Dynamics of Maize Production in different Agro Climatic Regions of Madhya Pradesh

THESIS

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Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

In partial fulfilment of the requirements for the degree of

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In

AGRICULTURE

(AGRICULTURAL ECONOMICS AND FARM MANAGEMENT)

By

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CERTIFICATE – I

This is to certify that the thesis entitled **"Dynamics of maize production in different agro climatic regions of Madhya Pradesh"** submitted in partial fulfilment of the requirement for the degree of **MASTER OF SCIENCE IN AGRICULTURE (Agricultural Economics and Farm Management)** of Jawaharlal Nehru Krishi Vishwa Vidyalya, Jabalpur, is a record of the bonafide research work carried out by Mr. **BAKHT AMIR ZADRAN** I.D. No. 170109002 under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instruction.

All the assistance and help received during the course of investigation has been acknowledged by him.

Place: Jabalpur

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This is to certify that the thesis entitled **"Dynamics of maize production in different agro climatic regions of Madhya Pradesh"** submitted by **BAKHT AMIR ZADRAN** to Jawaharlal Nehru Krishi Vishwa Vidyalya, Jabalpur, in partial fulfilment of the requirements for the degree of **MASTER OF SCIENCE IN AGRICULTURE** in the **Department of Agricultural Economics and Farm Management,** has been, after evaluation, approved by the External Examiner and by the student's Advisory Committee after an oral examination on the same.

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I, Bakht Amir Zadran, S/o Abdul Basir, Certify that the work embodied in thesis entitled **"Dynamics of maize production in different agro climatic regions of Madhya Pradesh"** is my own first hand bonafide work carried out by me under the guidance of Dr. H.O. Sharma at Department of Agricultural Economics and Farm Management, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalya, Jabalpur during 2019.

The matter embodied in the thesis has not been submitted for the award of any other degree/diploma. Due credit has been made to all the assistance and help.

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INTRODUCTION

Maize (*Zea mays*) originated in Mexico and Central America and belongs to the tribe Maydae of the family Poaceae. It was first domesticated by indigenous peoples in southern Mexico about 10,000 years ago. Maize known as queen of cereals, also called corn is one of the most important cereal crops of the world. It provides staple food to population. Maize is cultivated widely throughout the world and has the highest production among all the cereals. It is an important food staple in many countries and is also used in animal feed and many industrial applications. In addition to staple food for human being and quality feed for animals maize services as basic raw material as an ingredient to thousands of industrial products that include starch, oil, protein, Beverages, food, sweet, cosmetic, film, textile, paper industries *etc.* The area under maize in the world was cultivated 187.97 million hectares with the total production of 1060.10 million tonnes, with the average yield of 5.64 tonnes per hectare in 2016 (FAOSTAT). Maize is grown throughout the world; the top 10 producing countries are given in (Table 1.1). USA is the world's largest producers and consumer of corn. The weather conditions in USA are most favorable for corn.

Table 1.1: Top maize producing countries in the world (2016)

Country	Area (million ha)	Area Share (%)	Production (million t)	Production Share (%)	Productivity (kg/ha)
USA	35.11	19	384.78	36	10960.40
China	38.98	21	231.84	22	5947.70
Brazil	14.96	8	64.14	6	4288.00
Argentina	5.35	3	39.79	4	7442.70
Mexico	7.60	4	28.25	3	3718.10
Ukraine	4.25	2	28.07	3	6602.40
India	10.20	5	26.26	2	2574.50
Indonesia	3.79	2	20.37	2	5370.50
Russia	2.78	1	15.31	1	5513.00
Canada	1.32	1	12.35	1	9371.90
Others	63.63	34	208.94	20	5909.46
Total	187.97	100	1060.10	100	5640.00

Source: FAOSTAT

In India, maize is the third important cereal crop after rice and wheat in terms of area. Among the various food crops, the maize is used for different purposes as valued added products in India. There are several types of maize value added products the most important products are, Corn starch, Corn oil, Sorbitol, Corn Flakes, Corn syrup, High fructose corn syrup, Maize cob meals *etc.* Maize has three growing seasons in India, namely Kharif, Rabi and spring. India's maize production depends on the southwest monsoon as more than three-fourth of the maize is produced in the Kharif season and only one-fourth in Rabi and summer seasons. The area under maize in India was cultivated 8.71 million hectares with the total production of 21.81 million tonnes, with the average yield of 3215.20 kg/ha in 2015-16 (Agricultural Statistics at a glance 2016). India has exported 697.94 thousand tonnes of maize to other countries and earned 178.02 million US$, and also imported 181.76 thousand tonnes of maize from other countries with the total cost of 43.87 million US$ in 2015-16 (APEDA). The major producing states of maize in India are given in table 1.2, which contributed of total production of maize in the country basket.

Table 1.2: Top maize producing states in India (2015-16)

State	Area (Million ha)	Production (Million t)	Productivity (kg/ha)
Karnataka	1.18	3.27	2773.00
Madhya Pradesh	1.10	2.58	2350.00
Maharashtra	1.01	1.51	1500.00
Rajasthan	0.88	1.21	1374.00
Bihar	0.70	2.40	3416.00
Uttar Pradesh	0.68	1.26	1848.00
Tamil Nadu	0.36	2.38	6549.00
Andhra Pradesh	0.23	1.41	6069.00
West Bengal	0.16	0.72	4615.00
West Bengal	0.16	0.72	4615.00
Others	1.84	3.33	1843.18
All India	8.71	21.81	3215.20

Source: Agricultural Statistics at a glance: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

Madhya Pradesh is the 2nd largest state of maize contributing 13% and 12% of area and production respectively of the country (Fig. 1.1 and 1.2).

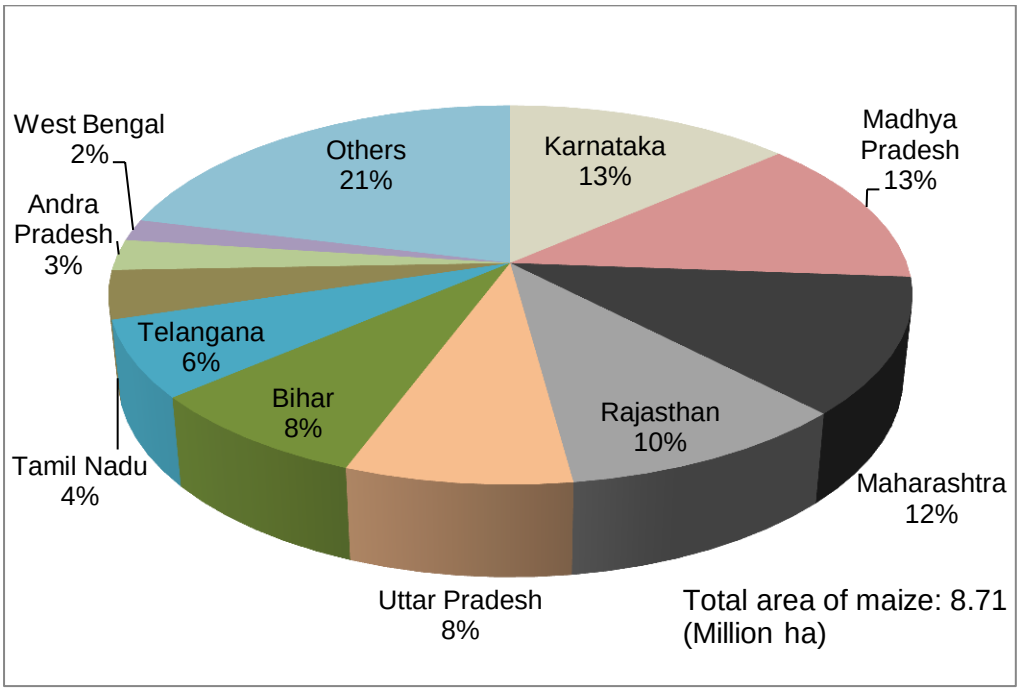

Fig. 1.1: Percentage share of maize area in different States of India (2015 – 16)

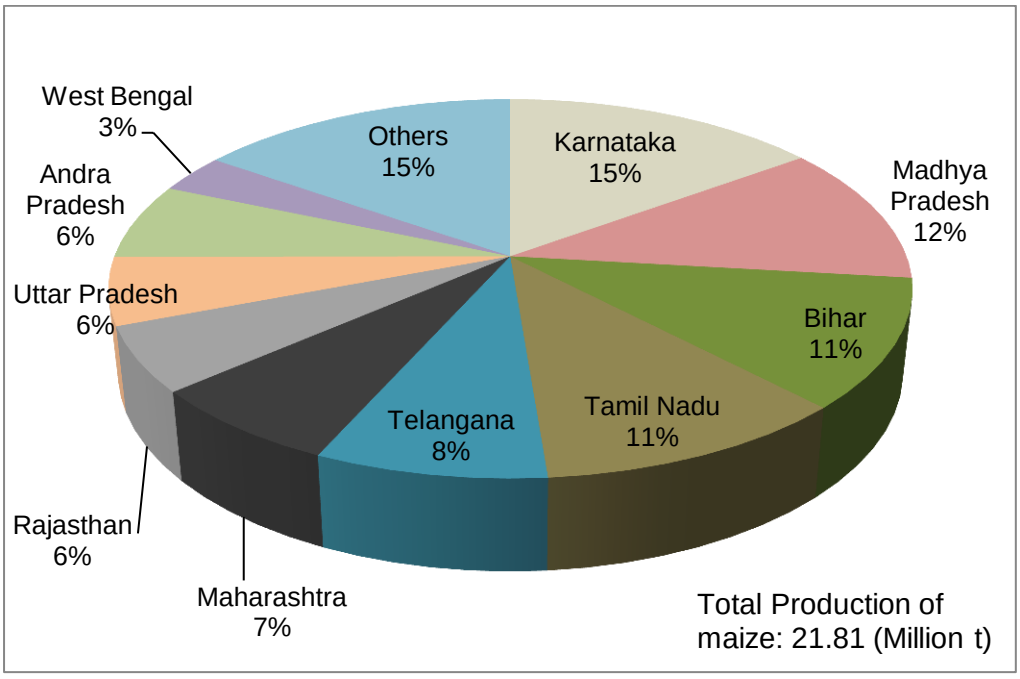

Fig. 1.2: Percentage share of maize production in different States of India (2015 – 16)

The state of Madhya Pradesh is blessed with varied agro climatic conditions which permit the farmers' of the state to cultivate a number of crops like cereals, pulses, oilseeds, commercial crops and horticulture crops across different seasons of the year. In Madhya Pradesh maize is found to be cultivating in all the agro climatic regions of the state in Kharif season. The area under maize in Madhya Pradesh was cultivated in 1.10 million hectares with the total production of 2.58 million tonnes, with the average yield of 2350 kg/ha in 2015-16 (Agricultural Statistics at a glance 2016). Average yield of the crop is still lower in Madhya Pradesh (2350 kg/ha) as compared to Tamil Nadu (6549 kg/ha), Andhra Pradesh (6069 kg/ha), West Bengal (4615 kg/ha), Punjab (3687 kg/ha), Bihar (3416 kg/ha), Telangana (3030 kg/ha) and Karnataka (2773 kg/ha) in 2015-16.

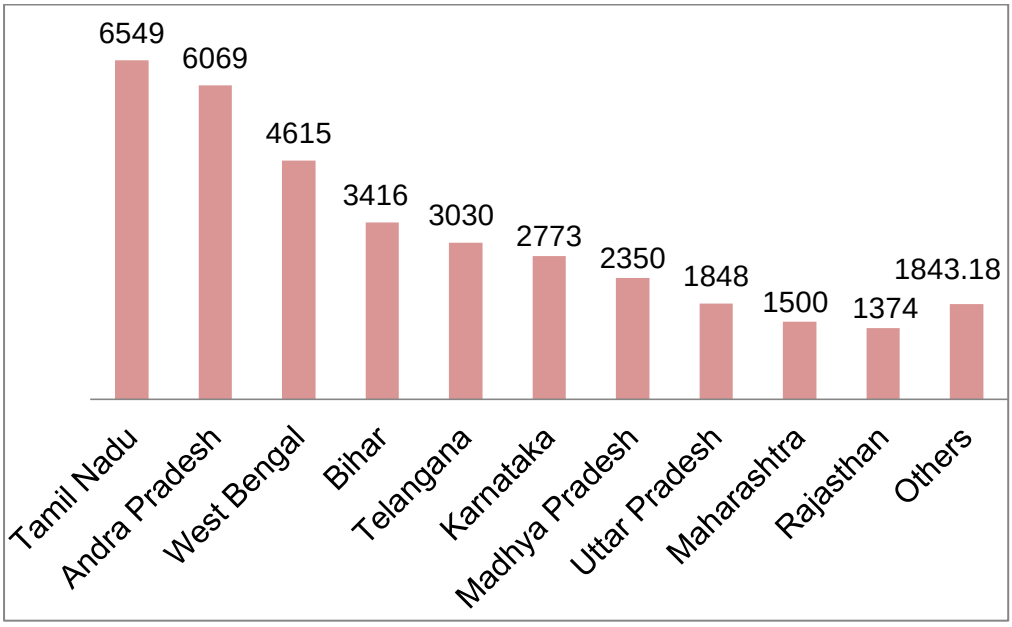

Fig. 1.3: Average yield of maize in different States of India

What is pace of trend and growth in area, production and productivity and factors, thereof in different agro climatic regions of Madhya Pradesh is the subject matter of the study. The present investigation is carried out for different maize growing regions of the state with the following objectives:

1. To analyze absolute change, relative change and fluctuation in area, production and productivity of maize.

2. To analyze trend and growth in area, production and productivity of maize.
3. To evaluate area, yield and interaction effects of maize production.
4. To suggest policy implications to increase maize production in different agro climatic regions of Madhya Pradesh.

REVIEW OF LITERATURE

A comprehensive review of literature is an essential part of any scientific investigation. In a scientific pursuit, a comprehensive review of literature is an essential pre-requisite. The main objective of it is to determine the status of previous researches done in the field of investigation and ascertained the problem area to provide basis for theoretical framework. In this chapter, an attempt is made to assimilate the previous works within the framework of the present study which are helpful in interpretation of results obtained during the analysis of dynamics of maize production in different agro climatic regions of the State.

a): Variation, trend and growth

b): Decomposition analysis

2.1 Variation, trend and growth

Prasher and Bahl (1998) measured the variation in crop production of the different districts *viz.,* Kangra, Mandi, Shimla and Chamba representing various agro-climatic zones of Himachal Pradesh. Time series data from 1980-81 to 1989-90 were employed and the data pertaining to area, production and yield of major crops were obtained from crop reports. The compound growth rates of area, production and yield of major crops for the period under study were evaluated. It was noted that the area under maize had increased significantly in the state; however, the productivity level was not significantly increased in the state. Barley and pulses showed a negative growth rate in area, which implies that farmers are shifting acreage towards high value cash crops like fruits and off-season vegetables.

Singh and Ranjan (1998) performed an analysis on growth performance of principal food grain crops in North Bihar, India, over the period 1970/71-1994/95 and revealed that production recorded positive growth rates during the post – green revolution period. Wheat was the only crop which recorded positive growth rates

in area, production and yield across the zone over different sub-periods. Moreover, a declining trend in rice area has been observed during the early 1990s. The study indicated that wheat, maize and pigeon peas witnessed a continuous decline in instability over the period under study. The decline has been due mainly to non-adoption of improved technology in crop production.

Badal and Singh (2001) conducted study on technological change in maize production. Technological change was attributing for 30 per cent of total yield increase in HYVs technology in *kharif* maize production. This shows that if local variety maize growers just shift from local varieties of maize to cultivation of HYVs of maize, they cultivated in *kharif* and simultaneously use inputs levels being used on HYVs farms they could earn an additional of 39 per cent of their existing Income from maize. Similarly the component of technological change in *rabi* maize production was 45 per cent and the rest 35 per cent was attributed to higher input use level on HYVs farms of maize.

Singh and Chandra (2001) observed the growth in food grain production and productivity trend in the state of Madhya Pradesh has increased, while area has shown decreasing trends. But rates of growth and production were low during the pre-green revolution period (3.12 per cent) compared to green revolution period (4.27 per cent). The difference in growth rate for production between pre- and post-green revolution periods did not differ significantly. In case of area, growth rate has declined during the post green revolution period of which decline was significant compared to pre- green revolution period. The rate of growth in productivity has shown increasing trend. The study shows significant impact of green revolution in the State in increasing the food grain production.

Singh *et al.* (2003) worked out the growth rate and stability of different crops *viz.,* rice, wheat, sorghum, maize and bajra. The data on the area and production were obtained from the year 1974-75 to 1997-98. The data can be classified into two broad components, including fluctuations due to year to year changes in

weather parameters. The highest stability index was observed for wheat followed by rice. Variation due to climate parameter was highest in Bajra and lowest in wheat. The growth rate of productivity index was positive for all crops except Sorghum and was highest in wheat.

Hasan *et al.* (2008) measured the change and instability in area, production, and yield of two major cereal crops wheat and maize in Bangladesh based on secondary data during 1980/81-2003/04 using different statistical techniques. They found that area and production of wheat increased satisfactorily. But yield was not increased to meet the demand of the country. In the case of maize, significant increment happened in yield during the study period. Area and production of maize also increased to fulfill the increasing demand of population. Presently production of maize increased more rapidly than its area. They also found that the growth rate in area, production, and yield of maize improved rapidly. Maize showed very instability in its area and production because of its increasing tendency in the recent years.

Dhakre and Sharma (2010) studied growth of area, production and productivity of maize in Nagaland and found the maximum decrease in area under maize crop was (-) 16.02 % found in the year 1999-2000 and maximum increase in area under maize crop was 30.23 % in the year 2000-01, whereas maximum increase in production and productivity of maize crop in Nagaland was 103.05 % in the year 1988-89 and 101.26 % in the 1988-89 respectively. Among area, production and productivity of maize the instability was highest for the production. Growth rates were significant at 1% level of significance.

Shankar *et al.* (2010) revealed that almost all the crops registered significant positive growth rate of area in Chhattisgarh plain except sorghum and kodo. The highest expansion was observed under pigeon pea (1.92%). The highest declining trend for kodo (-5.74%) and lowest declining trend for sorghum (-2.57%). Growth rate of area was positive for rice, groundnut, maize, pigeon pea and sesame, whereas it

was negative for sorghum and kodo. The growth rate of production was found to be positive for all selected *kharif* crops except sorghum and kodo that showed negative trend (-2.71%) and (4.43%) respectively in production mainly due to declining trend under area and partially due to adoption of HYV, seed *etc.* The highest production growth rate was observed for groundnut (4.12%) followed by pigeon pea (2.68%), rice (2.43%), maize (2.11%) and sesame (2.01%). The growth rate of productivity was statistically positively significant. The highest positive growth rate was found in maize (3.61%) and the lowest (0.67%) for sorghum. Maize exhibited high yield performance which was mainly due its area and production.

Kachroo *et al.* (2013) studied the growth and instability of maize in Jammu and Kashmir. It was observed that there was positive and significant growth trend in production (3.64 per cent) as well as yield (3.53 per cent) of maize in period-I in India. A drastic decline in yield (- 0.42 per cent) was observed in period-II even in spite of significant growth during period-I (3.19 per cent) and overall period (0.25 per cent). In Jammu region, the growth in area (0.80 per cent) and production (0.35 per cent) are positive and significant in spite of negative growth (-0.58 per cent) in yield. The area, production and yield instability in maize is very prominent in Jammu and Kashmir during the periods-I and II. The overall instability in area, production and yield are 5.04 per cent, 10.14 per cent and 10.20 per cent, respectively.

Sharma (2013) studied the compound growth rate, trends, coefficient of variation (CV) and instability index in area, production and productivity of food grains in India. The data was collected for the periods from 1950-51 to 2012- 13. The result shows that the growth in area, production and productivity for different food grain crops in India are positive and statistically significant. The coefficients of variation for almost all crops are less than 0.322 per cent which indicates that less risk is involved in cultivation of food grain

crops during the period under review. The lower value of instability indices also strengthens this fact.

Abid *et al.* (2014) analyzed growth and trend in area, production and yield of major crops of Khyber Pakhtunkhwa. A time series data from 1980-81 to 2011-12 (32 years) of major crops (wheat, maize, rice and sugarcane) were collected. The results show that area, production and yield of maize was increased over the time the reason is that more area was brought under hybrid and improved open pollinated maize varieties. The area under wheat and rice crops has decreased whereas their production increased due the corresponding increase in per hectare yield of wheat and rice crops. The area, production and yield of sugarcane crop were increasing at a rate of 0.24 per cent, 0.85 per cent and 0.60 per cent per annum, respectively.

Kumar *et al.* (2014) examined the growth and instability in maize production in the major districts of major maize growing States in the country. An attempt has also been made to forecast its production in near and mid-term under different scenarios. The results showed that more than 60 per cent of maize area is observed to be having maize yield less than 2 t/ha. At the same time, huge variability in maize yield between and within the maize growing States was also found. However, the maize yield is estimated to increase little more than3 t/ha by the year 2020, if the current policy and macro-economic environment continues.

Ammani (2015) analyzed the growth rates in output, hectare and productivity of the maize in Nigeria. Time series data on aggregate maize output and maize hectare in Nigeria for the period 1990-2011 were utilized. Findings of the study indicate (i) accelerated growth in maize production (IGR 1.3%; CGR 1.3%) and productivity (IGR 2.6%; CGR 2.6%); and (ii) significant growth deceleration in maize hectare (IGR -1.4%; CGR -201%) over the period 1990-2011.

Savitha and Kunnal, (2015) studied growth performance of cereals in Karnataka. The study examined the trend and growth

rates of major cereals *viz.,* maize, paddy, sorghum and wheat in Karnataka by using the compound growth rate function. The necessary secondary data were collected for a period of 15 years from 1998-99 to 2012-13. The growth in area, production and productivity of maize crop during the study, shows that the average area under maize in the state as a whole was 9.17 lakh hectares and average production was 25.49 lakh tonnes with an average productivity of 2.89 tonnes/ha. It could be observed that growth rate of maize area in Davangere (3.89 %), Haveri (6.49 %), Belagavi (3.37 %) and Chitradurga (8.14 %) was positive and significant. The state as a whole registered a significant increase in maize area (7.60 % per annum) during the study period. Maize yield has been increasing at the rate of 0.23 per cent per annum. But in the major maize growing districts like Chitradurga (-2.59%) and Bellary (-3.38 %), the growth in yield exhibited declining trend. However, Chitradurga district showed highest and significant annual growth rate (8.72 %) in production followed by Haveri (6.80 %) and Belagav district (6.60 %). In the state as a whole maize production showed a significant positive growth rate of 7.86 per cent per annum.

Selvi *et al.* (2015) studied on growth trends for area, production and productivity of maize in India. The secondary data between 1970-71 and 2013-14 were collected. Findings revealed that the percentage of growth was higher in terms of production (223.14 %) followed by productivity (91.41 %) and area (60.63 %). At the same time, linear growth rate was found to be high in terms of production as well as in area than productivity. The study reveals that the increase in production of maize over the years has been mainly due to the parallel expansion in area and not much contributed through productivity enhancement wherein the country is lagging far behind the global average productivity.

Ayalew and Sekar (2016) studied trends, instability and regional variations of maize production in major producing states of India. Compounded annual growth rate, Cuddy Della Valley Index and decomposition analysis were used to examine the data ranging from

1980 to 1981 and 2011 to 2012. The study revealed that area under maize in India has increased from 5.89 to 9.19 Million hectares and production has increased from 6.49 to 21 Mt between the period TE 1981 to 1982 and TE 2011 to 2012. For all India, area has expanded at 1.88% per annum between 1982 to 1983 and 2011 to 2012, while yield increased at a rate of 2.28% per annum during the same period.

Morojele and Sekoli (2016) studied growth performance of cereals in Karnataka. The study examined the trend of maize production, area planted and yield and to determine distribution of maize by production and area among ecological zones. Time series data from 1961 to 2013 on maize production, area and yield were collected from FAOSTAT (2015). Data on ecological zones were obtained from Bureau of Statistics in Lesotho (2014). Genstat software was employed for trend analysis using time series function and ANOVA was used to establish differences in maize production among ecological zones of Lesotho. The results revealed that trend line for maize production had declined from 107,000 in 1961 to 94,000 tonnes in 2013. Production and area curves appeared cyclical. Trend line for area planted maize for 54 years was constant from 1961 to 2013. Yield trend line was constant at 860 kg/ha -1. Maize production in the lowland was the highest, followed by Foothills, Mountain and Orange River zone.

Abu and Adakole (2017) examined growth rate and instability in area, output and yield of selected cereals crops and its implications for food security in Benue State, Nigeria from 1986 to 2012. In addition, sources of growth in output were also examined. For achieving this, exponential trend equation, Cuddy-Della Valle index (CDVI) and decomposition analysis were employed. The estimated compound growth rates for area of maize was 4.3%, compound growth rate of output was 4.7%, for maize and was significant. While compound growth rates for yield on the other hand showed growth rate of 1.8%, for maize in that order.

Ganjeer *et al.* (2018) conducted a study on the trends, compound growth rate, CV, instability index and prediction model of area, production and productivity of maize in Northern Hills of Chhattisgarh in India. Time series data for maize were collected for the period from 1979-80 to 2012-13. The whole period was divided into three sub periods (Period-I, 1979-80 to 1986-87; Period-II, 1987-88 to 1997-98 and Period-III, 1998-99 to 2013-13). The result of the study revealed that the growth in area, production and productivity for maize in Northern Hills was positive and statistically significant. The coefficients of variation for maize crop was less than 24.81 per cent which indicates that less risk is involved in cultivation of maize crop during the period under review. The lower value of instability indices also strengthens this fact. The production and productivity of the maize crop have increased during the period under review due to the combine effects of area and productivity.

Ranjeet *et al.* (2018) studied the growth rate in area, yield and production of different *Kharif* crops (Oilseed: soybean, cereals: maize, sorghum and pulse crop: pigeon pea) and *Rabi* cops (cereal crop: wheat and pulse crop: chick pea) in Malwa Agro climatic zone of Madhya Pradesh. They collected necessary secondary data for the period of 15 years from 1999-2000 to 2013-14, and observed that the average maize area occupied in the state was 856.24 thousand ha. The state registered low level of fluctuation (CV 3.1%) and slight increase in annual compound growth rate in maize area over the years during study period. 400 thousand hectares area of maize was under recorded Malwa plateau ACZ which is 46.73 % of the state area under maize. 12 per cent fluctuation and negative annual compound growth rate (-2.16 %) for the maize area was observed. The mean maize grain yield in the state noted as 1611.4 kg/ha with coefficient of variation 26.7 per cent and compound growth rate as 0.28 per cent, whereas the respective values estimated were 1432.8 kg/ha, 21.6 % and -1.20 % /annum respectively. The production of maize registered in Malwa

plateau ACZ was 584.1 thousand tones and showed negative trend (-3.22 %) with regards to compound growth rate.

Thus, it can be concluded from the above review that in North Bihar area of maize witnessed a continuous decline in instability over the period under study. The decline has been due mainly to non-adoption of improved technology in crop production (Singh and Ranjan 1998). Technological change was attributing for 30 per cent of total yield increase in HYVs technology in *kharif* maize production (Badal and Singh 2001). A significant impact of green revolution in the State of Madhya Pradesh was also found due to in increasing the food grain production (Singh and Chandra 2001). The growth rate in area, production, and yield of maize improved rapidly in Bangladesh (Hasan *et al.* 2008). Among area, production and productivity of maize the highest instability was highest for the production (Dhakre and Sharma 2010). The area, production and yield instability in maize is very prominent in Jammu and Kashmir during the periods (I) and (II) (Kachroo *et al.* 2013). More than 60 per cent of maize area is observed to be having maize yield less than 2 t/ha (Kumar *et al.* 2014). Nigeria has maintained a very low maize output growth rate when compared to most Asian countries (Ammani, 2015). In the state of Karnataka was also found as a whole maize production showed a significant positive growth rate of 7.86 per cent per annum (Savitha and Kunnal, 2015). The percentage of growth of maize in India was higher in terms of production followed by productivity and area (Selvi *et al.* 2015). Compound growth rate for area of maize was 4.3%, and for output was 4.7%, and was found significant in Benue State, Nigeria (Abu and Adakole 2017). The production of maize registered in Malwa plateau ACZ was 584.1 thousand tones and showed negative trend (-3.22 %) with regards to compound growth rate (Ranjeet *et al.* 2018).

2.2: Decomposition analysis

Rehman *et al.* (2011) studied decomposition of growth of Pakistani agriculture of major crops (wheat, rice, sugarcane and cotton). The study data period has been divided into two periods: period one, 1972 to 1988, and period two, 1989 to 2009, and suggests that for wheat, rice and cotton, yield effect is the major source of growth in period one except for sugarcane for which area effect was the major source. In period two, source of output growth for wheat and cotton was the yield effect; for sugarcane and rice, the growth source was the area effect. The sources of output for the overall study period revealed that in case of individual crops, the main output source was the yield effect for wheat and cotton and the area effect for sugarcane and rice. However, the analysis for the overall study period for aggregate crops revealed that the area and yield effects had almost equal contribution to total change in output growth.

Sharma (2013) studied the effects of area, productivity and their interactions towards increasing production of food grain in India. The data was collected for the periods from 1950-51 to 2012- 13. The result shows that the production and productivity of the different food grain crops have increased during the period under review due to the combine effects of area and productivity. Therefore, the productivity can be further increased by adopting appropriate technologies.

Ayalew and Sekar (2016) studied decomposition of maize production in different states of India, for the period from 1980 to 1981 and 2011 to 2012. And found that maize production has expanded mainly in Maharashtra and Karnataka. The increase in production of maize was mainly due to yield effect at country level and for the states mainly due to area in Karnataka (69.16%) followed by Maharashtra (43.99%), Andhra Pradesh (38.34%) and Gujarat (37.92%), whereas yield effect was the highest in Uttar Pradesh (171.75%) followed by Rajasthan (63.25%), Bihar (52.48%), and Madhya Pradesh (48.99%). The decomposition analysis of source of growth in maize output over

the period 1982 to 1983 and 2011 to 2012 showed that yield effect contributed about 44% and area effect about 26% at country level.

Abu and Adakole (2017) studied decomposition analysis in cereals crops (Rice, Maize, Sorghum, Wheat and Millet) in Benue State, Nigeria for the period 1986 – 2012. The results for instability showed that area, output and yield of the selected cereals were unstable during the period under study owing to instability index of over 10%. Sources of output growth for the selected cereals showed that increase in maize output was largely due to yield effect, while growth in millet output was due to yield, area and interaction effect. Source of output growth for rice was due mainly to yield effect, while increase in output of sorghum on the other hand, was due to area effect.

Kumar and Shekhar (2017) investigated the decomposition of rice and wheat in India from 1950-51 to 2015-16. The study divides the data into five intervals namely, 1950-51 to 1966-67, 1967-68 to 1979-80, 1980-81 to 1989-90, 1990-91 to 1999-2000 and 2000-01 to 2015-16. The decomposition analysis of production suggest that during 1980-81 to 1989-90 and 1990-91 to 1999-2000, the yield effect was major source of both rice and wheat production growth, while interestingly the area effect was dominating for both rice and wheat during the period of 1967-68 to 1979-80. During the period 2000-01 to 2015-16 the area effect for rice production growth was negative, while yield effect was 116.42 per cent. However for wheat production area effect was dominating the yield effect for wheat production.

Thus, it can be concluded from the above review that area and yield effects had almost equal contribution to total change in output growth (Rehman *et al.* 2011). The production of the different food grain crops have increased due to the combine effects of area and productivity (Sharma 2013).The yield effect contributed about 44% and area effect about 26% at country level in maize output in India during the period 1983-2012 (Ayalew and Sekar 2016).

PROFILE OF THE STUDY AREA

The profile of the study area is essential to know the important features of the area. This will facilitate the discussion with respect to similarities and variation of various components and that will be helpful in providing the background of the regions and importance of the study. The details on the above aspects have been presented in this chapter.

3.1 Topography

Madhya Pradesh literally means "Central Province", and is located in the geographic heart of India, between latitude 21°.2'N-26°.87'N and longitude 74°59'-82°06' E. Madhya Pradesh, with an area of 3, 08, 000 sq.km is the second largest state in India after Rajasthan. The state straddles the Narmada River, which runs east and west between the Vindhya and Satpura ranges; these ranges and the Narmada are the traditional boundary between the north and south of India. The highest point in Madhya Pradesh is Dhupgarh, with an elevation of 1,350 m (4,429 ft). The state is bordered on the west by Gujarat, on the northwest by Rajasthan, on the northeast by Uttar Pradesh, on the east by Chhattisgarh, and on the south by Maharashtra.

3.2 Climate and Temperature

Madhya Pradesh has a subtropical climate. Like most of north India, it has a hot dry summer (April–June), followed by monsoon rains (July–September) and a cool and relatively dry winter. The average rainfall is about 1,371 mm (54.0 in). The southeastern districts have the heaviest rainfall, some places receiving as much as 2,150 mm (84.6 in), while the western and northwestern districts receive 1,000 mm (39.4 in) or less. Usually we can't find extreme temperatures in Madhya Pradesh but still one can experience every season here like summers with heat waves, winters with cold waves and monsoon with heavy rain falls.

Fig. 3.1: District wise map of Madhya Pradesh

3.3 Economy

Economy of Madhya Pradesh comprises of agriculture and industries of Madhya Pradesh. In fact, industries and agriculture form the backbone of economy of Madhya Pradesh, whereas the supporting bones are mining, tourism and banking. About 80 percent of the population of Madhya Pradesh depends on agriculture for its livelihood. The major crops of the state are categories into their major types and these are food producer in India other crops include linseed.

3.4 Culture

Madhya Pradesh is bestowed with a rich historical background and cultural heritage. It is home of about 40 percent of India's tribal population. There are three distinct tribal groups in the state. The largest chunk is formed by the gonds, who once ruled a major part of the state and after whom gondwana, the central portion of the state is known. Western Madhya Pradesh is inhibited by the hills.

3.5 Soil type of Madhya Pradesh

Soils of Madhya Pradesh vary as per the structure, colour, texture and composition in the different regions Madhya Pradesh comprises of a variety of soils ranging from rich clayey to gravelly. According to the survey done in the state, the major groups of soils found in the state can be divided into five major categories namely Alluvial Soil, Black Soil or Regur Soil (medium and deep black, shallow and medium black, mixed red and black coloured), Clayey Soil, Mixed Soil and Red and Yellow Soil. The State is divided in 11 Agro-climatic regions and 5 crop zones.

Table 3.1: District-wise classification along with soil type and normal rainfall range

S. No.	Agro – Climatic Region	Soil Type	Rainfall (mm)	District Covered
1	Chhattisgarh plains	Red & Yellow (Medium)	1200 to 1600	Balaghat.
2	Northern Hill Region of Chhattisgarh	Red & Yellow Medium black & skeletal (Medium/light)	1200 to 1600	Shahdol,Mandla,Dindori, Anuppur, Sidhi(Partly), Umaria
3	Kymore Plateau & Satpura Hills	Mixed red and black soils (Medium)	1000 to 1400	Rewa,Satna,Panna,Jabalpur Seoni, Katni, Sidhi (except Singroli tehsil)
4	Central Narmada Valley	Deep black (deep)	1200 to 1600	Narsinghpur, Hoshangabad Sehore (Partly),Raisen (Partly)
5	Vindhya Plateau	Medium black & deep black (Medium/Heavy)	1200 to 1400	Bhopal, Sagar, Damoh, Vidisha, Raisen (except Bareli Teh.), Sehore (except BudniTeh.), Guna (Partly).
6	Gird Region	Alluvial (Light)	800 to 1000	Gwalior, Bhind, Morena, Sheopur-Kala, Shivpuri, (except Pichore, Karera, Narwar, Khania- dana Teh.), Guna (except Aron, Raghogarh, Chachoda Tehsil) Ashoknagar
7	Bundelkhand	Mixed red and black (Medium)	800 to 1400	Chhattarpur,Datia,Tikamgarh, & Shivpuri (Partly)
8	Satpura Plateau	Shallow black (Medium)	1000 to 1200	Betul & Chhindwara
9	Malwa Plateau	Medium black (Medium)	800 to 1200	Mandsaur, Neemuch, Ratlam, Ujjain, Dewas, Indore, Shajapur, Rajgarh & Dhar (Partly) Jhabua (Partly)
10	Nimar Plains	Medium black (Medium)	800 to 1000	Khandwa, Burhanpur, Khargone, Barwani ,Harda ,Dhar (Partly)
11	Jhabua Hills	Medium black skeletal (Light/Medium)	800 to1000	Jhabua District. (except Petlawad Tehsil) & Dhar (Partly)

Source: http://www.mpkrishi.org/krishinet

3.6 Population

Population census data of one of the Indian state Madhya Pradesh shows that it has total population of 7.25 crore, which is approximately 6.00 % of total Indian population.

Table 3.2: Madhya Pradesh population Statistics (2011)

Particulars	Value
Population of Madhya Pradesh	72,597,565 (census 2011)
Total Males	37,612,920
Total Females	34, 984,645
Area in (sq. km)	308245 sq. km
Districts	50
Tehsils	272
Developmental Block	313
Populated Villages	56346
Sex ratio females per 1000 males	930
Population Density of Madhya Pradesh	236 km sq.
Literacy rate	70.63
Males (literacy)	80.53
Females (literacy)	60.02
Total Child Population (0-6 Age)	10,809,395
Male Population (0-6 Age)	5,636,172
Female Population (0-6 Age)	5,173,223

Source: Population census 2011

3.7 Cropping Pattern

Crops of Madhya Pradesh are basically divided into three categories namely cash crops, oilseeds and food grains. Major crops of Madhya Pradesh include soybean wheat, gram, paddy, maize rapeseed & mustard and cotton. Madhya Pradesh is primarily kharif crop growing state. Cropping pattern refers to the sequence of crops grown in a year to maintain the fertility of the soil. In other words it indicates the allocation of cultivated land to different crops in various crop seasons during the year.

Table 3.3: Cropping pattern of Madhya Pradesh, (area 000' ha)

S. No	Name of Crop	2013-14	2014-15	2015-16	Average	% Covered
1	Wheat	5976.00	6002.00	5911.48	5963.16	26
2	Soybean	6164.40	5604.45	5906.39	5891.75	26
3	Gram	3160.29	2853.15	3016.84	3010.09	13
4	Paddy	1929.98	2152.70	2023.91	2035.53	9
5	Maize	848.60	1131.60	1098.30	1026.17	4
6	Rapeseed & Mustard	762.03	665.73	617.46	681.74	3
7	Urad	585.10	861.63	932.00	792.91	3
8	Cotton	514.19	636.23	562.67	571.03	3
9	Lentil	530.08	519.83	545.83	531.91	2
10	Tur	463.04	521.10	579.20	521.11	2
11	Sesamum	266.51	358.70	364.51	329.91	1
12	Bajra	195.90	225.47	267.15	229.51	1
13	Jowar	253.13	220.10	204.61	225.95	1
14	Other crops	1253.96	1232.34	1536.10	1340.80	6
15	State total	22903.21	22985.03	23566.45	1653.68	100.00

Source: mpkrishi. 2016. Agricultural Statistics, available at http://mpkrishi.mp.gov.in

RESEARCH METHODOLOGY

The present chapter deals with concise description of the data collection and analytical methods used in the light of the stated objectives. The specific methods concern to the analysis of time series data related to area, production and productivity of maize, in order to exhibit growth pattern and decomposition model in the different agro climatic regions of Madhya Pradesh are dealt this chapter. The research methodology has been discussed in detail under the following headings:

a): Area of the study

b): Nature of data

c): Source of data

d): Period of the study

e): Analysis of data

f): Limitation of data

4.1 Area of the study

The study confined to the different agro climatic regions of Madhya Pradesh. Among all agro climatic regions of Madhya Pradesh 6 regions, (Northern Hill Region of Chhattisgarh, Kymore Plateau & Satpura Hills, Satpura Plateau, Malwa Plateau, Nimar Plains and Jhabua Hills) have been selected, as these were contributed 86.34 % of total area of maize in Madhya Pradesh. The list of the selected agro climatic regions is given in table 4.1 with percentage share of area, production and productivity of maize in Madhya Pradesh.

Table 4.1: Area, production and productivity of maize in selected Agro Climatic Regions of Madhya Pradesh (2015-2016)

Agro - Climatic Regions	Area (000' ha)	Area Share (%)	Production (000' t)	Production Share (%)	Productivity (kg/ha)
Northern Hill Region of Chhattisgarh	114.00	11.72	240.60	10.78	2148.67
Kymore Plateau & Satpura Hills	110.30	11.34	137.54	6.16	1926.86
Satpura Plateau	125.92	12.95	384.42	17.22	2987.93
Malwa Plateau	280.40	28.83	576.04	25.81	1820.33
Nimar Plains	144.10	14.82	472.60	21.17	3132.80
Jhabua Hills	104.10	10.70	258.39	11.58	2431.50
Other Regions	93.70	9.63	162.53	7.28	1861.80
Madhya Pradesh	972.52	100.00	2232.12	100.00	2350.00

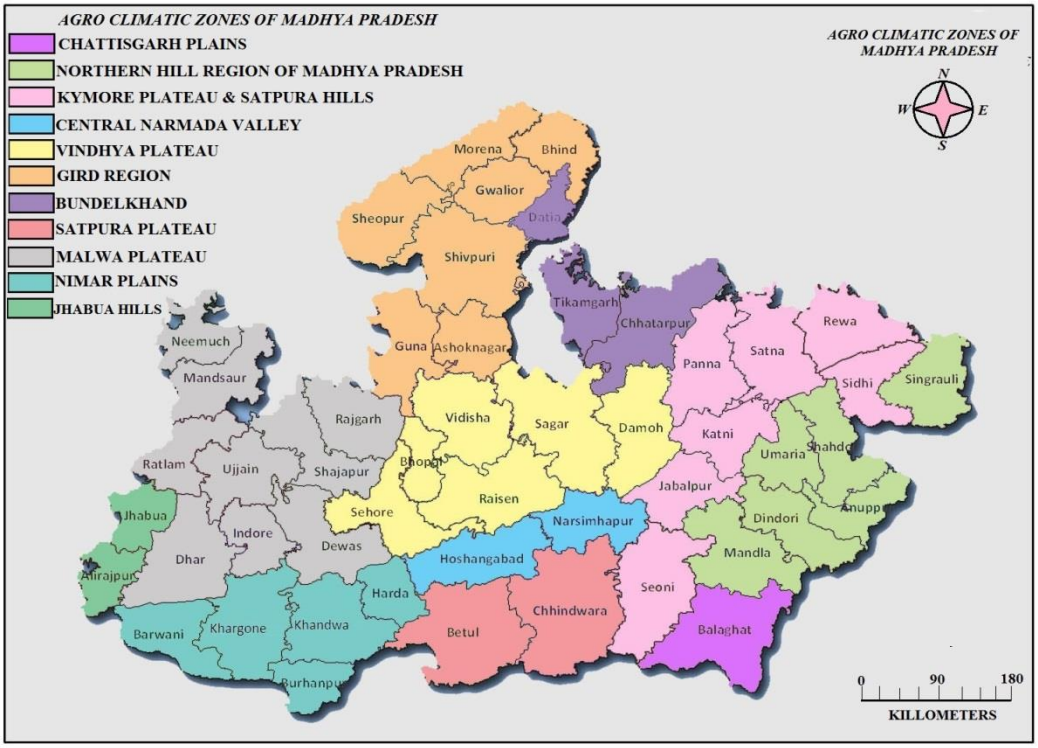

Fig. 4.1: Region wise map of Madhya Pradesh

4.2 Nature of data

The data were secondary in nature.

4.3 Source of data

The data have been collected from various published records from Directorate of Economics and Statistics of Agriculture, Web site *viz.*, Agricoop, Dacnet and Agricultural Statistics at a glance.

4.4 Period of the study

The data from 2001-02 to 2015-16 have been collected on area, production and yield of maize for all the districts of Madhya Pradesh and group them to their respective agro climatic region.

4.5 Analysis of data

Collected data have been analyzed through various statistical and econometrics tools such as, absolute change, relative change, Coefficient of variation, Standard deviation, mean, trend, simple growth rate, compound growth rate and decomposition model has been used to analyze area effect, yield effect and interaction effect.

4.6 Analytical tools used

Complete behavior of a variable cannot be understood by a single statistical tool. The science of statistics provides various tools to look into the variables at depth the tools used in this study have been spelled out in details in the following section.

4.6.1 Absolute change and relative change

One of the methods of studying comparison into change over time/state/crop is by estimation of absolute change. This can be carried out by the base and current year of the concerned period. Absolute change fails to depict a comparative change among the variables and therefore, in addition to absolute change, relative change also has been included in the present study.

For estimation of absolute and relative changes following equations have been used:

$$Absolute\ Change = Pn - P0$$

$$Relative\ Change\ (\%) = \frac{Pn - P0}{P0} \times 100$$

Where,

P_0 = Triennium Average of base year for area, production and productivity (2001-02 to 2003-04)

P_n = Triennium Average of current year for area, production and productivity (2013-14 to 2015-16)

4.6.2 Measure of fluctuation

For estimation of fluctuation in area, production and productivity of maize for the study period following equation has been used:

$$Coefficient\ of\ Variation\ (CV\ \%) = \frac{S.D}{mean} \times 100$$

Where,

$\overline{X} = \sum \mathrm{X}/\mathrm{n}$

$S.D. = \sqrt{v}$

4.6.3 Trend analysis

The linear trend shows a constant amount of change or constant arithmetic rate of growth (b) or an estimate of the absolute increase per unit. To study the trend of maize in different agro climatic regions the trend analysis has been carried out using linear trend method. For estimation of trend (linear) following equation has been used:

Linear model $Y = a + bx$

Where,

Y = Dependent variable (area, production and yield)

a = Constant/ intercept

b = Regression Coefficient

x = Independent variable (Time in years)

4.6.4 Growth analysis

In view of determining the rate of change in area, production and productivity of the maize per annum, simple and compound growth rates have been worked out for the maize in different agro climatic regions of Madhya Pradesh. For estimation simple and compound growth rates following equations have been used:

$$Simple\ Growth\ Rate\ (SGR\ \%) = \ b/\bar{y} \times 100$$

Where,

$\bar{Y}$ = Average mean of dependent variable

$$Compound\ Growth\ Rate\ (CGR\ \%) = (antilog\ b - 1) \times 100$$

4.6.5 Decomposition Analysis

For estimation of the contribution in area and yield towards increase/decrease in maize production under the study period, the simple decomposition model has been used to analyze area, yield and interaction effects:

$$\Delta P = Y0\Delta A + A0\Delta Y + \Delta A\Delta Y$$

$$Area\ Effect\ (AE) = \frac{(An-A0)Y0}{Pn-P0} \times 100$$

$$Yield\ Effect\ (YE) = \frac{(Yn-Y0)A0}{Pn-P0} \times 100$$

$$Interaction\ Effect\ (IE) = \frac{(An-A0)(Yn-Y0)}{Pn-P0} \times 100$$

Where,

A_0 = Triennium average of area in base year

P_0 = Triennium average of production in base year

A_n = Triennium average of area in current year

P_n = Triennium average of production in current year

$Y_0 = P_0/A_0$

$Y_n = P_n/A_n$

4.7 Limitations of the data

This data does not claim to be free from limitations. Major limitations of the present study are given below:

1. Instead of data of Tehsil, district wise data have been collected for the study.
2. The interpolation of data has been considered to fill the gap between time series data.
3. The empirical estimation are based on the data collected from different published records and reports, therefore, validity of data cannot be questioned.

RESULTS AND DISCUSSION

In this chapter, the empirical results and economic interpretation of the observation being presented in tabular and figures forms distinctly in respect of various regions to the earlier stated objectives. This chapter has been divided into 3 subheads *i.e.*

1) Fluctuation in area, production and yield of maize.

2) Trend and growth in area, production and yield of maize.

3) Area effect, yield effect and interaction effect towards production of maize in different agro climatic regions of Madhya Pradesh.

5.1 Fluctuation in area, production and yield of maize

The area, production and yield of maize crop of different agro-climatic regions in Madhya Pradesh based on chronological order of time *i.e.,* the base year average of the first triennium years (2001-02 to 2003-2004) and the current year average of the last triennium (2013-14 to 2015-16). The common measure of assessing the area, production and yield variability are absolute change, relative change and coefficient of variation, which have been worked out for each region of the state. The fluctuation in area, production and yield of maize has been observed in various agro climatic regions of Madhya Pradesh and presented in this subhead.

5.1.1 Area

The regional fluctuation in area of maize is mainly determined by absolute change, relative change and coefficient of variation over a period of time. The details of absolute change, relative change and coefficient of variation in area of maize are presented in table 5.1. The concentration in the area of maize in different agro climatic regions in the base and current year was observed, and presented in Fig. 5.1 and 5.2.

The area of maize was found to be increased 16.19 per cent (138.19 thousand ha) from 853.60 thousand hectares (the base year) to 991.79 thousand hectares (the current year) with the fluctuation of 9.18 per cent in Madhya Pradesh during the period of study (table 5.1). The area of maize in Nimar Plains was found to be increased 123.94 per cent (76.63 thousand ha) from 61.83 thousand hectares (the base year) to 138.47 thousand hectares (the current year) with the fluctuation of 39.31 per cent. It is revealed from the data that in Kymore Plateau & Satpura Hills the area of maize was found to be increased 117.82 per cent (44.37 thousand ha) from 37.66 thousand hectares (the base year) to 82.03 thousand hectares (the current year) with the fluctuation of 49.93 per cent. In the other regions of Madhya Pradesh the area of maize was found to be increased 49.58 per cent (44.90 thousand ha) from 90.57 thousand hectares (the base year) to 135.47 thousand hectares (the current year) with the fluctuation of 34.75 per cent. It is also revealed from the data that in Northern Hill Region of Chhattisgarh the area of maize was found to be increased 16.81 per cent (16.23 thousand ha) from 96.51 thousand hectares (the base year) to 112.73 thousand hectares (the current year) with the fluctuation of 7.67 per cent. The area of maize was also found to be increased 9.85 per cent (11.14 thousand ha) from 113.07 thousand hectares (the base year) to 124.21 thousand hectares (the current year) with the fluctuation of 19.92 per cent in Satpura Plateau. The area of maize was also found to be increased 6.08 per cent (6.57 thousand ha) from 108.07 thousand hectares (the base year) to 114.63 thousand hectares (the current year) with the fluctuation of 8.17 per cent in Jhabua Hills.

The results also show that the area of maize was found to be decreased -17.82 per cent (-61.65 thousand ha) from 345.90 thousand hectares (the base year) to 284.25 thousand hectares (the current year) with the fluctuation of 10.06 per cent in Malwa Plateau.

Table 5.1: Fluctuation in area of maize in different Agro Climatic Regions of Madhya Pradesh (000' ha)

Agro - Climatic Regions	Base year	Current year	Absolute Change	Relative Change (%)	Standard deviation	CV (%)
Northern Hill Region of Chhattisgarh	96.51	112.73	16.23	16.81	7.60	7.67
Kymore Plateau & Satpura Hills	37.66	82.03	44.37	117.82	22.40	49.93
Satpura Plateau	113.07	124.21	11.14	9.85	26.45	19.92
Malwa Plateau	345.90	284.25	-61.65	-17.82	30.77	10.06
Nimar Plains	61.83	138.47	76.63	123.94	32.67	39.31
Jhabua Hills	108.07	114.63	6.57	6.08	8.86	8.17
Other Regions	90.57	135.47	44.90	49.58	35.98	34.75
Madhya Pradesh	853.60	991.79	138.19	16.19	80.52	9.18

Thus, as regards to absolute change, relative change and fluctuation in area of maize in different agro climatic regions of Madhya Pradesh, the area of maize was found to be increased in all the agro climatic regions except Malwa Plateau, where it was found to be decreased by (-17.82) per cent during the period under study. The maximum increased in the area of maize was found in Nimar plains (123.94%) followed by Kymore Plateau & Satpura Hills (117.82%), Other regions of Madhya Pradesh (49.58%), Northern Hill Region of Chhattisgarh (16.81%), Satpura Plateau (9.85%) and Jhabua Hills (6.08). The fluctuation in area of maize was observed maximum in Kymore Plateau & Satpura Hills (49.93%) followed by Nimar Plains (39.31%), Other regions of Madhya Pradesh (34.75%), Satpura Plateau (19.92%), Malwa Plateau (10.06%), Jhabua Hills (8.17%) and Northern Hill Region of Chhattisgarh (7.67%).

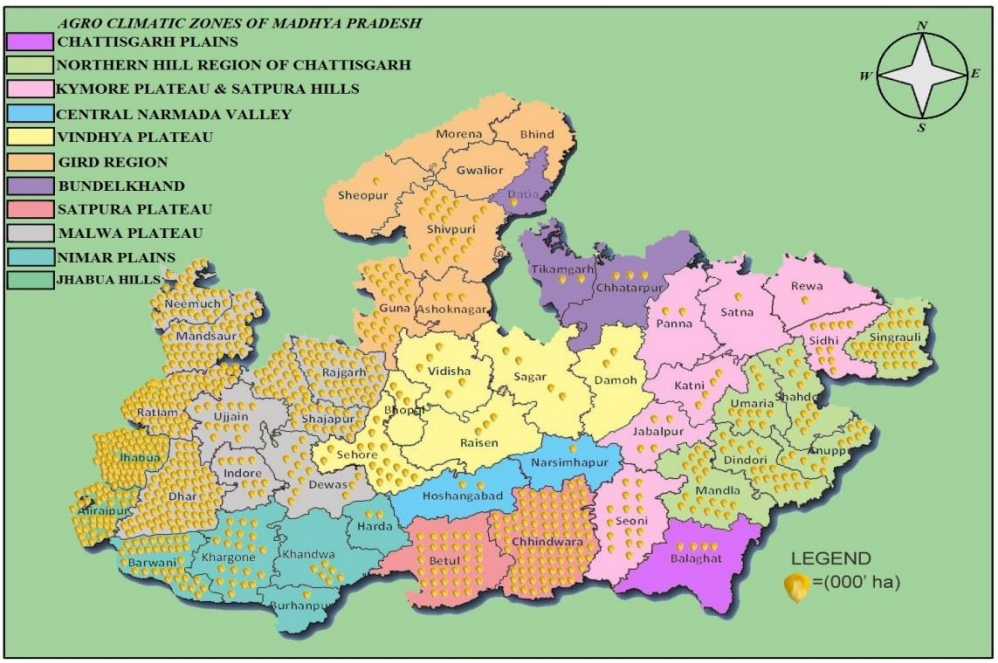

Fig.5.1: Area of Maize in different Agro-Climatic Regions of Madhya Pradesh in the Base Year

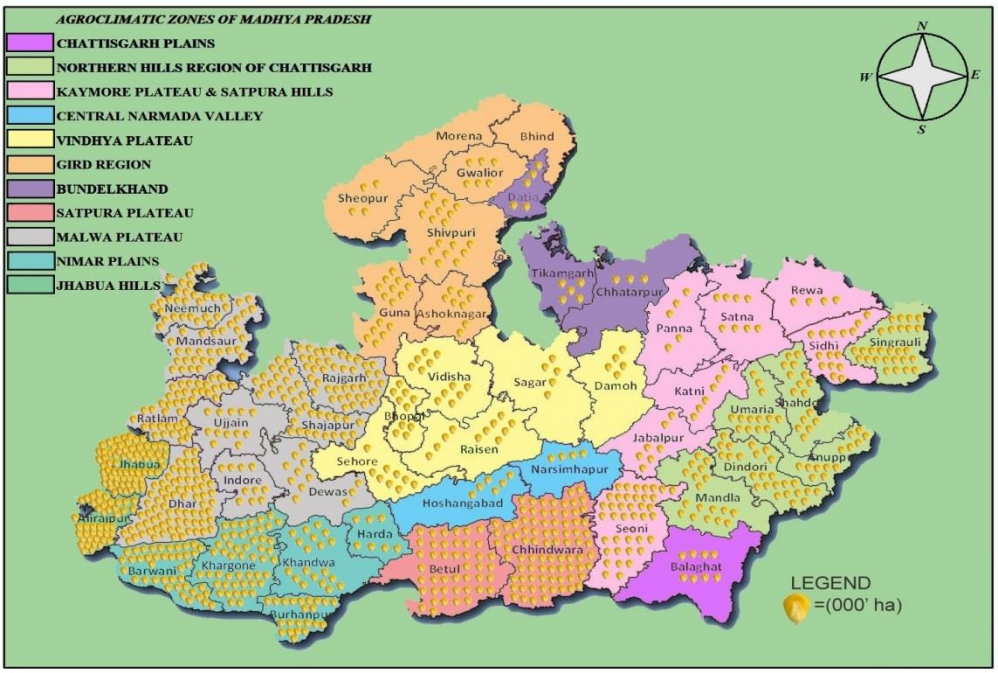

Fig. 5.2: Area of Maize in different Agro-Climatic Regions of Madhya Pradesh in the Current Year

Among different agro climatic regions the area of maize was found to be increased in all the agro climatic regions of Madhya Pradesh except Malwa Plateau, where it was found to be decreased 12 per cent from 41 per cent (the base year) to 29 per cent (current year) to the total area of maize in the state (Fig.5.3 and 5.4). It was found that area of maize increased from 4 per cent to 8 per cent, 11 per cent to 14 per cent and 7 per cent to 14 per cent in Kymore Plateau & Satpure Hills, Other regions of Madhya Pradesh and Nimar Plains respectively, while in Jhabua Hills the area of maize was found to be decreased from 13 per cent to 12 per cent. Similarly in Satpura Plateau it was also decreased from 13 per cent to 12 percent to the total area of maize in the state. The area of maize was found to be stagnant in Northern Hill Region of Chhattisgarh *i.e.,* 11 per cent both in the current and base year in the period of study.

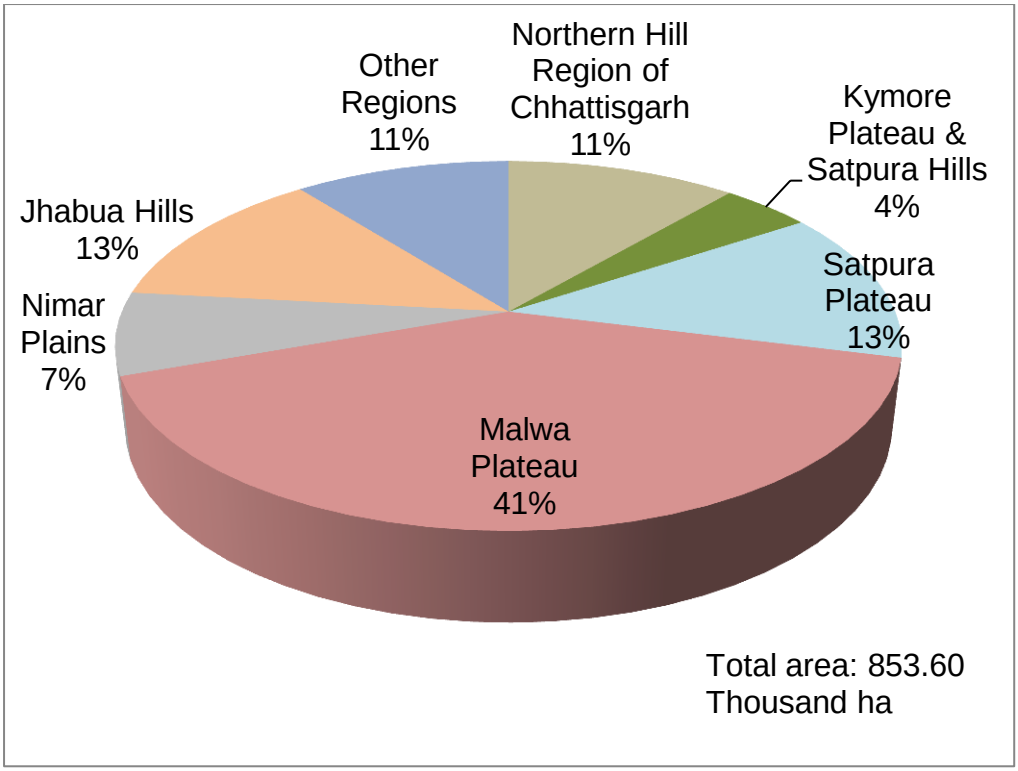

Fig.5.3: Percentage contribution in area of maize in different Agro-Climatic Regions of Madhya Pradesh in the Base Year

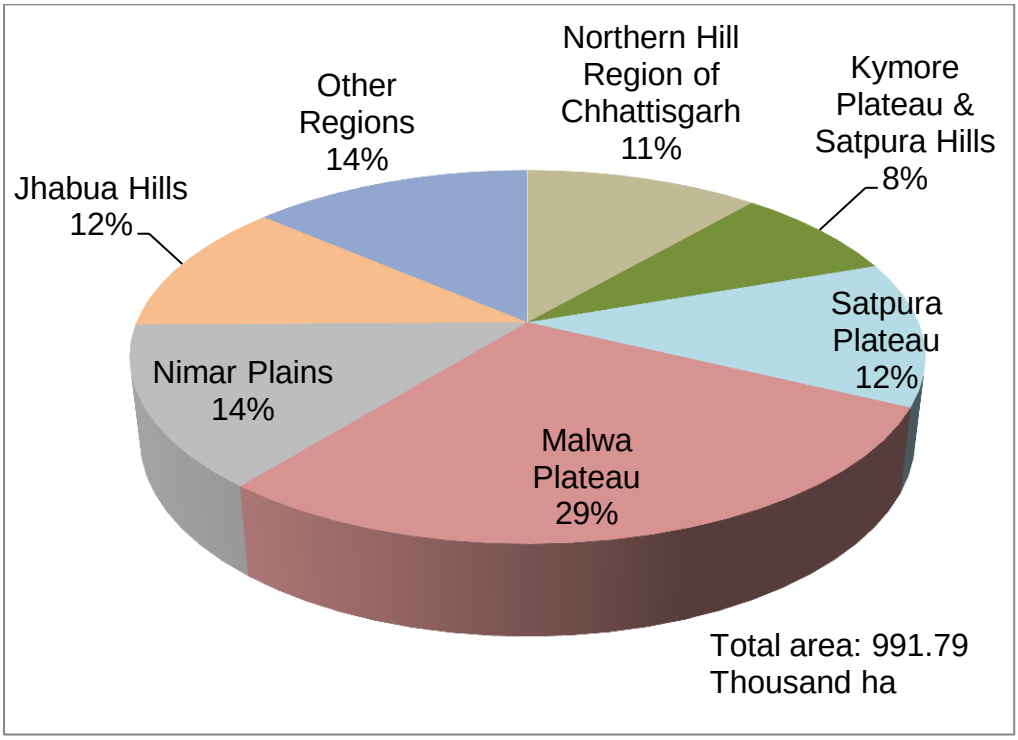

Fig. 5.4: Percentage contribution in area of maize in different Agro-Climatic Regions of Madhya Pradesh in the Current Year

5.1.2 Production

The regional fluctuation in production of maize is mainly determined by absolute change, relative change and coefficient of variation over a period of time. The details are presented in table 5.2. The concentration in the production of maize in different agro climatic regions in the base and current year was observed, and presented in Fig. 5.5 and 5.6.

The production of maize was found to be increased 36.03 per cent (602.40 thousand t) from 1672.09 thousand tonnes (the base year) to 2274.53 thousand tonnes (the current year) with the fluctuation of 33.67 per cent in Madhya Pradesh during the period of study (table 5.2). The production of maize was found to be increased 197.83 per cent (271.56 thousand t) from 137.27 thousand tonnes (the base year) to 408.83 thousand tonnes (the current year) with the fluctuation of 81.87 per cent in Nimar Plains. The production of maize in Kymore Plateau & Satpura Hills was found to be increased 117.02 per cent (73.38 thousand t) from 62.71 thousand tonnes (the base year) to 136.09 thousand tonnes (the current year) with the fluctuation of 70.74 per cent. In the other regions of Madhya Pradesh production of maize was found to be increased 42.72 per cent (70.24 thousand t) from 164.43 thousand tonnes (the base year) to 234.67 thousand tonnes (the current year) with the fluctuation of 43.41 per cent during the period of study. Similarly the production of maize was found to be increased 36.39 per cent (56.01 thousand t) from 153.93 thousand tonnes (the base year) to 209.94 thousand tonnes (the current year) with the fluctuation of 40.01 per cent in Northern Hill Region of Chhattisgarh. It was also observed from the data that the production of maize was found to be increased 34.50 per cent (94.64 thousand t) from 274.33 thousand tonnes (the base year) to 368.97 thousand tonnes (the current year) with the fluctuation of 30.99 per cent in Satpura Plateau. In Jhabua Hills the production of maize was found to be increased 29.92 per cent (60.49 thousand t) from 202.14 thousand

tonnes (the base year) to 262.63 thousand tonnes (the current year) with the fluctuation of 42.34 per cent.

In Malwa Plateau the production of maize was found to be decreased -3.53 per cent (-23.88 thousand t) from 677.27 thousand tonnes (the base year) to 653.39 thousand tonnes (the current year) with the fluctuation of 30.13 per cent.

Table 5.2: Fluctuation in production of maize in different Agro Climatic Regions of Madhya Pradesh (000't)

Agro - Climatic Regions	Base year	Current year	Absolute Change	Relative Change (%)	Standard deviation	CV (%)
Northern Hill Region of Chhattisgarh	153.93	209.94	56.01	36.39	53.23	40.01
Kymore Plateau & Satpura Hills	62.71	136.09	73.38	117.02	45.99	70.74
Satpura Plateau	274.33	368.97	94.64	34.50	97.63	30.99
Malwa Plateau	677.27	653.39	-23.88	-3.53	159.76	30.13
Nimar Plains	137.27	408.83	271.56	197.83	144.96	81.87
Jhabua Hills	202.14	262.63	60.49	29.92	70.25	42.34
Other Regions	164.43	234.67	70.24	42.72	68.95	43.41
Madhya Pradesh	1672.09	2274.53	602.44	36.03	520.20	33.67

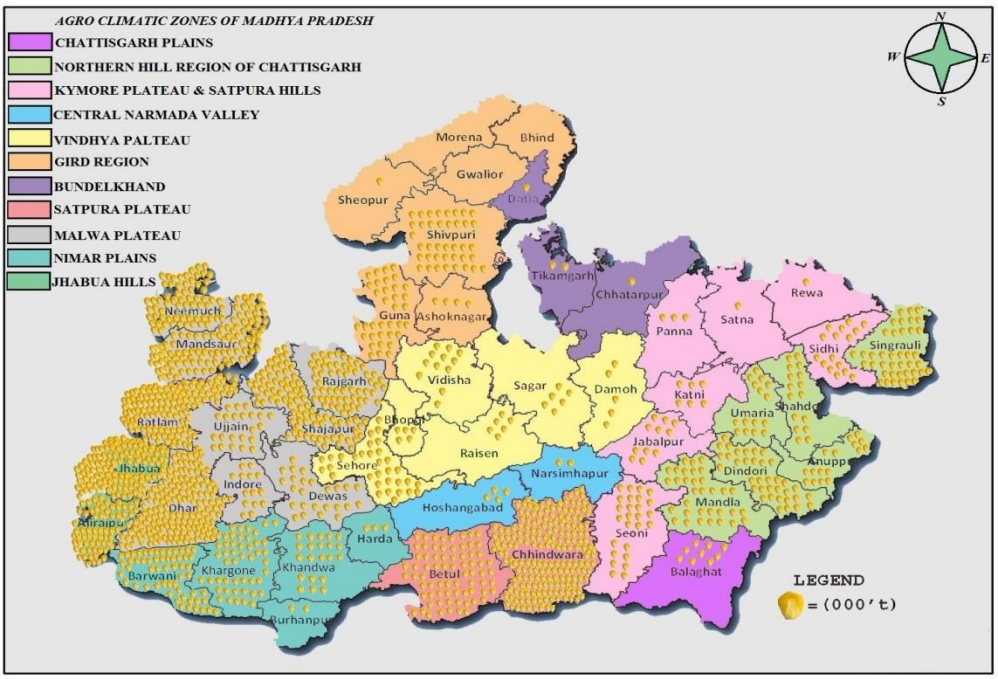

Fig.5.5: Production of Maize in different Agro-Climatic Regions of Madhya Pradesh in the Base Year

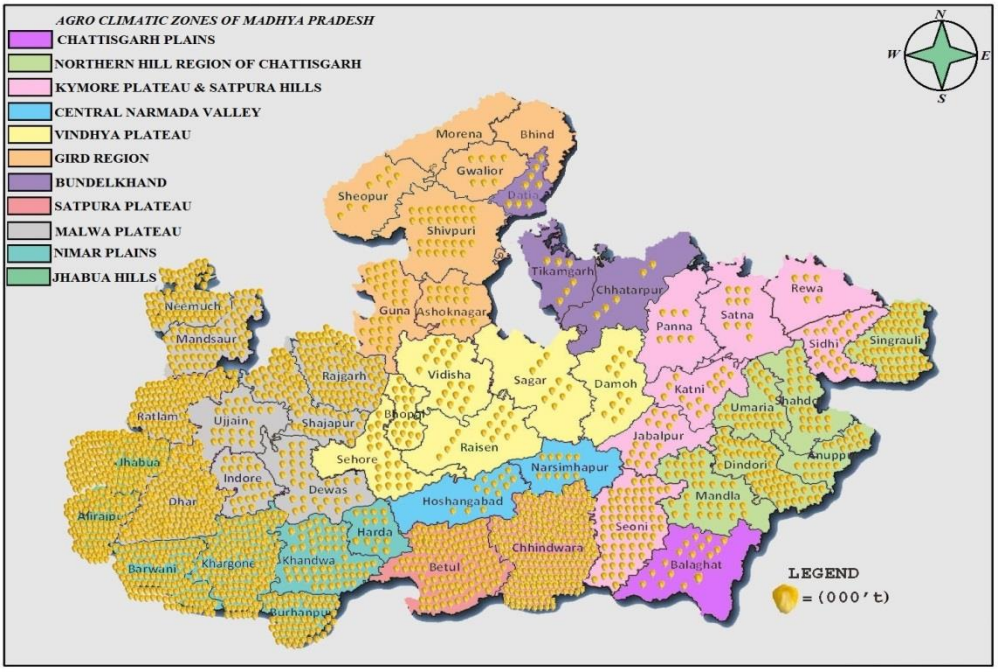

Fig. 5.6: Production of Maize in different Agro-Climatic Regions of Madhya Pradesh in the Current Year

Thus, with respect to absolute change, relative change and fluctuation in production of maize in different agro climatic regions of Madhya Pradesh, the production of maize was found to be increased in all the agro climatic regions except Malwa Plateau, where it was found to be decreased by -3.53 per cent during the period under study. The maximum increased in the production of maize was found in Nimar plains (197.83%) followed by Kymore Plateau & Satpura Hills (117.02%), Other regions of Madhya Pradesh (42.72%), Northern Hill Region of Chhattisgarh (36.39%), Satpura Plateau (34.50%) and Jhabua Hills (29.92 %). The fluctuation in production of maize was observed maximum in Nimar Plains (81.87%) followed by Kymore Plateau & Satpura Hills (70.74%), Other regions of Madhya Pradesh (43.41%), Jhabua Hills (42.34%), Northern Hill Region of Chhattisgarh (40.01%), Satpura Plateau (30.99%) and Malwa Plateau (30.13%).

Among different agro climatic regions of Madhya Pradesh, production of maize was found to be increased in all the agro climatic regions except Malwa Plateau, where it was found to be decreased 12 per cent from 41 per cent (the base year) to 29 per cent (the current year) to the total production of maize in the state (Fig.5.7 and 5.8). It was found that production of maize increased from 4 per cent to 6 percent and 8 per cent to 18 per cent in Kymore Plateau & Satpure Hills and Nimar Plains respectively to the total production of maize in the state. The production of maize was found to be stagnant in Northern Hill Region of Chhattisgarh, Satpura Plateau, Jhabual Hills and Other regions of Madhya Pradesh *i.e*., 9, 16, 12 and 10 per cent respectively both in the current and base year during the period under study.

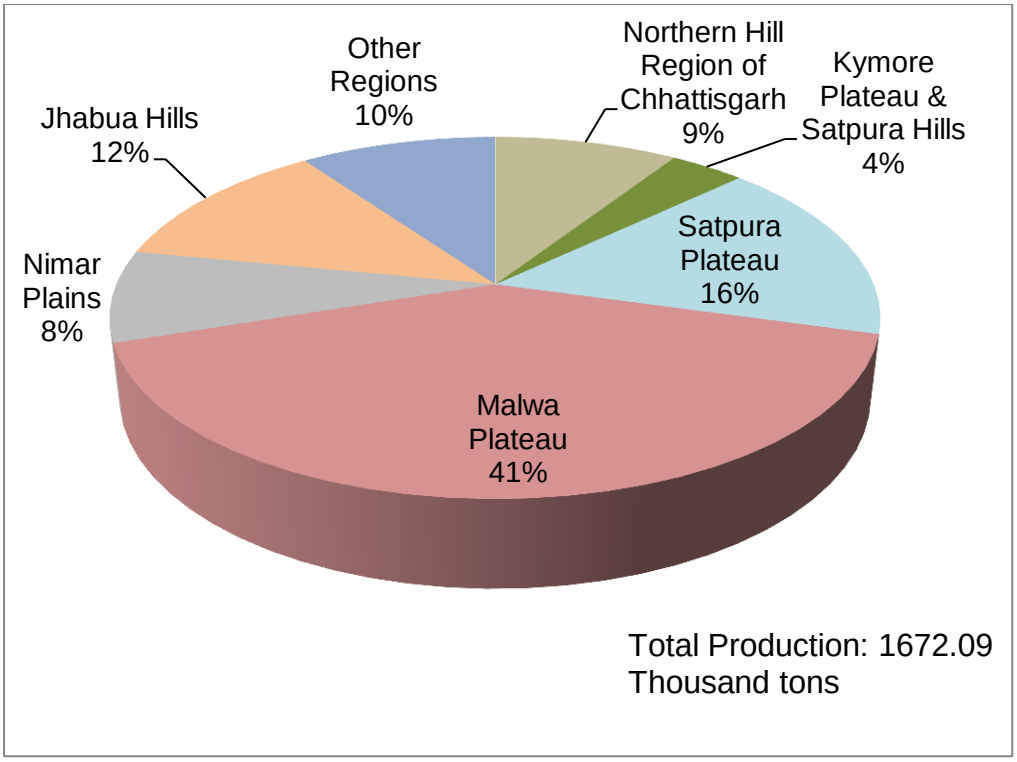

Fig.5.7: Percentage contribution in production of maize in different Agro-Climatic Regions of Madhya Pradesh in the Base Year

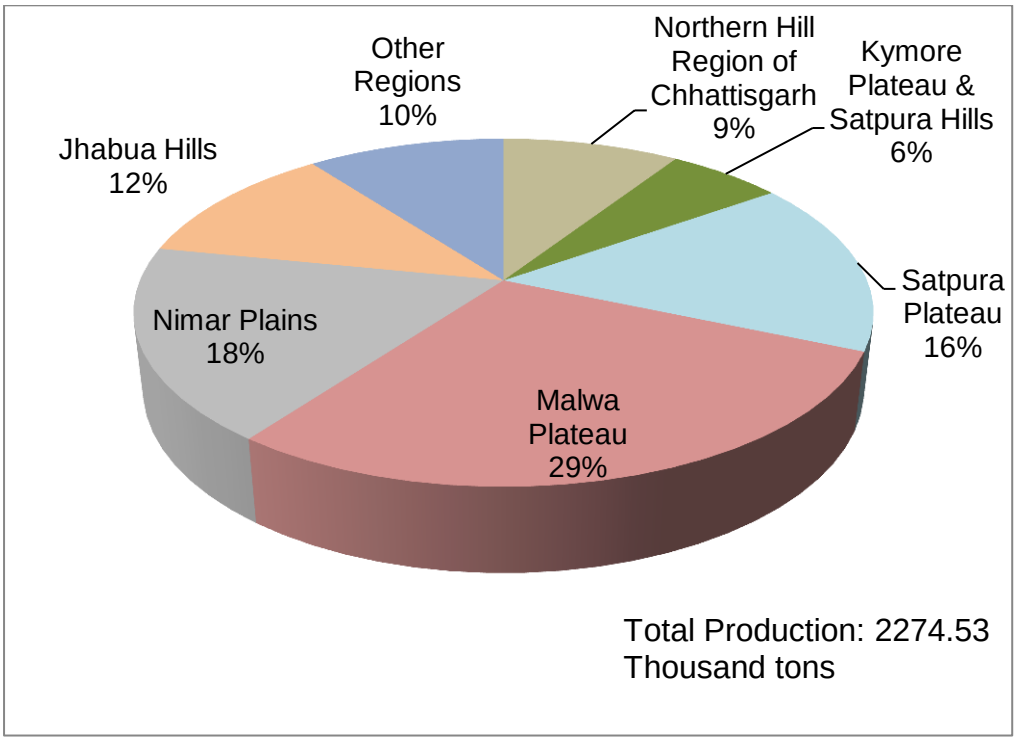

Fig. 5.8: Percentage contribution in production of maize in different Agro-Climatic Regions of Madhya Pradesh in the Current Year

5.1.3 Yield

The fluctuation in the yield of maize is mainly determined by absolute change, relative change and coefficient of variation over a period of time. The details of absolute change, relative change and coefficient of variation in the yield of maize are presented in table 5.3. The average yield of maize in different agro climatic regions in the base and current year was observed, and presented in Fig. 5.9.

The yield of maize was found to be increased 9.46 per cent (177.46 kg/ha) from 1876.87 kg/ha (the base year) to 2054.12 kg/ha (the current year) with the fluctuation of 27.55 per cent in Madhya Pradesh during the period of study (table 5.3). It was also revealed from the data that the yield of maize in Nimar Plains was found to be increased 48.80 per cent (956.64 kg/ha) from 1960.20 kg/ha (the base year) to 2916.84 kg/ha (the current year) with the fluctuation of 41.11 per cent. In Satpura Plateau the yield of maize was found to be increased 24.16 per cent (568.24 kg/ha) from 2351.67 kg/ha (the base year) to 2919.91 kg/ha (the current year) with the fluctuation of 22.15 per cent. In Jhabua Hills the yield of maize was found to be increased 22.69 per cent (425.54 kg/ha) from 1875.33 kg/ha (the base year) to 2300.87 kg/ha (the current year) with the fluctuation of 40.44 per cent. The results also show that the yield of maize was found to be increased 20.65 per cent (379.23 kg/ha) from 1836.07 kg/ha (the base year) to 2215.30 kg/ha (the current year) with the fluctuation of 30.41 per cent in Malwa Plateau. It was also observed from the data that the yield of maize was found to be increased 16.36 per cent (253.78 kg/ha) from 1551.67 kg/ha (the base year) to 1805.45 kg/ha (the current year) with the fluctuation of 35.87 per cent in Kymore Plateau & Satpura Hills. The yield of maize in Northern Hill Region of Chhattisgarh was found to be increased 13.47 per cent (216.30 kg/ha) from 1605.78 kg/ha (the base year) to 1822.08 kg/ha (the current year) with the fluctuation of 35.38 per cent.

In the other regions of Madhya Pradesh the yield of maize was found to be decreased -5.91 per cent (111.71 kg/ha) from

1889.87 kg/ha (the base year) to 1778.16 kg/ha (the current year) with the fluctuation of 25.00 per cent.

Table 5.3: Fluctuation in yield of maize in different Agro Climatic Regions of Madhya Pradesh (kg/ha)

Agro - Climatic Regions	Base year	Current year	Absolute Change	Relative Change (%)	Standard deviation	CV (%)
Northern Hill Region of Chhattisgarh	1605.78	1822.08	216.30	13.47	454.84	35.38
Kymore Plateau & Satpura Hills	1551.67	1805.45	253.78	16.36	458.15	35.87
Satpura Plateau	2351.67	2919.91	568.24	24.16	501.68	22.15
Malwa Plateau	1836.07	2215.30	379.23	20.65	506.27	30.41
Nimar Plains	1960.20	2916.84	956.64	48.80	796.63	41.11
Jhabua Hills	1875.33	2300.87	425.54	22.69	624.98	40.44
Other Regions	1889.87	1778.16	-111.71	-5.91	382.92	25.00
Madhya Pradesh	1876.66	2054.12	177.46	9.46	439.98	27.55

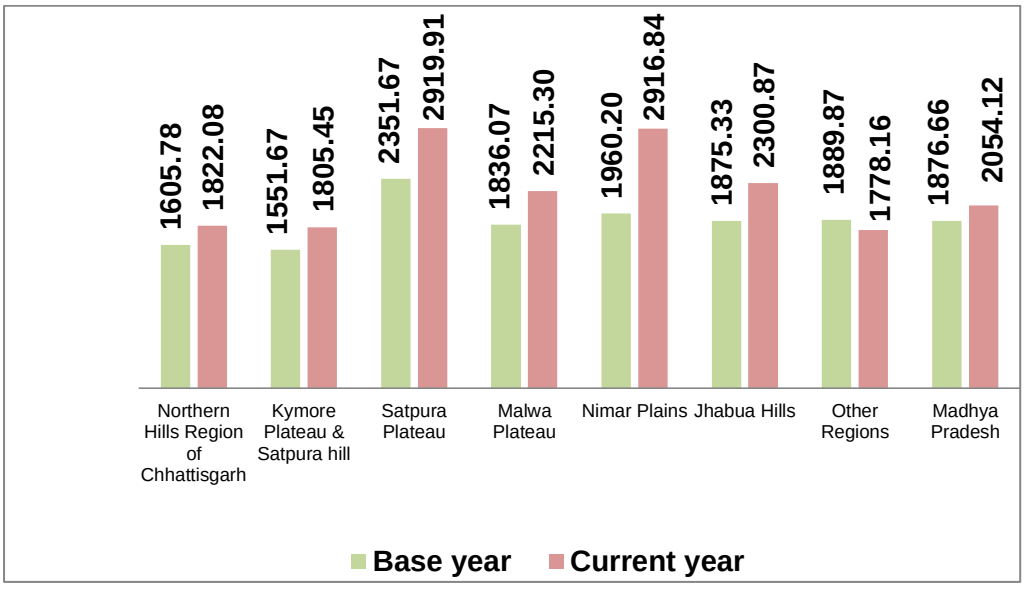

Fig 5.9: Yield of Maize in different Agro-Climatic Regions of Madhya Pradesh in the Base and Current Year (kg/ha)

Thus, in case of absolute change, relative change and fluctuation in the yield of maize in different agro climatic regions of Madhya Pradesh, was found to be increased in all the agro climatic regions except in the other regions, where it was found to be decreased by -5.91 per cent during the period under study. The maximum increased in the yield of maize was found in Nimar plains (48.80%) followed by Satpura Plateau (24.16%), Jhabua Hills (22.69%), Malwa Plateau (20.65%), Kymore Plateau & Satpura Hills (16.36%) and Northern Hill Region of Chhattisgarh (13.47%). The maximum fluctuation in the yield of maize was observed in Nimar Plains (41.11%) followed by Jhabua Hills (40.44%), Kymore Plateau & Satpura Hills (35.87%), Northern Hill Region of Chhattisgarh (35.38%), Malwa Plateau (30.41%), Other regions (25.00 %) and Satpura Plateau (22.15%).

5.2: Trend and growth in area, production and yield of maize

To synthesis the facts about maize in terms of area, production and yield of maize a statistical tool like linear equation has been used in this section, the result of this analysis provided trends of area production and yield in linear forms. For the purpose of giving agro climatic region wise picture of the trends in area, production and yield of maize crop, this has been fitted on the time series data. In view of determining the rate of change in area, production and yield of the maize per annum, simple and compound growth rates have been worked out in different agro climatic regions of Madhya Pradesh. The percentage growth rate showed the rate of growth per cent over the mean value of area, production and productivity accordingly. The trend and growth in area, production and yield of maize in different agro climatic regions have been observed and presented in this sub head.

5.2.1 Area

The region wise trend and growth rates in area of maize for different agro-climatic regions were estimated. The estimates in trend value and percentage growth rate in different agro- climatic regions are presented in Table 5.4.

The area of maize was found to be increased with positive trend of 8.84 thousand hectare per year, which was non-significant with simple and compound growth of 1.00 per cent and 0.93 per cent per year respectively in Madhya Pradesh (table 5.4). In Nimar Plains the area of maize was found to be increased with positive trend of 5.76 thousand hectare per year, which was highly significant with simple and compound growth of 6.93 per cent and 6.30 per cent per year respectively. Similarly in Kymore Plateau & Satpura Hills the area of maize was found to be increased with positive trend of 3.14 thousand hectare per year, which was significant at 5 % level with simple and compound growth of 7.01 per cent and 5.31 per cent per year in the period of study. The results show that the area of maize in Northern Hill Region of Chhattisgarh was found to be increased with positive trend of 0.99 thousand hectare per year, which was significant at 5 % level with simple and compound growth of 1.00 per cent and 0.93 per cent per year during the study period. The area of maize was found to be increased with positive trend of 2.20 thousand hectare per year, which was non-significant at with simple and compound growth of 2.12 per cent and 1.22 per cent per year in the other regions of Madhya Pradesh. It is revealed from the data that the area of maize in Satpura Plateau was found to be increased with positive trend of 2.20 thousand hectare per year, which was non-significant with simple and compound growth of 1.66 per cent and 1.40 per cent per year respectively.

The area of maize in Malwa Plateau was found to be decreased with negative trend of -5.38 thousand hectare per year, which was highly negative significant with simple and compound growth of -1.76 per cent and -1.74 per cent during the study period.

Similarly the area of maize was found to be decreased with negative trend of -0.07 thousand hectare per year, which was non-significant with simple and compound growth of -0.069 per cent and -0.12 per cent per year in Jhabua Hills.

Table 5.4: Trend and growth in area of maize in different Agro Climatic regions of Madhya Pradesh

Agro - Climatic Regions	Trend Value (b)	SE b	SGR (%)	CGR (%)
Northern Hill Region of Chhattisgarh	0.99*	0.38	1.00	0.93
Kymore Plateau & Satpura Hills	3.14*	1.08	7.01	5.31
Satpura Plateau	2.20*	1.52	1.66	1.4
Malwa Plateau	-5.38**	1.19	-1.76	-1.74
Nimar Plains	5.76**	1.25	6.93	6.3
Jhabua Hills	-0.07	0.55	-0.069	-0.12
Other Regions	2.2	2.15	2.12	1.22
Madhya Pradesh	8.84	4.35	1.00	0.93

Note: ** Significant at 1% level (t= 2.97), * Significant at 5% level (t= 2.14)

SGR= Simple Growth Rate, CGR= Compound Growth Rate

The trend and growth in area of maize were found to be positive and increased in all the agro climatic regions except Malwa Plateau and Jhabua Hills. Highly significant simple growth in area of maize was found in Kymore Plateau & Satpura Hills (7.01%) with compound growth of (5.31%) per year followed by Nimar Plains (6.93% and 6.30%) per year. The positive and non-significant simple and compound growths in area of maize were found in the other regions of Madhya Pradesh (2.12 % and 1.22 %) followed by Satpura Plateau (1.66% and 1.40%), Northern Hill Region of Chhattisgarh (1.00% and 0.93%) per year during the period under study.

The negative and non-significant simple and compound growths in area of maize were observed in Malwa Plateau (-1.76% and -1.74%) per year followed by Jhabua Hills (-0.069% and -0.12%) per year.

5.2.2 Production

The region wise trend and growth rates in production of maize for different agro-climatic regions of Madhya Pradesh were estimated for the period of 2001-02 to 2015-16. The estimates in trend value and percentage growth rate in different agro- climatic regions are presented in table 5.5.

The production of maize was found to be increased with positive trend of 56.63 thousand tonnes per year, which was non-significant with simple and compound growth of 3.66 per cent and 3.17 per cent per year respectively in Madhya Pradesh (table 5.5). It is revealed from the data that the production of maize in Nimar Plains was found to be increased with positive trend of 22.84 thousand tonnes per year, which was highly significant with simple and compound growth of 12.90 per cent and 10.54 per cent per year respectively. The production of maize in Satpura Plateau was found to be increased with positive trend of 13.88 thousand tonnes per year, which was highly significant with simple and compound growth of 4.41 per cent and 4.31 per cent per year respectively. The production of maize was found to be increased with positive trend of 5.31 thousand tonnes per year, which was non-significant with simple and compound growth of 3.20 per cent and 2.49 per cent per year in Jhabua Hills. The results also show that the production of maize in Kymore Plateau & Satpura Hills was found to be increased with positive trend of 5.22 thousand tonnes per year, which was non-significant with simple and compound growth of 8.03 per cent and 5.21 per cent per year respectively. The production of maize in Northern Hill Region of Chhattisgarh was found to be increased with positive trend of 4.25 thousand tonnes per year, which was non-significant with simple and compound growth of 3.19 per cent and 2.27 per cent per year. In the other regions of Madhya Pradesh, production of maize was found to be increased with positive trend of 4.21 thousand tonnes per year, which was non-significant with simple and compound growth of 2.65 per cent and 1.52 per cent per year. The production of maize in Malwa Plateau was found to be

increased with positive trend of 0.92 tonnes per year, which was non-significant with simple and compound growth of 0.173 per cent and 0.17 per cent, respectively per annum.

Table 5.5: Trend and growth in production of maize in different Agro Climatic regions of Madhya Pradesh

Agro - Climatic Regions	Trend Value (b)	SE b	SGR (%)	CGR (%)
Northern Hill Region of Chhattisgarh	4.25	3.08	3.19	2.27
Kymore Plateau & Satpura Hills	5.22	2.46	8.03	5.21
Satpura Plateau	13.88**	4.67	4.41	4.31
Malwa Plateau	0.92	9.90	0.173	0.17
Nimar Plains	22.84**	6.38	12.9	10.54
Jhabua Hills	5.31	4.10	3.2	2.49
Other Regions	4.21	4.11	2.65	1.52
Madhya Pradesh	56.63	28.18	3.66	3.17

Note: ** Significant at 1% level (t= 2.97), * Significant at 5% level (t= 2.14)

SGR= Simple Growth Rate, CGR= Compound Growth Rate

In Madhya Pradesh the trend and growth in production of maize were found to be positive and increased in all the agro climatic regions. Highly significant simple and compound growths in production of maize were found in Nimar Plains (12.90% and 10.54%) per year followed by Kymore Plateau & Satpura Hills (8.03% and 5.21%) per year, Satpura Plateau (4.41% and 4.31%) per year, Jhabua Hills (3.20% and 2.49%) per year and Northern Hill region of Chhattisgarh (3.19% and 2.27%) per year, while simple growth in the other regions of Madhya Pradesh was significant at 5 % level (2.65%) and the compound growth was positive but non-significant (1.52%) per year during the period under study. The simple and compound growths in Malwa Plateau were found to be positive but non-significant (0.173 % and 0.17 %) per year respectively.

5.2.3 Yield

The trend and growth rates in yield of maize were worked out in different agro climatic regions of Madhya Pradesh for the period of study. The region wise trend and growth rates in the yield of maize in different agro- climatic regions are presented in Table 5.6.

The result shows that the yield of maize was found to be increased with positive trend of 26.26 kg/ha per year, which was non-significant with simple and compound growth of 1.64 per cent and 1.45 per cent per year respectively in Madhya Pradesh (table 5.6). The yield of maize in Nimar Plains was found to be increased with positive trend of 97.32 kg/ha per year, which was significant at 5 % level with simple and compound growth of 5.02 per cent and 4.33 per cent per year respectively. In Satpura Plateau it was also found to be increased with positive trend of 66.17 kg/ha per year, which was significant at 5 % level with simple and compound growth of 2.92 per cent and 2.81 per cent per year. The yield of maize was found to be increased with positive trend of 49.90 kg/ha per year, which was non-significant with simple and compound growth of 3.23 per cent and 2.86 per cent per year in Jhabua Hills. It is revealed from the data that the yield of maize in Malwa Plateau was found to be increased with positive trend of 39.13 kg/ha per year, which was non-significant with simple and compound growth of 2.35 per cent and 2.05 per cent per year. The results show that the yield of maize in Northern Hill Region of Chhattisgarh was found to be increased with positive trend of 23.93 kg/ha per year, which was non-significant with simple and compound growth of 1.86 per cent and 1.46 per cent per year. The yield of maize in Kymore Plateau & Satpura Hills was found to be increased with positive trend of 23.18 kg/ha per year, which was non-significant with simple and compound growth of 1.81 per cent and 1.26 per cent per year respectively. In the other regions of Madhya Pradesh yield of maize was found to be increased with positive trend of 2.58 kg/ha per year, which was non-significant with simple and compound growth of 0.17 per cent and 0.15 per cent per year.

Table 5.6: Trend and growth in yield of maize in different Agro Climatic regions of Madhya Pradesh

Agro - Climatic Regions	Trend value (b)	SE b	SGR (%)	CGR (%)
Northern Hill Region of Chhattisgarh	23.93	27.42	1.86	1.46
Kymore Plateau & Satpura Hills	23.18	27.68	1.81	1.26
Satpura Plateau	66.17*	25.12	2.92	2.81
Malwa Plateau	39.13	29.46	2.35	2.05
Nimar Plains	97.32*	41.38	5.02	4.33
Jhabua Hills	49.9	36.20	3.23	2.86
Other Regions	2.58	23.74	0.17	0.15
Madhya Pradesh	26.26	26.30	1.64	1.45

Note: ** Significant at 1% level (t= 2.97), * Significant at 5% level (t= 2.14)

SGR= Simple Growth Rate, CGR= Compound Growth Rate

The trend and growth in the yield of maize were found to be positive and increased in all the agro climatic regions of Madhya Pradesh. Highly significant simple and compound growths in the yield of maize were found in Nimar Plains (5.02% and 4.33%) per year, while the simple growth was highly significant in Jhabua Hills (3.23%) and compound growth was significant at 5% level (2.86%). In Satpura Plateau simple and compound growths were significant at 5% level (2.92% and 2.81%), where in Malwa Plateau the simple growth was significant at 5 % level (2.35 %) and the compound growth was positive but non – significant (2.05 %). The positive but non-significant simple and compound growths in yield of maize were observed in Northern Hill Region of Chhattisgarh (1.86% and 1.46%) per year followed by Kymore Plateau & Satpura Hills (1.81% and 1.26%) per year and Other Regions of Madhya Pradesh (0.17% and 0.15%) per year during the period under study.

5.3 Area effect, yield effect and interaction effect towards production of maize

For the estimation of the contribution of area and yield towards increase/decrease in maize production under the study period, the simple decomposition model has been used in which contribution of productivity is the part of production due to increased maize acreage over the base year productivity. The contribution of interaction is the part of production due to increased yield in the increased acreage. The analyzed data for different agro-climatic regions are presented in this sub-section.

The area effect, yield effect and interaction effect towards production of maize have been analyzed and presented in table (5.7). It is observed from the data that the contribution of yield effect (47.39%) was found to be more than the area effect (44.93%) and interaction effect (7.67%) in increase in production of maize in Madhya Pradesh. In Northern Hill Region of Chhattisgarh it was found that the contribution of area effect (46.21%) was greater than the yield effect (46.02%) and interaction effect (7.74%) in increase in production of maize. The results show that in Kymore Plateau & Satpura Hills the contribution of area effect (100.68%) was more than the yield effect (-0.31%) and interaction effect (-0.37%) in increase in production of maize. It is observed from the data that the contribution of yield effect (65.03%) was found to be more than the area effect (28.56%) and interaction effect (6.41%) in increase in production of maize in Satpura Plateau. The contribution of area effect (505.56%) was more than the yield effect (-493.51%) and interaction effect (87.96%) in increase in production of maize in Malwa Plateau.

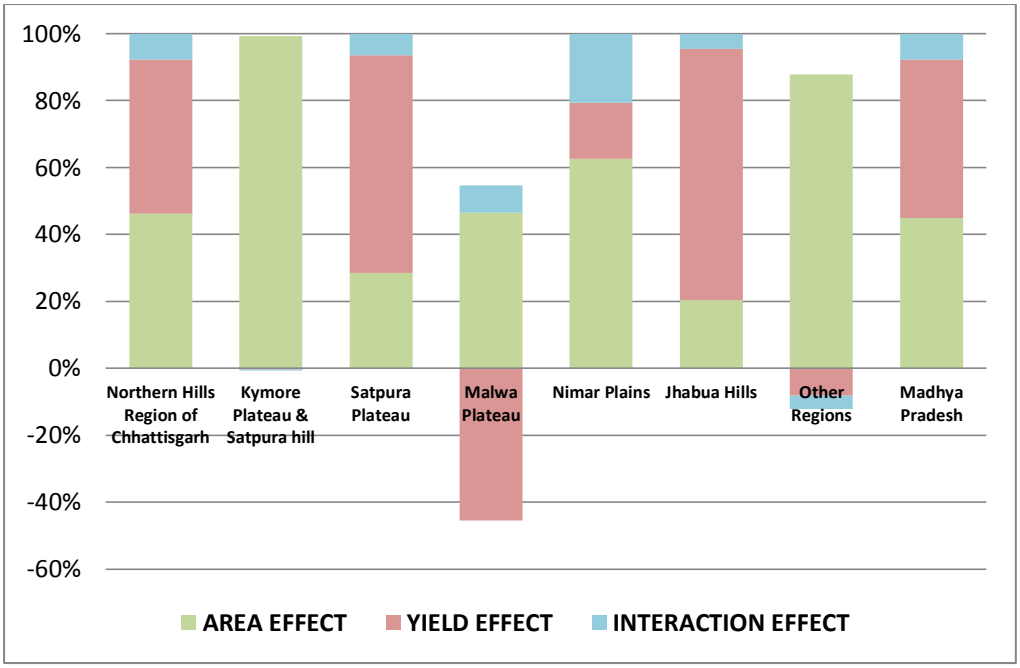

Fig. 5.10: Area, yield and interaction effects in production of maize in different Agro Climatic Regions of Madhya Pradesh (%)

Table 5.7: Area, yield and interaction effects in production of maize (%)

Agro - Climatic Regions	Area effect	Yield effect	Interaction effect
Northern Hill Region of Chhattisgarh	46.21	46.04	7.74
Kymore Plateau & Satpura Hills	100.68	-0.31	-0.37
Satpura Plateau	28.56	65.03	6.41
Malwa Plateau	505.56	-493.51	87.96
Nimar Plains	62.65	16.68	20.67
Jhabua Hills	20.31	75.13	4.57
Other Regions	116.06	-10.74	-5.32
Madhya Pradesh	44.93	47.39	7.67

In Nimar Plains it was found that the contribution of area effect (62.65%) was more than the yield effect (16.68%) and interaction effect (4.57%) in increase in production of maize. The results show that the contribution of yield effect (75.13%) was found to be more than the area effect (20.31%) and interaction effect (4.57%) in increase in production of maize in Jhabua Hills. In the other regions of Madhya Pradesh it was found that the area effect (116.06%) was more than the yield effect (-10.74%) and interaction effect (-5.32%) in the increase in production of maize.

Thus, increase in yield of maize was found to be major contributor followed by area in increase production of maize in Madhya Pradesh. In Northern Hill Region of Chhattisgarh, Kymore Plateau & Satpura Hills, Malwa Plateau, Nimar Plains and in the other regions of Madhya Pradesh the increase in production of maize was mainly due to area effect, whereas the increase in production of maize in Satpura Plateau and in Jhabua Hills was mainly due to yield effect.

SUMMARY, CONCLUSION AND SUGGESTIONS

6.1 Summary

Agriculture in India is one of the most successful sectors of the national economy. Agriculture sector plays a major role in the progress of the economy in achieving the developmental goals of society. Increased production of maize could not cope with their increasing demand in India even after addition of large area under maize crop. The area under maize in India was cultivated 8.71 million hectares with the total production of 21.81 million tonnes, with the average yield of 3215.20 kg/ha in (2015-16). India has exported 697.94 thousand tonnes of maize to others countries and earned 178.02 US$ million and also imported 181.76 thousand tonnes of maize from other countries with the total cost of 43.87 US$ million in (2015-16). Madhya Pradesh is the 2nd largest state contributing 13% and 12% of area and production respectively of the country. In Madhya Pradesh agriculture continuous to be the main stay of the economy.

The study confined to the different agro climatic regions of Madhya Pradesh. Among all agro climatic regions of Madhya Pradesh 6 regions, (Northern Hill Region of Chhattisgarh, Kymore Plateau & Satpura Hills, Satpura Plateau, Malwa Plateau, Nimar Plains and Jhabua Hills) were selected as these were contributed 86.34 % of total area of maize in Madhya Pradesh. The data were secondary in nature and collected from various published records from Directorate of Economics and Statistics of Agriculture, Web site *viz.*, Agricoop, Dacnet and Agricultural Statistics at a glance, for the period of 2001-02 to 2015-16. For the purpose of analysis of collected secondary time series data, various Statistical and econometrics tools such as absolute change, relative change, Coefficient of variation, Standard deviation, mean, trend, simple growth, compound growth and decomposition analysts were applied to diagnose the following objectives:

1. To analyze absolute change, relative change and fluctuation in area, production and productivity of maize.

2. To analyze trend and growth in area, production and productivity of maize.
3. To evaluate area, yield and interaction effects of maize production.
4. To suggest policy implications to increase maize production in different agro climatic regions of Madhya Pradesh.

The following result has been observed from the study:

As regards to absolute change and relative change the area of maize was found to be increased in all the agro climatic regions of Madhya Pradesh except Malwa Plateau. The area of maize was found to be increased 16.19 per cent (138.19 thousand ha) from 853.60 thousand hectares (the base year) to 991.79 thousand hectares (the current year) with the fluctuation of 9.18 per cent in Madhya Pradesh during the period of study.

The area of maize was found to be increased with positive trend of 8.84 thousand hectare per year which was non-significant with simple and compound growths of 1.00 per cent and 0.93 per cent per year respectively in Madhya Pradesh.

Among different agro climatic regions of Madhya Pradesh production of maize was found to be increased in all the agro climatic regions except Malwa Plateau with respect to absolute change and relative change. The production of maize was found to be increased 36.03 per cent (602.40 thousand t) from 1672.09 thousand tonnes (the base year) to 2274.53 thousand tonnes (the current year) with the fluctuation of 33.67 per cent in Madhya Pradesh during the period of study.

The production of maize was found to be increased with positive trend of 56.63 thousand tonnes per year, which was non-significant with simple and compound growths of 3.66 per cent and 3.17 per cent per year respectively in Madhya Pradesh.

In different agro climatic regions of Madhya Pradesh, in case of relative change the yield of maize was found to be increased in

all the agro climatic regions except in the other regions, where it was found to be decreased by -5.91 per cent during the period under study.

The yield of maize was found to be increased with positive trend of 26.26 kg/ha per year which was non-significant with simple and compound growths of 1.64 per cent and 1.45 per cent per year respectively in Madhya Pradesh.

The contribution of yield effect (47.39%) was found to be more than the area effect (44.93%) and interaction effect (7.67%) in increase in production of maize in Madhya Pradesh. In Northern Hill Region of Chhattisgarh, Kymore Plateau & Satpura Hills, Malwa Plateau, Nimar Plains and in the other regions of Madhya Pradesh the increase in production of maize was mainly due to area effect, whereas the increase in production of maize in Satpura Plateau and Jhabua Hills was mainly due to yield effect.

6.2 Conclusions

The analysis of data provides the following conclusion:

- As regards to relative change in different agro climatic regions of Madhya Pradesh, the area of maize was found to be increased in all the agro climatic regions except Malwa Plateau. The maximum increased in the area of maize was found in Nimar Plains, while higher Coefficient of variation in term of area was found in Kymore Plateau & Satpura Hills.
- In different agro climatic regions of Madhya Pradesh, with respect to relative change the production of maize was found to be increased in all the agro climatic regions except Malwa Plateau. Higher relative change and Coefficient of variation in the production of maize were found in Nimar plains.
- The yield of maize was found to be increased in all the agro climatic regions of Madhya Pradesh except in the other regions, where it was found to be decreased. The maximum relative change and Coefficient of variation in the yield of maize were found in Nimar plains.

- The trend and growth in area of maize were found to be positive and increased in all the agro climatic regions of Madhya Pradesh, except Malwa Plateau and Jhabua Hills. Highly significant compound growth in the area of maize was found in Nimar Plains, while highly significant simple growth was observed in Kymore Plateau & Satpura Hills.
- In Madhya Pradesh the trend and growth in production of maize were found to be positive and increased in all the agro climatic regions. Highly significant simple and compound growths in production of maize were found in Nimar Plains.
- The trend and growth in the yield of maize were found to be positive and increased in all the agro climatic regions of Madhya Pradesh. Highly significant simple and compound growths in the yield of maize were found in Nimar Plains.
- The contribution of yield effect was found to be more than the area effect and interaction effect in increase in production of maize in Madhya Pradesh.

6.3 Suggestions

- The area and productivity of maize crop at the regions and state level had increased. Therefore, efforts should be made to extend increase the value added technologies for the maize production *viz.,* Corn starch, Corn oil, Sorbitol, Corn Flakes, Maize cob meals, Corn syrup, High fructose corn syrup *etc.,*
- Efforts should also be made to strengthen the existing storage and processing technology in the area where crop is stable not fluctuates during the period under study *viz.,* Northern Hill Region of Chhattisgarh and Jhabua Hills.
- For most of the agro climatic regions, suitable transportation system should be searched out and recommended to transport maize from the places of surplus to the places of scarcity.
- Efforts should also be made to intensify maize production especially in those regions where the productivity level at

present is poor *viz.,* Northern hills region of Chhattisgarh, Malwa Plateau and Kymore Plateau & Satpura Hills.

- A comprehensive survey of the maize growers may be undertaken by the competent agencies to identify the problems faced by them in cultivation of maize in different agro climatic regions especially in Malwa Plateau and Jhabua Hills.

6.4 Suggestions for further work

The problems of maize production should be examined critically for Malwa Plateau and it will be judged through scientific procedures. If possible, district – wise studies should be conducted in Malwa Plateau to make the future programme of production more effective.

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APPENDICES

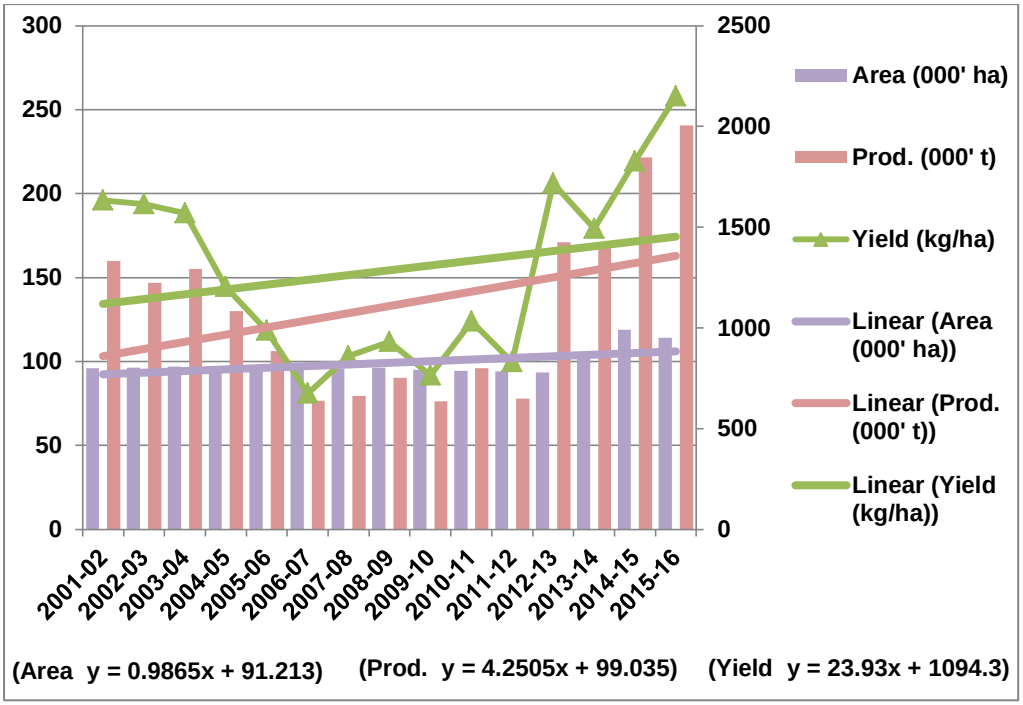

Fig. 5.1: Trend in Area, Production and Yield of Maize in Northern Hills Region of Chhattisgarh

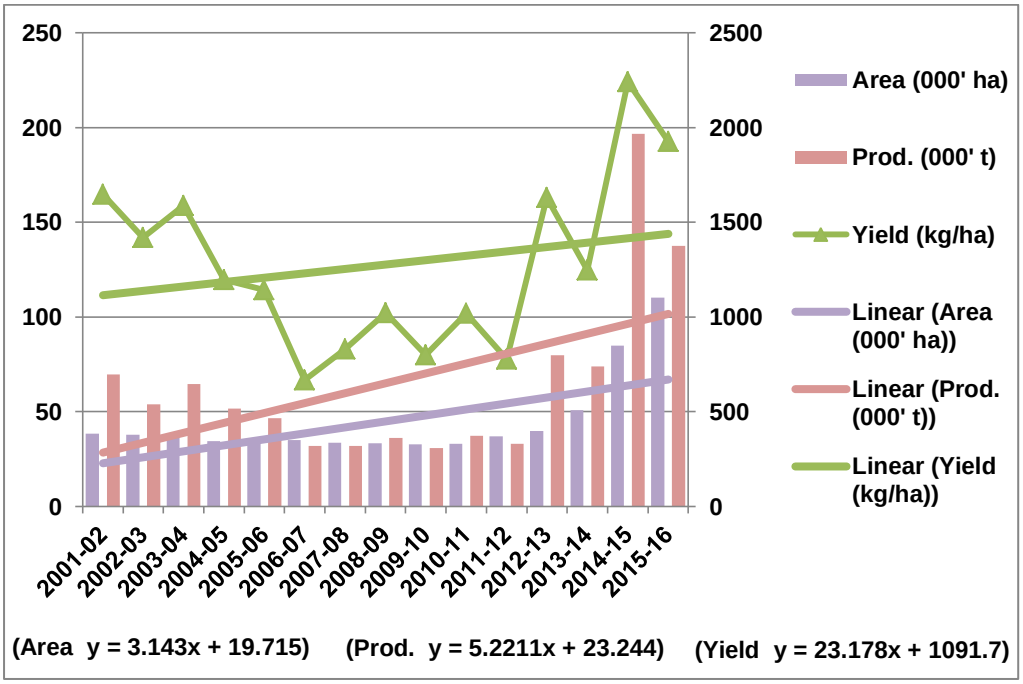

Fig. 5.2: Trend in Area, Production and Yield of Maize in Kymore Plateau & Satpura hills

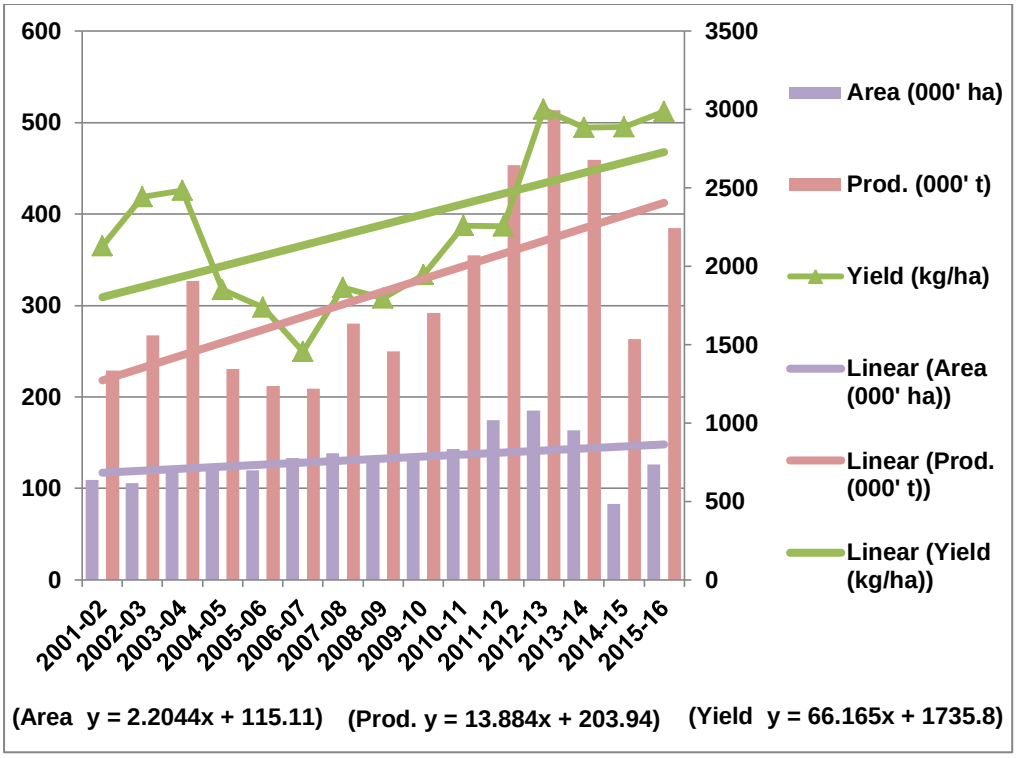

Fig. 5.3: Trend in Area, Production and Yield of Maize in Satpura Plateau

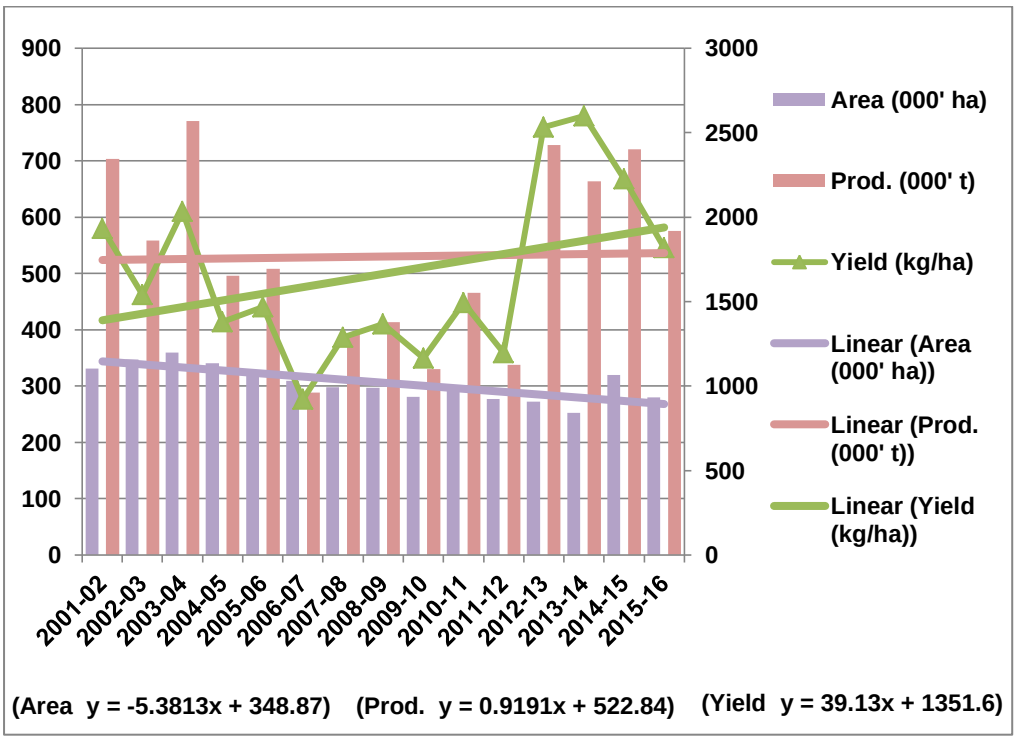

Fig. 5.4: Trend in Area, Production and Yield of Maize in Malwa Plateau

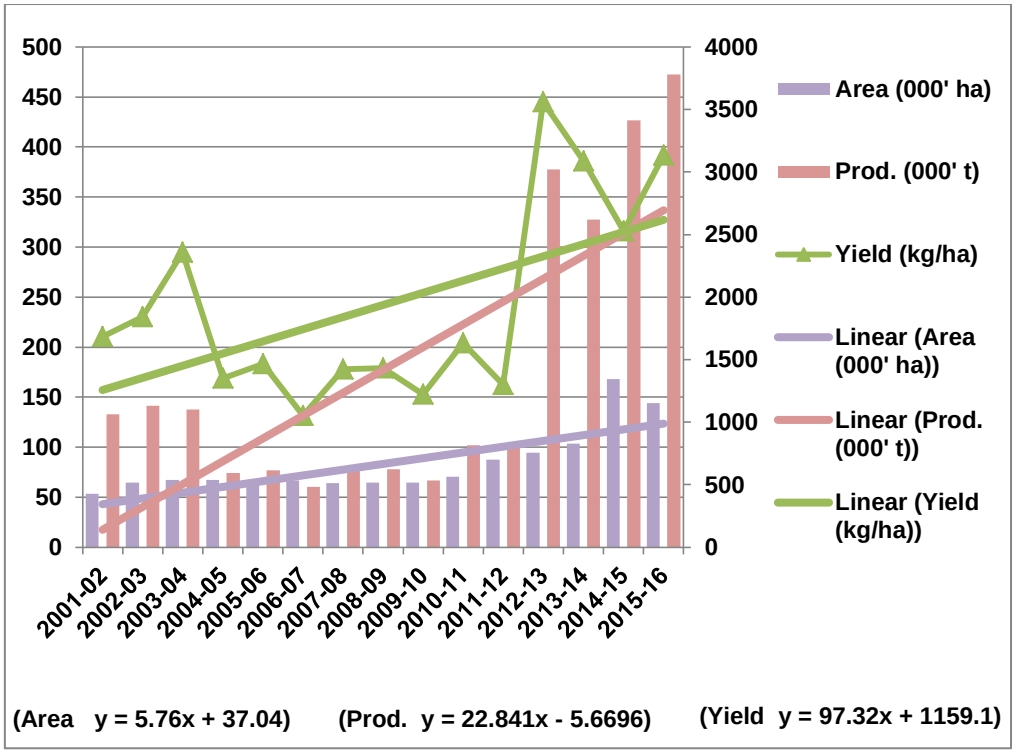

Fig. 5.5: Trend in Area, Production and Yield of Maize in Nimar Plains

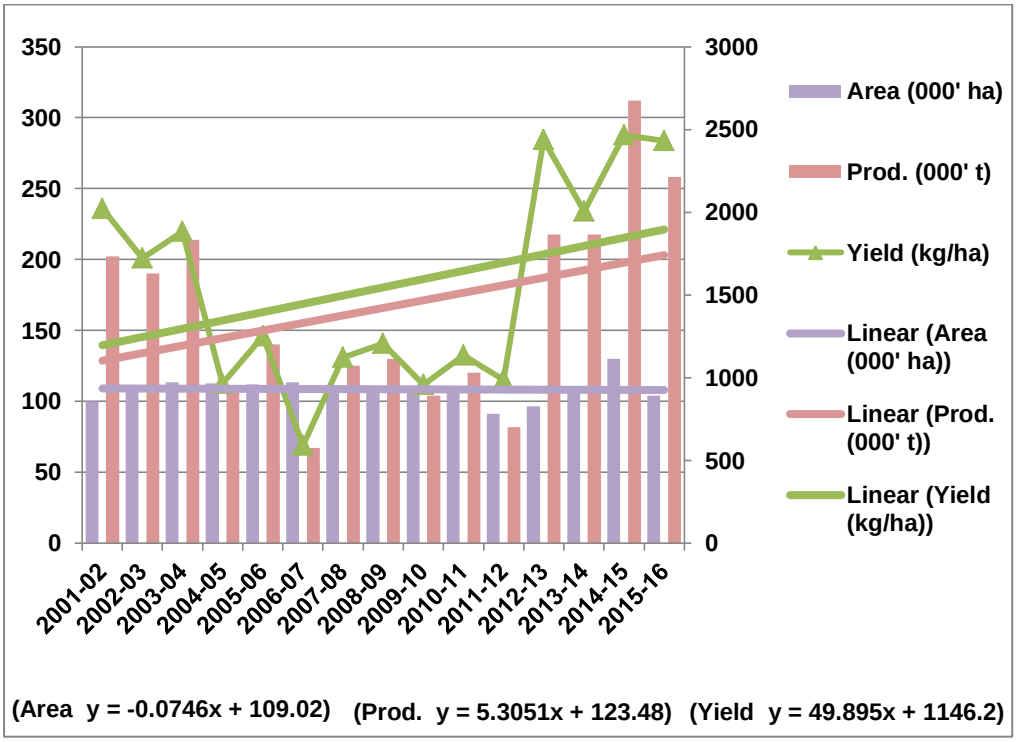

Fig. 5.6: Trend in Area, Production and Yield of Maize in Jhabua Hills

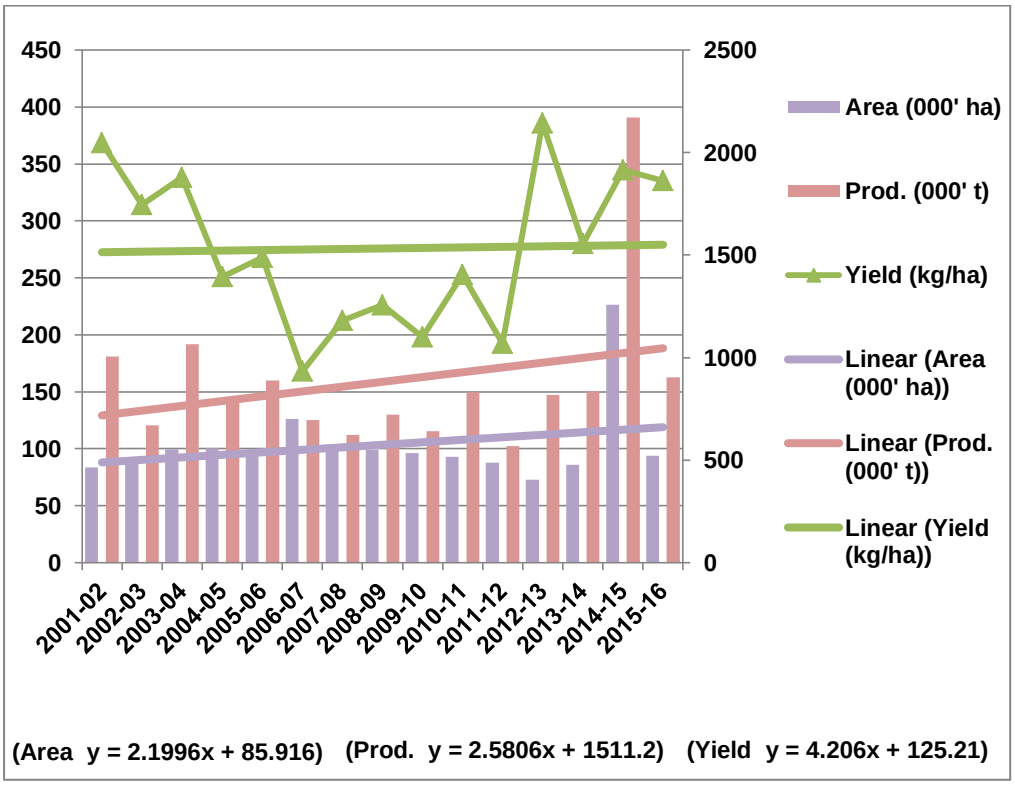

Fig. 5.7: Trend in Area, Production and Yield of Maize in the Other Regions

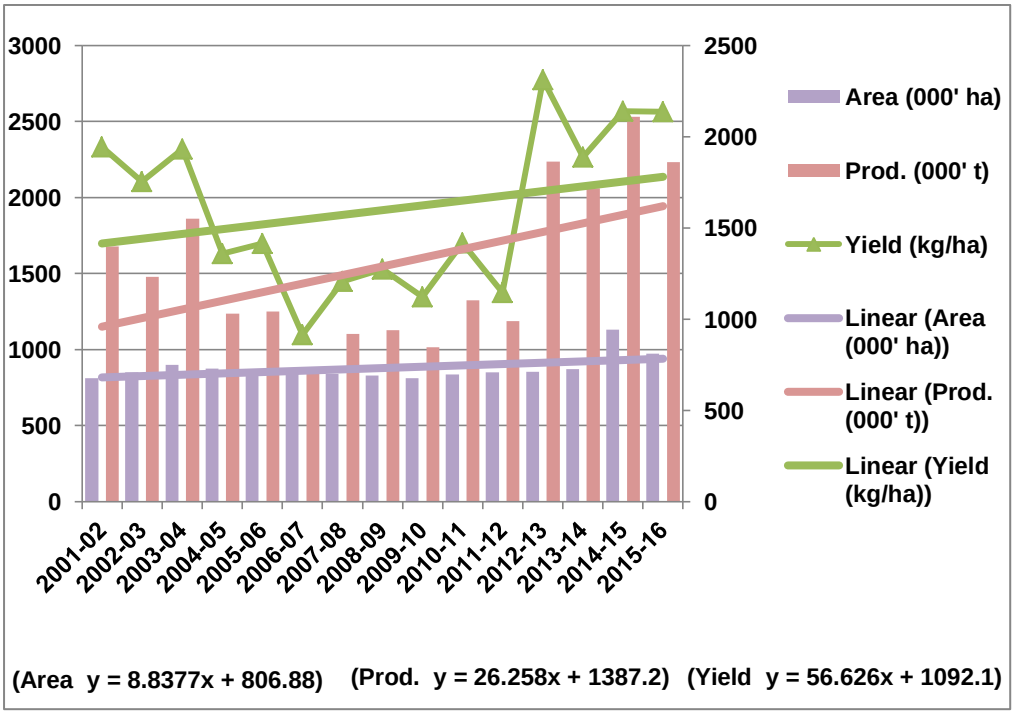

Fig. 5.8: Trend in Area, Production and Yield of Maize in Madhya Pradesh

ABSTRACT

Title of the thesis	-	**"Dynamics of maize production in different Agro Climatic Regions of Madhya Pradesh"**
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Year of award of degree	-	2019
Major subject	-	Agricultural Economics and Farm Management
Total no. of pages in the thesis	-	59
Number of words in the abstract	-	486

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ABSTRACT

The productivity of maize crop in Madhya Pradesh compared to other maize growing state and the country as a whole in the recent time is low being one of the maize growing states. What is pace of trend and growth of area, production and productivity and factors thereof in different agro climatic regions of Madhya Pradesh is the subject matter of the study. The present study entitled **"Dynamics of maize production in different agro climatic regions of Madhya Pradesh"** was undertaken with a view to examine the fluctuation, trend and growth in area, production and productivity of maize. Similarly contribution of area effect, yield effect and interaction effect towards maize production was done by decomposition analysis to examine the data ranging from 2001-02 to 2015-16 in Madhya Pradesh. The state is divided into eleven distinct agro climatic regions, which have resulted in great variation in farming patterns and growth rates in area, production and productivity in different parts of the state. Among the 11 agro climatic regions 6 regions were selected. Time series data on area, production and productivity of Maize were collected from various published records from Directorate of Economics and Statistics of Agriculture, Web site *viz.*, Agricoop, Dacnet and Agricultural Statistics at a glance.

The absolute change and relative change in area, production and yield of maize in Madhya Pradesh were found positive value which shows that the area, production and yield of maize were increases. More change was observed in Nimar Plains. The highest coefficient of variance was observed in Kymore Plateau & Satpura Hills region with respect to area. In case of production and productivity the highest coefficient of variance was found in Nimar Plains. As regard to trend value the area, production and productivity of maize increase in almost all the agro climatic regions of Madhya Pradesh except Malwa Plateau and Jhabua Hills. In all the agro climatic regions the value of simple and compound growth rates in area, production and yield of maize were found positive, except in Malwa Plateau and Jhabua Hills during the study period. The contribution of yield effect (47.39%) was found to be

more than the area effect (44.93%) and interaction effect (7.67%) in increase in production of maize. Increase yield of maize was found to be major contributor followed by area in increase in production of maize in Madhya Pradesh. Therefore, efforts should be made to extend increase the value added technologies for the maize production *viz.,* Corn starch, Corn oil, Sorbitol, Corn Flakes, Maize cob meals, Corn syrup, High fructose corn syrup *etc.,* and suitable transportation system should be searched out and recommended to transport maize from the places of surplus to the places of scarcity. A comprehensive survey of the maize growers may be undertaken by the competent agencies to identify the problems faced by them in cultivation of maize in different agro climatic regions especially in Malwa Plateau and in Jhabua Hills.

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12th	General	Nadirshahkoot High School Khost, Afghanistan	2007	9.766

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