AN ANALYTICAL STUDY OF CHANGING CROPPING PATTERN IN MAHARASHTRA FOR THE PERIOD OF 1991-2012

Thesis submitted to

Tilak Maharashtra Vidyapeeth, Pune (M.S.), India

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

Under

Faculty of Moral and Social Sciences
(Economics)

Submitted by

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Under the Guidance & Supervision of

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December 2015

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C E R T I F I C A T E

This is to certify that the thesis entitled **"An Analytical Study of Changing Cropping Pattern in Maharashtra for the Period of 1991-92"** which is being submitted herewith for the award of Degree of Vidyavachaspati (Ph. D.) in Economics of Tilak Maharashtra Vidyapeeth, Pune is the result of original research work completed by **Mrs.Vaishali Jayant Joshi** under my supervision and guidance. To the best of my knowledge and belief the work incorporated in this thesis has not formed the basis for the award of any Degree or similar title of this or any other University or examining body upon her.

Research Guide

Prof. Dr. S. N. Tupe

Place: Nashik

Date:

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I am also thankful to all my colleagues and relatives whose co-operation and encouragement helped me to cross all the barriers during the course of the study.

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Mrs. Vaishali Jayant Joshi

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List of Abbreviations Used

AGDP	Agriculture Gross Domestic Product
APMC	Agriculture Product Market Committee
ACABC	Agri Clinics and Agri Business Centres
AGDP	Agricultural Gross Domestic Product
AAGR	Annual Average Growth Rate
CAGR	Compounded Annual Growth Rate
CACP	Commission for Agricultural Costs and Prices
CPIS	Coconut Palm Insurance Scheme
CV	Coefficient of Variation
FAO	Food and Agriculture Organization
GCA	Gross Cropped Area
GCF	Gross Capital Formation
GDP	Gross Domestic Product
HDI	Human Development Index
HYVP	High Yield Variety Programme
KVK	Krishi Vigyan Kendra
MNAIS	Modified National Agricultural Insurance Scheme
MSP	Minimum Support Price
NEP	New Economic Policy
NDDP	Net District Domestic Product
NFSM	National food Security Mission
NAIS	The National Agricultural Insurance Scheme
RMSE	Root Mean Squared Error
SAME	Sub Mission on Agricultural Extension
WBCIS	Weather Based Crop Insurance Scheme

Glossary

Area : The size of flat surface

Production : The process of producing something

Productivity : The rate or efficiency of work

Productivity per Hector = Total production of crops in kg / Total land area under the crop

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Distribution of production of Jowar in Maharashtra

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Distribution of production of Sugarcane in Maharashtra

Chapter 1

Introduction

1.1 Introduction

Agriculture is an important sector in India which contributes 17 percent of GDP and provides job to 57 percent of working population. This is mainly important source of raw material for agro-based industries. It is a market for engineering and consumer industries. In the most of developing countries, labor force dependent upon agriculture and allied sector as a source of livelihood has been declining in the last centuries of 1990, but in case of India, its importance as

a major source of employment has not yet come down. Agriculture sector is vital for foreign exchange earnings. India's export is predominantly composed of agro-based commodities and materials. The pace of agricultural sector is fairly encouraging after liberalization and it is gradually gaining in strength. But the vital issues such as low productivity per hectare, low GDP growth rate of agricultural sector, declining size of public and private sector investment in agricultural sector, difficulties in marketing of produce, minimum and reasonable price to farmers, poor and slow infrastructure development, insufficient storage facilities , inadequate irrigation facilities are remained to resolve.

Maharashtra is one of the most industrialized and urbanized states in India. Paradoxically, it also enjoys the dubious distinction of a state having highest rural – urban disparity in standard of living of its population. Maharashtra state of Republic of India established in May 1, 1960. It has 3, 07,690 sq. km. geographical area. Maharashtra scattered from east to west 800 km; north to south 700 km. It has 720 km coastal line. Maharashtra is neighboring with Madhya Pradesh at east, Karnataka and Goa at south, Gujarat and Madhya Pradesh at north. Arabian Sea is at west. Summer temperature in Maharashtra's is minimum 22 degree Celsius and maximum 42 degree Celsius. Some times in the May it went up to 46 degree Celsius. Its winter temperature is 12 degree Celsius to 34 degree Celsius. Its capital is Mumbai. Political and cultural capitals of Maharashtra are Nagpur and Pune respectively.

1.2 Justification of selecting topic as a special case of Maharashtra

In Maharashtra, almost all types of crops can be grown. In decades of 1970 and 1980, Maharashtra was leading state in crops like Rice and Pulses.

Later on Cash crops such as Sugarcane, Cotton, Grapes, Onion and Bananas, Orange became popular amongst the farmers. However, after the introduction of the New Economic policy, cropping pattern went in favour of cash crops. Hence, present study explores the changing pattern of crops in Maharashtra. It also investigates the forces responsible for change in the cropping pattern. Present study verifies the impact of new economic policy on the cropping pattern of Maharashtra if any. The following table shows the agricultural production of the specific crop in a specific state in the year 2013-14 in India. The following Table 1.1 Gives trends in Agricultural Production for the year 2013-14.

Table 1.1 Agricultural Productions 2013-14

(Production in million ton, cotton in million bales)

Group	Crop	Highest crop producing state	Production in that state	Production in India
Food grains	Rice	West Bengal	15.31	106.54
	Wheat	Utter Pradesh	30.25	95.91
	Corn	Andhra Pradesh	4.97	24.35
	Course Cereals	Karnataka	6.72	43.05
	Pulses	Madhya Pradesh	5.09	19.27
	Total	Uttar Pradesh	**50.05**	**264.77**
Oilseeds	Ground nut	Gujarat	4.92	9.67
	Mustard	Rajasthan	3.83	7.96
	Safflower	Madhya Pradesh	5.37	11.99
	Sunflower	Karnataka	0.30	0.55
	Total	Gujarat	**6.84**	**32.88**
Cash crops	Sugarcane	Uttar Pradesh	135.16	350.02
	Cotton	Gujarat	10.95	36.59

Source: Agricultural statistics- At Glance2014. pp.61, 62

Why Maharashtra is lagging behind? Why this state is not in first five highest producing states in a specific crop? So, this study and findings out solutions, cropping pattern of Maharashtra is the research area of this thesis. Generally, crops are being taken in the two seasons. Sometimes farmers take crops in the summer also but that percentage is very low. Kharif crops in Maharashtra are Bajara, Rice, Cotton, Black gram, Tur and Jowar. Rabi crops are: wheat, Jowar and chana. Raigad, Sindhudurg, Ratnagiri, Thane, Bhandara, Chandrapur, Pune, Satara, Nagar and Nashik districts are rice bowl of Maharashtra. Pune, Satara, Nagar are famous for Bajra. Solapur, Beed, Osmanabad, Latur, Nagar, Nashik, Jalgaon, Pune, Dhule Yavatmal, Bhandara are growing Jowar. Similarly, Nashik, Nagpur, Osmanabad, Akola, Ahmad nagar, Dhule, Jalgaon, Beed, Wardha, Aurangabad, Beed, Parbhani are producing wheat. The western belt of Maharashtra- Sangali, Kolhapur and Pune along with Ahamednagar is famous for sugarcane crops as well as Dhule, Jalgaon, Buldhana, Akola and Amravati are producing cotton (white silver) exclusively in Maharashtra. In the recent years, various fruits are being grown in the various districts of Maharashtra. It is second among the states in India in respects of horticulture. Maharashtra has six administrative divisions. They are as follows:

Table 1.2 Administrative Divisions of Maharashtra

Region	Districts falls in the Region
Konkan	Mumbai, Thane, Ratnagiri, Sindhudurg and Alibag
Pune	Pune, Satara, Sangali, Satara, Kolhapur and Solapur
Nasik	Nashik, Ahamednagar, Dhule and Jalgaon
Aurangabad	Aurangabad, Jalna, Parbhani, Beed, Latur, Nanded, Osmanabad and Hingoli
Nagpur	Nagpur, Wardha, Bhandara, Chandrapur and Gadchiroli
Amravati	Amravati, Yavatmal, Akola, Washim and Buldhana

Source: GoM Diary Data

Maharashtra being an important producer of cotton, sugarcane, groundnut and quite a few horticulture crops, such a secondary linkages of agriculture assume added importance to its rural economy, more so now, in the context of new liberalized trade environment for farm products. That is why careful assessment of agriculture's past performance and based on it. Future prospects of growth are needed. The present study undertakes this exercise, focusing on the comparison between the early phase from 1991-1992 to 2000-2001, the later phase from 2001-2012 of the new millennium.

1.3 Background of Study

During the past two decades, the agriculture sector of Maharashtra has undergone wide ranging changes in terms of ownership of land, cropping pattern, cultivation practices, productivity and intensity of cultivation. Unlike the other regions in India, the farm sector of Maharashtra is characterized by extreme diversity in its bio-physical resource base and agro-climatic endowments providing multiple opportunities for growing a variety of crops. In earlier periods, the choice of cropping pattern was guided by agronomic considerations and consumption needs of the farmers. But in the recent past mainly market forces determine the trends in cropping pattern. Changes in cropping pattern are also determined by technological, infrastructural and institutional environment.

1.4 Importance of Study

Food, clothing and shelter are basic necessities of life. Agricultural sector plays an important role in fulfilling them. Indian population has almost doubled during the past two decades .The breakup of the traditional joint family system

and partitioning of households has resulted into fragmentation holdings from one hand and rise in the demand for new dwelling units on the other hand. This results into reduction in average size of holding in India. Increasing need of foods and requirement of cash forced the farmers to change the cropping pattern. In order to construct new houses and also to raise the required financial resources for construction, old trees like Banyan, Mango, Neem, Peepul tree in their homesteads happened to be cut down. Open space is created for building new houses and out houses for cattle and animals. This fact also made the small piece of land.

Government allotted the wastelands and non-agricultural lands for dwellings to landless farmers and agricultural workers and weaker section of the society which people later reclaimed to habitable areas through efforts. Due to difference in fertility of land over a period of time, changes in cropping pattern may take place. Government acquired a private land for military purposes and for construction of railway track, displacing a large number of households mostly belonging to rural laborer by paying them meager amount by Government. The new settlements and setting up new colonies also altered the exiting crop pattern.

Forest and Gavthan had been the main source of supply of green manure and fodder for cattle in earlier in India. Destruction of forests and encroachment on Gavthan land vanish this major source away. Cultivators had then to depend more on internal sources of fodder supply. As the results of which, cost of cultivation went up. Increase in the cost of cultivation is said to be one of the reasons for the shift from one crop to another crops.

Some agricultural land is affected by the problem of water logging and salinity. When the prices of crops went high, these land areas are used although the yield is poor. A chain reaction thus ensured. Agricultural sector in Maharashtra witnessed technological changes after the new economic policy 1991 by way of increasing use of high yielding variety seeds, chemical fertilizers and pesticides. Not only this modernization package increased the yield by two to three times using traditional varieties along with High Yielding Varieties considerably but also non availability of organic manure affected the micro organisms and other life forms in the field and reduced the texture and quality of the soil. This ultimately affected on the productivity per hectare. It is therefore, several farmers switched off traditional crops and varieties.

In the traditional system, cultivation was done mainly for home consumption. Crops were used as exchange medium for many requirements of the household. But over the period, consumption pattern of the people changed with greater dependence on the use of purchased goods. Therefore the purpose of cultivation changed from household consumption to production for the market. Now days the cultivators choose those crops that yield higher cash income to them in the long- run. Younger generation do not want to work on their farm as own force. Hence new generation prefer less laborious work which also changed the cropping pattern as they prefer labor saving crops.

1.5 Objectives of Research

Keeping in mind the broad theme of the research, following objectives are crafted for completing the task of the research:

1. To understand the cropping pattern of Maharashtra state.
2. To examine the trends of growth in production of major crops over the period under study.
3. To investigate the possible causes responsible for differential performance in growth.
4. To study the trends in instability in crop output, analysis the sources of the study period.
5. To analyse the inter district disparity in output growth for 1991-2012.
6. To identify technological and non technological variables.
7. To comment on the prospects of growth
8. To explore emerging constraints on growth path of agricultural sector in Maharashtra
9. To give suggestions to policy makers.

1.6 Hypotheses

A variety of factors such as natural, technological, institutional, social and economic can be considered to explain the backwardness of agriculture in Maharashtra. Nature is bounteous and sometimes it gives erratically and often snatches with one hand, what it gives with the other. If monsoons are kind and fields look resplendent with white green saplings, hail storms lash then mercilessly or floods wash them away and we are fortunate enough to escape the wrath of all this, we are sure to be blessed by locusts and other pest epidemics. Technological factors include primitive equipment, lack of irrigational facilities and inadequate availabilities of fertilizers. Institutional factors imply uneconomical size of holdings and defective land tenure system. Social and

economic factors include ignorance and superstitious nature of the farmers and their vulnerability on financial issues. After careful consideration the following hypothesis have been selected:

1. The cropping pattern under different regions of study is not same.
2. There is increasing tendency of changing cropping pattern in Maharashtra.

1.7 Research Methodology

1.7.1 Data and Data Sources

It is observed that 84% of cultivable land is rain fed and mostly depends on the rains received through south-west monsoon (June-September) Maharashtra has 226.12 lakh hectares of land under cultivation where cereals, pulses and other major food grains are grown. The extreme weather conditions coupled with low quality of soil and large area under rain fed cropping poses challenges in improving agricultural productivity. So all the important crops such as cereals, pulses, oilseeds, and commercial crops are selected for the present study.

Minor pulses and oilseeds and other crops are not considered for lack of data on these crops. Thus, the study was limited to principal crops with the assumption that expelled crops do not influence the cropping pattern which in turn, would not change the important findings and conclusions of this study. The selection of crops for study is dictated by the availability of data. The selected crops for study are Kharif Jowar, Rabi Jowar, Bajra, cereals, Tur, gram, other pulses, total food grains, oilseeds, cotton and sugarcane. The time series data on area, production and

(productivity) yield of selected crops and input use irrigated area, fertilizer consumption and area under high yielding varieties are collected from the various complications of government. The present study was conducted for Maharashtra state in India for the period 1991-2012.

Crop wise aggregate data on area, output and yield of 32 crops for 36 major districts have been obtained from publication of Government of Maharashtra. Detail fact and figure relates to Area, Production and Productivity of the principle crops in Maharashtra state are obtained from the Economic Survey of Maharashtra. The data is divided into two phases starting from 1991-1992 to 2001-2002 and 2002-03 to 2012-13. This period has been selected to know the impact of economic reforms on cropping pattern of Maharashtra if any.

Present data is culled from report of Annual report of Ministry of Agriculture Government of Maharashtra and in hand data is collected from Directorate of Agriculture Maharashtra state Pune. This study is undertaken to understand the trends in the cropping pattern of Yavatmal district. For that, time series data of major crops were collected from the office of Directorate of Agriculture, Pune, Maharashtra and office of the Commissioner of Land Record for the period 1991-92 to 2010-11. To observe the trends in major crops and cropping patterns data period has been divided in to two periods namely 1991-2000 and 2001-2010.

1.7.2 Study Period

The entire study period was split into two sub periods to evaluate the impact of a new production technology on agricultural development and take stock of the results in relative contribution of various parameters to output growth throughout the period of time. The sub-periods mentioned are as follows: period I-1991-92 to 2000-01, period II – 2001-02 to 2011-12. This research design has longitudinal study approach. Selection of study period is relevant to objectives of the study.

1.7.3 Research Tools

In the present study, we used statistical and econometric tools for writing this thesis. Besides averages, compounded annual growth rate, average annual growth rate, standard deviation, coefficient of variation, log linear model, dummy variable log linear model, mean comparison test and t test have been used for analyzing data and testing the hypotheses in the various chapters. Determinant of cropping pattern are analyzed using Log linear model. Case study method is also adopted for a study of cropping pattern in the Yavatmal district.

1.7.4 Limitations of Study

Present study is focuses on changing trends in cropping pattern in Maharashtra for the periods before reforms and after economic reforms. For that we used an aggregate data of main categories of the crops. However, crop specific study has not been conducted except cotton and sugar cane. In the district level trends in cropping pattern, region wise two districts have

been covered for observing trends in cropping pattern for the period 2000 to 2013. We could not cover all the districts of Maharashtra for this exercise. Panel data techniques is an appropriate for observing trends in cropping pattern in the Maharashtra but we have not tried panel data techniques due to continuity in the data and data constraints.

1.8 Organization of Thesis

Present study is divided into seven chapters. Chapter one introduces the research theme. It focuses on importance of study, study period, data sources and methodology perused for analyzing data. Chapter two reviews the relevant literature. This exercise helps us in creating background of the study and finding of a research gap exists on this theme of the research. Chapter three reviews the state of agriculture in India with recent data. The efforts made by central government in revitalizing agriculture sector are reviewed.

Chapter four is on trends and determinants of cropping pattern in Maharashtra. In this chapter trends in cropping pattern of major categories of crops are analyzed for the pre and post reforms period. The determinants of cropping patterns are analyzed for knowing active role of agricultural inputs/factors. Chapter five focuses on region and districts wise trends in cropping pattern in Maharashtra for the period 2000-2013. These efforts enable us to know variation and instability in the cropping pattern district wise.

Chapter six is case study of Yavatmal district. In this chapter, trends in cropping pattern of different crops is observed for which mean comparison t test

is used for the pre reforms and post reforms period. Along with this dummy variable regression is used for change in the cropping pattern.

In the last chapter, thesis is concluded with conclusions and policy suggestions are forwarded for balanced cropping pattern in Maharashtra. This may add into the overall richness and standard of Maharashtra.

REFERENCES

1. GoM Diary Data
2. A Book “General Studies” (2015) Mc Graw Hill Education New Delhi.

Chapter 2

Literature Review

2.1 Introduction

This chapter presents the review of literature relevant to study. Literature review gives background of the study and related issues. It also serves purpose of finding out gap exist in the earlier studies conducted so far. The present review is classified into three parts: 1) Cropping pattern in India.2) Cropping pattern in Maharashtra. 3) Statistical analysis of growth and instability in agricultural sector of Yavatmal. These classifications allows researcher to expose the research

problem in depth. Study conducted by (Raj, 1983) found that average rate of growth of agricultural output over the past three decades was same in India and China. In both the countries, there have been sharp fluctuations in output due to natural factors. The study also indicated that the role of prices was under rated and even neglected. Prices and other incentives suggest that substantial increases in output would have been possible only after the other constraints were effectively relaxed.

2.2 Relevant Literature on Agricultural Development and Cropping Pattern in India

(Gomatee Singh, 2012) explores a close relationship between the socio-economic status of the farmers and cropping pattern adopted by them. They always try to maximize their profit whether belong to the large, medium, small or marginal category of land holdings. As (Gomatee Singh, 2012) found that the most important factor influencing the cropping pattern are; price, yield, tradition, crop prospect and labour. The large farmers by and large belong to high economic status. They can take risk in changing their cropping pattern and they grow those crops which give them higher monetary benefits. They prepare the land for wheat in Rabbi Season and for rice and sugarcane during kharif season. Medium farmers prefer wheat in Rabbi and sugarcane in kharif season. The small or marginal farmers generally go for vegetable cultivation which provides them seasonal income for sustainability.

According to (Surinder Sood,2012) those who thought that good crops in the past seasons made farmers better off but the truth is that most of them are

worse off. Badly hit are those farmers who close to switch crops to improve their economic status lot but thanks to government policy and falling global prices for supporting farmers to survive.

It is seen by (Bhattacharya, 2011) that unbalanced use of fertilizers, lack of use of high yielding quality seeds, inadequate use of manures and micronutrients, insufficient and poor water management, lack of proper marketing arrangements in the neighbourhood, lower access to electrified irrigation sources, insufficient extension services and lesser interest in agriculture all these factors resulted in improper crop management and farming practices. He suggested for promoting research in agricultural sector. It should incorporate properly to high crop yields and increased crop productivity on a sustainable basis.

(Singh and Grover, 2011) concluded that in case of rice cultivation, one percent increase in cost of irrigation, zinc sulphate and machine labour, farming will not be remunerative to the farmers. Human labour would increase the productivity of rice. However recently, wheat cultivation has been found more profitable for the growers. It is true that farmers produce food for the billions and at affordable prices.

(Reddy, 2011) found that productivity, growth and diversification towards high value commodities have played a key role in changes of the value chain of the production. In his study, he considered only the crop sector for decomposition analysis to validate sources of growth in value production from the crop sector. The crop sub sector growth is higher in post liberalisation period compared to pre liberalisation period.

(Bhattacharya,2011) indicated that research should explore how farmers are being facing the constraints while increasing crop yields and provide farmers with appropriate technological packages for specific locations to bridge the yield gaps. Institutional and policy support to farmers was crucial for ensuring agricultural input supplies, farm credit, price incentives and adequate marketing system in a holistic manner for increased crop productivity on a sustainable basis.

(Das and Barman, 2010) give stress on foot hill situation in Assam. The supply of human labour and bullock labour is greater than working capital. The optimal plans could be made effective only when the constraints on resource availability are removed. Agricultural in West Bengal has registered a rapid rate of growth in output during 1977-95. The provision of large amount of agricultural credit in the post bank nationalisation period has played a catalytic role in accelerating agricultural growth through change in cropping pattern towards commercialisation of agriculture in West Bengal (Ray, 2009).

It is observed by (Ray, 2009) that credit plays a substantial role in effecting a significant change in cropping pattern in favour of more remunerative crops. A change in crop pattern towards commercialisation of agriculture, need to be encouraged so there is a need of design an appropriate crops wise credit policy to ensure food security. (Fazlur Rahman, 2009) attempt to discuss the adoption of innovation is to ensure sustainable agricultural productivity. Crop productivity depends on the availability of water, its proper use and management.

Vijay and Pattnaik,(2009) concluded that Odisha and Andhra Pradesh have gone through three phases- post independence period, green revolution period and after eighties period- and two turning points- subsidies and support to

agriculture sector- of income in agriculture. Odisha witnessed declaration over the three phases due to land constrained system and Andhra Pradesh adopted acceleration in the income originating in agriculture sector due to science based agriculture and increasing market interaction.

Bhalla and Singh, (1996) concluded that in the year 1992-95, there was a distinct change in cropping pattern away from Corse cereals towards oilseeds and other commercial crops, this shift was particularly strong in Maharashtra. However agricultural growth and crop diversification was not accompanied by any significant change in labour force diversification. Kalamkar, (2006) in his proposed work used Herfindahl Index and Entropy Index measures of crop diversification in the empirical analysis.

Vyjlij, (2009) used weaver's formula for crop combination. Using Cobb Douglas function (Tupe and Kamat, 2010) concluded that contribution of individual input in the agricultural gross domestic product of India (AGDP) is dominated by area under irrigation, minimum support prices and cultivable area. (Gatade and Pol, 2012) used Raffiullha method to understand the crop combination in their proposed work.

The Gibbs and Martin Index of diversification 1962 used by (Ratnaparkhi, Rajade and Wasnik,2008). (Singh and Grewal 1996) calculated the compound growth rate of area, production and yield of rice for India and for the different states using the function y=abt . (Joshi and Sharma,1995) estimated the compound growth rate of area, production and yield of rice for the period 1970-71 to 88-89 for various coastal districts of India using the growth equation $y = abt.$

Gajja, (1994) analysed the productivity variation and land irritability class in Kakrapar canal command area in Gujarat state. The result showed that the farmers in the command area allocated large acreage to high water requirement crops as compared to low water requirement crops because they had high profitability and low yield uncertainty than the latter ones. As cropping pattern is based on soil water relationship, they observed that any diversion from the suggested cropping pattern could lead to salinity and water logging which ultimately leads to a decline in farm production.

Krishnakumari and Swaminathan, (1992) examined the changes in cropping pattern, crop combination, crop area and diversification of crop enterprises in Tamil Nadu. The result revealed the period for 1956-57 to 1989-90 observed negative association between area and productivity growth. This suggested the change in cropping pattern. One feature observed was that the expansion of irrigation resulted in the lowering of instability in output. This situation led to a shift in the cropping pattern in favour of non-cereal crops.

One of the pioneering study made by (Gulati and Sharma, 1990) explains on cropping pattern change, Intensity of various crops, direct-indirect employment as well as their environmental effects etc. Desirable cropping pattern related to a cropping pattern which is oriented towards above factors.

2.3 Cropping Pattern in Maharashtra

The impact after new economic policy on Maharashtra's agriculture with reference to socio economic factors like cropping pattern has been documented in the various studies. (Bank of Maharashtra Report 2012) reveals that special state

level bankers committee for Maharashtra state focuses on flow on credit to agriculture especially crop loans during current kharif season in Maharashtra state convey that the major crops grown in Maharashtra state are jowar, Bajra, Paddy ,Maize, Oilseeds (Groundnut, Safflower, Soybean), Pulses(Tur, Gram),Sugarcane, Cotton ,Fruit crops (Mango, Grapes, Orange) and vegetables. The state has 18.9% of gross cropped area (GCA) under irrigation. As compare to 44.3% of all India GCA. Yet the state is large producer of food grains. Apart from traditional strengths in sugarcane, cotton and onion Maharashtra has emerged as one of the leading horticulture states in the country showing a path of diversification to other states.

National Sample Survey's estimates based on July 2009 to June 2010 convey that cereals constitute more than 90 per cent of food grains consumption of the people in the state. There is a deficiency in the production of cereals whereas, surplus production of pulses. Soya bin-wheat cropping sequence application of fertilisers as per soil test values is the best option for higher productivity, with higher monetary returns and organic nutrient (Jadhav, Waghmode, and Mote.2011).

Shaoo and Mahapatra, (2008) explore the determinants of the state domestic product for the period 1981-82 to 2002-2003. They found that there is strong inequality of agricultural income among the states are mostly in the western and southern regions. On the other hand poor performing states are from eastern and northern region. (Maharashtra Govt, Report, 2008-2009) elaborates that Yavatamal is a rain fed area. Most cultivable land was occupied by cotton and soybean. The command area utilised for gram and wheat respectively. Kharif

season had grown major crops in Yavatamal district. Area under cropping pattern specialised in intercropping system (cotton + Tur).

The rice- groundnut system was the most profitable cropping pattern in the command area of Natuwadi, Dist. Ratnagiri for maintaining the soil fertility (Nikam,Veerkar and Devrukhakar,2006). The above analysis shows that modelling techniques were used by different authors for different locations within the study period 1991-2012 in their research. (Kalamkar, 2006) in his proposed work used Herfindahl Index and Entropy Index measures of crop diversification in the empirical analysis.

Kalamakar, (2000) emerges through his work that during overall period of study (1991-98) growth in area of main crops in Maharashtra revealed mixed trend except Jowar, Bajra and wheat. Whereas commercial crops output (sugarcane) recorded remarkable increase due to the more area under the crop. Productivity (yield) growths as well as shift in cropping pattern were major factors for the growth of crop output in Maharashtra state. There has been considerable growth in the use of crucial inputs such as irrigation, high yielding variety seeds and chemical fertilizers.

Vyas, (1996) concluded that most of the areas where irrigation introduced, the cropping pattern was more diversified, especially if there was proper regulation of water delivery. According to (Kulkarni, 2000) cropping pattern is nothing but the predominance of growing one or more crops in the area year after year forms a regular feature of cropping. As sugar factories began to establish in Maharashtra one after another, methods of growing sugarcane also developed simultaneously pushing up the average yield of sugarcane from 40 tons per acre

to about 60 tons. However, industry needs promised source of raw material which only could be provided by a sustainable cropping pattern under irrigated agriculture.

According to (Rathod and Naik, 2009) agricultural production is influenced by physical, socio-economic, technological and organisation factor. An endeavour is made her to study the crop combination region in Yavatmal district. The crop data has been computed with the help of Doi's methods of crop combination. The study region covers 13,582 sq.km (4.4%) of the state and a population of the 2077144 (2.63%) of the state in1991 Census of Yavatmal district.

Sarkar, (2009) observed that modern agriculture spreads well beyond the traditional production of food for human and capital feeds. The pre industrial period saw massive changes in agricultural practice and in mechanisation. Agriculture practice includes the application of chemical fertiliser, insecticides, pesticides and fungicides, soil make up, nutritional needs of farm animals and analysis of agricultural products. HYVP seeds germinate faster. It is grown in an extended growing area. These crops have capabilities beyond those of naturally occurring plants.

2.4 Statistical Analysis of Growth and Instability in Indian Agriculture

(Parthasarthi, 1984) measured the growth rates and instability in agricultural production for different districts of Andhra Pradesh. He used Schulz's techniques of 1953 for observing year to year variation as one of the approach to measure instability. He concluded that degree of instability in agricultural production was high in all the districts. It was higher for food grains than for all groups.

The district of North Coastal Andhra combines high instability with low growth. Nalgonda district in Telangana was rather unique in having experienced high growth rates of production with low instability. The post green revolution period showed a higher degree of instability. The district which achieved higher growth rates were also subject to greater instability.

(Pawar, 1983) observed that growth rate of agricultural production in India has been falling and causing considerable anxiety. This was due to static level of production of pulses, inadequate oilseed production and cyclical fluctuations in a sugarcane production. It was concluded that growth rate of agricultural production must be increased in order to avoid imports of food grains and other products. The importance of an integrated price policy for removing imbalances in cropping pattern was also emphasized.

(Ray, 1983) examined the pattern of growth and instability in agricultural production in India for the period 1950-80. We came to know instability in production turned out to be relatively low during the fifties and it showed the tendency to increase in the following decades. The major source of instability

turned out to be yields fluctuations. The correlated changes in area, yield and cropping pattern showed increasing tendencies to rain force the variability in output growth rates.

(Gill, 1983) underlined the importance of governmental policy in the overall cropping pattern. He blamed the government for its policy of stagnation between 1972 and 1974. He emphasized on cooperative reforms, irrigation expansion and investment policies and held Punjab peasant responsible for this success that is always willing to take the risk of trying new technologies and new ways.

(K. Visweswara Reddy, 2010) concluded that cotton area is respond by irrigation facilities but not prices by providing better marketing conditions minimum support process by the government, providing new technology at cheaper process to the growers, the production may be raised in Kurnool district. (Mahendran R. 2006) made a mark on studied area that the change in cropping pattern was significant. The farmers are unaware of ground water exploitation and falling water table area under high water consuming crops should give way for low water consuming crops should give way for low water consuming crops without affecting the livelihood of the farmers.

According to (Vasanta K. 2013) there is an urgent necessity for the economy to speed up efforts to evolve climate-crop varieties, cropping patterns and management policies. As the temperature increases the rice production falls. Complete crop failure is possible if severe drought takes place during the odd seasons. (R. Vijay, 2009) concluded that the agrarian sector in Orissa is not influenced by science based agriculture and so does not have a break in the yield

series and increased market interaction also has not played an important role in initiating growth in the economy. Andhra Pradesh economy has witnessed a transformation with increasing role played by science based agriculture and increasing market interaction while in case of Orissa, agrarian economy continues to be land constrained system.

Karunakara, (2003) suggested that keeping in view the substantially and ecological problems created by rubber there is need to introduce legislative measures to divert area from rubber to rice. The study made by (Hement kumar, 2013) brings out a clear relationship between land degradation and agricultural productivity. The strength of the impact of land degradation on agricultural productivity increases with severity of land degradation.

The findings of (Marothia, 2007) clearly indicated that there is no evidence of crop diversifications in the agro-climatic zones as well as in the state even after a massive emphasis placed on agriculture diversification, particularly after the formation of the state. Study made by (Vivekanada, 1994) concluded that changes in the cropping pattern towards relatively high valued crops have given force to increase in the aggregate value of agricultural output through.

2.5 Conclusions

In the present chapter, relevant literature on the cropping pattern in India, and Maharashtra are referred for finding gap in the study conducted earlier. We focus on study period of earlier study, research techniques used by them and conclusions drawn by them. We also observed the policy implications of earlier studies with their limitations. Thesis in-depth exercise created the foundation of

the present study. We find that studies relating to cropping pattern concluded that cropping pattern were instable and after economic reforms it went in favour of cash crops from the food crops. Reason being is better support prices and need of cash for meeting day to day livings expenses.

Maharashtra specific study conducted by (Kalamakar, 2000) for the period (1991-98) concluded that the growth in area of major crops in Maharashtra reveals mixed trend except Jowar, Bajra and Wheat whereas commercial crop's output (sugarcane) recorded remarkable increase due to the more area under the crop. Productivity growth and shift in cropping pattern were major factor for the growth of crop output in Maharashtra.

REFERENCES

1. Gajja B.L., Sharma V.P. and Joshi P.K. (1994) Productivity variation and land irrigability class in Kakrapar canal command area in Gujarat state. Indian Journal of Agricultural Economics, 49(4) :609-619.
2. Gatade, Pol (2012), "Crop combination in Sangli district (Maharashtra): A Geographical Analysis", Variorum Multi-disciplinary e-Research Journal Vol.3, Issue-I, August 2012.
3. Gill, M. S. (1983), "The development of Punjab agriculture", Asian Survey, 23(7), pp. 830- 844.
4. Gomati Singh (2012), "Factors influencing cropping pattern- with special reference to the size of land holding", International Journal of Scientific and Research Publications, Vol.2, Issue.5, May 2012, ISSN 2250-3153.
5. Government of Maharashtra various years, Statistical-Season and Crop Report, Directorate of Agriculture, Government of Maharashtra, Pune.
6. Hemant Kumar and Padmini Pani, (2013) " Effects of soil erosion on Agricultural Productivity in Semi-Arid Regions: The case of lower Chambal Valley," Journal of Ruler Development, Vol.32, No.2, April-June 2013
7. Jadhav, V. T (2011), "Effect of Organic and Inorganic Sources of Nutrients on Yield, Nutrient Uptake, Soil Fertility and Economics of Soyabean-Wheat Cropping System", Journal of Agricultural Research and Technology, pp, 369-373.
8. Joshi P.K. and Sharma U.P. (1995), "Performance of rice production and factors affecting acreage under rice in coastal regions of India", Indian Journal of Agricultural Economics, 50(2): 153-160.

9. K. Vasanta, (2013), “Impact of climate change on wheat and rice production: An analysis,” Economic affairs; 52(2): 89-95 June 2013, pp.89-95.
10. K.M. Vivekananda (1994), “Karnataka’s Changing Cropping Pattern”, Agricultural Situation in India, pp. 441-444.
11. Krishnakumari A. and Swaminathan E. (1992), “changing farming scene in Nellore district, India”, Indian Geographical Journal, 65(2) 123-129.
12. Marothia, Singh and Koshta, (2007), “Crop diversification: Post reform lessons from Chhatisgarh”, Agricultural Situation in India, September, 2007, pp.215-226.
13. Mohindra Bhattacharya (2011), “Economic Analysis of Yield Gaps in Principal Crops in India”, Agricultural Situation in India.
14. Parthasarthi, G. (1984), “Growth rates and fluctuations of agricultural production – a district-wise analysis in Andhra Pradesh”, Economic and Political Weekly, 19(26), A74-A84.
15. Pawar, B. B. (1983), “Some dimensions of agricultural development in India”, State Bank of India Monthly Review, 22 (8), pp.333-341.
16. R. Das and R.N. Barman (2010), “Development of ideal agriculture production plan for the foothill agro ecological situation of Sonitpur district of Assam- A farming system approach”, Indian Journal of Economics, Vol. 65, No.3, July-September 2010.
17. Rathod, H.B. and Naik V.T. (2009), “Agricultural land use Cropping Pattern in Yavatmal District”, Journal of Shod Samiksha Aur Mulyankan Volume II, Issue-6, PP 780-782.

18. Ray, S. K. (1983),"An empirical investigation of the nature and causes for growth and instability in Indian agriculture: 1950-80", Indian Journal of Agricultural Economics, 38 - 40, pp. 459-474.
19. S.K .Ray (2009), "Availability of Institutional Credit change in cropping pattern and agricultural growth in West Bengal- A district level analysis", Indian Journal of Regional Science Vol. XXXX, No.1
20. Singh B. And Grewal S.S. (1996),"Economic profile of rice production in India", Agriculture Situation in India, 42(3) : 11-15.
21. Surinder Sood (2012), "Rich Crops, poor farmers", an article in Business Standard.
22. Tupe Sanjay and Manoj Kamat (2010), "An Empirical Study of Trends and Determinants of Indian Agricultural Production of Pre and Post Reforms period", Productivity-A Quarterly Journal of the National Productivity Council.Vol.50, January-March 2010,No.4.
23. Vivekananda M. And Satyapriya V.S. (1994), "Karnataka's changing cropping pattern", Agricultural Situation in India, 49(6):441-444."
24. Vyas V.S. (1996),"Diversification in agricultural research", Indian Journal of Agricultural Economics, 51(40); 639-640.
25. Sarkar U.A. (2009), Ph. D. Thesis, "Agriculture Research Education And Extension for Rural Development A Case Study of Krishi Vigyan Kendra (KVK) Kosbad, District Thane." Tilak Maharashtra Vidyapeeth, Pune.

Chapter 3

Overview of Indian Agriculture after Economic Reforms

3.1. Introduction

India is one of the ancient civilisations in the world. Rivers have been of fundamental importance throughout the history. Early humans wandered from place to place in search of food and water. The river banks have attracted settlers

from ancient times. After some time, they realised that settling near river banks gave them easy access to water. When they noticed plants, they observed that these plants produced seeds which could be eaten. In order to grow plants on their own, early humans collected these seeds and spread them near river banks. These seeds turned into plants.

Nomads started digging the soil using stone tools to plough the land. This was the beginning of agriculture. These settlements have now become big cities. Thus India is an agro- based country. About half of the population practise agriculture on 60 per cent of land. It earns about 15 per cent of our national income. It is also the principal source of livelihood in rural area. The climate conditions, the existence of huge plains and the fertility of soils make agriculture a profitable business in our country. It has achieved multi faceted socio-economic progress after economic reforms. It has moved forward displaying remarkable progress in the field of agriculture and overall economic development.

Before economic reforms India was facing hazardous economic problems and political imbalances. To overcome the critical situation Dr. Manmohan Singh drafted a new economic policy in June 1991. This new economic policy is the result of international, social and economic changes. In 1991 India's foreign exchange reserve balance was only 2.2 billion dollars. Inflation rate was near about 14 per cent. Fiscal deficit of GDP was 8.4 per cent and current account deficit was 9.9 billion dollars. This complicated situation turned into smooth functioning economy through New Economic Policy (NEP). So New Economic Policy is a compulsory product of the management of economic crisis. The achievement of New Economic Policy was that the inflation rate was decreased

from 13.6 per cent in 1991-92 to 6.5 per cent in 1992-93. And fiscal deficit was decreased by 4.9 per cent in same year.

Agriculture, basic industries, infrastructure, energy education are some of the important factors for the economic growth of the Indian Economy. Structural changes help Indian economy to develop fast. Economic reforms include liberalisation, privatisation and globalisation. Liberalisation indicates non interference of the government. Globalisation shows the free trade policy. It means to remove the obstacle between two countries. According to World Bank globalisation means: 1) Remove the tariff of all goods including consumption goods. 2) Decrease the rate of import duties and 3) the privatisation of public sector. India is a developing country and has mixed economy. It consists of two sectors namely public sector and private sector. According to Adam Smith, 'Privatisation is must.' written in his book The Age of Discontinuity in 1969. Now it is proved that India is the follower of Adam Smith's thoughts.

3.2. Dimensions of New Economic Policy for Agriculture Sector

After 1991 time, distance and value are three important dimensions of agriculture sector in India. The objectives of the dimensions of (NEP) New Economic Policy for agricultural sector are to prepare the plan, to produce according to the plan and to sell the produced goods in global market. It helps to increase the volume of international market. Due to economic reforms how agricultural key indicators works, record production of crops, compound growth rate of area, production and yield of major crops achieved successfully or not? We have to study all these objectives below in detail.

3.3 Key indicators of Agriculture

According to the constitutional subject list agriculture is a part of state list. Agriculture sector is supported by many centrally sponsored and central government schemes. Growth in Agriculture sector GDP was 0.8 per cent in 2009-10. It has a tremendous rise by 4.7 per cent in 2013-14.In first two consecutive years of Tenth Five Year plan (2002-07) agriculture sector had negative growth. Table 3.1 indicates key indicators of agriculture sector of Indian economy.

Table 3.1 Agricultural sector : Key-Indicators

(Percentage at prices of year 2004-05)

Sr. No.	Item details	2009-10	2010-11	2011-12	2012-13	2013-14
1	Growth in Agri GDP-	0.8	8.6	5	1.4	4.7*
	share in total GDP	14.6	14.6	14.4	13.9	13.9*
	of which, Agriculture	12.3	12.4	12.3	11.8	NA
2	share in total GCF	7.3	6.3	7	7.1	NA
	of which, Agriculture	6.7	5.8	6.5	6.5	NA
3	GCF as per cent of Agri GDP	20.1	18.5	20.8	21.2	NA
	of which, Private Sector	16.7	15.7	18	18.1	NA
4	Agri exports as percent of total exports	8.2	8	10.1	11.8	11.9(P)

Source: Data compiled from Economic Survey of India 2014-15, Ministry of Finance ,Government of India. P means projected.

But registered average growth rate of 4.1 per cent during Eleventh Five Year Plan is remarkable. As a concomitant of growth the share of agriculture and other farm activities in GDP declined to 15.2 per cent during 2007 to 2012. After that it was 13.9 per cent in 2013-14. Agriculture sector still mentioned about 54.6 percent of the total employment as per 2011 census. There has been declined in the absolute number of cultivators, which is never known to have happened before from 127.3 million to 118.7 million. These changes have taken place after

economic reforms. Track of this record shows that shift from farm to non- farm employment activities. So real farm wages increased over 7 per cent annually in back years.

Some of the activities related to farming consist of horticulture, fisheries, bee farming, rearing and orchard farming. Growth rate of agriculture and these activities GDP was 1.4 per cent and 4.7 per cent during 2012-13 and 2013-14 respectively. According to 2004-05 prices, from 2007-08, overall Gross Capital Formation (GCF) in agriculture and related activities has risen from 16.1 per cent of GDP to 21.2 per cent in 2012-13.

Among public and private sector, private sector is leading by more than 85 per cent investment. This indicate that the private sector investment has rising rapidly. In North India, there are three agriculture seasons. These are kharif, rabbi and zaid. June to September kharif season, October to march Rabi and from April to June arid season have been seen in India. In south India there is no such specific cropping seasons. Here if conditions are favourable then crops can be grown any time of the year.

3.4 Record of Production of Crops

India is the second largest producer of rice in the world after china. This is the staple crop of most of the Indians. It is grown in tropical humid regions over a vast area. This region has cleay soil which is rich in humus. Cleay soil is very fertile. Some of the states producing rice are Punjab. Haryana, northern Rajasthan, western Uttar Pradesh, Bihar West Bengal, Assam, Jharkhand, Andhra Pradesh, Tamil Nadu and Kerala. West Bengal has the highest production during

the study period which is 14885 thousand tonnes in the millennium decade on 2004-05. Andhra Pradesh produced 14,385 thousand tonnes whereas Uttar Pradesh had share of 14,025 thousand tonnes rice production. Tamil Nadu, Karnataka, Odisha and Madhya Pradesh had shown decrease in rice production during 1991- 2012. Arunachal Pradesh, Goa, Himachal Pradesh, Jammu and Kashmir, Kerala, Manipur, Meghalaya, Mizoram, Nagaland, Sikkim, Uttarakhand and all union territories had enough share in rice production after the new economic policy.

All India rice production went high in the year 2011-12. Export of cereals especially, rice has increased from USD 2575 million in 2010-11 to USD 7742 million in 2013-14. Agriculture export grew by 5.1 per cent in 2013-14 over 2012-13. Primary sector includes marine export also. These marine products increased by 44.8 per cent at same era. All primary sectors like dairy, poultry, meat and components of blue revolution consistently doubled their share from 2008-09 to 2013-14 in agricultural export. Table 3.2 shows details Area, Production and Yield of Major Crops in 2013-14 with percent change over 2012-13.

Table 3.2 Area, Production and Productivity of Major Crops

(Area: Million ha; Prod: Million Tonnes; Yield: kg/ha)

Group/ Commodity	Area		Production		Productivity	
	2013-14	2012-13	2013-14	2012-13	2013-14	2012-13
Food grains [a]	126.2	4.47	264.4	2.88	2095	-1.55
Rice	43.9	2.57	106.3	1.05	2419	-1.75
Wheat	31.3	4.33	95.8	2.46	3059	-1.86
Coarse cereals	25.5	2.98	42.7	6.64	1672	2.83
Maize	9.3	6.9	24.2	8.52	2602	1.4
Bajra	7.9	8.22	9.2	5.75	1161	-3.09
Pulses	25.4	9.01	19.6	7.1	770	-2.41
Gram	10.2	20	9.9	12.5	974	-5.98
Tur	3.9	0	3.4	13.33	857	10.44
Oilseeds	28.2	6.42	32.4	4.85	1149	-1.63
Groundnut	5.5	17.02	9.5	102.1	1723	73.17
Rapeseed and Mustard	6.5	1.56	7.8	-2.5	1208	-4.28
Cotton [b]	11.7	(-2.50)	36.5	6.73	529	8.85
Sugarcane	5	0	348	2.11	70	0

Source: Directorate of Economics and Statistics, Department of Agriculture and cooperation (DAC), Economic Survey of India 2014-15, Ministry of Finance, Government of India.
Note: * 3rd advance estimates ; a – Includes cereals, coarse cereals and pulses; b- million bales of 170 kg each; Figure indicate per cent change over 2012-13.

India is one of the top countries in agriculture production. Increase in production through increase in area is not possible for the peninsular land and man ratio. It would get still narrow in future. Hence Indian economy should be reorganised as place of intensive agriculture which becomes the basic characteristic of agriculture sector after 1991. Technological improvements in agriculture can be classified into biological and mechanical sections. Under biological section new seeds (HYVP), use of fertiliser in right time at right doses.

Mechanical innovations usually mean the use of more machinery like tractors, threshers etc. This framework would become a key factor in the rapid transformation of Indian agriculture in the next 20 years. In developed countries farm mechanisation played an important role.

More than 90 per cent farm activities done through mechanisation whereas; across the Indian states it varies around 25 per cent.

After economic reforms cereals has 126.2 million ha; pulses 25.4 million ha; oilseeds 28.2 million ha; cotton and sugarcane these cash crops are 11.7million ha and 5.0 million hectares respectively. As per the third advance estimates, the production has summed up by 264.4 million ha. Rice has 106.3 million tonnes and wheat has 95.8 million tonnes. Pulses scored 19.6 million tonnes. Oilseeds 32.4 million tonnes whereas cotton 36.5 million tonnes and sugar cane production recorded as 348 million tonnes. Rapeseed and mustard shows negative flow of production by change over in 2012-13. Yield in All India level has declined overall for major crops except tur, coarse cereals and cotton. National Food Security Mission (NFSM) set a new target after achieving the goal of increasing food grains production by 20 million tonnes to 25 million tonnes in thirteenth Five Year Plan Period. According to twelfth plan under Rashtriya Krishi Vikas Yojna will be through production growth 35 per cent. Seven Sisters' area of India is implementing a major sub scheme with an allocation of Rs. 1000 crore in the year 2013-14. The core geographical area of rice production in India was increased by 7 per cent in 2012-13 over 2011-12.

In 2013-14 productivity has decreased as compared to production by expanding acreage. Yield of Cotton and tur increased as against stagnant acreage.

Indian Agriculture shows the strong and robustness in area, production and yield in major crops. The integrated scheme of oilseeds (ground nut, sesaum, sunflower, safflower and soyabean) has resulted record production. Pulses recorded 16.6million tonnes, oilseeds 32.4 million tonnes in 2013-14. The Technology Mission on oilseeds and oil palm plans to increase domestic production of oilseeds which is near to 50 per cent short of domestic demand.

3.5 CAGR of Area, Production and Yield of Major Crops

After economic reforms green revolution has a major role to perform. High Yield Variety Programme seeds, fertilisers, irrigation facilities and mechanisation in agriculture sector are the key factors of green revolution. With the help of these factors rice production has increased by 2.02 per cent while wheat by 3.57 per cent. The area of rice has declined in 2000-01. Compound Annual Growth Rate of area, production and productivity of pulses has improved by 1.59 per cent, 3.72 per cent and 2.10 per cent respectively. The production of sugarcane has increased by seven times in 2013-14 as compared to 1999-2000. National Food Security Mission set a target to produce 25million tonnes of food grains; 8 million tonnes of wheat 10 million tonnes of rice, 3 million tonnes of coarse cereals and 4 million tonnes of pulses. The table shows the compound growth rate of area, production and productivity during 2000-01 to 2013-14 has been higher than in the previous two decades for coarse cereals, pulses, oilseeds and cotton, while it has largely declined for rice and wheat. Table 3.3 indicates CAGR of Area, Production and Yield of major crops.

Table 3.3.Compound Growth Rates of Area, Production and Yield of Major Crops

(Base TE 1993-94=100)

Year / Crop	(Base: TE 1981-82=100)			(Base :TE 1993-94=100)		
	1990-91 to 1999-2000			2000-01 to 2013-14		
	A	P	Y	A	P	Y
Rice	0.68	2.02	1.34	0	1.82	1.82
Wheat	1.72	3.57	1.83	1.35	2.65	1.29
Coarse Cereals	-2.12	-0.02	1.82	0.25	2.96	2.7
Pulses	-0.6	0.59	0.93	1.59	3.72	2.1
Sugarcane	-0.07	2.73	1.05	1.34	2.1	0.75
Nine Oilseeds	0.86	1.63	1.15	2.35	4.71	2.31
Cotton	2.71	2.29	-0.41	3.22	13.53	9.99

Source: Development of Agriculture and Cooperation, Economic Survey of India 2014-15, Ministry of Finance, Government of India.

Note: A-Growth rate of area, P- Growth rate of production, Y- Growth rate of Yield (% per annum)

3.6 Agricultural Productivity in Comparison with other Countries

India happens to be one of the largest growers and producers of most of the agricultural crops but ranks very low in terms of productivity. Its rank is only 52th in the world in rice and 38th in wheat. However in terms of area, India has the largest area under rice and wheat in the world and the second largest producer in these crops. It has the largest area under pulses in the world and is also the world's largest producer of pulses, but in terms of productivity its rank is 138th in the world. It is clear from the table; there has been a slow and steady rise in productivity during 1991-92 to 2012-13. However as compared to other countries the yield levels in agriculture continue to be very low. Table 3.4 shows Agricultural productivity in comparison with other countries.

Table 3.4 India's Productivity vis a vis World Average and Country with highest Yield for Major Crops (kg/ha)

Crop/Commodity	World Average (TE11-12)	India (TE 2012)	Country with highest yield (TE 2012)
Paddy	4397	3514	6661 (China)
Wheat	3094	3000	7360(UK)
Maize(corn)	507	2321	8858(USA)
Pulses			
Chickpeas (gram)	917	912	1663(Ethiopia)
Pigeon peas (Tur)	786	681	1320(Myanmar)
Oilseeds			
Groundnut	166	1212	4069(USA)
Rapeseed/Mustard	1855	1163	3588(UK)
Cotton	769	517	1920(Australia)
Sugarcane	70470	69227	125587(Peru)

Sources: Agricultural Statistics at a Glance2013; Economic Survey of India 2014-15, Ministry of Finance, Government of India. Kharif and Rabi Price Policy Reports, CACP. Note: TE: Triennium Ending.

Above table shows the comparisons of the productivity of some crops in India with their productivity in some other countries. As far as wheat is concerned, productivity of wheat in India is 48 per cent of the productivity in UK and 63 per cent in China. As this is clear from the table Rice productivity in India is half of the productivity of China and 43 per cent of the productivity in USA. About sugar cane we can mention, the productivity in India is 60 per cent of the productivity in Egypt. Similar conclusions hold for most of the other crops in India.

3.7 Relation of Land and Labour Productivity

Table 3.5 shows Land and Labour Productivity Growth in Indian Agriculture. The non agricultural sectors of the economy have not been able to expand at a sufficiently rapid pace over the period of last two decades. This pressure has continuously increased. In 2011, about 263 million workers or three quarters of the rural workers was employed in the agricultural sector. Increasing pressure of population on land is partly responsible for the sub division and fragmentation of holdings. Productivity on small uneconomic holdings is low.

Relation between land and labour productivity in Indian Agriculture in due course of 1991and 2011 are shown above. Land yield increased consistently through the period with an average growth of 2.38 per cent per annum. The growth was more or less equal in the 1990 and2000. The 1992-2001 decade registered an annual growth of 2.97 per cent and it declined slightly to 2.50 per cent in the 2001-2011 decade.

The land productivity is greater than labour productivity. Land productivity grew in all states since 1992.Maharashtra's Growth was 4.34 per cent while Bihar and Madhya Pradesh growth was well. Other states have shown moderate growth rate. Labour productivity rate was declined in Assam, Madhya Pradesh, Odisha, Rajasthan and Utter Pradesh with Uttarakhand.

Table 3.5 Land and Labour Productivity Growth in Indian Agriculture (1992-2011)

(Land and Labour Productivity values are at constant prices 2004-2005).

State	Values at 1992 (Rs)		Annual Growth (%)	
	Land Productivity	Labour Productivity	Land Productivity	Labour Productivity
Andhra Pradesh	27825	15,436	2.6	1.46
Assam	40,546	25,213	0.91	-0.52
Bihar+Jharkhand	14,876	5,232	5.92	2.9
Gujarat	17,220	21,155	3.25	1.22
Haryana	37,777	48,963	2.59	0.61
Himachal Pradesh	41,830	19,711	3.82	0.32
Jammu and Kashmir	58,138	22,623	3.28	3.58
Karnataka	20,516	21,188	2.16	0.5
Kerala	54,860	44,065	1.54	2.82
Madhya Pradesh+Chhattisgarh	11,186	16,703	4.13	-0.21
Maharashtra	14,796	14,915	4.34	2.14
Odisha	23,788	20,015	2.57	-0.12
Punjab	54,494	71,299	1.32	0.76
Rajasthan	11,480	20,125	2.11	-1.14
Tamil Nadu	27,975	12,684	2.16	0.73
Utter Pradesh+Uttarakhand	34,676	26,930	1.89	-1.16
West Bengal	49,390	25,221	2.32	0.21
All India	24,342	14,971	2.38	1.6

Source: Data compiled from Economic Survey of India 2014-15, Ministry of Finance, and Government of India.

3.8 Climate Change and its Impact

The incidence of higher temperatures and higher rainfall variability with lower mean rain falls is increasing over the years. El Nino effect occurs when surface temperatures in the Pacific ocean constantly increase above average for more than a few months, which harmfully affects weather in a lot of parts of the world. It cyclically occurs every three to five years often begins to form during June-August, and still 9-12 months. The event get importance in India since its effect is experienced around mid of rainy season during the south-west monsoon. While most of the drought years in India match with the incident of the El-Nino, the reserve link is not that strong. In nineties, India undergone a rainfall shortage of 10 per cent or more than in six places. In 1997, when the impact of El Nino was reported to be the most terrible, India had 2 per cent higher than standard rainfall.

The extended range forecast system indicates the probability of lower rainfall in the rain fed regions of peninsular India, which may affect the crops such as rice, soyabean, cotton, maize, jowar, groundnut and sugar cane. The weather fluctuations in India which affect the crops adversely like hailstorm, acid rain, thunder storms, floods , drought, heavy snow-fall, untimely rain, dust storms, cold waves, heat waves and frost etc. Accordingly, Indian farmers have developed crop varieties and agricultural practices which fit in the pattern of weather affects.

3.9 Manures and Fertilizers

The lack of nitrogenous contents in the soil can be overcome by a careful conservation and proper use of farmyard manure, animal produce, rotation of crops, the manufacture of composts from village and town, human waste, oilseeds cakes, use of green manure and the use of chemical fertilisers. Table 3.6 shows manures and fertilizers NPK Ratios.

Table 3.6 NPK Ratios (2009-10, 2010-11 and 2012-13)

State	2009-10	2010-11	2012-13
Bihar	5.3 : 1.5 : 1	5.8 : 1.9 : 1	12.3 : 3.6 : 1
Haryana	15.9 : 5.5 : 1	20.4 : 6 : 1	61.4 : 18.7 : 1
Punjab	18.4 : 5.9 : 1	19.1 : 5.4 : 1	61.9 : 19.3 : 1
All India	4.3 : 2 : 1	5.0 : 2.4 : 1	8.2 : 3.2 : 1

Source: Agricultural Statistics at a Glance, 2013; Economic Survey of India 2014-15, Ministry of Finance, Government of India. Report of working Group on fertilizer Industry for the Twelfth Plan, Planning Commission/ Note: Calculated from state wise fertilizer consumption data.

Above table consists the data of increasing ratio of Nitrogenous fertilizers (N), Phosphatic fertilizers (P) and Potassic (K). All India NPK ratio increased by twice in the year 2012-13 which was 4.3 : 2:1 in the year 2009-10. Increasing ratio of NPK worsen the situation of land in India. Nutrients based subsidy needs to be reviewed to prevent wasteful and suboptimal use of resources. Now day's trends in yield of agriculture reveal that the marginal productivity of soil in relation to the application of fertilizers is declining.

Chemical fertilizers can be classified in three ways. Nitrogenous fertilizers comprise sulphate, nitrate, ammonium sulphate, and urea etc. Phosphatic fertilizers are given to soil in the shape of phosphorus which is derived from bones and rock phosphates and the potassic fertilizers are given to the soil in the

form of potassium chloride and potassium sulphate. To address NPK nutrient imbalances and the lack of secondary and micro nutrients, through of fertilizers on specific soil moisture conditions and crop needs is the basic structure of nutrient based subsidy in 2010. The table 3.7 shows the availability as well as consumption N. The fact is that the new agriculture policy opened up to the new dimensions of growth in Indian economy.

Table 3.7 Availability and Consumption of Fertilizers

(Thousand tonnes of nutrients)

Fertilizers	2009-10	2010-11	2011-12	2012-13	2013-14
Nitrogenous (N)					
Availability	15347	16650	17499	16995	16258
Consumption	15580	16558	17300	16820	NA
Phosphatic (P)					
Availability	7077	8025	8531	6338	5302
Consumption	7274	8050	7914	6653	NA
Potassic (K)					
Availability	2945	4069	3335	1559	1926
Consumption	3632	3514	2576	2061	NA
All Fertilizers (NPK)					
Availability	25369	28744	29365	24892	23526
consumption	26486	28122	27790	25536	NA

Source: Department of Fertilizers, Economic Survey of India 2014-15, Ministry of Finance, Government of India.

3.10 Agriculture Marketing

Agriculture marketing is the new concept after economic reforms. It is true that if steps should be taken to secure high gains in productivity and other, steps should be taken to ensure that these gains reach all the pockets of the economy. Therefore all the strategy for enhancing agriculture production should consist of better land use policy which improves growth levels, a continuous improvement in yields, and an adequate support by research education and as mentioned above the agricultural marketing and pricing structure which sustains this growth.

Agricultural marketing is a new concept after economic reforms. It has the importance to address the issue of supply chain management. Its objectives are to remove market distortions in creating common market, to facilitate the creation of a national agriculture market and lastly to promote efficiency and growth. The food related notification was 'The Nation Food Security Act' (NFSA) announced on September 10, 2013. It has some specific objectives given as below.

- To provide food and nutritional security by ensuring access to adequate quantity of quality food at affordable prices.
- It gives coverage of up to 75 per cent of the rural population and up to 50 per cent of the urban population.

The annual food subsidy for implementation of the act at 2014-15 cost is about INR 1, 31,066 crore. The Food and Agriculture Organisation (FAO) has forecasts a comfortable global scenario for 2014-15 with high stocks to use

ratios of cereals and stable prices. India is well placed on food grains availability, with record domestic production and huge stock in central warehouses. Liberalising agriculture is the weapon for creating the legal and regulatory frame work for the well functioning of market economy.

Agriculture Product Market Committee (APMC) laws are major hurdle to modernisation of the food economy. There is a need to place the priority for removal of conventional interventions in the food economy. There are some ways to liberalise the agriculture. They are: obstacles to address the market failures in warehousing, regulations on future trading and knowledge of production should be available. This is a long overdue, more than that, needs to be implemented forthwith. This would make growth, and with it plan resource allocation, area and crop specific.

3.11 Seeds

Seed bank is a new scheme by government. Since 2013-14 all the states are going to achieve good varieties for the seed chain and agencies responsible for production of seeds at every level by 2016-17. New Policy on Seed Development includes 100 per cent Foreign Direct Investment under the Organisation for Economic Cooperation and Development Seeds Scheme. Seeds quality accounts for one-fourth of crop productivity. Quality seeds account for about 30 per cent of total seeds used , through there are significant variations across crops and states. The analysis of the yield data recorded from various states indicated that as compared to traditional varieties, the yield of these varieties was significantly higher by 10 to 15 per cent. It has resulted in the record production of cereals, pulses, oilseeds and cash crops also.

3.12 Credit

The farmer cannot carry on business whit out outside finance. Credit in agriculture is needed for both productive and non productive business needs of cultivators. About half of the borrowed funds were consumed for unproductive family expenditure and less than one third was spent on farm requirements. Agriculture credit flow in 2012-13 was 6, 07,375 crore and in 2013-14 it was extended to 7, 00,000 crore and achievement of 7,30,765 crore. Farmers were granted post harvest loans against negotiable warehouse receipts at commercial rates. Farmers can get the crop loan up to the principal amount of 3, 00,000 crore at 7 per cent rate of interest. Enhanced agriculture credit flows are exceeding the targets.

3.13 Irrigation

India's water resources come from the systems flowing into Bay of Bengal. While the water less regions of Thar Desert provide with nothing at all. Now 55 per cent of gross cropped area depends on rains. So Indian agriculture is called ' a gamble on monsoons'. Before economic reforms the degree of instability in agriculture output in irrigated areas was less than half of that in un-irrigated areas. The ultimate irrigation potential of 139.89 million hectares, as actual utilisation in 2011-12 was only 89.9 million hectors which is only 64.3 per cent of potential. Expenditure on irrigation in tenth plan was Rs. 1, 00,106 crore; Eleventh plan was Rs. 2, 11,700 Crore and Twelfth Plan has been kept as Rs.4, 22,012 crore. Substantial expenditure has gone in for developing the major, medium and minor irrigation projects. Under the Accelerated

Irrigation Benefit Programme Rs. 64,228 crore of central loan assistance grant has been released up to December31, 2013. Rice bowl of India has resulted in alarming reduction in the water table. So this overexploitation of water resources area of India was budgeted with Rs. 500 crore in 2013-14.

3.14 Crop Insurance

Modified insurance scheme is expected to have grater coverage. Ample of schemes are sponsored by government as a part of risk management and risk mitigation. The National Agricultural Insurance Scheme (NAIS) established on November1, 2013. It is consists of Pilot Modified National Agricultural Insurance Scheme(MNAIS), Pilot Weather Based Crop Insurance Scheme(WBCIS) and Pilot Cocount Palm Insurance Scheme (CPIS). The NAIS is approved for full fledged implementation from Rabi 2013-14.

Table 3.8 Trends in Disbursement of Crop Insurance

Scheme	Kharif 2013-14		Rabi 2013-14	
	Districts	States	Districts	States
WBICS	112	13	123	14
MNAIS	29	13	127	12

Source: Dept. of financial services. Economic Survey of India 2014-15, Ministry of Finance ,Government of India. Note: Figures are in numbers.

The Agriculture Insurance Company (AIC) implemented MNAIS and WBCIS in many districts. It developed crop insurance products from risk mitigation of various crops.

3.15 Agricultural Extension

Indian Centre for Agricultural Research has established a network of Krishi Vigyan Kendras (KVK) under the Twelfth plan. During 2013-14 from 637 KVKs 102.41 lakh farmers and other stake holders have benefited. The main objectives of Krishi Vigyan Kendras are to promote, refine and demonstrate the agricultural products.

Agricultural extension scheme strengthened more than 7 million women farmers in India to ensure the last mile connectivity. So the IT schemes and developing extensions from the eleventh plan were expanded correctly and implemented as components of Sub mission on Agricultural Extension under the National mission on Agricultural Extension and Technology. The scheme subsumed under the Sub Mission on Agricultural Extension (SMAE). The main components of SAME are Mass Media and Kisan Call Centre schemes, SMS portals for farmers and Central Sector Establishment of Agri Clinics and Agri – Business Centres (ACABC).

3.16 Agricultural Price Structure

The supply of agricultural products fluctuates widely from year to year. Prices actually fell in First Five Year Plan period. The commission for Agricultural Costs and Prices (CACP) recommends minimum Support Prices based on certain economic criteria. Pulses, Oilseeds and cotton have been increased in the Minimum Support Prices in the last few years. The objectives of price structure are as follows: 1. To ensure relationship between the prices of crops and commodities and manufactured products. 2. To compete the prices of similar kind of products. 3. To reduce the margin between producer's price and customer's price.

Table 3.9 Trends in Minimum Support Prices Declared by Central Government

Crops	2013-14	2009-10	Percentage change
Paddy(common)	1310	1000	31
Wheat	1400	1100	27
Maize	1310	840	56
Jowar (hybrid)	1500	840	79
Arhar(Tur)	4300	2300	87
Urad	4300	2520	71
Gram	3100	1760	76
Groundnut in shell	4000	2100	90
Rapeseed/Musturd	3050	1830	67
Sunflower	3700	2215	67
Soyabean	2500	1350	85
Cotton	3700	2500	48
Sugarcane(FRP)	210	129.84	62

Source: DAC, Economic Survey of India 2014-15, Ministry of Finance ,Government of India. Note: Inclusive of bonus wherever applicable.

Fair and Remunerative prices or Minimum supportive prices fixed for 2013-14 are higher than MSP's of 2009-10. It was from 27 percent to 90 per cent. The considerations in fixing MSPs for commercial crops are the same as in the case of food crops. The Agricultural Prices Commission should watch the price trends of other important crops and make its recommendations, in appropriate cases and the measures necessary to make them effective.

3.17 Agricultural Subsidies

This is much wider perspective of ensuring food security and safety net for the poor and protecting the interests of the country in the new planning international economic order that is taking shape under WTO. The important cause for the power subsidies is the pricing policy of the state electricity boards.

Irrigation subsidies arise because of the neglect of rational pricing for canal water. It is a heavy fiscal burden. Fertilizers should be available to the farmers at low and reasonable prices and ensure the high investment in fertilizer industry is the objectives of fertilizer subsidy. Expenditure on cereals between 1993-94 and 2011-12 declined in rural areas and also in urban areas of India. Food and Nutritional security concerns need to take account of changing consumption pattern. India is well placed on food grains availability, with record domestic production and huge stocks in central pool. Table 3.10 reveals structure of agricultural subsidies in India at current prices.

Table 3.10 Structure of Agricultural Subsidies in India at Current Prices

(Rs. Crore)

Year	Fertilizer	Electricity	Irrigation	Total
1999-2000	13244	6033	11196	30473
2000-01	13800	8919	13259	35978
2001-02	12595	10410	13009	36014
2002-03	11015	8521	12794	32330
2003-04	11847	14544	10921	37312
2004-05	15879	17977	12290	46146
2005-06	18460	19431	14280	52171
2006-07	26222	19729	16978	62929
2007-08	32490	20661	19457	72608
2008-09	76603	27489	23665	127757
2011-12	70010	N.A.	N.A.	70010
2012-13	65970	N.A.	N.A.	65970
2013-14	67972(R.E.)	N.A.	N.A.	67972
Total	**368135**	**153714**	**147849**	**737670**

Sources: Government of India, Agricultural Statistics at a Glance, 2009. Economic Survey of India 2014-15, Ministry of Finance, Government of India. N.A. Not Available; R.E. Revised Estimate

3.18 Conclusions

In this chapter, background facts of the Indian agriculture are reviewed. The core objective of writing this chapter was to overview that latest development in the Indian agriculture sector after the introduction of economic reforms. It can be concluded that, despite sizeable public and private sector investment in agriculture the performance of agriculture sector remains a centre of worry for the entire nation.

After economic reforms green revolution has a major role to perform. High Yield Variety Programme seeds, fertilisers, irrigation facilities and mechanisation in agriculture sector are the key factors of green revolution. With the help of these factors rice production has increased by 2.02 per cent while wheat by 3.57 per cent. India is the second largest producer of rice in the world after china. This is the staple crop of most of the Indians. The area of rice has declined in 2000-01. Compound Annual Growth Rate of area, production and productivity of pulses has improved by 1.59 per cent, 3.72 per cent and 2.10 per cent respectively. The production of sugarcane has increased by seven times in 2013-14 as compared to 1999-2000. National Food Security Mission set a target to produce 25million tonnes of food grains; 8 million tonnes of wheat 10 million tonnes of rice, 3 million tonnes of coarse cereals and 4 million tonnes of pulses.

Key concern of agriculture sector is that the annual growth rate of agricultural sector GDP is not stable in the last five year period; in fact it went down below 1 percent in 2009-10. From the productivity fronts land productivity and labour productivity is extremely below the international

standard. In the recent period it is observed that Labour productivity rate was declined in Assam, Madhya Pradesh, Odisha, Rajasthan and Utter Pradesh with Uttarakhand. Another concern is that the production of pulses and nine oilseeds do not increased despite special programme, mission and remunerative minimum support prices. Import dependency on chemical fertiliser is not yet over. One of the positive things is that the export share of agriculture in India's total export has increased from 8 percent in 2009-10 to 12 percent in 2014-15.

Chapter 4

Trends and Determinates of Cropping Pattern in Maharashtra

4.1 Introduction

Maharashtra is one of the developed state in India having a land of white silver, where cotton crop is grown on large scale. In Maharashtra, cotton,

sugarcane, onion, grapes are the major cash crops. This land enrich with black soil and better fertility factor. Its agriculture is largely commercial, cultivated for profit and mechanized to some extent. However, other weaken states are practicing agriculture to maximize the production, food requirements and cater the financial obligations of the farmers.

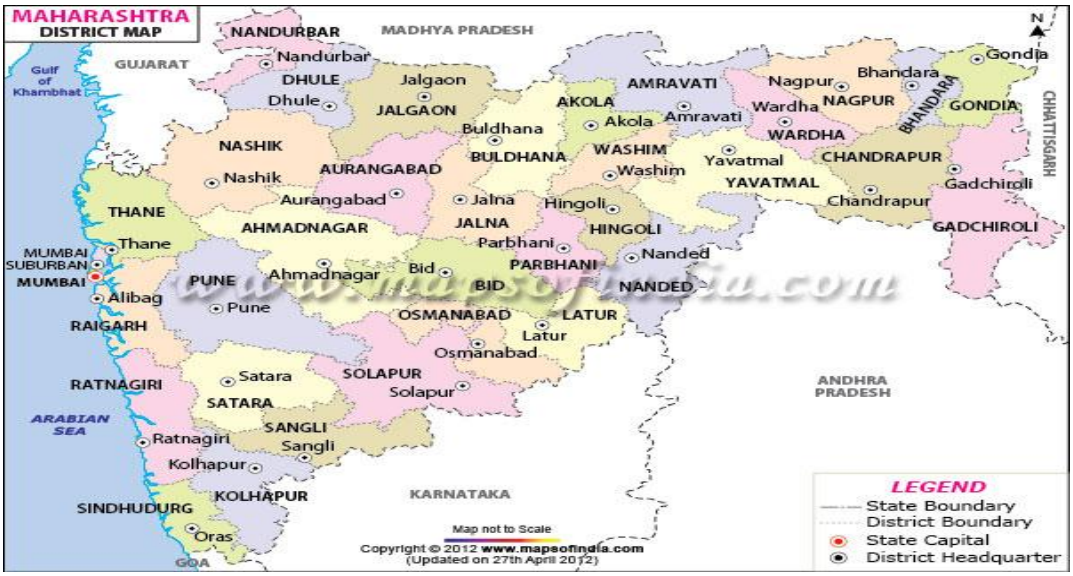
State of agriculture refers to structure of crop pattern, which also mean the proportion of area under various crops at a point of time or regional allocation of land under the different crops. An ideal crops plan should not only fulfil requirement of the local people or food for the farmers and their families, but also to meet fodder requirement for farm animals along with an assurance of income for sustaining their livelihood.

In the present study, we cover all the regions of Maharashtra for knowing the trends in cropping pattern. Maharashtra is in the west zone of India. It is situated between 15.8º North to 22.1º North latitude and72.6º East to 80.9º East longitude. It is bounded by Chhattisgarh in East, Arabian Sea in West, Gujarat and Madhya Pradesh in North and Karnataka and Goa in South. Sahyahdri ranges are in west zone. Mumbai is a capital of Maharashtra. It has six administrative regions such as; Konkan, Pune, Nashik, Aurangabad, Nagpur and Amravati. The Figure 4.1 gives the geographical idea about the state.

Literature is available on this cropping pattern subject at National and International levels is not enough and lacks in specific study. Most of the researchers have used either primary or secondary data for analysing trends in cropping patterns and its implication on the state economy. The Gibbs and Martin Index of diversification (1962) were used by (Ratnaparkhi, Rajade, Wasnik,

2008). Cobb Douglas function is used to trace out the contribution of individual input in the agricultural gross domestic product of India (AGDP) by (Tupe and Kamat, 2010). Raffiullha method is used to understand the crop combination by (Gatade and Pole2012) for the research work.

Figure 4.1 Maharashtra District Map



Source: Downloaded from the Maharashtra Government website

The objectives of this chapter are; (1) To find out whether the present cropping patterns are in the best possible manner or not. (2) To analyse the annual growth rate of the crops in Maharashtra. (3) To find out the change in the cropping pattern in general and yield in specific. (4) To study the implications of changing cropping pattern.

4.2 Factors Affecting Cropping Pattern in Maharashtra

Variations in agricultural production can be either man made or nature made. Man made variations like irrigation; land utilisation, operational holdings etc. They are also known as economic factors. Nature made variations like rainfall, temperature, humidity, etc. called as physical factors. Several studies

have shown that with the growth of production under the impact of modern technology in production has also increased. So in the present study an effort has been made to identify forces causing growth in production and productivity of a crop using time series data on total number of operational holdings, total average size of holdings, irrigated cropped area, land utilisation, crop-wise index numbers, total area of operational holdings and irrigation and non irrigation water charges. The results of the analysis for production and productivity of factors for kharif, rabi and summer seasons along with four principal crops of Maharashtra, namely, cereals, pulses, oilseeds and non-food grains are discussed as below.

4.2.1 Total Number of Operational Holdings

The small farmers are first interested in producing the food grains for their requirements. They would go in cash crops only after they have met their requirements of food grains. Small holders therefore devote relatively small acreage to cash crops than large holders. This point has been brought out in many empirical studies. But a study of Beed district of Maharashtra in recent years brings out clearly the fact that almost all farmers try to grow some cash crops to maximise their income. There is a relationship between farm size and cropping pattern. Agriculture was made to shelter a relatively larger size of labour force. We can observe the table, concluding that land-labour ratio from 1991 to 2006 increased by 33’00 ha. The large share of the small size class form below 0.5 to 3 ha. shows improvement in operational holdings. In Maharashtra, 31658’00 ha. land belongs to small tenants in 2005-06. As the size class increased the number of operational holding decreased from 7241’00 ha. to 5214’00 ha. as shown in table. The rich farmers class who

belongs to 10 to 20 ha. land was comparatively less in 2005 as compare to 1991.Landlords had less interested in ploughing fields. They migrated to another place, they sold the land to tenants, and they levied the land. Due to different reasons automatically number of operational holdings of this class caused less number of land in hand. Table 4.1 and Figure 4.2 shows in detail the total number of operational holdings in Maharashtra.

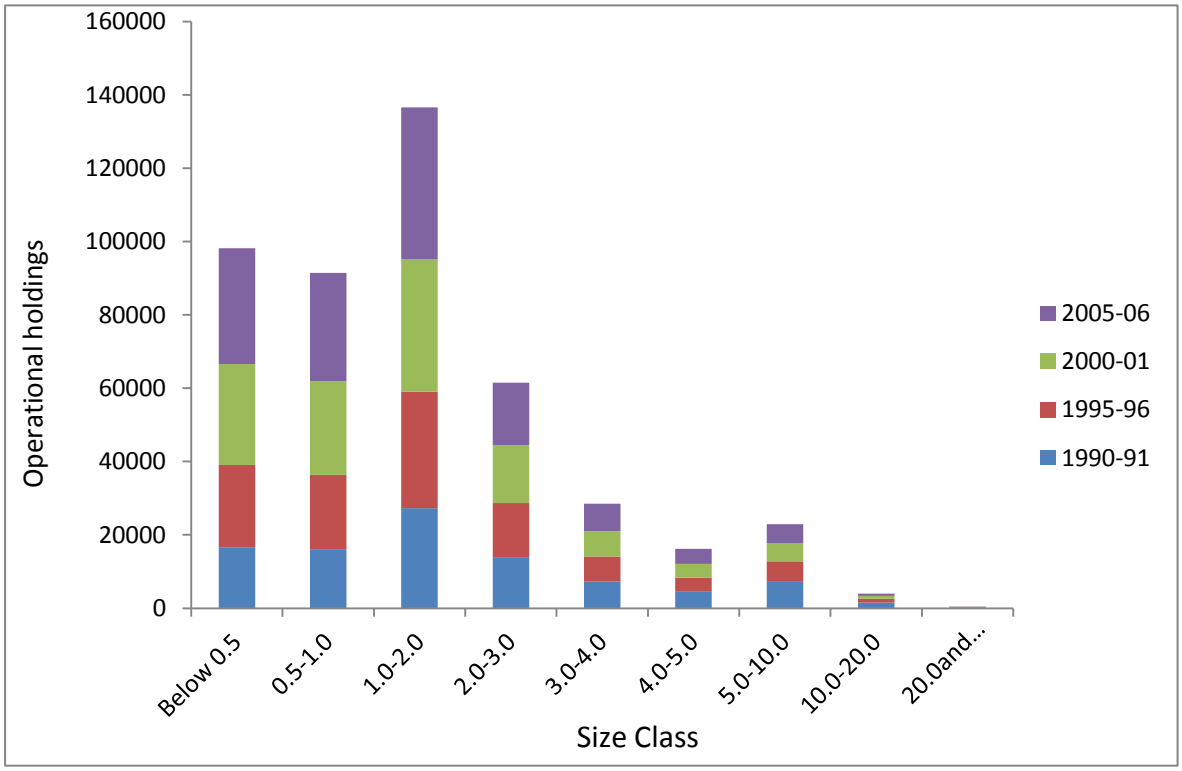
Table 4.1 Total Number of Operational Holdings

Percentages are in respect with total geographical area.

Total number of operational holdings ('00 ha.)				
Size class (ha)	**1990-91**	**1995-96**	**2000-01**	**2005-06**
Below 0.5	16672	22409	27462	31658
	5.41%	0.07%	0.08%	0.10%
0.5-1.0	16075	20252	25595	29525
	5.22%	0.06%	0.08%	0.09%
1.0-2.0	27276	31755	36056	41503
	8.86%	0.10%	0.11%	0.13%
2.0-3.0	13969	14745	15791	17020
	0.04%	0.04%	0.05%	0.05%
3.0-4.0	7289	6774	6949	7496
	0.02%	0.02%	0.02%	0.02%
4.0-5.0	4469	3874	3780	4037
	0.01%	0.01%	0.01%	0.01%
5.0-10.0	7241	5558	4873	5214
	0.02%	0.01%	0.01%	0.01%
10.0-20.0	1530	1029	773	622
	4.97%	3.34%	2.51%	2.02%
20.0 and above	176	132	97	81
	5.72%	4.29%	3.15%	2.63%

Source – Commissionerate of Agriculture, GoM

Figure 4.2 Total Numbers of Operational Holdings



Source : based on Table 4.1

4.2.2 Total area of Operational Holdings

The Maharashtra is having the highest area (52476'00 ha) in 1 to 2 ha. size class in 2005-06. Further, noticed that size class and study period has inverse relationship. Fewer farmers have been seen using mechanization in agriculture. So the total area of operational holdings decreased day by day. Chandrapur and Gadchiroli district has nil in sugarcane area of operational holdings as well as Konkan division has nil area under cash crops and less total area of operational holdings as compared to other divisions in Maharashtra. It is true that the need for subsistence has traditionally dominated the cropping pattern of small and medium farmers But his need for money income can't be less than that of the large farmer and as the economy grow we should expect the small farmer to make very significant adjustments in his

crop pattern in order to maximise his source of income. Below table (4.2) shows the total area of operational holdings in Maharashtra in the study period along with diagram (4.3).

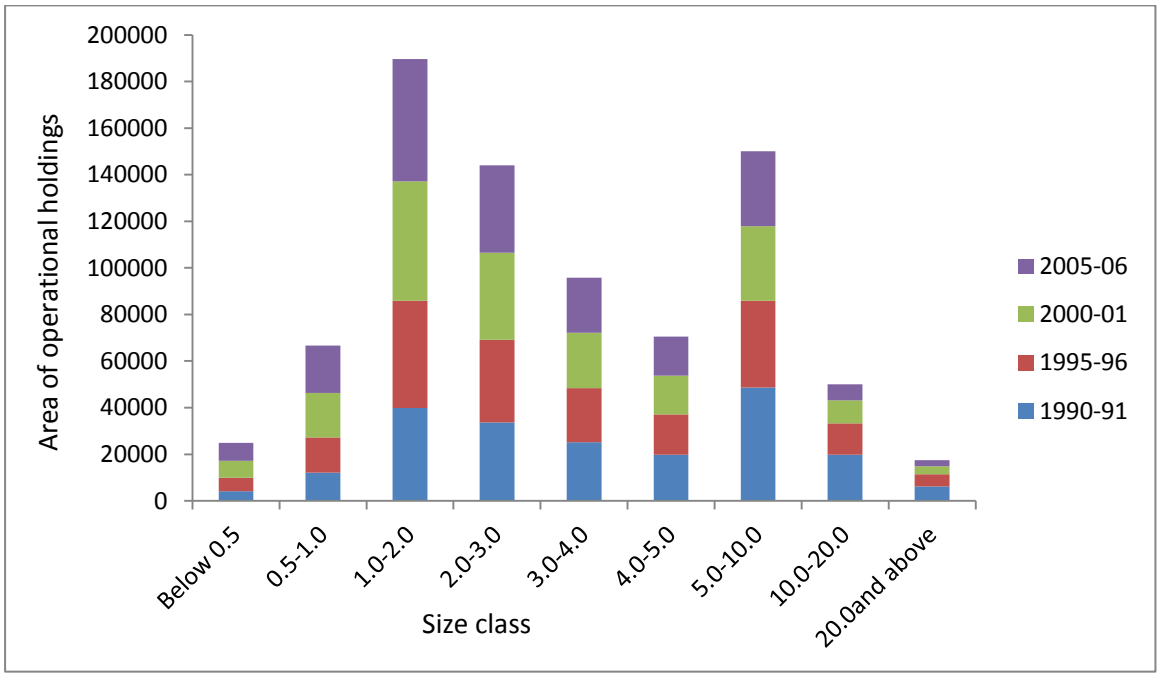
Table 4.2 Total Area of Operational Holdings

Percentages are in respect with total geographical area.

Area of Operational Holdings ('00 ha)				
Size class (ha)	**1990-91**	**1995-96**	**2000-01**	**2005-06**
Below 0.5	4119	5746	7328	7740
	0.01%	0.01%	0.02%	0.02%
0.5-1.0	12057	15120	19159	20274
	0.03%	0.04%	0.06%	0.06%
1.0-2.0	39833	46059	51271	52476
	0.12%	0.14%	0.16%	0.17%
2.0-3.0	33689	35420	37414	37542
	0.10%	0.11%	8.2%	0.12%
3.0-4.0	25108	2330.1103	23676	23756
	0.08%	0.07%	0.07%	0.07%
4.0-5.0	19864	17210	16717	16717
	0.06%	0.05%	0.05%	0.05%
5.0-10.0	48700	37150	32084	32135
	0.15%	0.12%	0.10%	0.10%
10.0-20.0	19749	13514	9961	6776
	0.06%	0.04%	0.03%	0.02%
20.0and above	6129	5274	3418	2634
	0.01%	0.01%	0.01%	8.56%

Source – Commissionerate of Agriculture, GoM

Figure 4.3 Total Area of Operational Holdings



Source: based on Table 4.2

4.2.3 Total Average Size of Operational Holdings

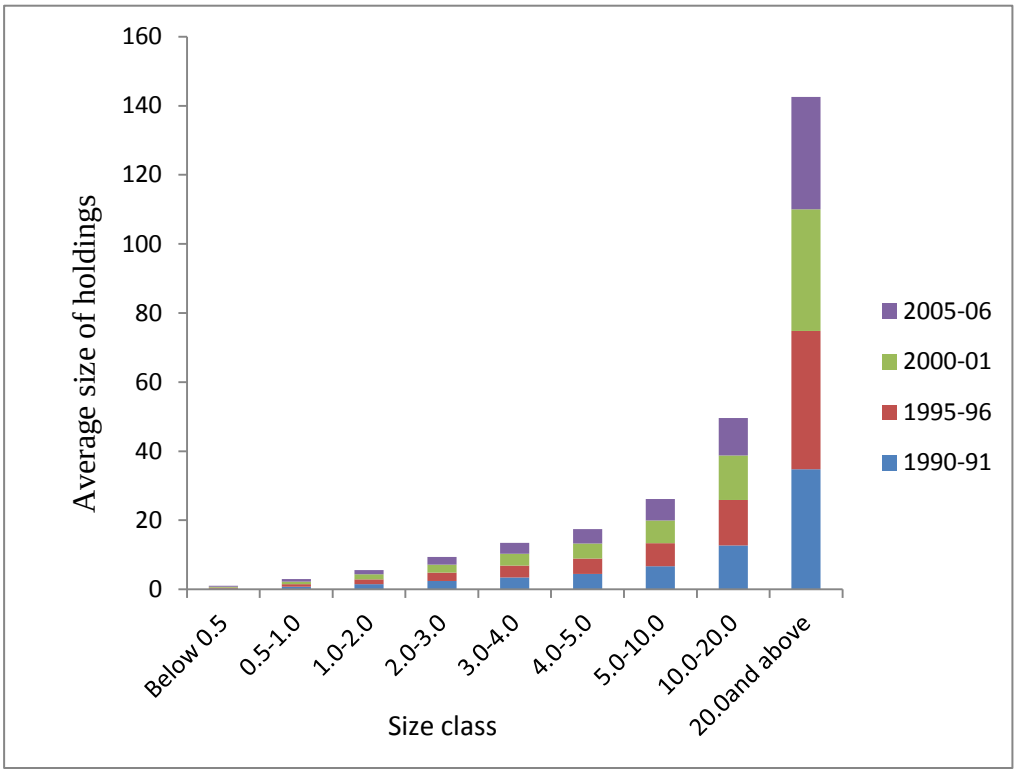
In Maharashtra, among three people there is a farmer. Almost everybody has a piece of land on his/her name. From 1990-91 total average size of holding pattern changed. It was almost in doubles. Recent changes shows (Table 4.3) that it reaches to 34.82 ha in 1990-91 but decreased in 2005-06 by 32.52 ha. Below table shows the five yearly moving average of average size of holding.

Table 4.3 Total Average Size of Operational Holdings

Total Average Size of Operational Holdings (ha)				
Size class (ha)	**1990-91**	**1995-96**	**2000-01**	**2005-06**
Below 0.5	0.25	0.26	0.27	0.24
0.5-1.0	0.75	0.75	0.75	0.69
1.0-2.0	1.46	1.45	1.42	1.26
2.0-3.0	2.41	2.4	2.37	2.21
3.0-4.0	3.44	3.44	3.41	3.17
4.0-5.0	4.44	4.44	4.42	4.14
5.0-10.0	6.73	6.68	6.58	6.16
10.0-20.0	12.71	13.13	12.89	10.89
20.0 and above	34.82	39.95	35.24	32.52

Source – Commissionerate of Agriculture, GoM

Figure 4.4 Total Average Size of Operational Holdings



Source: based on Table 4.3

4.2.4 Area Irrigated by Various Sources

Another important factor which affect on growth level of Maharashtra cropping pattern is area irrigated by various sources. The cropping pattern of a region will depend upon the nature and availability of irrigation facilities wherever water is available not only can a different crop can be grown but even double or triple cropping will be possible when new irrigation facilities are provided. The whole method of cultivation may change. A superior crop can be grown a new rotation of crops where there was none or better rotation over that prevailed may be possible. One of the important factor responsible for increase in the cultivation of sugar cane, cotton etc. is the extension of irrigation facilities. It is possible that because of lack of capital agricultural pre-requisites, better implements, improved seeds and finance for getting

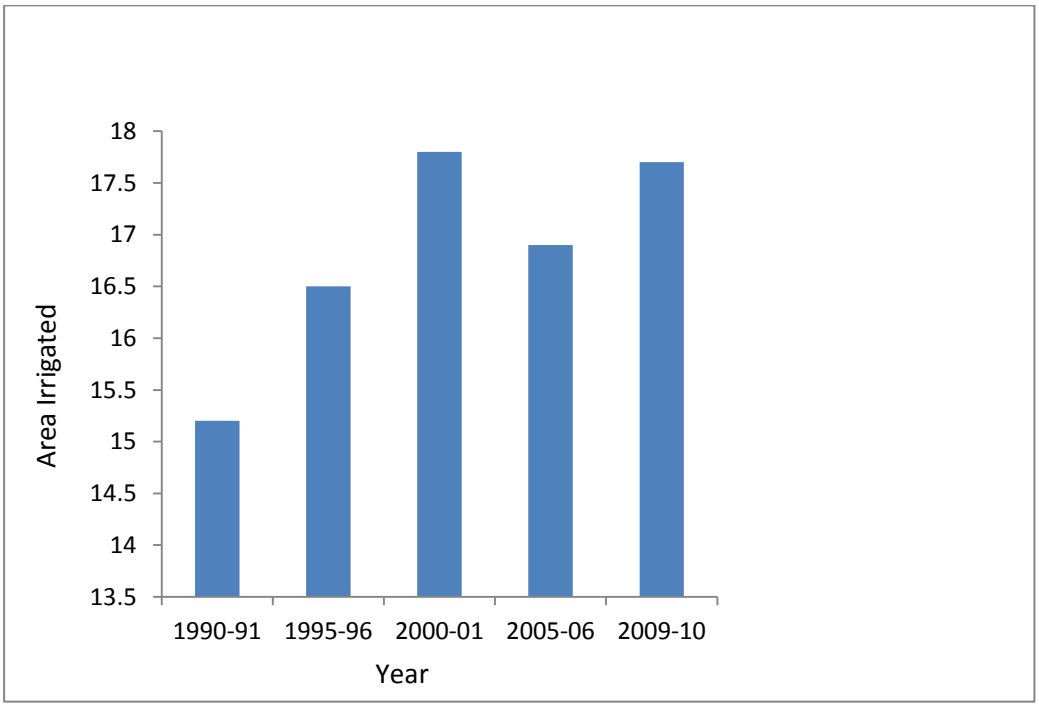
fertilisers. It might not have seen the right crop that was being grown but given these facilities the cropping pattern may change in Nashik division, Pune division and Aurangabad division. Wells and other sources plays a key role especially in rain fed areas and all over Maharashtra. In 1990-91 irrigated area was 15.2 % while in 2009-10 it was recorded as 17.7 %. Intensity of irrigated cropping had shown topsy-turvy graph over the study period. It is worked out by using the formula across area irrigated divided by net area irrigated ×100. In 1991, it had 124’000 ha. till 2010 it recorded 122’000 ha. Below Table 4.4 and the Figure 4.5 elaborates it in detail.

Table 4.4 Area Irrigated by Various Sources

Area Irrigated by Various Sources in Maharashtra (’000 ha)	
Year	**Percentage of area**
1990-91	15.2
1995-96	16.5
2000-01	17.8
2005-06	16.9
2009-10	17.7

Source – Commissionerate of Agriculture, GoM

Figure 4.5 Area Irrigated by Various Sources



Source: based on Table 4.4

4.2.5 Land Utilisation

Cropping pattern affected by land utilisation. Land is used for many aspects such as area under forests, land not available for cultivation, uncultivated land and fallow lands. Here land utilisation statistics of Maharashtra was developed by percentage method from 1991-92 to 2011-12. (Table 4.5 I, II) shows land utilisation percentage. Concluding so intensive cropping pattern has been developing fast in Maharashtra.

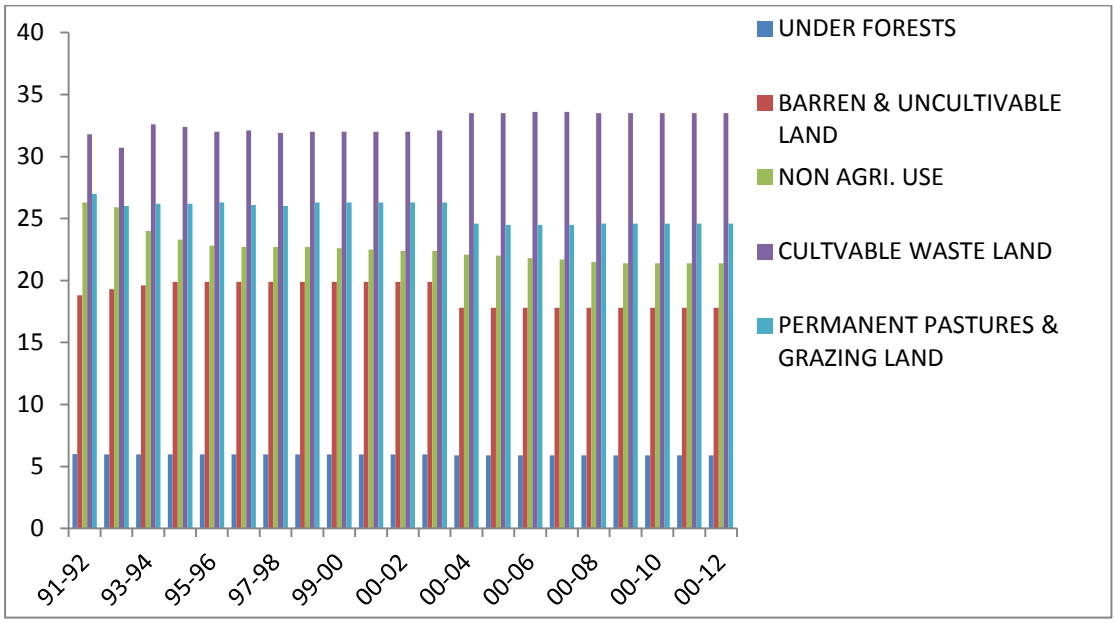
Table 4.5 Land Utilisation (I) in Maharashtra

Percentages are in respect with total geographical area.

Year	Under forests	Barren & uncultivable land	Non agri. Use	Cultivable waste land	Permanent pastures & grazing land
91-92	5.99	18.8	26.3	31.8	27.0
92-93	5.97	19.3	25.9	30.7	26.0
93-94	5.97	19.6	24.0	32.6	26.2
94-95	5.97	19.9	23.3	32.4	26.2
95-96	5.97	19.9	22.8	32.0	26.3
96-97	5.97	19.9	22.7	32.1	26.1
97-98	5.97	19.9	22.7	31.9	26.0
98-99	5.97	19.9	22.7	32.0	26.3
99-00	5.98	19.9	22.6	32.0	26.3
00-01	5.98	19.9	22.5	32.0	26.3
01-02	5.98	19.9	22.4	32.0	26.3
02-03	5.98	19.9	22.4	32.1	26.3
03-04	5.90	17.8	22.1	33.5	24.6
04-05	5.90	17.8	22.0	33.5	24.5
05-06	5.90	17.8	21.8	33.6	24.5
06-07	5.90	17.8	21.7	33.6	24.5
07-08	5.90	17.8	21.5	33.5	24.6
08-09	5.90	17.8	21.4	33.5	24.6
09-10	5.89	17.8	21.4	33.5	24.6
10-11	5.89	17.8	21.4	33.5	24.6
11-12	5.89	17.8	21.4	33.5	24.6

Source : Commissionerate of Agriculture GoM

Figure 4.6 Land Utilisation (I) in Maharashtra



Source : based Table 4.5

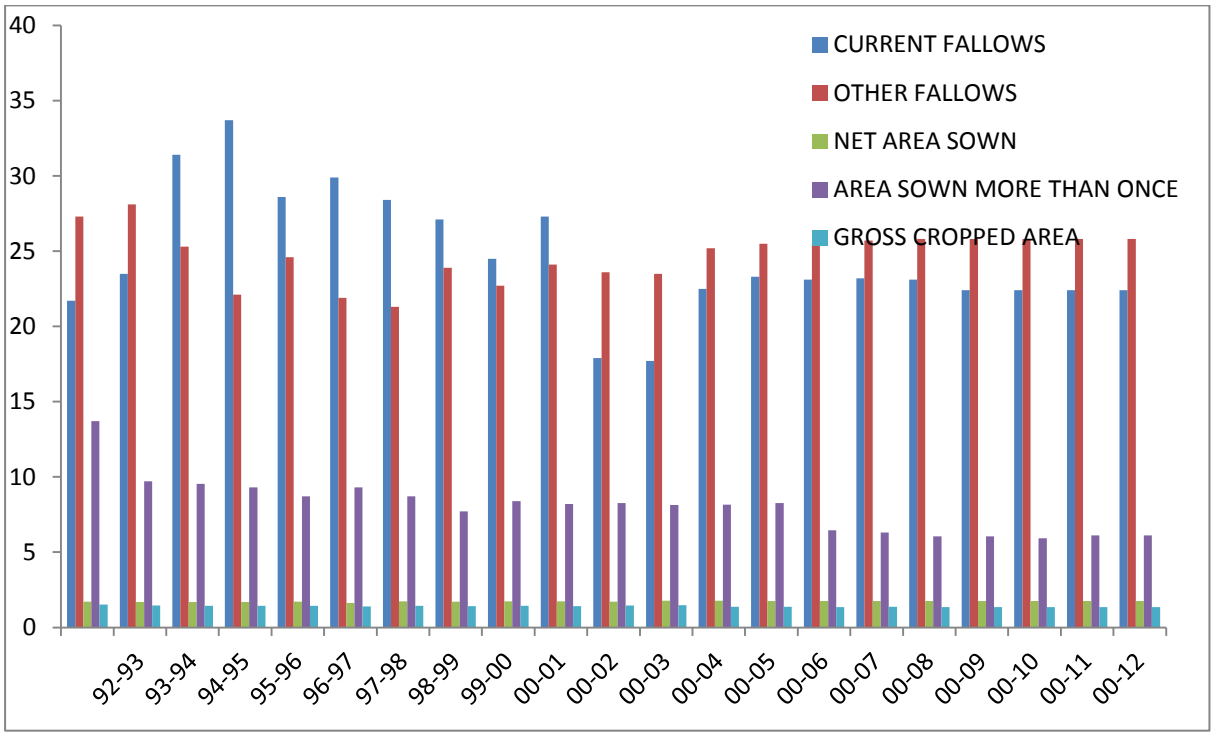
Table 4.6 Land Utilisation (II) in Maharashtra

Percentages are in respect with total geographical area.

Year	Current fallows	Other fallows	Net area sown	Area sown more than once	Gross cropped area
91-92	21.7	27.3	1.71	13.7	1.52
92-93	23.5	28.1	1.70	9.70	1.45
93-94	31.4	25.3	1.69	9.54	1.43
94-95	33.7	22.1	1.70	9.30	1.44
95-96	28.6	24.6	1.71	8.72	1.43
96-97	29.9	21.9	1.63	9.30	1.40
97-98	28.4	21.3	1.73	8.72	1.43
98-99	27.1	23.9	1.72	7.71	1.42
99-00	24.5	22.7	1.74	8.39	1.43
00-01	27.3	24.1	1.74	8.20	1.42
01-02	17.9	23.6	1.72	8.26	1.46
02-03	17.7	23.5	1.78	8.14	1.47
03-04	22.5	25.2	1.78	8.16	1.38
04-05	23.3	25.5	1.76	8.26	1.37
05-06	23.1	25.5	1.75	6.46	1.36
06-07	23.2	25.7	1.76	6.30	1.37
07-08	23.1	25.8	1.76	6.05	1.36
08-09	22.4	25.8	1.76	6.05	1.36
09-10	22.4	25.8	1.76	5.93	1.35
10-11	22.4	25.8	1.76	6.11	1.36
11-12	22.4	25.8	1.76	6.11	1.36

Source : Commissionerate of Agriculture GoM

Figure 4.7 Land Utilisation (II) in Maharashtra



Source: based on Table 4.6

4.2.6 Crop-wise Index Numbers

According to some authorities, income maximisation pull has greater influence in changing crop pattern, that is, the farmer of Satara, Aurangabad, Jalna, Nanded and Parbhani would choose that combination of crops which would give them maximum of income. One of the implications of changing cropping pattern is crop-wise index numbers of agricultural production in Maharashtra. Maharashtra is the basket of forty two crops. Classification of these crops are as; cereals, pulses, oilseeds and non- food grains, In 2000-01, cereals recorded lowest index number as 91.9 percentage. While pulses recorded highest crop wise index number as 243.4 percentage. So price hike of oilseeds in market received well in 2009. Maharashtra has blessed with non

food-grains crops. Table 4.7 and Figure 4.8 shows the changing cropping pattern from cereals to non food-grains crop from 1990-91 to 2009-10.

Table 4.7 Crop-wise Index Numbers

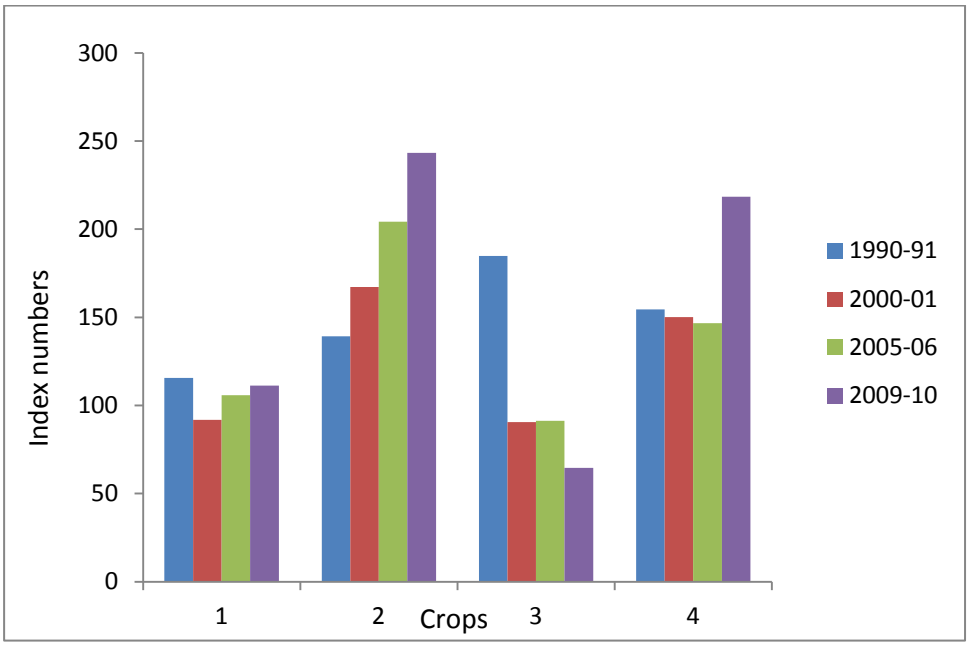
Crop wise Index Numbers of Agricultural Production in Maharashtra

(Triennial average)

Year	Cereals	Pulses	Oilseeds	Non-food grains
1990-91	115.7	139.2	184.8	154.5
2000-01	91.9	167.3	90.6	150.2
2005-06	105.8	204.3	91.2	146.7
2009-10	111.3	243.4	64.6	218.4

Source – Commissionerate of Agriculture, GoM

Figure 4.8 Crop-wise Index Numbers



Source: based on Table 4.7

4.2.7 Water Charges

Not only area irrigated but also irrigation and non-irrigation water charges levied, recovery and outstanding amounts are one of the determinants of changing cropping pattern. This is an input as seeds, fertilisers, water

storage, marketing and transport etc. of the additional facilities the most rewarding would be irrigation. The availability of ground nut seed was one of the important factors which induced many farmers to increase the area under this crop in Akola, Gadchiroli and Washim. Another reason for why farmers prefer oilseeds than cotton that the farmer is quick yielding. While cotton is on the field for a long time and does not easily satisfy the need for quick cash. Maharashtra government levied Rs.437.08 crore but outstanding amount was almost double till date. In 2009-10 outstanding amount was Rs.1028.15 crore. Table 4.8 and Figure 4.9 gives the details.

Table 4.8 Water Charges

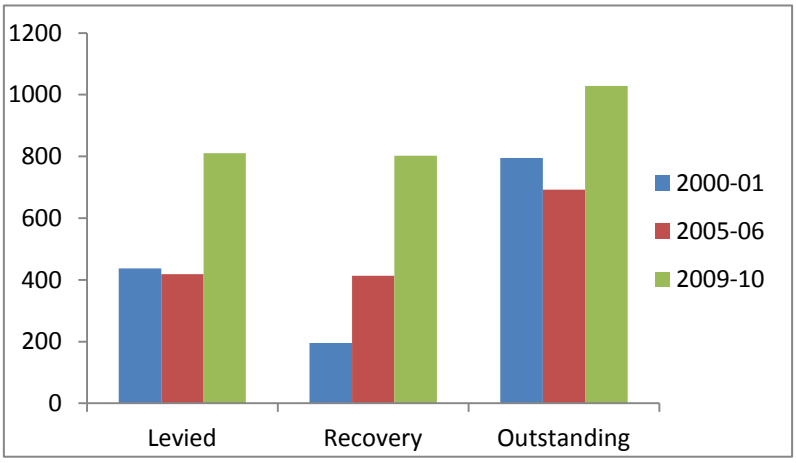
Irrigation and Non-irrigation Water Charges Levied, Recovery and Outstanding

(Rs. Crore)

Year	Levied	Recovery	Outstanding
2000-01	437.08	195.22	794.69
2005-06	418.53	413.48	692.27
2009-10	810.11	802.63	1028.15

Source – Commissionerate of Agriculture, GoM

Figure 4.9 Water Charges



Source: based on Table 4.8

4.2.8 Government Action :

Government can influence crop pattern through legislative and administrative measures. Steps may be taken by government to ease or subsidise the supplies of the farm inputs and knowledge. The provision of irrigation facilities or the supply of seeds and fertilisers etc. may be related to the adoption of a given crop pattern by the farmers.

Apart from the personal prejudices, inadequate financial and other resources of the farmers, there may be factors like recurrent drought or pest infestation that prevent them from opting for a more remunerative set of crops. In those situations if more of irrigation, institutional credit fertilisers, pesticides etc. are made available, it would be possible for them to change the crop structure and so earn larger returns from their land. To the extent it is not possible for a farmer to acquire all these by himself. The government could come to his help and procure these for him.

Yet another possibility of helping the farmer to improve the cropping pattern are building of new roads which will improve the flow of commodities to the market where they will fetch better prices and help to establish industries or townships nearer to their land.

The main conclusions from the forgoing functional analysis are:

In case of total crop production in Maharashtra, man- made variables along with rainfall were significant growth promoting variables.

Total numbers of operational holdings are increasing by doubles in size class of below 0.5 ha. And decline in the size class of 20.0 and above ha. holdings.

Growth take place in Maharashtra because area irrigated by various sources increases over the study period. During the growing study period of cropping pattern in Maharashtra resulted in 1.46 per cent decline in the total average size of holdings.

4.3 Data and Methodology

Crop wise aggregate data on area, output and yield of 32 crops for 36 major districts have been obtained from publication of Government of Maharashtra. Detail fact and figure relates to Area, Production and Productivity of the principle crops in Maharashtra state are obtained from the Economic Survey of Maharashtra. The data is divided into two phases starting from 1991-1992 to 2001-2002 and 2002-03 to 2012-13. This period has been selected to know the impact of economic reforms on cropping pattern of Maharashtra if any. The annual compounded growth rates (CAGR) are calculated according to following Semi Log Model.

$$\boldsymbol{ln\, Y_t = B_1 + \beta_2\, t + u_i} \quad \text{----------(1)}$$

Where B_1 = Constant and $\beta_2\, t$ is coefficient of time and u_i is error term. ln Y_t is dependant variable whose natural log is taken.

4.4 Data Analysis and Discussions

Present study is based on empirical experiences of cropping pattern spread over 36 districts of Maharashtra for the period 1991-2013. To accomplish the various objectives of the study, secondary data was used. Directorate of Agriculture, Pune provided the data for the present research work. We observed diversified cropping pattern in Maharashtra. All the important non cash crops and cash crops were selected for study. Table 4.9 gives snapshot of changing cropping pattern of Maharashtra. The analysis has been divided into three parts namely production, yield and area under the crops.

4.5 Growth in Agricultural Output

This study presents levels and growth of aggregate crop output of Maharashtra during 1991-92 to 20012-2013. It brings out several interesting features of the patterns in agricultural developments. For the analysis, 1991-92 to 2012-2013 periods is divided into two sub-periods of 10 years each. In the history of growth of agricultural output, period 1991-92 to 2001-2002 marks as turning point in the Indian economy because of the introduction of new economic programme. However it does not boost the cereal and food gratin production in Maharashtra. On the contrary, the production of food grains fallen by -2.76 CAGR.

Table 4.9 Trends in Cropping Pattern in Maharashtra

	Production (CAGR %)		Yield (CAGR %)		Area (CAGR %)	
Period / Crops	1991-92 to 2001-02	2002-03 to 2012-13	1991-92 to 2001-02	2002-03 to 2012-13	1991-92 to 2001-02	2002-03 to 2012-13
lnCereals	-0.6	1.33	0.31	3.5	-0.93	-2.09
LnPulses	2.98	2.81	2.22	1.24	0.73	-0.28
LnFoodgrains	-2.76	1.62	0.41	16.22	-4.56	-1.56
LnOilseeds	4.74	6.52	4.57	3.1	0.04	3.37
lnCotton	3.83	11.34	1.63	6.29	2.18	4.59
lnSugarcane	4.44	12.1	7.27	2.73	3.63	9.29

Source : Researcher own calculations
Note: CAGR is calculated by researchers using Semi-log Model.

However, in the latter period (2002-03 to 2012-13) the production cereals and food grains picked up. Cotton crop output accelerated to 11.34 percentage. An interesting feature of the millennium decade (2002-03 to 2012-13) was that agricultural growth permitted to all the regions in Maharashtra. The most significant development was an acceleration of growth in sugarcane crops due to better and remunerative support prices declared by the government. Total food grains and cereals also recorded a significant acceleration but there was a minor deceleration in production pulses.

Cotton crop has made a tremendous stride in growth of production from 3.83 percent to 11.34 percent while the cereals have shown poor performance. Table 4.9 shows several features of agricultural development in Maharashtra after liberalization for the period II. It reveals that cropping pattern went in favour of cash crops namely cotton and sugarcane. It is therefore the Maharashtra is experiencing the inflation of food grains since 2002 onwards.

4.6 Growth in Yields

In addition to growth in production of different crops, another factor of agricultural output is growth in yields. It deals with changes in the two periods. Here are the details of the growth in yield during the period 1991-1992 to 20012-2013. Yield of food grains rose from 0.41 percent to 16.22 percent, which seem to be the highest among the other crops. Cotton crop yield also elevated from 1.63 percent to 6.29 percent and cereals from 0.31 percent to 3.5 percent. Sugarcane had negative trend level. Yield of pulses declined from 2.22 percent to 1.24 percent. The continued spread of cotton and food grains crops in the states have shown notable gain in crop productivity.

4.7 Area under Crops

This section deals with changes in cropping pattern related to area under the crops in the state after 1991. Result of semi log model shows that the maximum area were covered by 32 crops during period I and period II. The variations in oilseeds and sugarcane are noticeable. It was 0.04 percent in period I which increased to 3.37 percent in period II and 3.63 percent to 9.29 percent for oilseeds and sugarcane respectively. Further, area under the cereals (-2.09 percent), pulses (-0.28 percent) and food grains (-1.56 percent) crops declined as shown in the brackets. Cash crops had positive trend in area.

The main feature of cropping pattern in Maharashtra for the study period shows that shifting from low priced crops to cash crops for gaining more income. Percentage of area under oilseeds, cotton and sugarcane rose considerably to cash the good price ruled in the market for these crops. Increased area of under sugarcane crop depicts that farmers prefer this crop due to better price and some

political edge. However, shifting of farming towards sugarcane crops may not be viable in future as it takes lot of water. The water table has been depleting year after year in Maharashtra. Major chunk of water of irrigation dam is being consumed by sugarcane crop. Farmer must prefer other food and non-food crops for sustainable and viable farming in Maharashtra.

4.8 Determinants of Cropping Pattern in Maharashtra

In order to find out the possible determinants of food grain and major crops we employ the linear regression. Data used for this regression is collected from the various sources such as Directorate of Agriculture Maharashtra; Pune, Various Economic Survey of Maharashtra, Directorate Economics and Statistics, Maharashtra State, Mumbai. Various Irrigation Status Reports, Maharashtra State, Results appeared after running six regressions (Models) are reported in the Table 4.3. In the following six models the dependant variables are food grain production and other major crops grown in the Maharashtra. Time series data has been collected for the period 2001 to 2013. We tried to collect data from 1991 of specified variables but we couldn't get on all the variables. Hence, we precede with thirteen yeas data for the present regression. All the figures are converted into natural log to avoid data specification problem.

4.9 Model

Following linear regression model is used for this research purpose. The general form of the model is expressed as follows.

$$Y_t = \beta_0 + \beta X_t + \mu_t \text{----------(2)}$$

Where, subscript t represents time series data used for the regression starting from year 2001- 2013. Left hand variable Y_t is dependant in the model. Among the right hand side variables, variable β_0 is constant term. X_t Contains set of variables in the following models are explanatory (Independent). μ_t is error term it captured the factors that left out in the model. Using regression numbered as 2 the following regressions are measured one by one. The results are reported in the Table 4.2.

4.10 Results of Model

In the model 1 dependant variable is total food grain production and independent variables are area under canal irrigation, fertiliser used and area under cultivation. The results appeared from model 1 shows that food grain production in Maharashtra is significantly determined by area under canal irrigation and area under cultivation. But the impact of fertiliser is insignificant in accelerating production of food grain. Model 1 also point out that R2 value is 74% and F test results are acceptable, model is free from autocorrelation problem. In the subsequent models, area under canal irrigation is significant and other determinants are not showing any significant impact in propagating production size of the crop. In the case of crop pulses none of the variable is significant. It is because pulses are grown basically of rainfall.

Model 2 result shows that irrigation is an important determinant of cotton crop production. Model 3 reveals that none of the independent factor is significant determinant of pulses crops in Maharashtra. Basically this crop is grown in rain fed area. It is therefore productions of pulses are not picking up despite better supportive prices. Model 4 shows that oilseeds crop production is significantly determined by irrigation facility.

Table 4.10 Determinants of Cropping Pattern in Maharashtra

Model 1	**Lnfood**	**Coef.**	**Std. Err.**	**T**	**P>t**	**Number of obs**	**13**
	Lnfer	0.214379	0.158662	1.35	0.21	F(3, 9)	8.38
	Lnirr	0.450572	0.219542	2.05**	0.07	Prob > F	0.01
	Lnarea	1.079325	0.310948	3.47*	0.01	R-squared	0.74
	Cons	-2.49482	1.725432	-1.45	0.18	Adj R-squared	0.65
						DW Stat(4,13)	2.23
Model 2	**Lncott**	**Coef.**	**Std. Err.**	**T**	**P>t**	**Number of obs**	**13**
	Lnfer	0.660671	0.440092	1.50	0.17	F(3, 9)	12.59
	Lnirr	1.453526	0.608960	2.39*	0.04	Prob > F	0.00
	Lnarea	-0.41739	0.862500	-0.48	0.64	R-squared	0.81
	Cons	-0.84772	4.785959	-0.18	0.86	Adj R-squared	0.74
						DW Stat(4,13)	2.08
Model 3	**Lnpul**	**Coef.**	**Std. Err.**	**T**	**P>t**	**Number of obs**	**13**
	Lnfer	0.140795	0.321257	0.44	0.67	F(3, 9)	2.88
	Lnirr	0.724974	0.444527	1.63	0.14	Prob > F	0.10
	Lnarea	0.877372	0.629605	1.39	0.20	R-squared	0.49
	Cons	-3.71256	3.493639	-1.06	0.32	Adj R-squared	0.32
						DW Stat(4,13	2.21
Model 4	**Lnoil**	**Coef.**	**Std. Err.**	**T**	**P>t**	**Number of obs**	**13**
	Lnfer	-0.02585	0.465727	-0.06	0.96	F(3, 9)	4.22
	Lnirr	1.412947	0.644431	2.19**	0.06	Prob > F	0.04
	Lnarea	-0.20737	0.912740	-0.23	0.83	R-squared	0.58
	Cons	0.680572	5.064739	0.13	0.90	Adj R-squared	0.45
						DW Stat(4,13)	1.95
Model 5	**Lnsug**	**Coef.**	**Std. Err.**	**t**	**P>t**	**Number of obs**	**13**
	Lnfer	0.034722	0.506384	0.07	0.95	F(3, 9)	7.85
	Lnirr	2.176143	0.700688	3.11*	0.01	Prob > F	0.01
	Lnarea	0.61876	0.992419	0.62	0.55	R-squared	0.72
	Cons	-2.83381	5.506871	-0.51	0.62	Adj R-squared	0.63
						DW Stat(4,13)	1.95

Source : Researchers own Calculation

Note: 1) ln means Natural log value.2) Food mean food production.3) Fer mean Fertiliser used in lakh metric tonne. 4) Irr means area under canal irrigation. 5) Area means area under cultivation. 6) Pul means Pulses production. 7) Cott means cotton production. 8) Oil means oilseedproduction.9) Sug means sugar production. 10) cons means constant. 11) *, ** significant at 1 and 5 percent respectively.

The results of Model 5 point out that sugarcane crop production is significantly determined by irrigation facility. This crop requires constant water throughout year. Hence it consumes lot of potential of other crops and it also makes lazy to farmers in Maharashtra. Each models' R2 value is reasonable and f test values are significant at 1 and 5 percent except model 3.

4.11 Conclusion and Policy Implications

During the first twenty two years (1991-92 to 20012-2013) of new economic policy and its impact on the transformation traditional agriculture was by and large spread over the Maharashtra. Prior of 1991, the growth rate in output was not significant in cash crops but in the last twenty years production has increased many fold in cash crops due the extension services and remunerative prices. Limited availability of agricultural land, poor quality of land and rain fed agriculture has restricted the scope for agricultural production. However, emerging agricultural areas such as horticulture, floriculture, food processing etc. are gaining its importance. Equally important is the production of poultry, meat and fish, are increasing. In the context of economic liberalization, Investment in new technology is must for better scale of production and yield. There is need to give high priority to investment in research and development and extension relating to agriculture so that we may give food to everybody in India at affordable price. Government should make publicity to motivate people to go for food crops and also offer good supportive prices to these crops then only the shifting would be possible from cash crops to non cash crops. An affordable technology with assure supply of manures and natural fertilisers may boost the production of food grain in Maharashtra.

Chapter 5

District Level Study of Cropping Pattern in Maharashtra

5.1 Introduction

This chapter is prepared for the presentation of divisions of Maharashtra related to cropping pattern by studying two districts in each division. There are thirty-six districts in Maharashtra as on 2014-15.They are divided into six divisions. Each division consists of minimum five and maximum eight districts. These divisions are: Konkan, Pune, Nashik, Aurangabad, Amravati and Nagpur. Divisions were made for effective and decentralized of administration. Headquarter of each

division is a leading district. To collect revenue and implementation of government scheme revenue division plays an important role. Maharashtra has geographical area about 3.08 lakh sq. km. According to census 2011, Maharashtra's total population is 11.24 crore. It is the second largest state in India in terms of population. It has up to 1350 meters high altitude. All the rivers in Maharashtra are eastward flowing towards Bay of Bengal except Tapi which is flowing towards Arabian Sea at west. Maharashtra's soil is divided into nine types.

1. Coarse shallow soils (high level)
2. Medium black soils (plains)
3. Deep black soils (valleys)
4. Redish brown soils of hill slopes (trap)
5. Coastal alluvium
6. Yellowish brown soils (mixed origin at high level)
7. Yellowish brown soil of plains (mixed origin)
8. Laterite and lateritic soil
9. Coastal saline

As well as Maharashtra state has nine agro- climatic zones. They are as follows.

1. Very high rainfall zone with lateritic soils
2. Very high rainfall with non-lateritic soils
3. Ghat zone
4. Transition zone-I
5. Transition zone-II

6. Scarcity zone
7. Moderate to moderately high rainfall zone
8. High rainfall zone with soils formed rocks of mixed origin

Above mentioned soil types and agro- climatic zones for the overall study purpose of district wise analysis. We had chosen two districts of each revenue division. The summary of these districts discussed here. The population of districts measured in ‘000 units. Konkan division lies between Arabian Sea and Western Ghat of Maharashtra. It is represented by Mumbai, Thane, Palghar, Raigad, Ratnagiri and Sindhudurg districts.

5.2 Objectives, Data and Methodology

This chapter is prepared for verifying the cropping pattern of sample district under the study. This exercise enables us to find out district wise trends in leading crops and food grain in the entire Maharashtra. The study period chosen for the study is 2001-2013 for which latest data was available at the data source. In fact we had plan to compare the cropping pattern of 1991-2000 with 2001-2013 but due to data constraint we confine our study of cropping pattern for the period 2001-2013. Present data is culled from report of Annual report of ministry of agriculture Government of Maharashtra and in hand data is collected from Directorate of Agriculture Maharashtra state Pune.

Average Annual growth rate is calculated using simple statistical method. We had tried to calculate compounded annual growth rate but data variations and outlier

we could not get appropriate figure hence we relied upon the Average Annual growth rate. As it was used earlier by (Dholakia and Sapre, 2014) for observing trends in agriculture and cropping pattern.

Formula for Average Annual Growth Rate

AAGR = (Growth Rate in Period A + Growth Rate in Period B + Growth Rate in Period C + ...Growth Rate in Period X) / Number of Periods.

Coefficient of Variation (CV)

The CV is calculated as the ratio of the root mean squared error (RMSE) to the mean of the dependent variable. In both settings, the CV is often presented as the given ratio multiplied by 100. The CV for a single variable aims to describe the dispersion of the variable in a way that does not depend on the variable's measurement unit. The higher the CV greater the dispersion in the variable.

The coefficient of variation (CV) is defined as the ratio of the standard deviation σ to the mean μ:

$$c_v = \frac{\sigma}{\mu}$$

It shows the extent of variability in relation to the mean of the population. Using above formula we calculated coefficient of variation (CV) for each crop.

5.3 District Profile and Region-wise Cropping Pattern: Statistical Analysis

In this section, the profile of districts in Maharashtra and region-wise respective cropping pattern is presented.

5.3.1 Konkan Region

Mumbai City

Area: 157 sq km.

Urbanization: 100 %

Rainfall (average 2011) : 190 cm.

HDI: Second Rank

Climate: Hot and Humid

Rivers: Mithi, Poisar and Dhahisar.

Population: 31, 45,966

Mumbai Upnagar

Area: 446 sq km.

Urbanization: 100%

Rainfall (average 2011): 190 cm.

HDI: First Rank

Climate: Hot and Humid, minimum 22 Centigrade

Rivers: Mithi, Poisar, Oshivara and Dhahisar.

Population: 93, 32,481

Thane

Area: 9,558 sq km.

Urbanization: 72.58%

Rainfall (average 2011): 232 cm.

HDI: Third Rank

Climate: Hot and Humid, minimum 23 Centigrade to 31 Centigrade

Rivers: Vaitarna, Ulhas, Deheraja, Surya, Tansa, Barvi, Kalu, Bhatsa, Pinjal, Sai, Varoli and Murbadi.

Population: 1, 10, 54,131

Crops: Rice

Talukas: Dahanu, Mokhade, Jwahar, Wada, Vasai, Bhivandi, Shahapur, Murbad, Thane, Kalyan, Ulhas Nagar, Talsari, Vikramgarh, Ambarnath.

Raigad

Area: 7,152 sq km. . Urbanization: 27.88%

Rainfall (average 2011): 392 cm HDI: Sixth Rank

Climate: Hot and Humid

Rivers: Ulhas, Patal Ganga, Bhogeshwari, Amba, Kundlika, Kal, Savitri, Ghod and Page.

Population: 93, 32,481 Crops: Rice

Talukas: Poladpur, Mahad, Tale, Shrivardhan, Mangaon, Mhasala, Roha, Murud, Aligag, Pen, Uran, Panvel, Khalapur, Karjat, Sudhagad(Pali)

Ratnagiri is situated in the south west part of Konkan region. It has coastal saline and coastal alluvium soil. It receives very high rainfall and Laterite soils. According to census 2011, the total population of Ratnagiri as on 2014-15 is 1,615. The decennial growth rate from 2001-2011 was decreased by 4.8 per cent. Total literacy rate is 82.2 per cent. Sex ratio is 1,122 and child sex ratio is 936. Ratnagiri's Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 is Rs. 90,226. Table 5.1 shows trends in cropping pattern of Konkan region. It can be concluded that AAGR of cereals production recorded in Ratnagiri and Sindhudurg is 2.51 and 2.04 percent respectively. However, the coefficient variation of cereal is 8 and 7.2 percent. It shows that there is not much variation of production in the cereal crops of both districts.

Table 5.1 Trends in Cropping Pattern of Konkan Region

Division	Districts	Crops	Tools	Area	Production	Productivity
Konkan	Ratnagiri	Total Cereals	AAGR	-0.56	2.51	3.28
			CV	2.5	8.0	9.3
		Total Pluses	AAGR	1.25	4.04	2.1
			CV	2.5	8.0	9.3
		Total Oilseeds	AAGR	-0.07	-2.61	-3.23
			CV	2.5	8.0	9.3
	Sindhudurg	Total Cereals	AAGR	0.28	2.04	0.84
			CV	5.2	7.2	5.7
		Total Pluses	AAGR	-0.06	4.65	5.02
			CV	5.3	12.0	13.8
		Total Oilseeds	AAGR	0.54	1.8	1.14
			CV	6.4	5.4	7.2

Source : Researcher own Calculations

Sindhudurg lies on southern part of Konkan region. Its altitude ranges from 0 to 150 m. in height. It has coastal saline and coastal alluvium soil. Sindhudurg receives very high rainfall. Rice is the main food crop and perennial rivers are the main characteristics of Konkan region/division. According to census 2011, the total population of Sindhudurg as on 2014-15 is 850. The decennial growth rate from 2001-2011 was decreased by 2.2 per cent. Total literacy rate is 85.6 per cent. Sex ratio is 1,036 and child sex ratio is 922. Sindhudurg Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 is Rs. 1,03,742.

5. 3. 2 Nashik Region

Dhule

Area: 8,063 sq km Urbanization: 27.08%

Rainfall (average 2011): 60 cm. HDI: Thirtieth Rank

Climate: Hot and Dry Minimum 12 and Maximum 45 Centigrade

Rivers: Tapi, Panzara, Bori, Kan, Aner, Aru and Arunavati.

Population: 20, 48,781

Crops: Bajara, Jowar, Wheat, Rice, Sugarcane

Talukas: Dhule, Sakri, Sindhakhed, Shirpur

Nandurbar

Area: 5,034 sq km Urbanization: 15.45%

Rainfall (average 2011): 80 cm. HDI: Thirty second rank

Climate: Hot and Dry; Maximum 45 Centigrade

Rivers: Narmada, Tapi, Nagan, Gomai, Delhi, Kanni, Devnad and Udai.

Population: 16, 46,177

Crops: Bajara, Jowar, Wheat, Rice, Cotton

Talukas: Akkaluka, Dhadgaon, Talode, Shahade, Nandurbar, Navapur

Nashik division represented by Nashik, Dhule, Nandurdar, Jalgaon and Ahamednagar districts. Nashik and Jalgaon are studied here. Both belong to North Maharashtra.

Table 5.2 Trends in Cropping Pattern of Nashik Region

Division	Districts	Crops	Tools	Area	Production	Productivity
Nashik	Nashik	Total Cereals	AAGR	-0.56	9.28	9.33
			CV	4.7	31.2	31.7
		Total Pluses	AAGR	-0.01	6.72	6.31
			CV	7.5	20.0	15.9
		Total Oilseeds	AAGR	4	11.04	6.38
			CV	15.2	33.5	21.5
		Sugarcane	AAGR	5.79	4.27	-0.32
			CV	38.7	41.7	16.7
		Cotton	AAGR	24.92	45.36	16.16
			CV	71.0	83.2	34.7
	Jalgaon	Total Cereals	AAGR	1.92	8.92	6.79
			CV	15.6	25.1	20.2
		Total Pluses	AAGR	-0.43	2.07	10.28
			CV	11.4	10.5	20.3
		Total Oilseeds	AAGR	0.76	9.27	13.06
			CV	17.0	39.5	32.9
		Sugarcane	AAGR	-0.2	-0.7	2.74
			CV	25.3	23.3	18.0
		Cotton	AAGR	2.67	14.68	11.18
			CV	12.0	35.5	25.4

Source : Researcher own Calculations

Nashik is situated on the banks of river Godavari. Nashik Some taluka of Nashik district lie in agro climatic transition zone II like Kalvan, Dindori, Nashik, Igatpuri and remaining talukas lie in agro climatic scarcity zone like Baglan, Chandvad, Niphad,Yeola and Sinner. According to census 2011, the total population of Nashik district is 6,107. It has 600-900 m. high altitude range. It has reddish

brown soils of hill slopes. The total area of Nashik is 15,530 sq. km. Rainfall is 112 cm. The decennial growth rate from 2001 – 2011 increased by 22.3 per cent. Literacy rate 82.3 per cent. While sex ratio is 934 and child sex ratio is 890. Nasik's Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 lie Rs. 1, 10,717. Nashik division covers all important crops such as cereals, pulses, oilseeds, sugarcane and cotton.

Jalgaon is at extreme north of Nashik division. It is 150-300 m. high from sea level. The total area of Jalgaon is 11,765 sq. km. Rainfall is 74 cm. Girna river and other distributaries of Tapi are the main water sources for this region. Jalgaon has coarse shallow soil at high level like Raver, Yaval, Chopda, Shirpur, Shahada and medium black soil in the remaining taluka places like Arondol, Parola, Jamner, Pachora, and Bhadgaon of the district. According to census 2011, the total population of Jalgaon district is 4,230. The decennial growth rate from 2001 – 2011 increased by14.9 per cent. Literacy rate 78.2 percent. While sex ratio is 925 and child sex ratio is 842. Jalgaon's Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 lie Rs. 81,741.

Table 5.2 shows Trends in Cropping Pattern of Nashik Region. Nashik region comprises five districts. However, we concentrate on two prominent districts for observing cropping pattern. As it is shown in the table, production of cereals AAGR is almost same in both the districts in the range of 8-9 percent. Coefficient variation rate is 35 to 30 percent which is quite high. It shows that the area under cereal crops and growth rate of cereals are uneven during the period of study. Nashik is leading district over Jalgaon in terms of AAGR of other crops due to irrigation potentials.

5.3.3 Pune Region

Ahamednagar

Area: 17,000 sq km. Urbanization: 22.4%

Rainfall (average 2011): 56 cm. HDI: Eleventh Tank

Climate: Hot and Dry Minimum 12 and Maximum 40 Centigrade

Rivers: Sina, Ghod, Mula, Pravara, Godavari, Bhima and Kukadi

Population: 45, 43,083

Crops: Jowar, Wheat, Rice, Sugarcane, Cotton

Talukas: Kopargaon, Akole, Sangamner, Shrirampur, Rahuri, Newase, Shevgaon, Parner, Ahamednagar, Pathardi, Shrigonde, |Karjat, Jamkhed, Rahata

Pune region is presented by Pune, Satara, Sangali, Solapur and Kolhapur districts. This region is also known as west Maharashtra. Pune is situated at the bank of river Mula and Mutha. Pune has 600-900 m. high altitude range. It has reddish brown soils of hill slopes such as Junnar, Ambegaon, Khed, Paud, Haveli; Saswad.Some taluka of Pune district has coarse shallow soils at Shirur, Daund. Reddish brown soils lie in agro climatic transition zone I where as coarse shallow soils taluka categorized in transition zone II. According to census 2011, the total area of Pune is 15,642 sq. km. Rainfall is 95 cm. The total population of Pune district is 9,429. The decennial growth rate from 2001 – 2011 increased by30.4 per cent. Literacy rate 86.2 per cent. While sex ratio is 915 and child sex ratio is 883. Pune's Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 lie Rs. 1, 71,636

Solapur lies at the east of Pune division. Bhima is the main river of this district. Solapur has 600-900 m. high altitude range. Solapur has coarse shallow soil at Mohol, Modha, Pandharpur and Mangalvedha taluka and medium black soil at plains in Akkalkot and South Solapur. This district is a part of scarcity zone. According to census 2011, the total area of Solapur is 14,895 sq. km. Rainfall is 56 cm. The total population of Pune district is 9,429. The total population of Solapur district is 4,318.The decennial growth rate of population from 2001–2011 increased by12.2 percent. Literacy rate 77 percent. While sex ratio is 938 and child sex ratio is 883. Solapur's Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 lie Rs. 88,821.

Table 5.3 shows the cropping pattern in Pune region. AAGR of production all the crops in Pune district is less than 1 percent whereas in Solapur district the AAGR of cereals production is less than 1 percent. However, the total pulses production grown by 3.77 percent but oilseeds production is suffered by -3.47 percent. One of the positive parts is that sugarcane production grown by 16.41 AAGR. CV in both the districts found higher under the production of major crops that points the unstable cropping pattern.

Table 5.3 Trends in Cropping Pattern of Pune Region

Division	Districts	Crops	Tools	Area	Production	Productivity
Pune	Pune	Total Cereals	AAGR	-0.4	0.14	0.84
			CV	16.9	6.7	21.4
		Total Pluses	AAGR	-0.69	-0.18	0.54
			CV	16.3	14.5	18.3
		Total Oilseeds	AAGR	-0.6	-0.42	0.16
			CV	18.3	17.9	13.5
		Sugarcane	AAGR	1.33	0.83	0.16
			CV	44.2	50.8	9.5
	Solapur	Total Cereals	AAGR	-2.31	0.2	1.49
			CV	9.6	18.8	18.4
		Total Pluses	AAGR	5.76	3.77	5.5
			CV	29.2	33.7	34.3
		Total Oilseeds	AAGR	-5.82	-3.47	6.6
			CV	32.1	24.8	24.7
		Sugarcane	AAGR	16.97	16.41	0.74

Source : Researcher own Calculations

Satara

Area: 10,480 sq km. Urbanization: 14.86%

Rainfall (average 2011): 131 cm. HDI: Tenth Rank

Climate: Hot and Dry

Rivers: Krishna, Koyana, Urmodi, Venna, Tarali, Kudali, Neera, Banganga, Man, Vasana and Yerala

Population: 30, 03,922

Crops: Kharif Jowar, Bajara, Wheat, Rice, Sugarcane, Cotton

Talukas: Khandala, Phaltan, Wai, Mahabaleshwar, Jawali, Man, Koregaon, Khatavkar, Satara, Patan and Karad

Kolhapur is situated at 300-900 m. high altitude. Sindhudurg, Ratnagiri, Satara and Solapur are the neighboring districts of Kolhapur. River Warna is the main water source of the district. Kolhapur is blessed with Redish brown soils of the hill slopes and on the plains Talukas like Chandgad, Gadhingalaj, Ajra, and Radhanagariand Panhala. Kolhapur taluka has medium black soils at plains. The agro climatic zone of Kolhapur is under transition zone I, Ghat zone and very high rainfall zone with non lateritic soils zone. Generally it receives heavy rain in the month of July up to 25-750 mm yearly. According to census 2011, the total area of Kolhapur is 7,760 sq. km. Rainfall is 213 cm. the total population of Kolhapur district is 3,876.The decennial growth rate of population from 2001–2011 increased by 10 percent. Literacy rate 81.5 percent. While sex ratio is 957 and child sex ratio is 863. Kolhapur's Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 lie Rs. 1, 19,783.

Sangali is situated at 300- 900 m. high altitude. Kolhapur, Satara and Solapur are the neighboring districts of Sangali. River Krishna is the main water source of the district. Sangali is blessed with medium black soil on the plains Talukas like Miraj, Khanapur, Tasgaon and Kawathe Mahakankal. Hath Kanangale taluka has coarse shallow soils at high level. The agro climatic zone of Sangali is under transition zoneII and scarcity zone. Generally, Sangali receives heavy rain in the month of July and September up to 25-125 m.m. yearly. According to census 2011, the total population of Sangali district is 2,822.The decennial growth rate of population from 2001–2011 increased by 9.2 percent.

Literacy rate 81.5 percent. While sex ratio is 966 and child sex ratio is 867. The total area of Sangali is 8,572 sq. km. Rainfall is 49 cm. Sangali's Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 lie Rs. 1, 03,588.

In the Table 5.4 cropping pattern in the Kolhapur region can be seen. Except oilseeds, AAGR of production of major crops in the Sangli district is in the range of 3 to 7 percent. However the oil seeds production growth rate is -2.12 percent. The performance of Kolhapur district in the all the crops remains disappointing over Sangli district. The CV rates in all the crops in Sangli district more volatile that Kolhapur.

Table 5.4 Trends in Cropping Pattern of Pune Region

Division	Districts	Crops	Tools	Area	Production	Productivity
Pune	Sangali	Total Cereals	AAGR	1.07	3.26	3.77
			CV	15.2	24.3	23.5
		Total Pluses	AAGR	5.25	6.12	2.91
			CV	27.5	38.3	25.9
		Total Oilseeds	AAGR	-1.9	-2.12	0.26
			CV	13.8	18.6	16.2
		Sugarcane	AAGR	5.38	7.47	0.94
			CV	27.7	34.4	9.0
	Kolhapur	Total Cereals	AAGR	-0.31	2.6	2.87
			CV	2.8	11.0	10.3
		Total Pluses	AAGR	-0.84	0.45	-1
			CV	16.9	7.6	41.1
		Total Oilseeds	AAGR	2.12	0.53	2.68
			CV	13.2	15.5	16.5
		Sugarcane	AAGR	4.62	5.96	1.26
			CV	18.1	25.5	11.1

Source : Researcher own Calculations

5.3.4 Aurangabad Division

Beed

Area: 10,440 sq km

Urbanization: 17.91%

Rainfall (average 2011): 72 cm.

HDI: Eighteenth Rank

Climate: Hot and Dry

Rivers: Godavari, Sindafana, Bindusara, Talwar, Kambali, Ruti, Mehekari, wan and Manjara

Population: 25, 85,962

Crops: Jowar, Bajara, Wheat, Rice, Sugarcane, Cotton

Talukas: Gevrai, Ashti, Majalgaon, Patoda, Keg, Ambejogai, Beed, Dharur, Parali-Vaijnath, Vadvani, Shirur- Kasar.

Aurangabad division is also known as Marathwada. It consists of Aurangabad, Jalana, Parbhani, Hingoli, Beed Nanded, Osmanabad and Latur districts. Aurangabad and Jalana districts have been considered. Aurangabad has 600-900 m high altitude range. Aurangabad has coarse shallow soil at Sillod, Kannad, Khultabad, Vaijapur, Paithan and deep black soil at Gangapur.Aurangabad is under the agro-climatic zone of assured rainfall zone and scarcity zone. . According to census 2011, the total population Aurangabad of district is 3,701. The decennial growth rate from 2001–2011 increased by 27.8 per cent. Literacy rate 79 percent. While sex ratio is 923 and child sex ratio is 858. The total area of Aurangabad is 10,100 sq km. The annual rainfall is 53 cm. Aurangabad

Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 lie Rs. 1, 07,784.

Table 5.5 Trends in Cropping Pattern of Aurangabad Region

Division	Districts	Crops	Tools	Area	Production	Productivity
Aurangabad	Aurangabad	Total Cereals	AAGR	-2.45	6.88	10.38
			CV	9.7	26.9	33.4
		Total Pluses	AAGR	-1.35	8.82	71.19
			CV	13.9	39.2	42.1
		Total Oilseeds	AAGR	-9.26	2.22	12.71
			CV	35.5	31.6	38.5
		Sugarcane	AAGR	10.9	17.46	5.75
			CV	48.0	58.1	21.0
		Cotton	AAGR	9.85	31.11	17.38
			CV	34.4	71.3	49.4
	Jalna	Total Cereals	AAGR	-4.64	0.4	5.1
			CV	16.4	16.1	17.6
		Total Pluses	AAGR	-0.65	9.11	6.11
			CV	15.2	28.3	23.6
		Total Oilseeds	AAGR	2.98	15.12	12.84
			CV	15.1	43.7	36.6
		Sugarcane	AAGR	10.51	10.91	2.27
			CV	37.5	43.9	16.1
		Cotton	AAGR	7.17	22.28	13.78
			CV	29.8	58.3	37.0

Source : Researcher own Calculations

Jalna is neighboring district of Aurangabad at east. It has black soils at Ambad and Partur. It has 300-900 m. altitude height. River purna is an important water resource for this division. Jalana is categorized in assured rainfall zone. According to census 2011, the total population of Jalana district is 1959.The decennial growth rate of population from

2001 – 2011 increased by 21.1 per cent. Literacy rate 71.5 percent. While sex ratio is 937 and child sex ratio is 870. The total area of Jalna is 7,718 sq km. The annual rainfall is 56 cm. Jalana Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 lie Rs. 77,251. Latur NDDP at current prices in 2013-14 remains Rs. 80,352.

Table 5.5 exhibits the cropping pattern in Aurangabad region. AAGR of the crops such as sugarcane and cotton is in Aurangabad district is recorded as 17.46 and 31.11 percent respectively whereas in the Jalana district, AAGR is observed as 10.91 and 22.28 percent for the same crops. AAGR of these crops is much higher than other crops in both districts. This tendency shows that farms prefer that cash crops in which they have good margin and better prospectus. The CV for all the crops in both districts are observed much higher, that shows that instability in the cropping patterns.

Osmanabad

Area: 7,512 sq km

Urbanization: 15.96 %

Rainfall (average 2011): 54 cm.

HDI : Twenty-eighth Rank

Climate: Hot and Dry

Rivers: Manjara, Sina, Terana, Bori, Benitura, Banganga, Bhagavati

Population: 16, 60,311

Crops: Jowar, Bajara, Wheat, Rice, Pulses, Sugarcane, Cotton

Talukas: Paranda, Bhum, Osmanabad, Tuljapur, Kalamb, Umerga, Lohara, Vashi.

Parbhani

Area: 6,511 sq km Urbanization: 34.08 %

Rainfall (average 2011): 66 cm. HDI: Twenty-Forth Rank

Climate: Hot and Dry

Rivers: Godavari, Purna, Masali, Dudhana, Kapara and Painganga

Population: 18, 35,982

Crops: Cotton Jowar, Rice, Pulses, Sugarcane

Talukas: Jintur, Pathri, Parbhani, Gangakhed, Purna, Palam, Setu, Sonpeth, Manvat.

Hingoli

Area: 4,526 sq km. Urbanization: 16.62 %

Rainfall (average 2011): 76 cm. HDI: Twenty-Fifth Rank

Climate: Hot and Dry

Rivers: Kayadhu, Painganga, Purna, and Asana

Population: 11,785,973

Crops: Cotton Jowar, Rice, Wheat, Pulses, Sugarcane

Talukas: Sengaon, Hingoli, Kalmnuri, Aundha-Nagnath, Basmat.

Latur is situated at 300-900 m. high altitude. Osmanabad, Beed, Parbhani and Nanded are the neighboring districts of Latur. River Terna is the main water source of the district. Latur is blessed with medium black soils on the plains Talukas like Udgir, Nilanga, Omaraga, and Tuljapur. Ahamadpur taluka has coarse shallow soils at high level. The agro climatic zone of Latur is under assured rainfall zone. Generally it receives heavy rain in the month of July and Monthly normal rainfall from June to November in Jalana district of Maharashtra is 25-175 mm yearly. According to census 2011, the total population of Latur district is 2,454. The decennial growth rate of population from 2001 – 2011 increased by 18 per cent. Literacy rate 77.3 percent. While sex ratio is 928 and child sex ratio is 88 and annual rainfall is 72 cm. The total area of Latur district is 7,157 sq. km. Latur Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 lie Rs. 80,352.

Nanded is at extreme north-east of Aurangabad division. It is 300-600 m. high from sea level. Godavari River and other distributaries of it are the main water sources for this region. Nanded has completely medium black soils at plains like Deglur, Mukhed, Kandhar, Billoli, Bhokar and Nanded itself. Rain occurs in the month of September heavily. Monthly normal rainfall from June to November in Nanded district of Maharashtra is 25-175 m.m. yearly. Latur, Parbhani and Yavatmal are the neighboring districts of Nanded. According to census 2011, the total population of Nanded district is 3,361. The decennial growth rate from 2001–2011 increased by 16.9 per cent. Literacy rate 75.5 per cent. While sex ratio is 943 and child sex ratio is 910. Annual rainfall is 69 cm. The total area of Nanded district is 10,502 sq. km. Nanded's Per Capita Net District

Domestic Product (NDDP) at current prices in 2013-14 laid Rs. 67,654. Table 5.6 show the cropping pattern in the Latur region. Latur and Nanded is hub of oilseed and pulses crops in Maharashtra. The AAGR of production for Pulses and Oilseeds is observed as 16.2 and 43.4 in Latur and 9.56 and 35 percent in Nanded district respectively. Cotton is also a leading crop in the region. AAGR OF Cotton crops in both districts is not same. In Nanded it is 27.41 whereas in Latur it was hardly 5.85 percent. CV rate for all the crops is high. It shows that cropping pattern of these crops is subject to monsoon, support prices declared by the government time to time.

Table 5.6 Trends in Cropping Pattern of Aurangabad Region

Division	Districts	Crops	Tools	Area	Production	Productivity
Aurangabad	Latur	Total Cereals	AAGR	-2.37	2.48	4.29
			CV	14.8	20.2	15.7
		Total Pluses	AAGR	0.32	16.2	38.44
			CV	10.3	37.9	47.7
		Total Oilseeds	AAGR	9.22	43.04	33.14
			CV	29.0	72.5	60.5
		Sugarcane	AAGR	11.94	13.57	2.09
			CV	41.2	45.0	15.4
		Cotton	AAGR	-5.86	5.85	12.13
			CV	92.0	69.6	49.9
	Nanded	Total Cereals	AAGR	-2.76	1.55	3.5
			CV	16.2	26.1	17.5
		Total Pluses	AAGR	1.23	9.56	6.82
			CV	7.2	27.1	22.3
		Total Oilseeds	AAGR	13.4	35	20.58
			CV	39.6	52.6	31.3
		Sugarcane	AAGR	16.62	20.23	2.71
			CV	41.6	47.5	16.1
		Cotton	AAGR	2.24	27.41	24.85
			CV	15.1	60.6	42.5

Source : Researcher own Calculations

5.3.5 Amravati Division

Akola

Area: 5,428 sq km. Urbanization: 39.56%

Rainfall (average 2011): 80 cm. HDI: Twenty-Third Rank

Climate: Very Hot and Dry

Rivers: Purna, Painganga, Morna, Katapurna, Dudhna, Shahanur, Pedhi, Mas man, Arunavati, Gandhari and Nigurna

Population: 18, 18,617

Crops: Jowar, Wheat, Bajara, Rice, Pulses, Cotton

Talukas: Akot, Telhara, Akola, Balapur, Patur, Barshita kali, Murtizapur.

Washim

Area: 5,196 sq km. . Urbanization: 17.93%

Rainfall (average 2011): 79 cm. HDI: Thirty-First Rank

Climate: Very Hot and Dry

Rivers: Painganga, Arunavati, Adan, Morana, Chandrabhaga, Puse, Katapurna, and Bembana

Population: 11, 96,714

Crops: Cotton, Jowar, Wheat, Pulses

Talukas: Risode, Washim, Manora, Malegaon, Mangalur-Pir, Karanja

Yavatmal

Area: 13,584 sq km. Urbanization: 19.37%

Rainfall (average 2011): 79 cm. HDI: Thirty-Fourth Rank

Climate: Very Hot and Dry

Rivers: Wardha, Painganga, Bembala, Ramganga, Nirgunda, Khuni, Pus, Arunavati, Waghadi, Vidarbha, Arna and Adan

Population: 11, 96,714

Crops: Cotton, Jowar, Wheat, Pulses

Talukas: Darva, Yavatmal, Pusad, Vani, Babhulgaon, Kalamb, Ghatanji, Ralegaon, Morgaon, Digras, Ner, Umerkhed, Mahagaon, Arni, Pandharkawada, Zarijamni.

Buldhana East taluka of like Chikhali deposited with medium black soil on plains and other taluka places deposited with coarse shallow soil at high level in Devulgaon Raja, Jafarabad. Buldhana scatters through 150-900 m altitude range. It is in assured rain fall zone. According to census 2011, the total population of Buldhana district is 2586. The decennial growth rate of population from 2001–2011 increased by 15.8 percent. Literacy rate 83.4 percent. While sex ratio is 934 and child sex ratio is 855. Buldhana has total area of 9,661 sq.km and annual rainfall is 66 cm. Buldhana Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 lie Rs. 67,730. Buldhana is a part and parcel of Vidarbha.

Amravati is situated between Akola, Yavatmal and Wardha district. It has a medium black soil which is an important for cotton on plains available in Akot, Murtijapur and Chandur. Amravati scatters through 150-1350 m altitude range. It is in moderate to moderately high rainfall zone. Chikhaldara is a famous hill station situated in this district at the north. According to census 2011, the total population of Amravati district is 2888.The decennial growth rate of population from 2001–2011 increased by 10.8 percent.

Literacy rate 87.4 percent. While sex ratio is 951 and child sex ratio is 935. Amravati has total area of 12,210 sq. km and annual rainfall is 71 cm. Amravati Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 lie Rs. 79,945.

Table 5.7 Trends in Cropping Pattern of Amravati Region

Division	Districts	Crops	Tools	Area	Production	Productivity
Amravati	Buldhana	Total Cereals	AAGR	-1.47	4.91	6.4
			CV	8.5	24.8	24.5
		Total Pluses	AAGR	-0.23	19.27	16.55
			CV	9.6	33.8	32.2
		Total Oilseeds	AAGR	10.02	39.97	34.16
			CV	38.6	68.1	45.6
		Sugarcane	AAGR	17.49	42.14	0.85
			CV	58.3	52.6	19.7
		Cotton	AAGR	1.81	19.58	17.96
			CV	13.5	46.0	37.6
	Amravati	Total Cereals	AAGR	-4.43	0.5	3.55
			CV	17.4	21.4	14.2
		Total Pluses	AAGR	2.3	1.92	6.18
			CV	9.5	24.3	17.5
		Total Oilseeds	AAGR	0.51	24.61	26.87
			CV	31.8	57.4	41.1
		Sugarcane	AAGR	-7.02	-1.76	-1.76
			CV	76.7	87.8	87.8
		Cotton	AAGR	-1	10.23	14.42
			CV	29.8	24.3	41.5

Source : Researcher own Calculations

The cropping pattern in Amravati region is shown in the Table 5.7. It can be seen that both districts are leader in the three major crops such as oilseeds, cotton and pulses. The AAGR of oilseeds, pulses and cotton recorded as 39.97, 19.27, and 19.58 percent in Buldhana district whereas in Amravati it is recorded as 24.61, 1.92, and 10.23 percent respectively. CV of these crops in both districts are high that concludes instability in the cropping pattern.

5.3.6 Nagpur Division

Wardha

Area: 6,309 sq km. Urbanization : 26.28%

Rainfall (average 2011): 98 cm. HDI : sixteenth Rank

Climate: Hot and Dry

Rivers: Wardha, Bakali, Yashoda, Venna, Bor, and Dham

Population: 12, 96,157

Crops: Jowar, Rice, Pulses, Wheat, Cotton, Sugarcane

Talukas: Arvi, Wardha, Hingan Ghat, Devali, Samudrapur, Karanja, Ashti, Selu

Bhandara

Area: 3,895 sq km. Urbanization: 16.06%

Rainfall (average 2011): 108 cm. HDI : Twentieth Rank

Climate: Hot and Dry

Rivers: Vainganga, Bavanthadi, Chandan, Sur, Bagh, Pangodi-Pagoli, Gadhavi

Population: 11, 98,810 Crops: Jowar, Wheat, Rice, Pulses

Talukas: Bhandara, Sakoli, Lakhandur, Pavani, Lakhni, Mohadi, Tumser

Gondia

Area: 5,425 sq km. Urbanization: 11.95%

Rainfall (average 2011): 108 cm. HDI : Twenty-first Rank.

Climate: Hot and Dry

Rivers: Vainganga, Bavanthadi, Chandan, Sur, Bagh, Pangodi-Pagoli, Gadhavi

Population: 13, 22,331

Crops: Pulses, Wheat, Sugarcane

Talukas: Amgaon, Arjuni-Morgaon, Devery, Gonregaon, Sadak-Arjuni, Salekasa and Tiroda.

Chandrapur

Area: 11,443 sq km. . Urbanization: 34.33%

Rainfall (average 2011): 99 cm. HDI: Twenty-Sixth Rank.

Climate: Very Hot and Dry

Rivers: Wardha, Vainganga, Painganga, Erai, Andhari, Mul, Pranhita, Bandia

Population: 21, 94,262

Crops: Rice, Jowar, Pulses, Wheat

Talukas: Gaund-pimpari, Brahampuri, Varora, Chandrapur, Rajura, Bhadravati, Chimur, Nagbhid, Mul, Sindevahi, Ballarpur, Pombhurna, Korapna, Jivati, Savali.

Nagpur is located at the center of the India and eastward of Maharashtra. It is connected through modern means of transportation to the world. It has 150-600 m. altitude. The north taluka of Nagpur such as Ramtek, Parshivani and Savner has yellowish brown soils on high level. It has mixed origin. Western and southern taluka of Nagpur like Katol, Hingana, has coarse shallow soils. Whereas Nagpur city, Kamthi, Moudha and

Kalmeshwar has yellowish brown soil of plains with mixed origin. Nagpur receives moderate to moderately high rainfall. According to census 2011, the total population of Nagpur district is 4,654. The decennial growth rate of population from 2001 – 2011 increased by 14.4 per cent. Literacy rate 88.4 per cent. While sex ratio is 951 and child sex ratio is 931. Nagpur have total area of 9,812 sq.km and annual rainfall is 93 cm. Nagpur's Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 lie Rs. 1, 23,610.

Table 5.8 Trends in Cropping Pattern of Nagpur Division Region

Division	Districts	Crops	Tools	Area	Production	Productivity
Nagpur	Nagpur	Total Cereals	AAGR	2.81	9.47	5.31
			CV	11.6	26.2	15.9
		Total Pluses	AAGR	4.22	12.35	7.3
			CV	20.7	36.3	20.8
		Total Oilseeds	AAGR	7.3	0.48	3.55
			CV	12.2	28.0	24.0
		Sugarcane	AAGR	3.83	8.32	53.45
			CV	67.8	68.2	31.6
		Cotton	AAGR	19.27	4.75	10.61
			CV	18.6	26.3	174.7
	Bhandara	Total Cereals	AAGR	2.2	17.7	14.2
			CV	8.1	31.7	27.4
		Total Pluses	AAGR	7.7	15.7	4.2
			CV	23.3	34.3	15.3
		Total Oilseeds	AAGR	-2.5	2.3	4.9
			CV	11.2	25.3	26.0
		Sugarcane	AAGR	25.1	45.6	4.8
			CV	43.2	63.2	23.6

Source : Researcher own Calculations

Gadchiroli has 75-300 m. high altitude. This is high rainfall zone. The soil is formed by the rocks of mixed origin. Atapalli district is famous for Laterite and lateritic soil. Sironcha Chamorshi, the southern districts and Gadchiroli has yellowish brown soils of plains. According to census 2011, the total population of Gadchiroli district is 1,073. The decennial growth rate of population from 2001 – 2011 increased by 10.6 per cent. Literacy rate 74.4 per cent. While sex ratio is 982 and child sex ratio is 961. Gadchiroli have total area of 14,412 sq.km and annual rainfall is cm. Gadchiroli Per Capita Net District Domestic Product (NDDP) at current prices in 2013-14 stretch out Rs. 58,603.

Table 5.8 shows cropping pattern in Nagpur region. The performance of Nagpur district is poor in all the major categories of the crops. In Bhandara district, the AAGR of cereals, pulses, oilseeds and recorded as 17.7, 15.7 and 2.3 percent respectively. AAGR of oilseeds is found as less than 1 percent in the Nagpur district. The CV rate of sugarcane crop in both districts is very high that shows last variations in the crop. The cereals AAGR is good in both the district are 9.47 and 17.7 which is fairly good due to rice crops is grown on large scale in the region.

5.4 Conclusions

In this chapter, six administrative regions of the Maharashtra are covered for observing district level trends in cropping pattern for the period 2001-2012. For that we have chosen two districts under each region. Total 16 districts are observed for the task of knowing cropping pattern. These districts are representative of all remaining districts of Maharashtra. An aggregative study has been made in the chapter five of this thesis. The district level analysis shows that the production, area and productivity trends of the major categories of the crops are differs district wise and CV rates are also not same. The factual observation is that region like Latur, Aurangabad, Amravati, where the AAGR of oilseeds, pulses and cotton found more over the other districts. Regions such as Nashik, Pune and Kolhapur found leader in sugarcane crops. Basically, cropping pattern is decided by number of factors such as climatic zones, rainfall intensity, supportive prices and marketing network. The production of Pulses, Oilseed and Sugarcane crops are in increasing in the recent years due to remunerative supportive prices declared by center and state government and increasing need of cash requirements of the farmers.

Chapter 6

Trends in Agriculture of Yavatmal Maharashtra: District Level Analysis

6.1. Introduction

The Maharashtra state has more heterogeneity in crop production and cropping pattern arising from its varied agro-climatic conditions. Cropping pattern in the state varies from region to region and few changes have been

taken place in cropping pattern in certain regions and these changes are continuing as new crops are being introduced and the traditional crops are on the decline. Remunerative price, high yield, low rain fed or low water intake varieties and better income to the farmers are the main motivating factors for changing cropping pattern. Publicity drive and exposure the information flows are also forces farmers to give up traditional crops.

Maharashtra state has eight revenue administrative divisions: Nashik, Pune, Kolhapur, Aurangabad, Latur, Amravati and Nagpur. Yavatmal comes under Amravati division. Akola, Buldhana, Amravati and Washim districts are under this division located between the Northern latitude of 20º 23' 50.51" and East longitude 78º 07' 42.42". Altitude remains 451m. It consists of 16 Talukas. It is a major cotton producing district of Maharashtra. The district boundery touches five districts of Maharashtra namely Nanded, Parbhani, Washi, Wardha and Chandrapur. Andhra Paradesh remains the neighbouring state of Yavatmal.

Agro climatically Yavatmal falls in the category of western plateau and hills region zone XI. It can be sub divided into four sub agro climatic zones namely the deccan plateau, the hot semi-arid region, western Maharashtra Plateau and hot moist semi arid eco sub-region. The average rain fall across the agro climatic zones and in the Yavatmal district ranges 775.2 mm. from south west monsoon (June-September). This zone receives 69.6 mm rainfall from North-East monsoon (October-December) 29.4 mm in winter and 12.2 mm in summer. Annual normal rain fall was 886.4 mm. Normal rainy days from south west monsoon records 39.9%. Rainy season generally starts on June 11 till October 7.

Yavatmal spread over the area of 13, 52,000 ha. However, cultivable area is near about 8, 84, 000 ha. Yavatmal has three types of soil namely; shallow black soil (52.2 per cent), deep black soil (34.7 percent) and medium deep black (13 per cent).15000 ha. Area sowed more than once in a year hence gross cropped area increases to 899,000 ha. Latur division constantly under the rain fed area zone. Yavatmal has 839.3 thousand ha rain fed area. The share Canals is 21.6 per cent and open wells 78.4 percent in total irrigation. This paper is attempt in this direction.

Dev (1996) concluded that the large part of Marathwada comes under the rain shadow. Thus agriculture is characterized by the low rainfall and low irrigation. Dastane (2002) observed that Maharashtra lags behind in the productivity of all crops as compared to the national averages, which itself is away behind the averages of some of the other progressive countries of Europe and Asia. Gadgil (2006) found that there is an asymmetry in the response to monsoon variability. Therefore indirect impact of drought on the purchasing power of the majority of the population in this region remains very significant in the modern era as well.

6. 2. Methodology

This study is undertaken to understand the trends in the cropping pattern of Yavatmal district. For that, time series data of major crops were collected from the office of Directorate of Agriculture, Pune, Maharashtra and office of the Commissioner of Land Record for the period 1991-92 to 2010-11. To observe the trends in major crops and cropping patterns data period has been divided in to two periods namely 1991-2000 and 2001-2010. After calculating

mean and standard deviation of each crops, independent sample mean comparison test is used to see where there is any significant difference in the mean of the two periods if any in the given time periods. The reason being of using classical independent sample t test is that, it allows to make decision of mean of crop is not same in the two periods.

Besides mean comparison test, we also used dummy variable regression on the same data and for the same period. In this exercise, we used dummy variable which is also knows an as dichotomous variable. In the linear regression, dummy variable is used to see the structural change or trend change in the given data set. The result appeared from Dummy variable regression model shows that production of major crops has been gone under change in the two periods or not. The beta coefficient values shows whether production has increased or decreased over the earlier period and also depicts that is change is significant or not?

6.3. Background of the Yavatmal District

The changes in the cropping pattern have been studied for the year 1991-2011. Yavatmal is under central Vidarbha Zone (MH-8). A brief discussion of land use pattern, cropping pattern, cropping intensity, production and productivity of major crops, annual rainfall, and major contingency for Yavatmal district is presented in this section.

6.3.1 Land Use Pattern

The pattern of land use of the district was quite similar after the liberalisation period in India. Cultivable area is 8,84,000 ha. Forest area is 2,43,000 ha Land under non-agriculture use is 25,000 ha. Permanent pastures cover 35,000 ha. Cultivable waste land covers 22,000 ha. Land under miscellaneous tree .crops and groves are 29,000 ha. Barren and uncultivable land is 39.4 and current fallows, other fallows are 33,000 ha. and 25,000 ha. respectively.

6. 3.2 Annual Rain Fall

Yavatmal located at western plateau and hills regions (XI). Highest rainfall measured in Kelapur, Ghatnanji & Ralegaon 1117 cm. Normaly onset of rain begins from June 11-17 till October 01-07. The graph gives details of all the Talukas annual rain fall of Yavatmal district. Figure and data indicates Darva taluka has lowest rainfall.

6.3.3 Weather Related Contingencies

Due to rain fed area Yavatmal district has to cope up with different situations. It may be early season drought or rain delayed by two weeks. Farmers had shown on deep to medium deep black soil the Bt cotton, cotton + tur , soybean , pigeon pea, sorghum (jowar), as per recommended package of practices by Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola. Major farming situation on shallow black soil the cropping pattern is soybean, green gram and black gram. Farmers do cultivate cotton in shallow black soil, however the productivity is low. Drought can be delayed by two weeks, four weeks or six to

eight week also. Different contingency measures suggested by Dr. Punjabrao Deshmukh Krishi Vidyapeeth, Akola.

6.3.4 Cropping Pattern

Cotton is the most important crop under the rain fed area of this (MH-8) zone occupying 4,05,000 ha. It is largely grown during Kharif season. Soybean cultivated on 2,87,000 ha. land. While pigeon pea cultivated on 1,06,000 ha. land. Sourghum, green pea, black gram also grown in this rain fed area as 70,000 ha., 12,000 ha., and 10,000 ha .respectively. Although some crops like gram, wheat and safflower were grown in rabbi season. The main crop remains wheat in Yavatmal district during post rainy season. The most prominent cropping pattern followed by the farmers of Yavatmal was cotton and tur. The analysis does not provide strong evidence in favour of changing cropping pattern.

6.3.5 Cropping Intensity

The changes in cropping intensity reflect the sensitivity of agricultural activities to agro- biological and socio–economic condition from time to time. Cropping intensity index is a ratio of gross sown area to the net sown area. It measures the extent of land utilisation by taking into account the area planted more than once. In 2008-09 the cropping intensity actually calculated as 101.6 percent.

6.4. Trends in Production of Major Crops

Cotton is the crop key in Yavatmal district. As Yavtmal is in rain fed area, its agriculture is totally depends on monsoon. So cotton, Soyabin, Pigeon Pea, Sourgham, Green Gram Black Gram are rainy season (Kharif) crops as well as Wheat and Chick Pea are Rabbi crops. Following Table 6.1 shows Mean Comparisons Test for Trends in Major Crops in Yavatmal district for the period 1991-2010.

6.4.1 Mean Comparison Test of Two Independent Samples

$$t = \frac{\overline{x_1} - \overline{x_2} - \Delta}{\sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}}$$

where $\overline{x_1}$ and $\overline{x_2}$ are the means of the two samples taken for two respective periods. Δ is the hypothesized difference between the population means (0 if testing for equal means), $s1$ and $s2$ are the standard deviations of the two samples, and $n1$ and $n2$ are the sizes of the two samples. The number of degrees of freedom for the problem is the smaller of $n1 - 1$ and $n2 - 1$.

Using above formula we test the following null hypothesis:

$H_0 = \mu_1 = \mu_2$

or

$H_0 = \mu_1 - \mu_1 = 0$

Where μ_1 represents population mean of period 1991-2000 and μ_2 represents population mean of period 2001-2010.

Table 6.1 Mean Comparisons Test for Trends in Major Crops in Yavatmal

Variable	1991-2000		2001-2010		t Test	Probability
	Mean	Std. Dev.	Mean	Std. Dev.		
Rice	40.4	9.191784	12.1	14.90302	5.11*	0.0001
Wheat	212.8	74.82097	347.7	282.204	-1.46***	0.0806
Jawar	2206.3	608.6672	990.4	427.526	5.16*	0.0001
Bajra	49	19.79338	14.9	10.35428	4.82*	0.0001
Maize	2.6	1.429841	7.6	7.136759	-2.17**	0.0200
Total cereal	2515.6	632.7698	1266.7	470.2619	5.00*	0.0001
Gram	80.6	25.49161	301.4	270.1811	-2.57*	0.0096
Tur	1031.3	282.0371	1033.9	279.584	-0.02	0.9837
Mung	259	67.82985	102.3	63.63621	5.32*	0.0000
Udid	111.4	41.56441	64.1	38.40558	2.64*	0.0165
Total pluses	1482.8	392.7263	979.8	630.5207	2.14*	0.0462
Sugarcane	4735.3	1550.238	4344.5	2907.285	0.37	0.712
Cotton	3015.9	992.263	5064.4	2492.529	-2.41*	0.0266
Sunflower	20.8	10.5704	0.9	0.7378648	5.93*	0.0000
Soybean	574.6	485.5371	1808.6	935.161	-3.70*	0.0016

Source : Researcher own Calculations
Note: sign * Significant at 1%, ** significant at 5% and *** significant at 10% level.

It can be seen in the Table 6.1 that production of rice has been declined from mean value 40.4 to 12.1 in the period 1991-2010 and that change is

significant. However, the production of wheat has increased during the same period as shown by mean value 212.8 to 347.7 is also significant change supported by t test at 8% level of significance. One of the striking changes is that the production of Jowar crop has drastically declined from 2206.3 mean values to 990.4 and its place has been taken over by soybean and sunflower crops in the recent past.

The good supportive price has attracted farmers for growing Maize in the period of study. This argument has been supported by the mean values of maize production has increased from 2.6 to 7.6. This change is also supported by t test. The overall production trends in the cereal is a cause of concern for the government in particular and public in general. The mean values of cereal are declined from 2515.6 to 1266.7, which is significant change at 1% level of significance.

In the category of pluses the production of Gram has significantly increased but the production of Tur has not increased at all the span of 10 years. The production of green gram and black gram crops are significantly declined during the study period. The aggregate production of Pulses has also declined from mean value 1482.8 to 979.8. This change is also matter of worry of the government and also public. The price level of pulses has been increasing because of shortfall in the production.

Major Cash crops comprises sugarcane, cotton, sunflower and soybean. Among these crops production of cotton and soybean has been significantly increased during second period 2001-2010. However the production of sugarcane has been suffered but not significantly. Another noticeable change is

that the production of sunflower crop has declined mean value 20.9 to 0.9. In the cash crops, the production of cotton and soybean were scaled up due to the use of BT Cotton seeds and better support prices declared by the government.

It can be concluded from the Table 6.1 that the production of cereals and pulses reduced significantly. It is matter of concern for the government because shortages escalated the inflation of foods and may work as reason not to complying food security right of many poor people. It may perpetuate the poverty percentage due to food inflation in the Yavatmal district and Maharashtra.

6.5. Trends in Production of Major Crops of Yavatmal District: Using Dummy Variable Regression Model

Besides, independent sample mean comparison t test, we also used dummy variable regression to see the change occurred in the production of major categories of the crops widely grown in the Yavatmal district. The following four regressions have been run on the same data for the period 1991-2010.

$$Total\ cereal_i = \alpha + \beta_2 D_{2i} + \mu_i \text{----------(1)}$$

Where Total cereal is dependant variable and α is constant term and β_2 is coefficient value of dummy variable shown by D. μ is error term. Dummy variable takes value 0 and 1 for the period 1991-2000 and 2001-2010 respectively.

$$Total\ pluses_i = \alpha + \beta_2 D_{2i} + \mu_i \text{----------(2)}$$

$$Cotton_i = \alpha + \beta_2 D_{2i} + \mu_i \text{----------(3)}$$

Soybean= $\alpha + \beta_2 D_{2i} + \mu_i$----------(4)

Above four regressions are tried on the data set under the study. The regression results are reported in the Table 6.2. The results appeared from the regression supports the finding appeared from independent sample mean t test.

It can be seen from the regression result of model 1 that the production of cereals fallen during the period 2001-2010 and same results are supported by minus sign of t test. R2 value of regression is 53% but the sign of coefficient and t test are making sense hence low R2 has least impotence in the present regression model. Subsequent regression number 2 also shows that negative trend in the (ttpa) pluses production in the second period of study and coefficient value is significant at 9 percent.

The results of regression number 3 reveals that the production of cotton has increased significantly, that is supported by coefficient value at 1 % level of significance. Last regression number 4 also shown positive trend in the production of the soybean in the period 2001-2010 results thereof are significant at 1% level of significance.

The results appeared from the dummy variables regression models are correct to our expectation. The declining trends in the production of cereal and pluses are the cause of concern keeping in mind the food security and poverty reduction. Durbin Watson test of autocorrelation is used to check the autocorrelation problem in the data. The results of DW test in the above four regressions are above 0.511 Co integrating regression Durbin Watson (CRDW) rule. Hence the results appeared from the above regressions are valid.

Table 6.2: Trends in Production of Major Crops District Yavatmal: Using Dummy Variable Regression Model

Dep. vari.	lnd. vari.	Coef.	Std. Err.	t stats.	P>t	Number of obs	20
Total Cereal	dummy	-0.72787	0.161462	-4.51	0.000	F (1, 18)	20.32
Production	cons.	7.797824	0.114171	68.3	0.000	Prob > F	0.0003
						R-squared	0.5303
						Adj R-squared	0.5042
						DW stat(2,20)	1.164277
Total Pluses	dummy	-0.23759	0.132449	-1.79	0.090	Number of obs	20
Production	cons.	7.266405	0.093656	77.59	0.00	Prob > F	0.0897
						R-squared	0.1517
						Adj R-squared	0.1045
						DW stat(2,20)	0.953215
Total Cotton	dummy	0.469808	0.181249	2.59	0.018	Number of obs	20
Production	cons.	7.96063	0.128162	62.11	0.000	F(1, 18)	6.72
						Prob > F	0.0184
						R-squared	0.2718
						Adj R-squared	0.2314
						DW stat(2,20)	1.229129
Total Soybean	dummy	1.364844	0.324424	4.21	0.001	Number of obs	20
Production	cons.	6.016379	0.229403	26.23	0.000	F(1, 18)	17.7
						Prob > F	0.0005
						R-squared	0.4958
						Adj R-squared	0.4678
						DW stat(2,20)	0.751978

Source : Researcher own Calculations

6.6. Conclusions

In present chapter, options open to policy makers are; (i) to achieve further growth in cereals and pulses' output (ii) to consolidate the relative advantages of the crops. The option of non-cereal crops appears to be encouraging and more possible option open to the farmers. A justification for such a course of change can easily be found in the changing cropping pattern in favour of non-cereal crops. From the above discussion, one may conclude that production of cotton and soybean is increasing since the 1991 due to better prices for the produce and more yield over the other crops. This trend is being supported by dummy variable regression. The cash requirements of the farmers are met by these crops hence farmers prefer these two crops on large scale during the period 2001-2010. However, there is need to work on few policy aspects such as better marketing conditions, minimum support prices, providing new technology at cheaper cost, training and extension service of sustainable farming to the farmers, this may foster the production of various crops in the Yavatmal district.

Figure 6.1 Soil Map of Yawatmal

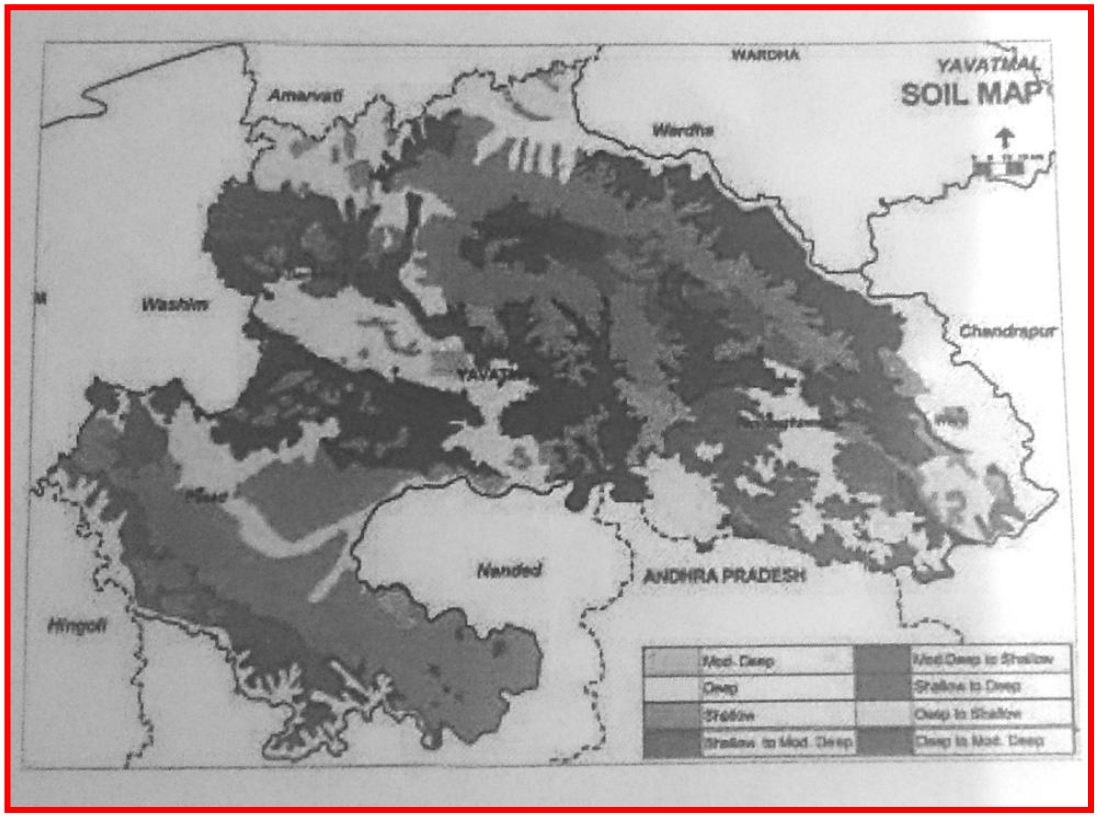


Figure 6.2 Taluka wise yearly rainfall

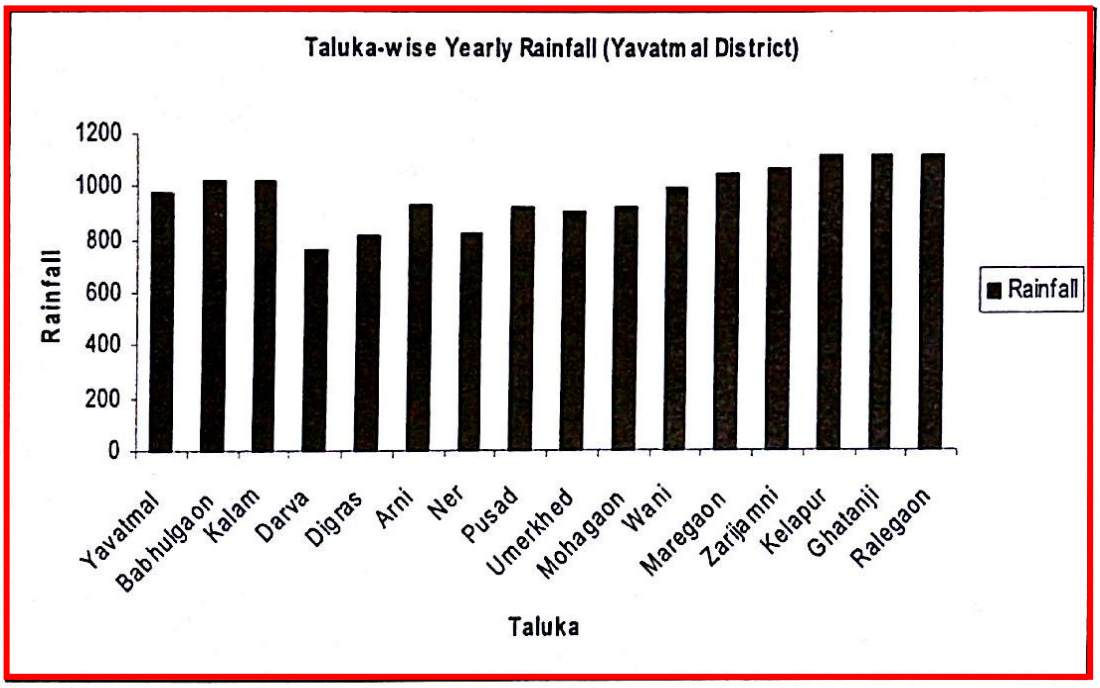
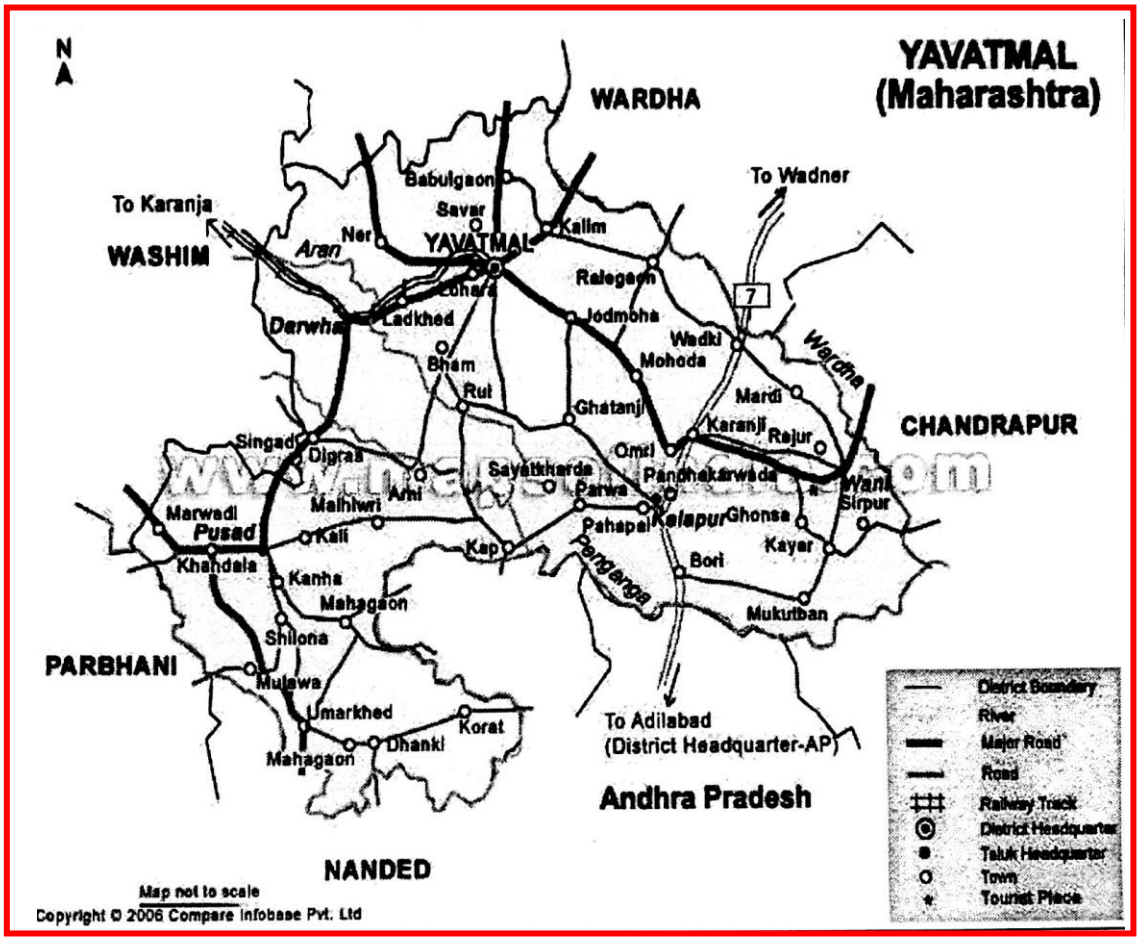


Table 6.3 Taluka wise Rainfall in Yavatmal District

District Yavatmal		
Taluka	**Rainfall**	**Rainy Day**
Yavatnal	977.1	55.6
Babhulgaon	1021.0	47.6
Kalam	1021.0	47.6
Darva	762.6	60.9
Digras	818.2	54.1
Arni	930.0	47.6
Ner	824.0	47.6
Pusad	918.3	52.2
Umerkhed	908.8	53.5
Mohagaon	923.0	47.7
Wani	990.0	56.5
Maregaon	1050.0	4.6
Zarijamni	1064.0	47.6
Kelapur	1117.0	47.6
Ghatanji	1117.0	47.6
Ralegaon	1117.0	47.6
Overall	966.2	50.6

Source : Contingency plan of Yavatmal, GoM

Figure 6.3 Physical Map of Yavatmal



Chapter 7

Conclusions and Policy Implications

7.1 Introduction

Maharashtra is one of the developed state in India having a land of white silver, where cotton crop is grown on large scale. In Maharashtra, cotton, sugarcane, onion, grapes are the major cash crops. This land enrich with black

soil and better fertility factor. Its agriculture is largely commercial, cultivated for profit and mechanized to some extent. However, other weaken states are practicing agriculture to maximize the production, food requirements and cater the financial obligations of the farmers.

State of agriculture refers to structure of crop pattern, which also mean the proportion of area under various crops at a point of time or regional allocation of land under the different crops. An ideal crops plan should not only fulfil requirement of the local people or food for the farmers and their families, but also to meet fodder requirement for farm animals along with an assurance of income for sustaining their livelihood. Maharashtra is one of the most industrialized and urbanized states in India. Paradoxically, it also enjoys the dubious distinction of a state having highest rural – urban disparity in standard of living of its population.

The share of agriculture in the Net State Domestic Product of Maharashtra declined steeply in 1992-93. The share for Indian agriculture was 27 percent. Yet in terms of proportion of labour force engaged in agriculture which was 60 percent in 1991, Maharashtra's economy continues to be predominantly agrarian. Indeed the share of states in rural labor force employed in agriculture (main workers only) was as high as 63 percent in 1991.Nearly half of the farmers in Maharashtra are agricultural laborer. Thus the crucial dependence of its rural labour force on agriculture is quite evident and is unlikely to diminish drastically in the near future. It is against this scenario that importance of accelerated growth in Maharashtra's agriculture must be judged.

7.2 Major Findings of the Study

In the present study, statistical and econometric tools have been used for writing thesis. Besides averages, compounded annual growth rate, average annual growth rate, standard deviation, coefficient of variation, log linear model, dummy variable log linear model, mean comparison test and t test have been used for analyzing data and testing the hypotheses in the various chapters. Determinant of cropping pattern are analyzed using linear model. Case study method is also adopted for a study of cropping pattern in the Yavatmal district. Following findings emerged after careful use of the research techniques.

7.2.1 Trends in Cropping Pattern in Maharashtra

1. This study presents levels and growth of aggregate crop output of Maharashtra during 1991-92 to 20012-2013. It brings out several interesting features of the patterns in agricultural developments. For the analysis, 1991-92 to 2012-2013 periods is divided into two sub-periods of 10 years each. In the history of growth of agricultural output, period 1991-92 to 2001-2002 marks as turning point in the Indian economy because of the introduction of new economic programme. However it does not boost the cereal and food gratin production in Maharashtra. On the contrary, the production of food grains fallen by -2.76 CAGR.

2. However, in the latter period (2002-03 to 2012-13) the production cereals and food grains picked up. Cotton crop output accelerated to 11.34%. An interesting feature of the millennium decade (2002-03 to 2012-13) was that agricultural growth permitted to all the regions in Maharashtra. The most

significant development was an acceleration of growth in sugarcane crops due to better and remunerative support prices declared by the government. Total food grains and cereals also recorded a significant acceleration but there was a minor deceleration in production pulses.

3. Cotton crop has made a tremendous stride in growth of production from 3.83% to11.34% while the cereals have shown poor performance. Above table shows several features of agricultural development in Maharashtra after liberalization for the period II. It reveals that cropping pattern went in favour of cash crops namely cotton and sugarcane. It is therefore the Maharashtra is experiencing the inflation of food grains since 2002 onwards.

7.2.2 Determinants of Cropping Pattern in Maharashtra

1. The results appeared from model 1 shows that food grain production in Maharashtra is significantly determined by area under canal irrigation and area under cultivation. But the impact of fertilizer is insignificant in accelerating production of food grain. Model 1 also point out that R2 value is 74% and F test results are acceptable, model is free from autocorrelation problem. In the subsequent models, area under canal irrigation is significant and other determinants are not showing any significant impact in propagating production size of the crop. In the case of crop pulses none of the variable is significant. It is because pulses are grown basically of rainfall.

2. Model 2 result shows that irrigation is an important determinant of cotton crop production. Model 3 reveals that none of the independent factor is significant determinant of pulses crops in Maharashtra. Basically this crop is grown in rain fed area. It is therefore productions of pulses are not picking up despite better supportive prices. Model 4 shows that oilseeds crop production is significantly determined by irrigation facility. The results of Model 5 point out that sugarcane crop production is significantly determined by irrigation facility. This crop requires constant water throughout year. Hence it consumes lot of potential of other crops and it also makes lazy to farmers in Maharashtra. Each models' R2 value is reasonable and f test values are significant at 1 and 5 percent except model-3.

7.2. 3 Cropping Pattern Region Wise: Statistical Analysis

1. Cropping pattern of Konkan region shows that AAGR of cereals production recorded in Ratnagiri and Sindhudurg is 2.51 and 2 percent respectively. However, the coefficient variation of cereal is 8 and 7 percent. It shows that there is not much variation of production in the cereal crops of both districts
2. Nashik region comprises five districts. However, we concentrate on two prominent districts for observing cropping pattern. As it is shown in the table, production of cereals AAGR is almost same in both the districts in the range of 8-9 percent. Coefficient variation rate is 35 to 30 percent which is quite high. It shows that the area under cereal crops and growth rate of cereals are uneven during the period of study. Nashik is leading district over Jalgaon in terms of AAGR of other crops due to irrigation potentials.

3. Cropping pattern in Pune region reveals AAGR of production all the crops in Pune district is less than 1 percent whereas in Solapur district the AAGR of cereals production is less than 1 percent. However, the total pulses production grown by 3.77 percent but oilseeds production is suffered by -3.47 percent. One of the positive parts is that sugarcane production grown by 16.41 AAGR. CV in both the districts found higher under the production of major crops that points the unstable cropping pattern.
4. Cropping pattern in Aurangabad region shows that AAGR of the crops such as sugarcane and cotton is in Aurangabad district is recorded as 17.46 and 31.11 percent respectively whereas in the Jalana district, AAGR is observed as 10.91 and 22.28 percent for the same crops. AAGR of these crops is much higher than other crops in both districts. This tendency shows that farms prefer that cash crops in which they have good margin and better prospectus. The CV for all the crops in both districts are observed much higher, that shows that instability in the cropping patterns.
5. Cropping pattern in Nagpur region shows that the performance of Nagpur district is poor in all the major categories of the crops. In Bhandara district, the AAGR of cereals, pulses, oilseeds and recorded as 17.7, 15.7 and 2.3 percent respectively. AAGR of oilseeds is found as less than 1 percent in the Nagpur district. The CV rate of sugarcane crop in both districts is very high that shows last variations in the crop. The cereals AAGR is good in both the district are 9.47 and 17.7 which is fairly good due to rice crops is grown on large scale in the region.

7.2.4 Mean Comparison Test and Dummy Variable Regression Used for Observing Cropping Pattern in Yavatmal District

1. It can be seen in the Table 6.1 that production of rice has been declined from mean value 40.4 to 12.1 in the period 1991-2010 and that change is significant. However, the production of wheat has increased during the same period as shown by mean value 212.8 to 347.7 is also significant change supported by t test at 8% level of significance. One of the striking changes is that the production of Jowar crop has drastically declined from 2206.3 mean values to 990.4 and its place has been taken over by soybean and sunflower crops in the recent past.
2. The good supportive price has attracted farmers for growing Maize in the period of study. This argument has been supported by the mean values of maize production has increased from 2.6 to 7.6. This change is also supported by t test. The overall production trends in the cereal are a cause of concern for the government in particular and public in general. The mean values of cereal are declined from 2515.6 to 1266.7, which is significant change at 1% level of significance.
3. In the category of pluses the production of Gram has significantly increased but the production of Tur has not increased at all the span of 10 years. The production of Mung and Udid crop are significantly declined during the study period. The aggregate production of Pluses has also declined from mean value 1482.8 to 979.8. This change is also mater of worry of the government and also public. The price level of pluses has been increasing because of shortfall in the production.

4. Major Cash crop comprises sugarcane, cotton, sunflower and soybean. Among these crops production of cotton and soybean has been significantly increased during second period 2001-2010. However, the production of sugarcane has been suffered but not significantly. Another noticeable change is that the production of sunflower crop has declined mean value 20.9 to 0.9. In the cash crops, the production of cotton and soybean were scaled up due to the use of BT Cotton seeds and better support prices declared by the government.
5. It can be concluded from the table 6.1 that the production of cereals and pulses went down significantly. It is matter of concern for the government because shortages escalated the inflation of foods and may work as reason not to complying food security right of many poor people. It may perpetuate the poverty percentage due to food inflation in the Yavatmal district and Maharashtra.

7.2.5 Trends in Production of Major Crops of Yavatmal District: Using Dummy Variable Regression Model

1. The regression result of model 1 shown in the Table 6.2 reveals that the production of cereals fallen during the period 2001-2010 and same results are supported by minus sign of t test. R2 value of regression is 53% but the sign of coefficient and t test are making sense. Hence low R2 has least impotence in the present regression model. Subsequent regression number 2 also shows that negative trend in the (ttpa) pluses production in the second period of study and coefficient value is significant at 9 percent.

2. The results of regression number 3 exhibits that the production of cotton has increased significantly, that are supported by coefficient value at 1 % level of significance. Last regression number 4 also shown positive trend in the production of the soybean in the period 2001-2010 results thereof are significant at 1% level of significance. One may conclude that production of cotton and soybean is increasing since the 1991 due to better prices for the produce and more yield over the other crops. This trend is being supported by dummy variable regression.

7.3 Policy Implications

We employ statistical and econometric techniques such as averages, compounded annual growth rate, average annual growth rate, and standard deviation, coefficient of variation, log linear model, dummy variable log linear model, mean comparison test t test for analyzing data and testing the hypotheses in the various chapters. After using all these tools, the following policy implications are emerged from the findings of the present study.

1. Regression results shows that food grain production in Maharashtra is significantly determined by area under canal irrigation and area under cultivation. Hence in near future more areas are to be brought under irrigation by implementing micro irrigation and small irrigation schemes, even today hardly percentage of gross irrigated area is 18 percent of the total cultivable land, which can be taken to 35 percent. .This aspect should be taken care of in future policy for state development of Maharashtra.
2. Region level analysis shows that production of Pulses, Oilseed and Sugarcane crops are in increasing in entire Maharashtra in the recent years due to

remunerative supportive prices declared by central and state governments and increasing need of cash requirements of the farmers.

3. But this trend is creating threat to food grain crops. Hence, the productivity and area under food grain crops should be increased by working on solution such as micro irrigations, disease free crops and high yielding varieties, low water intake crops, low gestation period crops. For that, the research in plants, crops, pesticides, fertilizer, and extension is essential.
4. In the context of economic liberalization, investment in new technology is must for better scale of production and yield. There is a need to give high priority to investment in research and development and extension services relating to agriculture so that we may give food to everybody in Maharashtra and India at affordable price.
5. Production of Cereals and Pulses has fallen during the period 2001-2010 in Yawatmal district and same results are supported by minus sign of t test. R^2 value of regression hence government must pay attention to this fact otherwise the food security and protein security programme will come in trouble.
6. Production of Cereals and Pulses has fallen, on the other hand cotton and soybean has increased in Yavatmal district during the period 2001-2010. This uneven cropping pattern should be controlled by devising balanced plan of crops. For that, policy measures such as better marketing conditions, minimum support prices, providing new technology at cheaper cost, training and extension service for sustainable farming to the farmers; this efforts may foster the production of various crops in the Yavatmal district.

7. Government should make publicity to motivate people for cultivating food crops and also offer good supportive prices to these crops then only the shifting would be possible from cash crops to non cash crops.
8. An affordable technology with assure supply of manures and natural fertilizers may boost the production of food grain in Maharashtra.

7.4 Limitations of the Study

Present study is focuses on changing trends in cropping pattern in Maharashtra for the periods before reforms and after economic reforms. For that we used an aggregate data of main categories of the crops. However, crop specific study has not been conducted except cotton and sugar cane. District level trends in cropping pattern region, wise two districts have been covered for observing trends in cropping pattern for the period 2000 to 2013. We could not cover all the districts of Maharashtra for this exercise. However, in aggregate level data, all the districts have been covered. Panel data techniques is an appropriate for observing trends in cropping pattern in the Maharashtra but we have not tried panel data techniques due to continuity in the data and data constraints.

7.5 Scope for Further Research

The micro level data of all the districts of Maharashtra has not been considered for this exercise. In future, this gap may be filled up by taking data set of the entire district together for the period 2001-2014. The econometric technique such as Panel data methodology can be used for observing trends in cropping pattern in the Maharashtra. Besides this, more advanced techniques and indices can be tried in future study.

References

1. "Changing Indian Agriculture" by Jain S.C. Vora and Company, Publishers PVT. Limited, Mumbai.
2. "Agriculture Contingency Plan for District: Yavatamal", Maharashtra Govt. Report. 2008- 2009.
3. "Crop production and field experimentation" by Vaidya V. G., Continental Prakashan, Pune.
4. "Introduction to Agricultural economic analysis" by Bishop C.E, Toussaint W. D, John Wiley and sons, Inc. New York.
5. "People and irriculture" by D.G. Kulkarni., Orient Longmans Ltd., New Delhi.
6. Chand Ramesh and S. Chauhan (2002), "Socio economic factors in agricultural diversification in India", Agricultural Situation in India, pp. 523-529.
7. Damodar N Gujrathi, Dawn C Porter, and Sangeetha Gunasekar, "Basic Econometrics", McGraw Hill education, Fifth Edition, 2009.
8. Dastane Santosh, (2002), "Agriculture, Glimpses of Maharashtra", Dastane Ramchandra Company , Pune.
9. Dev, Mahendra S. (1996), "Agricultural Policy Framework for Maharashtra: Issues and Options", Proceeding / Project Report No. 21 Indira Gandhi Institute of Development Research, Mumbai.
10. Dr. N. Karunakaran (2013),"Change in cropping pattern and food security," Social action, Vol.63, January-March 2013.
11. Economic Survey of Maharashtra 2010 - 2011.

12. Fazlur Rahman's (2009), "Diffusion of irrigation and its impact on agriculture: A case study", Indian Journal of Regional Science, Vol. XXXX, No.1
13. Gadgil Sulochana (2006), "The Indian Monsoon, GDP and Agriculture", Economic and Political Weekly Nov 25, PP.4887-4890.
14. Gajja B.L., Sharma V.P. and Joshi P.K. (1994), "Productivity variation and land irrigability class in Kakrapar canal command area in Gujarat state", Indian Journal of Agricultural Economics, 49(4):609-619.
15. Gatade, Pol (2012), "Crop combination in Sangli district (Maharashtra): A Geographical Analysis", Variorum Multi-disciplinary e-Research Journal Vol.3, Issue-I, August 2012.
16. Gill, M. S. (1983), "The development of Punjab agriculture", Asian Survey, 23(7) , pp. 830- 844.
17. Gomati Singh (2012), "factors influencing cropping pattern- with special reference to the size of land holding", International Journal of Scientific and Research Publications, Vol.2, Issue.5, May 2012, ISSN 2250-3153.
18. Government of Maharashtra various years, Statistical-Season and Crop Report, Directorate of Agriculture, Government of Maharashtra, Pune.
19. Gulati A and Kelly T.G.(1999), "Trade Liberalisation and Indian Agriculture Cropping Pattern Changes and efficiency Gains in Semi-Arid Tropics", Oxford University Press New Delhi.
20. Gulati Ashok, Sharma A. (1994), "Culture under GATT: What it holds for India", Economic and Political Weekly, July 16, 1994.
21. Hemant Kumar and Padmini Pani, (2013), "Effects of soil erosion on Agricultural Productivity in Semi-Arid Regions: The case of lower Chambal Valley," Journal of Ruler Development, Vol.32, No.2, April-June 2013)

22. Hanumantha Rao C.H. “Agricultural Growth and Stagnation in India in readings in Agricultural Development”, GOI, Ministry of Finance, Economic Survey, 2007-08.
23. Inder Pal Singh, Grover D. K. (2011), “Organic farming in context of sustainable agriculture and food security”, The Indian Economic Journal, Vol.59(3), October-December 2011.
24. Jadhav, V. T (2011), “Effect of Organic and Inorganic Sources of Nutrients on Yield, Nutrient Uptake, Soil Fertility and Economics of Soyabean-Wheat Cropping System”, Journal of Agricultural Research and Technology, pp, 369-373.
25. Joshi P.K. and Sharma U.P. (1995), “Performance of rice production and factors affecting acreage under rice in coastal regions of India”, Indian Journal of Agricultural Economics, 50(2): 153-160.
26. K. Vasanta, (2013), “Impact of climate change on wheat and rice production: An analysis,” Economic affairs; 52(2): 89-95 June 2013, pp.89-95).
27. K.M. Vivekananda (1994), “Karnataka’s Changing Cropping Pattern”, Agricultural Situation in India, pp. 441-444.
28. Krishnakumari A. and Swaminathan E. (1992), “changing farming scene in Nellore district, India”, Indian Geographical Journal,65(2) 123-129.
29. Mahadevan R; Chandrashekharan M. and S. Gurunathan (2006), “Study on temporal changes in irrigated area and cropping pattern premature district of Tamil Nadu state” Agricultural situation in India, October 2006, 2684 AGRI/07-6B, pp.439-444

30. Marothia, Singh and Koshta,(2007), "Crop diversification: Post reform lessons from Chhatisgarh", Agricultural Situation in India, September, 2007, pp.215-226
31. Mohindra Bhattacharya (2011), "Economic Analysis of Yield Gaps in Principal Crops in India", Agricultural Situation in India
32. Parthasarthi, G. (1984), "Growth rates and fluctuations of agricultural production – a district-wise analysis in Andhra Pradesh" , Economic and Political Weekly, 19(26), A74-A84.
33. Pawar, B. B. (1983), "Some dimensions of agricultural development in India", State Bank of India Monthly Review, 22 (8), pp.333-341.
34. Phuke K.D., Satpute T.G. and Gawate A.S. (1994), "A study of investment pattern on Marathwada farms", Maharashtra Journal of Agricultural Economics, 6(1):1-3.
35. Das R, Barman R.N. (2010), "Development of ideal agriculture production plan for the foothill agro ecological situation of Sonitpur district of Assam- A farming system approach", Indian Journal of Economics, Vol. 65, No.3, July-September 2010.
36. R. Vijay, (2009),"Accounting for breaks in Agriculture: A study of Andhra Pradesh and Orissa" Artha Vijnana, Vol. LI, No.4, December 2009, pp. 360-376
37. Raj, K.N. (1983), "Agricultural growth in China and India: Role of price and non-price factors", Economic and Political Weekly, 18(3), pp.69-75.
38. Rao Dayakar and Shahid Perves (2005), "Dynamics of Cropping Pattern in Sourgham Growing State of India", Indian Journal of Agricultural, 60(4) pp. 644 – 655.

39. Rathod, H.B. and Naik V.T. (2009), "Agricultural land use Cropping Pattern in Yavatmal District", Journal of Shod Samiksha Aur Mulyankan Volume II, Issue-6, and PP 780-782.
40. R.Vijay and Itishree Pattnaik (2009), "Accounting for breaks in Agriculture: A study of Andhra Pradesh and Orissa", Artha Vijnana, Volume LI, No. 4, pp 360-376.
41. Ray, S. K. (1983), "An empirical investigation of the nature and causes for growth and instability in Indian agriculture: 1950-80", Indian Journal of Agricultural Economics, 38 - 40, pp. 459-474.
42. Ray S.K. (2009), "Availability of Institutional Credit change in cropping pattern and agricultural growth in West Bengal- A district level analysis", Indian Journal of Regional Science Vol. XXXX, No.1
43. Singh B, Grewal S.S. (1996), "Economic profile of rice production in India", Agriculture Situation in India, 42(3): 11-15.
44. Surinder Sood (2012), "Rich Crops, poor farmers", an article in Business Standard
45. Tupe Sanjay and Manoj Kamat (2010),"An Empirical Study of Trends and Determinants of Indian Agricultural Production of Pre and Post Reforms period", Productivity-A Quarterly Journal of the National Productivity Council.Vol.50, January-March 2010,No.4.
46. Joshi Vaishali J, Sanjay Tupe Sanjay (2014), "An Empirical Analysis of Changes in Agricultural Crop- Pattern in Maharashtra State during the Post-reform period (1991 to 2013)", Journal of Commerce and Management Thought, pp.618-624.

47. Reddy Visweswara, Reddy Satyanarayana (2010), " An Economic Analysis of supply response of cotton crop in Kurnool district (AP)" Asian Economic Review, April 2010, Volume 52, No.1, pp.129-138.
48. Vivekananda M. And Satyapriya V.S. (1994), "Karnataka's changing cropping pattern", Agricultural Situation in India, 49(6):441-444.
49. Vyas V.S.(1996), "Diversification in agricultural research", Indian Journal of Agricultural Economics, 51(40); 639-640.
50. Sarkar Urmila A. (2009), Thesis, "Agriculture Research Education And Extension for Rural Development A Case Study of Krishi Vigyan Kendra (KVK) Kosbad, District Thane." Tilak Maharashtra Vidyapeeth, Pune

Reports and in-hand information collected

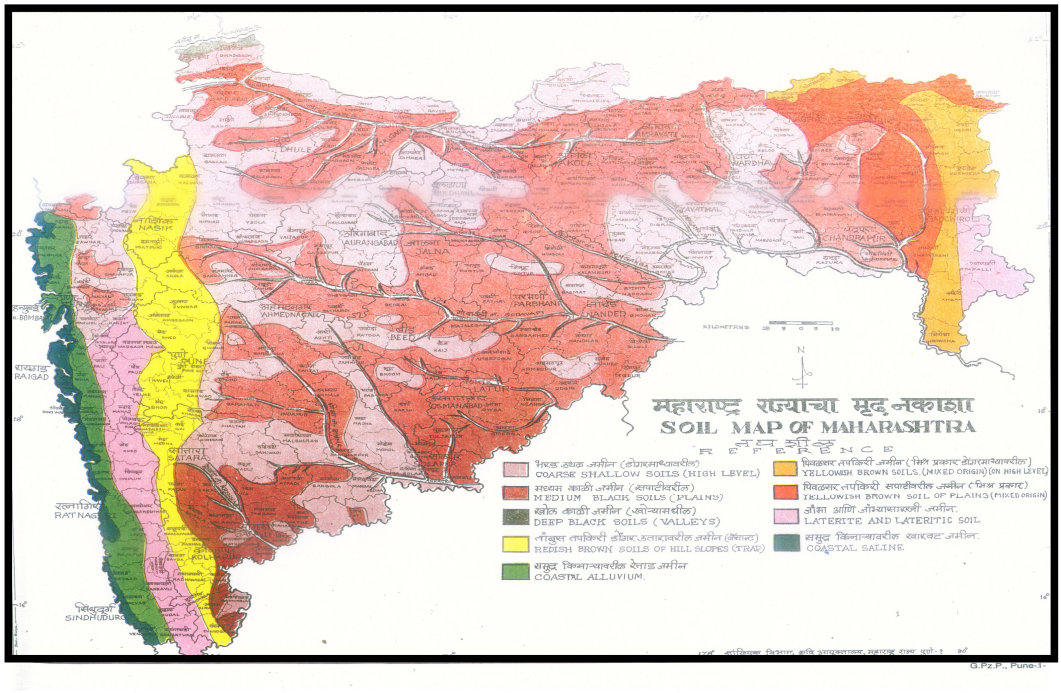
Various years, District-wise Agricultural Statistical information of Yavatmal, Directorate of Agriculture, Pune, Maharashtra.

Websites referred

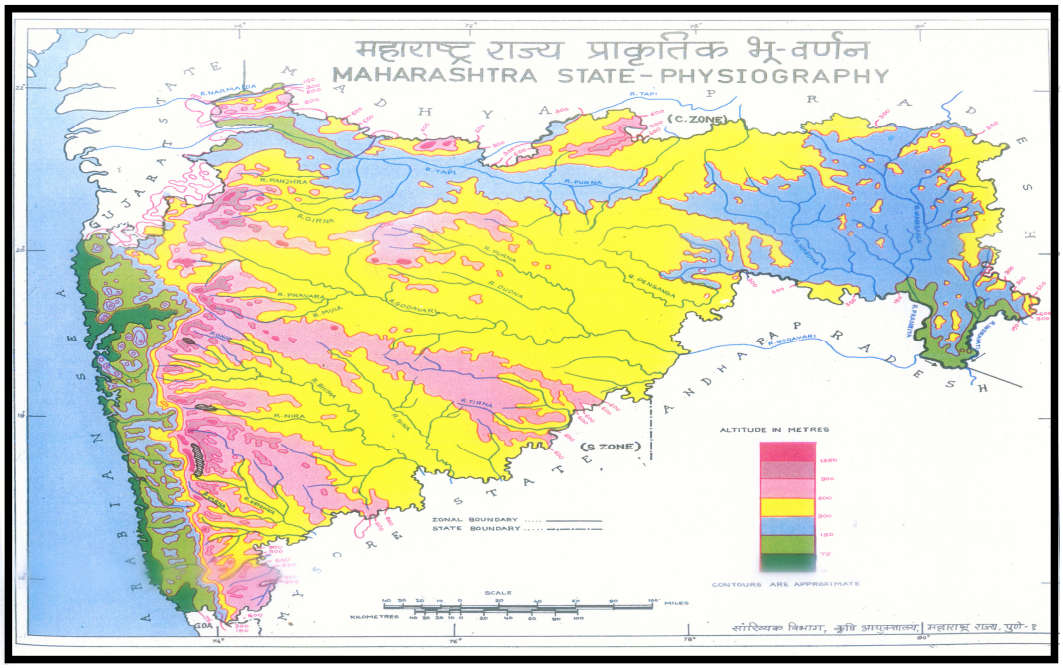
www. mapsinindia.com

www.theuniqueacademy.com

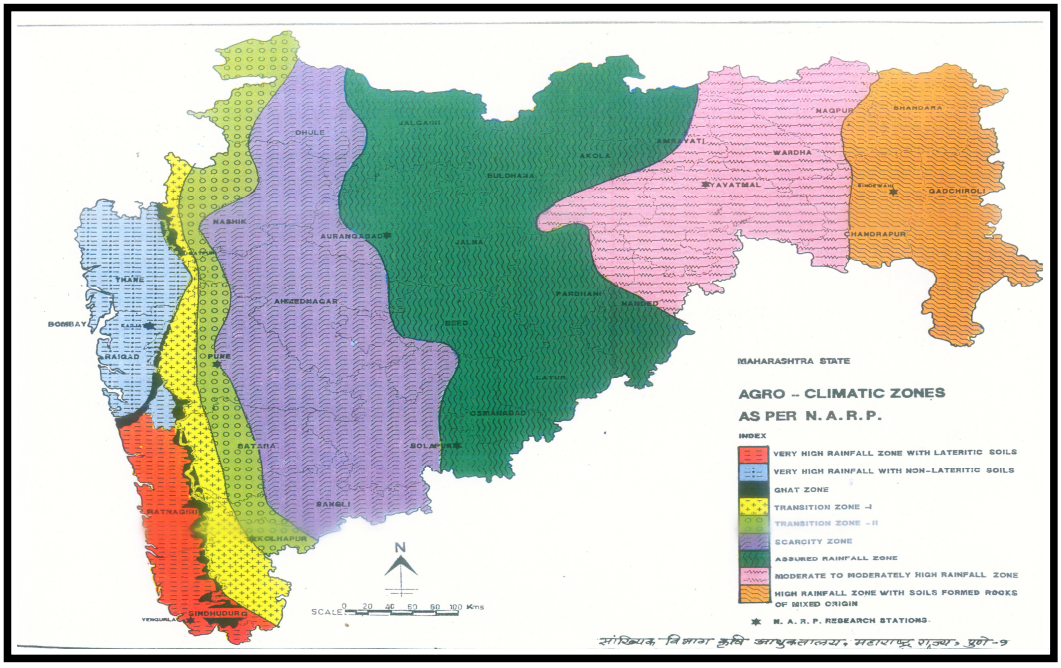
Soil Map of Maharashtra



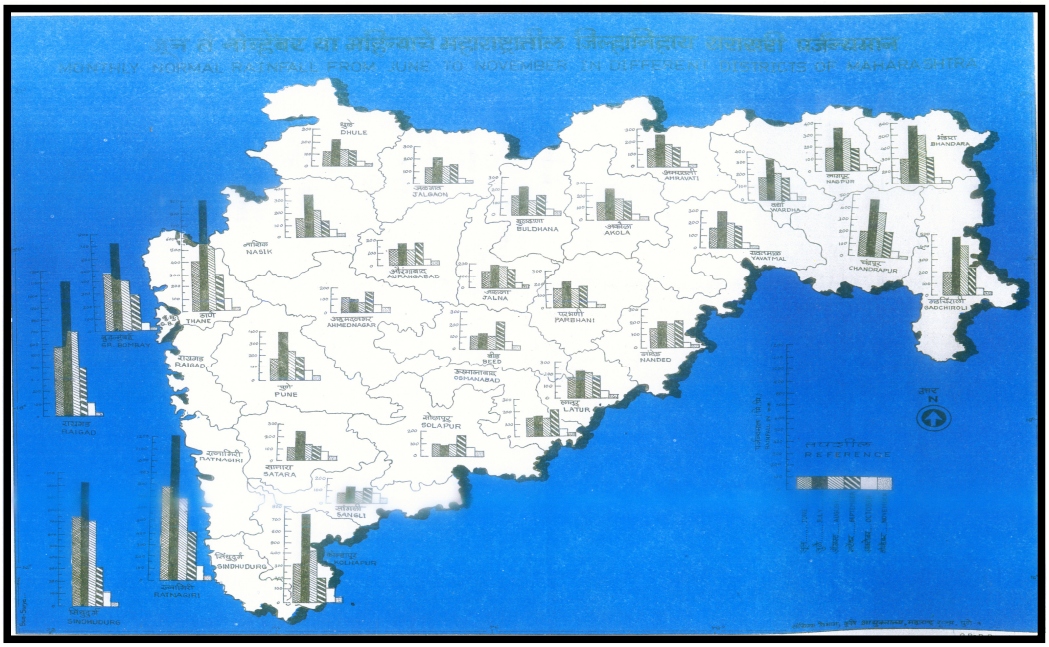
Maharashtra State Physiographic Map



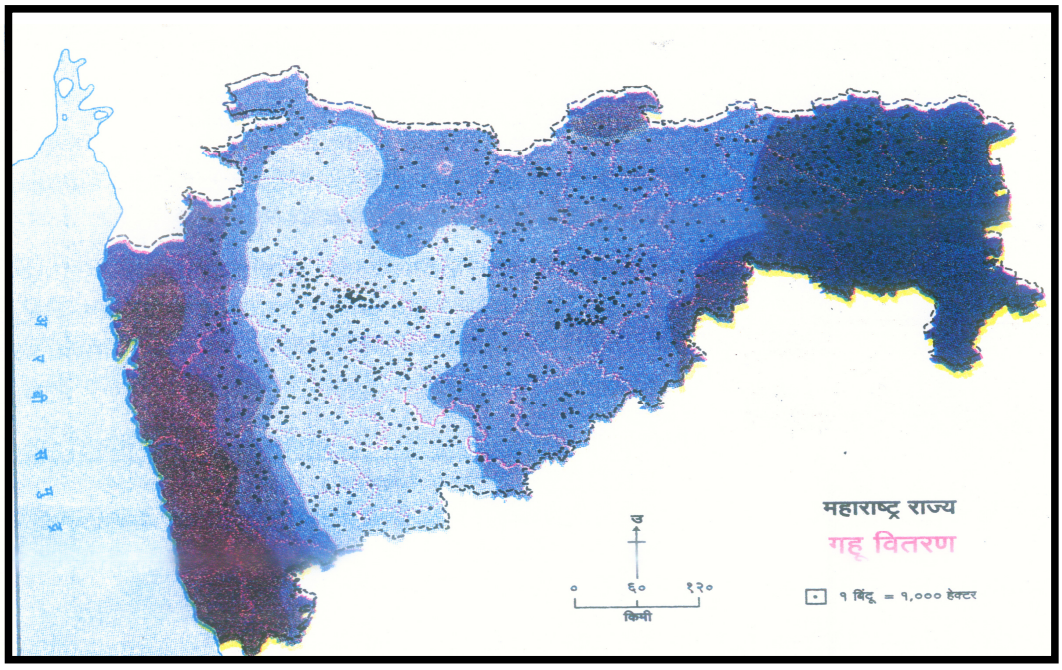
Agro-Climatic zones of Maharashtra as per N.A.R.P.



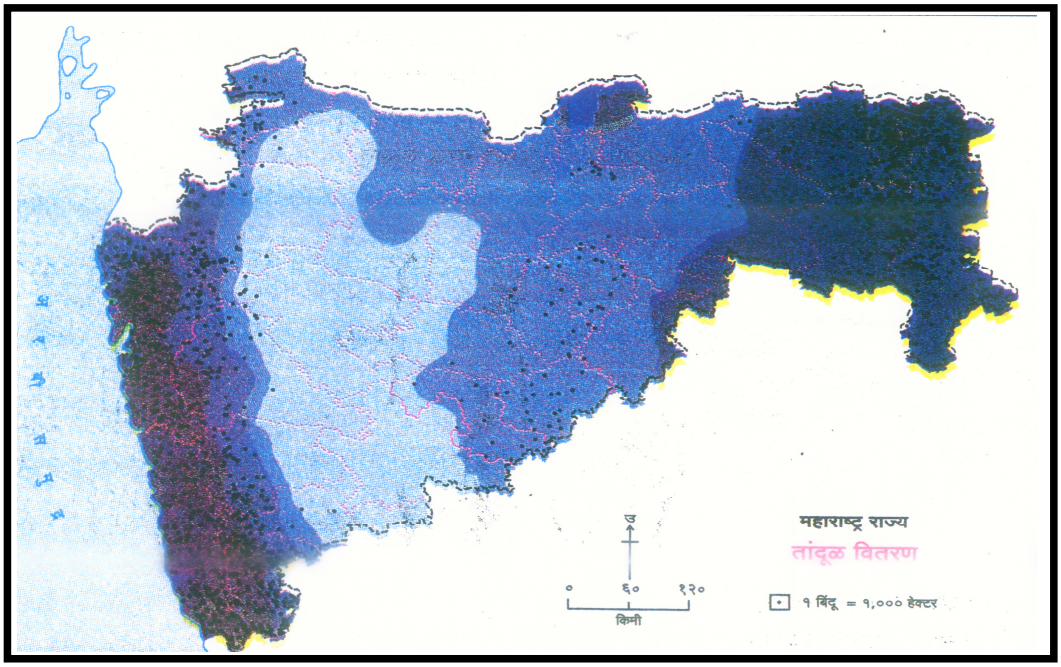
Monthly normal rainfall from June to November in different District of Maharashtra



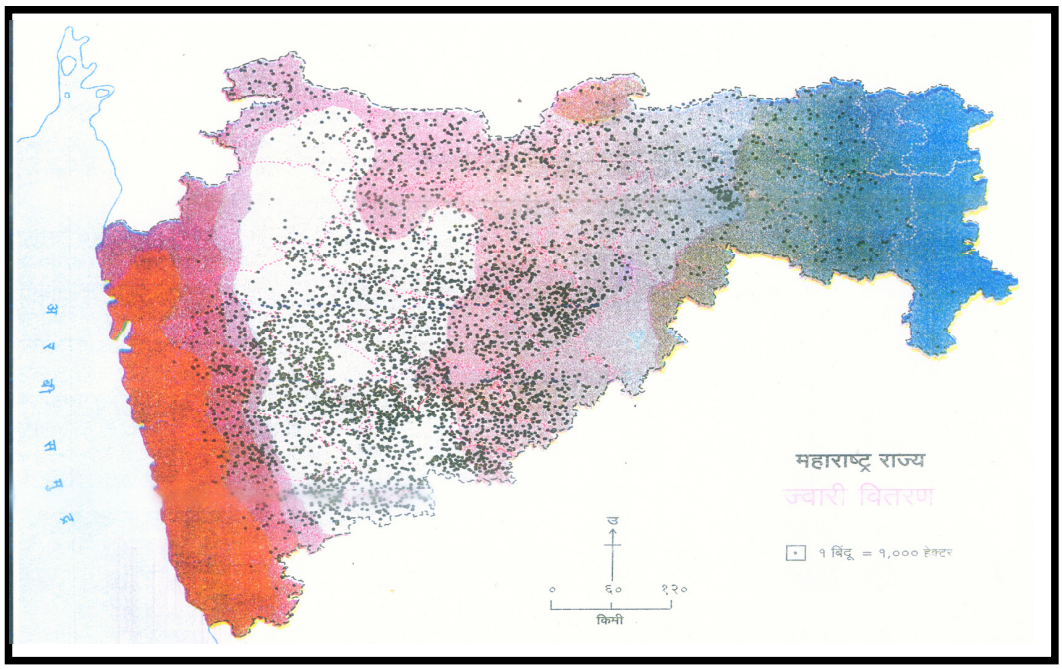
Distribution of production of Wheat in Maharashtra



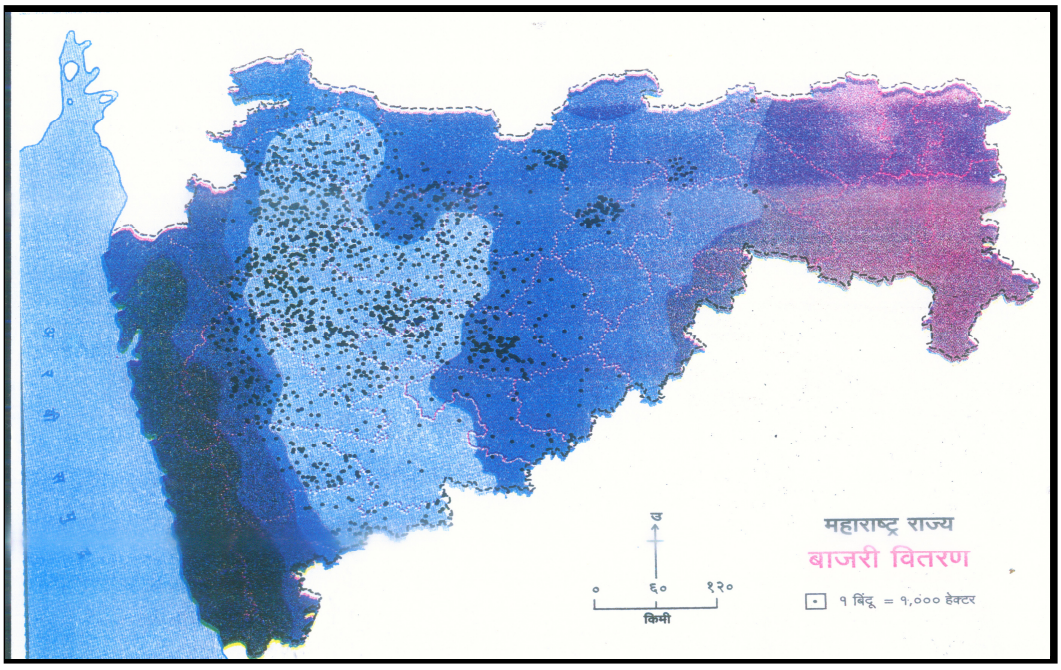
Distribution of production of Rice in Maharashtra



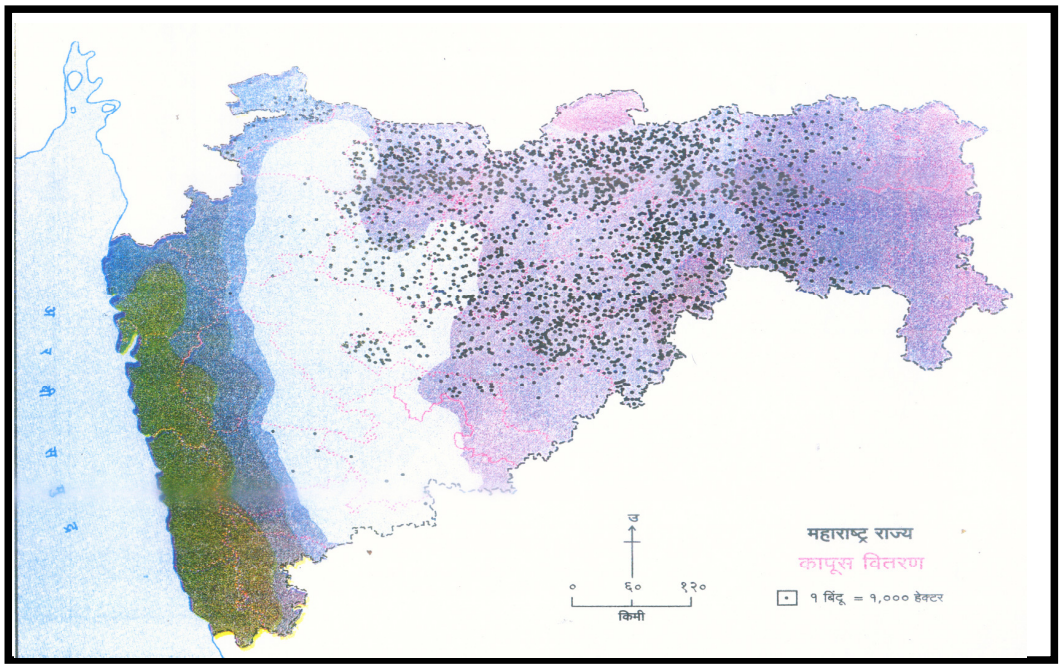
Distribution of production of Jowar in Maharashtra



Distribution of production of Bajara in Maharashtra



Distribution of production of Cotton in Maharashtra



Distribution of production of Sugarcane Maharashtra