TRENDS IN AGRICULTURAL PRODUCTION AND PRODUCTIVITY OF DRYLAND OF SATARA DISTRICT

(Study Period 2001 to 2013)

A DISSERTATION PRESENTED BY

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UNDER THE GUIDANCE OF

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M.A.,Ph.D., SET, G.D.C.&.A.

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF

MASTER OF PHILOSOPHY

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TO

TILAK MAHARASHTRA VIDYAPEETH, PUNE

Appendix-III

Form 'A'

DECLARATION BY STUDENT

I hereby declare that the dissertation entitled "TRENDS IN AGRICULTURAL PRODUCTION AND PRODUCTIVITY OF DRYLAND OF SATARA DISTRICT" (Study Period 200102 to 2012-13) completed and written by me has not previously formed the basis for the award of any Degree or other similar title upon me of this or any other Vidyapeeth or examining body.

Place: Pune Research Student

Date:

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FORM 'BC'

C E R T I F I C A T E

This is to certify that the dissertation entitled "TRENDS IN AGRICULTURAL PRODUCTION AND PRODUCTIVITY OF DRYLAND OF SATARA DISTRICT" (Study Period 2001-02 to 2012-13) which is being submitted for the award of the Master of Philosophy (M.Phil.) in Economics of Tilak Maharashtra Vidyapeeth, Pune is the result of original research work completed by **Ghadge Ankush Krishnarao** (PRN- 0221343400393) under my supervision and guidance. To the best of my knowledge and belief the work incorporated in this dissertation has not formed the basis for the award of any Degree or similar title of this or any other University or examining body upon him.

Place: Satara
Date:

Research Guide

Dr. A. K. Wavare

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Mr. A.K. Ghadge

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LIST OF ABBREVIATIONS

Sr.No.	Abbreviation	Full form
1	ha	Hector
2	mm	Mili Meter
3	A	Area
4	Y	Yield (Productivity)
5	P	Production in Tonnes
6	Kg	Kilo grams
7	NSDP	National Domestic Product
8	SDP	State Domestic Product
9	ICAR	Indian Council of Agriculture Research
10	AIIDA	All India Institute of Dryland Agriculture
11	ICRISAT	International Crop Research Institute for Semi- Arid Tropic
12	CRIDA	Central Research Institute for Dryland Agriculture

1. INTRODUCTION

Agriculture and its allied sectors are the arts and science of growing plants, crops, rising of animals, and human needs. There are various scientific and practical definitions of agriculture. Agricultural activities are divided into two main parts one is crop production and other is animal or livestock production. It is human needs for growing plants and animals. Agriculture includes various branches like Cultivation, Growing and Harvesting of any agricultural and horticultural commodities, rising of livestock, rising of poultry etc.

The main and important purpose of agricultural activity of men is producing food and other needs such as clothing, medicines, shelter, tools, ornaments and many more. Now, agricultural activity practiced as a business for economic gain. Since, population increases by geometric process and requirements or needy thinks for that population are increases by algebraic process.

All agricultural activities are based on various parameters, but most weighted parameters are Water availability, Soil pattern, Land Utilization and Crop pattern. All over the world agriculture is divided in two parts i) Irrigated agriculture and ii) Dryland agriculture.

To know the status of agricultural field, government of India has been conducting “Agriculture Census” in India since 1970-71. Agriculture census gives information of Indian agriculture which continues to be the main stay of the Indian Economy. The total area of India is 297 million ha. It is 2.3 percent of the total world land area. However, India has 158.7

million ha of arable land which is 11.2 percent of the total cultivable land in the entire world. India is one of the leading producers of important agricultural crops like rice, pulses, wheat, oilseeds, sugar, tea, rice etc. Agriculture sector of India plays an important role as a source of income and employment. The major export items of India are tea, coffee, rice, sugar, wheat, cotton, tobacco, oil meals, fruits, marine products and meat. All these things are from agriculture and its allied sectors.

The data collected by agriculture census is about operational holding. The ninth census has been conducted in year 2010-2011. According to the ninth census the total number of operational holdings in the country is about 138.35 million. Average size of operational holdings has been steadily declining in the country in successive censuses. The average operated size of holding which was 1.23 ha in 2005-06 has declined to 1.15 ha in 2010-11 at all India level.

A National Commission on Agriculture in 1976 predicted that even when the full irrigation potential is tapped by 2013, over 50% of arable land would continue to remain under dryland agriculture in the future. These figures show the importance of dryland agriculture. Because of dryland agriculture supports 40% population of India.

Growth in the agricultural production is depends on acreage / ha and yield of the major crops, India stood far away as compare to the world's most agriculture productivity countries. Table No 1.1 shows the average productivity in major crops of India in the year 2010-11.

Table No. 1.1

Agriculture productivity in India against world's most productivity countries

Sr.No.	Product	Average Productivity, India (2010)	World's most productive farms (2010)	
		Tonnes per ha	Tonnes per ha	Country
1	Rice	3.3	10.8	Australia
2	Wheat	2.8	8.9	Pakistan
3	Mangoes	6.3	40.6	Israel
4	Sugarcane	66	125	Peru
5	Cotton	1.6	4.6	Israel
6	Vegetables	13.4	76.8	USA
7	Potatoes	19.9	44.3	USA
8	Tomatoes	19.3	524.9	Belgium
9	Soyabean	1.1	3.7	Turkey
10	Onions	16.6	67.3	Ireland

Source: Agriculture Census of India.

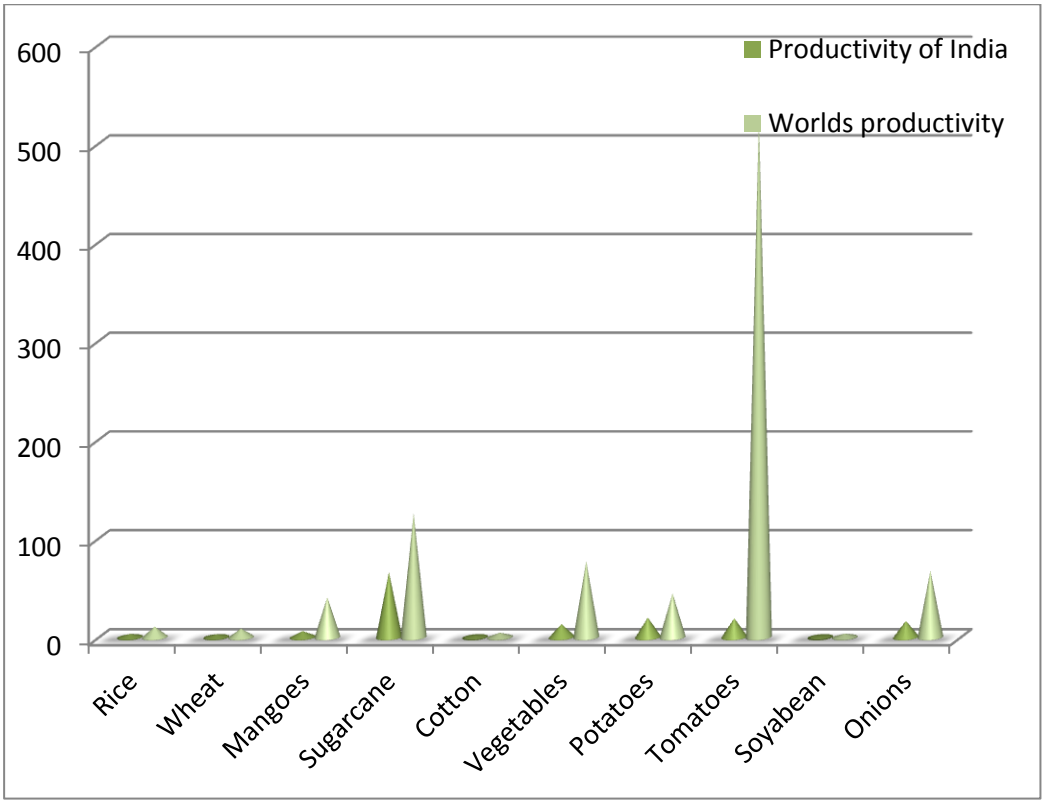
From the Table No. 1.1, it can be shown that average productivity in the major crops is very low as compare to world's most agricultural productivity. The average productivity of India in almost all crops is far away from the world's productivity figures. However no any country shows high productivity in more than two crops. Due to the atmospheres,

land pattern, water availability and many other reasons are affected in productivity of the crops.

In India there are two-third land is under rainfed or dry zone area. This is one more reason for the productivity showing low. Here question is how we can change this distribution and improve the productivity?

Figure No. : 1.1

Agriculture productivity in India against world's most productivity countries (in tonnes)



Source-: Agriculture census of India

In terms of population Maharashtra state is second largest state in India and third in respect of area. Maharashtra is one of the industrialized states in India. The state contributes about 13 percent of the national income and per capita state income (30.7%) is higher than the national income

(27.5%). Maharashtra had second position in State Domestic Product (SDP). Agriculture is the major source of income for the most of the population,. As per the population census 2001, 55.41 percent population was depend on agriculture for livelihood and as per census 2011, it is 60 percent population is depend on agriculture.

Agricultural production growth is the most important determinant of rural poverty and therefor agricultural productivity growth has a positive impact on reducing poverty. During the last four decades, the population growth is 2.67 percent per annum and it is higher than agriculture growth (0.67 percent per annum). The slow crop output growth is due to low productivity of different crops in the state as compared to the national average. Low productivity of crops pulls down the overall growth rate of agriculture production in Maharashtra. Improvement in growth performance of the agriculture and allied sectors would be the most important factor for reducing rural poverty.

According to the economically, the contribution in production in different commodities, Maharashtra has better position in India. Maharashtra is one of the industrialized and most developed state in India. However, agriculture and its allied activities are steel predominant, instability and irrelevant in crop production.

The table below presents average farm productivity in India over three farming years for some crops. Improving road and power generation infrastructure, knowledge gains and reforms has allowed India to increase farm productivity between 40% to 500 % over, 40 years. India's recent

accomplishments in crop yields while being impressive, are still just 30% to 60% of the best crop yields achievable in the farms of developed as well as other developing countries. Additionally, despite these gains in farm productivity, losses after harvest due to poor infrastructure and unorganized retail cause India to experience some of the highest food losses in the world.

Table No. 1.2

Agriculture productivity in India, growth in average yields in kg/ha (Sugarcane in Tonnes) from 1970 to 2010.

Crop	Average YIELD, 1970-1971	Average YIELD, 1990-1991	Average YIELD, 2010–2011
Rice	1123	1740	2240
Wheat	1307	2281	2938
Pulses	524	578	689
Oilseeds	579	771	1325
Sugarcane	48322	65395	68596
Tea	1182	1652	1669
Cotton	106	225	510

Source: Various Issues of Agricultural Statistics at a Glance

Agricultural production in each and every crop is depends on Rainfall, Land pattern, Soil Pattern, Cropping Pattern, Water Management. Geographically, Maharashtra has four regions. These four regions are Konkan, Western Maharashtra, Vidharbha and Marathawada. Western

Maharashtra and Marathawada are falls on the plateau. Out of these two regions rainfall in Western Maharashtra is low and highly unstable. Satara district is situated in the Western Maharashtra.

As concern to the agricultural development Satara district is one of the important district. It has typical landscapes due to relief, climate and vegetation. There is wide agro-climatic variation shows in Satara district. According to the rainfall, soil, climate Satara district is divided into two zones namely Western zone and Eastern zone. Western zone is rainy and Eastern zone is dry zone. Total eleven tehsils are divided in these two zones. In Eastern zone there are seven tehsils and in Eastern zone there are four tehsils situated according to the rainy and dry zone respectively. Tehsil Khatav, Man , Phaltan and Khandala are situated in dry zone of Satara district.

Dryland Agriculture:

The cultivation of crops without irrigation is called dry farming. Dryland farming is depends upon storage of the moisture in the soil and types of the crops. The crops Bajara, Jowar, Gram , Pulses, Oil Seeds etc. cultivated growing in dryland because of shortage of moisture and drought resistant crops. The types of soils in dryland area are low in fertility.

Satara district has wide agro-climatic variation due to its size and topography. The cultivated area of district is divided in plain and plateaus. The developments of tehsils are taken with their respective categories such as high, medium and low. In the present study focus has been given to the

indicate agriculture production and productivity in dry zone tehsil of Satara district.

Dryland agriculture is depending on uncertain with monsoon and soil variety. Rainfall is a prime important factor considered by influences the agricultural economy of the region. Monsoon is more or less regular in its cycle of onset, spread and withdrawal over the country. The rain water availability in different monsoon periods indicates major contribution from the southwest monsoon (74%) as compared to northeast monsoon (10%) . Most future scenarios indicate that there may not be a significant change in the total rainfall. The challenge is to harvest the monsoon rains during excess rain and re-use efficiently during dry spells for improving the yield and income per drop of rainwater.

The most fascinating feature of the country's agricultural scenario is represented by the dryland farming which covers about 70 percent of the total cropped area of 143 million hectares. This land alone accounts for about 40 percent of the food grains output. Almost all the coarse like Jowar, Bajara, Ragi and other millets are grown in the rainfed land and 75 percent of pulses and oil seed come from the dryland agriculture.

Looking to the future projection of developing span of dryland agriculture in the country in the recent past the Indian Council of the Agriculture Research (ICAR) has extended its plan to provide a full scale program of national level 'All India Institute of Dryland Agriculture (AIIDA)', Central Arid Zone Research Institute (CAZRI) and International Crop Research Institute for Semi-Arid Tropic (ICRISAT) are come

forward to technological know-how and National Bank for Development Rural Development (NABARD) has volunteered to provide funds for it besides the Central Research Institute for Dryland Agriculture (CRIDA) has special responsibility of the development of dryland farming in the country. With the national perspective of dryland farming states have been asked to locate the potential area of dry farming wherever conditions are suitable in the country the Semi And Topics (SAT) of the India may be look upon future potential breeding ground for the dry farming and associated enterprises.

The point may well be considered from the fact that dryland farming have been identified from the obsoletely arid and semi-arid conditions with an average rainfall of 750 mm or area of assured rainfall of 1125 mm, on this bases about 25 districts with net are sown of about 80 million have been located very high intensing of farming. These areas receive between 375mm to 750 mm and have less than one million hectares of irrigation facilities that means about 75 percent of land is unirrigated.

In fact and region are characteristic by harsh environment for plant growth particularly for erratic and uncertain rainfall high solar incident ,high wind velocity and wind sorted in fertility sandy soil leading to frequent drought,. This problem future aggravated by a water tube and occurrence of saline ground water infertile soils.

Agricultural productivity of is becoming important issue. India is world's most populous country has taken steps in the past three to four decades to increase its land productivity. Production and Productivity in

agriculture and its allied sector is now increases rapidly it is due positively efforts of farmers. Agriculture and its allied activities constitute the single largest contribution in the Gross Domestic Product (GDP). Various attempts have been made for the growth in agricultural output in terms of area and yield components.

About 70 percent of the total cultivated area in the country is dryland or rainfed area. The contribution of food grains of total production is about 42 percent. The dryland areas suffer due to frequent whether aberration resulting in crop failure. There are high risks of cultivation in dryland because of crop failure. The farmers in dryland area were unable to make high investment in their land for improvement.

The problems are arises when we look at the production side. There is need to find the trend of agricultural production and what are the effects take role in the agriculture production and productivity?

The present study is taken on the account of trends of agricultural production and productivity of various crops of dryland of Satara district.

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Chapter-2

Review of Literature

Introduction:

Now a days Indian Economy has making fastest growing in the world. The rate of GDP is increased from 5 percent (1999-2000) to more than 7 percent (2003 -2007). India's agricultural economy has performed erratically during the past three to four decades. It indicates that development of Indian economy is largely depends on the performance of its agriculture. There is need to study about agricultural development. There have been a large number of studies examining the growth and trends of agricultural and its allied sector. Many researchers have focus towards evaluating at the micro and macro level. Following are the some selected studies are reviewed.

There are number of studies on measurement of growth in area, production and productivity of crop at state level as well as national level by taking different time period.

Achrya (1973) : Acharya discussing importance of green revolution in Maharashtra ,where improved water management needed before yields can be increased as less than 10 percent of total cropped.

Patil and Jha (1979) : They studied the district wise output growth and technological change in Maharashtra agriculture in year 1951-52 to 1971-72. In fourteen district total factor productivity growth rates were positive and it is lise between 0.85 to 5.92 percent per annum. In 23 districts of Maharashtra shows growth rate decreased by 9, during the sub period of 1960-61 to 1971-72.

Kanwar J.S. (1982) , Rainwater and Dryland Agriculture : In this article authors suggested importance of rain water in dryland agriculture. Most of the agriculture area of India is depend on rain water. They also suggest about how to increase moisture storage in the soil, optimum use of this moisture through efficient cropping. According to some estimates out of 370 million ha meters of rain water which falls on 329 million ha of land in 2 to 5 months in a year, 170 million ha meters runs off in rivers and streams and hardly 80 million ha meters seems to be entering the soil system.

Kanwar gives comments to a few basic aspects which are:

1) Develop a small watershed for life saving irrigation.
2) Constructions of new tanks and farm ponds.
3) Making cheaper sources of energy of devices available for lifting water for "lifesaving" irrigation is critical to the practical success of runoff collection and use system.
4) Technology with higher payoffs and better incentives for increasing production and facilities for marketing of produce must be available.
5) Development of water resources in dryland areas should be considered as a long term investment for stabilization of agriculture and for catalyzing a highly productive farming system.

   These basic ideas are given by Kanwar for improvement the dry land agriculture production.

Dev (1987) : In his study , he reported a progressive but marginal decline in instability in food grain production in the all India level and mixed results at state level.

Bhalla and Tyagi (1989): They estimate the growth in agricultural output in the country by taking 19 major crops. Author noted that with adoption of new seed fertilizer technology, agriculture in major part of India has undergone a significant transformation. Drought is the main reason for deceleration in appears investment in infrastructure like irrigation. Author studied about the fluctuations in agricultural output continue to be very large in Maharashtra, Madhy Pradesh and Rajasthan. At last they suggest that large investments will be required to increase irrigated area as also to undertake watershed management.

Mitra (1990) : Mitra examined growth and instability of agricultural production in Maharashtra for the period 1956-57 to 1984-85. Author observed that the annual compound rate of growth of agricultural production in the state as well as in the entire region especially that of food grains was relatively higher. The rate of growth in production of food grains is around two percent per annum.

Uriel Safriel, Zafar Adeel (1992) , Dryland System Chapter Number 22: This chapter describes the current condition of dryland system with respect to the service they provide and the drivers that determine trends in their provision. The chapter also explore options for the sustainable use of drylands and points to human and societal responses that have succeeded or failed. This chapter explores land degradation in all global drylands including the hyper arid areas.

Sawant and Achutan (1995) : They studied agricultural growth performance in India during 1967-68 to 1992-93 argues that there has been a significant rise in the

production and productivity growth in Indian agriculture which cannot be attributed merely to a favorable weather growth in production.

Dev (1996) : He focused on the reduction on input subsidies in irrigation and power in Maharashtra agricultural policy. In selected crops Maharashtra has lower profitability as compared to other states. He suggested that diversification in agriculture towards high value crops in the state. Dev argues that there is greater need for public investment in agriculture, irrigation, credit availability, better marketing of the agricultural products, research and development.

Desai (2002) : He suggested that government expenditure should be focused on agricultural research and development, education and extension services, rural electricity, roads and marketing, irrigation and water shade development.

Larson (2004): The study of Larson is same as study of Dev. The study period of Larson is 1950 to 1965 and 1967 to 2002. Larson studied after green revolution period. In his study by the government policy and green revolution scheme there is increasing production of food grains and other crops in India but this has come at a cost of greater instability in production and yield.

Rane A.A. , Deorukhakar (2007) " Economics of Agriculture", Second revised edition". This book is related to recent development in rural finance and also in other branches of Agricultural Economics. There are seven sections in this book viz; Agricultural Finance, Co-operation , Agricultural marketing, Farm management and production Research Methodology, Economics information about Indian Agriculture, Agricultural growth and Economic development, Agricultural business management. In this book pair of authors gives basic and useful definitions in simple words about the economics of agriculture. They give

formulae about Land or Production efficiency indicators yields per acre, crop yield index, labour efficiency indicators etc.

Kiran Yadav(2008) :In modern concept ,dryland areas are those where ,the balance of moisture is always on the deficit side. He gives the example of Varanasi. The average annual rainfall of Varanasi is around 1100 mm and the annual potential evapotranspiration is 1500 mm. this deficit in moisture is bound to affect the crop production under dryland situation ultimately resulting into total or partial failure of the crops. According to writer the production is either low or extremely uncertain and unstable which are the real problems of dryland agriculture. Also writer says that in dry land area deficiency and uncertainty in rainfall of high intensity causes excessive loss of soil through erosion which leaves the soil infertile. Kiran Yadav gives production capacity of different types of soils such as Vertisoiles, Alfisoils, Entisoils, Submontane soils, Sierozems. Also he gives ideal about how to improved dryland agriculture technology by crop planning, planning for aberrant whether , crop substitution, efficient cropping system, fertilizers used, rin water management.

S. Mahendra Dev (2009): He was director and Vice-chancellor of IGIDR Mumbai. He focused on three goals of agriculture development and dryland agriculture.

i) Achieve 4 percent growth in agriculture and raise income by increasing productivity. ii) Sharing growth by focusing on small and marginal farmers, lagging regions, women etc. iii) To maintain sustainability of agriculture by focusing an environmental concerns.

He gave solution to achieve these three goals; there are seven factors which need focused reforms in the short and medium terms. These are Price policy, Subsidies and Investment, Land Issues, Irrigation and Water Management, Research and Extension, Credit, and Domestic Market reforms and diversification.

Alka Shingh and Suresh Pal (2010) : Pair of authors suggest and focus on the various issues in changing pattern of agricultural growth during the period of green revolution. They noticed that if we exclude some years specifically the years 2002-2003 and 2004-2005 because of abnormally adverse weather, an adjusted annual growth rate of more than 3 percent per year was sustained over the period 1997-98 to 2008-2009. The trend towards commercialization and diversification of agriculture is increasing and most of the growth in output in recent years was realized through production growth. Authors note that ," Finally development of human capital is the key to innovation and acceleration of agricultural growth".

Kalamkar S.S. (2011) ; Agricultural Growth and Productivity in Maharashtra : This study has been carried for Maharashtra Agriculture productivity and finding trends and determinants. Also this book is collection of literature on agricultural growth and productivity in Maharashtra by various scholars and officials from different government departments. In this book Dr. Kalamkar writes about sustained growth in India's agricultural sector is essential for economic development and maintaining overall stability of the economy. Agricultural growth plays an important role in achieving certain national goals ,such as reducing rural poverty, providing food and nutritional security. Further he says that agriculture is the dominant sector of the Indian economy because more than half the workforce being employed in this sector. It is observed that growth in

agriculture contributed to poverty alleviation and employment generation in the rural areas and achievements of higher rates of economic growth and therefore, prosperity of the rural economy is closely linked to agriculture and allied activities. In this book main focusing topics are

Recent development in Agriculture in Maharashtra- Here Dr. Kalamkar writes present scenario of Indian agriculture economy and Maharashtra agriculture economy. Inter-regional inequality within the Maharashtra has been a matter of concern for a long. Among the four regions in the state viz. Konkan, Western Maharashtra , Vidharbh and Marathawada. There is information about the rainfall data which are divided districtwise in three groups as high, mediumand low rainfaa groups.

Elumalai Kanna , Sujata Sundaram (2011) : The present study was discussed the trends and pattern in agricultural growth at the national and subnational levels in India. Data on important variables were compiled for the period 1967-68 to 2007-2008. The analysis of data revels that the cropping pattern in India has undergone significant changes over time. There is marked shift from the cultivation of food grins to commercial crops. However, technological and institutional support for a few crops brought significant changes in crop area and output composition in some regions. The second section of this article is on analyses changes in cropping pattern and output at national level.

All India report on number and area of operational holdings (2010-2011) : The department of Agriculture and cooperation, ministry of Agriculture, government of India conduct agriculture census to collect the data on operational

holdings in the country. The highlights of the report on number and area operational holdings 2010-11 are given in details in this report (page number 5 to 7).

Evaluation Report on Dryland Farming: The reference period of this report is during the year 1987-88 and the secondary data collected for the years 1983-84 and 1985-86. In this report there are given main finding and major suggestions for the dryland farming (page number 3 to 5).

National Kharif Conference on Agriculture (2012): The title of this conference was " Water Management and Dryland Farming". The conference held on 5th and 6th March 2012. Following subjects were discussed and these are:

i. Rainfall pattern of region wise.
ii. Dimension of the problems of dryland agriculture.
iii. Major constraints of dryland agriculture area.
iv. Soil fertility status of Maharashtra.
v. Extent of soil erosion.
vi. Cropping pattern.

Dr.Mahendra Nagdeve (Chief Scientist, All India Co-ordinated Research Project for Dryland Agriculture) : In this article there are information for the dryland of Vidarbha region of Maharashtra State. This region is mostly affected by dryland agriculture. There are eleven districts in this region. It covers an area of 97762.9 km square, which is 31.92 percent area of Maharashta state. The climatic condition of this region can be broadly described as semi-arid type on annual basic. The soil patterns are derived from trap rock and have varying depth depending upon their physiography.

Ramakrishna Y.S. , Rao G.G.S.N. ,Water Management –*Water use in Rainfed Region of India* : Authors gives the various numerical information about status of irrigation facility across India, Rain fall, Estimation of water need for India, Ground water status state wise , Water management related problems in rainfed areas, Surface water status.

Elke Noellemeyer , Romina Fernandez, Alberto : This article is depend on the 'Raising demand for food and uncertainties about climate change. Authors estimate water productivity of different crops under No-Till (NT) and Conventional Till (CT), in order to identify rotation that improves the water productivity of dryland agriculture. They set up the hypothesis that NT and cereal crops would have a positive effect on overall water productivity. The result of this study indicates that NT improved available water use, yield and water productivity of all studied crops.

Devid Niemeijer and others ; (Book); " Dryland Systems", chapter 22, P.No. 624-626, this chapter describes the current condition of dryland system with respect to the services they provide and the drivers that determine trends in their provision. The chapter assesses desertification as a persistent reduction in the services provided by dryland ecosystems, leading to unsustainable use of the drylands and their impaired development. The chapter also explores option for the sustainable use of drylands and points to human and societal responses that have succeeded or failed.

The references which are given above are used for my study. These gives me direction to present my work, especially a book by Dr. Kalamkar gives me to present my findings in proper way. Agriculture production is depends on various

factors, this concept understood me by articles and research papers of Kiran Yadav, Dr. Mahendra Nagdev, Dr. Devid Niemeijer's book 'Dry Land System' .

The subject of my work is 'Trends in agricultural production and productivity of dryland of Satara district, duration of study is 2001-02 to 2012-13. I split up this study period in two phase (Period-I, duration is 2001-02 to 2007-08 and Period –II , duration 2008-09 to 2012-13).

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Chapter-3

Research Methodology

Introduction:

Research is an academic activity. The term Research refers to the systematic method consisting of enunciating the problem, formulating a hypothesis, collecting the facts or data, analyzing the facts and reaching certain conclusions. The research for knowledge through objectives and systematic methods of finding solution to a problem is research. Research inculcates scientific and inductive thinking and it promotes the development of logical habits of thinking and organization. Research provides the basis for nearly all government policies in our economic system.

Research methods which are used during the studying consist of statistical techniques which are used for establishing relationship between available data. Also this work consists to evaluate the accuracy of the results obtained.

Title of the Research Work:

Trends in Agricultural Production and Productivity of Dryland of Satara District. (Study period 2001-02 to 2012-13).

3.1 Concept of Production and Productivity:

i) **Production :** Total Production of crop is depend on productivity and it is obtain by multiplication of area under crop to the productivity in units.

Production = Area * Productivity

ii) **Productivity**: The term 'Productivity' is regarded as "A ratio of the output to input in relation to land, labour, capital and over all resources employed in agriculture".

Singh(1979) defined agricultural productivity as ,"The quantity of returns from arable land". According to Jasbir Singh (1972) –" Productivity is the degree of which the economic, cultural, technical, and organizational variables are able to exploit the biotic resources of the area for agricultural production".

iii) **Dry Land**: Area which receive an annual rainfall of 750 mm or less and there is no irrigation facility for raising crops.

iv) **Dry Land Agriculture**: Scientific management of soil and crops and crops under dry land without irrigation is called dry land agriculture.

v) **Drought:** It is an condition of insufficient moisture supply to the plants under which they fail to develop and mature property. It may be caused by soil, atmosphere or both.

vi) **Dry Land Crops**: All such crops which are drought resistant and can complete their life cycle without irrigation in areas receives an annual rainfall less than 750 mm.

vii) **Kharif Crops (Mansoon Crops):** The crops which are grown during the rainy season are called Kharif crops. These crops are Bajara, Maize, Soyabean, Pulses, Cotton, etc.

viii) **Rabi Crops (Winter Crops) :** The crops which are grown in winter season are called Rabi crops. These crops are Jowar, Wheat, Gram, etc.

3.2 Study Area :

Satara district is situated in the Western part of the Maharashtra state. Satara district is lies between North latitude $17^0$41' and $18^0$11', East longitude $74^0$00'3.38" and $74^0$54'. Satara district is bounded in the North by Pune district, on East by Solapur and on South by Sangli and Kolhapur district, on the west by Konkan region. There are eleven tehsil in Satara district. The total area of district is 10582 sq.km.. Satara district has typical landscapes due to variation in relief, climate and vegetation. The climate ranges from rainiest in the Mahableswar region which has an average annual of over 6000 mm to the driest in Man , Khatav, Phaltan, and Khandala tehsils where the average annual rainfall is about 500 mm . Rice, Jowar , Bajara, Onion, Potato, Ginger, Sugarcane, Pulses and vegetables are mainly cultivated in the Satara district. The present study deals with the geographical perspectives of the agriculture production and productivity of Satara district.

Basically there are four factors which need focused reforms in the agriculture production and productivity, these are;

1) Rain fall
2) Land Issues
3) Soil pattern
4) Water management

3.3 Importance of Study:

India has made impressive strides on the agricultural front during the past three decades. This credit goes to the million small farmers. Government policy, Infrastructure, Marketing Facility, Transport Facility, Research and Extension for

crop have significantly helped in increasing the agricultural productivity. The term agricultural productivity is dynamic and relative complex. The real problem of dryland agriculture is low, uncertain or unstable agriculture production. Production of agriculture is mainly depends on rainfall, stored moisture in soil and moisture used by crops. India has about 47 million hector dryland and it contributes 42 percent of the total food grains production of the country. So, there is need to study about agriculture production in dryland area. If we want to increase productivity of dryland must be to study the past carefully. That's why there is need to find the trend of agricultural production and what are the effects take role in the agriculture production and productivity?

The present research work intends to analyze the change in trend of agricultural production and productivity of Satara district. This study is based on secondary data. Agriculture production is influenced by Geographical, Climatological, Socio-Economic and Technological factors. Also there is need of farmer's attitude and direction of new thinking. The present study should be discussed the trends and pattern in the production and productivity of Satara district during the years 2001 to 2013.

3.4 Parameters :

1) Geographical Region.
2) Yield
3) Climate
4) Crop management
5) Area under crop
6) Cropping Pattern
7) Production and productivity

3.5 Objectives :

The objectives of the this study are as follows;

1) To study the trends of growth in area, production and productivity during the year 2001 to 2013.
2) To study the changes in cropping pattern.
3) To study the problems faced by dryland cultivator farmers and to suggest for the solving such problems.

3.6 Hypothesis:

1 More variability of rainfall which affect the yield of crops.

2 Development of production and productivity will be improved in dryland agriculture of Satara District.

3.7 Database and Methodology:

This study is based on secondary data. The sources of secondary data are District Statistical Office, Department of Agriculture Z.P. Satara, Statistical Abstract of Maharashtra, Socio Economic Review of Satara District, Maharashtra State Gazetteers Satara District, Statistical Review of Satara District etc. The numerical data could be analyze by statistical tools and somewhere maps and graphs are used for to find the trend of production and productivity and comparative study of irrigated and dryland agricultural production.

3.8 Statistical Tools:

1) Descriptive Statistics tools are used to graphical presentation, measure average production of yield, variance and standard deviation used to measure variation of crops.

2) Index numbers are used to compute indices for crops, productivity yield index of the different crops.
3) Time Series analysis and used for prediction total agriculture production and productivity.
4) Correlation and Regression techniques are used to find the relation between rainfall and agriculture production.

3.9 Scope of Study :

Scope of present study is drought prone area of Satara District of Maharashtra state. Eastern part of the Satara district is under drought prone area. Four tahsils are there in that area viz. Khatav, Man, Phaltan, Khandala.

3.10 Study Period:

The study period is from 2001 to 2013. This study period is split up in two time period.

Period-I : Duration from year 2001-02 to 2007-08.

Period-II : Duration from year 2008-09 to 2012-13.

3.11 Chapter wise scheme of the work:

The completed work deals with the trend of agricultural production and productivity of dryland of Satara District. The contents of the chapter are as under.

Chapter-1: Introduction

This is introductory chapter; present a brief account on growth in productivity and so, production of agricultural production of major crops of India and also Maharashta state.

Chapter 2 : Research Methodology

Research methodology is given in details with Study Region, Importance of Study, Objectives, Hypothesis, Various Statistical tools used to measure trends and variation.

Chapter 3: Review of literature. :

In this chapter there are various revived of literature given. Review of Research papers, Articles, Information from the government departments such as District Agriculture office, Statistical hand book of district, Review of books.

Chapter 4: Research Methodology:

Some definitions, objectives, hypothesis, methodology, scope of study, study period and used statistical tools, these points are discussed in this chapter.

Chapter 5: Profile and management of agriculture sector in Satara District:

This chapter deals with recent agricultural development in Satara District, Land used pattern of drought prone tehsil of Satara district, changing structure of landholding change in area, Tehsilwise trends in area, productivity of major crops in study area.

Chapter 6: Determination of Trends in production and Productivity of dryland. :

This is main chapter of the study. In this chapter it gives determinates for trends in Area, Productivity, and Production of major crops sown in drought prone tehsil of Satara district. Correlation between Agriculture production and rainfall, there are numerical as well as whenever it is possible

data are represent by diagram. Index number technique is used to find the index value of productivity. by using regression technique of statistical tool, regression equation is used forecasting for the productivity of major crops.

Chapter 7 : Finding – Problems - Recommendations:

Finding, problems and suggestions are given in this chapter. Also there are suggestions are noted for how to increase productivity.

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Chapter- 4

Profile and Management of Agriculture Sector of Satara District.

4.1 District at a glance:-

Geographically Satara district is located in the Western part of the Maharashtra state. Krishna, Bhima, Nira, Koyana, Venna, Yerala, Man are the main rivers of Satara district. There are mainly three factors relief, climate, vegetation are affected for dividing the district geographically in two parts. These factors play the role as;

i) The variation in the relief ranges from the pinnacles and high plateaus of Sahyadrians ranges.

ii) The climate ranges from the rainiest in the Western part of district which has an average annual rainfall is about 500 mm or less.

iii) The vegetal covers two varieties from typical monsoon forest in the Western part to sorub and poor grass in the Eastern part.

The climate ranges from the rainiest in the Western part and driest region in the Eastern part of the district. In rainiest part ,there are seven tahsils are situated viz. Patan, Karad, Satara, Wai, Mahableshwar, Jawali, Koregaon and in direst region there are four tehsils viz. Khatav, Man, Phaltan, Khnadala.

It is bounded by Pune district to the North, Solapur district to the East, Sangli district to the South and Ratnagiri to the West. Satara district is situated in the river basins of the Bhima and Krishna rivers. The physical settings of Satara shows a contrast of immense dimensions and reveals a variety of landscapes influenced by relief, climate and vegetation. The variation in relief ranges from

the pinnacles and high plateaus of main Sahyadrians ranges having height over 4500 feet above mean sea level to the subdued basin of the Nira river in Khandala and Phaltan tehsil with the average height of about 1700 feet above mean sea level.

The climate ranges from the rainiest in the Western part of district that called Mahableswar region which has an average annual rainfall is over 6000 mm to the driest region viz. tehsils Man , Khatav, Phaltan and Khandala where average annual rainfall is about 500 mm or less. The vegetal cover too varies from typical monsoon forest in the Western parts to sorub and poor grass in the Eastern parts.

Following map shows the location of Satara district in Maharashtra;

4.2 Agro climatic / Ecological Zone:

a) Agro Ecological Sub Region (ICAR) - Deccan Plateau for semi-arid region

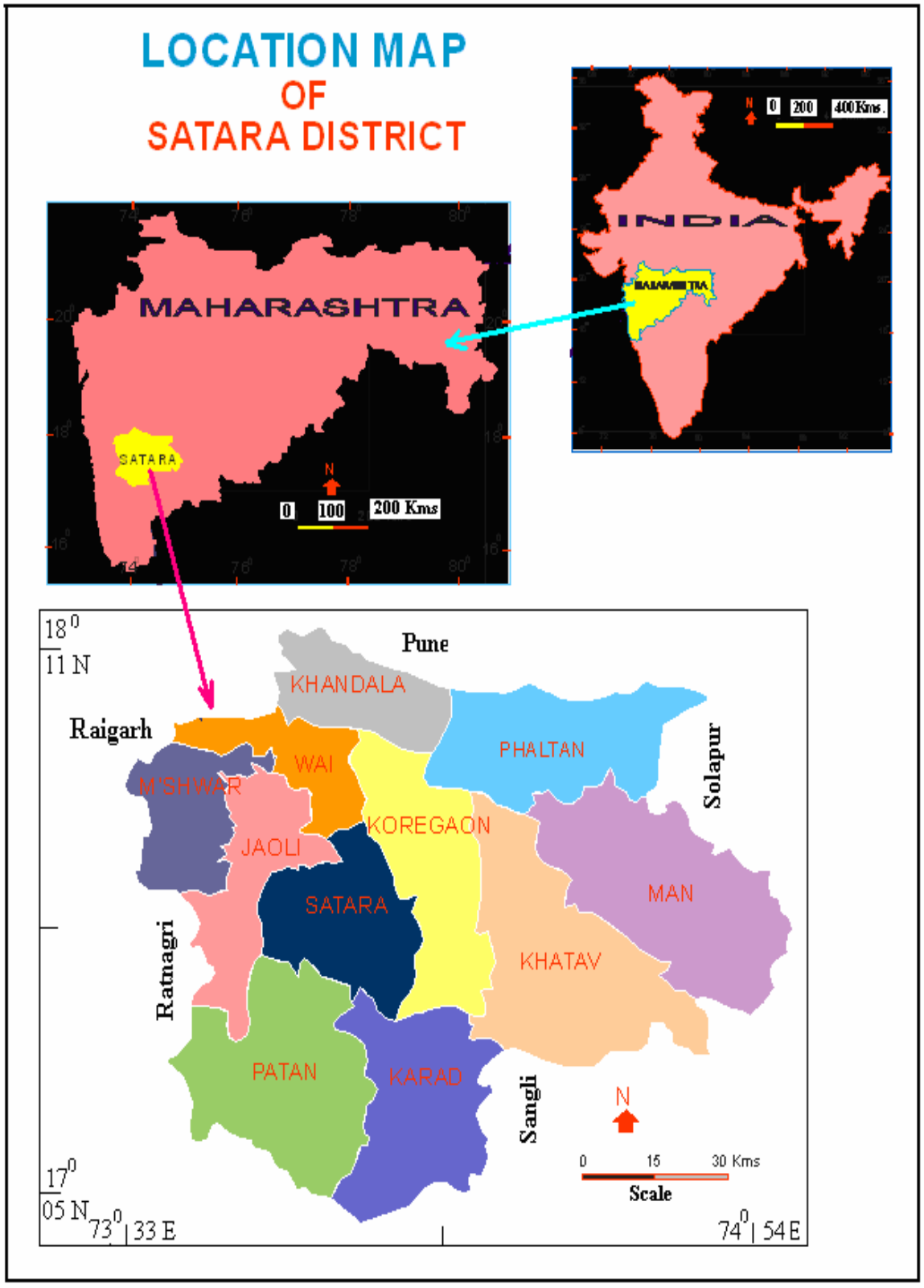
b) Agro-Climatic Region -Western Plateau and Hill region

c) Agro –Climatic Zone -Western Maharashtra Scarcity Zone.

d) Geographical co-ordinates -Latitude : 170 41’ 29.04”-N

Longitude: 740 00’ 03.38” E

Altitude: 760 m MSL.



Map No- 4.1 : Location map of Satara District

4.3 Major Soil Pattern:

The nature of soil is collectively influenced by relief, nature of parent rocks, climate and vegetation wherever these factors are favorable soils have been formed and agricultural has flourished. Soil condition and agriculture production are closely related.

Soils of the arid tropics are highly variable. It is possible to make some generalization about such soils. Because of the low rainfall and consequently reduced plant growth, organic materials are reduced slowly. Soils of the semi-arid and arid zones might support few plants on the surface but a good part of the biomass be in the soil itself as roots.

1.. Soil is the natural and a vital resource for growing food, fiber and firewood to meet the human needs.

2. The soils are highly vulnerable to degradation and nature takes very long period (say 300 – 1000 years) to form an inch of the top soil mainly due to the combined effects of climate, vegetation, organisms, relief and time on the rocks and parent material.

3. Soil is a life supporting system upon which human beings have been dependent from the dawn of the civilization.

4. The soil performs many functions such as media for biomass production, filtering and buffering, a habitat and gene reservoir, a source of raw materials, a substrate for buildings, roads and other structures and as an archaeological artifact.

5. Impairment in any function of soils reduces their quality, value and capacity to provide the basic necessities to support ecosystems. Hence, comprehensive information on soil resources in terms of types of soils, their spatial distribution, extent, their limitations *viz*., erosion, salinization / alkalization, water logging etc., and their potential / capabilities, is required for a variety of purposes such as command area development, soil conservation in catchment areas, rainfed farming, watershed management and reclamation of degraded lands. Such information also plays an important role in non-agricultural sectors like, construction of roadways, railways, dams and engineering structures, etc.
6. Management of soil resources is essential for continued agricultural productivity and protection of the environment.

Fertile soil has the following characteristics:

- It is rich in nutrients necessary for basic plant nourishment. This includes nitrogen, phosphorus and potassium.
- It consists of adequate minerals such as boron, chlorine, cobalt, copper, iron, manganese, magnesium, molybdenum, sulphur and zinc. These minerals promote plant nutrition.
- It contains soil organic matter that improves the structure of the soil. This enables the soil to retain more moisture.
- The soil pH is in the range 6.0 to 6.8.
- It has a good soil structure which results in well-drained soil.
- It consists of a variety of micro-organisms that support plant growth.
- It often contains large amounts of topsoil

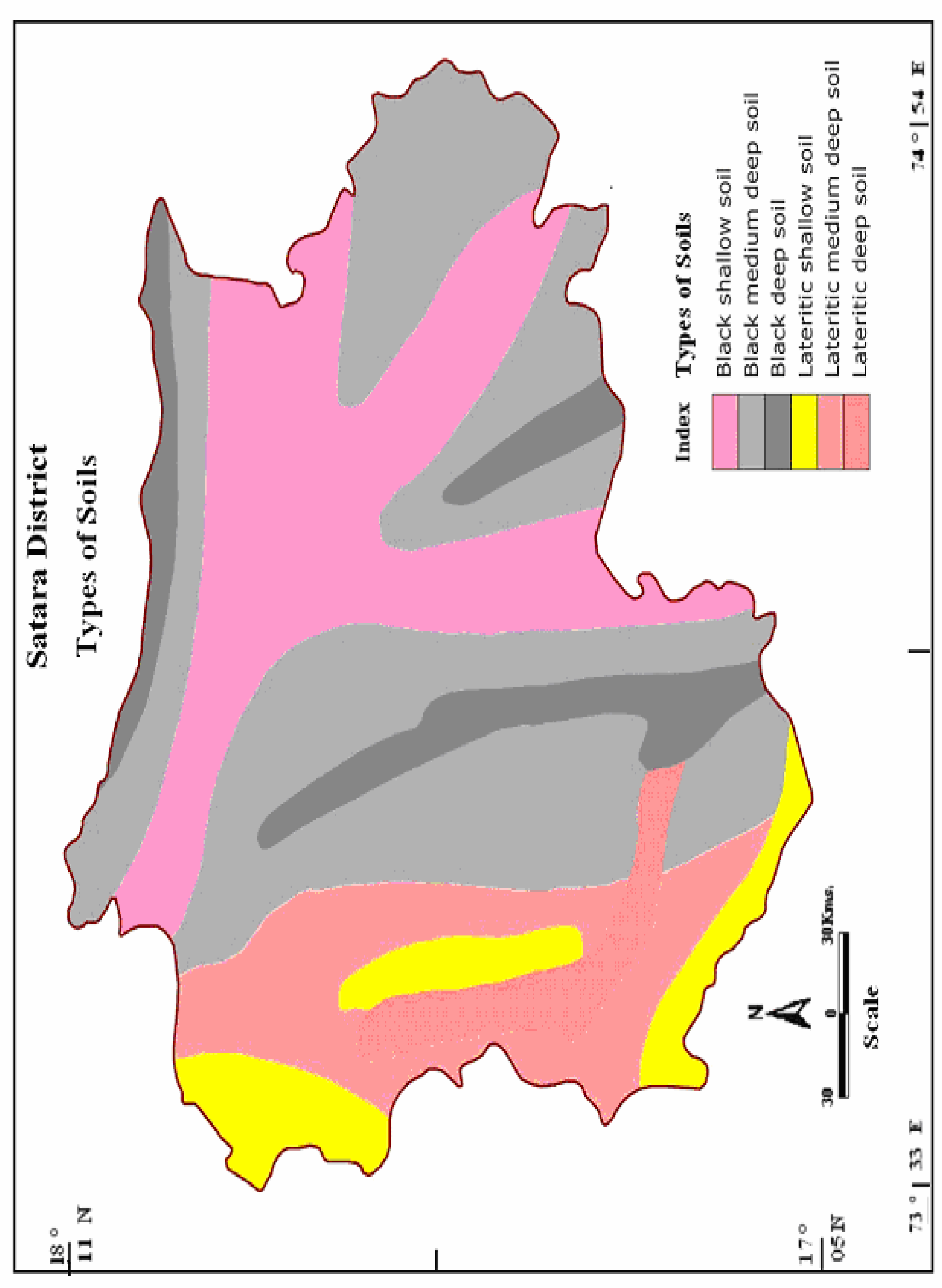
There are three main types of soils are shown in Satara district. Coarse Shallow Soils, Laterite Soils, Black Soils.

Coarse Shallow Soils: The coarse shallow soils occur mainly in the hill ranges, especially offshoots of the Shayadri and southern flanks of Mahadeo ranges. This group of soil is shallow and mostly covered by the forest.

Laterite Soils: This group of soils covers Western part of the district. The colors of laterite soils are red to brownish. These soils are acidic and low in phosphoric content. These soils have different depths and are classified as deep and medium laterite soils. The deep laterite soils largely occur in Koyana river valleys and upper part of Krishna river. Crop rice is produce in that region.

Medium deep laterite soil occurs in the river valley and plateau top and covers large area. The medium deep laterite soils have less depth and course and depth. These types of soils are suitable for agriculture.

Black soils: The black soils have different colors from brown t dark black and occur in various depth. Black soils classified as deep black and medium black soils. The deep black soils mostly found in central part of tehsil Wai, Satara, Karad. The deep soils have having high water holding capacity. The medium black soils are found everywhere. This type of soils are thinner and less fertile comparing to deep black soils the medium black soils occupy in central part of the Satara district.



Map No- 4.2 : Soil Pattern of Satara District

4.4 Rainfall :

The focus in the study of rainfall has been to describe rainfall variability as a basis for improving the understanding of crop climate relationship in the drought prone region. By analyze impacts of rainfall variability of yield of major crops and investigate the benefits of rainwater harvesting as a livelihood strategy. It shows that there are significant intra-regional differences in rainfall amount , variability and trend.

Satara district is divided in dry-semi arid areas and arid tropics areas. These areas are depending on natural rainfall for cropping. In a limited area two crops are grown bur their production and productivity are low. The rainfall of all these areas is variable in intensity, amount and distribution in time and space. Most of the runoff occurs in a few storms of high intensity. If the runoff water is locally stored, one must know how best to use it for productive agriculture. If the rainfall intensity and amount exceed the infiltration and storage capacity of the soil, the excess water may be harvested nearly in the same field or at another convenient point in the same field or at another convenient point in the same watershed. Data recorded on red soils (Alfisoils) of ICRISAT show that on these soils about 25 % of the seasonal rains runoff. Most of the soil of the semiarid of Satara district have a sloping topography and are not suitable for conventional basin type irrigation. Dry land farming must be based on the increasing the stored water in the root profile and increasing its efficiency.

Water that falls in arid regions may be of little use for crops , because the amount is too small to penetrate the soil sufficiently or it may run quickly. On another hand some soils can store water so efficiently that is possible to grow

crops in such soils over an extensive period of drought. In all arid regions a major challenge is to manage water appropriately. The purpose of such management is to obtain water conserve it, to use it efficiently and to avoid damage to the soil.

Table No- 4.1

Tehsil wise Annual Average Rainfall of Satara District Duration 2001-2013

Year	M'war	Jawali	Patan	Wai	Satara	Karad	Koregaon	Khandala	Phaltan	Khatav	Man
2001	4501	1092	1203	678	1031	655	519	349	478	518	357
2002	5094	1320	1244	561	341	467	586	NA	344	398	353
2003	4441	1191	987	541	583	419	393	NA	NA	NA	NA
2004	6501	1103	1612	1129	1092	777	987	760	764	951	354
2005	6824	3679	3250	1574	1849	1230	1435	735	471	684	572
2006	8669	2760	2851	1510	1676	1070	1345	786	689	602	558
2007	6265	1679	2220	1033	1231	1025	895	685	725	593	595
2008	5604	1520	1239	836	764	880	568	440	342	419	455
2009	2553	1894	1875	937	1091	797	752	584	652	566	627
2010	4244	1530	1511	1029	1011	872	904	662	1028	814	761
2011	6456	1737	1804	873	777	593	497	433	342	373	225
2012	3908	1259	1574	650	686	550	360	451	267	273	269
2013	3812	1787	1510	881	1283	569	596	633	469	575	407
Average	5297.85	1734.6	1760	941	1032	762	756.7	593	547.8	564	461

Source Socio- Economic Review and District Statistical Abstract of Satara District.

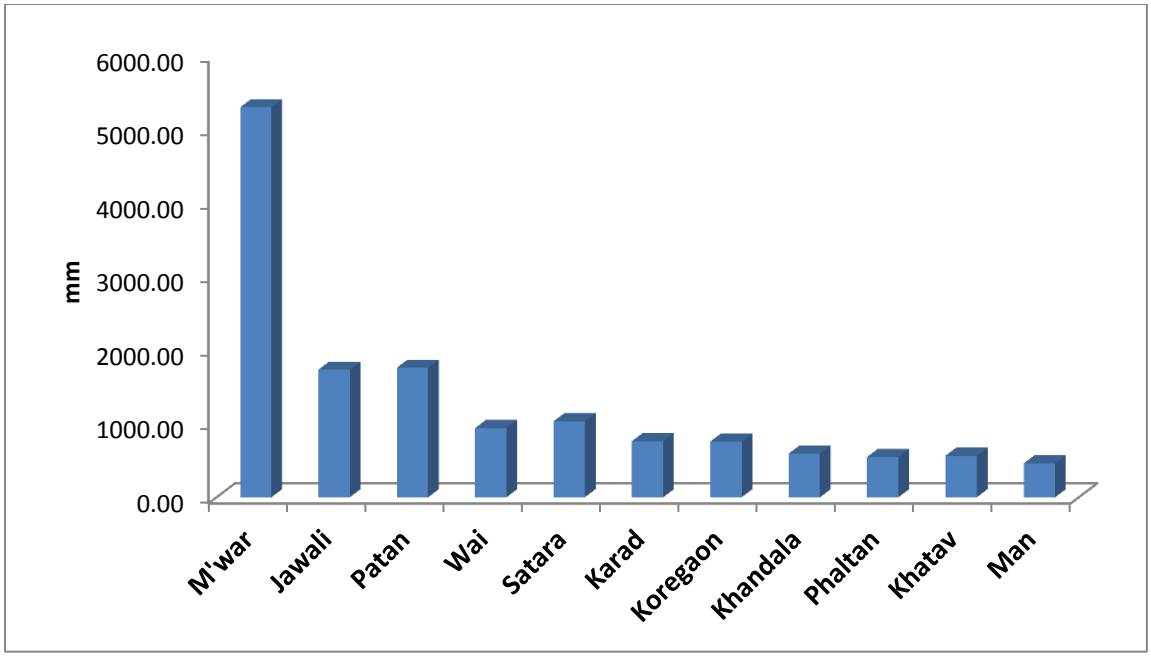


Fig 4.1: Tehsil wise Average Rainfall of Satara District

4.5 Land Utilization of Satara District area in hector during the Year 2001-02 to 2007-08 and Year 2008-09 to 2012-13:

Development in irrigation and growth in population are the two important factors which mostly decide the land use pattern. Land use pattern explains how effectively land resources are utilized for different purposes in a state while there is no significant change in area under fallows, land under cultivable waste, permanent pastures, and grazing land, land used for non-agricultural purpose, barren and uncultivable land which has increased about 10 percent from 1962 to 2008. The increase land put to the nonagricultural uses is due to the fact that more and more land is brought under construction of buildings, roads, industries and other development purposes. Out of total arable land available in the Satara district, 80 percent land already used for agricultural production. Altogether about 8 lakh hectares of land are available in the form of cultivable waste, permanent pasters, land under tree crops and groves etc. with the proper waste land

development program , these lands can be brought under productive use, which may help to reduce the normal poverty in the state.

Land Utilization:

1. Net sown area : Total area sown with crops and orchards may be sown more than once in the same year but counted only once.

2. Current fallow: Cultivated area, which is kept fallow during the current year but was cropped in the previous year. For example, any seeding area is not cropped in the same year, it may be treated as current fallow.

3. Fallow land other than current fallow: All lands, which are taken up for cultivation but are temporarily out of cultivation for a period not less than one year and not more than five years.

4. Other uncultivated land excluding fallow: This will include :-

i) Permanent pastures and other grazing lands: All grazing lands, whether they are permanent pastures and meadows or not. Village common grazing lands would, however, be excluded.

ii) Land under Miscellaneous Tree Crops: Cultivable land, which is not included in the net area sown but is put to some agricultural use. Land under Caesarians trees, thatching, Grasses, Bamboo bushes and other groves for fuel which are not included under ‘ Orchards ’ would be covered under this category.

5. Cultivable Waste: All lands available for cultivation whether not taken up for cultivation or taken up for cultivation once but not cultivated during the current year and the last five years or more in succession for one reason or other. Such lands may be either wholly or partly covered with shrubs and jungles, which are not put to any use. Land once cultivated but not cultivated for five years in succession would also be included in this category.

6. Not available for cultivation: This would include forest area under non-agricultural use, barren and uncultivable land.

Agriculture land use means land under net sown area, fallows land and uncultivable land excluding fallow land. The cultivated area is known as net sown area it is agriculture land. This type of land is under various crops. The agriculture land use is the result of the direct application of efforts applied is related to decision made by farmers regarding the actual use of land. These decisions are based on appreciation of the available land resources. Table number 4.3 shows the total area of Satara district and this area is distributed into various factors. Due to there be increasing pattern of land uses under cultivation, the total area of land is shown in two period of time like 2001 to 2008 and 2009- to 2013.

The area available for agriculture which includes current fallow land increased highly from 14500 ha area in 1985-86 to 51000 during 1996-97 and decreased slightly to 32200ha in 2008-09. The land under cultivated waste decreased continuously from 47800 ha in 1985-86 to 38200 ha in the year 2008-09. In percentage, it decreased from 4.52 to 3.61 percent of total geographical area. This clearly showed that, the area under agriculture has increased over period of time.

Land holding pattern of Satara district is different from the state Maharashtra level. The proportion of marginal and small has been increasing in the district. The changing structure of land holdings and area operated in Satara district is represented in Table No- 4.2.

Table No- 4.2

Structure of Landholdings of Satara District (in percentage)

Land Holders	Period-I		Period-II	
	No of Operating Holdings (%)	Area of Operational Holding (%)	No of Operating Holdings (%)	Area of Operational Holding (%)
Marginal	57.5	17.2	67.9	29
Small(1 to 1.99)	23.4	24.4	19.7	26.5
Semi Medium (2 to 2.99)	13.4	26.5	9.7	26
Medium (4 to 4.99)	5.6	21.7	2.5	13.7
Large (more than 5 ha)	o.79	10.2	0.2	4.8

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

The marginal and small holding accounted for about 74.7 percent of the total holdings in Satara district. An important aspect of land utilization is the area used for cultivation. This is indicated by the net cultivated area which is sum of the net sown plus the area under current fallows. The net cultivated area is 94 percent of the total operated area in 2000-01. Out of the remaining 6 percent, 4 percent is uncultivated land and 2 percent area not available for cultivation.The most important factor in agriculture is land. knowledge of it as also of crops grown on it vital to an understanding of the basic elements of agriculture. The study that follows depends upon land, its use, crops and their pattern. Data is regarding the number and size of operational holdings in Satara District of Maharashtra state. The land utilization pattern have presenting its existing availability, the possibilities of augmenting, its quantity

and making the best of what is available. Therefore, 'Land Utilization Pattern' has presented in Table No. 4.3.

Land utilization of Satara district explains how efficiency land resources are utilized for different purposes. Table No.4.3 represents the detailed land use pattern of Satara district. These table shows that pattern of land use has been fairly stable. Crops are cultivated under drought prone area are predominantly or need based crops are cultivated. Net sown area has declined between study Period –I and study Period –II by 24,795 ha while there is no significant change in area under follow, land under cultivable waste, permanent pastures, land used for non-agricultural purpose and barren . Total non-cultivated area in study period-I is 121,425 ha and in study period-II is 121548 ha it means 123 ha non-cultivated land is more in Period-II than Period –I. Also there is total follow land in Period-I is 118674 ha and that of in Period-II is 141875 ha. The follow area increased about 23,201 ha more than Period-I. It shows that year by year there is increasing trend in follow area. The last two columns in Table No-4.3 shows the total cultivated area in ha and total cultivable area in hector.

It can be seen from the Table No.4.3 , 720534 ha area is under cultivated and that time cultivable area is 799266 ha. It shows that 78,732 ha area may be converted into agriculture production. In time Period–II, the figures corresponding to total cultivated area is 695739 ha and total cultivable area is 799123 ha. The difference is 10,3384 ha. From the above conclusions it shows that in study Period-II, cultivated area transfer to cultivable area by 24652 ha.

In study period –I and period-II near about 12 percent area and 13.5 percent area is cultivable respectively.

Table No : 4.3

Land Utilization of Satara District area in hector

(Year 2001-02 to 2007-08 and Year 2008-09 to 2012-13)

Sr. No.	Tehsil	Total Geographical Area (ha)	Land Under Forest (%)	Cultivated Land (%)	Cultivable Waste (%)	Land Available for Cultivation (%)
	1	2	3	4	5	6
1	Mahableshwar	22190	29.53 **29.15**	59.65 **59.66**	6.66 **6.66**	3.76 **3.76**
2	Wai	61909	64.73 **80.94**	20.62 **20.62**	9.82 **9.82**	4.80
3	**Khandala**	***53608***	**40.10** **76.30**	**12.12** **12.12**	**10.51** **10.51**	**17.47** **17.50**
4	**Phaltan**	***119029***	**66.56** **54.12**	**9.15** **9.15**	**12.79** **12.79**	**11.50** **14.10**
5	**Man**	***150787***	**50.95** **37.04**	**8.59** **8.59**	**23.71** **23.71**	**16.75** **16.75**
6	**Khatav**	***136457***	**82.92** **61.14**	**3.01** **3.02**	**5.80** **5.80**	**8.27** **8.28**
7	Koregaon	94840	74.21 **72.56**	11.07 **11.07**	5.40 **5.40**	9.32 **9.24**
8	Satara	87953	64.05 **104.78**	9.66 **9.66**	11.63 **11.63**	14.66 **14.83**
9	Javali	86895	56.30 **52.20**	22.76 **22.77**	7.86 **7.86**	13.08 **13.11**
10	Patan	140364	49.75 **66.22**	19.74 **19.74**	19.25 **19.25**	11.26 **11.28**
11	Karad	104211	82.53 **91.43**	10.17 **10.17**	1.60 **1.61**	5.70 **5.73**
	Total	**1058243**	**68.09** **65.74**	**13.00** **13.00**	**11.62** **11.62**	11.47 **11.49**

Source – Compile from the Various Annual Socio-Economic Review and District Statistical Abstract of Satara District.

Note: Values are shown Percentage.

The land use pattern has got importance in the economy of the region. Human activity is depending on land use, socio-economic picture and the status of community indicates by land use pattern. Table No. 4.3 shows the general land use pattern of the study region.

The study region having 1058243 hectors the total geographical area. The net swan area is 63.01 percent of the total geographical area of the region. Total cultivable waste land is 122968 ha (11.62 percent) and 121380 ha (11.47 percent) land is not for available for cultivation. Table No. 4.3 shows tehsil wise general land use pattern that the tehsil included in high land zone, the cultivated land is vary less amount. Due to physiographic and other favorable condition in the central part of the study region having more cultivated land (63.91 percent). The highest cultivated land is recorded in Karad tehsil is 76826 ha (82.53 percent), and the lowest in Mahableshwar tehsil 6553 ha (29.93 percent). This is below as compare to district average. The undulating physiographic condition has more under area cultivation which is 1250033 ha (82.92 percent) in Khatav and 76826 ha (50.95 percent) in Man tehsil respectively. Tehsil Khandala 21497 ha (40.10 %), Mahableshwar 29.93 %, and Patan 49.75 % is recorded lowest percent of cultivated land. The second category is cultivable waste land, such as follow land with scrubs and grazing land. The area under this type of land is 11.62 percent of total geographical area. The high land zone has more percent under this category. The highest percent of cultivable waste land was found in Man tehsil. It is recorded 23.71 percent and it is higher than district average. The lowest percent of cultivable waste is recorded in 1.60 percent in Karad tahsil. The discussion reveals that the lowest groups of percent is in Mahableshwar 1478 ha (6.66 %), Khatav 7915 ha (5.80 %), Koregaon 5121 ha (5.40 %) and highest in Satara 10229 ha

(11.63 %) and in Khandala 5634 ha (10.51 %). The third category of land is land not available for cultivation, such as land under settlements, roads, railways, rivers, canals, barren land and uncultivable land. This type of land has having 11.47 percent of the total geographical area. It is observed that Satara 12894 ha(14.66 %), Khandala 9365 ha (17.47 %), Man 25257 ha (16.75 %), Phaltan 13688 ha(11.50 %) have recorded high percent than the study region average. The Khandala (17.47 %) tehsil having the percent of the land not available for cultivation in the whole study region, and Mahableshwar (3.76 %) tehsil have recorded very low percent in the study region. The fourth and last category is under forest. It is observed that the percent of land under forest is 13 percent in average. The Mahableshwar (59.65 %) tehsil recorded high percent land under this category, because of high rainfall and hilly region, the growth of vegetation is high. The evergreen monsoon forests are found in this tehsil. It is observed that Javali (22.76 %), Wai (20.62 %) and Patan (19.74 %) have recorded high percent than the whole study region. Tehsil like Satara (9.66 %), Khandala (12.12 %), Khatav (03.01%), Man (8.59 %), Phaltan (9.15 %), Koregaon (11.07 %) and Karad (10.17 %) have recorded below in the average of study region.

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Chapter-5

Determination of Trends in Agriculture Production and Productivity of Major Crops

Introduction:

Agricultural productivity is defined in agricultural geography as well as in economics as "Output per unit of input" or "Output per unit of area". Researcher develops new knowledge and technology, the output of the system per unit of input, its efficiency or productivity increases. Agricultural productivity has been defined by several scholars with reference to their own views and disciplines. Agricultural efficiency as productivity expressing the varying relationship between agricultural produce and one of the major inputs like land , labour, capital etc.

Productivity of land is a very important factor of agriculture because it is the most permanent and fixed factor among the three categories of input, land labour and capital. Productivity of land raised by applying input items consisting of improved seeds, fertilizers, agrochemicals and labour intensive methods. The concept of productivity has been extensively used to explain the spatial organization and pattern of agriculture. Productivity is generally considered from two directions i) productivity of land and ii) productivity of infrastructure engaged agriculture. Land is permanent and fixed factor among other production factor. Agricultural productivity of land is explained by production of crops in terms of output yield per unit of land. During the last three- four decades , India has made impressive strides on the agricultural front . The credit for this success should go to the several millions small farmers. These families of small farmers form the backbone of Indian agriculture and also Indian economy. India has experienced

considerable changes in the crop mix, yield and production since the inception of the green revolution.

Population growth is increases in geometric progress and for this increasing population, need based activities are increases in arithmetic progress. In every region of the world it is necessary to develop appropriate techniques for agriculture. A large part of the surface of the world is arid for conventional rain fed agriculture. Millions of people live in such regions. These people must eat and the wisest course for them is to produce their own food. The techniques are so varied that only a very large volume would cover the entire subject. In many cases the most suitable techniques for a particular region may be those suitable techniques for a particular region may be those already developed by the local inhabitants. Here suggestion is that to improve agriculture in arid zones by learning what is already there?

Dry farming is the earlier concept for which amount of rainfall remained the deciding factor for more than fifty years. In modern concept dry land areas are those where the balance of moisture is always on the deficit side. Accordingly the production is either low or extremely uncertain and unstable which are the main problems of dry land farming. The success of crop production in these areas depends on the amount and distribution of rain fall as these influences the stored soil moisture and moisture used by crops.

5.1 Rainfall of dry zone tehsils of Satara District:

Rainfall is the prime important factor for agricultural economy. Rainfall also determines the cropping pattern, performance, of different agricultural practices. The growth of prospect of agriculture is largely associated with the level and distribution of rainfall. Monsoon rain plays a critical role in the agriculture

development. About 83 percent of cropped area is cultivated under Rainfed condition. The average rainfall for the Maharashtra state is relatively higher as compared to many states in India. Nearly one third of area of state falls under the rain shadow region. In these areas only dry land cultivation is undertaken. An analysis shows that the productivity of agricultural commodities goes down, whenever there is a reduction in rainfall. This is because of the fact that food grains and other crops are cultivated predominantly in those districts which receive relatively less normal rainfall. There is variation in the normal rainfall across districts; it also widely varies across Tehsil within district.

From the Table No 4.1 it can be seen that, average rainfall of the drought prone tehsil i.e. Eastern part of the Satara district is about 541 mm during the study period 2001-02 to 2012-13 and that of average rainfall of Western part of district is 1754.87mm. It is three times more than the average rainfall of study area. As compare to variation, it shows that in drought prone tehsil variation in rainfall is high as compare to rainy region (Western Region). Rain fall data of year 2003 is not available. Average rainfall of these four tehsil is highest in the year 2010 (816.25 mm) and that of lowest in the year 2002 (273.75 mm), 2011 (343.25 mm) and 2012 (315.13 mm).

The average rainfall for Satara district is 1441 mm. there is huge variation in the rainfall figures of Satara district as considered to the tehsilwise annual rainfall. It is found that high rainfall recorded in Mahableshwar tehsil near about 6000 mm, Patan 1802.52 mm and Jawali 1714.16 mm. Medium rainfall in central and middle part of Satara tehsil 1009.47 mm, Wai 982.85 mm , Karad 784.33 mm and Koregaon 797.04 mm.

Table No. – 5.1

Average Rainfall of Dry zone tehsils (Study Area) of Satara district

Year	Khatav	Man	Phaltan	Khandala	Average
2001	518	357	478	349	425.50
2002	398	353	344	NA	273.75
2003	NA	NA	NA	NA	NA
2004	951	354	764	760	707.25
2005	684	572	471	735	615.50
2006	602	558	689	786	658.75
2007	593	595	725	685	649.50
2008	419	455	342	440	414.00
2009	566	627	652	584	607.25
2010	814	761	1028	662	816.25
2011	373	225	342	433	343.25
2012	273.4	269	267.1	451	315.13
2013	574.9	407.2	469	633.2	521.08
Average	**563.86**	**461.10**	**547.59**	**592.56**	
CV	**1083.58**	**1325.30**	**1115.57**	**1124.43**	

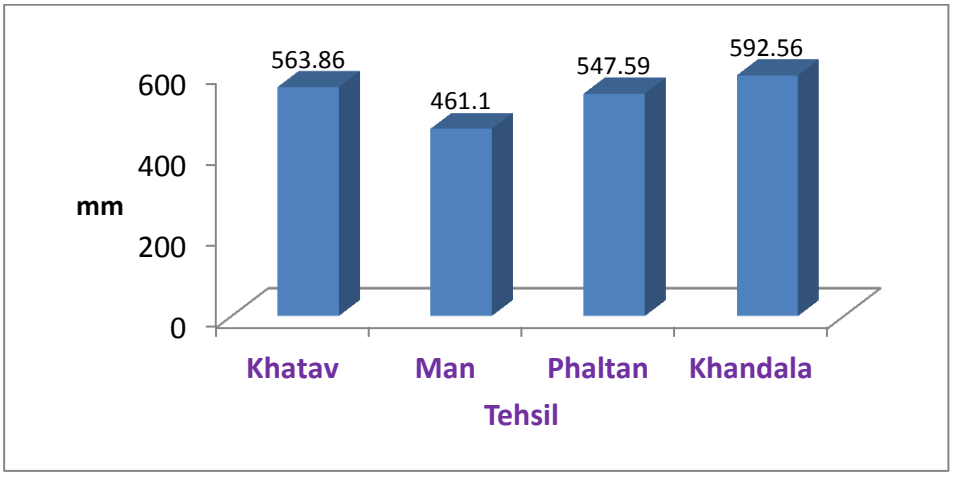

Fig No - 5.1: Average Rainfall of Dry zone Tehsils of Satara District

5.2 Rainfall and Agriculture Production:

Rainfall is the prime important factor for agricultural economy. Rainfall also determine the cropping pattern , performance ,of different agricultural practices. The growth of prospect of agriculture is largly associated with the level and distribution of rainfall. Mansoon rain plays a critical role in the agriculture development. About 83 percent of cropped area is cultivated under Rainfed condition. The average rainfall for the Maharashtra state is relatively higher as compared to many states in India. Nearly one third of area of state falls under the rain shadow region. In these areas only dry land cultivation is undertaken. An analysis shows that the productivity of agricultural commodities goes down, whener there is a reduction in rainfall. This is because of the fact that food grains and other crops are cultivated predominantly in those districts which receive relatively less normal rainfall. There is variation in the normal rainfall across districts; it also widely varies across Tehsil within district.

The average rainfall for Satara district is 1441 mm. there is huge variation in the rainfall figures of Satara district as considered to the Tehsilwise annual rainfall. It is found that high rainfall recorded in Mahableshwar Tehsil near about 6000 mm, Patan 1802.52 mm and Jawali 1714.16 mm. Medium rainfall in central and middle part of Satara tehsil 1009.47 mm, Wai 982.85 mm , Karad 784.33 mm and Koregaon 797.04 mm. Rainfall figure decreasing rapidly towards eastern part of the district. Tehsil Khandala 605.42 mm, Tehsil Khatav 568.30 mm , Tehsil Phaltan 542.05 mm and Tehsil Man 495.55 mm.

Mainly dryland agriculture farming is depends on rainfall. Average rain fall of dry zone tehsil of Satara district and agriculture production are presented in the

Table No. 5.2. From this table it can be seen that highest average rain fall is 816.25 mm in the year 2010-11 , that time agriculture production is 1,06,660 tonnes. In the year 2004-05, agriculture production was 1,63,260 tonnes and that time average rain fall is 707.25 mm. by comparing these two years with respect to agriculture production rain fall decreases by 109 mm but agriculture production increases by 56,600 tonnes.

Table No-5.2
Average rainfall and Agriculture Production of drought prone tehsil

Year	Average Rain Fall (mm)	Agriculture Production in '000 Tonnes
2001-02	425.5	96.45
2002-03	273.75	83.79
2003-04	NA	37.55
2004-05	707.25	163.26
2005-06	615.5	104
2006-07	658.75	122.25
2007-08	649.5	135.37
2008-09	414	91.75
2009-10	607.25	93.81
2010-11	816.25	106.66
2011-12	343.25	66.32
2012-13	315.125	92.69

Source- Compile from various annual Socio-Economic Survey of Satara district

During the year 2008-09 agriculture production was 91750 tonnes and that

Year rainfall was 414 mm. Table shows lowest productivity was 37550 tonnes during the year 2003-04 and that year rainfall may be near about 110 mm.

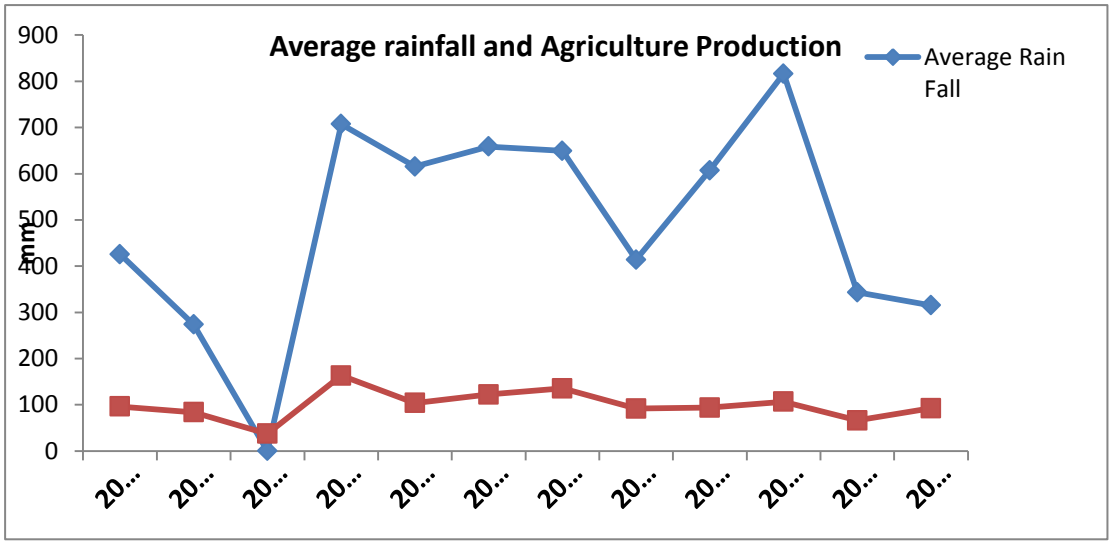

Fig No- 5.2: Average Rainfall and Agriculture Production of Dry zone Tehsils of Satara District.

5.3 Land Use Pattern:

In Table No. 5.3 (a) present the land utilization of drought prone Tehsil of Satara district during the year 2001 to 2008.

Table No- 5.3 (a) Land Utilization of Satara District area in ha Year 2001-02 to 2007-08

Figure in the bracket indicates percentage

Tehsil	Geographical Area (ha)	Forest Area	Total non-cultivated Area	Other than non-cultivated	Total Follow Area	Total cultivated area	Total cultivable area
Khatav	136457	4121 (3.02)	11295 (8.28)	7923 (5.81)	20682 (15.16)	110335 (80.86)	121041 (88.70)
Man	150787	12954 (8.59)	25264 (16.75)	35757 (23.71)	18627 (12.35)	74077 (49.13)	112569 (74.65)
Phaltan	119029	10892 (9.15)	16784 (9.15)	15227 (12.79)	21883 (18.38)	77823 (65.38)	91353 (76.75)
Khandala	53608	6498 (12.12)	9369 (17.48)	5637 (10.52)	9514 (17.75)	33794 (63.04)	37741 (70.40)

Table No- 5.3 (b) Land Utilization of Dryaland of Satara District area in hector Year 2008-09 to 2012-13

Figures in the bracket indicates percentage

Tehsil	Geographical Area (ha)	Forest Area	Total non-cultivated Area	Other than non-cultivated	Total Follow area	Total cultivated area	Total cultivable area
Khatav	136457	4121 (3.02)	11295 (8.28)	7923 (5.81)	30029 (22.01)	83428 (61.14)	103481 (75.83)
Man	150787	12954 (9.15)	25269 (16.76)	35757 (23.71)	20353 (13.50)	55851 (37.04)	96194 (63.79)
Phaltan	119029	10892 (9.15)	16784 (14.10)	15227 (12.79)	23136 (19.44)	64419 (54.12)	79426 (66.73)
Khandala	53608	6498 (12.12)	9384 (17.50)	5637 (10.52)	14031 (26.17)	40903 (76.30)	49588 (92.50)

Source: Compile from various annual Socio-Economic Survey of Satara District

Land Utilization of dryland of Satara District area in hector Year 2001 to 2008

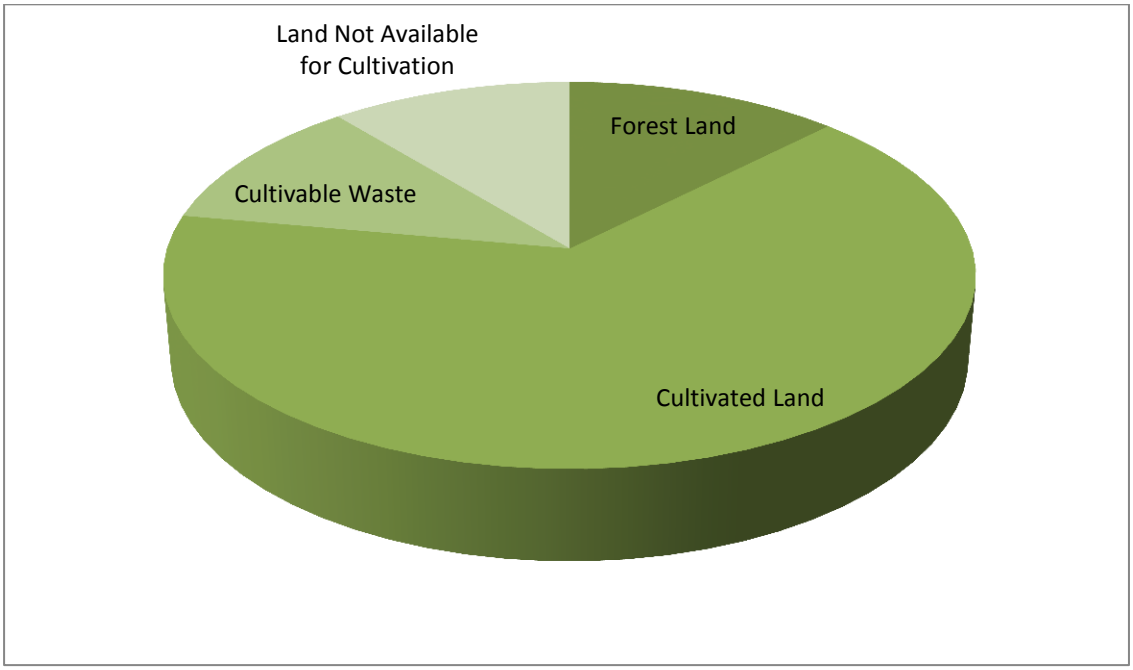

Fig No- 5.3 : Land Utilization of dryland area in hector Year 2001 to 2008

Land Utilization of dryland of Satara District area in hector Year 2009-2011

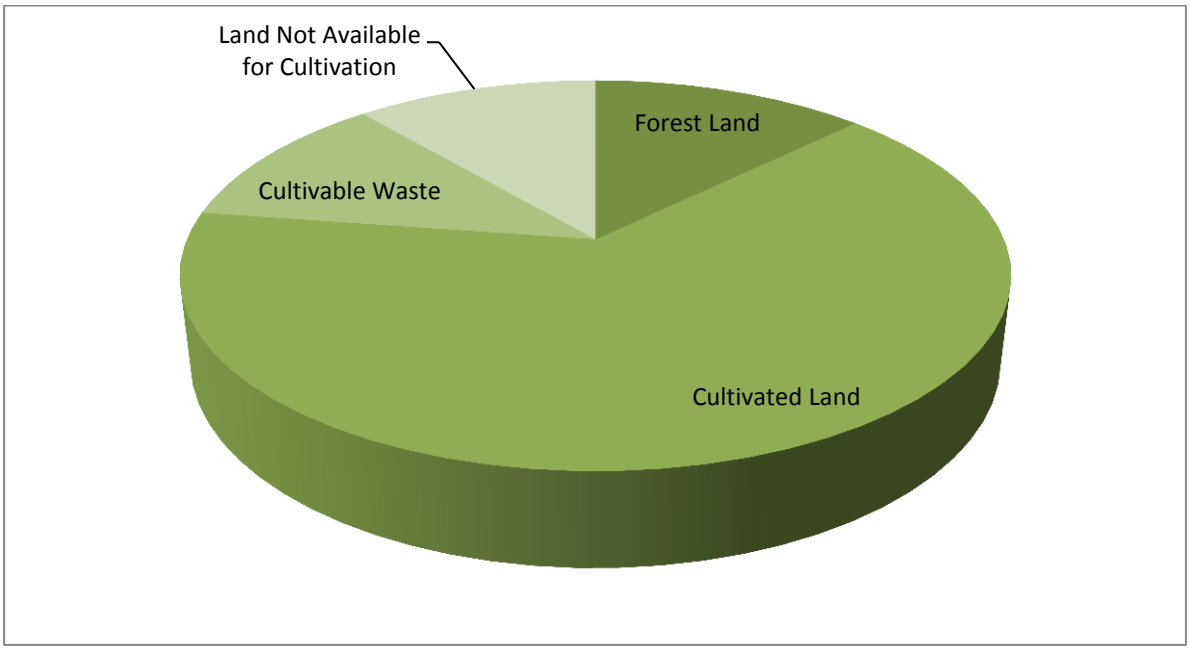

Fig No- 5.4 : Land Utilization of Satara District area in hector Year 2009-2011

Table No. 5.4
Trends of utilization of land in year 2013 as compared to year 2001

Sr.No	Tehsil	Forest Area Ha in %	Total non-cultivated Area Ha in %	Fallow Area in Ha (%)	Total cultivated area	Total cultivable area
1	Khandala	0.00	0.03	8.43	13.26	22.10
2	Phaltan	0.00	0.00	1.05	-11.26	-10.02
3	Man	0.00	0.00	1.14	-12.09	-10.86
4	Khatav	0.00	0.00	6.85	-19.72	-12.87

Source : Compile from Socio Economic Survey of Satara District

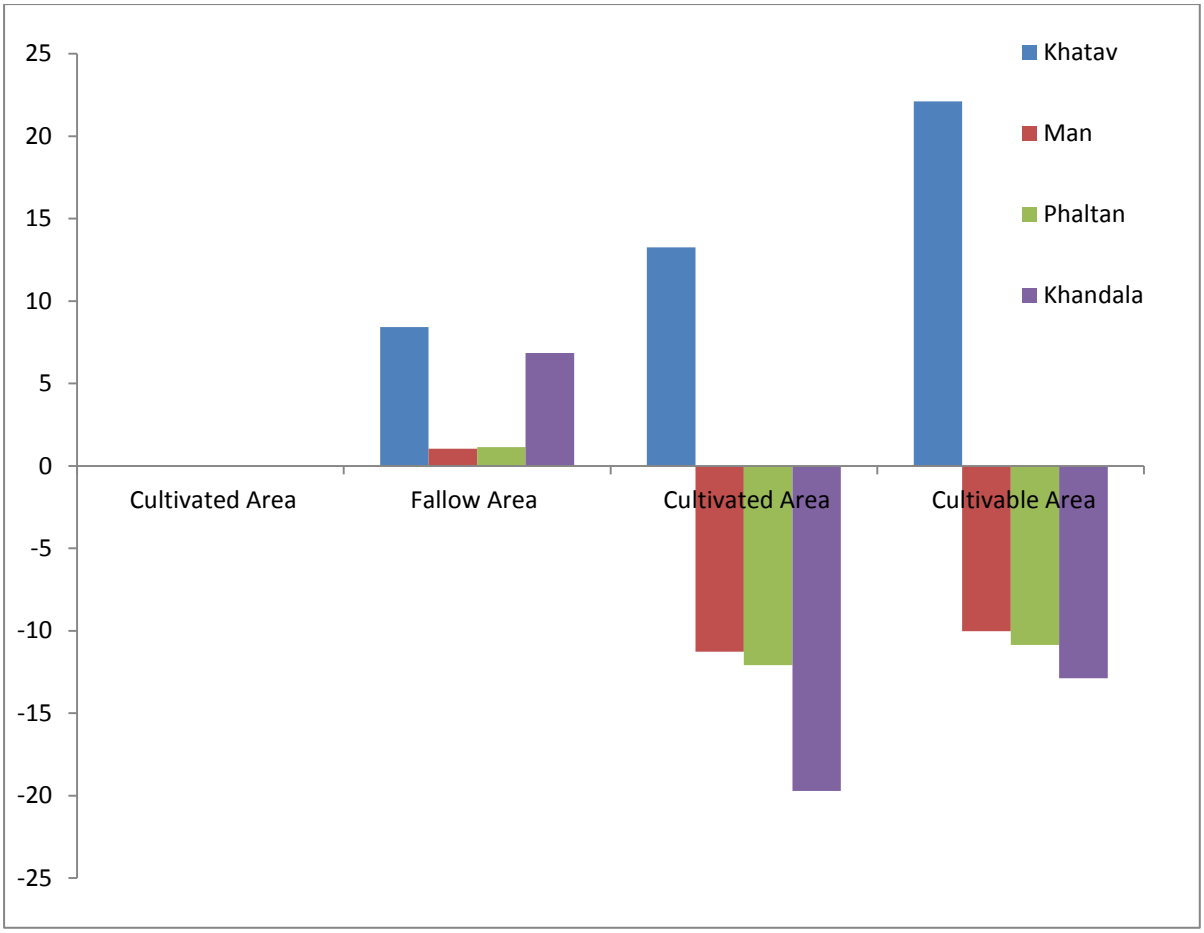

Fig No- 5.5 : Trends of utilization of land in year 2013 as compared to year 2001.

5.4 Statistical Test for equality of proportions for land used pattern in time Period-I and Period-II:

Duration of the study is from 2001-02 to 2012-13, this total period is divide into two phases depend upon use of land pattern. The duration of Period-I is from year 2001-02 to 2007-08 and that of Period-II is from year 2008-09 to 2012-13. Land under the different heads in time Period-I are changes in time Period-II. The geographical area is remains the same. Here there is need to test whether the land utilization is proportionally significant or not. So, by using statistical proportional test, whether the hypothesis is accept or reject.

Here, the hypothesis is setup;

H0 : P1=P2 ; that is there is no significant difference between the land use under the crop during the time Period-I and Period-II .

Against,

H1: P1 ≠ P2

Where ,

$$P1=\frac{Land\ under\ the\ crop\ in\ time\ period-I\ of\ dry\ zone\ tahsil}{Total\ Geographical\ land\ of\ four\ tahsil\ in\ time\ period-I}$$

$$P2=\frac{Land\ under\ the\ crop\ in\ time\ period-II\ of\ dry\ zone\ tahsil}{Total\ Geographical\ land\ of\ four\ tahsil\ in\ time\ period-II}$$

The test statistics is,

$$Z=\left|\frac{P1-P2}{SE}\right| \sim Z_{\text{df , 10\% l.o.s.}}$$

$$SE=\sqrt{\frac{p1q1}{n1}+\frac{p2q2}{n2}}$$

Here ; P1= 0.64 P2= 0.53

q.1= 0.36 q2= 0.47 SE= 0.28

So, Z= 0.3928 this is calculated Z value , Z table value at 10 % los is 1.64.

Decision: Z cal value is less than Z table value, thus hypothesis is accepted. It means that there is no significant difference between land used patterns in both the stated time period.

5.5 Trend in Production and Productivity:

The green revolution phase displayed a high yield growth per unit of input. The first post green revolution phase (from 1960s to mid-1980s) was marked by the continued growth in return from land through the intensification in use of chemical inputs and machine. The second post green revolution phase (beginning the mid-1980s) was characterized by high input use and decelerating productivity growth.

Agricultural development is important not only because of its high potential to raise the income and employment to poverty stricken rural masses but also due to its capacity to provide food , raw material and ever expanding market for industrial goods for speedy development of overall economy.

The term 'productivity' is regarded as "A ratio of the output to input in relation to land, labour, capital and overall resources employed in agriculture". Bhatia (1967) agriculture efficiency as " The aggregate performance of various crops in regard to their output per acre". Singh defined agricultural productivity as "The quality of return from arable land".

The present study is focus on computing crop productivity of drought prone tehsil of Satara district. Dryzone tehsil is the basic unit of study. Jowar ,Bajra, Soyabean, Pulses, sugarcane, cotton groundnut etc. are the main crops are studied for study the trend of cropping pattern.

Crop production (P) is expressed as product of Area (A) and Production per unit i.e. yield (Y) i.e. **P = A*Y.**

1. **Crop-Bajara :** Bajara Jowar and are the two major crops cereals grown in Satara district. These two crops are drought resistant. Bajara Crop is well adapted to production system characterized by low rainfall, low fertility and high temperature. It is mostly grown in drought prone area. Table No. 5.5 shows the Tehsil wise changing trend in Area, Production and Productivity (Yield) of Bajara crop. It can be seen from table that area under the crop has decreased by 8219 hector in study Period-II as compare to Period-I. During Period-I and Period-II growth in area was negative, however productivity and production rate during second period was positive. Mainly Bajara crop is cultivated in Khatav, Man, Khandala and Phaltan tehsil of Satara district.

Table No- 5.5:

Tehsil-wise changing trend in Area, Production and Productivity of Bajara

		Period-I				Period-II			
Tehsil	**Geo. Area in ha**	**Arable Land in ha**	**A**	**Y**	**P**	**Arable Land**	**A**	**Y**	**P**
Khatav	136457	110335 (80.85)	33700 (30.54)	393.6	13263.4	83428	25481	467.8 (1.84)	11920.3 (-10.13)
Man	150787	74077 (49.12)	19211 (25.93)	396.7	7621.3	55851	14484	426.6 (2.95)	6179.0 (-18.92)
Phaltan	119029	77823 (65.38)	8202 (10.54)	1250.6	1025.72	64419	6789	1212.2 (17.85)	8230.0 (-19.76)
Khandala	53608	33794 (63.03)	11499 (34.03)	729.3	8386.1	40903	13918	770.4 (5.54)	10722.4 (27.86)
Total			72612		30296.5		60672		37051.7

Source- Agriculture Department of Satara District (ATMA).

A- Area in hector , Y- Yield (Productivity) in Kg/ ha , P – Production in Tonnes

Note:1) Figures in the bracket indicates percentage.

2) Graphical presentation of Trend line shown in Appendix No- A1.

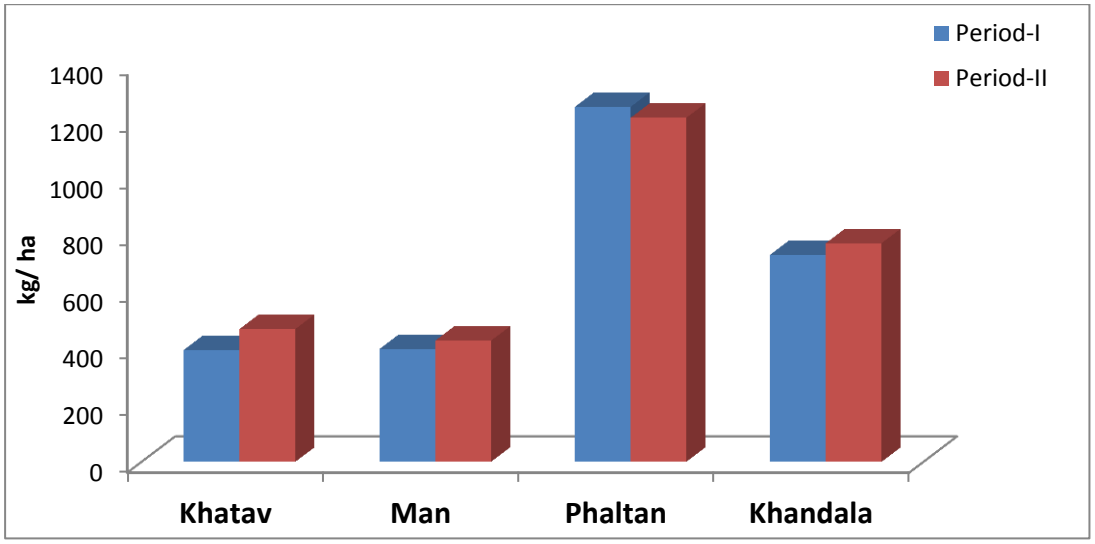

Fig No- 5.6 : Trends in productivity of Bajara Crop

The average productivity of crop Bajara in Khatav and Man during Period-I is 393.6 kg/ha and 396.7 kg/ha, while in Phaltan tehsil it is 1250.6 kg/ha, it shows 3.5 times more than Khatav and Man tehsil. From the table it shows that productivity of Khandala tehsil is two times than Khatav and Man tehsil. During the Period-II, productivity in Khatav, Man and Khandala tehsil are showing increases as 64 kg/ha, 30 kg/ha and 40 kg/ha respectively. The average growth rates of productivity in Khatav tehsil is increased in Period-II by 18.86 percent, in Man tehsil it is 7.53 percnet and in Khandala tehsil it is 5.64 percent as compare to Period-I. While in Phaltan tehsil productivity is high but it shows decreasing trend in Period-II by 3.07 percent. Total average production in Period-I is 30296.5 tonnes and that of in Period-II is 37051.7 tonnes.

2. Crop- Jowar : Jowar is grown in arid and semiarid regions. Jowar is meant for both food and feed. Jowar crop consist sugar in the stalk, so it can be used for bio-fuel production. Jowar is the main food grain crop. The average area under this crop was 45747 ha in 2001-02, which was decreased by 7903 ha in 2010-2011.

The drought prone tehsil wise growth in production and productivity of Jowar crop is presented in Table No.-5.6. It can be seen from the table that during Period-II as compare to Period-I productivity (Yield) of Jowar crop has increased. substantially. The Productivity of Jowar crop in Man and Khandala tehsil shows increased while in Tehsil Khatav and Phaltan it shows decreased in Period-II as compare to Period-I. The growth rate of productivity in Man tehsil is increased in Period-II as compare to Period-I by 5.16 percent, while in Khandala tehsil productivity has increased by 11.14 percent. While in Khatav and Phaltan tehsil productivity shows decreases by 13.07 percent and 3.15 percent respectively. Total average production in Period-I is 33337.1 tonnes and that of in Period-II is 27183.7 tonnes. Crop-Jowar is stable food crop of farmers grown by constant because it is food and feed crop**.**

Table No 5.6

Tehsil-wise changing trend in Area, Production and Productivity of Jowar

		Period-I				**Period-II**			
Tehsil	**Geo. Area in ha**	**Arable Land**	**A**	**Y**	**P**	**Arable Land**	**A**	**Y**	**P**
Khatav	136457	110335	17429 (15.79)	797.0	13891	83428	13179	692.8 (-13.0)	9130.2 (-34.2)
Man	150787	74077	13505 (18.23)	494.9	6683	55851	10182	520.4 (5.16)	5298.8 (-20.7)
Phaltan	119029	77823	9000 (11.56)	902.4	8122	64419	7450	874 (-3.15)	6511.2 (-19.8)
Khandala	53608	33794	5813 (17.20)	798.4	4641	40903	7036	887.4 (11.14)	6243.6 (34.5)
Total			45747		33337		37847		27183.8

Source: Same as table no. 5.5

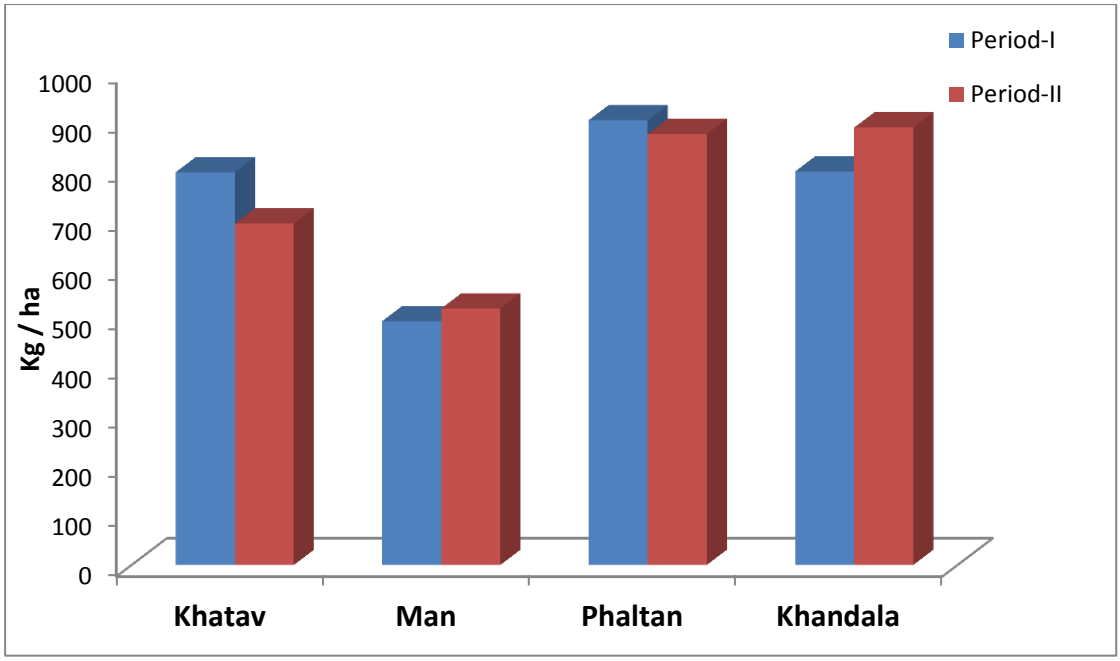

Fig No- 5.7 : Trends in Productivity of Jowar Crop

3. Crop- Wheat

Wheat is major crop in drought prone tehsil, this crop required more water than other crops except sugarcane. Near about 5 to 6 times water is required in the life cycle of this crop. It can be seen from the Table No. 5.7 that productivity of crops remains near about constant in time Period-I and Period-II. The productivity is high in Phaltan tehsil in both the time period and productivity is low in Khatav tehsil. Crop-Wheat sown in Phaltan tehsil is in more area of land (56%) during the Period-I and that of Period-II. Productivity as well as production of crop-Wheat is maximum in Phaltan tehsil other than all Tehsils of study area. The trend of area under the crops in Period-II is decreases as compare to Period-I throughout all tehsils. Average productivity in Man tehsil shows decreases by 11.84 percent. Productivity in Phaltan and Khandala tehsil shows slight decreases by 1.19 and 0.90 percent

respectively. In Khatav tehsil productivity remains same in Period-I and also in Period-II.

Table No- 5.7

Tehsil-wise changing trend in Area, Production and Productivity of Wheat

		Period-I				Period-II			
Tehsil	**Geo. Area in ha**	**Arable Land**	**A**	**Y**	**P**	**Arable Land**	**A**	**Y**	**P**
Khatav	136457	110335	4315 (3.9)	1268.4	5473	83428	3262	1270 (0.09)	4142 (-24.32)
Man	150787	74077	1893 (2.5)	1552.0	2938	55851	1427	1368 (-11.8)	1953 (-33.53)
Phaltan	119029	77823	4404 (5.6)	2336.6	10290	64419	3645	2309 (-1.19)	8416 (-18.21)
Khandala	53608	33794	2148 (6.3)	1488.4	3197	40903	2599	1475 (-0.9)	3835 (19.94)
Total			12760		21898		10933		18346

Source: Same as table no. 5.5

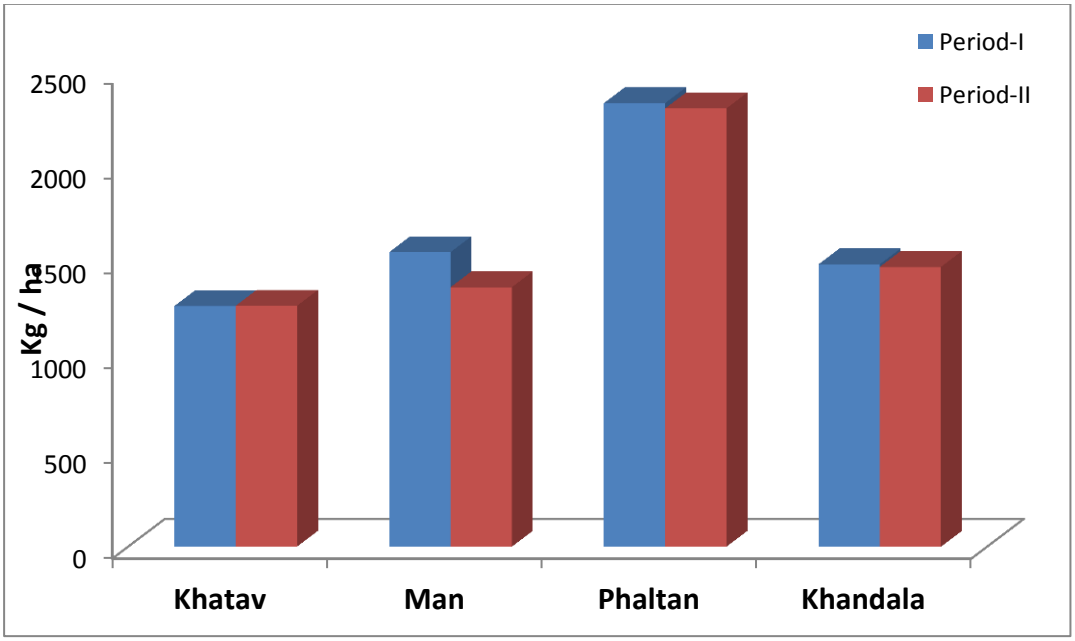

Fig No- 5.8 : Trends in Productivity of Wheat Crop

Total average area under the crop Wheat during Period-I is 12760 hector and during Period –II is 10834 hector. It can be shown that area under the crop during Period-II is decreased by 1926 ha (15 %). Total average production of crop Wheat in Period-I is 21898.6 tonnes and that of in Period-II is 18346.6 tonnes.

4. Crop-Maize:

Maize is a source of large number of industrial products besides its uses as human food and animal feed. Tehsil wise changing growth in production(P) and productivity (Y) of Maize crop of drought prone tehsil of Satara district. It can be seen from Table No.-5.8 that average productivity of crop Maize in tehsils Khatav, Man, Khandala shows lower in Period-II as compare to Period-I by 40.47 percent, 16.87 percent and 80 percent respectively. In Khandala tehsil productivity shows very low. However in tehsil Phaltan the average productivity has increased by 29.39 percent in Period-II.

Total average area in Period-I is 2504 ha and in Period-II is 2288 ha, it shows during Period-II area area under the crop Maize has decreased by 8.61 percent. Total average production in Period-I is 7367 tonnes and that of in Period-II is 5818 tonnes.

Table No- 5.8

Tehsil-wise changing trend in Area, Production and Productivity of Maize

		Period-I				Period-II			
Tehsil	**Geo. Area in ha**	**Arable Land**	**A**	**Y**	**P**	**Arable Land**	**A**	**Y**	**P**
Khatav	136457	110335	238 (0.21)	4394	1046	83428	180	2616 (-40.47)	471 (-55)
Man	150787	74077	229 (0.3)	4175	956	55851	173	3471 (-16.87)	599 (-37.3)
Phaltan	119029	77823	1387 (1.8)	3001	4162	64419	1148	3882 (29.39)	4457 (7.1)
Khandala	53608	33794	650 (1.9)	1850	1203	40903	787	370 (-80)	291 (-75.8)
Total			2504		7367		2288		5818

Source : Same as Table No. 5.5

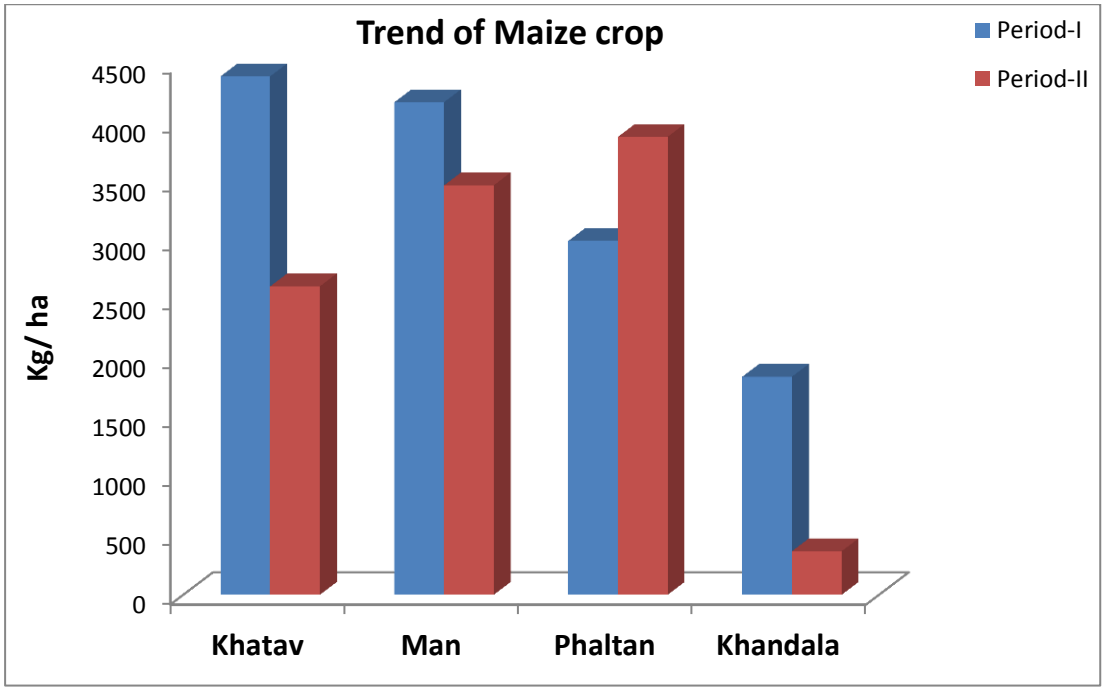

Fig No- 5.9 : Trends in Productivity of Maize Crop

The average area under the crop Maize (R.) is shown in Phalatn tehsil 1387 ha during the Period-I and 1148 ha during the Period-II.

5. Crop-Pulses : (Udid, Moog, Gram)

Udid ,Moog ,Gram are the crops which are included in pulses are sown in Satara district. Out of these Udid and Moog are the Kharif crops and Gram is a Rabbi crop. Gram is mostly sown crop. Pulses are major source of protein. The contribution of pulses in total food grains production has increased during the last three –four decades. Pulses are generally grown in rainfed conditions of arid and semiarid regions. Among the various pulses grown in Kharif occupy a major share in area and so production. They are grown as mixed as well as pure crops. Due to different agro-climatic conditions the changes in area , production and productivity (Yield) are not uniform in all Tehsil of Satara district.

Udid- Table No.5.9 has been shows that Udid pulse grown in three drought prone Tehsil except Phaltan Tehsil. In Khatav and Man tehsil the production and productivity increases year to year. However in tehsil Khandala it decreases. In tehsil Man production of Udid crop is increased by 105.31 percent in time period-II as compare to Period –I and in tehsil Khatav it is 11.17 percent. In tehsil Khandala area under the crop increases by 63 hector in Period-II as compare to Period-I but the productivity has been decreases by 2.45 percent. Total average area of all study region in Period-I is 1931 ha, while in Period-II it shows decreases by 336 ha (12.1 percent). Total production of crop Udid in Period-I is 867.7 tonnes and that of in Period-II is 866.a tonnes.

Moog is another important pulse, it grown in all four drought prone tehsil. It can be seen from the Table No. 5.10 that in tehsil Khatav and Man, average productivity shows increases by 33.35 percent and 49.65 percent respectively,

while in Phaltan and Khandala tehsil it shown decreases trend by 23.25 percent and 2.37 percent respectively in Time Period-II as compare to Period-I. Total average production during Period-I is shown 856.7 tonnes and that of in Period-II shows 845.5 tonnes. Total average area under the crop in Period-I is 1938 ha and in Period-II is 1628 ha. Area under the crop decreases by 15.99 percent. The average production in Period-I and Period-Ii shows 857 tonnes and 845.5 tonnes respectively.

Table No 5.9

Tehsil-wise changing trend in Area, Production and Productivity of Udid

		Period-I				**Period-II**			
Tehsil	**Geo. Area in ha**	**Arable Land in ha**	**A**	**Y**	**P**	**Arable Land in ha**	**A**	**Y**	**P**
Khatav	136457	110335	1214 (1.10)	481.4	584	83428	918	535.2 (11.17)	491 (-15.9)
Man	150787	74077	417 (0.56)	263.5	110	55851	314	541.0 (105.31)	170 (54.8)
Khandala	53608	33794	300 (0.89)	578.1	173	40903	363	564.0 (-2.45)	205 (18.0)
Total			1931		867		1595		866

Source : Same as Table No. 5.5

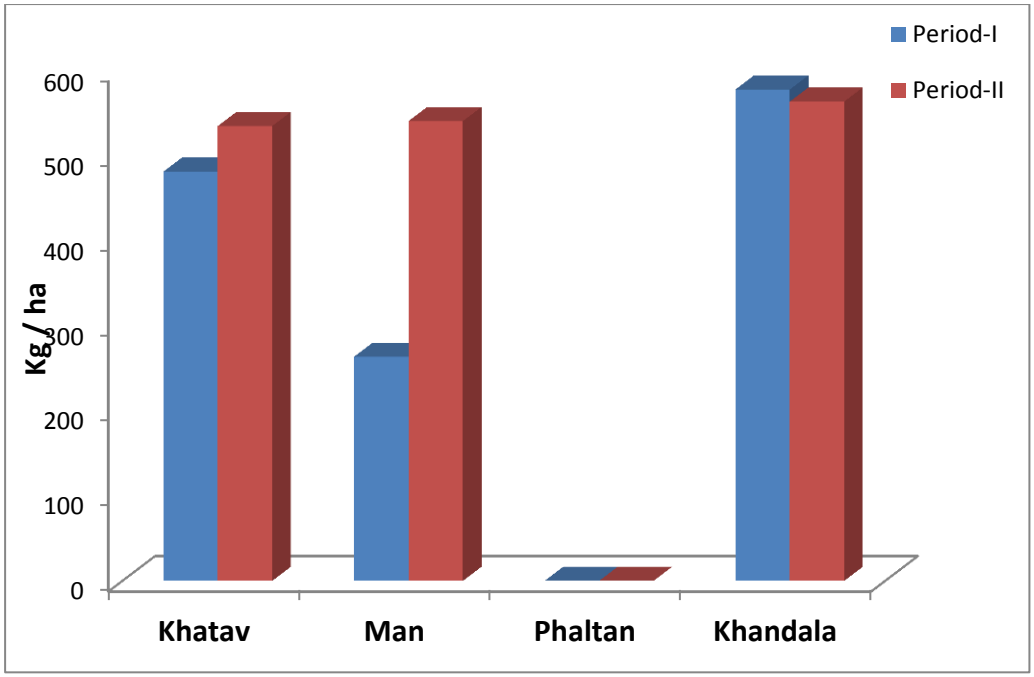

Fig No- 5.10 : Trends in Productivity of Udid Crop

Table No 5.10

Tehsil-wise changing trend in Area, Production and Productivity of Moog

		Period-I				Period-II			
Tehsil	**Geo. Area (ha)**	**Arable Land (ha)**	**A**	**Y**	**P**	**Arable Land (ha)**	**A**	**Y**	**P**
Khatav	136457	110335	670 (0.6)	451.0	302	83428	507	601.4 (33.3)	305 (0.83)
Man	150787	74077	638 (0.8)	285.3	182	55851	481	427.0 (49.6)	205 (12.8)
Phaltan	119029	77823	320 (0.4)	601.3	192	64419	265	461.5 (-23.2)	122 (-36.4)
Khandala	53608	33794	310 (0.9)	582.4	181	40903	375	568.6 (-2.37)	213 (18.1)
Total			1938		857		1628		845

Source : Same as Table No. 5.5

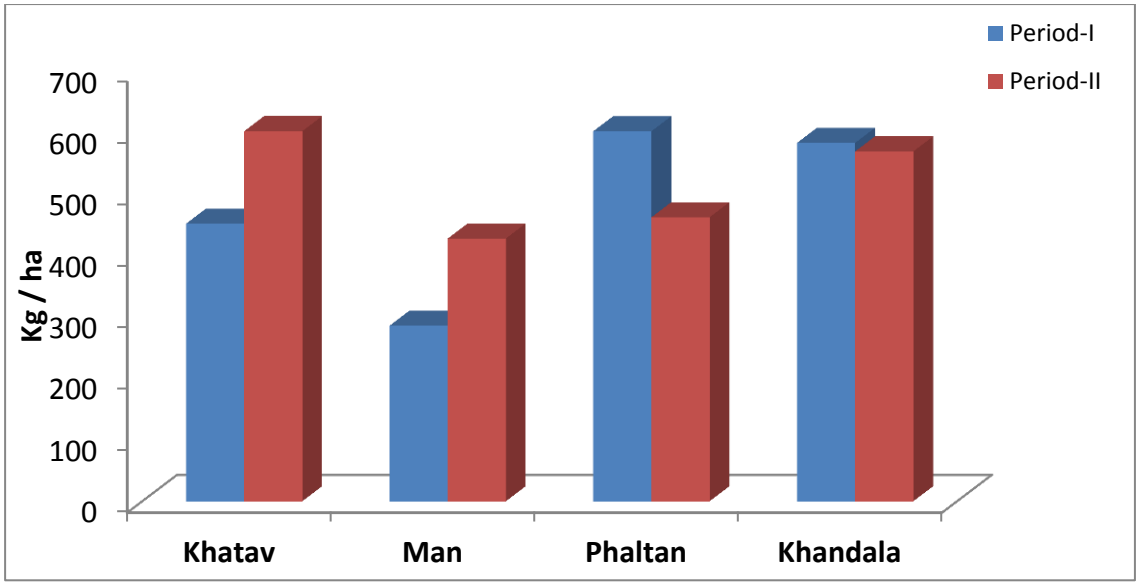

Fig No- 5.11 : Trends in Productivity of Moog Crop

Gram : Gram is major pulse crop sown in all over Satara district . This crop is drought resistant so it mainly sown in drought prone region of district. Gram is major crop of farmers of study region tehsil. The importance given by farmers for this crop is first after food grain crops i.e. after Jowar , Whete and Bajara. The changes in production and productivity of Gram crop is presented in Table No. 5.11. This crop included in pulse but it is very important crop in respect to food grains as well as money earning crop. Day by day there is problem of agriculture labours arises in rural area. The crop Gram has no required water only labours are required for to pround from sown field. It can be seen from the table that in all four drought prone tehsil Crop Gram is sown large scale. Near about on an average 6789 ha area occupied by this crop in study Period-I and 5721 ha in study Period-II The productivity of Gram in Man and Phaltan tehsil shows decreases by 1.19 percent, 16.08 percnet in Period-II as compare to Period-I respectively, while in tehsil Khatav ad Khandala the productivity shows increases in Period-II by 17.72 and 17.02 percent respectively than Period-I. Total average production of

crop Gram during Period-I is 3729.65 tonnes and that of during Period-II is 3396.5 tonnes.

Table No.-5.11

Tehsil-wise changing trend in Area, Production and Productivity of Gram

		Period-I				Period-II			
Tehsil	**Geo. Area in ha**	**Arable Land in ha**	**A**	**Y**	**P**	**Arable Land in ha**	**A**	**Y**	**P**
Khatav	136457	110335	3091 (2.8)	481.0	1487	83428	2337	551.8 (17.72)	1289 (-13.2)
Man	150787	74077	1983 (2.7)	573.8	1135	55851	1495	562.2 (-1.91)	840 (-26.0)
Phaltan	119029	77823	490 (0.6)	849.8	416	64419	406	713.2 (-16.1)	289 (-30.5)
Khandala	53608	33794	1225 (3.6)	563.1	689	40903	1483	659.0 (17.0)	977 (41.6)
Total			6789		3727		5721		3395

Source : As per Table No. 5.5

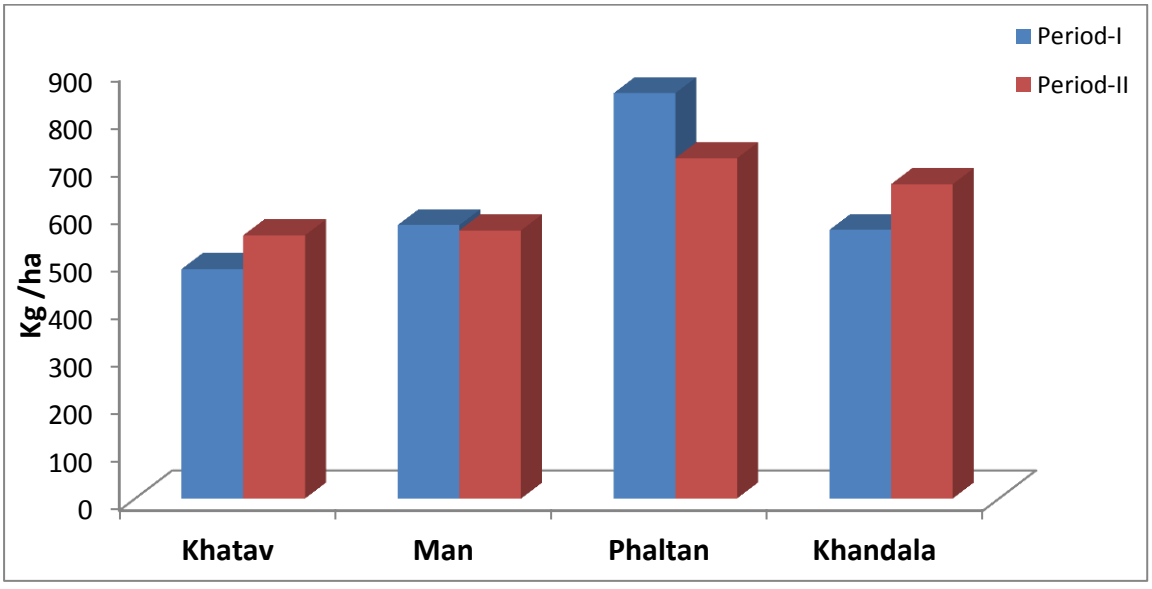

Fig No- 5.12 : Trends in Productivity of Gram Crop

Groundnut(S) : Groundnut is major oilseed crop sown in Satara district in Kharif and Rabbi Season. The area occupied by this crop is high before 1990's but there after importance of Soyabean crop, the area of groundnut crop declines. Groundnut crop is sown in drought prone tehsil by farmers who have water availability. Table No.5.12 shows the changes in production and productivity in crop. It shows that during period-I and Period-II productivity growth was positively changes but vary low as compared to area. In all drought prone tehsils Khatav, Man, Phaltan, and Khandala shows the productivity of crop groundnut decreases by -18.2 percent, -18.2 percent , -34.58 percent and -47.62 respectively as compare to Period-I to the Period-II. In tehsil Khatav and Khandala shows the average area under the crop is more than tehsil Man and Phaltan in time Period-I as well as Period-II. From the table it can be seen that the productivity of groundnut in Khatav tehsil decreases by 391.5 kg/ha and that of Man , Phaltan and Khandala tehsils decreases by 346.7 kg/ha, 943.1 kg/ha and 1495.9 kg/ha respectively. The total average production of crop Groundnut during Period-I is 1260.6 tonnes and during Period-II is 7559.7 tonnes, it shows that production decreases by 4800 tonnes and area under the crop decreases by 165 ha.

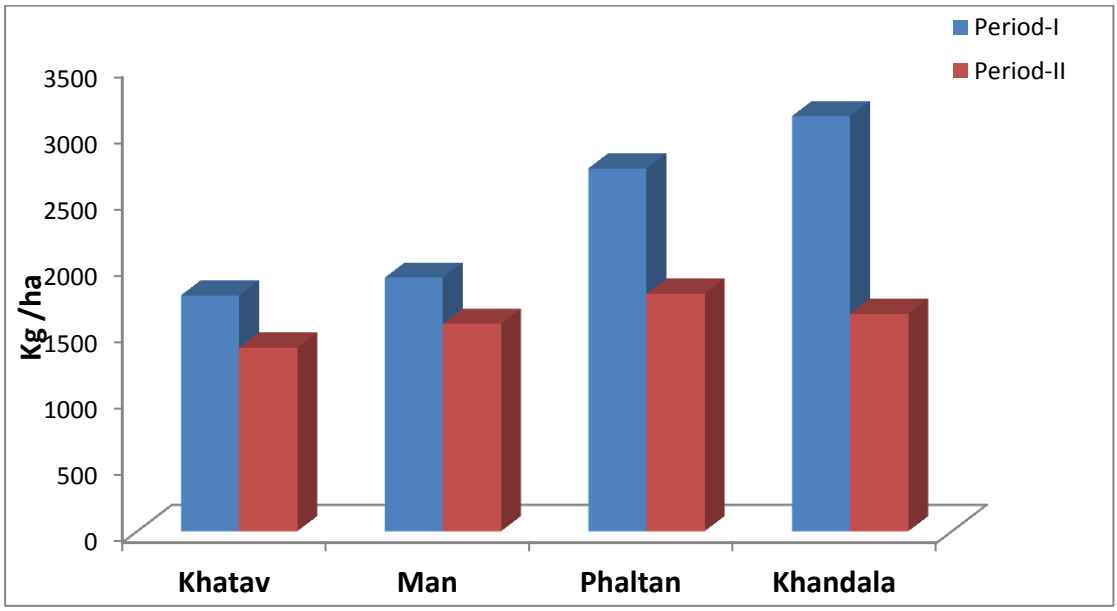

Fig No- 5.13 : Trends in Productivity of S. Groundnut Crop

Table No.-5.12

Tehsil-wise changing trend in Area, Production and Productivity of Groundnut

		Period-I				Period-II			
Tehsil	**Geo. Area in ha**	**Arable Land**	**A**	**Y**	**P**	**Arable Land**	**A**	**Y**	**P**
Khatav	136457	110335	2089 (1.8)	1773.5	3705	83428	1579	1382 (-22.0)	2184 (-41.0)
Man	150787	74077	243 (0.32)	1905.7	463	55851	183	1559 (-18.2)	286 (-38.3)
Phaltan	119029	77823	412 (0.52)	2728.1	1124	64419	341	1785 (-34.6)	608 (-45.8)
Khandala	53608	33794	2265 (0.42)	3120.9	7068	40903	2741	1635 (-47.6)	4482 (-36.6)
Total			5009		12360		4844		7560

Source : As per Table No.-5.5

6. Soyabean : Soyabean is commercial oilseed crop. Among oilseed crops, ,soyabean crop accounts highest share in area throughout the district. Under the crop Soyabean area is increases year to year during the study period. Soyabean is a Kharif crop and it take a place of groundnut and bean (Rajama). The characteristic of crop Soyabean is it grown in rainy areas as well as drought prone areas. It is Kharif crop so uncertainly if there is high rainy season that time there is no effect on production of crop Soyabean . Table No.5.13 shows that Soyabean crop grown in only Khatav and Phaltan tehsils. There is high variation in area under this crop of these two tehsil. In Khatav tehsil productivity of Soyabean has increases by 4.58 percent and in Phaltan tehsil production has decreases by 15.34 percent in Period-II as compare to Period-I respectively. The average productivity has increased in Khatav tehsil by 39 kg/ha however in Phaltan tehsil it has

decreased by 234.4 kg/ha. The total average production during Period-I is 2629.7 tonnes and during Period-II is 1921 tonnes per annum.

Table No.-5.13
Tehsil-wise changing trend in Area, Production and Productivity of Soyabean

		Period-I				Period-II			
Tehsil	**Geo. Area in ha**	**Arable Land**	**A**	**Y**	**P**	**Arable Land**	**A**	**Y**	**P**
Khatav	136457	110335	1021 (0.09)	850.4	868	83428	772	889.4 (4.58)	686 (-20.9)
Phaltan	119029	77823	918 (0.01)	1918.8	1761	64419	760	1624.4 (-15.3)	1235 (-29.9)
Total			1939		2629		1532		1921

Source : As per Table No.-5.5

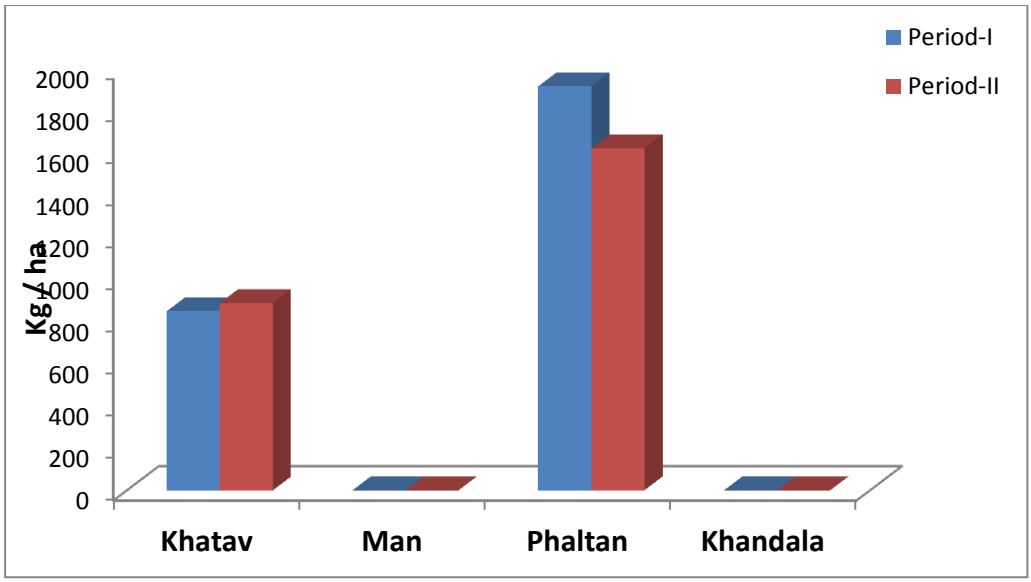

Fig No- 5.14 : Trends in Productivity of Soyabean Crop

7. Cotton : This is commercial crop grown by farmers. The important of this crop is significantly in agricultural and industrial economy. India is the third largest producer of Cotton in the world. Cotton yield in India is one of the lowest in the world because its cultivation is predominantly under rainfed condition. Almost 66 percent of area under crop Cotton was cultivated under rainfed area. In Satara

district mostly this crop produced mostly in drought prone area. Tehsilwise growth in production and productivity of Cotton crop is presented in Table No. 5.14. It can be seen from the table that area under crop Cotton is 2959 ha in Period-I and 2599 ha in Period-II, while predominant cultivation of cotton under rainfed condition increases the uncertainty in getting expected yield, different kinds of pests attack significantly reduce the yield of crop. Bt cotton varieties were released, which leads to significant increase in production and productivity of cottaon crop. In tehsil Khatav, Man, Phaltan the productivity showing incerses by 17.85 percent, 9.99 percent ,31.67 percent during Period-II as compare to Period-I. While in Tehsil Khandala productivity showing decreases by 21.53 percnet. Total average area under the crop in Period-I is 2959 ha and that of in Period-II is 2599 ha. Total average production during Period-I is 1496.7 tonnes per annum and 1143 kg/ha per annum in Period-II.

Table No.-5.14
Changes in production of Cotton crop in time Period-I and Period-II

		Period-I				Period-II			
Tehsil	**Geo. Area in ha**	**Arable Land**	**A**	**Y**	**P**	**Arable Land**	**A**	**Y**	**P**
Khatav	136457	110335	962 (0.9)	388.0	373	83428	727	457.2 (62.8)	333 (45.7)
Man	150787	74077	456 (0.6)	451.1	206	55851	344	496.2 (144.3)	170 (49.6)
Phaltan	119029	77823	882 (1.1)	551.1	486	64419	730	725.6 (99.4)	530 (72.8)
Khandala	53608	33794	659 (1.9)	655.0	431	40903	798	514.0 (64.4)	410 (51.4)
Total			2959		1496		2599		1443

Source : As per Table No- 5.5

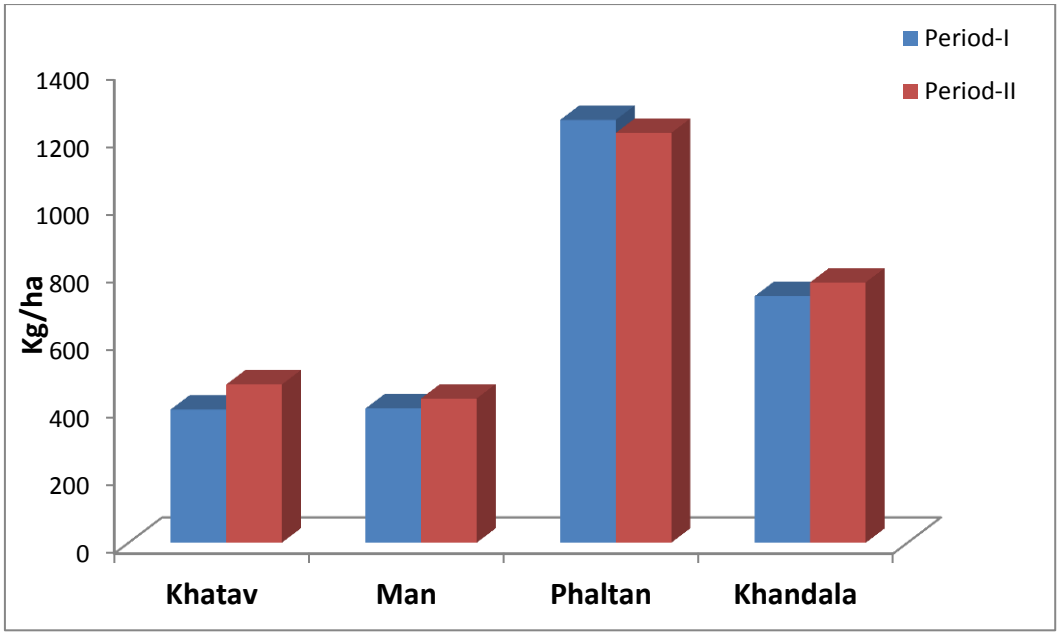

Fig No- 5.15 : Trends in Productivity of Cotton Crop

8. Sugarcane : Sugarcane is a commercial crop cultivated in Western part of Maharashtra state. The sugarcane productivity is almost stagnant during last two decades. Sugarcane crop consumes nearly 60 to 70 percent of available water. Keeping in the view the availability of water in drought prone area of district , how the farmers grown this crop in their field. Table No. 5.15 shows the area , production and productivity (Y) of this crop. Average area of this crop is nearly remaining constant throughout study period i.e. from year 2001-02 to 2012-13. Particularly area under this crop of tehsil Khatav shows decreased from 82.4 ha to 65.6 ha as in Period-II as compare to Period-I. and remaining three tehsil i.e. Man, Phaltan, Khandala there is slight change in area. The total average area under this crop showing 11016 ha during the Period-I to and that of in Period-II it is 8905 ha. Area under this crop shows decreases by 19.16 percent in Period-II than Period-I.

Table No.-5.15
Changes in production of Sugarcane crop in time period-I and period-II
(Yield in tonnes, Production in tonnes)

		Period-I				Period-II			
Tehsil	**Geo. Area in ha**	**Arable Land**	**A**	**Y**	**P**	**Arable Land**	**A**	**Y**	**P**
Khatav	136457	110335	3540 (3.2)	82.4	291696	83428	2677	65.6 (20.3)	175592 (-39.8)
Man	150787	74077	2291 (3.1)	80.2	183738	55851	1727	85.4 (6.5)	147513 (-19.7)
Phaltan	119029	77823	4637 (5.9)	93.3	432565	64419	3838	91.0 (-2.5)	349288 (-19.2)
Khandala	53608	33794	548 (1.6)	73.9	40473	40903	663	90.4 (22.4)	59960 (48.1)
Total			11016		948472		8905		732353

Source – Same as Table No-5.5

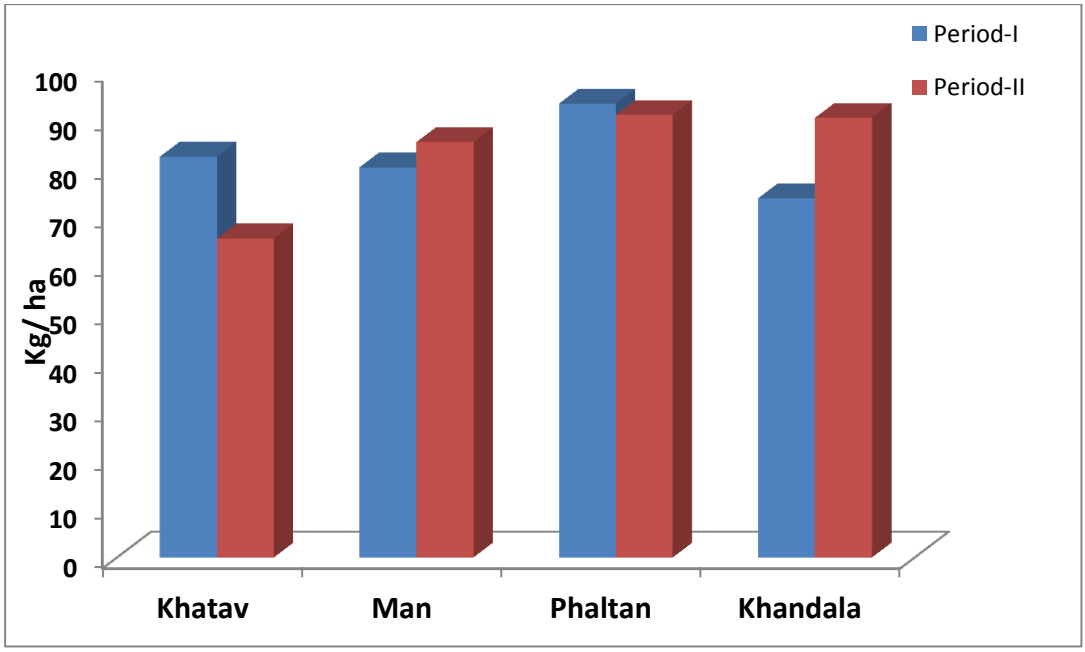

Fig No- 5.16 : Trends in Productivity of Sugarcane Crop

Table No-5.16

Crop wise Variation in Productivity across Tehsil

Crops	Period (I /II)	Highest (H)		Lowest (L)		Ratio	Difference in Ratio (II-I)
		Tehsil	Yield(Kg/Ha)	Tehsil	Yield(Kg/Ha)		
Bajara	I	Phaltan	1250.6	Khatav	393.6	3.18	-0.34
	II	Phaltan	1212	Man	426.6	2.84	
Jowar	I	Phaltan	902	Man	494.9	1.82	+0.12
	II	Phaltan	1010	Man	520.4	1.94	
Wheat	I	Phaltan	902.4	Man	494.9	1.82	+0.05
	II	Phaltan	1010	Man	538	1.88	
Maize	I	Phaltan	4161	Man	956.1	4.35	+6.14
	II	Phaltan	3882	Khandala	370	10.49	
Udid	I	Khandala	578.1	Man	263.5	2.19	-1.14
	II	Khandala	564	Khatav	534.2	1.06	
Moog	I	Phaltan	601.3	Man	285.3	2.11	-0.70
	II	Khatav	601.4	Man	427	1.41	
Gram	I	Phaltan	849.9	Khatav	481	1.77	-0.47
	II	Phaltan	713.2	Khatav	551.8	1.29	
Groundnut	I	Man	998.7	Khatav	622.3	1.60	-0.07
	II	Phaltan	1053	Khatav	686.2	1.53	
Soyabean	I	Phaltan	1918.8	Khatav	850.4	2.26	-0.43
	II	Phaltan	1624	Khatav	889.4	1.83	
Cotton	I	Khandala	655	Khatav	388	1.69	-0.10
	II	Phaltan	726	Khatav	457	1.59	
Sugarcane	I	Phaltan	93.3	Khandala	73.9	1.26	+0.12
	II	Phaltan	91	Khandala	65.6	1.39	

Source: Compile from various socio- economic review of Satara district

It can be seen from the table that the crop wise variation in productivity across tehsil that in Phaltan tehsil crop Bajara , Jowar, Wheat, Maize, Gram, Soyabean, Sugarcane getting the productivity during the Period-I and also during the Period-II. Again it shows that the difference in Productivity against in Period-I and Period-II is not finding more. The productivity in crop Jowar, Wheat, showing increases and in crop Bajara, Maize, Gram, Soyabean and Sugarcane were dereases. The productivity of S. Groundnut in tehsil Man is highest in Period-I and Phaltan tehsil is highest in Period-II. The productivity of crop Cotton is highest in Khandala tehsil in Period-I and tehsil Phaltan in Period-II.

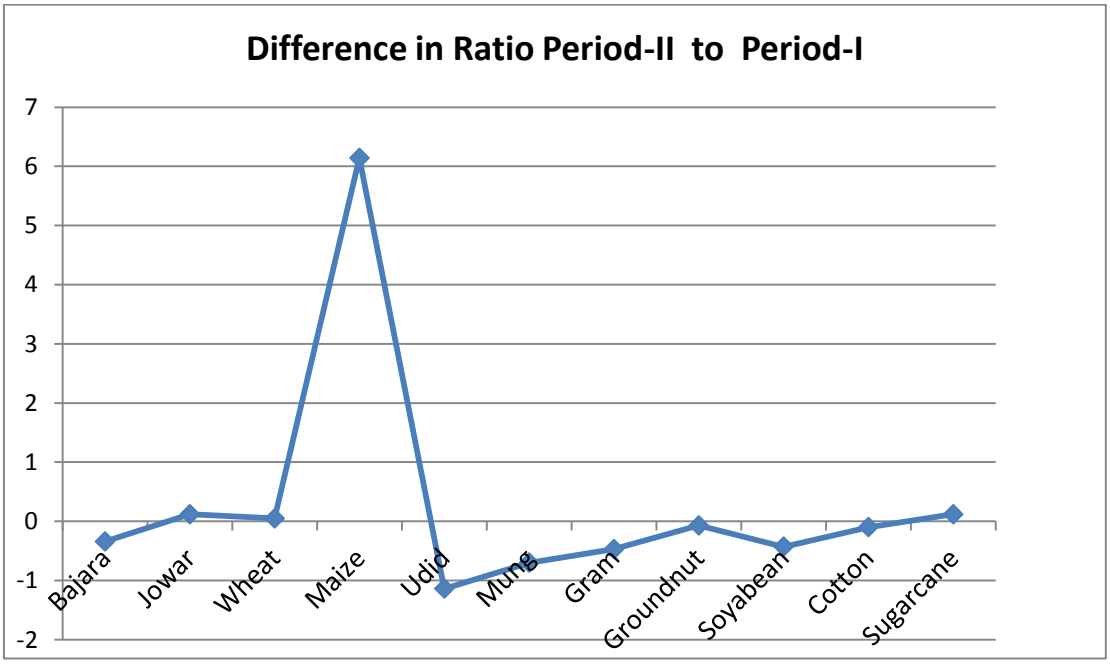

Fig No- 5.17 :Difference in Ratio Period-II to Period-I

From the table it can be seen that the Man and Khatav tehsil has lowest productivity in almost all the major crops. The difference in the highest and lowest productivity across Period-I and Period-II shows more than two times i.e. there is more variation in productivity of crops across tehsil.

The last column of the table shows the difference in the ratio of crops. The graphical presentation shows that the trend in productivity of major crops.

5.6 Index of Productivity of Major Crops

Index number of productivity (Yield) is shown the changes in the productivity of the crop in dry zone tehsil of Satara district. Index numbers are computed for 2012-13 with respect to base year 2001-02 and 2007-08. Index numbers of the major crops are presented in the Table No.5.16.

Table No. – 5.17

Index number of Productivity in kg/ha measuring scale of major crops

Crop	Tehsil							
	Khatav		Man		Phaltan		Khandala	
	2001-02	2007-08	2001-02	2007-08	2001-02	2007-08	2001-02	2007-08
Bajara	123.08	81.28	176.84	56.55	110.85	90.21	146.73	68.15
Jowar	105.30	94.97	144.24	69.33	120.29	82.79	128.40	77.88
Wheat	105	94.97	144.27	69.33	120.79	82.79	82.79	77.88
Maize	..	..	230.54	43.38	156.02	64.09	..	..
Udid	200	50	71.59	**139.68**	..	..	148.28	67.46
Moog	182.63	54.75	116.80	85.62	111.15	89.97	175.06	57.12
Gram	126.92	78.79	126.14	79.28	51.46	**194.32**	108.97	91.77
Groundnut	124.29	80.45	167.33	59.76	85.39	**117.11**	128.43	77.86
Cotton	200	49.92	91.61	**109.16**	83.27	**120.09**	..	..

From the Table No. 5.17, it can be seen that the trend of index numbers of major crops from drought prone tehsil of Satara district during the study period. Table gives productivity (Yield) in kg/ ha of drought prone tehsil. Index numbers

are computed for the year 2012-13 by taking base year 2001-02 and 2007-08. Index numbers gives the changes in the productivity, so here index number compute for to find the trend of productivity of year 2012-13 with respect to base year 2001-02 and middle year of 2007-08 because it shows normal year of total study period duration.

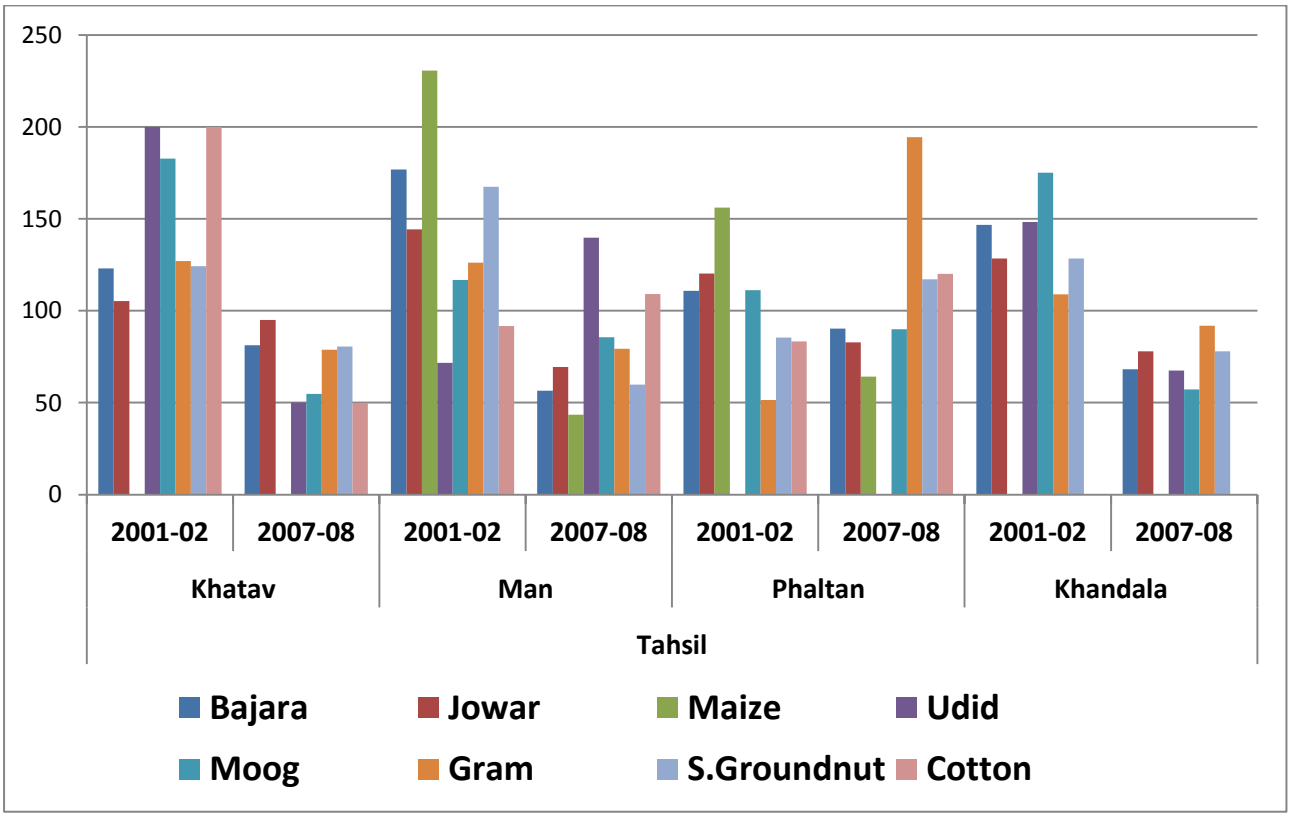

Fig No-5.18 : Index number of Productivity of major crops

The variation among the index number of major crops with respect to base year 2001-02 comparing with index number of base year 2007-08 , there is terrible insignificant.

Index number of crop Bajara in tehsil Khatav , Man ,Phaltan and Khandala are shows increasing trends. It increases by 23%, 76.8 %, 10.8 % and 46.7% respectively. However the index number with respect to base year 2007-08, the productivity shows decreasing trend. Productivity is decreases in Tehsil Khatav by

19 % as well as in Man by 43.45 % Phalatn by 9.79% and in Khandala Tehsil by 11.85 %. Productivity is highly decreases in Man tehsil as compare to year 2007-08.

In tehsil Khatav ,index number of major crops of 2012-13 with respect to 2001-02, the trend is increasing, however the index number with respect to base year 2007-08 the trend is decreasing. It shows that in Khatav tehsil productivity of crops goes decreasing by year to year.

In Man tehsil except crop Udid and Cotton all other crops shows increasing trend w.r.to year 2001-02 and it shows decreasing trend w.r.to year 2007-08. In Phaltan tehsil, crops Groundnut, Gram and Cotton shows increasing trend and all other crops shows decreasing trend.

The productivity of major crops in tehsil Khandala, shows decreasing trend as compare to Index number w.r.to year 2001-02 and 2007-08.

Highlighted figure shows the increasing trend of the crops Udid in Man tehsil, Gram in Phaltan tehsil, Groundnut in Phalatn tehsil and cotton in Man and Phaltan tehsil.

5.7 Correlation coefficient between rain fall and agriculture production and fitting of a line of regression:

Table No-5.18: Calculation of Correlation Coefficient and line of Regression

Sr.No.	Average Rain Fall (X) in mm	Agriculture Production in '000 Tonnes (Y)	X^2	Y^2	XY
1	425.5	96.45	181050.25	9302.6	41039.48
2	273.75	83.79	74939.06	7020.76	22937.51
3	127.65	37.55	16294.52	1410	4778.23
4	707.25	163.26	500202.56	26653.83	115465.64
5	615.5	104	378840.25	10816	64012
6	658.75	122.25	433951.56	14945.06	80532.19
7	649.5	135.37	421850.25	18325.04	87922.82
8	414	91.75	171396	8418.06	37984.5
9	607.25	93.81	368752.56	8800.32	56966.12
10	816.25	106.66	666264.06	11376.36	87061.23
11	343.25	66.32	117820.56	4398.34	22764.34
12	315.125	92.69	99303.77	8591.44	29208.94
	5953.775	**1193.9**	**3430665.4**	**130057.81**	**650673**

X bar= 496.15

Ybar= 99.49

r= 0.81

Regression line for to estimate value of agriculture production (Y) when rain fall value is known.

Regression coeff. byx = 0.11

Regression equation for Estimate Agriculture production (Y)

Y= Y bar+ byx (X-x bar)

For e.g.

1) When the average rainfall of study region will be for the 2015 is 400 mm
then agriculture production may be (‘ooo tonnes)

Y= 89.82

2) When the average rainfall of study region will be for the 2015 is 600 mm
then agriculture production may be (‘ooo tonnes)

Y= 112.44

5.8 Drought prone Tehsil wise Average, Variability and F-Value of major crops:

There are four tehsils are in drought prone area of Satara district. These are Khatav, Man, Phaltan, Khandala. In each tehsil crops are produced by farmers depending on the availability of water and soil pattern. Tehsil wise the variances among the crops are shown in huge quantity. Duration of the study period is from 2001-02 to 2012-13 and this total period is split up in two parts. Viz. Period-I and Period-II. The duration of the period –I is from 2001-02 to 2007-08 and the duration of period-II is from 2008-09 to 2012-13. So, by comparing the productivity of crops in Kg/Ha , against tehsil wise and for drawing the inference about the productivity variation I use variance teat (F-Test).

Table No. 4.15 (a), 4.15(b), 4.15(c) and 4.15(d) shows the average (mean) , standard deviation , coefficient of variation of both the time period of major crops of corresponding tehsil. Coefficient of Variation used for comparison of variability of these two time period. For find out the inference i.e. to check whether there is significant difference among the crop productivity or not with respect to two time period. For this, I first set up the hypothesis and the test statistic such as;

Based on sample standard deviation S1 and S2 available from the values of productivity (yield) of each crops in study time Period-I and Period-II. The sizes of time period are n1=7 and n2=5. The Hypothesis is;

H0 : $\sigma 1 = \sigma 2$ i.e. there is no significant difference in variation against the time period-I and Period-II. Against

H1: : $\sigma 1 \neq \sigma 2$ i.e. there is significant difference in variation against the time period-I and Period-II.

Test statistic is ,

$$F=\frac{S1\text{^}2}{S2\text{^}2} \sim F_{7,5,10\%\ los}$$

(Table value for F test with d.f. 7,5 and at 10 % level of significant is 0.9956.)

Where S1 and S2 are sample standard deviation.

Decision rule: If F calculated value is greater less than F table value then accept the null hypothesis otherwise reject.

Table No- 5.19
Crop wise Average and S.D. of Khatav Tehsil of Period-I and Period-II

		Period-I		Period-II		
Tehsil	**Crop**	**Mean**	**SD**	**Mean**	**SD**	**F-test value**
Khatav	Bajara	393.57	293.78	467.8	150.63	3.8038
	R.Jowar	797.00	267.35	692.8	202.9	1.7362
	Wheat	1268.43	433.1	1269.6	505.62	**0.7337**
	Udid	481.43	259.03	535.2	612.28	**0.1790**
	Moog	451.00		601.4	154.89	0.0000
	Gram	481.00	254.3	551.8	146.19	3.0259
	K.Gnut	622.29	464.7	686.2	117.63	15.6066
	S.Gnut	1773.50	642.8	1382.4	609.63	1.1118
	Soyabean	850.43	508.5	889.4	455.98	1.2436
	Sugarcane	82.40	8.82	65.6	29.94	**0.0868**
	Cotton	388.00	167.29	457.2	164.54	1.0337

For a Khatav tahsil; From the Table No. 5.19 it can be seen that the average yield in kg/ha of crops Bajara, Jowar, Gram, Groundnut (K and R), Soyabean and Cotton, the hypothesis is rejected that means there is significant difference in the productivity of crops in the duration of the Period-I and Period-II. However for the crops Wheat, Udid and Sugarcane, hypothesis is accepted, that means there is no significant difference between productivity of crops in time duration of Period-I and Period-II.

Table No- 5.20
Crop wise Average and S.D. of Man Tehsil of Period-I and Period-II

		Period-I		Period-II		
Tehsil	**Tehsil**	**Mean**	**SD**	**Mean**	**SD**	**F-test value**
Man	Bajara	396.71	244.62	426.6	206.65	1.4012
	R.Jowar	494.86	238.5	520.4	188.55	1.6000
	Wheat	1334.00	233.96	1368.2	123.85	3.5685
	Udid	263.50	74.5	541	277	**0.0723**
	Moog	285.33	145.54	427	118.23	1.5153
	Gram	573.17	204.39	562.2	287.17	**0.5066**
	K.Gnut	998.71	478.39	1014.5	47.5	101.4325
	S.Gnut	1905.67	705.02	1558.75	398.28	3.1335
	Sugarcane	80.20	38.23	85.4	13.84	7.6302
	Cotton	451.14	164.93	496.2	275.18	**0.3592**

Table no. 5.9 : For a Man tehsil except the productivity of crops Udid, Gram

Cotton shows the hypothesis is accepted i.e. there is no significant difference in the productivity. For the crops Bajara, Jowar, Wheat, Moog, Groundnut, Sugarcane hypothesis is rejected i.e. there is significant difference in productivity of crops.

Table No- 5.21
Crop wise Average and S.D. of Phaltan Tehsil of Period-I and Period-II

		Period-I		Period-II		
Tehsil	**Tehsil**	**Mean**	**SD**	**Mean**	**SD**	**F-test value**
Phaltan	Bajara	1250.57	446.12	1212.2	173.59	6.6047
	R.Jowar	902.43	238.5	874	124.41	3.6751
	Wheat	2336.57	284.37	2308.8	114.12	6.2093
	Moog	601.33	433.01	461.5	184.32	5.5189
	Gram	849.86	364.04	713.2	139	6.8591
	K.Gnut	842.71	271.86	1053.4	47.5	32.7569
	S.Gnut	2728.14	409.98	1784.8	542.92	**0.5702**
	Soyabean	1918.75	398	1835.5	731.68	**0.2959**
	Sugarcane	93.29	14.49	91	4.9	8.7447
	Cotton	551.14	161	725.66667	696.16	0.0535

Table no. 5.21: Tehsil Phaltan shows hypothesis is accepted for the productivity of the crops S.Groundnut, Soyabean and Cotton i.e. there is no significant difference in the productivity of crops. And all other crops has significant different in the productivity of crops.

Table No- 5.22
Cropwise Average and S.D. of KhandalaTehsil of Period-I and Period-II

		Period-I		Period-II		
Tehsil	**Tehsil**	**Mean**	**SD**	**Mean**	**SD**	**F-test value**
Khandala	Bajara	729.29	207.35	770.4	170.04	1.4870
	R.Jowar	798.43	262.94	887.4	184.43	2.0326
	Wheat	1488.43	158.06	1475	116.73	1.8335
	Udid	578.14	249.5	564	119.85	4.3338
	Moog	582.43	908.72	568.6	135.88	44.7249
	Gram	563.14	193.77	659	58.9	10.8229
	S.Gnut	3120.86	572.26	1634.8	768.8	**0.5541**
	Sugarcane		11.74		1037	**0.0001**

Table No. 5.22: It can be seen from the table that only the crops S.Groundnut and sugarcane shows the hypothesis is rejected i.e. there is no significant difference between in productivity of crops, however all other crops shows that there is significant difference between crop productivity.

5.9 Forecasting :

In our daily lives, we plan our future events on the basis of a reasonable estimate by using past. One of the major elements of planning and specifically strategic planning of any business is accurately forecasting the future event that would have an impact on the operations of the organization (of the study). Previous performance must be studied so, as to forecast future activity. The quality of such forecasts is strongly related to the relevant information that can be extracted and used from past data. In that respect, least square method of time series time series can be used to determine the pattern in the data of the past over a period of time and generalize the data into the future. The underlying assumption in time series is that the same factor will continue to influence the future pattern of economic activity in a similar as in the past.

The analysis can be used i) to control the process producing the series. For instance, it may suggest method to check inflationary forces before they raise their heads. ii) the past trends can be projected into future trends, to predict the changes which are likely to occur in the economic activity of trend cycle.

Here, in my study I use this time series technique for predict the value in future, study is depend on duration of time period since it is time series data. Least square method of time series is most popular method for prediction the value in future. In this study I predict the productivity of the major crops. The time duration of the study is from year 2001-02 to 2012-13, so I predict the crop productivity for the year 2015-16.

Major crops of this study area are Bajara, Jowar, Wheat, Gram, Pulses, Cotton, Groundnut, Soyabean etc. Table No. 4.20, present the analysis of time series for

various crops and there is predicted value for the year 2015-16. The obtained predicted value is in kg per hector. Also there is graphical presentation of each major crop because graphical presentation tails us more than numerical data.

Table No- 5.23 (a)

Trend values and Forecasting of productivity (Yield) in Kg/ha for the crop Bajara, Jowar and Wheat

Year	Bajara		Jowar		Wheat	
	Yield in Kg/ha	Trend Values	Yield in kg/ha	Trend values	Yield in kg/ha	Trend values
	1	2	3	4	5	6
2001-2002	585.25	617.5	663.7	635.1	1737	1487.4
2002-2003	600.50	633.2	381	652.3	1198	1508.9
2003-2004	287.50	648.8	250.8	669.5	971.7	1530.4
2004-2005	1156.2	664.5	1020.5	686.7	1786	1551.9
2005-2006	653.25	680.1	857.8	703.9	1845.7	1573.4
2006-2007	605.5	695.8	880.5	721.1	1737.2	1594.9
2007-2008	959.5	711.5	983.8	738.3	1965.7	1616.4
2008-2009	590.7	727.1	883.5	755.5	1408.2	1637.9
2009-2010	637.0	742.8	840.2	772.7	1544.7	1659.4
2010-2011	1010.0	758.5	712	789.9	1928.5	1680.9
2011-2012	626.0	774.1	484	807.1	1484.2	1702.4
2012-2013	732.5	789.8	798.5	824.2	1661.2	1723.9

Table No- 5.23 (b)

Trend values and Forecasting of productivity (Yield) in Kg/ha for the crop Pulses, Sugarcane, S.Groundnut and Cotton

	Pulses		Sugarcane		S.Groundnut		Cotton	
Year	Yield	Trend values	Yield	Trend values	Yield	Trend values	Yield	Trend values
	7	8	9	10	11	12	13	14
2001-2002	1562.7	1152.1	65.5	59.13	2516	2529.4	538.7	511.2
2002-2003	1006	1181.1	77.25	62.4	2482.7	2422.8	550.5	496.8
2003-2004	461.7	1210.0	48	65.7	1651.5	2316.2	465.7	482.4
2004-2005	1545	1239	41.75	69.0	2530.7	2209.6	354.2	467.9
2005-2006	1215.8	1367.9	63.5	72.3	2212.2	2103	472.5	453.5
2006-2007	1164.2	1296.9	98.7	75.6	2071	1996.4	572	439.1
2007-2008	1678.2	1325.8	101	78.8	2290.2	1889.8	364.7	424.7
2008-2009	1441.5	1354.8	75.5	82.1	1959	1783.2	336.7	410.3
2009-2010	1468.8	1383.7	83.25	85.4	1984.2	1676.6	454.5	395.8
2010-2011	1765	1412.7	91.75	88.7	999.7	1570	210.5	381.4
2011-2012	1058	1441.6	91	92.0	717.2	1463.4	417	367.0
2012-2013	1370	1470.6	89.75	95.3	1901	1356.8	445.7	352.6

Forecasting of productivity (Yield) in Kg/ha for the major crop for the next three years (Sugarcane in Tonnes /ha)

Forecasting or predictions of the major crops are estimated for the next three years i.e. for the years 2013-2014, 2014-2015, 2015-2016 by using time series techniques. However, productivity of the crops in dryland is depends on rainfall, storage moistures in the soil, water management and crop pattern. Suppose all these things are in average then we estimate productivity in coming future years. Table No. 5.27 shows the productivity of major crops. Graphically it also shows by green color dots. By using trend linear model there are the statistical values of Mean Average Percentage Error (MAPE), Mean Average Deviation (MAD), Mean Square Deviation (MSD). It can be shows from the graph that there is high variation in the productivity of all the major crops.

Table No 5.24
Forecasting of productivity (Yield) in Kg/ha (sugarcane in tonnes /ha) for the major crop

Crop	2013-2014	2014-2015	2015-16
Bajara	805.41	821.07	836.72
Jowar	840.97	858	875
Wheat	1720.94	1734.52	1748.1
Gram	644.84	649.72	854.59
S. Groundnut	1193.74	1054.24	914.73
Sugarcane	92	93.4	94.9
Cotton	565.36	571.3	577.40

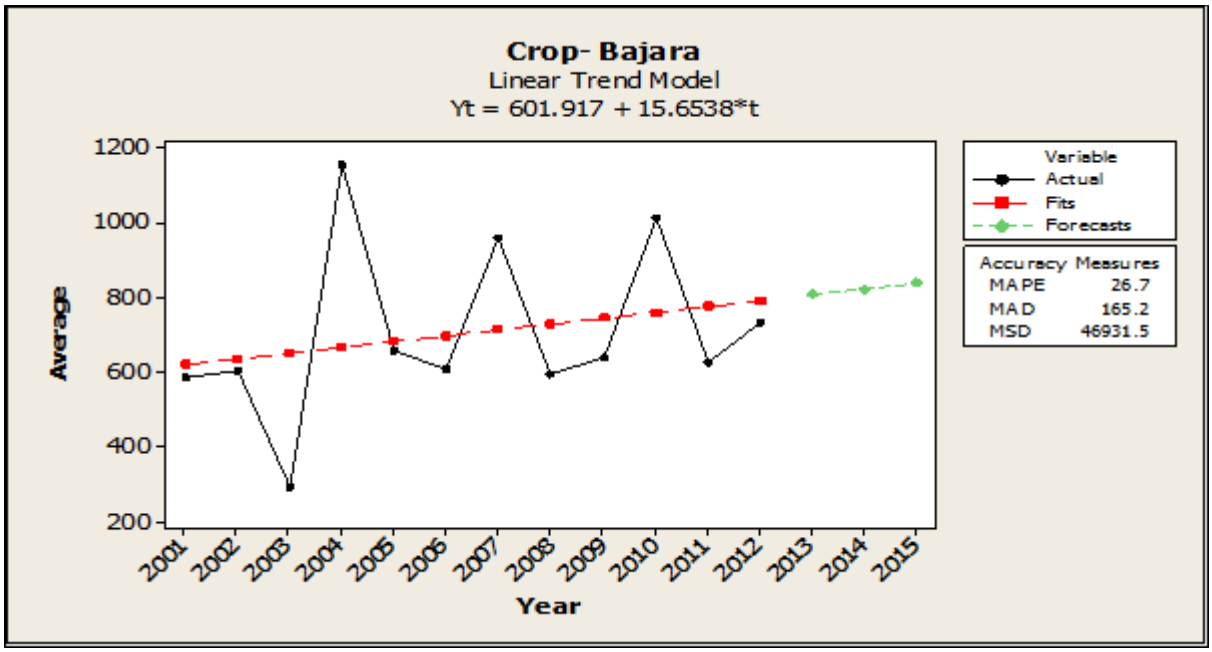

Fig. No- 5.19 ;Trends in productivity of Bajara crop

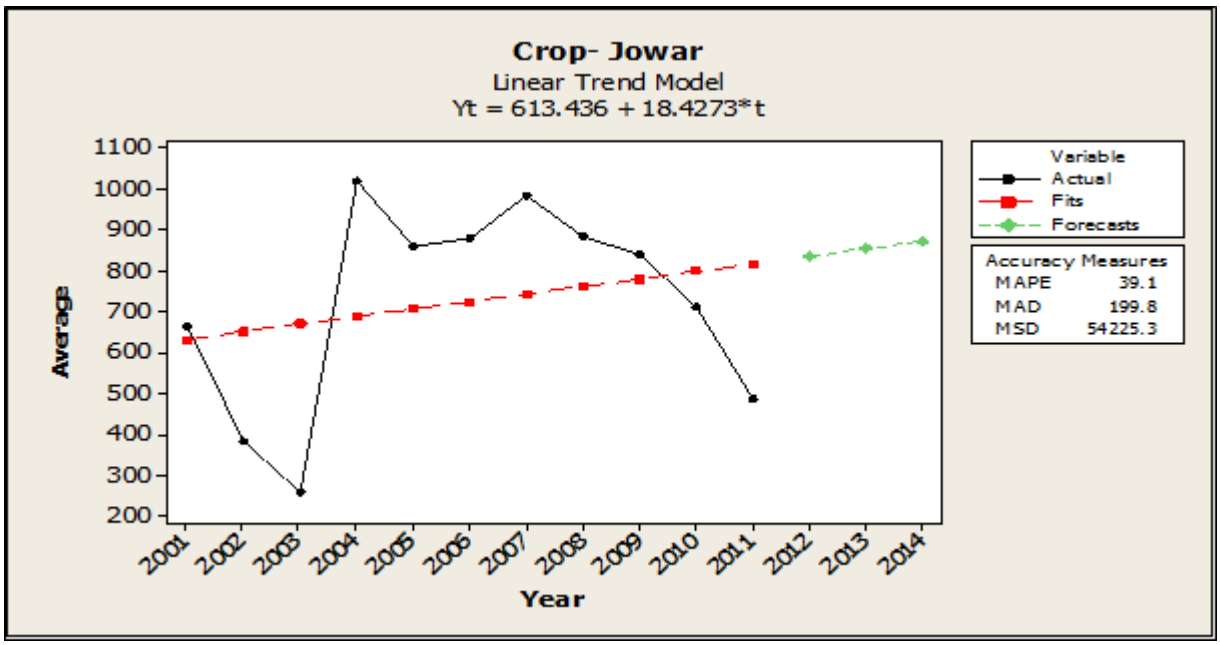

Fig. No- 5.20 ; Trends in productivity of Jowar crop

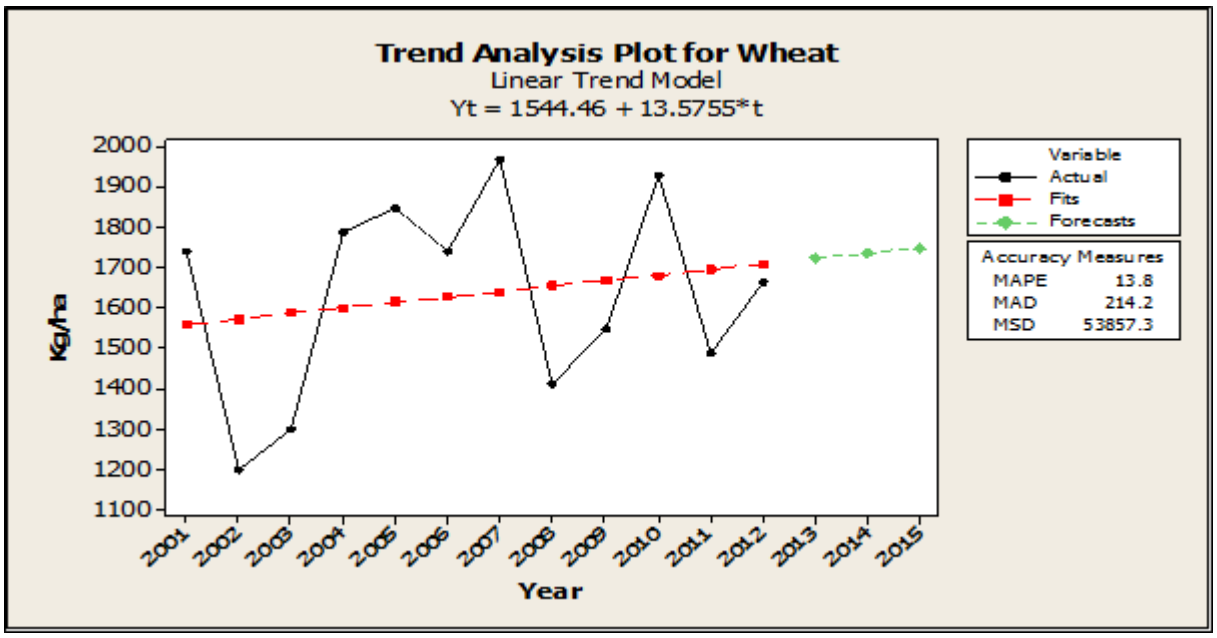

Fig. No- 5.21 ; Trends in productivity of Wheatr crop

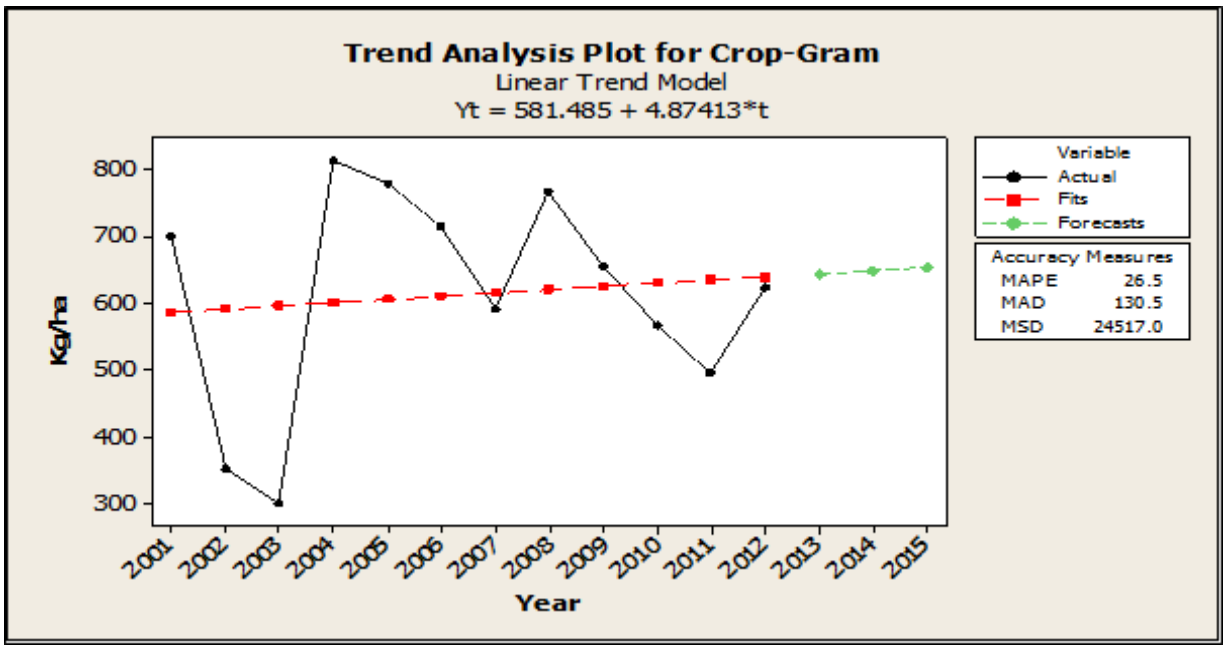

Fig. No- 5.22 ; Trends in productivity of Gram crop

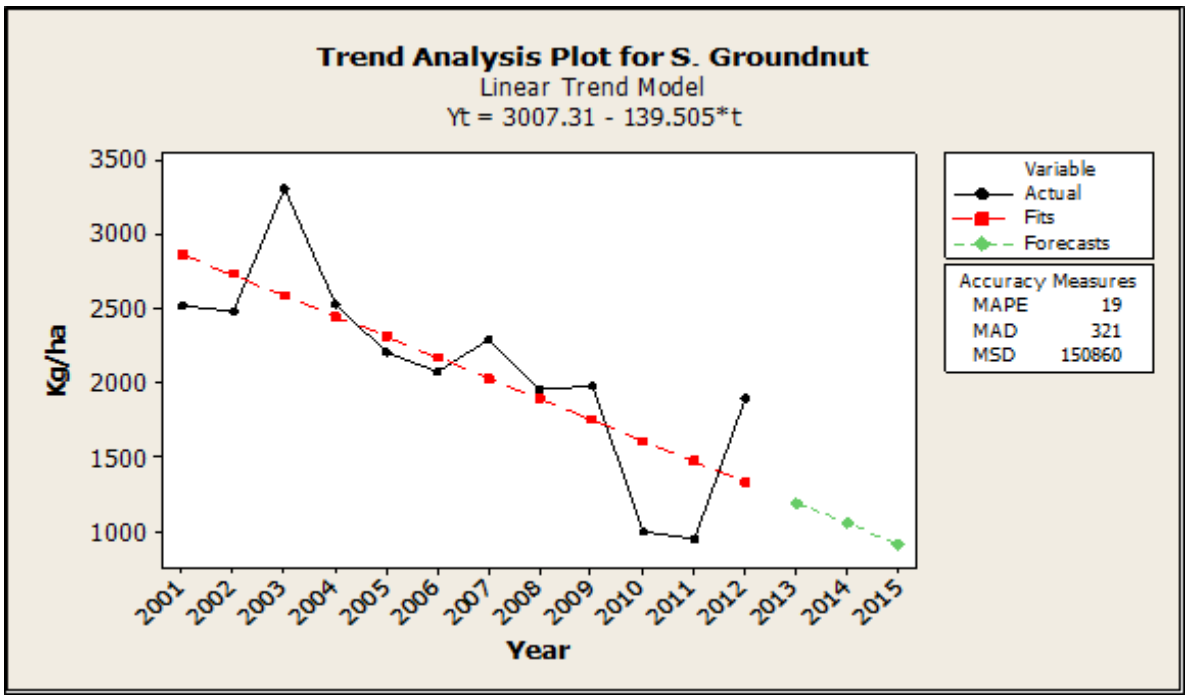

Fig. No- 5.23 ; Trends in productivity of Groundnut crop

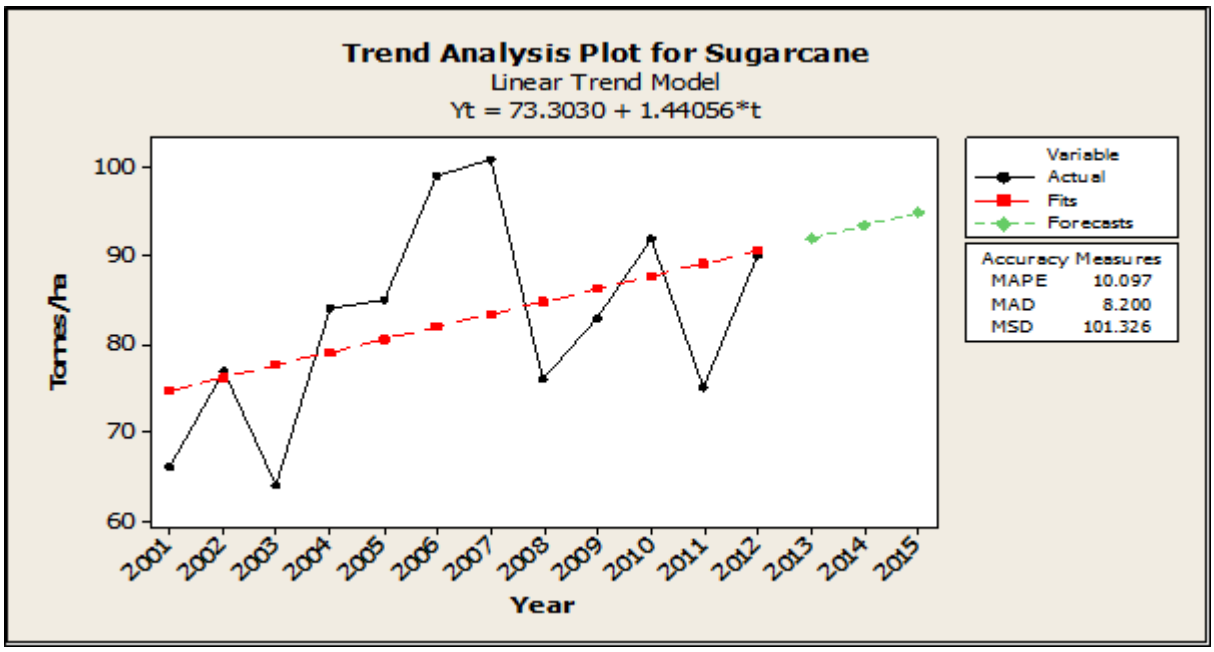

Fig. No- 5.24 ; Trends in productivity of Sugarcane crop

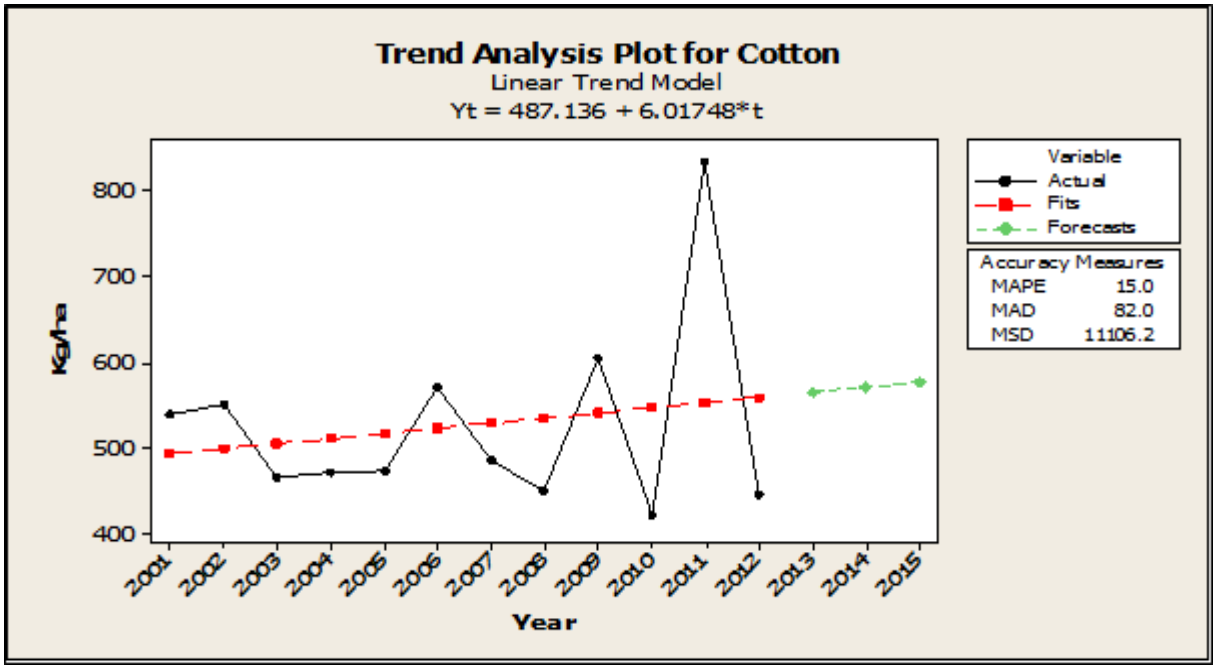

Fig. No- 5.25 ; Trends in productivity of Cotton crop

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Chapter – 6

Findings, Problems and Recommendation

6.1 Findings:

1) Proportionally there is no significant difference of the land used pattern in the study duration Period-I and Period-II. The area under the available cultivated land is decreases and area of the fallow land increases throughout all the tehsil of study area.
2) Average rainfall of Satara district is 1441 mm and in drought prone tehsils shows near about 500 mm only. So, tehsil wise there is high variation in rainfall. Maximum average rainfall in Satara district is near about 5297 mm at Mahableshwar.
3) Land holding pattern of Satara district is different from the Maharashtra state level. Marginal land holding accounted about 74.7 percent of the total land holdings in Satara District. Whereas total 6.59 percent of medium and large farmers have 31.9 percent area of operational holding in the Time Period-I and that of in Time Period-II number of operating marginal holdings increases by 0.79 percent farmers have land more than 5 ha in Period-I and only 0.2 percent in Period-II.
4) In time Period-I: Land utilization of drought prone tehsils shows that total cultivated area in Khandala tehsil shows 63.04 percent, in Phaltan tehsil it is 65.38 percent, in Man tehsil it is 49.13 percent and in Khatav tehsil it is 80.86 percent. By comparing this area with cultivable area , there is scope to convert fallow area to cultivable area in Man tehsil. Near about 25.52 percent area may be converted to cultivable in Man tehsil. In Khatav tehsil farmers used maximum cultivable area.

5) In time Period-II: Total cultivated area increases only in Khandala tehsil, however in Phaltan , Man and Khandala tehsil total area shows decreases and result shows fallow area increases.
6) There is no significant difference between land used pattern in both the time Periods.
7) There is high degree correlation between rainfall and agriculture productivity and production. It shows that agriculture production of drought prone tehsil is depending on only rain fall.
8) Productivity of major crops of tehsil Phaltan is high as compare to other three tehsil of study area. Productivity in kg/ha of the crops Bajara, Jowar, Wheat, Maize, Gram, Soyabean are high and also productivity of Sugarcane in tonnes /ha is increases as compare to other. The productivity of major crops is very low in tehsil Man and Khatav. The crop Bjara, Jowar, Wheat, pulses like Moog shows low productivity. The crops Gram, Soyabean , S. Groundnut shows the productivity in Khatav tehsil are very low. Tahsil Khandala has lowest productivity in all the crops.
9) Whenever the water availability is there, sugarcane crop is cultivated. The major parts of these drought prone tehsils are; in Khatav tehsil area is near Ner dam, Veralwadi dam. In Man tehsil area is near Andhali dam, Palashi Dam, Rajewadi dam. In Phaltan tehsil there is canal of Neera dam, so near of this canal crop sugarcane is cultivated in major areas. In Khandala tehsil the farmers who have the water availability those farmers cultivate crop sugarcane but they are in little number.
10) By using variance test (F-test), there is no significant difference in the crop productivity in both the time Periods.

11) Variation in productivity within major crops in each tehsil is decrease but in time Period-II shows high variation as compare to Period-I, in crop Maize ,Soyabean, Groundnut(S) etc.
12) Productivity of major crops shows more consistent in time Period-II than Period-I.
13) By using the regression techniques, forecasting for the productivity of major crops are estimate, but these estimated values are depends on rainfall.
14) The correlation coefficient between rainfall and agriculture production is +0.81, it is high degree positive correlation. It shows that there is close relation of rainfall and agriculture production in dry land of Satara district.
15) The study period are divided into two phase, these are Period-I (duration 2001-02 to 2007-08) and Period –II (duration 2008-09 to 2012-13). By computing trend values and plotting linear equation on a graph, it shows that in major crops productivity has been increases in study Period-II as compare to Period-II.

Conclusion is that both the stated hypothesis are accepted.

6.2 Problems of Dry Land Farming :

Dry land farming means practice of growing profitable crops without irrigation. There are many characters affected in dryland agriculture crop production, they are as follows;

i. Uncertain ability in annual rainfall.
ii. Undulating soil surface.
iii. Occurrence of extensive and large holdings.
iv. Very low crop yield.
v. Poor economy of the farmers.

The major problem of dry land farming is insufficiency of water. In dry land area agriculture is now becomes risky because of improper distribution of rain fall There are several factors or causes affecting on the low agriculture production in dry land, these factors are ;

1. Moisture Stress: The rains are very erratic, uncertain and unevenly distributed. Therefore the agriculture in these areas has become a sort of gamble with the nature and very often the crops have to face climatic hazards.
2. Effective storage of rain water: Due to the uncertainty in rain fall that is either there will be no rain at all or there will be heavy rain with very high intensity. Thus in former case the crops will have to suffer a severe drought and in the latter case they suffer either flood or water logging and they will be spoilt. The excess water gets lost as run-off which goes to the ponds and ditches etc.
3. Disposal or dry farming products: Almost all the farmers from dry land area, they grow similar crops which are drought resistant. These crops grown-up the same time and the growth like to dispose their products soon after the harvest. This results in a excess of products in the market and the situation is badly demoralized by the grain traders and middlemen. Therefore marketing becomes a serious problem in dry land farming.
4. Selection or limited crops: Only drought resistant crops like Jowar, Bajara, Oilseeds, Pulses etc. can be grown in dry land areas. Thus the farmers have to purchase other food grains and household commodities that unbalance their economic position.
5. Careful use of fertilizers: The farmers in a dry area, they have to very careful in fertilizer application. Due to lack of available moisture, broadcasting or top dressing becomes wasteful and meaningless.

6. Quality of the produce: The quality of the produce from dry farming areas are not good, it is due to sometimes grains are not good fully developed or they are not filled properly. All these products are not get market value and hence farmers do not get the profit.

6.3 Recommendations:

There are various improvement techniques and practices which have so far been generated and recommended for achieving the objective of increased and stable crop production in dry land areas.

1. Rain Water Management : Water Management can be increase agriculture production four to five times as compared to normal production. Rain water can be stored in soil. Shet-Tali or ponds are built in dry area and store rain water in that for irrigation during dry period. Therefore the water, collected during the rainy season need special technique and skill for its efficient utilization.

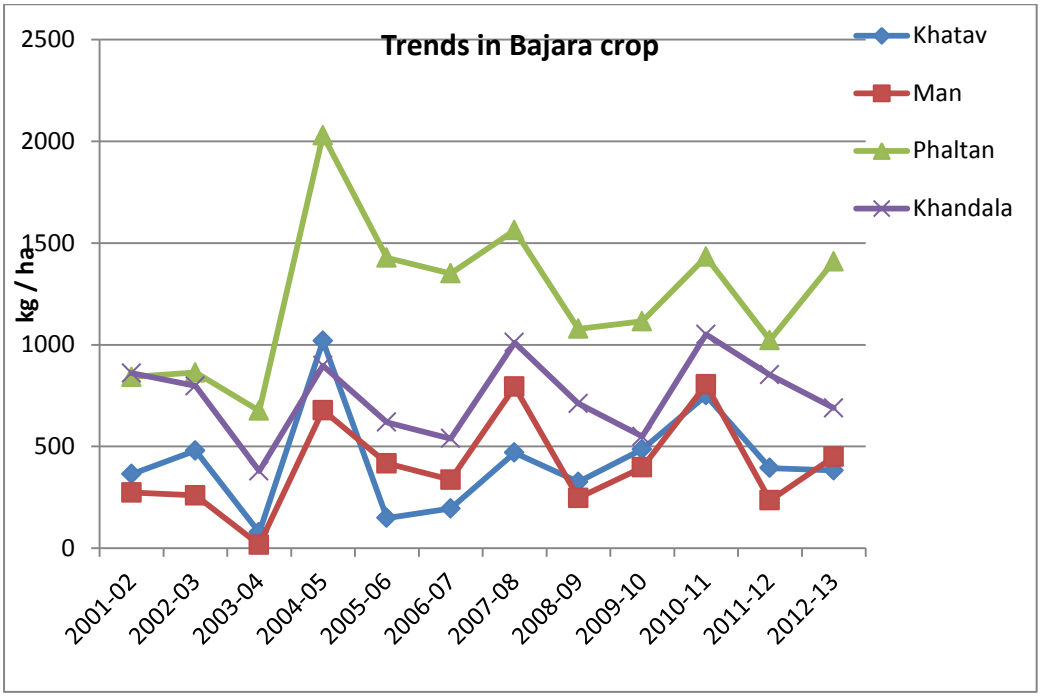
2. Utilization Moisture In The Soil : Improving the sustainability of dryland farming is mostly depends on moisture in the soil. For that purpose increase the capacity of soil moisture in the soil for increasing productivity. Actually it is depends upon types of soil, crop type and other factors.

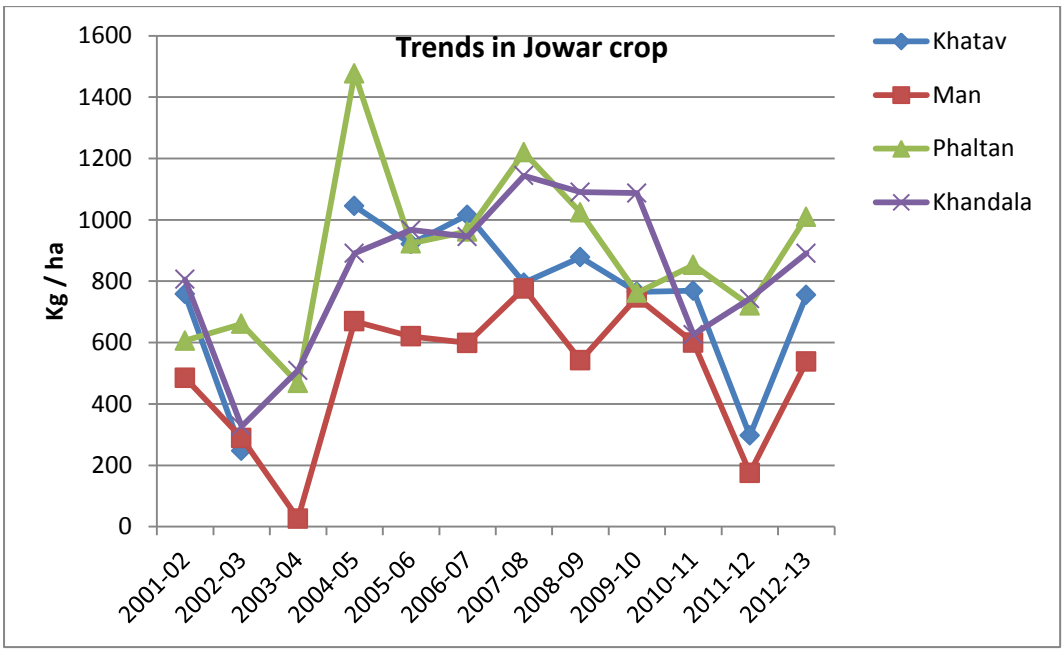
3. Selection of crop: Crop varieties for dry land areas should be a short duration through resistant tolerant and high yielding which can be harvested with in rainfall period for post monsoon cropping. The widely spaced crops can be intercropped with oilseeds or pulses for increasing the productivity of the land per unit area and per unit time.

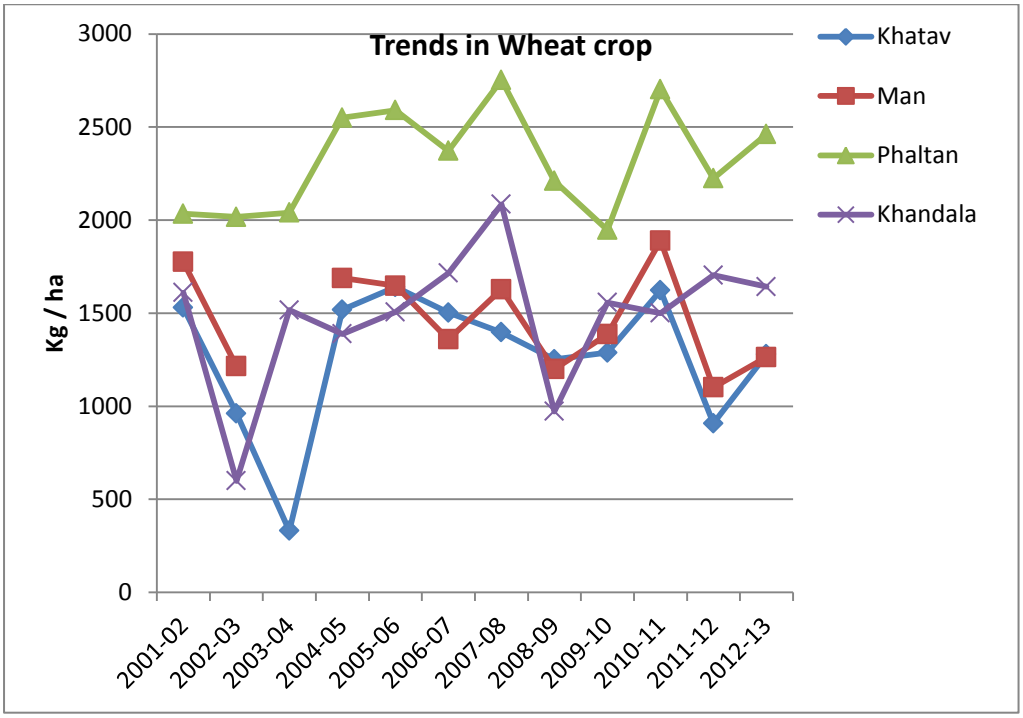
4. Cropping System: Traditional crops or varieties which is inefficient utilizer of soil moisture, less responsive to production input. Increasing cropping intensities by using the practice of intercropping and multiple cropping. The cropping intensity would depend on the length of growing season, which is depends on rainfall pattern and the soil moisture storage capacity of the soil. Use different crop varieties, which are highly resistant power in dry land farming.
5. Use of fertilizers: Due to limiting soil moisture the nutrient is very low in dryland area. Uses of fertilizers are helpful in providing nutrients to crop and also helpful in efficient use of soil moisture. The proper mixture of organic and inorganic fertilizers improves moisture holding capacity of soil.
6. Timing of Tillage and Depth of Plowing: Plowing should be done when soil is either too wet or dry. Moisture conditions are likely to occur only at the beginning of the rainy season and should be done on the same day. If possible, planting should immediately follow plowing. Deep plowing on sandy soils, which are naturally absorbent and open, tends to disconnect the seed bed from the subsoil and speeds soil dying by too free a circulation of air in the soil. When land is plowed more than 4 to 5 inches deep, the hard plow sole is very likely to form through which roots grow and rain water can be percolates in soil. Depending on soil pattern and rainfall a deep plowing of 4 to 5 inches every two years is satisfactory.
7. Water Management: Use drip irrigation or sprinkler system for saving water. Drip irrigation system is not only save water but this system reduces expenditure on workers.
8. Provide small tractors or tiller on minimum rent through Mahila Bachat Gat or Vikas Seva Society.

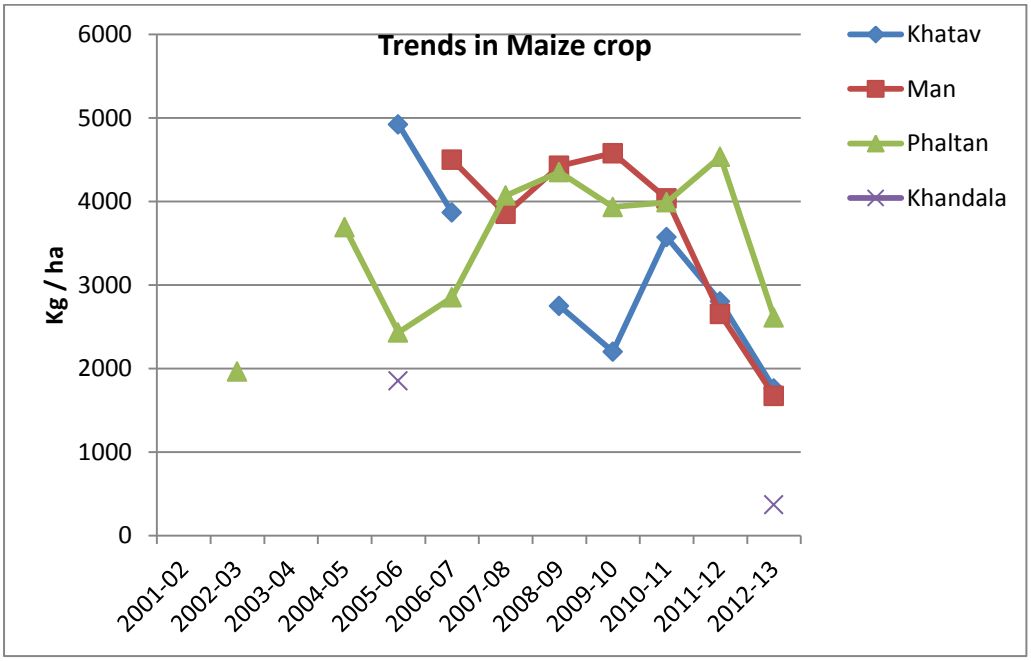
Annexure -A1

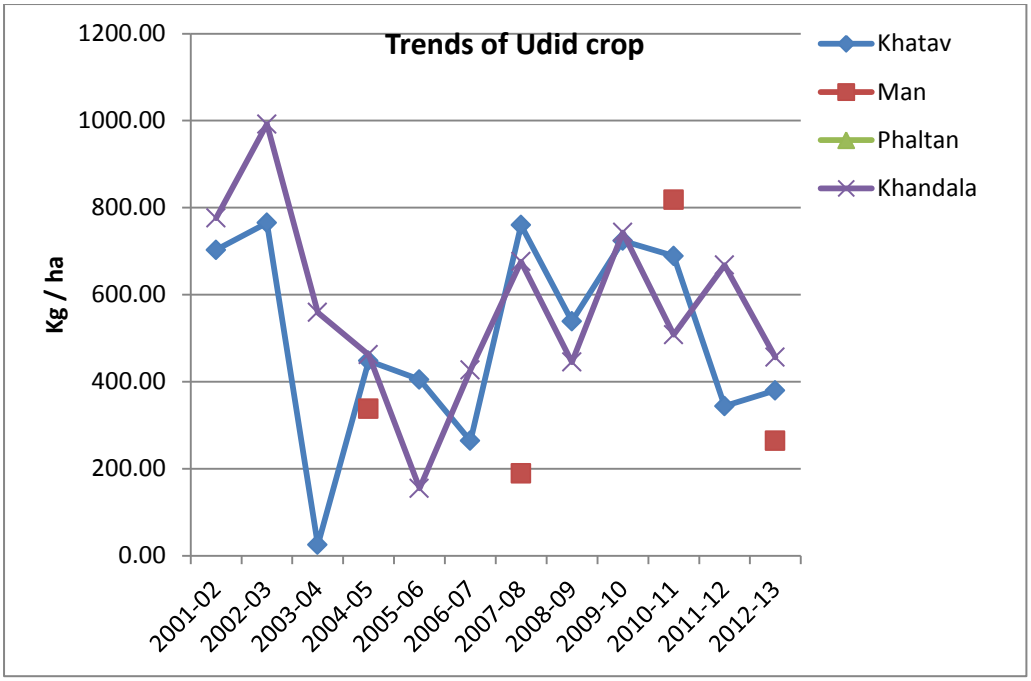
Tehsil wise Trends in the major crops of drought prone area of Satara district.

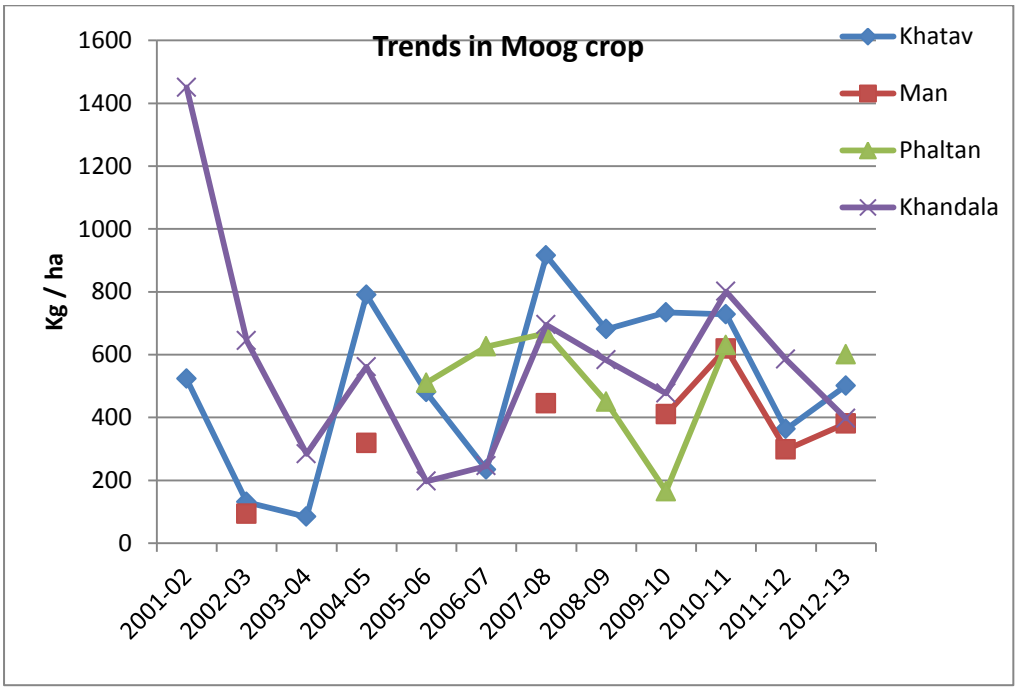


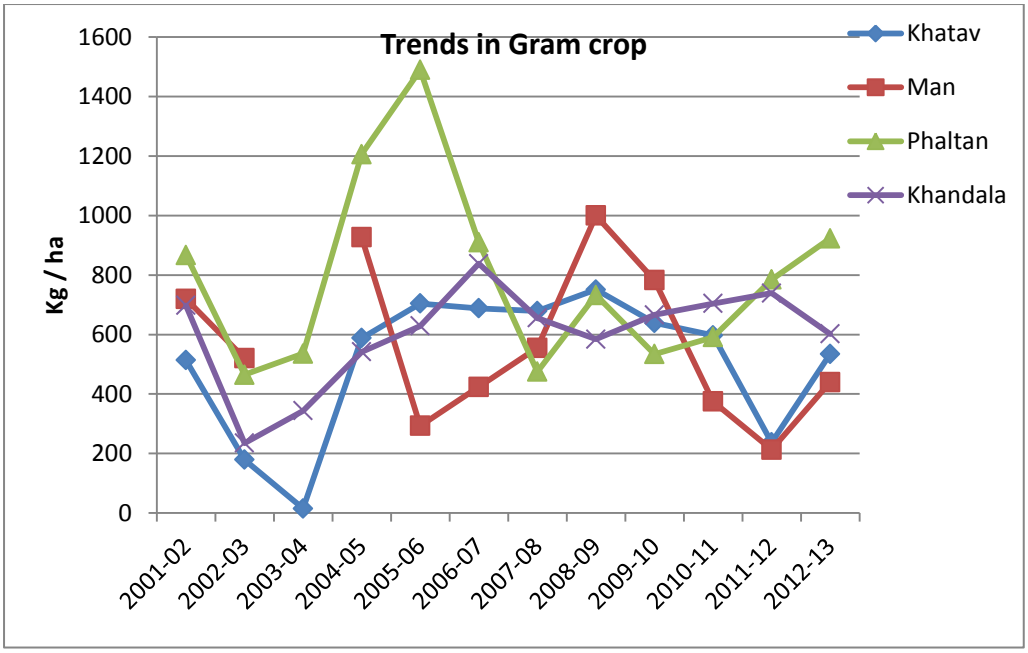


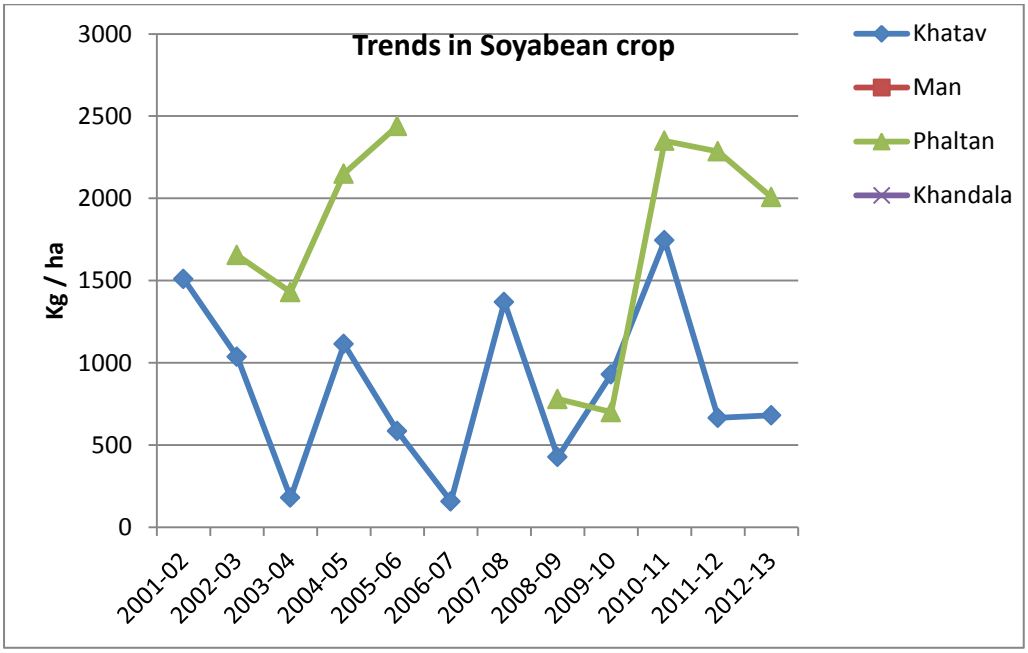

Trends in Wheat crop
Kg / ha
3000
2500
2000
1500
1000
500
0
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
Khatav
Man
Phaltan
Khandala

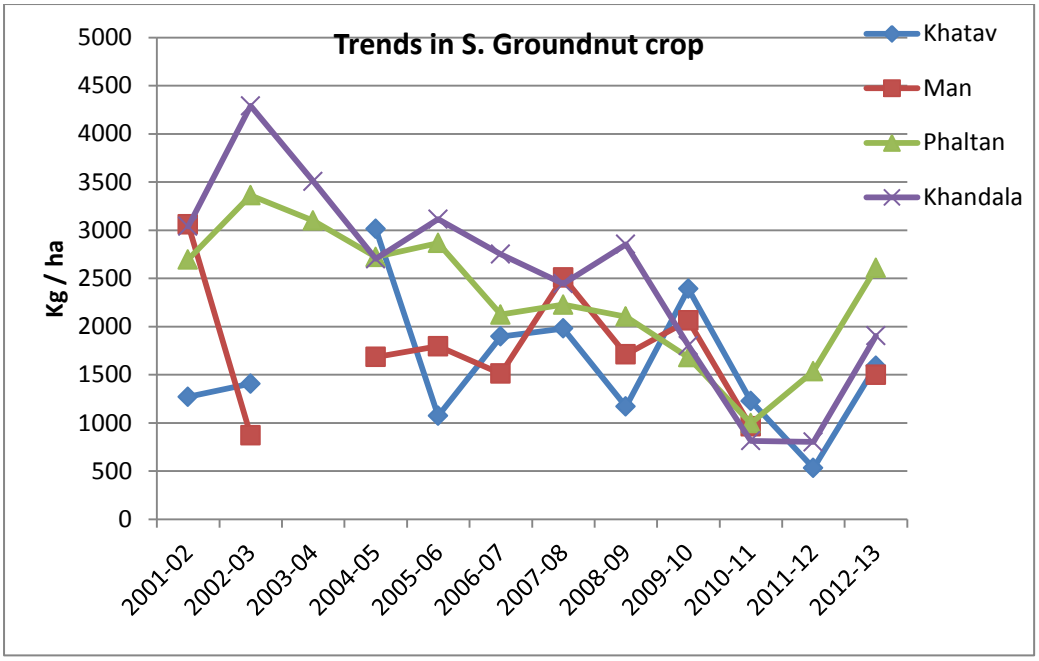

Trends in Maize crop
Kg / ha
6000
5000
4000
3000
2000
1000
0
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
Khatav
Man
Phaltan
Khandala

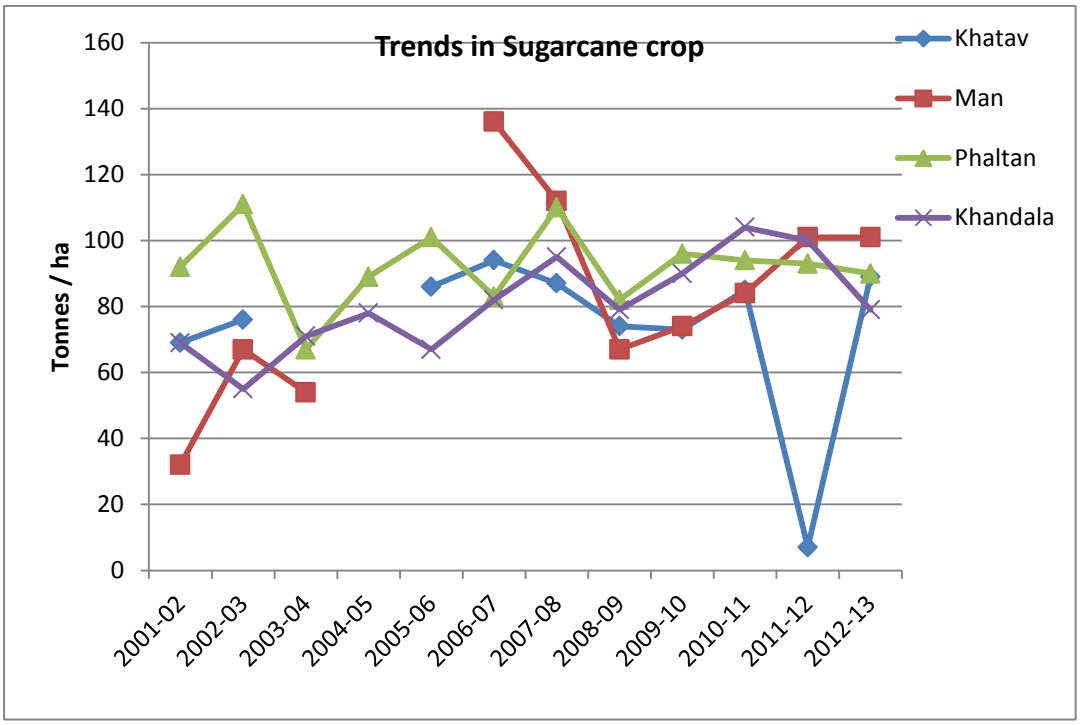

Trends of Udid crop
Kg / ha
1200.00
1000.00
800.00
600.00
400.00
200.00
0.00
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
Khatav
Man
Phaltan
Khandala

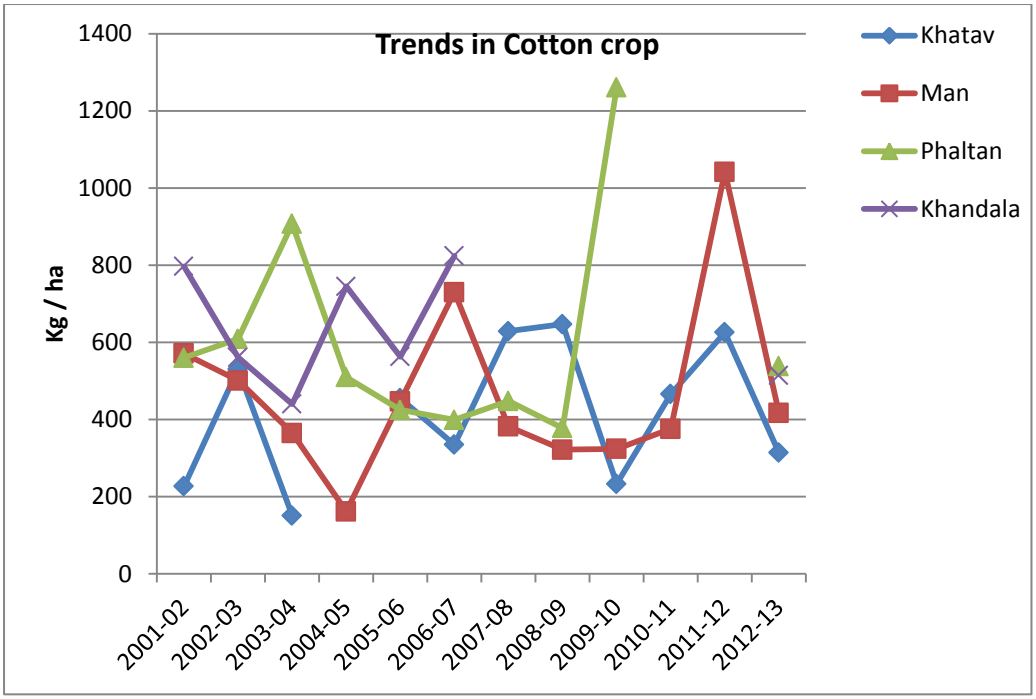

Trends in Moog crop
Kg / ha
1600
1400
1200
1000
800
600
400
200
0
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
Khatav
Man
Phaltan
Khandala


Trends in Gram crop
Kg / ha
1600
1400
1200
1000
800
600
400
200
0
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
Khatav
Man
Phaltan
Khandala


Trends in Soyabean crop
Kg / ha
3000
2500
2000
1500
1000
500
0
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
Khatav
Man
Phaltan
Khandala


Trends in S. Groundnut crop
Kg / ha
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
Khatav
Man
Phaltan
Khandala


Trends in Sugarcane crop
Tonnes / ha
160
140
120
100
80
60
40
20
0
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
Khatav
Man
Phaltan
Khandala


Trends in Cotton crop
Kg / ha
1400
1200
1000
800
600
400
200
0
2001-02
2002-03
2003-04
2004-05
2005-06
2006-07
2007-08
2008-09
2009-10
2010-11
2011-12
2012-13
Khatav
Man
Phaltan
Khandala