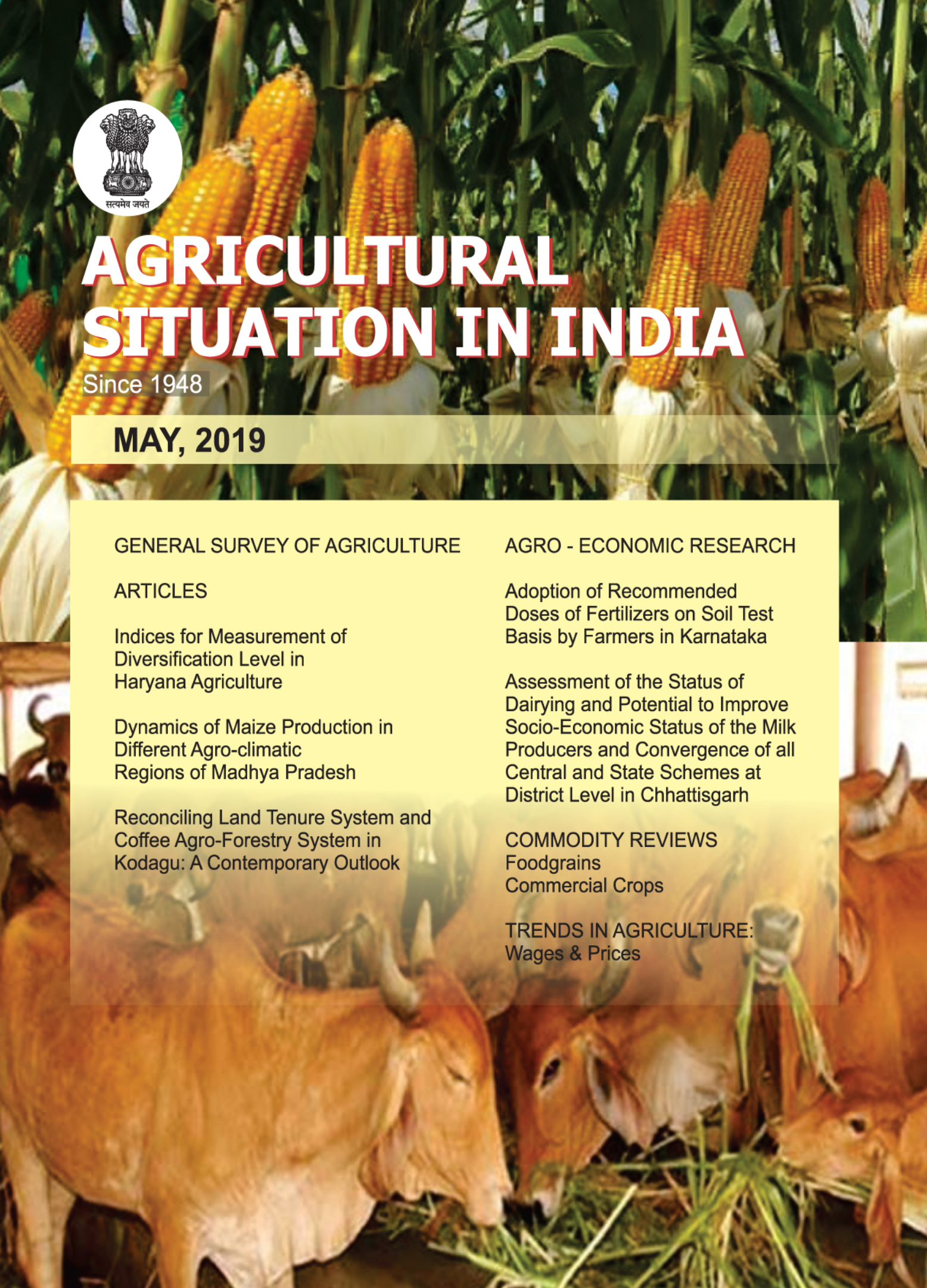

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CONTENTS

Dynamics of Maize Production in different Agro-climatic Regions of Madhya Pradesh

BAKHT AMIR ZADRAN[1] AND HARI OM SHARMA[2]

Abstract

In this article, we have analysed the pace of growth of area, production and yield and area effect, yield effect and their interaction effect towards production of maize in different agro-climatic regions of Madhya Pradesh for the period of 2001-02 to 2016-17. It is observed from the study that the production of maize significantly increases with the magnitude of 56.63 thousand tonnes per year and a fluctuation of 33.63 percent during the period under study in Madhya Pradesh, which was found to be mainly due to yield effect (47.39%) followed by area (44.93%) and their interaction effect (7.67%). It is also observed that area, production, and yield of maize increased in all the major maize growing agro-climatic regions except Malwa Plateau and Jhabua Hills , where area of maize was found to have decreased significantly during the period under study. Hence, efforts should be made to find out the reasons behind decreasing area in these two prominent maize growing regions and establishing more and more processing plants for preparation of various value added products of maize in all the promising maize growing agro-climatic regions of the State.

Keywords: *Maize production, Area, Yield, Agro-climatic regions, Madhya Pradesh.*

1. 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 staple food 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 serves 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 cultivation in the world was 187.98 million hectares with the total production of 1060.08 million tonnes, with the average yield of 5640 kg per hectare in 2016 (FAOSTAT). Maize is grown throughout the world; the top 10 producing countries are given in Table 1.

TABLE 1: TOP MAIZE PRODUCING COUNTRIES IN THE WORLD (2016)

Country	Area (million ha)	Area share (%)	Production (million tonnes)	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	187.98	100	1060.08	100	5640.00

Source: FAOSTAT.

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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 related value added products, most important among them 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 cultivated area under maize in India was 10.20 million hectares with the total production of 26.26 million tonnes, with the average yield of 2574.50 kg/ha in 2016 (Table1). India has exported 697.94 thousand tonnes of maize to other countries and earned 178.02 million US$, and also imported 181.76 thousand tonnes of maize from other countries with a total cost of 43.87 million US$ in 2015-16.

Madhya Pradesh is the 2nd largest maize producing state contributing 13% and 12% of total area and production, respectively, of the country (Fig. 1 and 2). In Madhya Pradesh, maize is found to be cultivated in all the agro-climatic regions of the state in kharif season. The area under maize cultivation in Madhya Pradesh was 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).

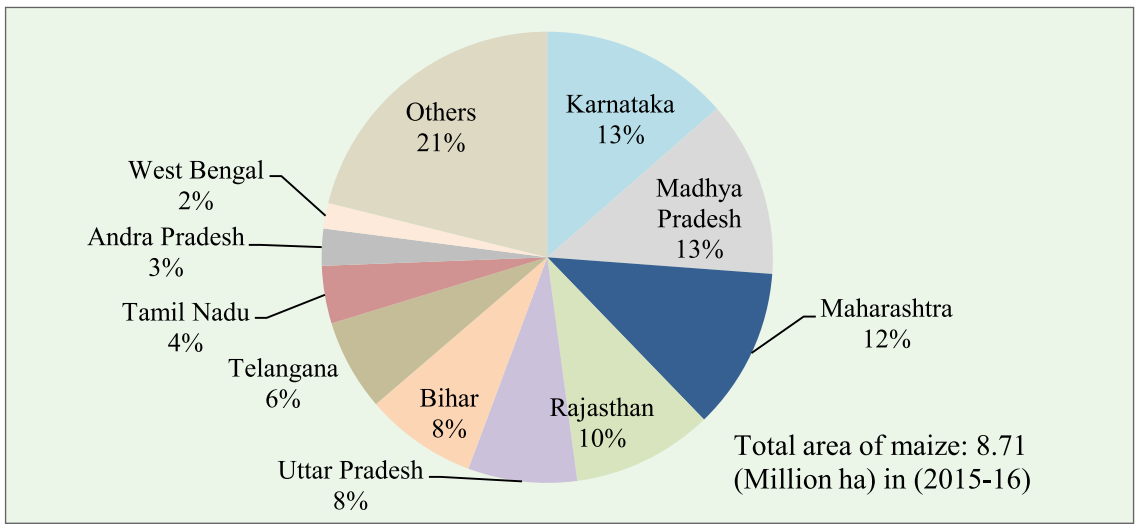

Fig. 1: Percentage share of maize area in different states of India

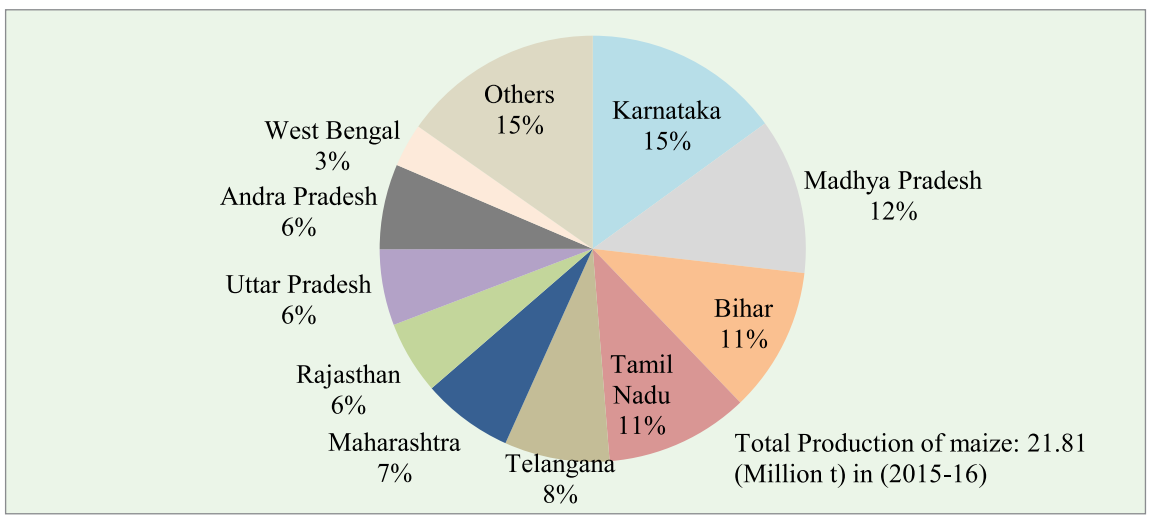

Fig. 2: Percentage share of maize production in different states of India

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. 3).

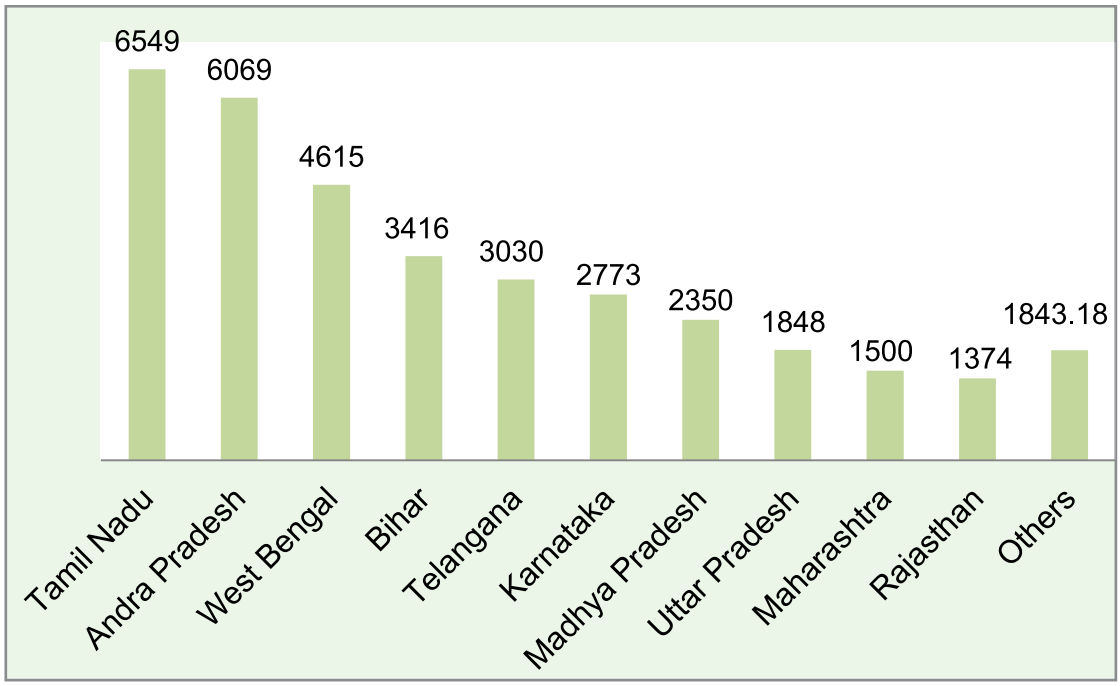

Fig. 3: Average yield of maize in different States of India (kg/ha)

What is the pace of trend and growth in area, production and yield 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 fluctuations 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.

2. Research Methodology

The study is confined to the different agro-climatic regions of Madhya Pradesh. Among all agro-climatic regions of Madhya Pradesh, 6 regions, viz. Northern Hill Region of Chhattisgarh, Kymore Plateau & Satpura Hills, Satpura Plateau, Malwa Plateau, Nimar Plains and Jhabua Hills were selected, as these consisted 90.36 % of total area of maize in Madhya Pradesh (Table 2).

The data was secondary in nature. The data was collected from various published records from Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, websites viz., Agricoop, Dacnet and Agricultural Statistics at a Glance. The data from 2001-02 to 2015-16 was collected on area, production and yield of maize for all the districts of Madhya Pradesh and grouped into their respective agro-climatic region.

TABLE 2: MAJOR MAIZE GROWING AGRO-CLIMATIC REGIONS IN 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	11.72	240.6	10.78	2148.67
Kymore Plateau & Satpura Hills	110.3	11.34	137.54	6.16	1926.86
Satpura Plateau	125.92	12.95	384.42	17.22	2987.93
Malwa Plateau	280.4	28.83	576.04	25.81	1820.33
Nimar Plains	144.1	14.82	472.6	21.17	3132.80
Jhabua Hills	104.1	10.7	258.39	11.58	2431.50
Total	878.82	90.36	2069.59	92.72	2408.02
Other Regions	93.7	9.64	162.53	7.28	1861.80
Madhya Pradesh	**972.52**	**100.00**	**2232.12**	**100.00**	**2350.00**

The triennium average upto 2003-04 and 2015-16 have been considered as the base year and current year of the study, respectively. Collected data has 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.

3. Results and Discussion

The fluctuation, growth and trend in area, production and yield of maize and area effect, yield effect and interaction effect towards production of maize have been analyzed for all the agro-climatic regions of Madhya Pradesh.

3.1. Fluctuation in area, production and yield of maize

The percentage contribution to total area of maize increased in all the agro-climatic regions of Madhya Pradesh except Malwa Plateau, where it decreased by 12 percent from 41 percent (the base year) to 29 percent (current year) of the total area of maize in the state (Fig.4 and Fig. 5). It was found that percentage contribution to total area of maize increased from 4 percent to 8 percent, 11 percent to 14 percent and 7 percent to 14 percent in Kymore Plateau and Satpura Hills, other regions of Madhya Pradesh and Nimar Plains respectively, while in Jhabua Hills, It decreased from 13 percent to 12 percent. Similarly, in Satpura Plateau, it decreased from 13 percent to 12 percent of 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 percent both in the current and base year in the period of study. (Fig. 4 & 5)

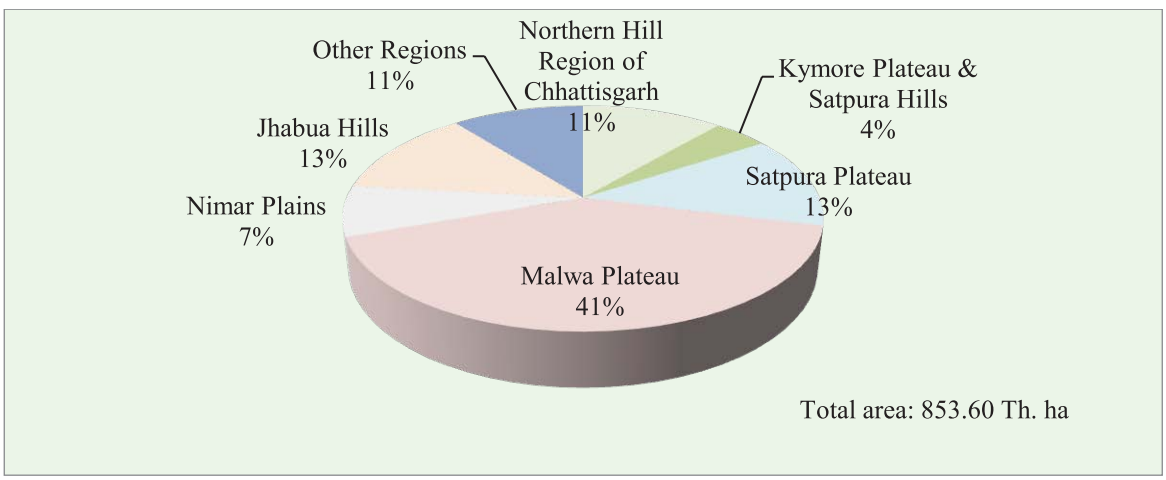

Fig. 4: Percentage contribution in area of maize in different Agro-Climatic Regions of Madhya Pradesh in the Base Year

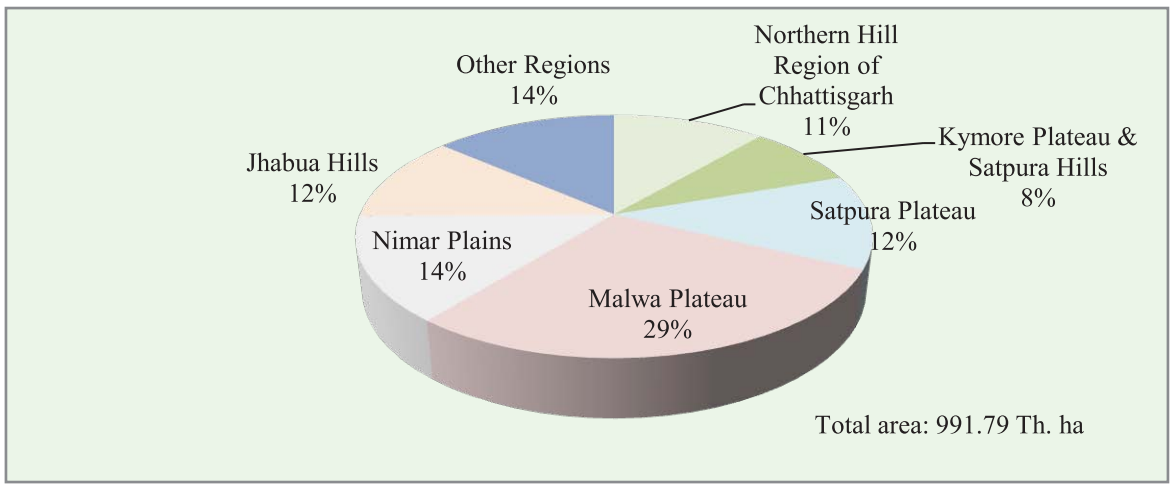

Fig. 5: Percentage contribution in area of maize in different Agro-Climatic Regions of Madhya Pradesh in the Current Year

The absolute area of maize was found to have increased in all the agro-climatic regions of Madhya Pradesh except Malwa Plateau, which experienced decrease of 17.82 percent during the period under study (Table -3). The maximum increase in the area under maize was found in Nimar plains (123.94%) followed by Kymore Plateau and 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%) .

In Madhya Pradesh, percentage contribution to production of maize was also found to have increased in all the agro-climatic regions except Malwa Plateau, where it decreased by 12 percent from 41 percent (the base year) to 29 percent (the current year) of the total production of maize in the state (Fig. 6 and Fig. 7). It was found that percentage contribution to production of maize increased from 4 percent to 6 percent and 8 percent to 18 percent in Kymore Plateau and Satpure Hills and Nimar Plains, respectively, of the total production of maize in the state. It was found to be stagnant in Northern Hill Region of Chhattisgarh, Satpura Plateau, Jhabual Hills and Other regions of Madhya Pradesh, i.e., at 9, 16, 12 and 10 percent, respectively, of the total production of maize in the state both in the current and base year during the period under study.

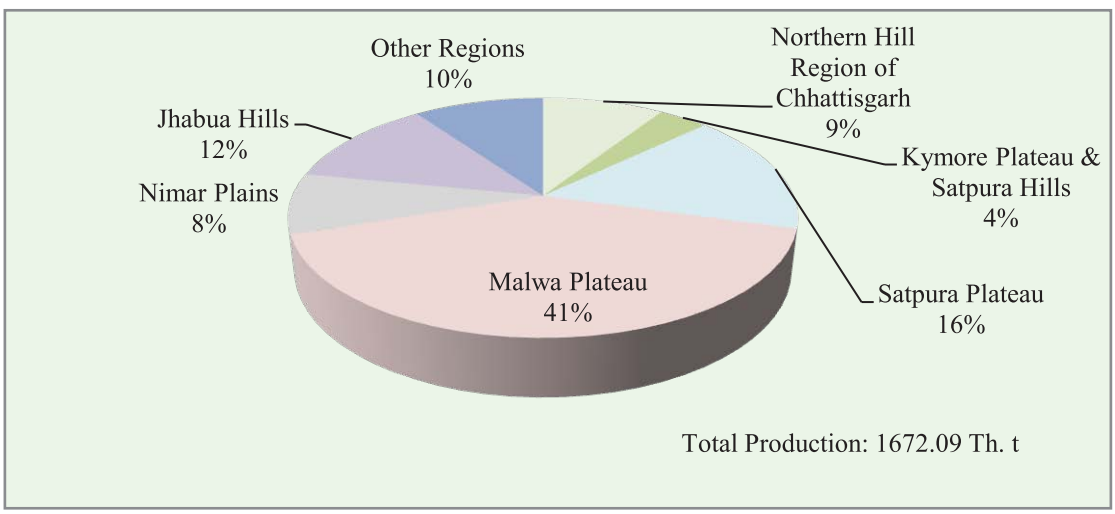

Fig. 6: Percentage contribution in production of maize in different Agro-Climatic Regions of Madhya Pradesh in the Base Year

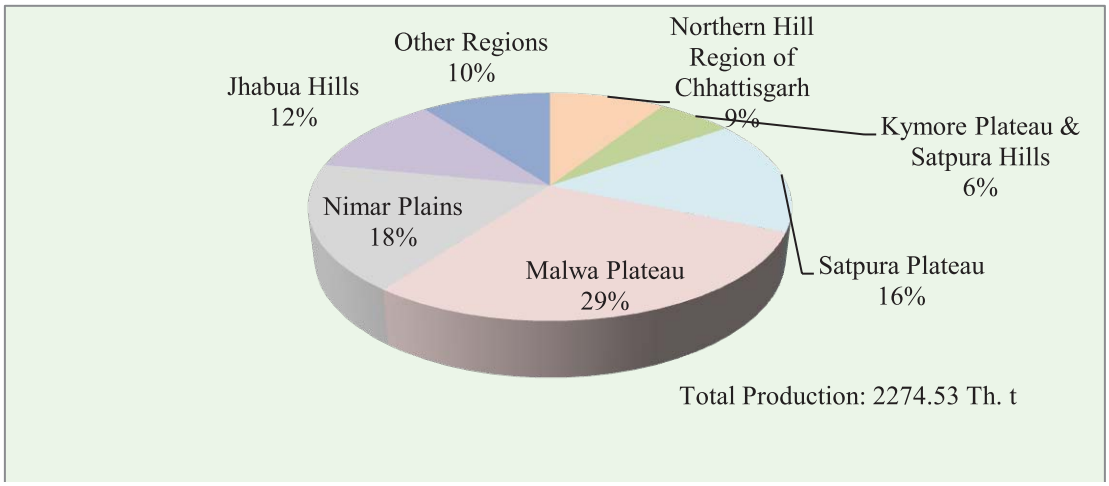

Fig. 7: Percentage contribution in production of maize in different Agro-Climatic Regions of Madhya Pradesh in the Current Year

The absolute production of maize was also found to have increased in all the agro-climatic regions of Madhya Pradesh except Malwa Plateau, where it was found to have decreased by -3.53 percent during the period under study (Table -3). The maximum increase in the production of maize was found in Nimar plains (197.83%) followed by Kymore Plateau and 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%).

TABLE 3: FLUCTUATION IN AREA, PRODUCTION AND YIELD 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	Coefficient of Variation (%)
Area						
Northern Hill Region of Chhattisgarh	96.51	112.73	16.23	16.81	7.6	7.67
Kymore Plateau & Satpura Hills	37.66	82.03	44.37	117.82	22.4	49.93
Satpura Plateau	113.07	124.21	11.14	9.85	26.45	19.92
Malwa Plateau	345.9	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	44.9	49.58	35.98	34.75
Madhya Pradesh	853.6	991.79	138.19	16.19	80.52	9.18
Production						
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	34.5	97.63	30.99

TABLE 3: FLUCTUATION IN AREA, PRODUCTION AND YIELD OF MAIZE IN DIFFERENT AGRO-CLIMATIC REGIONS OF MADHYA PRADESH (000′ HA)-CONTD.

Agro - Climatic Regions	Base year	Current year	Absolute change	Relative change (%)	Standard deviation	Coefficient of Variation (%)
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	520.2	33.67
Yield						
Northern Hill Region of Chhattisgarh	1605.78	1822.08	216.3	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	2215.3	379.23	20.65	506.27	30.41
Nimar Plains	1960.2	2916.84	956.64	48.8	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
Madhya Pradesh	1876.66	2054.12	177.46	9.46	439.98	27.55

The yield of maize was found to have increased in all the agro-climatic regions of Madhya Pradesh except in the other regions, wherein it decreased by 5.91 percent during the period under study. (Table -3) The maximum increase 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 and 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%).

3.2. Trend and growth in area, production and yield of maize

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 and Satpura Hills 7.01% with compound growth of 5.31% per year followed by Nimar Plains (6.93% and 6.30%) per year. (Table -4) 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 % per year) followed by Satpura Plateau (1.66% and 1.40% per year), 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)

In Madhya Pradesh, the trend 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 (2.65% per year) of Madhya Pradesh was significant at 5 % level and the compound growth was positive but non-significant (1.52% per year). The simple and compound growths in Malwa Plateau (0.17 % and 0.17 % per year) were found to be positive but non-significant during the period under study.

The trend and growth in the yield of maize were

found to be positive and have noticed increase in all the agro-climatic regions of Madhya Pradesh (Table-4). The 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% per year) and compound growth was significant at 5% level (2.86% per year). In Satpura Plateau, simple and compound growths were found significant (2.92% and 2.81% per year). In Malwa Plateau the simple as well as compound growth were also found significant with 2.05% 2.05% per year respectively. 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.

TABLE 4: TREND AND GROWTH IN AREA, PRODUCTION AND YIELD OF MAIZE IN DIFFERENT AGRO-CLIMATIC REGIONS OF MADHYA PRADESH

Agro - Climatic Regions	Base year	Current year	Absolute change
	Area		
Northern Hill Region of Chhattisgarh	0.99*	1.00	0.93
Kymore Plateau & Satpura Hills	3.14*	7.01	5.31
Satpura Plateau	2.20*	1.66	1.4
Malwa Plateau	-5.38**	-1.76	-1.74
Nimar Plains	5.76**	6.93	6.3
Jhabua Hills	-0.07	-0.069	-0.12
Other Regions	2.20	2.12	1.22
Madhya Pradesh	8.84	1	0.93
	Production		
Northern Hill Region of Chhattisgarh	4.25	3.19	2.27
Kymore Plateau & Satpura Hills	5.22	8.03	5.21
Satpura Plateau	13.88**	4.41	4.31
Malwa Plateau	0.92	0.173	0.17
Nimar Plains	22.84	12.9	10.54
Jhabua Hills	5.31	3.2	2.49
Other Regions	4.21	2.65	1.52
Madhya Pradesh	56.63	3.66	3.17
	Yield		
Northern Hill Region of Chhattisgarh	23.93	1.86	1.46
Kymore Plateau & Satpura Hills	23.18	1.81	1.26
Satpura Plateau	66.17*	2.92	2.81
Malwa Plateau	39.13	2.35	2.05
Nimar Plains	97.32*	5.02	4.33
Jhabua Hills	49.90	3.23	2.86
Other Regions	2.58	0.17	0.15
Madhya Pradesh	26.26	1.64	1.45

*Note: ** Significant at 1% level, * Significant at 5% level*
SGR= Simple Growth Rate, CGR= Compound Growth Rate

3.3. Area effect, yield effect and interaction effect towards production of maize

The area effect, yield effect and interaction effect towards production of maize have been analyzed and presented in Table 5. 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%) towards increase in production of maize in Madhya Pradesh. Amongst all the major maize growing agro-climatic regions the contribution of area effect was found more than the yield effect and interaction effect except for Jhabua Hills and Satpura Plateau, where yield effect was found to be dominant over area and interaction effect towards increase in production of maize.

The maximum area effect was observed in Malwa Pleateau (505.56%) followed by Other regions (116.06%), Kymore Plateau & Satpura Hills (100.68%), Nimar Plains (62.65%), Northen Hills Regions of Chattisgarh (46.21%), Satpura Plateau (28.56%) and Jhabua Hills (20.31%) during the period under study.

TABLE 5: 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

4. Conclusion and Policy Suggestions

Thus, it can be concluded from the study that area, production and yield of maize was found to have increased in Madhya Pradesh as well as all the major maize growing agro-climatic regions of the state except Malwa Plateau and Jhabua Hills, where area decreased significantly during the period under study. It is also concluded that increase in yield of maize was found to be major contributor followed by increase in area towards increase production of maize in Madhya Pradesh. In all the major maize growing agro-climactic regions viz; Northern Hill Region of Chhattisgarh, Kymore Plateau and Satpura Hills, Malwa Plateau, and Nimar Plains, the increase in production of maize was found mainly due to area effect followed by yield and interaction effect expect in Satpura Plateau and Jhabua Hills where the increase in production of maize was mainly due to yield effect followed by area and interaction effect.

Hence, it can be suggested that, as the area and yield of maize crop at the regions and state level had increased, efforts should be made to increase the extent of value addition for the maize production, viz., corn starch, corn oil, sorbitol, corn flakes, maize cob meals, corn syrup, high fructose corn syrup, etc., through establishment of processing plants in these promising maize growing regions of the state. Efforts should also be made to strengthen the existing storage and processing technology in the area where crop is stable during the period under study viz., Northern Hill Region of Chhattisgarh and Jhabua hills. Efforts should also be made to intensify maize production especially in those regions where the yield level at present is poor, viz., Northern Hills Region of Chhattisgarh, Malwa Plateau and Kymore Plateau and 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.

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