e. above 1270 kgs., due to favorable soil and climate. The low per hectare yield of Tur is noticed in Upla, Jagji, Terkheda, Dindori, Washi, Indapur, Loni, Nipani, Pachpimpla, Hasegaon Kej, Andora and Walwad villages i.e. below 1000 kgs.

6. Groundnut

The region as a whole has 891.83 kgs. per hectare yield of Groundnut crop in selected villages, but spatial distribution is uneven. The table no. 5.9 reveals that the low per hectare yield of Groundnut is observed in Chincholi, Dindori, Washi, Loni, Upla, Pachpimpla, Terkheda, Dhanori, Jagji, Indapur, Hasegaon Kej and Andora villages i.e. below 850 kgs. The high per hectare yield of Groundnut is noticed in Shirala, Manmodi, Andur, Warewadgaon, Jakekur and Naigaon villages i.e. above 1000 kgs, due to the development of irrigation facilities and high rainfall.

7. Soybean

The region as a whole has 904.71 kgs. per hectare yield of Soybean crops in selected villages, but spatial distribution is varies from village to village. The table no. 5.9 indicates that the low per hectare yield of Soybean is observed in Loni, Pachpimpla and Walwad villages i.e. below 800 kgs., due unsuitable climate. The high per hectare yield of Soybean is noticed in Naigaon, Manmodi, Shirala, Andur, Nipani, Jakekur, Kaudgaon, Warewadgaon, Hasegaon Kej, Palsap and Andora

villages i.e. above 925 kgs. Because of favorable soils, suitable climate and assures rainfall in these villages.

8. Sugarcane

The region as a whole has 114.75 tons per hectare yield of Sugarcane in selected villages, but spatial distribution varies from village to village. The table 5.9 indicates that the high per hectare yield of Sugarcane is found in Shirala, Manmodi, Warewadgaon, Kaudgaon, Andur and Jakekur villages i.e. above 140 tons, due to the high development of surface irrigation facility and deep Regur soil. The low per hectare yield of Sugarcane is noticed in Loni, Pachpimpla, Dindori, Washi, Indapur, Terkheda, Naigaon, Nipani, Jagji, Upla, Chincholi, Walwad, Hasegaon Kej and Andora villages i.e. below 110 tons.

5.10 AGRICULTURAL PRODUCTIVITY IN THE SELECTED VILLAGES:

The patterns of agricultural productivity of sample villages have been delineated with the help of Kendall's Ranking Co-efficient method (1939). The ranking coefficient technique is quite simple and easy to apply. In this technique the component areal units are ranked according to per hectares yields of selected crops and the arithmetical average of ranks are calculated for each unit. It is obvious that a component areal unit with relatively high will have low ranking coefficient, indicating a high agrcultural productivity and vice versa. The ranking coefficient values of high, medium and low productivity have been given in table no. 5.10.

1. Villages of High Agricultural Productivity

The table no. 5.10 exhibits that the high agricultural productivity is found in Shirala, Manmodi, Andur, Warewadgaon, Jakekur and Naigaon. In Shirala, Manmodi, Andur, Jakekur and Warewadgaon it is high due to the development of surface irrigation facility i.e. canal and lift irrigation facilities, whereas it is high in Naigaon due to the development of both well and borewell irrigation.

2. Villages of Moderate Agricultural Productivity

The table 5.10 indicates that the moderate level of agricultural productivity is found in the villages of Antargaon, Chinchpur (D), Kaudgaon, Palsap, Terkheda,

Table No. 5.10: Agricultural Productivity by Kendall's Ranking Coefficient Method

Sr.No.	Villages	Jowar	Wheat	Bajra	Gram	Tur	Groun-dnut	Soy-bean	Sugar-cane	Composite Index of Rank
		Rank	Rank	Rank	Rank	Rank	Rank	Rank	Rank	
1	Shirala	1	1	7	1	2	1	3	1	2.13
2	Loni	18	15	16	17	8	16	22	6	14.75
3	Pachpimpla	20	16	14	18	1	18	23	6	14.50
4	Antargaon	10	10	2	10	10	7	12	4	8.13
5	Walwad	21	19	11	19	15	9	24	7	15.63
6	Chinchpur (D)	6	12	4	9	11	8	14	4	8.50
7	Warewadgaon	4	6	1	4	19	4	8	3	6.13
8	Dindori	11	13	6	12	23	14	19	6	13.00
9	Washi	16	18	9	14	12	15	21	6	13.88
10	Indapur	17	20	12	16	7	22	20	6	15.00
11	Terkheda	15	17	3	13	6	19	16	6	11.88
12	Hasegaon Kej	23	23	10	22	22	23	9	7	17.38
13	Andora	24	24	13	23	21	24	11	7	18.38
14	Naigaon	9	5	5	7	13	6	1	6	6.50
15	Nipani	19	22	8	21	5	12	5	6	12.25
16	Kaudgaon	8	4	18	6	20	10	7	3	9.50
17	Palsap	7	8	19	8	14	11	10	4	10.13
18	Jagji	22	21	21	20	24	21	17	6	19.00
19	Upla	13	14	23	15	16	17	15	6	14.88
20	Chincholi	12	11	22	11	18	13	13	6	13.25
21	Andur	3	3	17	3	9	3	4	3	5.63
22	Manmodi	2	2	9	2	3	2	2	2	3.00
23	Dhanori	14	9	20	12	17	20	18	5	14.38
24	Jakekur	5	7	15	5	4	5	6	3	6.25

Source: Compiled by Researcher on the basis of Field Survey (2014)

Nipani, Dindori and Chincholi. These villages are benefitted by minor irrigation projects which is well affected on well and borewell irrigation facilities.

3. Villages of Low Productivity

The low agricultural productivity is found in Washi, Dhanori, Pachpimpla, Loni, Upla, Indapur, Walwad, Hasegaon Kej, Andora and Jagji villages due to lack of irrigation facilities and lower technological development.

5.11 IMPACT OF IRRIGATED AREA ON AVERAGE PER HECTARE YIELD OF SELECTED CROPS IN SELECTED VILLAGES:

Attempt is made here to assess the impact of percentage of net irrigated area on average per hectare yield of selected crops in selected villages of the Osmanabad Distrrict. For the convenient prediction the per hectare yield of 8 selected crops are converted into kgs.

In the context of objective the following findings have come to light.

1. The very high positive correlation between net irrigated area and average per hectare yield of selected crops is observed in the selected villages. The coefficient of correlation in this regard is + 0.93. The degree of linear association between these two variable obtained by using the coefficient of determination (r^2) which is found to be at 0.8667. It reveals that the independent variable (X) i.e. net irrigated area are explaining 86.67 per cent of the total variations in dependant variable (Y) i.e. average per hectare yield of selected crops in selected villages. It explanation that 86.67 per cent of variation in 'Y' average per hectare yield of selected crops in selected villages to be influenced by the variable 'X' i.e. net irrigated area and about 13.33 percent of variation is left to be influenced by other variables.

2. The functional form of linear relationship of 'Y' on 'X' found to be at y = 6415.5 + 351.5x. The line of best fist is shown in figure no. 5.2. The regression coefficient indicates that increase of one percent net irrigated area causes for increase of average per hectare yield of villages by 351.5 kgs. in the study area. By testing the significance of regression coefficient (a test of significance), the validity of this causal relationship has been confirmed,

The calculated value of't' in this exercise is found at 11.96. It is observed that this calculated value is higher than the tabulated value of't' at the 22 degree of freedom (df = n –2, where 'n' is 24) even at 5 per cent level of significance.

Table No. 5.11: Percentage of net irrigated area and average per hectare yield of selected crops in the selected villages of Osmanabad Distrrict during 2014.

Sr. No	Villages	X (% of Net irrigated area to net area sown)	Y (average per hectare yield of selected crops in kgs.)	Sr. No	Villages	X (% of Net irrigated area to net area sown)	Y (average per hectare yield of selected crops in kgs.)
1	Shirala	46.12	22953	13	Andora	9.98	10021
2	Loni	19.77	13215	14	Naigaon	25.58	13432
3	Pachpimpla	19.74	13203	15	Nipani	15.89	13230
4	Antargaon	22.91	13361	16	Kaudgaon	27.36	19684
5	Walwad	19.35	10074	17	Palsap	25.46	16512
6	Chinchpur (D)	22.76	16471	18	Jagji	17.43	13191
7	Warewadgaon	38.83	19734	19	Upla	20.73	13226
8	Dindori	20.76	13254	20	Chincholi	22.43	13289
9	Washi	20.33	13239	21	Andur	42.14	19774
10	Indapur	20.2	13227	22	Manmodi	42.33	21805
11	Terkheda	20.35	13251	23	Dhanori	20.45	14861
12	Hasegaon Kej	10.05	10032	24	Jakekur	37.34	19731
Coefficient of correlation							0.9309
Coefficient of determination							0.8667

Source: Compiled by researcher on the basis of field survey(2014).

3. In order to understand the degree of fit of regression equation and the accuracy level of predicted values (y) average per hectare yield of crops in the selected villages of Osmanabad district, the standard error (SE) of estimate is being done with the equation SE (Y) = SY $\sqrt{1-r^2}$, where SE (Y) is the standard deviation of residuals (Y-y); and 'SY' is the standard deviation of 'Y'.

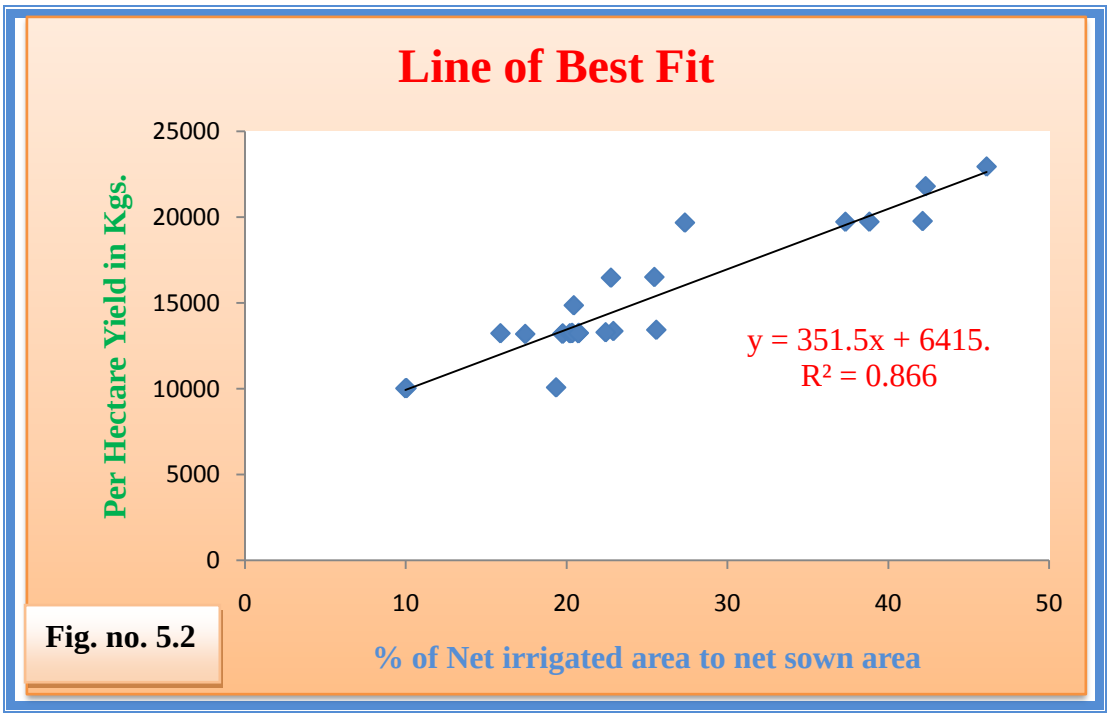

Fig. no. 5.2

Table No. 5.12: Residuals from regression of average per hectare yield of selected crops in selected villages during field survey (2014).

Sr. No	Villages	yi	Yi-yi	Sr. No	Villages	yi	Yi-yi
1	Shirala	22627.8	325.22	13	Andora	9923.71	97.29
2	Loni	13365.1	-150.13	14	Naigaon	15407.5	-1975.5
3	Pachpimpla	13354.6	-151.58	15	Nipani	12001.2	1228.78
4	Antargaon	14468.9	-1107.91	16	Kaudgaon	16033.2	3650.81
5	Walwad	13217.5	-3143.49	17	Palsap	15365.30	1146.70
6	Chinchpur (D)	14416.2	2054.81	18	Jagji	12542.6	648.44
7	Warewadgaon	20065.2	-331.17	19	Upla	13702.6	-476.59
8	Dindori	13713.1	-459.14	20	Chincholi	14300.2	-1011.18
9	Washi	13562	-322.98	21	Andur	21228.7	-1454.71
10	Indapur	13516.3	-289.28	22	Manmodi	21295.5	509.50
11	Terkheda	13569	-318.01	23	Dhanori	13604.2	1256.84
12	Hasegaon Kej	9948.32	83.68	24	Jakekur	19541.40	189.60

Source: Compiled by Researcher

The confidence interval of the predicted values are worked out at Y ± SE (Y) (The SE (Y) for the present exercise is 1379 and SY is the 3692.86). Thus it is assumed that if the values of 'Y' (Y-y) lie within the range of Zero to ± SE, the prediction could be expected to be accurate. In other words, the role of independent variables in explaining the change in dependent variable can be accepted as correct.

The equation used $t = (b-\beta) \sqrt{(n-2)\Sigma(Xi-\bar{X})^2 \div \Sigma (Yi-yi)^2}$

In this context it has been observed that the predicted values (given in table no. 5.12) of 19 out of 24 in selected villages in the present study lie within the range of ± SE, and 3 villages within ± SE to ± 2 SE and 2 villages lie >± 2 SE. Now the obvious inference is that the 79.16 per cent of the total number of observation (n is 24) the regression is a good indicator meaning thereby that the variations in average per hectare yield of selected crops in selected villages of Osmanabad Distrrict is the function of the variations in net irrigated area. In the case of other selected villages with residuals between > ± SE to ± 2 SE the situation is different because here the regression is a poor indicator. It clearly indicates that these are the selected villages whom the influence of variables other than the independent one. The variations in average per hectare yield of selected crops in selected villages in the latter case may be due to the variation in climatic condition, variation in soil, variation in use of fertilizer and variation in consciousness of farmers.

5.12 PROBLEMS REGARDING AGRICULTURAL PRODUCTIVITY:

During field survey farmers of the selected villages told different problems to the researcher at the time of their interview. Selected villages are facing the following problems regarding agricultural productivity.

i) Problem of Drought or Extreme Rainfall

There is not an assured rainfall in most of the villages; hence there is problem of water supply in these villages during summer season. There is no guarantee of monsoon rainfall in all villages. Erratic nature of monsoon rainfall affects on the cropping pattern and agricultural productivity. Major part of the district is identified as drought prone area. Some time study region also faces the problem of heavy rainfall during November to January which adversely affects on the flowering of the plants. In such a humid condition, it leads to increase in several types of insects, pests and deseases which resulted into failure of the crop production.

ii) Soil Erosion

Soil erosion problem is found in all the selected villages of the study region. It is caused by gully erosion and heavy crops. Soil erosion occurs because of cutting of trees, removal of vegetation, which exposes land to win and running water and uncontrolled grazing. Soil erosion by water occurs when bare-sloped soil surface is exposed to rainfall, and the rainfall intensity exceeds the rate of soil intake, or infiltration rate, leading to soil-surface runoff. It results in large decreases in soil productivity.

ii) Problem Regarding Mechanization/ Equipments

Most of the farmers of selected villages have been using old and inefficient methods and techniques of production. The village of Pachpimpla, Nipani, Washi, Terkheda, Naigaon, Walwad, Dhanori, Dindori, Indapur, Antargaon, Loni, Andora, Warewadgaon, Hasegaon Kej, Jakekur, Andur and Chincholi have low number of tractor. The facts indicate that due to poorness of farmers of such villages are unable to use of modern techniques of farming, which leads to lower productivity.

iii) Labour Problem

Agricultural practices are largely labour intensive activity. The availability of labour is the backbone of agricultural growth. Most of the farmers told that out migration of people from rural area creates labour problem in the study area. It is observed that there is no availability of laboures in time when performing different operations in the field. The wedges are also higher and less efficient one. Out of total sample farmers 88 percent have expressed the problem of non availability of laborers.

iv) Lack of Surface Irrigation

Case study reveals that 62.5 per cent villages have less than 5 per cent surface irrigated area and 8.33 per cent villages are deprieved from surface irrigation. These villages are totally depended on well irrigation and water table of well depends on erratic monsoon rainfall, due to this reason there is no assure perennial irrigation, which very adversely affects on agricultural productivity. The total source-wise irrigated area of the study region is 24.51 per cent to net sown area. More than 67 per cent of farmers are facing the problems of shortage of water in summer season.

v)) Poor Economic Condition of Farmer And Problem Of Indebtedness

About 68 per cent farmers having poor economic status, they are unable to purchase and use modern equipment and High Yielding Variety, which adversely affects on agricultural productivity.

The farmers of the selected villages borrow loan year after year but they are not in a position to clear off the loans, either because the loans are larger or their agricultural output is not large enough to pay off their debt. Therefore, the debt of the farmer goes on increasing this is known as rural indebtedness. Out of total farmers 30 per cent farmers told that they are taking loans from the private moneylenders because banks demand much more documents. The rate of private moneylender is about 5 to 10 per cent per month, hence, the poor farmer is born in debt, lives in debt and dies in debt. Sometimes small farmers mortgage their land property to the moneylenders and ultimately lose it latter on and they became landless labors.

vi) Increasing Prices of Chemical Fertilizer and Pesticides

The farmers of the selected villages told that the prices of chemical fertilizer and pesticides are very high and they are increasing day by day. The quality of materials is not also satisfactorily. Over 65 per cent farmers in the study region faced the difficulties of non-availability of finance for purchase of material in time. It is also observed that about 73 percent of the farmers are unknown about exact technical knowledge of fertilizing the crops and plant protection operations.

Such mismanagement of farm has created many problems. Any mistakes in this regard lead to adverse effect on plant growth, yield and quality of produce.

viii) Problem of Load Shedding

Irregular electricity supply is another serious problem in the study region. Allmost all interviewed farmers of the selected villages raised this problem. The farmers told that load shedding is upto 18 hours per day. During the rabbi and summer season there is irregular supply of electricity in the selected villages therefore; electric motors do not run properly to fetch water for agriculture, which resulted into low agricultural productivity. Irregular supply of electricity makes difficulty to spray the pesticides at requisite time, which affects again the yield and quality of the produce.

ix) Ignorance about Soil and Water Testing

During field survey, 85 per cent farmers told negative answer about soil and water testing. It means that they are cultivating their crops blindly as well as using chemical fertilizer blindly, which result into low agricultural productivity.

X) Low and Uncertain Prices of Agricultural Commodities and high charges of Middle man and Traders

Most of the farmers of the selected villages told that they are getting very low prices of agricultural commodities and the prices of it decreased during harvesting season and they are uncertain, which resulted into poor economic condition of the farmers. Favorable weather conditions bring abundant production and when it is marketed, it causes sudden fall in market rates. Almost all farmers have expressed the problem of high charges of middle man and traders.

xi) Problem of Capital

During the field survey, most of the farmers told that they are unable to use innovate techniques due to lack of capital. They said that loan is not easily sanctioned. Banks are neutral to advance the loan to farmer. Regarding the production cost of crops, farmers faced the difficulties of non availability of finance to purchase of material in time. Such fact adversely affects on agricultural productivity.

xii) Decline of the Water Table

During the field survey, farmers mentioned that declining water table is a serious problem in the study area. Majority of the villages are depended on the well and bore well irrigation system. So the ground water bail out through wells and bore wells at faster rate than ground water recharge which resulted into decline of water table. About 83 percent of the farmers told that the increasing demand of water to agriculture and scarcity of rainfall in the past five years causes declining water which affect on low agricultural productivity.

xiii) Less use of Vermicompost:

The vermicompost is an excellent, nutrient-rich, organic and soil conditioner. It is rich in nitrates, phosphorus, potassium, calcium and magnesium which maintain natural fertility of the soil and increases water holding capacity. But during field survey only 13 per cent of the farmers give vermiculture to the crops. Most of the farmers have no knowledge about vermicompost.

5.13 SUMMARY:

The foregoing analysis reveals that the physiography and soils of all villages are favorable for agricultural activity. In general, all physical factors are favorable for farming operations except rainfall particularly in villages' lies in western part of study region. The high density of population in Washi, Terkheda, Naigaon and Antargaon villages mainly due to their site and situation i.e. situated in plane area and well connected with roads. The low literacy in Manmodi, Kaudgaon, Chincholi, Dhanori, Walwad and Jakekur village is main barrier in acceptance of innovation, which resulted into low agricultural productivity. The high density of farm workers in Naigaon, Palsap, Chincholi, Hasegaon (K), Kaudgaon, Andora, Terkheda and Washi villeges offers scope for better agricultural development. The high well irrigated area in Palsap, Chincholi, Antargaon, Terkheda, Chinchpur (D), Loni, Upla(M), Washi, Walwad, Indapur, Jagji, and Dhanori villages compel farmer to cultivate seasonal crops as these are deprived from surface irrigation facilities, which resulted into ups and down in production. Case study reveals that 92.5 per cent of villages have less than 26 percent net irrigated area indicates great need of expansion of irrigation facility. As compare to other villages, share of surface irrigated is high in the villages of Shirala, Andur, Jakekur, Warewadgaon and Manmodi, which is favorable for higher agricultural productivity.

The high use of compost fertilizer in Shirala, Chinchpur (D), Manmodi, Panchpimpala, Warewadgaon, Dindori, Kaudgaon, Upla (M), Jakekur and Andur is mainly due to development of irrigation. The low density of bullock carts in Antargaon, Indapur, Chinchpur (D), Jakekur, Andora, Chincholi, Nipani, Dindori, Hasegaon (Keij), Warewadgaon, Walwad and Washi villages is because of farmers in these villages trends to carry their agricultural production through rental vehicle i.e. pickup or small Appe. The high density of Electrical pump in Palsap, Loni, Indapur, and Antargaon is a result of high density of irrigation well because of inadequate surface irrigation facility. The the high density of Tractor per 100 hectares in Manmodi, Shirala, Jagji, Kaudgaon , Upla, Chinchpur (D), Palsap i.e. above 2, is because of development of irrigation leads better production which resulted into high purchasing power of farmers.

The high proprtion of Baffeloes in Manmodi, Jakekur, Dhanori, Chincholi, Palsap, Upla, Kaudgaon, and Jagji is mainly due to the availability of green fodder with the development of irrigation. The low per cent of Goats in Nipani, Washi,

Palsap, Andora, Terkheda, Indapur, Walwad, Jagji, Upla, Warewadgaon, Jakekur, Dhanori, and Dindori is mainly due to plane topography and farmers are more interested in farming rather than Goat raring. The high per cent of Goats in Shirala, Andur and Manmodi is a result of favorable physiography and higher number of nomadic tribes i.e. Dhangar social group. The proportion of sheep is high in Dhanori, Pachpimpla, Loni, Andur is a result of scarcity and uncertainity of rainfall leads to paucity of pastures.

The study of area under forest reveals that all most all villages (24 surved) have less than 6 per cent area under forest indicates that there is dire need of afforestation, which is useful to conserve soil and recharge ground water table. The high fallows land in Panchpimpala and Chincholi villages is mainly due to uncertain and low rainfall. The low Net Sown area only in Dindori village is a result of unfavorable physiography.

The low area under Cereals Crops in Jagji, Dindori, Terkheda, Jakekur, Chinchpur (D), Upla, Dhanori, Palsap and Shirala is mainly due to development of irrigation farmers turn toward cash crops. The high proportion of Jowar in Loni, Pachpimpla, Andora and Nipani villages is aresult of lower development of irrigation and drought- registrant nature of Jowar.

The high area under Wheat in Manmodi and Shirala is mainly due to high development of irrigation, while it is in Asonda and Gojegaon due to high rainfall. The high area under Gram in Auruangapur is mainly due to high development of irrigation, while the high proportion of Bajara in Walwad, Warewadgaon and Antargaon villages is aresult of low rainfall as Bajara is drought- registrant crop.

The high proportion of Sugarcane in Shirala village is result of high development of surface irrigation facility and fertile soil. The high proportion of fruit and vegetables in Shirala, Manmodi, Kaudgaon, Dindori and Palsap is mainly due to due to development of irrigation facilities and other technical facilities. The share of Soybean is high in Terkheda, Naigaon, Nipani, Jagji, Dindori, Dhanori, Palsap, Indapur, Jakekur, Upla and Hasegaon (Keij) villages mainly due to suitable soil and farmer's tendancy to cultivate Soyabin due to fetching better price.

The case study reveals that the agricultural productivity is highly related to nature and expansion of irrigation and other technical inputs. The high per hectares yield of Jowar in Shirala, Manmodi, Andur, Warewadgaon, Kaudgaon, Jakekur, Naigaon and Palsap villages is mainaly due to suitable soil for Jowar and

development of irrigation facilities. Per hectare yield of Wheat is high in Shirala, Manmodi, Andur, Jakekur and Warewadgaon is result of the development of irrigation facilities and high rainfall. The high per hectare yield of Bajara in Warewadgaon, Antargaon, Terkheda, Chinchpur (D), Naigaon, Dindori, Shirala, Nipani, Washi, Manmodi, Hasegaon Kej, Walwad and Indapur villages, due to suitable soil and climate.. The low per hectare yield of Gram in Jagji, Nipani, Hasegaon Kej and Andora villages, is result of inadequate rainfall. The high per hectare yield of Tur is observed in Shirala, Kaudgaon, Manmodi, Andur, Jakekur, Warewadgaon, Palsap and Naigaon villages, due to favorable soil and climate. The high per hectare yield of Groundnut is noticed in Shirala, Manmodi, Andur, Warewadgaon, Jakekur and Naigaon villages, due to the development of irrigation facilities and high rainfall. The low per hectare yield of Soybean is observed in Loni, Pachpimpla and Walwad villages i.e. below 800 kgs., due unsuitable climate. The high per hectare yield of Sugarcane is found in Shirala, Manmodi, Warewadgaon, Kaudgaon, Andur and Jakekur villages i.e. above 140 tons, due to the high development of surface irrigation facility and deep Regur soil.

As per Kendal's ranking coefficient method the high agricultural productivity in Shirala, Manmodi, Andur, Warewadgaon and Jakekur is a result of development of surface irrigation facility, whereas it is high in Naigaon mainly due to development of both well and tubewell irrigation. The low agricultural productivity is found in Washi, Dhanori, Pachpimpla, Loni, Upla, Indapur, Walwad, Hasegaon Kej, Andora and Jagji villages due to lack of irrigation facilities and lower technological development.

The very high positive correlation between net irrigated area and average per hectare yield of selected crops is observed in the selected villages. The coefficient of correlation in this regard is + 0.93. The degree of linear association between these two variables (r^2) is found to be at 0.8667. It reveals that 86.67 per cent of variation in 'Y' average per hectare yield of selected crops in selected villages to be influenced by the variable 'X' i.e. net irrigated area and about 13.33 percent of variation is left to be influenced by other variables. The functional form of linear relationship of 'Y' on 'X' found to be at $y = 6415.5 + 351.5x$. The regression coefficient indicates that increase of one percent net irrigated area causes for increase of average per hectare yield of villages by 351.5 kgs.

The Problem of Draught, Soil ersion, Problem Regarding Mechanization/ Equipment, Labour Problem, Lack of Irrigation, Problem of Indebtedness, Increasing

Prices of Chemical Fertilizer , Soil Erosion , Poor Economic Condition of Farmer , Problem of Load Shading, Ignorance About Soil And Water Testing, Low And Uncertain Prices of agricultural Commodity, Problem of Capital , decline of water table and less use of vermiculture are the major problems in selected villages.

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CHAPTER-VI

CONCLUSIONS AND SUGGESTIONS

In the previous chapters we analysed the physical, non-physical determinants, general and agricultural land use and impact of irrigation on agricultural productivity of Osmanabad district as a study region during 1999-00 to 2013-14. This study seeks to identify, classify, describe and analyze the problems of agricultural landscape. From the preceding analysis, the following findings have been drawn.

1. The Balaghat range is prominent physical feature in the study area. The high proportion of hilly area in Bhum and Tuljapur tahsils and northern bounding scrap of Balaghat range are not favorable for better agricultural productivity but favorable for fruit crops such as pomegranate, custard apple and mango fruits by using modern techniques. The plateau and plain area occupy 88.65 percent of the total area of district with good cultivated areas offer scope to increase in per hectare yield of crops in the district. Hot and dry climate except some months of rainy season has its peculiar features which influence crop growth in the study area. The Osmanabad districts falls under the rain shadow of Sahyadri Mountains and therefore the beginning and end of the rainy season is quite uncertain and scanty, which affects on cereal production. It also puts limitation to the quantity of surface as well as groundwater in the region. The region therefore has the problem of inadequate water which adversely affects on agricultural productivity. Almost all tahsils of study area have above 28 per cent of rainfall variability which indicates that there is a dire need to develop irrigation facilities for better agricultural output.

2. The district is drained by Manjra, Sina, Terna, Bori, Benitura and Banganga rivers which are fordable throughout the year except rainy season. Fertility of soils in these river basins is high, so that the agricultural productivity is also high in these regions. The district has high proportion of shallow soils and medium deep soil collectively. These soils offer scope for good productivity, if perennial water supply is available. The deep to very deep soils have moisture retaining capacity, which gives better yield of Jowar, Wheat, Gram, Sugarcane, Soybean and Tur crops. The potash content is high in each tahsil of Osmanabad district which states that the soil of the district offers good future for fruit farming. The phosphorus content

is low in the study area; so that there is dire need to improve the soil fertility using artificial doses for better productivity. The high balance of ground water in Washi, Kalam and Lohara tahsils indicates that there is high scope for digging wells for better agricultural production. The Decline of water table is a burning problem of Osmanabad district with increasing population and development of water lifting technology, and it has become a barrier in the development of agriculture.

3. The high growth rate of population in Osmanabad tehsil is a result of district headquarter and agricultural as well as industrial development, however it is high in Bhum tahsil mainly due to the Dairy farming. The high Crude density is found in Osmanabad tahsil because district head quarter is located in this tahsil which leads secondary and tertiary activities resulted into high urbanization. The high agricultural and caloric density in Osmanabad, Kalam and Omerga Tahsil is mainly due to the lower development of mechanical implements of agriculture. The high co-efficient of overpopulation in the Osmanbad, Lohara and Omerga indicates high pressure of population on agricultural land. This increasing pressure of population, decreases in net sown area and increase in literacy, has brought change in cropping pattern.

4. Irrigation facilities are highly inadequate in Osmanabad district. Irrigation is somewhat better developed in those tehsils where agricultural productivity is also high. The study region is benefited by three major irrigation projects. The Manjara, Lower Terna and Sina-Bhima Joint Canal Irrigation Projects play a very important role in the development of agriculture as well as productivity. The high irrigation potential of these projects offers scope to increase agricultural productivity of Kalam, Lohara, Omerga and Paranda Tehsils. The high concentration of medium projects in Bhum and Tuljapur tahsil is mainly due to favorable physiography. Most of the minor irrigation schemes become dry in summer season mainly due to the rate and distribution of the monsoon rainfall. The high density of percolation tanks in Tuljapur, Bhum and Paranda tahsil offers groundwater recharge. Evidences show that Osmanabad district as a whole has only 4.65 percent surface irrigated area to net sown area, states that there is dire need to develop surface irrigation facility for better agricultural productivity. The high surface irrigated area to net sown area in Paranda tahsil is a result of Sina-Kolegaon Joint Canal.

The high density of irrigation wells in Kalam, Paranda and Osmanabad tahsils is result of physiography and geology. The district as a whole has 5.12 percent positive change in percentage of well irrigated area is mainly due to the lower development of surface irrigation. The high well irrigated area and remarkable increase in Tuljapur and Paranda tahsils is mainly due to the recharge from surface irrigation. The negative change in well irrigated area in Kalam, Bhum, washi and Lohara tahsil is a result of scarcity of rainfall and lowing of ground water. The high intensity of irrigation in Paranda and Omerga tahsils is mainly due to Sina-Kolegaon Joint Canal Project and Lower Terna Project at Makhni respectively.

5. With the availability of iron ploughs, the density of wooden ploughs is decreased in almost all tahsils. The considerable decrease in oil engine in all over the region is due to increase in electric pumps at greater level. The density of bullock carts decreased in all over the study region with an increase in number of tractors. The high density of tractors in Paranda, Tuljapur and Osmanabad tahsils states the association of tractor with irrigated areas. The low percentage of agricultural labors in Paranda, Kalam and Osmanabad tahsils indicates high use of mechanical implements mainly due to the development of surface irrigation facilities. The high increase in density of Buffaloes in Osmanabad, Omerga and Tuljapur is due to the development of surface irrigation and high urbanization. The high proportion of Catteles in Bhum, Washi and Kalam tahsils is mainly due to the growth of dairy industry. The number of agricultural societies is high in the Eastern part of region, which is mostly irrigated area. The lower number of regulated markets in the study area indicates that there is a need to increase number of regulated markets. The low length of state highway in Washi, Omerga, Paranda, Bhum and Lohara tahsil is a result of adverse physiographic condition. Almost all tahsils are deprived from railway transportation except Osmanabad tahsil, which adversely affects agricultural marketing.

6. The land use pattern shows that there is considerable cultivable land in the Osmanabad district due to high percentage of plateaus and plains. The low proportion of area under forest in the Osmanabad district is result of frequency of droughts and cutting of trees for different purposes due poverty of farmers. The

high other uncultivable land in Tuljapur tahsil is because of hilly area of Balaghat range leads to permanent pastures. The negative change in other uncultivable land in Kalam, Tuljapur and Omerga tahsils is mainly due to the availability of irrigation facilities. Farmers brought this land under cultivation. The high proportion of current fallow land in Bhum, Washi, Omerga and Tuljapur tahsils is because of draught conditions in recent years and poor irrigation facilities. The high proportion of net sown area in Kalam and Osmanabad tahsil is a result of major and medium irrigation project. While in Washi and Tuljaur Tahsil it is low due to the adverse physiography. The high positive change in net sown area in Kalam Tahsil is because of other uncultivable land is brought under cultivation with the growth of population and development of irrigation. The high negative correlation between fallow land and net sown area in all most all tahsil except Tuljapur and decrease in net sown area in Washi and Lohara indicates that the net sown area has been converted into fallow land due to inadequate and unpredictable rainfall and lack of irrigation facilities. The high negative correlation between area not available for cultivation and other uncultivated land i.e. -0.69 and increase in area not available for cultivation indicates that other uncultivable land is converted into area not available for cultivation during the period of investigation.

7. The agricultural land use indicates that there is a dominance of food crops in the study region. The Jowar, Wheat, Maize, are dominant cereals in cropping pattern, while Bajara and other cereals are insignificant in the cropping pattern of the region. Sugarcane and Fruit & Vegetables is important cash crop of study region because of favorable climate and fertile soils in the Sina and Manjra river basins. Soybean and Safflower are the two important non-food crops occupying significant position in the cropping pattern of study region. Crop combination analysis reveals that as per Rafiulla's method Jowar crop is the monoculture crop in the seven tahsils of the Osmanabad district i.e. Bhum, Washi, Kalam, Osmanabad, Tuljapur, Lohara and Omerga due to the regur soil and drought resistance nature of Jowar. The change in crop combination region based on maximum deviation method is recorded in five tahsils, i.e. Bhum, Washi, Kalam, Osmanabad and Lohara tahsils and it is two crops to one crop.

8. There is positive correlation between net irrigated area and per hectare yield of selected crops. The high positive correlation is found in case of Sugarcane, Gram and Wheat, the coefficient of correlation in this regard is + 0.837, + 0.794 and + 0.700 respectively.. The coefficient of determination reveals that the independent variable (X) i.e. net irrigated area are explaining 83.70 , 79.40 and 70.00 per cent of the total variations in dependant variable (Y) i.e. average per hectare yield of Sugarcane, Gram and Wheat respectively. The analysis of impact of irrigation on average agricultural productivity shows that there is high positive correlation between net irrigated area to net sown area and per hectare yield of selected crops in the study region i.e. + 0.82821. The degree of linear association between these two variable reveals that the independent variable (X) i.e. net irrigated area is explaining 68.59 per cent of the total variations in dependant variable (Y) i.e. average per hectare yield of selected crops in tahsils of Osmanabad District. The regression coefficient indicates that increase of one percent net irrigated area causes for increase of 56.90 kgs. average per hectare yield of selected crops in tehsils of Osmanabad District.

9. The analysis of variation in productivity and productions reveals that uncertain and erratic nature of Monsoon as well as inadequate irrigation facilities. The coefficient of variation in per hectare yield of selected crops shows that the high degree of variability is found in case of Groundnut and Bajra crops, because most of irrigated area is devoted to other cash crops such as Soybean and Sugarcane. The low degree of variability in production is recorded in case of Gram, Tur, Jowar and Sugarcane. As per Jasbir Singh's method the high level of overall productivity is found in Paranda, Lohara and Kalam tehsils, due to high development of surface irrigation facilities and fertile soil. The moderate overall productivity is recorded in Osmanabad and Omerga tehsils, while it is low in Washi, Bhum and Tuljapur tehsils. As per Bhatia's method the high productivity is observed in the Western, Northern and South eastern part of the study region which comprises Paranda, Kalam and Lohara tehsils these tehsil, due to fertile soil in Sina, Manjara and Terna river basin and these tehsils are benefited by surface irrigation facilities i.e. Sina-Kolegaon Joint canal, Manjara and Lower Terna Irrigation Projects respectively. As per Shafi's method high prductivity is confined in Western, Central part and South Western part of the district, which

constist of Paranda, Osmanabad and Tuljapur tehsils. These tehsils having high overall yield index in relation to other tehsils, because of development of surface irrigation facilities and high development of technological factrors. The composite index of overall productivity indicates that high level of agricultural productivity is observed only in Paranda tehsil, due to fertile soil, development of irrigation facility and other technological factors. This tehsil covers 11.15 percent of total geographical area of the study region and shares 11.50 per cent of net sown area. The low aggregate productivity is found in Bhum, Washi and Omerga tehsils. These tehsils covers 31.77 percent of total geographical area of the district and share 31.52 per cent of net sown area, it is low in Washi tehsil, due to the inadequate, rainfall.

10. The case study reveals that the physiography and soils offer good prospectus for agriculture development in the selected villages of Osmanabad district. But uncertain and erratic nature of rainfall is the main constraint in agricultural production of selected villages in the study region especially in villages' lies in western and northern part of the study region. The high well irrigated area in Palsap, Chincholi, Antargaon, Terkheda, Chinchpur (D), Loni, Upla(M), Washi, Walwad, Indapur, Jagji, and Dhanori villages compel farmer to cultivate seasonal crops as these are deprived from surface irrigation facilities, which resulted into ups and down in production and per hectare yield. Case study reveals that 92.5 per cent of villages have less than 26 percent net irrigated area indicates great need of expansion of irrigation facility. As compare to other villages, share of surface irrigated is high in the villages of Shirala, Andur, Jakekur, Warewadgaon and Manmodi, which offers better productivity. The case study reveals that the agricultural productivity is highly related to nature and expansion of irrigation and other technical inputs. The high per hectares yield of Jowar is observed in Shirala, Manmodi, Andur, Warewadgaon, Kaudgaon, Jakekur, Naigaon and Palsap villages due to favorable climatic conditions, suitable soil and development of irrigation facilities. The high per hectare yield of Wheat is observed in Shirala, Manmodi, Andur, Jakekur and Warewadgaon villages i.e. above 1400 kgs, due to the development of irrigation facilities and high rainfall. The high per hectare yield of Tur is observed in Shirala, Kaudgaon, Manmodi, Andur, Jakekur, Warewadgaon, Palsap and Naigaon villages, due to favorable soil and climatic

conditions. The high per hectare yield of Groundnut is noticed in Shirala, Manmodi, Andur, Warewadgaon, Jakekur and Naigaon villages i.e. above 1000 kgs, due to the development of irrigation facilities and high rainfall. The high per hectare yield of Soybean is noticed in Naigaon, Manmodi, Shirala, Andur, Nipani, Jakekur, Kaudgaon, Warewadgaon, Hasegaon Kej, Palsap and Andora villages i.e. above 925 kgs. Because of favorable soils, suitable climate and assures rainfall in these villages. The low horticultural productivity in Loni, Washi, Indapur, Dindori, Naigaon, Nipani, Upla, Terkheda, Hasegaon (Kej) and Andora villages is a result of lack of unsuitable soils, irrigation facilities and lower development of technological development.

14. The very high positive correlation between net irrigated area and average per hectare yield of selected horticultural crops is observed in selected villages. The degree of linear association between these two variables (r^2) is explaining that 86.67 per cent of variation in 'Y' average per hectare yield of selected crops in selected villages to be influenced by the variable 'X' i.e. net irrigated area. The regression coefficient indicates that the increase of one percent net irrigated area causes for increase of average per hectare yield of villages by 351.5 kgs. A per Kendall's Ranking Co-efficient method, the high agricultural productivity is found in Shirala, Manmodi, Andur, Warewadgaon, Jakekur and Naigaon. In Shirala, Manmodi, Andur, Jakekur and Warewadgaon it is high due to the development of surface irrigation facility i.e. canal and lift irrigation facilities, whereas it is high in Naigaon due to the development of both well and borewell irrigation. The low agricultural productivity is found in Washi, Dhanori, Pachpimpla, Loni, Upla, Indapur, Walwad, Hasegaon Kej, Andora and Jagji villages due to lack of irrigation facilities and lower technological development.

15. The Problem of Draught, Soil erosion, Problem lower Mechanization, Labour Problem, Lack of Irrigation, Problem of Indebtedness, Increasing Prices of Chemical Fertilizer, Soil Erosion, Poor Economic Condition of Farmer, Problem of Load Shedding, Ignorance about Soil And Water Testing, Low And Uncertain Prices of horticultural Commodity, Problem of Capital, decline of water table and less use of vermiculture are the major problems in selected villages.

SUGGESTION

1. To overcome the problem of drought, it is suggested that the awareness should be made among farmers about use of micro irrigation such as drip, zirpi or sprinklers and mulching. The knowledge about drought resistance seeds and plants should be given to the farmers and promote them to use it in the study area. To recharge ground water, the government should provide funds to the farmers and make it compulsory.

2. Problem of soil erosion is found all over the study region which restricts agricultural productivity. Soil conservation practices are important in reducing soil erosion. Improving the soil infiltration rate, resulting in less surface runoff, can lead to reduction of soil erosion. The most effective way to control erosion to maintain a permanent surface covers on the soil surface, such as pasture meadow. Management of new plantation is another way of controlling soil erosion by intercepting raindrops, thereby reducing surface runoff and protecting soil surface runoff and protecting soil surface particle detachment by raindrop impact.

3. Lack of surface irrigation is main barrier in the agricultural development, therefore it is suggested to increase minor irrigation projects, Kolhapur Types Wears as far as possible and to complete uncompleted irrigation projects.

4. To overcome the problem of poor economic conditions of farmers, it is suggested to make awareness among the farmers to do allied activities like dairy, poultry and goat raring furthermore and for that to organize workshop for farmers to produce quality production which have export potential. Government should promote horticulture based industry such as Vinery, Juice and Jam.

5. To overcome the problem of indebtedness government should restrict the rate of interest of private money lender and compel banks to sanction loans to the farmers.

6. The poor economic status of farmers is main reason for less mechanization. Therefore it is suggested to make awareness among the farmers about to purchase mechanical equipment on the co-operative basis at Grampanchayat level. Labour problem is a serious problem in the study area, to overcome this problem it is suggested that farmers should be shifted towards farm mechanization.

7. To overcome the problem of load shedding, it is suggested that government should provide electric pumps those run on solar and wind energy to the farmers and sanction subsidy to the farmers to purchase them.
8. Most of the farmers ignore soil and water testing in their farm. Therefore it is suggested to make awareness among the farmers about soil and water testing. The government scheme like Soil Health Card (SHC) should be implemented properly. The agricultural clinic and labs should be established in rural areas.
9. The district as whole has 41685 hectares other uncultivable land which consists of culturable waste and barren land with rich in potash content and useful for fruit crops. So effort should be made to plant pomegranate as rainfed because pomegranate is drought resistance plant.
10. To overcome the problem of increasing prices of chemical fertilizers and pesticides, it is suggested that government should restrict prices and make awareness about organic farming. Organic farming reduces the unnecessary usage of chemical fertilizers and pesticides. It helps to retain fertility of land for a long time and reduces costs in the long run.
11. Per hectare yield is restricted due to the appearance of different insects and pests. Therefore it is suggested to make awareness among the farmers about integrated pest management practices. It is also useful to reduce air water and soil pollution.
12. None of the tehsils of Osmanabad district has more than 2 per cent area under forest and most of the tehsils have very negligible area under forest. So it is suggested that afforestation should be done by public and private sector, which is better for increasing ground water level and soil conservation which in turn will be useful for better agricultural productivity.
13. Almost all farmers told the problem of decrease of prices of agricultural commodities during harvesting season. Therefore, it is suggested that government should declare minimum fixed prices of agricultural commodity.
15. Research efforts should be continued for the production of cost with higher yield potential and better resistance to pest. Technological advancement in agriculture should be passed down to the smaller farmers. To enhance agricultural production, it is suggested tot make awareness among the farmers regarding government schemes such as Kissan Call Center (KCC), Kissan SMS Portal (KSP), Village Knowledge Center (VKC and Village Resource Center (VRC).

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APPENDIX I

"IMPACT OF IRRIGATION ON AGRICULTURAL PRODUCTIVITY OF OSMANABAD DISTRICT: A GEOGRAPHICAL ANALYSIS"

SCHEDULE FOR FARMERS

1. General Information of the Farmer

1. Name:_____

2. Age: _____ 3. Education: _____

4: Tahsil: _____ 5. Village:_____

6: Occupation: a) Main: _____b) Subsidiary: _____

2. Information about Family Members

Sr.no	Name of family number	Male	Female	Age	Education	Occupation
1						
2						
3						
4						
5						
6						
7						
8						

3. Soil Types:

Types	Deep black	Medium	Shallow	Total
Area				

4. Land Utilization:

Total Geographical area	Area not available for cultivation	Fallow land	Net sown area

5. Source of Irrigation Irrigated Area And Non Irrigated Area:

Source of irrigation	Irrigated			Total Irrigated	Non irrigated
	Drip	Sprinkler	Flood		
Well					
Canal					
Lift irrigation					
Any other					

6. Cropping Pattern & Production

Crops	**Area under crops**		**Production**		**Total Area**	**Total Production**
	Irrigated	**Non-irrigated**	**Irrigated**	**Non-Irrigated**		

7. Impements and Machinary

Category	**Number**	**Category**	**Number**
i. Iron plough		i.Bullock carts	
ii. Wooden plough		ii.Tractors	
iii.Harrow		iii. JCB	
iv. Hoe		iv. Power Tiller	
i.Oil engine		v. Harvester	
ii.Electric moter		vi. Any other	
iii.Spray sets			

8. Have you test Soil & water? Yes/No.

9. Are you taking opinion of Agricultural officers for better productivity?

Yes/No.

10. Have you visited to Agricultural University? Yes/No.

If yes, how many times?

11. Are you obtaining information from periodicals, magazines, newspaper, radio, Television? Yes/No.

If yes, how many times?

12. Are you involved in agricultural tour? Yes/No.

If yes, how many times?

13. Problems faced by the Farmers:

_____

_____

_____

_____

_____

_____

Signature/Thumb of Interviewer with name.

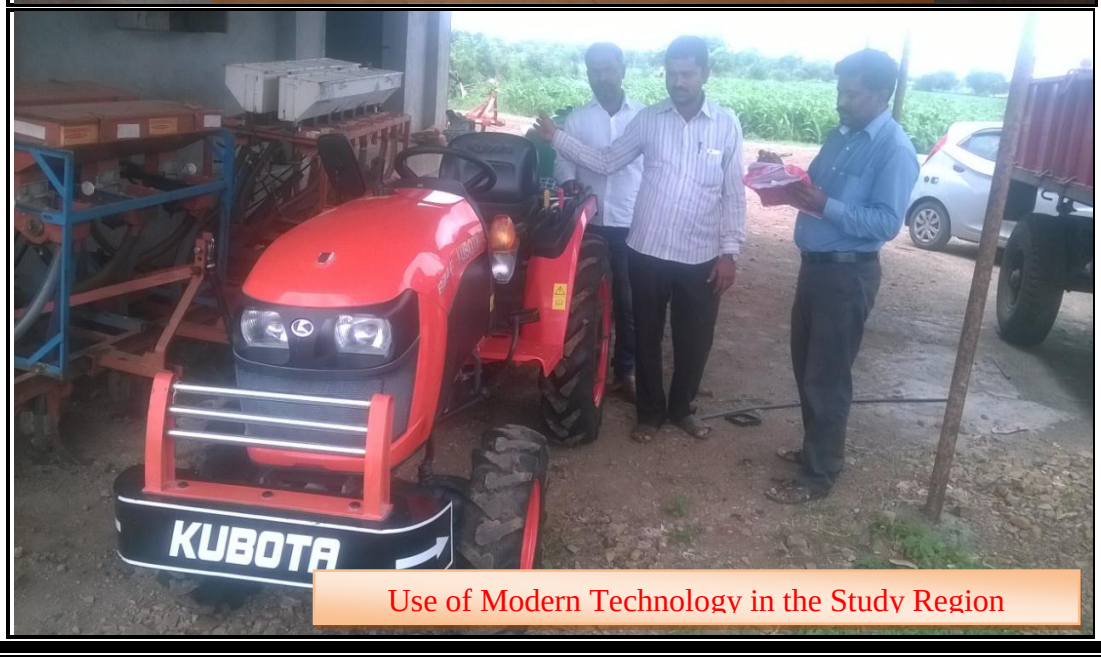
MANJARA IRRIGATION PROJECT

Interview of Farmers at Village Loni Ta.

Jowar Cultivation- Monocrop in the Study

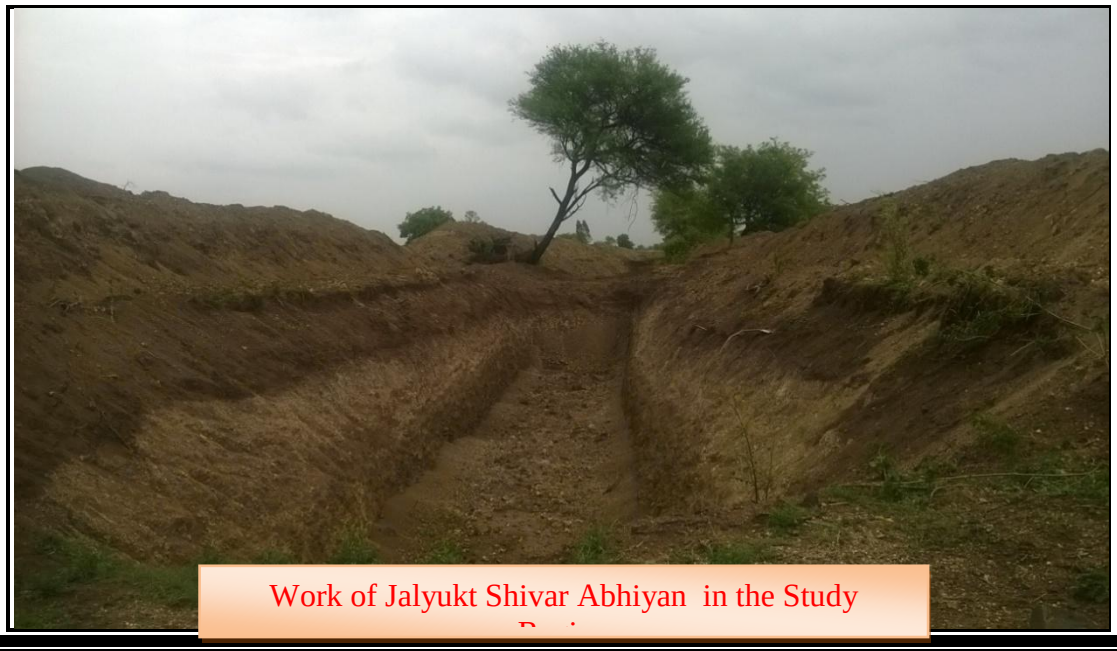
Declining Water Table in the Study Region

Discussion with Farmers at Village Panch Pimpala



Use of Modern Technology in the Study Region

Gram Cultivation- As a Rubi Crop in the Study



Work of Jalyukt Shivar Abhiyan in the Study

MaizeCultivation- for Dairy Farming in the

Kolhapur Type Bandhara on Terna River

Interview of Grape Cultivator at Manmodi