Growth Pattern and Production Projection for Maize Crop in Madhya Pradesh

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CERTIFICATE – I

This is to certify that the thesis entitled ***"Growth Pattern and Production Projection for Maize Crop in Madhya Pradesh"*** *submitted in partial fulfillment of the requirements for the degree of* ***MASTER OF SCIENCE IN AGRICULTURE (Agricultural Economics and Farm Management)*** *of* ***Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur*** *is a record of the bonafide research work carried out by* ***Mr. AYODEJI 'SEUN OGUNLEKE*** *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 the investigation has been dully acknowledged by him.

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INTRODUCTION

The transformation of agriculture to more productive systems has often been accompanied by increased production in a fewer crop species. Concurrently, the area and production of a great diversity of traditional crops have declined. Yet in many parts of the world, these traditional crops play an important role in maintaining stable and sustainable forms of agriculture. Maize is globally a top ranking cereal not only in productivity but also as human food, animal feed and as a source of large number of industrial products. Maize considered as queen of the cereal is one of the most important cereal crop in the world, next only to rice and wheat. Worldwide the area, production and productivity of maize are 137 million ha, 610 million tones and 4.43 t/ha, respectively (Navadkar et al., 2012). Maize in India occupies fourth place in average area in the world, the first three being US, China, and Brazil respectively and ranks sixth in production (Table 1.1). It is grown in 23 states in India with an area of 8.78 million hectare and production of 21.59 million tons with average productivity of 2470kg/ha during 2011-12 (Agricultural Statistics at a glance, 2012). In India, rice and wheat among cereals and maize among the millets took a large share in the country's agricultural economy. Maize is having a promising option for diversifying agriculture in upland areas of India and has got more than 3500 value added products as food, feed etc. in daily consumption. (Singh et. al., 2003). Also, 55 per cent of the maize produce concurrently is used for food purposes, about 14 per cent for livestock feed. 18 per cent for poultry feed, 12 per cent for starch and 1 per cent for seed. By the end of this century the expected demand will be around 46 per cent for food, 14 per cent for livestock feed, 19 per cent for poultry feed, 19 per cent for starch industry and 2 per cent for seed (Navadkar et al., 2012). The state of Madhya Pradesh is one of the traditional and potential maize growing states, (Table 1.2) accounting for almost 10 per cent of the total maize area and contributing 6 percent to the total maize production in the country (Agricultural Statistics at a glance, 2012). However, the productivity of maize in Madhya Pradesh (1500kg/ha) is very

low as compared to that of other maize-growing states and average productivity in the country (2470kg/ha)

Scope of the study

The present investigation relates to different districts of agroclimatic region of Madhya Pradesh, where maize crop is cultivated on ten thousand (10,000) and above hectares of land as kharif crop. The effective changes in relative position of maize crop as a competing crop for land resources with other kharif crops is continuously inducing its adjustment in the cropping pattern. This study examines the relative position of maize and asses its adjustment in the cropping pattern so that the possibilities of acreage and yield expansion may be explored in different agroclimatic regions of the State. Since Madhya Pradesh is one of the high rank states in acreage and production of cereals in the Country with maize being an important cereal crop, it is necessary to examine its growth pattern and have an estimate of likely supply of this crop by the year 2025 in the state. The nature of the study is both positive and normative and it will seek to diagnose the present trend of growth, adjustment in cropping pattern and likely projection by the year 2025 in the different districts of the state. The diagnoses of growth pattern and projection necessitate the prescriptive measure for adjustment in the cropping pattern and needed technological development for higher level of productivity.

Looking to the overall problem of maize production and its potential and future requirement, the present investigation is carried out for different maize growing districts of the state with the following objectives:

1. To analyse the growth pattern and contribution of area, productivity and its interaction towards the change in maize production.
2. To estimate production projection of maize in the State by the year 2025.
3. To evaluate the adjustment of maize in the cropping pattern for exploring possibilities of increasing its production in the State.
4. To suggest the various policies implication for sustainable growth of maize production in the State.

Limitations of the study

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

1. The result of this study will be situation specific.
2. The empirical estimation are based on the data collected from different published records and reports, therefore, validity of data cannot be questioned.

Setting of the chapter

This study is organized into five chapters. Chapter one is introductory chapter, followed by the review of literature. Methodology aspect is presented in chapter three, while the result and discussion is placed in chapter four. The summary of the result and, conclusion based on the results, policy implications and suggestions are given in chapter five, and then followed by bibliography.

Table1.1: Top maize producing Countries in the World (2011-2012).

S.N.	Country	Area ('000 ha)	Area Share (%)	Production ('000MT)	Production Share (%)	Productivity (MT/ha)
1.	USA	34151	20.28	317440	37.14	9.30
2.	China	33000	19.60	178000	20.83	5.39
3.	Brazil	8731	5.18	61043	7.14	6.99
4.	Argentina	3600	2.14	27500	3.22	7.64
5.	Mexico	7050	4.19	24000	2.81	3.40
6.	India	8500	5.05	21000	2.46	2.47
7.	Others	73376	43.57	225691	26.41	3.08
8.	Total	168408	100	854674	100	5.08

Source: US Department of Agriculture.

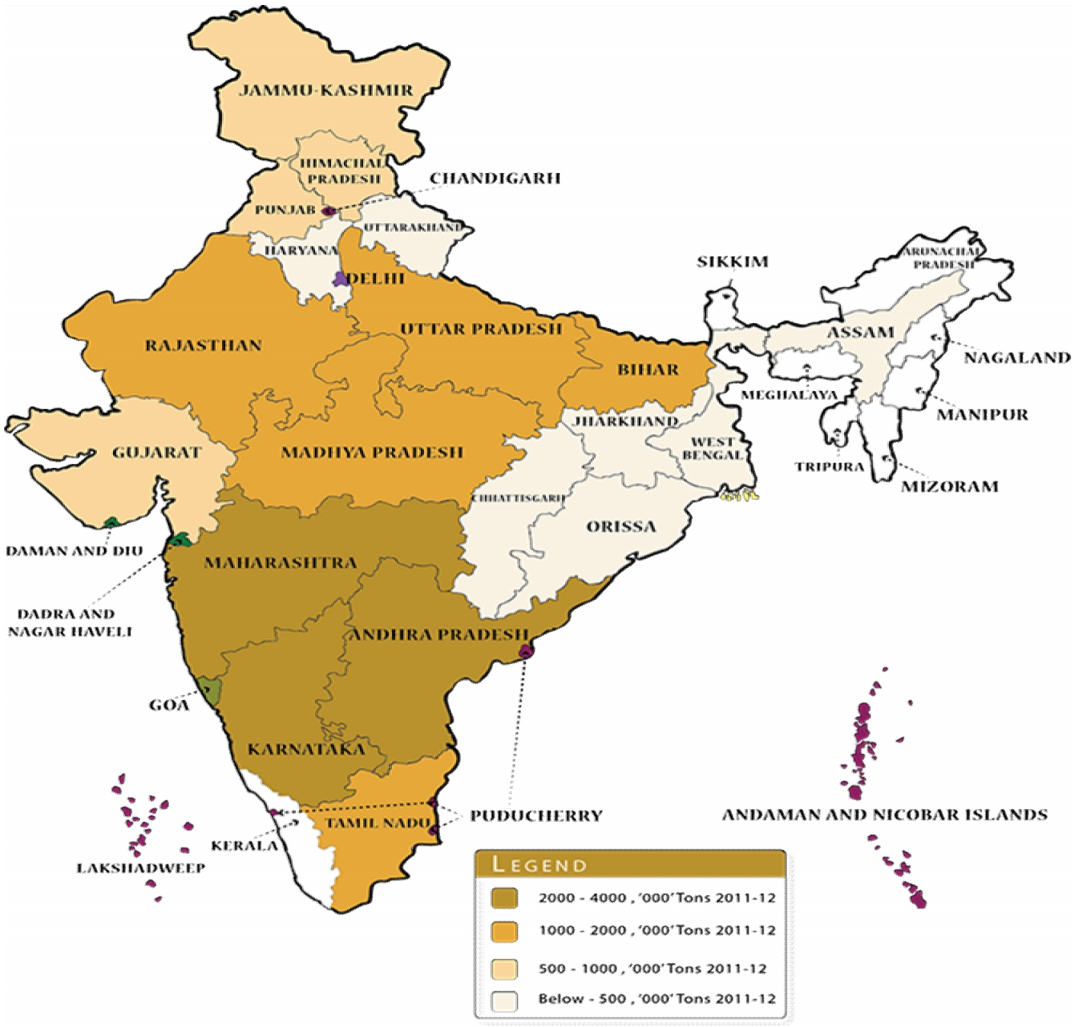

Fig 1: Map of India showing major maize growing states

Table1.2: Top maize producing States in India (2011-2012).

S.N.	STATE	Area ('000 ha)	Area Share (%)	Production ('000MT)	Production Share (%)	Productivity (MT/ha)
1.	Karnataka	1349.0	13.36	4090	18.94	3.03
2.	Andhra Pradesh	864.0	9.84	3760	17.42	4.35
3.	Maharashtra	736.0	8.38	2300	10.65	3.13
4.	Rajasthan	1045.6	11.91	1670	7.74	1.60
5.	Tamil Nadu	280.6	3.20	1570	7.27	5.60
6.	Bihar	675.0	7.69	1520	7.04	2.25
7.	Uttar Pradesh	787.0	8.96	1310	6.07	1.67
8.	Madhya Pradesh	862.8	9.83	1290	5.97	1.50
9.	Others	2181.9	24.85	4080	18.90	1.87
10.	Total	8781.9	100	21590	100	2.46

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India.

REVIEW OF LITERATURE

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 maize production growth pattern in different districts of agro-climatic regions of the state. The review is presented in the following headings:

2.1 Studies on growth and cropping pattern of crops.

2.2 Use of ARIMA model for crop production projection.

2.1 Studies on growth and cropping pattern of crops.

Lal *et al.* (1994), conducted a study on growth rate of area, production and productivity of rice, wheat and maize in Bihar state over the period 1951-52 to 1987-88, findings which is encompasses the pre and post green revolution period. This showed that the growth rate of production was increased significantly for all crops due to growth in productivity. The contribution of area to production was not significant for rice in the study period.

Shete *et al.* (1997), studied an annual compound growth of area, production and productivity of total cereals, pulses, oilseeds, sugarcane and cotton crops during different time period viz, period- I (1956-57 to 1966-67), period-ii (1967-68 to 1977-78) and period-iii (1978-79 to 1989-90). The increase in the production of cereals during period-I was due to area expansion and during subsequent period it was combined with productivity improvements in all the regions. The productivities of pulses declined in period-I and witnessed some home of increasing production during dates periods. Maharashtra continued to be the deficient state of oilseeds

production during the sixties and seventies and experienced some dramatic changes in production during the eighties.

Mazundar and Das (1999) studied the compound growth rates, variability and relative contribution of area and productivity to change in production of cereal crops in Assam state using exponential function and a three factor decomposition model. The study period 1951-52 to 1995-96 was divided in three sub period. The results showed that the growth rates of productivity in particular were lower in the state than all India average. The value of coefficient of variation indicated that wheat crop was an unstable crop in the period. As shown by decomposition analysis, the yield effect increased for paddy and coarse cereals, whereas for wheat, both area and productivity effect increased with a reduction in interaction effect. The finding of the study indicated that the less impact of green revolution/ improved technology in the state. It was revealed that appropriate policy measures need to be implemented to increase production and productivity.

Soni (2000); concluded that the absolute acreage change under kharif expect soybean decreased in current year (1998-99) over base year (1983-84). Whereas, it was found that there are increase in area of gram, lentil and linseed (Rabi crops). Thus, there was a shift in cropping pattern for low valuable crops to remunerative once. This shift has been found proportionately more in kharif as compared to rabi crops in the region. The study also revealed that the intensity of cropping increased from 108.00 to 130.67% showing more intense use of land during these years.

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. But 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. Introduction of high yielding varieties in the year 1964 served as fillip in real breakthrough for increasing the food grain production.

Singh and Shrivastava (2003) studied the area, production and productivity of Sugarcane for western, eastern and central India, (including Bundelkhand) as well as for the state with reference to the period 1980-81 to 1998-99. A significant and positive growth rate of area in all the region was reported. Production was also registered a significant and positive growth in the three regions. Although significant and positive growth in the production of sugarcane has emerged as a common feature in all the three regions of the state, its magnitude is not uniform across the regions. This calls for adequate measures to improve location specific production technology through research development and extension efforts and also through ensured input supply mechanism. Further, sugarcane production instability is observed in the state with its varied magnitude across the regions.

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. Bhatriagar and Joshi (2004); presents an overview of the economic importance of the soybean crop in India and examined the trends in soybean production, utilization and processing in the country from the 1960s to early 2005. An overview of the soybean production technology and cultivars in India as well as the biotic constraints to production was also presented.

Jahagirdar *et al*. (2004), analysed growth rate of production components of cotton in Maharashtra covered data from 1960-60 to 1995-96. They observed that production and productivity of cotton were found to be

highly inconsistent over the entire period of the study. The magnitude of variability in production and yield were low in the phase prior introduction of new technology but there after from 1970's, it has increased considerably. Significant growth rates were not observed for almost all districts during any phase.

Samul *et al.* (2004), studied trends in area, production and productivity of sugarcane in relation to weather in Maharasthtra and Uttar Pradesh during period 1970-71 to 1990-91. The compound growth rate of area, production and productivity of sugarcane in Maharasthtra and Uttar Pradesh are positive except in few cases where it is negative. The total output of sugarcane has increased mainly due to rise in area and productivity in the states of India, which revealed that weather played a significant role in the growth and production of sugarcane and cause variation of yield in Maharasthtra and Uttar Pradesh.

Singh *et al.* (2004) reported that Punjab has been well known for productivity increase by more than five times in five decades (1950 to 2000), area by three times and production by more than fifteen times. Its productivity continues to increase at the growth rate of more than 2 per cent. Its yielded variability across districts has declined over time. Various deficiency parameters were not in any uniform association with farm size. The constraints to efficiency have to be found more in terms of the structure and level of inputs used rather than the achievement of outputs in case of wheat, the share of mechanization of Punjab agriculture having taken place by that time.

Ahirwar *et al.* (2005), studied the relative change, growth and variation in area, production and productivity of major oilseed crops in India, viz, Rapeseed, Mustard and Soybean. The study is based purely on secondary data, which were collected over 32 years (1970-71 to 2003-04). The growth rate in area, production and productivity of soybean was 18.91, 20.87 and 1.65 respectively. The growth rate of Rapeseed and Mustard was recorded as 1.95 in area, 3.81 in production and 2.08 in productivity in India and its

relative change in area, production and productivity was found to be 59.09, 86.96 and 68.05 per cent in the country respectively.

Nahatkar *et al.* (2005) made an attempt to ascertain the growth pattern of soybean production in major soybean growing agro-climatic zones of Madhya Pradesh for the period of 1981 to 2001, using secondary data on area, production and yield. They concluded that the higher growth in production of soybean in the State was due to significantly higher growth of area (horizontal expansion). The growth of soybean production during first decade (1981 – 1990) was higher (25.07%) as compared to the growth (6.92%) during second decade (1991 – 2001). This clearly indicates that increase in soybean production is only possible through breaking yield barriers and reducing exciting yield gaps (up to 7q/ha) through increasing rate of adoption production technologies along with supply of quality inputs. There is a need to identify the focal point of intervention after assessing and prioritizing biotic and abiotic stress for different agro-climatic zones and within zones for different agricultural production systems (micro-situation).

Prajneshu and Candran (2005) stated that growth rates are widely employed in the field of agriculture as these have important policy implications. The usual parametric approach for growth rate analysis is to assume multiplicative error in the underlining non-linear geometric model and fit the linearized model by method of Least squares. The deficiencies of this approach had been highlighted. It has been argued that nonlinear estimation procedures should be employed for fitting the model and then only the growth rate should be computed. A methodology has been discussed to compute the compound growth rate by using growth model, viz, monomolecular, logistic and Gompertz. Further, as an illustration, the total food grain production of India during the period 1980 to 2001 has been considered and its growth rate has been computed.

Vitonde *et al.* (2005) examined the growth and instability in area, production and productivity of important oilseeds and pulses, viz, sunflower, groundnut, soybean, mung, urid, tur and gram for period 1970-71 to 2000-01. The time series data have been collected from the government publication of

joint Directorate of Agriculture, Amaravati Division (MS). The data have been analysed by fitting exponential function to estimate growth rate and instability index model for measuring instability. Chow's test was used to measure the structural changes during different periods. The study was performed during three periods; 1970-71 to 1979-80 (period I), 1980-81 to 1989-90 (period II) and 1990-91 to 2000-01 (period III) – the period after the green revolution. The growth rates of area, production and productivity have shown mixed trends. Groundnut crop has noticed negative growth rate during all the periods, soybean crop has registered maximum growth rate during the study period in all the districts. The maximum instability has been found during period III for most of the crops. Equality of growth rate (structural changes) has been observed for the area, production and productivity in different districts for the crops. Increasing trends had been observed in respect of area, production and productivity in the western Vidarsha for all the crops. Productivity level was maximum during the second period due to adoption of new technologies, improved varieties and disease and pest management during this period.

Ahirwar *et al.* (2006); study addressed the issues concerning growth in area, production and productivity and supply response of soybean in different districts in Malwa Plateau of Madhya Pradesh. The secondary data related to area, production and productivity of soybean, were collected for the period of 1990-91 to 2002-03. The results show that the growth of soybean productivity was positive in Dhar, Mandsour, Ratlam, Dewas and Rajgarh districts but it was insignificant except for Dewas, while in case of area, growth was positive and significant for all districts of Malwa Plateau. The coefficient of lagged area under soybean was having positive and highly significant impact on current area under soybean area in Indore, Ujjain, Dewas and Rajgarh districts as well as lagged yield of soybean was found to have positive and highly significant impact on the current area of soybean in Dhar, Mandsour and Dewas districts.

Devraj *et al.* (2006), analyzed growth and instability of Chickpea (gram) production in Madhya Pradesh. It was revealed that the state registered a positive compound growth rate in area, production and productivity of

chickpea production but insignificant growth rate was observed only in area under the crop. An inter period analysis indicated that the state witnessed insignificant growth rate of chickpea production during 1990-91 to 2000-01 and significant and positive growth rate during 1980-81 to 1989. The study of instability index indicated that productivity variability has more revealed that half of area under chickpea in the state suffered from low growth rate in production. Hence, there is a need for developing district and sumbhag specific strategy rather than old blanket strategy of state as a whole

Kumar and Mittal (2006) reported that sustainability issue of the crop productivity is fast emerging. The post-Green Revolution phase is characterized by high input-use and decelerating total factor productivity (TFP). The agricultural productivity attained during the 1980s has not been sustained during the 1990s and has posed a challenge for the researchers to shift the production function upward by improving the technology index. It calls for an examination of issues related to the trends in agricultural productivity, particularly with reference to individual crop grown in the major states of India. Temporal and spartial variations of TFPG for major crops of India have also been examined.

Sadeesh (2006) analysed the growth and instability of major oilseeds in India. The study covered the period 1971-72 to 2002-03 and estimated compound growth rate and coefficient of area, production and yield of total oilseeds in major states of India. The study concluded that the area under groundnut has been contributing maximum to oilseed crops of the Country. Now , it is been replaced by other fast emerging crops such as soybean, sunflower, rapeseed and mustard and sesame. Yield of groundnut is almost stagnant over the year. Production of almost all oilseed crops is stable and increased in soybean. However, the total production of oilseed was found to increase. This was because of implementation of technology mission on oilseeds. Thus, there was increase in area and productivity and this increases average productivity of oilseed in order to reduce import of oilseeds.

Ahirwar *et al*. (2007) while examining the compound growth rate of pigeon pea found out that 2.17%, 0.031% and 0.206% of area, production and

productivity in India respectively. The highest and highly significant growth rates of area and production were 4.17 and 5.19 per cent in Andhra Pradesh. The percent variation of area, production and productivity of pigeonpea were 3.04, 10.84 and 10.61 per cent respectively in India. The highest variation in area and production was found for Mizoram State (72.76% and 92.49%), however, the highest productivity variation was noted for Rajasthan (48.72%). The relative change was found negative in area, production and productivity in India during the period under study. The projected area is expected to decrease from 35.18 to 33.70 million hectares, while production and productivity are expected to increase from 23.47 to 23.50mt and 667kg/h to 696kg/ respectively in year 2015-16, if all things remain constant. It also indicates that pigeon pea as a slow growth crop needs special attention by the researchers for ensuring the livelihood and nutritional security of increasing population.

Malley *et al*. (2007): stated that sustainable development is necessary for sustainable economic growth and social development in Africa. Sustainable agriculture largely depends on how effective natural and environmental resources are managed and utilized. It also depends on the security of access to such resources. This research was aimed at lauding the trends in agricultural productivity, examining the persistence of the environmental insecurity, analysing the relationship between the two, and exploring their links to the national development policies. The variations was observed in total annual production of rice and maize, which are major cereals in the study area as a result of education of farmers on sustainable use and management of land resources and pro-poor rural policies in agriculture.

Dhakre and Sharma, (2010); stated that maximum decrease in area under maize crop was (-) 16.02 % in the year 1999-2000 and maximum increase in area under maize crop was 30.23 % in the year 2000-01. 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.

Shankar *et al.* (2010). The result 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 crop (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 sesamum, whereas it was negative for surghum and kodo. The growth rate of production was found to be positive for all selected kharif crops except surghum and kodo that showed negative trend in production mainly due to declining trend under area. Surghum and kodo exhibited declining production trend (-2.71%) and (4.43%) respectively which was 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 sesamum (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.

Kirtti and Goyari (2013); used kink exponential growth rate model to analyse growth rates of area, production and yield of major crops in Odisha for pre-liberalization and post-liberalization periods The results show that all crops, except rice experienced deceleration in area during post-liberalization period. Among those crops, bajra, jowar, wheat, ragi and small millet

experienced a higher deceleration. Even the positive growth rate of rice area was very trivial. The analysis of growth rate of production has shown that some crops like wheat, ragi and millet experienced decline in the pre-liberalization period, which exacerbated in the post-liberalization period. Other crops like sorghum, gram, arhar, experienced a deceleration in post-reform period compared to pre-reform period. Rice and maize are the two crops which maintained a positive growth trend in both periods. It shows that rice is the only crop that has been benefitting from the reforms. Somehow maize also benefitted though its area is declining. The trade liberalization induced crop concentration instead of diversification as expected. The deceleration of production performance of other crops in post-reform period revealed that reforms have not been in favour of agricultural growth in Odisha.

2.2 Use of ARIMA model for crop production projection.

Najeeb *et al.* (2005) employed Box-Jenkins model to forecast wheat area and production in Pakistan. Their study showed that ARIMA (1, 1, 1) and ARIMA (2, 1, 2) were the appropriate models for wheat area and production respectively.

Falak and Eatzaz (2008) analyzed future prospects of wheat production in Pakistan. They obtained the parameters of their forecasting model using Cobb-Douglas production function for wheat, while future values of various inputs are obtained as dynamic forecasts on the basis of separate ARIMA estimates for each input and for each Province.

Badmus and Ariyo (2011); used ARIMA model to forecast area and production of maize in Nigeria. They estimated ARIMA (1, 1, 1) and ARIMA (2, 1, 2) for cultivated area and production respectively. The result shows maize production forecast for the year 2020 to be about 9952.72 tons with upper and lower limits 6479.8 and 13425.64 thousand tons respectively. The model also shows that the maize area would be 9229.74 thousand hectares with lower and upper limit of 7087.67 and 11371.81 thousand hectares respectively by 2020.

Suleman and Sarpong, (2012), employs the Box-Jenkins approach to model milled rice production in Ghana using time series data from 1960 to

2010.The analysis revealed that ARIMA (2, 1, 0) was the best model for forecasting milled rice production. Although, a ten years forecast with the model shows an increasing trend in production, the forecast value at 2015 (283.16 thousand metric tons) was not good enough to compare with the current production of Nigeria (2700 thousand metric tons), the leading producer of rice of rice in West Africa.

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 its projection for 2025 AD in the different agroclimatic regions of Madhya Pradesh are dealt within this chapter.

The research methodology has been discussed in detail under the following headings:

3.1 Study area

3.2 Nature, sources of data and reporting period

3.3 Analytical tools used.

3.1 Study area:

The study is carried out in the State of Madhya Pradesh. The State comprises of eleven (11) agro-climatic regions, which are; Chhattisgarh plains, Northern hill region of Chhattsgarh, Kaymoor plateau and Satpura hills, Vindhya plateau, Central Narmada valley, Gird region, Bundelkhand region, Satpura plateau, Malwa plateau, Nimar plateau and Jhabua hills. For the purpose of the present investigation, districts within each region were treated as micro (primary) units of the study and agroclimatic regions within the state as macro (secondary) units. The major maize growing districts in different agroclimatic regions were selected based on the area under cultivation of the crop. Any district that allocates ten thousand (≥10,000ha) and above area for the cultivation of maize were selected. The list of the selected districts and agroclimatic regions on the basis of above criteria is given in Table 3.1 and

the details on districtwise area, production and productivity along with its share is given in table 3.2

Fig 2: Map of Madhya Pradesh showing agroclimatic zones

Table 3.1: Selected agro-climatic regions and districts covered

S.N.	Agro-climatic region	Districts covered	% of maize area to GCA	% of maize area to Cereals area
1.	Northern hill region of Chhattsgarh	Anuppur, Mandla, Umaria, Shahdol, Dindori.	5.67	7.95
2.	Keymore plateau and Satpura hills	Sidhi, Seoni.	4.16	6.68
3.	Vindhya plateau	Sehore.	2.04	6.81
4.	Gird region	Guna, Shivpuri	3.62	11.08
5.	Satpura plateau	Betul, Chhindwara.	8.30	17.77
6.	Malwa plateau	Neemuch,Mandsour,Rajgarh, Ratlam,Dewas,Ujjain, Shajapur.	5.43	23.73
7.	Nimar valley	Khargone, Barwani.	6.13	15.43
8.	Jhabua hills	Jhabua, Dhar.	13.48	34.72

Table 3.2: Selected districts in Madhya Pradesh (2011-2012).

S.N.	Districts	Area ('000 ha)	Area Share (%)	Production ('000t)	Production Share (%)	Productivity (kg/ha)
1	Mandla	18.2	2.09	28.4	1.20	1313
2	Anuppur	13.1	1.33	9.7	0.78	738
3	Umaria	10.6	1.22	9.0	0.50	848
4	Shahdol	10.8	1.27	10.9	0.56	1007
5	Dindori	25.9	2.10	30.8	0.91	1192
Region 1	**Northern hill region of Chhattsgarh**	**78.6**	**9.5**	**84.3**	**6.4**	**1073**
6	Sidhi	9.2	1.02	10.0	0.51	1083
7	Seoni	11.5	1.78	14.8	1.24	1289
Region 2	**Keymore plateau and Satpura hills**	**32.7**	**3.9**	**37.8**	**2.9**	**1156**
8	Sehore	7.5	1.26	14.0	0.71	1870
Region 3	**Vindhya plateau**	**28.3**	**3.4**	**46.6**	**3.5**	**1647**
9	Guna	13.3	2.08	21.8	1.80	1639
10	Shivpuri	27.4	2.78	48.3	2.31	1758
Region 4	**Gird region**	**48.1**	**5.8**	**80.7**	**6.1**	**1678**
11	Betul	44.0	5.75	69.6	5.61	1584
12	Chhindwara	89.70	10.84	268.70	40.11	2996
Region 5	**Satpura plateau**	**133.7**	**16.1**	**338.3**	**25.7**	**2530**
13	Neemuch	29.5	3.26	57.1	3.21	1938
14	Mandsour	34.0	3.85	47.0	3.05	1381
15	Rajgarh	51.1	5.96	62.0	3.55	1215
16	Ratlam	50.2	5.85	111.7	8.41	2223
17	Dewas	8.7	1.33	12.6	1.15	1455
18	Ujjain	6.1	0.68	7.0	0.47	1144
19	Shajapur	39.7	4.21	60.6	1.73	1528
Region 6	**Malwa plateau**	**222.2**	**26.8**	**361.8**	**27.5**	**1628**
20	Khargone	20.7	2.68	26.6	2.11	1285
21	Barwani	31.3	4.08	42.8	3.86	1368
Region 7	**Nimar valley**	**59.3**	**7.1**	**84.0**	**6.4**	**1417**
22	Dhar	63.1	6.44	91.4	4.29	1449
23	Jhabua	68.5	7.90	78.7	4.24	1150
Region 8	**Jhabua hills**	**131.6**	**15.8**	**170.1**	**12.9**	**1293**
s24	Others	143.63	16.65	99.20	7.71	690.00
25	**Total**	**830.6**	**100.00**	**1315.2**	**100.00**	**1595**

Source: Directorate of Economics and Statistics, Ministry of Agriculture, Government of India

3.2 Nature, Sources of Data and Period of study

In order to get comprehensive picture of growth pattern of maize production for the selected 23 districts covering 8 agro-climatic regions, the time series data for the period of years, i.e. 1990-91 to 2011-12 were collected. The data were collected on area, production and productivity of maize crop for each selected district of the region. Three year moving average has been worked out in order to minimize the irregular fluctuations in time series data.

The data were secondary in nature and mainly collected from Agricultural Statistics of Madhya Pradesh (an annual publication of Directorate

of Agriculture, Madhya Pradesh, Bhopal and Commissioner of Land Records, Madhya Pradesh, Gwalior).

Study Period – 1990-91 to 2011-12

3.3 Analytical Tools Used:

3.3.1 Growth Pattern

$$\text{Relative change (\%)} = \frac{P_n - P_o}{P_o} \times 100$$

Where,

Pn = Triennium Average of current year for area, production and yield (2009-10 to 2011-12)

Po = Triennium Average of base year for area, production and yield (1990-91 to 1992-93)

Trend (Linear)

$$Y = a + bt$$

Where,

Y= Trend value of dependent variable (Area, Production, Yield)

a = constant

b =Trend coefficient

t = Independent variable (Time in years)

$$\text{Linear Growth Rate (LGR)} = \frac{b}{\overline{Y}} \times 100$$

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

3.3.2 Decomposition Analysis:

$$\text{Area Effect (AE)} = \frac{(An - Ao)Yo}{(Pn - Po)} \times 100$$

$$\text{Yield Effect (YE)} = \frac{(Yn - Yo)Ao}{(Pn - Po)} \times 100$$

$$\text{Interaction Effect (IE)} = \frac{(An - Ao)(Yn - Yo)}{(Pn - Po)} \times 100$$

A_o = Triennium Average of Area in base year

P_o = 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

$Y_n = P_n/A_n$

3.3.3 Adjustment in Cropping Pattern:

$$\text{Index level} = \frac{Current\ Year}{Base\ Year} \times 100$$

Table 3.3: Departure of index from the base

S.N.	Group	Percentage extent of Variation in area or yield	Index level of Area or yield
1.	A	More than 30	Above 130
2.	B	+10 to 30	110 to 130
3.	C	±10	90 to 110
4.	D	-10 to -30	70 to 90
5.	E	Below -30	Up to 70

Table 3.4: Combination representing different set of situation

S.N.	Crop adjustment Category	Area dominating	Yield dominating
1.	Well-adjusted	AA ,BB, CC	DD, EE
2.	Sufficiently-adjusted	AB, BC, CD, DE	BA, CB, DC, ED
3.	Tolerable-adjusted	AC, BD, CE	CA, DB, EC
4.	Poorly-adjusted	AD, BE	DA, EB
5.	Very poorly adjusted	AE	EA

3.3.4 Production Projection

ARIMA Model: Auto Regressive Integrated Moving Average is the most general class of models for forecasting a time series. The ARIMA model is denoted by ARIMA (p,d,q),

Where,

p – stands for the order of the auto regressive process

d – is the order of the data stationary and

q – is the order of the moving average process.

The general form of the ARIMA (p,d,q) can be written as:

$$\Delta^d y_t = \delta + \theta_1 \Delta^d y_{t-1} + \theta_2 \Delta^d y_{t-2} + - - - + \theta_p \Delta^d y_{t-p} + e_{t-1} \alpha e_{t-1} - \alpha_2 e_{t-2} \alpha_q e_{t-2} \ldots$$

…… (1)

Where,

Δ^d denotes differencing of order d, i.e., $\Delta y_t = y_t - y_{t-1}$,

$\Delta_t y_t = \Delta y_t - \Delta_{t-1}$ and so forth,

Y_{t-1} ……..Y_{t-p} are past observations (lags),

$\delta . \theta_1$ ……θ_p are parameters (constant and coefficient) to be estimated similar to regression coefficients of the Auto Regressive process (AR) of order "p" denoted by AR (p) and written as;

$$Y = \delta + \theta_1 y_{t-1} + \theta_2 y_{t-2} + \ldots\ldots\ldots + \theta_p y_{t-p} + e_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

Where,

e_t is forecast error, assumed to be independently distributed across time with mean θ and variance $\theta_2 e$, e_{t-1}, e_{t-2} ……..e_{t-q} are past forecast errors,

α_1, …….. α_q are moving average (MA) coefficient that needs to be estimated.

MA model of order q, i.e. MA (q) can be written as

$$Y_t = e_t - \alpha_1 \alpha_{t-1} - \alpha_2 e_{t-2} \ldots\ldots\ldots\ldots\alpha_q e_{t-q} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (3)$$

The estimation procedure of the model consists of four steps, namely: identification, estimation of parameters, diagnostic checking and forecasting.

Identification step:

Identification step involves the use of the techniques to determine the values of p, q and d. The values are determined by using Autocorrelation Function (ACF) and Partial Autocorrelation Function (PACF).

Estimation of parameters:

The second step is the estimation of the model parameters for the tentative models that have been selected.

Diagnostic checking:

Having chosen a particular ARIMA model and having estimated its parameters the fitness of the model is verified. One simple test is to see if the residuals estimated from the model are white noise, if not we must start with other ARIMA model. The residuals were analyzed using Box-Ljung Statistic.

Forecasting:

One of the reasons for the popularity of the ARIMA modeling is its success in forecasting. In many cases, the forecasts obtained by this method are more reliable than those obtained from the traditional econometric modeling, particularly for short-term forecasts. An Autoregressive Integrated Moving Average Process model is a way of describing how a time series variable is related to its own past value. Mainly an ARIMA model is used to produce the best weighted average forecasts for a single time series (Rahulamin and Razzaque 2000).The accuracy of forecasts for both Ex-ante and Ex-post were tested using tests; such as Mean square error (MSE) and Mean Absolute percentage error (MAPE) (Markidakis and Hibbon, 1979).

RESULTS AND DISCUSSION

In this chapter, the empirical results pertaining to the earlier stated objectives are presented for different agro-climatic region of Madhya Pradesh.

4.1 Relative change in production components

The acreage and productivity are the main components of total production of any crop and therefore, the relative change in acreage, production and productivity of maize crop were estimated for different agro-climatic regions of Madhya Pradesh. Data on relative change and coefficient of variation of production components of maize for different agro-climatic regions are presented in Table 4.1.1 to 4.1.8.

4.1.1 Northern Hill region of Chhattisgarh

Table 4.1.1: Relative Change and Coefficient of Variation of area, production and productivity of maize in Northern hill region of Chhattisgarh

Districts		P_o	P_n	RC (%)	CV (%)
	A	14.55	18.31	25.85	10.15
Mandla	**P**	22.12	21.05	-4.81	17.32
	Y	1520.28	1149.65	-24.38	16.32
	A	11.81	12.08	2.32	1.45
Anuppur	**P**	14.72	10.05	-31.71	16.99
	Y	1246.40	831.95	-33.25	14.42
	A	9.35	10.48	12.22	5.09
Umaria	**P**	10.29	6.34	-38.37	31.38
	Y	1100.54	604.96	-45.03	29.89
	A	23.49	11.34	-51.73	33.13
Shahdol	**P**	24.09	10.96	-54.52	40.66
	Y	1025.54	966.49	-5.76	14.42
	A	20.72	19.00	-8.30	5.93
Dindori	**P**	30.04	17.61	-41.40	27.68
	Y	1449.81	926.84	-36.07	28.48
	A	79.89	71.20	-10.88	7.19
Region	**P**	101.25	66.00	-34.81	25.00
	Y	1267.37	926.97	-26.88	20.68

A: Area (‘000 ha), P: Production (‘000 tones), Y: Yield (kg/ha)

In Northern hill region of Chhattisgarh maize is grown in area of 71.20 thousand hectares which accounts for 8.57 per cent of the total maize area

in the state during the current year. The data on relative change and variation in acreage, production and productivity are presented in Table 4.1.1.

The data show that the relative change in area, production and productivity is negative and variation in production was higher than that of productivity and acreage of maize. All the districts of Northern Hill region of Chhattisgarh experienced reduction in production and productivity of maize. There is increase in maize area in Mandla, Anuppur and Umaria while Shahdol and Dindori experienced decrease in the area.

The results show that decrease in acreage and productivity had resulted in low production of maize crop in the entire Northern hill zone of Chhattisgarh.

4.1.2. Keymore plateau and Satpura hills

In Keymore plateau and Satpura hills, 20.68 thousand hectares is used to grow maize crop during the current year which accounts for 2.49 per cent of the total area of this crop in the state. The data revealed that relative change for acreage, production and productivity were negative. Sidhi district shows decrease in acreage, production and productivity. Relative change in acreage and production for Seoni district is positive while negative for productivity.

Table 4.1.2: Relative Change and Coefficient of Variation of area, production and productivity of maize in Keymore plateau and Satpura

Districts		P_o	P_n	RC (%)	CV (%)
	A	37.61	9.18	-75.60	34.38
Sidhi	**P**	44.53	10.70	-75.99	38.52
	Y	1183.99	1165.58	-1.56	14.33
	A	9.48	11.50	21.36	16.12
Seoni	**P**	12.73	13.05	2.53	31.11
	Y	1342.83	1134.78	-15.49	18.15
	A	47.08	20.68	-54.24	26.29
Region	**P**	57.26	23.75	-58.53	32.33
	Y	1216.23	1148.45	-5.57	13.48

A: Area ('000 ha), P: Production ('000 tones), Y: Yield (kg/ha)

The results show that there is significant decrease in maize production in the region which is a result of higher decrease in acreage especially in

Sidhi district of the plateau. The variation in production is higher than the variation in acreage and productivity in the region.

4.1.3. Vindhya Plateau and Madhya Pradesh

In Vindhya plateau maize crop is grown in area of 14.65 thousand hectares which accounts for 1.76 per cent of the total area of this crop in the state. The data revealed that in Sehore, which is the only major maize producing district in the region, the relative change in area and production is positive and the variation in production is higher than variation in acreage and productivity.

Table 4.1.3: Relative Change and coefficient of variation of area, production and productivity of maize in Vindhya plateau

Districts		P_o	P_n	RC (%)	CV (%)
Sehore	**A**	10.05	14.65	45.80	18.69
	P	13.23	16.52	24.83	34.35
	Y	1316.42	1127.65	-14.34	19.60
Madhya Pradesh	**A**	887.60	830.53	-6.43	2.98
	P	1175.77	1172.47	-0.28	20.75
	Y	1321.67	1406.00	6.38	19.65

A: Area ('000 ha), P: Production ('000 tones), Y: Yield (kg/ha)

In this region, especially in Sehore, the increase in production is due to increase in acreage. For the state as a whole, the relative change in area and production is negative while that of productivity is positive. Variation in production is higher than variation in acreage and productivity. According to the data, decrease in maize production in Madhya Pradesh is a result of decrease in acreage.

4.1.4 Gird region

Maize crop in Gird region is grown in area of 48.45 thousand hectares and it accounts for 5.83 per cent of the total area of maize crop in the state. In this region, relative change for area, production and productivity is positive. In Guna district, there is relative decrease in area and production while productivity increased. Shivpuri shows significant increase in area, production and productivity.

Table 4.1.4: Relative Change and coefficient of variation of area, production and productivity of maize in Gird region

Districts		P_o	P_n	RC (%)	CV (%)
	A	22.64	20.48	-9.55	6.88
Guna	**P**	25.36	23.56	-7.10	28.57
	Y	1120.14	1150.39	2.70	23.72
	A	20.19	27.96	38.52	14.10
Shivpuri	**P**	29.10	43.10	48.44	24.81
	Y	1441.31	1541.49	6.95	22.04
	A	42.83	48.45	28.97	4.96
Region	**P**	54.46	66.75	22.58	23.82
	Y	1271.54	1377.71	8.35	23.08

A: Area ('000 ha), P: Production ('000 tones), Y: Yield (kg/ha)

In Gird region, area and productivity of maize increased satisfactorily, especially in Shivpuri district of the region. This reveals that the production of maize in the region increased due to increase in area and productivity. The variation in acreage is lower as compared to variation in production and productivity.

4.1.5 Satpura plateau

Maize was grown in area of 129.86 thousand hectares in Satpura plateau which account for 15.64 per cent of the total area of this crop in the state in the current year. In this region, area and production increased in current year over base year while productivity decreased

Table 4.1.5: Relative Change and coefficient of variation of area, production and productivity of maize in Satpura plateau

Districts		P_o	P_n	RC (%)	CV (%)
	A	20.86	42.70	104.69	35.50
Betul	**P**	31.16	59.90	92.28	37.30
	Y	1493.77	1402.81	-6.09	23.46
	A	54.67	87.16	59.44	20.15
Chhindwara	**P**	124.88	190.29	52.38	22.86
	Y	2284.25	2183.23	-4.42	10.05
	A	75.53	129.86	71.93	24.51
Region	**P**	156.03	250.19	60.35	25.46
	Y	2065.80	1926.61	-6.74	13.05

A: Area ('000 ha), P: Production ('000 tones), Y: Yield (kg/ha)

In Betul district, relative change is positive for area and production and negative for productivity. Increase in production in this district is a result of

increase in area. Also, in Chhindwara, the relative change is positive for area and production and negative for productivity. Although, the productivity of maize in this district is highest as compared to other districts. Increase in production in this district is also due to only increase in area. In the entire region of Satpura plateau, increase in production result due to increase in area.

4.1.6 Malwa plateau

Table 4.1.6: Relative Change and coefficient of variation of area, production and productivity of maize in Malwa plateau

Districts		P_o	P_n	RC (%)	CV (%)
	A	30.10	27.77	-7.71	9.35
Neemuch	**P**	53.16	49.01	-7.81	16.51
	Y	1766.11	1764.85	-0.07	14.18
	A	59.84	37.58	-37.21	19.97
Mandsour	**P**	101.26	52.20	-48.45	31.43
	Y	1692.18	1389.04	-17.91	20.83
	A	44.69	50.66	13.37	5.71
Rajgarh	**P**	57.88	60.03	3.70	17.94
	Y	1295.14	1184.96	-8.51	18.16
	A	44.43	53.76	21.01	16.43
Ratlam	**P**	43.98	107.77	145.03	41.64
	Y	989.87	2004.65	102.52	29.46
	A	6.96	10.73	54.14	31.777
Dewas	**P**	6.14	14.79	141.14	49.54
	Y	882.18	1378.38	56.25	24.13
	A	2.60	7.57	191.94	60.99
Ujjain	**P**	4.96	8.45	70.31	66.14
	Y	1907.69	1116.25	-41.49	26.21
	A	33.83	41.16	21.66	11.58
Shajapur	**P**	30.40	36.15	18.89	42.67
	Y	898.61	878.28	-2.26	33.68
	A	222.43	229.23	3.06	7.15
Region	**P**	297.79	328.41	10.28	21.32
	Y	1338.80	1432.67	7.01	14.18

A: Area (‘000 ha), P: Production (‘000 tones), Y: Yield (kg/ha)

Maize is grown in area of 229.23 thousand hectares in Malwa plateau and this account for 27.60 per cent of the total area of this crop in the state during current year. The data on relative change and variation in acreage, production and productivity are presented in Table 4.1.6. The data show that

the relative change is positive for area, production and productivity. The variation in production is higher as compared to variation in acreage and productivity. All the districts of Malwa plateau show increasing trends for area and production, except in Neemuch and Mandsour districts where decrease in area, production and productivity of maize is noted.

4.1.7 Nimar valley

In Nimar valley, 52.84 thousand hectares was used to grow maize crop and therefore acreage of maize crop to gross cropped area in this region is only 6.36 per cent. The relative change in area, production and productivity were positive and variation is higher in production compared to acreage and productivity. Production is positive in both Barwani and Khargone districts. Only Barwani district shows positive trend in acreage and productivity. Productivity in Khargone district is on the decline.

Table 4.1.7: Relative Change and coefficient of variation of area, production and productivity of maize in Nimar valley

Districts		P_o	P_n	RC (%)	CV (%)
	A	16.54	20.56	24.25	11.19
Khargone	**P**	21.07	21.62	2.61	37.81
	Y	1273.88	1051.56	-17.45	33.15
	A	28.93	32.28	11.57	7.18
Barwani	**P**	24.10	35.93	49.10	24.25
	Y	883.05	1113.07	26.05	21.26
	A	45.48	52.84	35.82	8.78
Region	**P**	45.17	57.55	27.41	29.92
	Y	1295.95	1077.97	-16.82	27.63

A: Area (‘000 ha), P: Production (‘000 tones), Y: Yield (kg/ha)

The above results show that in the entire region of Nimar valley, productivity and other factors such as technology adopted, seed planted,

climatic factor etc are likely responsible for the low production of the crop and not acreage.

4.1.8 Jhabua hills

The area of maize is 131.77 thousand hectares in Jhabua hills which account for 15.87 per cent of total maize area in the state during the current year. The relative change in area, production and productivity were shown in Table 4.1.8. The variation in production is higher as compared to variation in acreage and productivity. Both districts of Jhabua hills show decrease in production. There is increase in acreage and decrease in productivity in Dhar district while Jhabua district shows decrease in acreage and productivity.

Table 4.1.8: Relative Change and coefficient of variation of area, production and productivity of maize in Jhabua hills

Districts		P_o	P_n	RC (%)	CV (%)
Dhar	**A**	59.10	61.31	3.75	9.82
	P	89.61	76.06	-15.12	30.38
	Y	1516.24	1240.58	-18.18	21.70
Jhabua	**A**	104.09	70.46	-32.31	14.78
	P	147.80	84.93	-42.53	27.72
	Y	1419.93	1205.37	-15.11	20.39
Region	**A**	163.18	131.77	-28.56	11.54
	P	237.41	161.00	-32.19	28.44
	Y	1454.89	1221.83	-16.02	21.07

A: Area (‘000 ha), P: Production (‘000 tones), Y: Yield (kg/ha)

In Jhabua hills, there is poor performance of maize crop. This is a result of decrease in acreage and productivity of maize in the current year on account of substituting by other crops like Soybean.

4.2 Growth in area, production and productivity

The districtwise growth rates of area, production and productivity of maize for different agro-climatic regions were estimated. The growth rates show the trend in area, production and productivity and it is a base for projection of maize production by 2025 AD. The percentage growth rate shows the growth over the mean value of area, production and productivity. The estimates in trend value and percentage growth rate of different agro-climatic regions are presented in Table 4.2.1 to 4.2.8

4.2.1 Northern hill region of Chhattisgarh

In Northern hill region of Chhattisgarh, area, production, and productivity show decreasing trend and all were significant.

Table 4.2.1: Growth in area, production and productivity of maize in Northern hill region of Chhattisgarh

Districts		b-Value	S.Eb	t-value	LGR (%)
Mandla	**A**	0.23**	0.03	8.71	1.38
	P	$-4.3x10^{-3}$	0.14	0.03	-0.01
	Y	-20.00**	6.00	-3.03	-1.37
Anuppur	**A**	0.02**	$4.05x10^{-3}$	4.89	0.16
	P	-0.28**	0.05	-5.76	-2.07
	Y	-25.00**	4.00	-6.28	-2.21
Umaria	**A**	0.06**	0.01	4.45	0.55
	P	-0.23**	0.10	-2.45	-2.32
	Y	-28.00**	8.00	-3.63	-2.85
Shahdol	**A**	-0.81**	0.11	-7.11	-4.02
	P	-0.89**	0.21	-4.32	-4.35
	Y	-11.22*	6.63	1.69	-0.47
Dindori	**A**	-0.13**	0.03	-4.76	-0.67
	P	-0.77**	0.19	-4.01	-2.85
	Y	-10.89	12.82	0.85	-2.19
Region	**A**	-0.63**	0.12	-5.42	-0.63
	P	-2.18**	0.63	-3.48	-2.36
	Y	-109.00**	34.00	-3.25	-1.87

**Significant at 1percent probability level, *Significant at 5percent probability level.

The negative growth in production of maize in this region is mainly due to significant decrease in acreage and productivity in Shahdol and Dindori. In Mandla, Anuppur and Umaria, there is significant increase in acreage. All the districts show negative trend in the production of maize in this region. The growth rate of maize in Northern hill region of Chhattisgarh shows that maize crop is experiencing negative production in the region as a whole as well as in all the districts in the region.

4.2.2 Kaymore plateau and Satpura hills

In Kaymore plateau and Satpura hills, area and production show negative but significant growth rate. The productivity of maize crop is negative but insignificant. In Sidhi district, area, production and productivity show negative trends and also significant. Only area is positive and significant in Seoni district. Production is positive but insignificant while there is insignificant decrease in productivity.

Table 4.2.2: Growth in area, production and productivity of maize in Kaymore plateau and Satpura hills

Districts		b-Value	S.Eb	t-value	LGR (%)
	A	-1.20**	0.27	-4.48	-3.78
Sidhi	**P**	-1.42**	0.43	-3.31	-3.89
	Y	-1.00	6.00	-0.17	-0.08
	A	0.15**	0.05	2.73	1.30
Seoni	**P**	0.12	0.16	0.73	0.78
	Y	-7.00	8.00	-0.88	-0.53
	A	-1.04**	0.29	-3.47	-2.23
Region	**P**	-1.30*	0.55	-2.38	-2.34
	Y	8.00	12.00	0.70	-0.17

**Significant at 1percent probability level, *Significant at 5percent probability level.

The overall results show that in Kaymore plateau and Satpura hills maize production decreased significantly and this decrease is mainly brought by area reduction.

4.2.3 Vindhya plateau and Madhya Pradesh.

In Vindhya plateau the growth of maize crop production is significant and this is due to higher (2.28%) growth in acreage. There is 0.22 percent decrease in growth of productivity.

Table 4.2.3: Growth in area, production and productivity of maize in Vindhya plateau

Districts		b-Value	S.Eb	t-value	LGR (%)
	A	0.32**	0.04	7.10	2.28
Sehore	**P**	0.37*	0.20	1.87	2.04
	Y	-3.00	9.00	0.33	-0.22
	A	-1.66*	0.81	-2.05	-0.19
Madhya Pradesh	**P**	3.45	8.76	0.39	0.28
	Y	6.75	9.48	0.71	0.48

**Significant at 1percent probability level, *Significant at 5percent probability level.

For the state as a whole, the growth in productivity was higher than acreage. The area shows negative and significant trend while productivity was positive but insignificant. The overall production of maize crop is mainly due to positive and insignificant growth in productivity. This reveals that maize crop production can be increased in the state if area can be increased on sustainable manner.

4.2.4. Gird region

The data on trend value and percentage growth rate of maize crop for Gird region are given in Table 4.2.4.

Table 4.2.4: Growth in area, production and productivity of maize in Gird region

Districts		b-Value	S.Eb	t-value	LGR (%)
	A	-0.14**	0.04	3.38	-0.64
Guna	**P**	0.01	0.30	0.04	0.04
	Y	8.00	11.00	0.75	0.60
	A	0.44**	0.06	7.84	1.89
Shivpuri	**P**	0.94**	0.24	3.86	2.49
	Y	13.00	12.00	1.06	0.79
	A	0.29**	0.04	8.25	0.64
Region	**P**	0.95*	0.49	1.93	1.41
	Y	21.00	22.00	0.94	0.73

**Significant at 1percent probability level, *Significant at 5percent probability level.

From the data it is observed that there are positive and significant growth of area and production but positive and insignificant growth of productivity. The acreage of maize crop is negative and significant in Guna district while in Shivpuri district, positive and significant growth is observed for area and production while productivity is positive but insignificant.

Above overall results show that production of maize crop is significant despite small area allocation for the cultivation of the crop. This shows that there is still chance of increasing production of maize through increase in acreage in the region.

4.2.5 Satpura plateau

In Satpura plateau, area and production show significant growth rate. The productivity of maize crop shows negative growth rate but insignificant. The more or less similar trend was observed for both the districts of the region.

Table 4.2.5: Growth in area, production and productivity of maize in Satpura plateau

Districts		b-Value	S.Eb	t-value	LGR (%)
Betul	**A**	1.52**	0.17	8.89	4.88
	P	2.23**	0.43	5.21	4.36
	Y	-1.00	13.00	-0.08	-0.46
Chhindwara	**A**	1.96**	0.22	8.90	2.77
	P	3.98**	0.87	4.55	2.51
	Y	-6.00	8.00	-0.78	-0.27
Region	**A**	3.48**	0.29	12.01	3.42
	P	6.21**	1.11	5.60	3.06
	Y	-7.00	17.00	-0.42	-0.19

**Significant at 1percent probability level, *Significant at 5percent probability level.

Both Betul and Chhindwara show positive and significant trend in area and production while productivity is negative but insignificant. The overall results show that in Satpura plateau, maize production increased significantly and the increase is brought about by area expansion.

4.2.6 Malwa plateau

The estimates of trend value and linear growth rate of maize production components in Malwa plateau are presented in Table 4.2.6.

Table 4.2.6: Growth in area, production and productivity of maize in Malwa plateau

Districts		b-Value	S.Eb	t-value	LGR (%)
	A	-0.21*	0.08	-2.50	-0.70
Neemuch	**P**	-0.26	0.30	-0.87	-0.49
	Y	4.00	9.00	0.45	0.22
	A	-1.43**	0.14	-10.47	-2.67
Mandsour	**P**	-3.19**	0.57	-5.61	-3.78
	Y	-2.00	12.00	0.16	-1.11
	A	0.35**	0.05	7.39	0.75
Rajgarh	**P**	0.03	0.35	0.96	0.06
	Y	-8.00	7.00	-1.16	-0.67
	A	0.81**	0.24	3.35	1.52
Ratlam	**P**	4.42**	0.92	4.83	4.07
	Y	44.00**	10.00	4.46	2.55
	A	0.34**	0.09	4.02	3.27
Dewas	**P**	0.69**	0.17	3.95	5.85
	Y	32.00**	8.00	4.00	2.61
	A	0.44**	0.12	3.82	6.10
Ujjain	**P**	0.39*	0.20	1.92	4.03
	Y	-46.00**	8.00	-5.62	-2.23
	A	0.54**	0.10	3.79	1.32
Shajapur	**P**	0.92	0.73	1.28	1.79
	Y	8.00	15.00	0.54	0.42
	A	0.86	0.53	1.63	0.49
Region	**P**	2.99	2.48	1.21	0.83
	Y	29.00	48.00	0.60	0.31

**Significant at 1percent probability level, *Significant at 5percent probability level.

The estimates show that in this region, production of maize shows positive trend and this is due to the insignificant growth level of area and productivity. Out of all the districts, only Neemuch and Mandsour show negative trend in area and production others show positive trend and were significant. In Neemuch and Mandsour negative trend in production is a result of significant decrease in acreage while in Rajgarh, Ratlam, Dewas, Ujjain and Shajapur, positive trend in production was observed due to positive and significant growth of acreage in those districts.

The overall results in the region show that production of maize is in the increasing rate and this increase is brought due to significant growth in productivity.

4.2.7. Nimar Valley

In Nimar valley, there is significant increase in acreage followed by insignificant decrease in productivity. The more or less similar trend was observed for both the districts of the region. In Khargone district, production of maize increased though insignificant despite of significant increase in area while in Barwani the production decreased despite significant increase in area.

Table 4.2.7: Growth in area, production and productivity of maize in Nimar valley

Districts		b-Value	S.Eb	t-value	LGR (%)
	A	0.27**	0.04	7.10	1.46
Khargone	**P**	0.21	0.33	0.65	0.83
	Y	6.00	16.00	0.39	-0.58
	A	0.26**	0.05	4.86	0.81
Barwani	**P**	-0.08	0.33	-0.25	-0.21
	Y	-13.00	9.00	-1.44	-1.04
	A	0.53**	0.09	6.22	1.05
Region	**P**	0.13	0.65	0.20	0.20
	Y	20.00	24.00	0.83	-0.79

**Significant at 1percent probability level, *Significant at 5percent probability level.

The overall results show that in Nimar valley, increase in maize production is due to the expansion in area.

4.2.8 Jhabua hills

In this region, there is negative growth trend in production which is due to reduction in acreage and productivity, though insignificance. In Jhabua district, area and production show decreasing trends and these are highly significant. It implies that decrease in production was due to reduction in acreage. On the other hand, decrease in production in Dhar district is as a result of decreasing trend of productivity despite of insignificant increase in area

Table 4.2.8: Growth in area, production and productivity of maize in Jhabua hills

Districts		b-Value	S.Eb	t-value	LGR (%)
Dhar	**A**	0.21	0.22	0.99	0.33
	P	-0.27	0.99	-0.27	-0.29
	Y	-11.00	10.00	-1.03	-0.65
Jhabua	**A**	-1.15**	0.44	-2.62	-1.15
	P	-2.63*	1.17	-2.26	-1.92
	Y	-4.00	10.00	0.40	-0.77
Region	**A**	-0.94	0.60	-1.57	-0.48
	P	-2.91	2.11	-1.38	-1.25
	Y	-23.00	18.00	-1.22	-0.75

**Significant at 1percent probability level, *Significant at 5percent probability level.

Generally, growth rate in production in this region is negative (-1.25 %) and this is due to negative growth rate in acreage (-0.48%) and productivity (-0.75%) which is likely due to the allocation of land to other profitable kharif crop in the region.

4.3 Decomposition analysis

For the estimation of the contribution of area and yield towards increase/decrease in maize production under the study period, the simple decomposition model (Sharma model), sited in Manas Gupta,(1998) 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 analysed data for different districts in different agro-climatic regions are presented in the following sub-sections.

4.3.1 Northern hill region of Chhattisgarh

In Northern hill region of Chhattisgarh, the relative change in maize production is negative (-34.81%) and for this, contribution of acreage is found to be less as compared to yield but interaction effect shows the decline contribution of 8.39 per cent to the production. In all the districts of the Northern hill region, the relative change in production is negative.

Table 4.3.1: Relative contribution of area and yield in production of maize in Northern hill region of Chhattisgarh

Districts	RC	AE	YE	IE
Mandla	-4.81	-537.14	506.41	130.89
Anuppur	-37.77	-6.44	104.87	2.42
Umaria	-38.37	-31.81	115.92	15.89
Shahdol	-54.52	95.25	10.73	-5.98
Dindori	-41.40	20.04	87.19	-7.23
Region	-34.81	31.25	77.12	-8.39

RC: Relative change in production, AE: Area effect, YE: Yield effect and IE: Interaction effect

Area effect is negative in Mandla, Anuppur and Umaria, while yield effect is positive. In Anuppur, Umaria and Dindori, yield effect is higher than area effect. Results of the decomposition analysis show that negative relative change in maize production in Northern hill region of Chhattisgarh is mainly brought by higher negative effect of area in some of the districts in the region.

4.3.2 Kaymore plateau and Satpura hills

In Kaymore plateau and Satpura hills as a whole, the positive relative change in maize production is brought about by higher increase in area as compared to yield. In the districts, that is, Sidhi and Seoni, area effect is dominating over yield effect. Both area effect and yield effect were positive in Sidhi district but in Seoni district, area effect is positive while yield effect is negative.

Table 4.3.2: Relative contribution of area and yield in production of maize in Kaymore plateau and Satpura hills

Districts	RC	AE	YE	IE
Sidhi	-75.99	98.13	2.12	-0.16
Seoni	2.53	842.95	-612.68	-130.86
Region	-58.53	96.12	9.83	-5.52

RC: Relative change in production, AE: Area effect, YE: Yield effect and IE: Interaction effect

For Kaymore plateau and Satpura hills as a whole, it can be concluded that positive relative change in maize production is as a result of higher effect of acreage in relation to yield effect.

4.3.3 Vindhya plateau and Madhya Pradesh

The data presented in Table 4.3.3 shows that in Vindhya plateau, increase in maize production is a result of area effect and it is dominating over yield effect. In Sehore district, relative change and area effect were positive while yield effect is negative.

Table 4.3.3: Relative contribution of area and yield in production of maize in Vindhya plateau

Districts	RC	AE	YE	IE
Sehore	24.83	183.95	-57.88	-26.51
Madhya Pradesh	-0.28	19.68	78.52	1.47

RC: Relative change in production, AE: Area effect, YE: Yield effect and IE: Interaction effect

For the Madhya Pradesh as a whole being one of the major maize producing states in India, it is observed that yield effect dominates over area effect but increase in productivity is the main reason for increase in total maize production.

4.3.4 Gird region

In Gird region, the data on contribution of area and yield towards total maize production are presented in Table 4.3.4. The data show that for the Gird region as a whole, the value of relative change is positive. The contribution of area and yield towards this change were identical. Although area effect towards change in maize production is higher than yield effect. In all the districts, that is, in Guna and Shivpuri, area effect dominates over yield effect.

Table 4.3.4: Relative contribution of area and yield in production of maize in Gird region

Districts	RC	AE	YE	IE
Gune	-7.10	134.38	-37.96	3.62
Shivpuri	48.44	79.42	14.79	5.69
Region	22.58	57.99	38.32	5.02

RC: Relative change in production, AE: Area effect, YE: Yield effect and IE: Interaction effect

Above results show that in Gird zone, total maize production increase on the account of increase in acreage as compared to yield increase.

4.3.5 Satpura plateau

The data on contribution of area and yield towards increase in maize production is shown in Table 4.3.5. The data reveal that relative change in maize production is positive (60.35) in Satpura plateau. Contribution of area towards total maize production is higher and positive (119.44) as compared to that of yield, which is lower and negative (-11.28). Similar trends were also observed in the districts. In both Betul and Chhindwara districts, area effect dominates over yield effect.

Table 4.3.5: Relative contribution of area and yield in production of maize in Satpura plateau

Districts	RC	AE	YE	IE
Betul	92.28	113.18	-6.56	-6.87
Chhindwara	52.38	113.25	-8.44	-5.02
Region	60.35	119.44	-11.23	-8.08

RC: Relative change in production, AE: Area effect, YE: Yield effect and IE: Interaction effect

From the overall results of decomposition analysis of maize production in Satpura plateau, it can be concluded that area effect is dominating over yield effect for increase in total maize production.

4.3.6 Malwa plateau

The data on contribution of area and yield towards total maize production in Malwa plateau are presented in Table 4.3.6.

Table 4.3.6: Relative contribution of area and yield on production of maize in Malwa plateau

Districts	RC	AE	YE	IE
Neemuch	-7.81	98.92	1.37	-0.11
Mandsour	-48.45	76.71	37.81	-14.07
Rajgarh	3.70	359.79	-230.53	-30.81
Ratlam	145.03	14.49	71.05	14.49
Dewas	141.14	38.30	39.99	21.66
Ujjain	70.31	273.71	-59.26	-113.75
Shajpur	18.89	114.63	-12.01	-2.60
Region	10.28	29.73	68.22	2.00

RC: Relative change n production, AE: Area effect, YE: Yield effect and IE: Interaction effect

The data show that for the plateau as a whole, relative change in production is positive (9.32%). The contribution of yield was higher than that of area towards change in maize production. In Neemuch and Mandsour, relative change is negative but positive in the rest of the districts. Also, area effect is dominating over yield effect in Neemuch, Mandsour, Rajgarh, Ujjain and Shajapur districts while yield effect is dominating over area effect in Ratlam and Dewas. Above results show that in Malwa plateau total maize production increase on account of increase in yield as compared to acreage increase.

4.3.7 Nimar Valley

The data on decomposition analysis for Nimar valley region is given in Table 4.3.7. The data show that there is negative relative change (-3.36)

which is brought about by higher yield effect as compared to area effect. Area effect dominates over yield effect in Khargone district but in Barwani district, yield effect is dominating over area effect.

Table 4.3.7: Relative contribution of area and yield in production of maize in Nimar valley

Districts	RC	AE	YE	IE
Khargone	2.61	929.79	-668.01	-161.96
Barwani	49.10	-172.46	244.97	28.34
Region	27.41	-483.37	501.37	81.80

RC: Relative change in production, AE: Area effect, YE: Yield effect and IE: Interaction effect

Results of the decomposition analysis show that negative relative change in maize production in Nimar valley is mainly brought by higher yield effect as related to area effect.

4.3.8 Jhabua hill

In Jhabua hills as a whole, the negative relative change in production is a result of higher decrease in area as compared to yield. In Dhar district, yield effect is dominating over area effect while in Jhabua district, area effect dominates over yield effect.

Table 4.3.8: Relative contribution of area and yield on production of maize in Jhabua hills

Districts	RC	AE	YE	IE
Dhar	-15.12	-24.87	120.29	4.51
Jhabua	-42.53	75.96	35.51	-11.47
Region	-32.19	60.02	51.25	-9.87

RC: Relative change in production, AE: Area effect, YE: Yield effect and IE: Interaction effect

For Jhabua hill as a whole it can be concluded that decrease in maize production is brought about by higher decrease in area as compared to that of yield.

4.4 Projection for maize area and production in Madhya Pradesh

Forecast has traditionally been made using structural econometric models. Concentration have been given on the univariate time series models known as Auto-regressing Integrated Moving Average (ARIMA) models, which are primarily due to works of Box and Jenkins (1970). These models have been extensively used in practice for forecasting economic time series, inventory and sales modeling (Brown, 1959, Holt *et al.,* 1960) and generalization of the exponentially weighted moving average process. Several methods for identifying special cases of ARIMA models have been suggested by Box – Jenkins and others. In this study, these models were applied to forecast the production of maize crop in the selected districts of different agroclimatic regions of Madhya Pradesh. This would enable to predict the expected maize crop production for the years from 2012 to 2025. Such an exercise would enable the policy makers to foresee ahead of time the future requirements for maize seed, import and/or export of maize, thereby enabling them to take appropriate measures in this regard. The forecast will help to save much of the precious resources of this state which otherwise would have been wasted.

4.4.1 Northern hill region of Chhattisgarh

Area projection in Northern hill region of Chhattisgarh reveals 75.77 and 72.53 thousand hectares as maximum and minimum values for acreage in 2025-26 and 2012-13 respectively. Out of all the districts in this region, only Anuppur and Shahdol districts show decline in acreage, others show increase in cultivated area for maize. The upper limit of area expansion would be expected to reach 86.91 thousand hectares by the year 2025-26 over the present acreage of 77.56 thousand hectares (2012-13).

Production projection in Northern hill region of Chhattisgarh, the maximum production of maize crop is 85.4 thousand metric tons which will be expected to occur in the year 2025-26 with upper and lower limits of 141.7 and 48.1 thousand tons. The minimum is 67.1 thousand metric tons which occurred in the year 2012 -2013 with upper and lower limits 78.2 and 57.3 thousand metric tons respectively. All the districts in this region show the

trend of increase in the production of maize crop according to the projection result. The maximum production of maize crop in Mandla, Anuppur, Umaria, Shahdol and Dindori districts are expected to reach at 23.6, 12.1, 9.8, 18.7 and 25.6 thousand metric tons respectively during 2025-26 while the minimum values are 21.9, 10.4, 6.6, 11.9 and 18.8 thousand metric tons respectively during 2012-13. By the year 2025, the production of maize crop in Dindori (25.6 thousand tons) will be the highest in the region as against Mandla district (23.6 thousand tons) which is the present leading district in maize production in the region.

Table 4.4.1a: Forecast for Maize area in Northern hill region of Chhattisgarh

Districts	Mandla			Anuppur			Umaria			Shahdol			Dindori			Region		
Years	FA	UL	LL	FA	UL	LL	FA	UL	LL	FA	UL	LL	FA	UL	LL	FA	UL	LL
2012-13	18.70	20.05	17.36	12.12	12.33	11.91	10.50	11.04	9.97	11.31	15.53	8.03	19.19	20.46	17.98	72.53	77.57	67.75
2013-14	18.89	20.80	16.99	12.08	12.38	11.79	10.47	11.21	9.76	10.93	16.37	7.01	19.23	20.92	17.65	73.02	79.82	66.67
2014-15	19.09	21.42	16.76	12.05	12.39	11.72	10.44	11.32	9.61	10.55	16.56	6.39	19.27	21.22	17.47	73.44	81.40	66.11
2015-16	19.28	21.97	16.59	12.03	12.39	11.67	10.41	11.40	9.49	10.17	16.41	5.94	19.31	21.43	17.35	73.82	82.58	65.79
2016-17	19.47	22.48	16.46	12.01	12.38	11.64	10.39	11.46	9.39	9.79	16.09	5.59	19.34	21.57	17.28	74.15	83.51	65.62
2017-18	19.66	22.96	16.37	11.99	12.38	11.61	10.36	11.50	9.31	9.42	15.67	5.29	19.36	21.68	17.23	74.44	84.25	65.53
2018-19	19.86	23.41	16.30	11.98	12.37	11.60	10.34	11.54	9.25	9.06	15.19	5.04	19.38	21.77	17.19	74.69	84.84	65.50
2019-20	20.05	23.85	16.25	11.97	12.36	11.59	10.32	11.56	9.19	8.71	14.69	4.81	19.39	21.83	17.18	74.91	85.33	65.50
2020-21	20.24	24.27	16.21	11.96	12.36	11.58	10.30	11.58	9.14	8.38	14.18	4.61	19.41	21.87	17.17	75.11	85723	65.53
2021-22	20.43	24.69	16.18	11.96	12.35	11.57	10.29	11.60	9.09	8.05	13.67	4.42	19.42	21.91	17.16	75.28	86.05	65.57
2022-23	20.63	25.08	16.17	11.95	12.35	11.56	10.27	11.61	9.06	7.74	13.17	4.24	19.43	21.94	17.15	75.43	86.33	65.62
2023-24	20.82	25.48	16.16	11.95	12.34	11.56	10.26	11.61	9.02	7.45	12.67	4.07	19.44	21.96	17.15	75.56	86.56	65.67
2024-25	21.01	25.86	16.16	11.95	12.34	11.56	10.24	11.62	8.99	7.16	12.19	3.91	19.45	21.98	17.15	75.67	86.75	65.72
2025-26	21.20	26.23	16.17	11.94	12.34	11.56	10.23	11.62	8.97	6.88	11.73	3.75	19.46	21.99	17.15	75.77	86.91	65.77

Area in '000 hectares **FA: Forecasted Area, UL: Upper limits and LL: Lower limits**

Table 4.4.1b: Forecast for Maize production in Northern hill region of Chhattisgarh

Districts / Years	Mandla			Anuppur			Umaria			Shahdol			Dindori			Region		
	FP	UL	LL	FP	UL	LL	FP	UL	LL	FP	UL	LL	FP	UL	LL	FP	UL	LL
2013-14	22.28	28.96	16.86	10.57	13.30	8.29	7.59	12.96	4.13	13.02	23.39	6.61	19.99	12.53	29.90	69.61	92.04	51.66
2014-15	22.61	30.14	16.63	10.77	14.08	8.09	8.28	15.20	4.09	13.94	27.43	6.25	21.01	12.29	33.89	71.87	101.55	49.37
2015-16	22.86	30.87	16.55	10.95	14.72	7.97	8.76	16.57	4.16	14.74	30.73	6.09	21.89	12.09	36.92	73.89	109.07	48.18
2016-17	23.04	31.36	16.54	11.12	15.27	7.90	9.10	17.43	4.24	15.45	33.46	6.03	22.62	12.04	39.26	75.70	115.25	47.55
2017-18	23.18	31.68	16.55	11.28	15.74	7.86	9.32	17.97	4.31	16.06	35.73	6.03	23.24	12.06	41.10	77.32	120.41	47.23
2018-19	23.28	31.90	16.58	11.42	16.15	7.84	9.48	18.32	4.36	16.59	37.59	6.05	23.76	12.12	42.55	78.77	124.76	47.12
2019-20	23.36	32.05	16.61	11.55	16.51	7.83	9.57	18.55	4.40	17.05	39.15	6.09	24.19	12.20	43.69	80.06	128.45	47.13
2020-21	23.42	32.15	16.64	11.67	16.82	7.84	9.66	18.70	4.43	17.44	40.44	6.14	24.55	12.29	44.61	81.22	131.59	47.22
2021-22	23.47	32.23	16.66	11.78	17.10	7.85	9.71	18.80	4.45	17.78	41.50	6.19	24.85	12.37	45.34	82.25	134.28	47.36
2022-23	23.50	32.29	16.68	11.89	17.34	7.86	9.74	18.87	4.47	18.07	42.39	6.25	25.10	12.45	45.93	83.17	136.58	47.53
2023-24	23.52	32.33	16.69	11.98	17.56	7.88	9.76	18.91	4.48	18.31	43.13	6.30	25.31	12.52	46.40	83.99	138.55	47.71
2024-25	23.54	32.36	16.71	12.06	17.75	7.89	9.78	18.95	4.48	18.53	43.75	6.34	25.49	12.59	46.78	84.71	140.26	47.91
2025-26	23.56	32.38	16.72	12.14	17.92	7.92	9.79	18.97	4.49	18.71	44.26	6.39	25.64	12.64	47.09	85.36	141.73	48.10

Production in '000 tons **FP: Forecasted production, UL: Upper limits and LL: Lower limits**

4.4.2 Kaymore plateau and Satpura hills

Area projection in Kaymore plateau and Satpura hills reveals that Sidhi district shows decreasing trend in area with maximum value of 9.91 thousand hectares expected in 2014/15 and minimum value of 6.36 thousand hectares in 2025/26. Seoni district on the other hand shows increase in area for the production of maize crop with maximum and minimum values of 15.37 and 12.28 thousand hectares in 2025/26 and 2012/13 respectively. The entire region of Kaymore plateau and Satpura hills shows decrease in area for maize production with maximum and minimum values of 21.51 and 16.87 thousand hectares in 2012/13 and 2025/26 respectively. In order to have significant increase in the production of maize crop in this region, there must be significant increase in acreage by bringing Kharif fallow under cultivation.

Table 4.4.2a: Forecast for Maize area in Kaymore plateau and Satpura hills

Districts	Sidhi			Seoni			Region		
Years	FA	UL	LL	FA	UL	LL	FA	UL	LL
2012-13	9.65	17.52	4.83	12.27	14.59	10.25	21.51	31.72	14.04
2013-14	9.86	21.22	3.89	12.49	16.37	9.37	21.64	35.96	12.19
2014-15	9.91	23.49	3.37	12.71	17.86	8.79	21.62	38.60	11.08
2015-16	9.82	24.77	3.03	12.93	19.23	8.36	21.46	40.21	10.31
2016-17	9.62	25.33	2.76	13.16	20.53	8.02	21.19	41.10	9.71
2017-18	9.34	25.35	2.55	13.39	21.81	7.73	20.85	41.45	9.22
2018-19	9.02	24.99	2.37	13.62	23.07	7.48	20.44	41.39	8.81
2019-20	8.66	24.37	2.22	13.86	24.32	7.27	19.98	41.04	8.44
2020-21	8.28	23.57	2.08	14.10	25.57	7.08	19.50	40.47	8.11
2021-22	7.89	22.65	1.95	14.34	26.83	6.91	18.99	39.73	7.81
2022-23	7.49	21.66	1.83	14.59	28.10	6.76	18.46	38.87	7.53
2023-24	7.11	20.63	1.72	14.85	29.38	6.62	17.93	37.93	7.26
2024-25	6.73	19.60	1.62	15.11	30.68	6.49	17.39	36.93	7.01
2025-26	6.36	18.57	1.52	15.37	31.99	6.37	16.86	35.90	6.77

Area in '000 hectares **FA: Forecasted Area, UL: Upper limits and LL: Lower limits**

In Kaymore plateau and Satpura hills, maximum production of maize crop is 42.2 thousand tons during the year 2025-26 based on the projection result with upper and lower limits of 97.4 and 14.9 thousand tons. The minimum values occurred in the year 2012-13 (25.9 thousand tons) with upper and lower limits of 38.3 and 16.8 thousand tons. Sidhi and Seoni districts also shows increase in the production projection for maize crop with maximum values 27.0 and 15.1 thousand tons and minimum values 12.3 and 14.2 thousand tons respectively. The overall result reveals that maize crop production can further be increased in the region due to significant increase in acreage.

Table 4.4.2b: Forecast for Maize production in Kaymore plateau and Satpura hills

Districts	Sidhi			Seoni			Region		
Years	FP	UL	LL	FP	UL	LL	FP	UL	LL
2012-13	12.26	21.41	6.47	14.19	22.85	8.31	25.88	38.31	16.81
2013-14	13.69	28.54	5.65	14.42	23.68	8.24	27.73	46.64	15.35
2014-15	15.10	35.23	5.26	14.59	24.22	8.23	29.47	53.78	14.66
2015-16	16.47	41.61	5.05	14.72	24.57	8.24	31.11	60.13	14.30
2016-17	17.80	47.70	4.94	14.81	24.81	8.25	32.64	65.84	14.13
2017-18	19.08	53.48	4.90	14.88	24.97	8.27	34.07	70.99	14.07
2018-19	20.29	58.94	4.90	14.93	25.09	8.29	35.40	75.64	14.08
2019-20	21.45	64.06	4.92	14.97	25.17	8.30	36.62	79.82	14.15
2020-21	22.54	68.85	4.96	15.00	25.22	8.32	37.75	83.59	14.24
2021-22	23.57	73.30	5.01	15.02	25.26	8.33	38.79	86.98	14.36
2022-23	24.53	77.42	5.07	15.04	25.29	8.33	39.74	90.03	14.48
2023-24	25.43	81.23	5.14	15.05	25.31	8.34	40.62	92.76	14.62
2024-25	26.26	84.73	5.21	15.06	25.33	8.34	41.42	95.22	14.76
2025-26	27.04	87.95	5.28	15.07	25.34	8.35	42.15	97.42	14.89

Production in '000 tons **FP: Forecasted production, UL: Upper limits and LL: Lower limits**

4.4.3 Vindhya plateau and Madhya Pradesh as a whole

The only district selected in this region i.e. Sehore, shows increase in the production of maize crop. It is reveals that by the year 2025-26, the production of maize crop in the region will be 30.9 thousand tons with upper and lower limits of 144.0 and 2.7 thousand tons respectively. The maximum value of area in Sehore district is 19.36 thousand hectares in 2025/26 while the minimum value, 14.93 thousand hectares occurs in 2012/13.

For the whole state of Madhya Pradesh, the result reveals that the production of maize crop had reduced from previous figure (1290 thousand tons 2011-12) to 1181.0 thousand tons in 2012-13 production year based on the forecast. The maximum value forecast is 1407.0 thousand tons with upper and lower limits of 3371.0 and 472.0 respectively in 2025-26 while the minimum value is 1181.0 thousand tons with upper and lower limits of 1866.0 and 709.0 thousand tons respectively in 2012-13.

Table 4.4.3a: Forecast for Maize area in Vindhya Plateau and Madhya Pradesh as a whole

Districts / Years	Sehore			Madhya Pradesh		
	FA	UL	LL	FA	UL	LL
2012-13	14.93	16.21	13.74	841.00	893.00	791.00
2013-14	15.23	17.92	12.87	843.00	899.00	790.00
2014-15	15.54	19.24	12.42	843.00	899.00	790.00
2015-16	15.86	20.43	12.11	842.00	898.00	788.00
2016-17	16.18	21.57	11.88	840.00	896.00	787.00
2017-18	16.50	22.69	11.71	839.00	895.00	785.00
2018-19	16.83	23.78	11.57	837.00	893.00	784.00
2019-20	17.17	24.88	11.45	835.00	891.00	782.00
2020-21	17.52	25.98	11.36	834.00	889.00	781.00
2021-22	17.87	27.09	11.29	832.00	888.00	779.00
2022-23	18.23	28.21	11.23	831.00	886.00	778.00
2023-24	18.60	29.34	11.19	829.00	884.00	776.00
2024-25	18.98	30.49	11.15	827.00	882.00	775.00
2025-26	19.36	31.66	11.12	826.00	881.00	773.00

Area in '000 hectares **FA: Forecasted Area, UL: Upper limits and LL: Lower limits**

Table 4.4.3b: Forecast for Maize production in Vindhya Plateau and Madhya Pradesh as a whole

Districts	Sehore			Madhya Pradesh		
Years	FP	UL	LL	FP	UL	LL
2012-13	17.07	21.99	13.05	1181.00	1866.00	709.00
2013-14	17.60	27.73	10.60	1261.00	2034.00	737.00
2014-15	18.28	34.25	8.78	1249.00	2141.00	676.00
2015-16	19.08	41.41	7.43	1271.00	2263.00	655.00
2016-17	19.97	49.12	6.40	1281.00	2373.00	625.00
2017-18	20.93	57.36	5.61	1296.00	2486.00	603.00
2018-19	21.95	66.11	4.97	1309.00	2596.00	581.00
2019-20	23.04	75.40	4.46	1322.00	2707.00	562.00
2020-21	24.18	85.24	4.03	1336.00	2817.00	544.00
2021-22	25.39	95.68	3.67	1350.00	2927.00	527.00
2022-23	26.65	106.74	3.37	1364.00	3037.00	512.00
2023-24	27.99	118.46	3.10	1378.00	3148.00	498.00
2024-25	29.39	130.88	2.87	1392.00	3259.00	484.00
2025-26	30.86	144.04	2.67	1407.00	3371.00	472.00

Production in '000 tons **FP: Forecasted production, UL: Upper limits and LL: Lower limits**

The maximum and minimum maize area according to projection result in the state of Madhya Pradesh is 843.0 and 826.0 thousand hectares in the year 2013/14 and 2025/26 respectively. Overall result shows that, area is in decline trend in the state, therefore, there must be proper adjustment in cropping pattern for maize crop in order to increase production in the state of Madhya Pradesh looking to industrial demand for this crop in the state.

4.4.4 Gird region

Maximum value of area of maize in Gird region is expected to be 53.88 thousand hectares by the year 2025/26 according to the result of projection and the minimum value of 49.30 thousand hectares in 2012/13. Both Guna and Shivpuri districts show increase in acreage with maximum and minimum values of 22.05, 35.21, 21.03 and 28.41 thousand hectares respectively.

Table 4.4.4a: Forecast for Maize area in Gird region

Districts	Guna			Shivpuri			Region		
Years	FA	UL	LL	FA	UL	LL	FA	UL	LL
2012-13	21.03	22.76	19.40	28.41	32.38	24.84	49.30	52.63	46.13
2013-14	21.21	23.48	19.12	28.82	33.77	24.46	49.56	54.94	44.60
2014-15	21.36	23.96	18.99	29.27	34.70	24.51	49.96	56.54	43.99
2015-16	21.49	24.31	18.93	29.73	35.46	24.75	50.27	58.13	43.26
2016-17	21.60	24.57	18.91	30.22	36.15	25.07	50.65	59.51	42.84
2017-18	21.69	24.77	18.91	30.72	36.81	25.45	50.98	60.88	42.37
2018-19	21.76	24.92	18.93	31.24	37.46	25.85	51.35	62.16	42.05
2019-20	21.83	25.04	18.94	31.77	38.12	26.28	51.69	63.43	41.71
2020-21	21.88	25.13	18.96	32.32	38.78	26.72	52.06	64.65	41.45
2021-22	21.93	25.21	18.98	32.87	39.45	27.18	52.41	65.86	41.19
2022-23	21.97	25.27	19.00	33.44	40.13	27.65	52.78	67.05	40.98
2023-24	22.00	25.32	19.02	34.02	40.82	28.13	53.14	68.22	40.78
2024-25	22.03	25.36	19.04	34.61	41.52	28.62	53.51	69.39	40.61
2025-26	22.05	25.39	19.06	35.21	42.24	29.12	53.88	70.54	40.44

Area in '000 hectares **FA: Forecasted Area, UL: Upper limits and LL: Lower limits**

The results of the production projection for maize crop in Gird region reveals that the production is on the increasing track in the region. The maximum production is 86.4 thousand tons with 206.6 and 29.0 thousand tons upper and lower limits respectively. Production in Guna district shows increasing trend while it is otherwise in Shivpuri district. The maximum production of maize crop in Guna district is observed in the last year of projection (2025-26) (28.1 thousand tons) while in Shivpuri district, maximum production (41.8 thousand tons) is in 2012-13 and minimum value of production in the last year of projection (2025-26). The overall result shows that if more area can be allocated to maize crop in the region, there will be possibility of increasing production.

Table 4.4.4b: Forecast for Maize production in Gird region

Districts	Guna			Shivpuri			Region		
Years	FP	UL	LL	FP	UL	LL	FP	UL	LL
2012-13	23.03	30.92	16.79	41.79	63.24	26.44	68.96	100.02	45.94
2013-14	23.85	39.78	13.37	41.18	64.12	25.15	70.17	108.74	43.13
2014-15	23.95	44.31	11.71	40.65	64.53	24.24	71.40	117.03	40.90
2015-16	24.41	49.89	10.39	40.19	64.66	23.57	72.65	125.09	39.05
2016-17	24.70	54.56	9.38	39.80	64.63	23.06	73.92	133.05	37.48
2017-18	25.08	59.48	8.54	39.46	64.51	22.68	75.22	140.96	36.11
2018-19	25.42	64.17	7.84	39.17	64.34	22.38	76.54	148.88	34.89
2019-20	25.79	68.92	7.24	38.93	64.15	22.14	77.88	156.84	33.81
2020-21	26.16	73.63	6.72	38.72	63.96	21.96	79.24	164.87	32.82
2021-22	26.53	78.38	6.25	38.54	63.77	21.81	80.63	172.98	31.93
2022-23	26.91	83.15	5.84	38.38	63.60	21.69	72.04	181.21	31.11
2023-24	27.30	87.96	5.47	38.25	63.44	21.59	83.48	189.55	30.36
2024-25	27.69	92.81	5.14	38.14	63.30	21.51	84.94	198.02	29.66
2025-26	28.09	97.71	4.84	38.05	63.17	21.44	86.43	206.64	29.01

Production in '000 tons **FP: Forecasted production, UL: Upper limits and LL: Lower limits**

4.4.5 Satpura plateau

Area projection in Satpura plateau reveals that, there has been decrease in the area of maize crop production in the region in the recent time. This has eventually affected the production of the crop. The maximum and minimum values of area are 128.80 and 118.13 thousand hectares in the year 2012/13 and 2025/26 respectively. Chhindwara district shows increased area while Betul district shows decrease in area for maize production.

The cultivation of maize crop is highly encouraging in Satpura plateau agro-climatic region of Madhya Pradesh, with acreage being the major contributor to the increase in the production during past year.

Table 4.4.5a: Forecast for Maize area in Satpura Plateau

Districts	Betul			Chhindwara			Region		
Years	FA	UL	LL	FA	UL	LL	FA	UL	LL
2012-13	42.94	49.70	36.91	89.83	114.80	69.27	128.80	157.52	104.30
2013-14	42.54	55.19	32.25	92.54	130.34	63.79	127.78	163.90	98.13
2014-15	42.15	58.63	29.49	95.32	144.43	60.20	126.80	168.68	93.44
2015-16	41.77	61.19	27.48	98.20	158.04	57.53	125.86	172.42	89.65
2016-17	41.40	63.21	25.91	101.15	171.55	55.43	124.95	175.44	86.48
2017-18	41.04	64.84	24.62	104.20	185.14	53.71	124.07	177.90	83.77
2018-19	40.69	66.18	23.54	107.34	198.95	52.26	123.22	179.92	81.42
2019-20	40.36	67.28	22.62	110.58	213.06	51.04	122.41	181.59	79.35
2020-21	40.03	68.19	21.82	113.91	227.52	49.98	121.62	182.97	77.52
2021-22	39.72	68.95	21.12	117.34	242.40	49.05	120.87	184.10	75.88
2022-23	39.42	69.57	20.51	120.88	257.74	48.24	120.14	185.02	74.41
2023-24	39.12	70.08	19.96	124.52	273.57	47.53	119.45	185.77	73.08
2024-25	38.84	70.50	19.47	128.27	289.93	46.90	118.78	186.37	71.88
2025-26	38.57	70.84	19.03	132.13	306.85	46.34	118.13	186.84	70.78

Area in '000 hectares **FA: Forecasted Area, UL: Upper limits and LL: Lower limits**

Table 4.4.5b: Forecast for Maize production in Satpura Plateau

Districts	Betul			Chhindwara			Region		
Years	FP	UL	LL	FP	UL	LL	FP	UL	LL
2012-13	59.21	83.24	40.91	179.54	253.18	123.62	243.24	326.03	177.68
2013-14	58.43	91.77	35.30	172.25	258.45	110.09	137.15	344.70	157.50
2014-15	57.68	97.19	31.88	167.46	257.07	104.08	232.04	352.54	146.07
2015-16	56.97	100.83	29.51	164.34	254.60	101.00	227.80	355.44	138.77
2016-17	56.30	103.32	27.78	162.32	252.41	99.30	224.30	355.86	133.82
2017-18	55.67	105.00	26.46	161.01	250.76	98.31	221.41	355.06	130.33
2018-19	55.08	106.11	25.43	160.17	249.60	97.71	219.04	353.71	127.80
2019-20	54.54	106.81	24.61	159.62	248.81	97.35	217.10	352.17	125.94
2020-21	54.04	107.21	23.94	159.26	248.29	97.12	215.50	350.64	124.54
2021-22	53.58	107.39	23.40	159.04	247.95	96.97	214.20	349.21	123.47
2022-23	53.17	107.42	22.95	158.89	247.72	96.88	213.13	347.93	122.66
2023-24	52.78	107.34	22.57	158.79	247.57	96.82	212.26	346.81	122.02
2024-25	52.44	107.19	22.26	158.73	247.48	96.78	211.55	345.85	121.52
2025-26	52.12	106.98	21.99	158.69	247.42	96.76	210.97	345.04	121.13

Production in '000 tons **FP: Forecasted production, UL: Upper limits and LL: Lower limits**

According to the projection result, the feature of this crop is at stake due to the decreasing trend observed in the production in the coming years. The maximum production is observed in 2012-13 (243.2 thousand tons) and the minimum is 210.9 thousand tons. Both the districts selected i.e. Betul and Chhindwara districts follow decrease in production. For districts, the maximum productions are 59.2 and 179.5 thousand tons respectively while the minimum productions are 52.1 and 158.7 thousand tons respectively. Chhindwara which is considered as the leading maize crop producing district in Madhya Pradesh is losing her form due to substitution of this crop by others and this will definitely affect the production of maize in state of Madhya Pradesh as a whole.

4.4.6 Malwa plateau

Acreage projection in Malwa plateau shows constant trend, with upper and lower limits of 272.02 and 205.98 thousand hectares respectively. Neemuch, Mandsour, Rajgarh and Dewas show slight increase in area while Shajapur, Ujjain and Ratlam show decrease in acreage. Therefore, it can be concluded that there is very little possibilities of enhancement of acreage under maize in Malwa plateau and hence, there is only possibility to increase maize production by technological intervention in the future.

Production projection for maize crop in Malwa plateau agroclimatic region reveals that by the year 2025-26, the production of maize crop will be 372.5 thousand tons with upper and lower limits 684.5 and 183.7 thousand tons respectively. Among all the districts of Malwa plateau, only Neemuch and Dewas shows decreasing trend of maize crop production with highest values of 48.0 and 15.1 thousand tons in the year 2012-13 respectively and lowest values of production of 35.4 and 13.6 thousand tons by 2025-26 respectively. Ratlam district is considered to be the leading producer of the crop with production of 118.9 thousand tons in 2012-13 and 236.4 thousand tons by the year 2025-26 while Ujjain district has the lowest output of 9.0 and 19.5 thousand tons in 2012-13 and 2025-26 respectively.

Table 4.4.6a: Forecast for Maize area in Malwa Plateau

Districts	Neemuch			Mandsour			Rajgarh			Ratlam			Dewas			Ujjain			Shajapur			Region		
Years	FA	UL	LL	FA	UL	LL	FA	UL	LL	FA	UL	LL	FA	UL	LL	FA	UL	LL	FA	UL	LL	FA	UL	LL
2012-13	28.05	32.62	24.00	38.36	44.18	33.15	51.10	54.28	48.06	53.79	61.13	47.15	11.04	13.93	8.64	7.64	10.90	5.19	40.96	44.27	37.85	237.24	272.02	205.98
2013-14	28.07	35.77	21.72	38.86	47.17	31.73	51.45	55.16	47.94	53.60	65.23	43.64	11.34	16.36	7.60	7.64	13.35	4.03	40.69	46.46	35.50	237.24	272.02	205.98
2014-15	28.09	37.76	20.45	39.34	49.56	30.83	51.81	55.71	48.13	53.42	67.54	41.70	11.69	18.91	6.81	7.63	15.07	3.40	40.45	47.60	34.16	237.24	272.02	205.98
2015-16	28.10	39.65	19.35	39.80	51.60	30.20	52.18	56.16	48.41	53.26	69.01	40.44	12.08	21.58	6.20	7.61	16.42	2.99	40.23	48.31	33.23	237.24	272.02	205.98
2016-17	28.12	41.29	18.46	40.24	53.40	29.73	52.55	56.58	48.73	53.11	69.99	39.55	12.51	24.36	5.70	7.58	17.51	2.68	40.03	48.77	32.55	237.24	272.02	205.98
2017-18	28.13	42.84	17.67	40.66	55.02	29.37	52.92	56.99	49.07	52.97	70.65	38.91	12.97	27.26	5.30	7.55	18.40	2.45	39.86	49.08	32.03	237.24	272.02	205.98
2018-19	28.15	44.29	16.98	41.06	56.49	29.10	53.29	57.40	49.41	52.84	71.10	38.43	13.45	30.28	4.96	7.51	19.14	2.27	39.70	49.27	31.63	237.24	272.02	205.98
2019-20	28.17	45.68	16.36	41.44	57.84	28.88	53.67	57.81	49.76	52.73	71.40	38.07	13.95	33.43	4.67	7.47	19.74	2.13	39.56	49.40	31.30	237.24	272.02	205.98
2020-21	28.18	47.00	15.80	41.81	59.08	28.72	54.05	58.22	50.12	52.63	71.60	37.79	14.47	36.71	4.43	7.42	20.24	2.01	39.43	49.47	31.04	237.24	272.02	205.98
2021-22	28.20	48.28	15.28	42.16	60.22	28.59	54.43	58.63	50.47	52.54	71.73	37.58	15.02	40.13	4.22	7.38	20.64	1.91	39.32	49.50	30.83	237.24	272.02	205.98
2022-23	28.21	49.53	14.80	42.49	61.28	28.49	54.82	59.04	50.83	52.46	71.81	37.41	15.59	43.70	4.03	7.33	20.97	1.82	39.21	49.51	30.65	237.24	272.02	205.98
2023-24	28.23	50.73	14.35	42.81	62.26	28.42	55.21	59.46	51.19	52.39	71.85	37.28	16.17	47.44	3.86	7.28	21.23	1.75	39.12	49.51	30.51	237.24	272.02	205.98
2024-25	28.25	51.91	13.94	43.12	63.17	28.37	55.60	59.88	51.56	52.33	71.87	37.17	16.79	51.34	3.71	7.24	21.44	1.69	39.04	49.49	30.39	237.24	272.02	205.98
2025-26	28.26	53.06	13.54	43.41	64.02	28.33	55.99	60.30	51.93	52.28	71.87	37.09	17.42	55.43	3.58	7.19	21.61	1.64	38.97	49.47	30.29	237.24	272.02	205.98

Area in '000 hectares

FA: Forecasted Area, UL: Upper limits and LL: Lower limits

Table 4.4.6b: Forecast for Maize production in Malwa Plateau

Districts	Neemuch			Mandsour			Rajgarh			Ratlam			Dewas			Ujjain			Shajapur			Region		
Years	FP	UL	LL	FP	UL	LL	FP	UL	LL	FP	UL	LL	FP	UL	LL	FP	UL	LL	FP	UL	LL	FP	UL	LL
2012-13	48.01	65.87	34.15	56.00	84.17	35.73	62.17	101.67	35.72	119.00	175.17	77.86	15.11	19.82	11.31	8.97	16.18	4.53	34.54	54.75	20.64	334.59	440.06	249.79
2013-14	47.56	66.14	33.31	58.21	93.71	34.11	62.60	106.14	34.33	122.27	182.98	78.43	15.02	24.77	8.54	9.60	19.74	4.05	38.49	76.67	16.99	336.04	446.65	247.87
2014-15	46.54	71.06	29.15	60.26	101.87	33.17	63.86	120.59	30.34	131.70	216.84	75.01	14.91	27.77	7.22	10.12	24.61	3.31	37.94	85.65	13.95	340.17	485.21	231.12
2015-16	45.83	71.70	27.86	62.15	108.98	32.62	64.58	127.94	28.70	137.14	231.90	75.48	14.79	29.89	6.39	10.81	28.66	3.08	41.21	105.26	12.47	342.25	496.97	227.64
2016-17	44.81	47.80	25.24	63.89	115.24	32.30	65.63	138.71	26.57	146.15	261.45	74.69	14.66	31.44	5.81	11.41	33.76	2.68	41.46	115.71	10.80	345.77	523.63	218.59
2017-18	43.95	75.24	23.83	65.49	120.78	32.13	66.50	147.19	25.14	153.22	282.34	75.25	14.53	32.58	5.39	12.17	38.33	2.52	44.30	134.99	9.87	348.24	538.31	214.68
2018-19	42.92	76.98	21.89	66.97	125.68	32.08	67.49	156.89	23.67	162.46	311.88	75.43	14.40	33.42	5.06	12.86	44.19	2.27	45.14	147.56	8.81	351.49	560.19	208.59
2019-20	41.95	77.62	20.52	68.32	130.03	32.10	68.43	165.84	22.48	170.89	337.79	76.18	14.27	34.04	4.81	13.70	49.82	2.15	47.76	167.19	8.13	354.21	576.35	204.79
2020-21	40.88	78.67	18.96	69.56	133.90	32.17	69.42	175.27	21.35	180.76	369.36	76.85	14.14	34.48	4.60	14.48	56.23	1.98	49.06	182.04	7.39	357.35	596.05	200.17
2021-22	39.88	79.08	17.70	70.69	137.34	32.28	70.40	184.49	20.36	190.46	400.04	77.82	14.02	34.78	4.44	15.41	62.83	1.88	51.58	202.47	6.87	360.23	612.93	196.66
2022-23	38.75	79.61	16.39	71.73	140.41	32.41	71.41	193.95	19.44	201.22	434.92	78.82	13.90	34.98	4.30	16.31	70.17	1.76	53.24	219.66	6.33	363.34	631.58	192.90
2023-24	37.66	79.72	15.26	72.67	143.14	32.56	72.42	203.40	18.61	212.19	470.52	79.99	13.79	35.11	4.19	17.35	77.87	1.68	55.76	241.28	5.91	366.32	648.84	189.72
2024-25	36.54	79.81	14.14	73.54	145.57	32.71	73.46	213.01	17.83	224.05	509.69	81.24	13.69	35.18	4.09	18.37	86.29	1.58	57.74	260.85	5.50	369.44	667.00	186.51
2025-26	35.41	79.60	13.13	74.33	147.74	32.87	74.51	222.69	17.13	236.35	550.61	82.63	13.59	35.20	4.01	19.53	95.24	1.52	60.33	283.99	5.16	372.50	684.49	183.65

Production in tons **FP: Forecasted production, UL: Upper limits and LL: Lower limits**

4.4.7 Nimar valley

In Nimar valley maize area shows increasing trend based on the result of projection. The maximum and minimum values are 58.77 and 53.50 thousand hectares in the year 2025/26 and 2012/13 respectively. Both Khargone and Barwani districts show increasing trends of area in maize production.

Table 4.4.7a: Forecast for Maize area in Nimar Valley

Districts	Khargone			Barwani			Region		
Years	FA	UL	LL	FA	UL	LL	FA	UL	LL
2012-13	20.97	23.00	19.07	32.56	34.01	31.16	53.50	56.26	50.84
2013-14	21.19	24.44	18.29	32.74	35.31	30.31	53.86	58.60	49.42
2014-15	21.42	25.68	17.74	32.92	36.54	29.58	54.24	60.82	48.22
2015-16	21.66	26.80	17.31	33.11	37.72	28.96	54.63	62.92	47.20
2016-17	21.89	27.86	16.97	33.31	38.83	28.42	55.02	64.92	46.34
2017-18	22.13	28.86	16.69	33.51	39.88	27.96	55.43	66.82	45.59
2018-19	22.37	29.84	16.45	33.72	40.89	27.56	55.83	68.65	44.95
2019-20	22.62	30.79	16.24	33.92	41.86	27.20	56.24	70.42	44.38
2020-21	22.87	31.73	16.05	34.13	42.80	26.88	56.66	72.14	43.88
2021-22	23.12	32.66	15.89	34.34	43.71	26.60	57.07	73.82	43.43
2022-23	23.37	33.58	15.75	34.55	44.60	26.34	57.49	75.46	43.03
2023-24	23.62	34.49	15.62	34.76	45.47	26.11	57.92	77.08	42.66
2024-25	23.88	35.41	15.50	34.97	46.33	25.89	58.34	78.68	42.33
2025-26	24.14	36.32	15.39	35.18	47.18	25.70	58.77	80.27	42.03

Area in '000 hectares **FA: Forecasted Area, UL: Upper limits and LL: Lower limits**

In this region, the production of maize crop is expected to be 85.7 thousand tons in the year 2025-26 with upper and lower limits 372.9 and 8.9 thousand metric tons respectively. The minimum value is 60.6 thousand metric tons with upper and lower output limits of 96.0 and 36.2 thousand metric tons in the year 2013-14 was noted.

Table 4.4.7b: Forecast for Maize production in Nimar Valley

Districts	Khargone			Barwani			Region		
Years	FP	UL	LL	FP	UL	LL	FP	UL	LL
2012-13	22.58	36.58	13.13	37.03	55.16	23.90	60.56	96.01	36.20
2013-14	23.63	49.04	9.83	37.66	59.65	22.53	60.84	116.32	28.44
2014-15	24.74	60.67	7.97	37.92	61.33	22.11	63.95	138.69	24.97
2015-16	25.89	72.34	6.71	38.01	61.97	21.93	64.43	155.91	21.26
2016-17	27.10	84.34	5.78	38.01	62.18	21.84	67.55	178.29	19.36
2017-18	28.36	96.82	5.05	37.96	62.20	21.77	68.22	195.24	17.01
2018-19	29.69	109.87	4.47	37.90	62.13	21.71	71.36	218.57	15.74
2019-20	31.07	123.56	3.99	37.81	62.01	21.66	72.22	236.03	14.09
2020-21	32.52	137.94	3.59	37.72	61.87	21.61	75.40	260.61	13.17
2021-22	34.04	153.07	3.24	37.63	61.71	21.55	76.45	278.98	11.94
2022-23	35.63	168.98	2.95	37.54	61.55	21.50	79.67	304.96	11.23
2023-24	37.29	185.72	2.69	37.44	61.38	21.45	80.92	324.49	10.27
2024-25	39.03	203.33	2.47	37.35	61.21	21.40	84.20	351.98	9.70
2025-26	40.86	221.84	2.27	37.25	61.04	21.35	85.65	372.86	8.95

Production in '000 tons FP: Forecasted production, UL: Upper limits and LL: Lower limits

The production of maize according to the districts data reveals that, Khargone district will outmatch Barwani district in production by the year 2024-25 which is currently the leading maize producing district in the region. The maximum production of Khargone and Barwani district are 40.9 and 37.3 thousand tons respectively which would be expected to occur in 2025-26 and the minimum are 22.6 and 37.0 thousand tons in 2012-13.

4.4.8 Jhabua hills

According to maize area projection in Jhabua hills, it is reveals that decline in acreage is expected by the year 2025-26. The maximum value is 131.41 thousand hectares in the year 2012/13 while the minimum value is 119.97 thousand hectares in the year 2025/26. Dhar district shows increase in acreage while Jhabua district reduces her area cultivation for maize crop. More of acreage is needed in this region to increase the production of maize crop, although decline is marginal.

Table 4.4.8a: Forecast for Maize area in Jhabua hills

Districts	Dhar			Jhabua			Region		
Years	FA	UL	LL	FA	UL	LL	FA	UL	LL
2012-13	61.73	69.16	54.93	71.14	88.20	56.75	131.41	150.45	114.28
2013-14	61.95	72.25	52.81	71.34	94.69	52.71	130.48	160.06	105.32
2014-15	62.17	74.84	51.21	71.30	98.69	50.19	129.57	167.00	98.99
2015-16	62.39	77.14	49.91	71.07	101.22	48.38	128.67	172.71	93.86
2016-17	62.61	79.25	48.80	70.68	102.73	46.97	127.77	177.64	89.49
2017-18	62.83	81.24	47.82	70.16	103.51	45.80	126.88	182.02	85.64
2018-19	63.05	83.12	46.94	69.54	103.75	44.79	126.00	185.98	82.20
2019-20	63.27	84.93	46.15	68.84	103.57	43.89	125.12	189.61	79.06
2020-21	63.50	86.68	45.42	68.08	103.08	43.06	124.25	192.95	76.19
2021-22	63.72	88.38	44.74	67.26	102.35	42.29	123.38	196.05	73.53
2022-23	63.95	90.04	44.11	66.41	101.44	41.56	122.52	198.95	71.06
2023-24	64.17	91.67	43.52	65.53	100.39	40.86	121.67	201.67	68.74
2024-25	64.40	93.26	42.97	64.62	99.23	40.18	120.82	204.22	66.57
2025-26	64.63	94.83	42.45	63.70	97.99	39.52	119.98	206.63	64.51

Area in '000 hectares **FA: Forecasted Area, UL: Upper limits and LL: Lower limits**

Maize crop production in Jhabua hill region of Madhya Pradesh is on the decreasing trend, and this is in relation to the negative growth trend of area in the region. In the year 2012-13, the production of maize is 162.5 thousand tons according to the projection and this is considered to be the maximum output with upper and lower limit of 265.2 and 93.6 thousand tons. The minimum output occurred in 2025-26 with output of 140.5 thousand tons with upper and lower limits of 368.3 and 40.6 thousand tons.

Dhar district shows increase in production because of positive growth rate of acreage while Jhabua district shows decrease in production due to negative growth rate of acreage. Overall result shows that if more area is allocated for the cultivation of maize, there will be higher increase in the

production of this crop in the region. But on the basis of present trend, the production of maize by the year 2025-26 will decrease and reached at 140 thousand tons from 162.46 thousand tons in 2012-13

Table 4.4.8b: Forecast for Maize production in Jhabua hills

Districts / Years	Dhar			Jhabua			Region		
	FP	UL	LL	FP	UL	LL	FP	UL	LL
2012-13	77.52	122.14	46.67	88.93	151.17	48.61	162.47	265.15	93.57
2013-14	78.70	144.63	38.80	86.94	152.07	45.78	160.66	277.67	85.94
2014-15	79.92	165.02	33.48	85.00	152.72	43.19	158.87	288.85	79.46
2015-16	81.16	184.34	29.50	83.10	153.14	40.81	157.11	299.00	73.83
2016-17	82.42	203.13	26.36	31.24	153.36	38.61	155.36	308.31	68.87
2017-18	83.69	221.65	23.78	79.43	153.42	36.57	153.64	316.91	64.44
2018-19	84.99	240.06	21.61	77.65	153.31	34.67	151.93	324.90	60.46
2019-20	86.30	258.44	19.76	75.92	153.07	32.90	150.24	332.34	56.85
2020-21	87.64	276.89	18.16	74.22	152.71	31.24	148.57	339.31	53.55
2021-22	88.99	295.43	16.76	72.56	152.24	29.70	146.92	345.84	50.54
2022-23	90.37	314.11	15.51	70.94	151.66	28.24	145.29	351.97	47.76
2023-24	91.77	332.96	14.41	69.35	150.99	26.88	143.67	357.74	45.20
2024-25	93.19	352.00	13.42	67.81	150.24	25.59	142.07	363.17	42.82
2025-26	94.63	371.24	12.52	66.29	149.41	24.38	140.49	368.28	40.61

Production in '000 tons **FP: Forecasted production, UL: Upper limits and LL: Lower limits**

4.5 Crop performance and adjustment in Madhya Pradesh

In agricultural production, land is an important and scarce factor among the major factors of production. With increase in population, the area under cultivation cannot be extended behind certain limits. Therefore, study on its efficient use and proper adjustment and allocation is necessary. In previous studies on agriculture land use, many types of inefficient use of land interms of mal-adjustment are generally observed. The study on cropping pattern in Madhya Pradesh (Anonymous, 1967) reveals that even under existing physical conditions, there is considerable scope for improving the cropping pattern in all the districts, regions and state as a whole. With this basic information, here in this section, an attempt has been made to examine the localization of maize crop and its adjustment in the cropping pattern.

4.5.1 Northern hill region of Chhattisgarh

The districtwise maize crop performance in Northern hill region of Chhattisgarh and its localization is dealt in tables 4.5.1 to 4.5.8. From data presented in table 4.5.1, it can be observed that the cultivation of maize was mainly concentrated in Dindori and Shahdol districts.

Table 4.5.1a: Area and yield index of maize in Northern hill region of Chhattisgarh

Name of districts	Area ('000 ha)	Yield (kg/ha)	GCA ('000 ha)	% of maize area to GCA	Area index	Yield index
Mandla	18.31	1149.65	292.21	6.26	125.85	108.15
Anuppur	12.08	831.95	197.17	6.13	102.32	62.23
Umaria	10.48	604.96	134.76	7.78	112.22	84.65
Shahdol	11.34	966.49	192.37	5.90	48.27	124.79
Dindori	19.00	926.84	286.88	6.62	91.70	91.29
Region	71.20	926.97	1103.39	6.45	89.12	73.14

The yield index is highest in Shahdol district, followed by Mandla district. Anuppur experienced the lowest yield index in the region. The percentage of maize area to gross cropped area in Northern hill zone of Chhattisgarh is 6.45 per cent. The percentage of maize area is highest in Umaria district while in other districts, it is more or less identical. The area index is higher than yield index in the region as a whole.

In Northern hill region of Chhattisgarh, 26.69%, 25.72% and 31.69% of maize crop area was well adjusted, significantly adjusted and tolerably adjusted respectively while 15.93% maize crop area was poorly adjusted. In this region, all the districts were area dominating in the cropping pattern, except Shahdol district. Dindori district was well adjusted in cropping pattern with domination of area. Mandla district was sufficiently adjusted with area domination while Umaria and Anuppur districts were tolerably adjusted with domination of area.

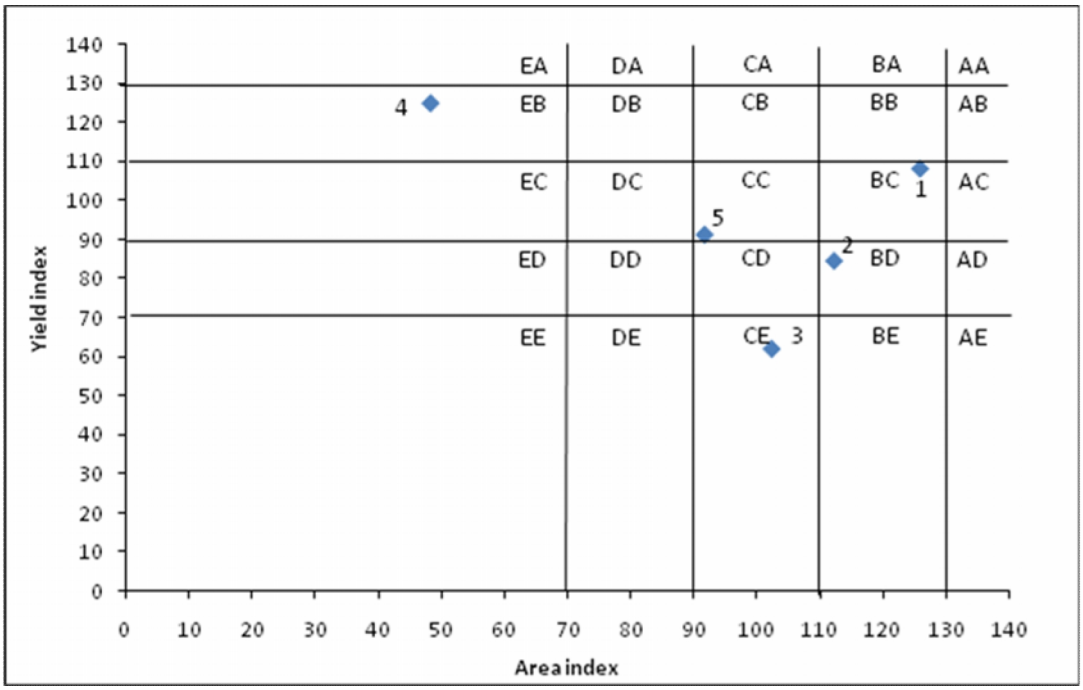

Fig. 4.5.1: Placement of districts of Northern hill region according to crop adjustment categories

North hill region: - Districts (1) Mandla (2) Anuppur (3) Umaria (4) Shahdol and (5) Dindori

Table 4.5.1b: Placement of districts of Northern hill region according to crop adjustment categories

Particulars	Category					Total
	I	II	III	IV	V	
Area dominating districts	Dindori	Mandla	Umaira, Anuppur	-	-	4
Yield dominating districts	-	-	-	Shahdol	-	1
% of maize area in the region	26.69	25.72	31.69	15.93	-	100
% of maize area in the state	2.29	2.21	2.72	1.37	-	8.59

i. Well adjusted
ii. Sufficiently adjusted
iii. Tolerably adjusted
iv. Poorly adjusted
v. Very poorly adjusted

4.5.2 Kaymore plateau and Satpura hills

Maize crop performance in Kaymore plateau and Satpura hills and its localization is dealt in tables 4.5.2a and 4.5.2b. From the data presented in table 4.5.2a, it can be observed that the cultivation of maize in this region was higher in Sidhi district compared to Seoni district.

Table 4.5.2a: Area and yield index of maize in Kaymore plateau and Satpura hills

Name of districts	Area ('000 ha)	Yield (kg/ha)	GCA ('000 ha)	% of maize area to GCA	Area index	Yield index
Sidhi	9.18	1165.58	230.53	3.98	24.41	102.65
Seoni	11.50	1134.78	535.65	2.15	121.36	132.78
Kaymore plateau and Satpura hills	20.68	1148.45	766.18	2.70	43.93	94.43

The yield index is higher in all the districts and in the region as a whole compared to area index. The percentage of maize area to gross cropped area in the region is 2.70 percent. Sidhi district has higher percentage of maize crop of 3.98 percent compared to Seoni district with 2.15 percent.

All the districts of Kaymore plateau and Satpura hills were yield dominating. Seoni district is sufficiently-adjusted and shared 55.61 percent of

area while Sidhi district is tolerably-adjusted in area and shared 44.39 percent.

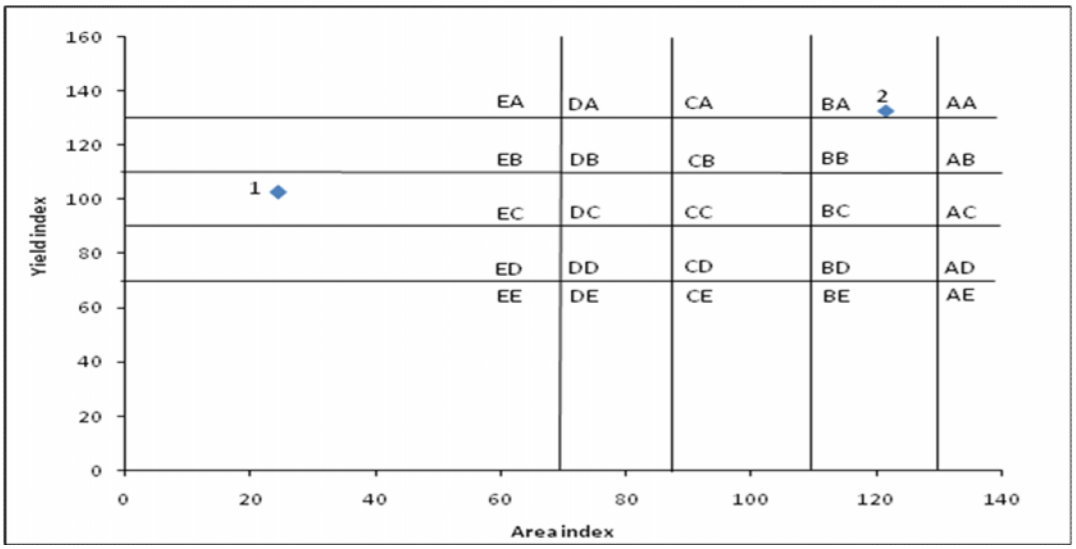

Fig. 4.5.2: Placement of districts of Kaymore plateau and Satpura hills according to crop adjustment categories

Kaymore plateau and Satpura hills: - Districts (1) Sidhi (2) Seoni

Table 4.5.2b: Placement of districts of Kaymore plateau and Satpura hills according to crop adjustment categories

Particulars	Category					Total
	I	II	III	IV	V	
Area dominating districts	-	-	-	-	-	-
Yield dominating districts	-	Seoni	Sidhi	-	-	2
% of maize area in the region	-	55.61	44.39	-	-	100
% of maize area in the state	-	1.39	1.11	-	-	2.50

4.5.3 Vindhya plateau

The data on maize crop performance and its adjustment in the cropping pattern is presented in Table 4.5.3a and 4.5.3b. Vindhya plateau accounts for 2 percent of the gross cropped area in the state.

Table 4.5.3a: Area and yield index of maize in Vindhya plateau

Name of districts	Area ('000 ha)	Yield (kg/ha)	GCA ('000 ha)	% of maize area to GCA	Area index	Yield index
Sehore	14.65	1127.65	129.76	2.19	145.79	127.47

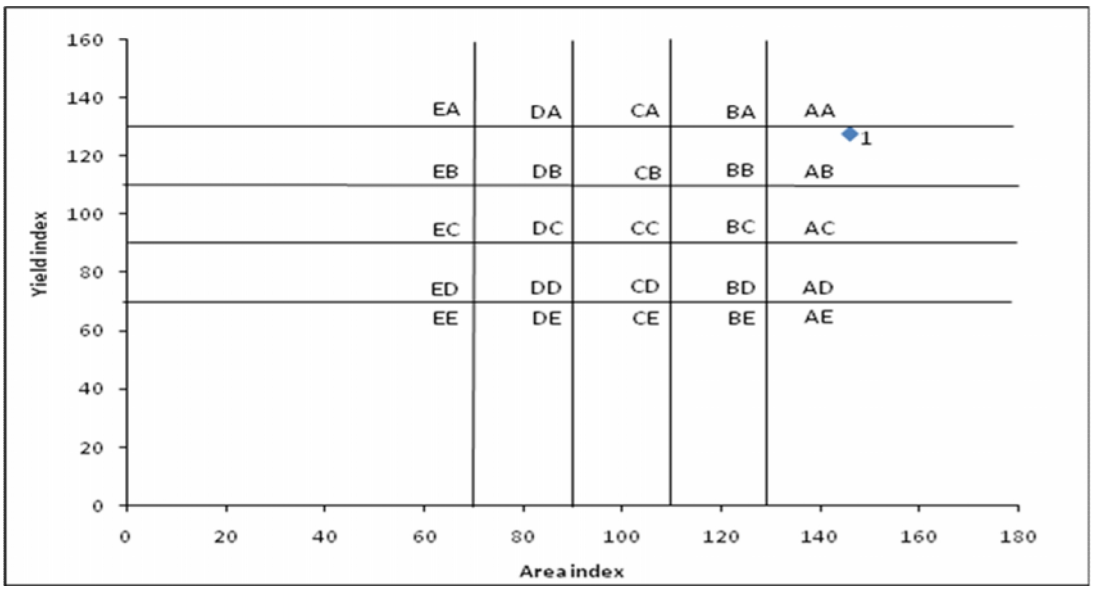

Fig. 4.5.3: Placement of district of Vindhya plateau according to crop adjustment categories

Vindhya plateau: - District (1) Sehore

The area index is 145.79 percent while yield index is 127.47 percent. Maize crop in Vindhya plateau is sufficiently-adjusted in the cropping pattern and is dominated by area. Therefore, there is scope of increasing production of maize in the area through expansion of acreage. For the state as a whole, the crop is well adjusted in the cropping pattern with area domination. It can then be concluded that, if there is proper adjustment in cropping pattern of maize crop, the production will increase.

Table 4.5.3b: Placement of district of Vindhya plateau according to crop adjustment categories

Particulars	Category					Total
	I	II	III	IV	V	
Area dominating districts	-	Sehore	-	-	-	1
Yield dominating districts	-	-	-	-	-	-
% of maize area in the region	-	100.00	-	-	-	100
% of maize area in the state	-	1.76	-	-	-	1.76

4.5.4 Gird region

In Gird region, which is mainly wheat and rapseed mustard growing region of Madhya Pradesh, the share of maize crop in the gross cropped area is 3.95 percent. The percentage of maize crop to gross cropped area in Shivpuri and Guna districts are 4.37 per cent and 3.60 percent respectively.

Table 4.5.4a: Area and yield index of maize in Gird region

Name of districts	Area ('000 ha)	Yield (kg/ha)	GCA ('000 ha)	% of maize area to GCA	Area index	Yield index
Guna	20.48	1150.39	488.03	4.20	90.46	113.27
Shivpuri	27.96	1541.49	589.46	4.74	138.52	149.84
Gird region	48.45	1377.71	1077.49	4.50	113.12	108.35

Shivpuri district is area dominating while Guna district is yield dominating. Shivpuri district is well-adjusted and shared 57.71 percent of the area in the region while Guna is sufficiently-adjusted and shared 42.27 percent of the area in the region.

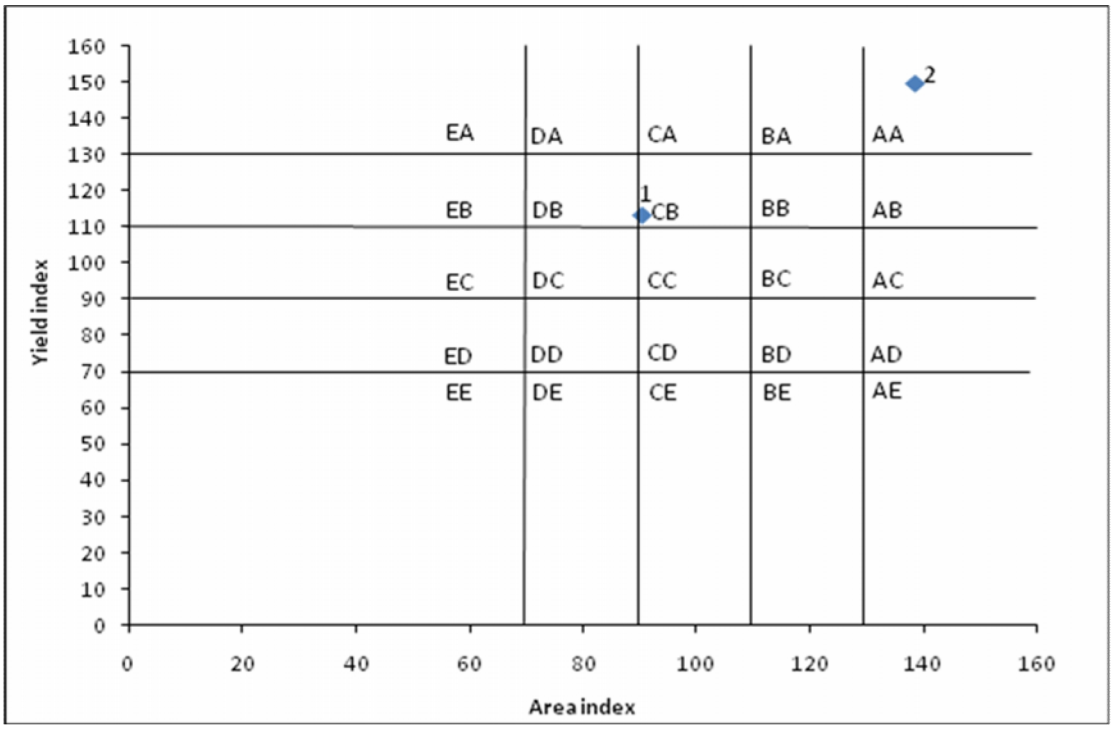

Fig. 4.5.4: Placement of districts of Gird region according to crop adjustment categories

Gird region: - Districts (1) Guna (2) Shivpuri

Table 4.5.4b: Placement of districts of Gird region according to crop adjustment categories

Particulars	Category					Total
	I	II	III	IV	V	
Area dominating districts	Shivpuri	-	-	-	-	1
Yield dominating districts	-	Guna	-	-	-	1
% of maize area in the region	57.71	42.27	-	-	-	100
% of maize area in the state	3.37	2.47	-	-	-	5.84

4.5.5 Satpura plateau

In Satpura plateau, maize crop shared 10 percent of the gross cropped area in the region. The percentage of maize acreage is higher in all the districts and in the region as a whole as compared to the yield index. All the districts were area dominating during the period of study.

Table 4.5.5a: Area and yield index of maize in Satpura plateau

Name of districts	**Area ('000 ha)**	**Yield (kg/ha)**	**GCA ('000 ha)**	**% of maize area to GCA**	**Area index**	**Yield index**
Betul	42.70	1402.81	622.77	6.86	204.69	119.26
Chhindwara	87.16	2183.23	645.18	13.51	159.44	99.83
Satpura plateau	129.86	1926.61	1267.95	10.24	171.93	93.26

Betul district shared 32.88 per cent of the area and is sufficiently – adjusted. Chhindwara district is tolerably–adjusted and shared 67.12 per cent of the area. Therefore, in this region, maize production can be increased if area allocation to maize can be well taken care of.

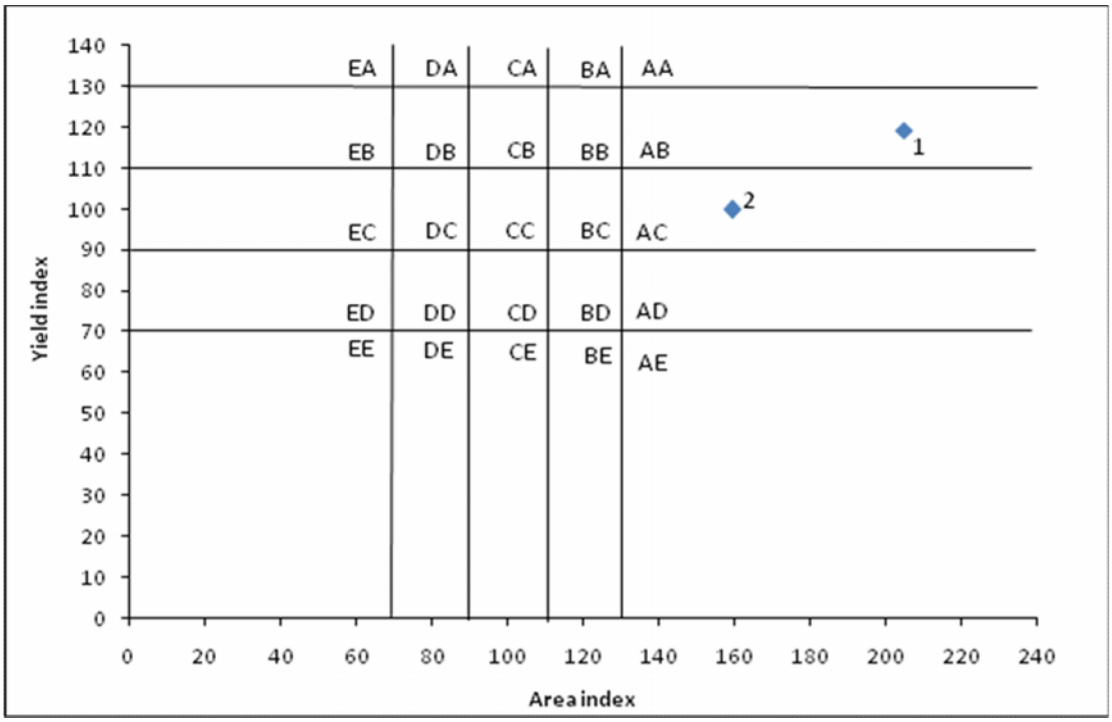

Fig. 4.5.5: Placement of districts of Satpura plateau according to crop adjustment categories

Satpura plateau:- Districts (1) Betul (2) Chhindwara

Table 4.5.5b: Placement of districts of Satpura plateau according to crop adjustment categories

Particulars	Category					Total
	I	II	III	IV	V	
Area dominating districts	-	Betul	Chhindwara	-	-	2
Yield dominating districts	-	-	-	-	-	-
% of maize area in the region	-	32.88	67.12	-	-	100
% of maize area in the state	-	5.14	10.50	-	-	15.64

4.5.6 Malwa plateau

The cultivation of maize crop in Malwa plateau is highly concentrated in Ratlam, Mandsour and Rajgarh districts. Dewas district has the highest yield index, followed by Ratlam district. Rajgarh district has the lowest yield index in the region. Area index is higher than yield index in Ujjain, Shajapur

and Rajgarh while in Dewas, Ratlam, Neemuch and Mandsour, yield index is higher than area index. In Malwa plateau as a whole, area index is more than yield index.

Table 4.5.6a: Area and yield index of maize in Malwa plateau

Name of districts	Area ('000 ha)	Yield (kg/ha)	GCA ('000ha)	% of maize area to GCA	Area index	Yield index
Neemuch	27.77	1704.85	288.03	9.64	92.28	139.23
Mandsour	37.85	1389.04	546.69	6.92	62.79	117.84
Rajgarh	50.66	1184.96	720.75	7.03	113.37	112.46
Ratlam	53.76	2004.65	512.31	10.49	121.01	160.33
Dewas	10.73	1378.38	674.68	1.59	154.14	166.92
Ujjain	7.57	1116.25	873.81	0.87	291.94	115.54
Shajapur	41.16	878.28	765.63	5.38	121.66	118.67
Region	229.23	1432.67	4381.90	5.23	103.06	107.01

In Dewas, Rajgarh and Shajapur districts cultivation of maize crop is well-adjusted showing 44.74 per cent of the maize area in the region, and sufficiently-adjusted in Ujjain district with domination of area. Ratlam, Neemuch and Mandsour on the other hand were sufficiently, tolerably and poorly-adjusted respectively with yield domination. Therefore, from Malwa plateau, four out of seven districts were area dominating while the remaining three were yield dominating. The percentage of maize crop to gross cropped area in different districts of the region are ranging from 0.87 per cent in Ujjain district to 10.49 percent in Ratlam district as observed from data presented in table 4.5.6a.

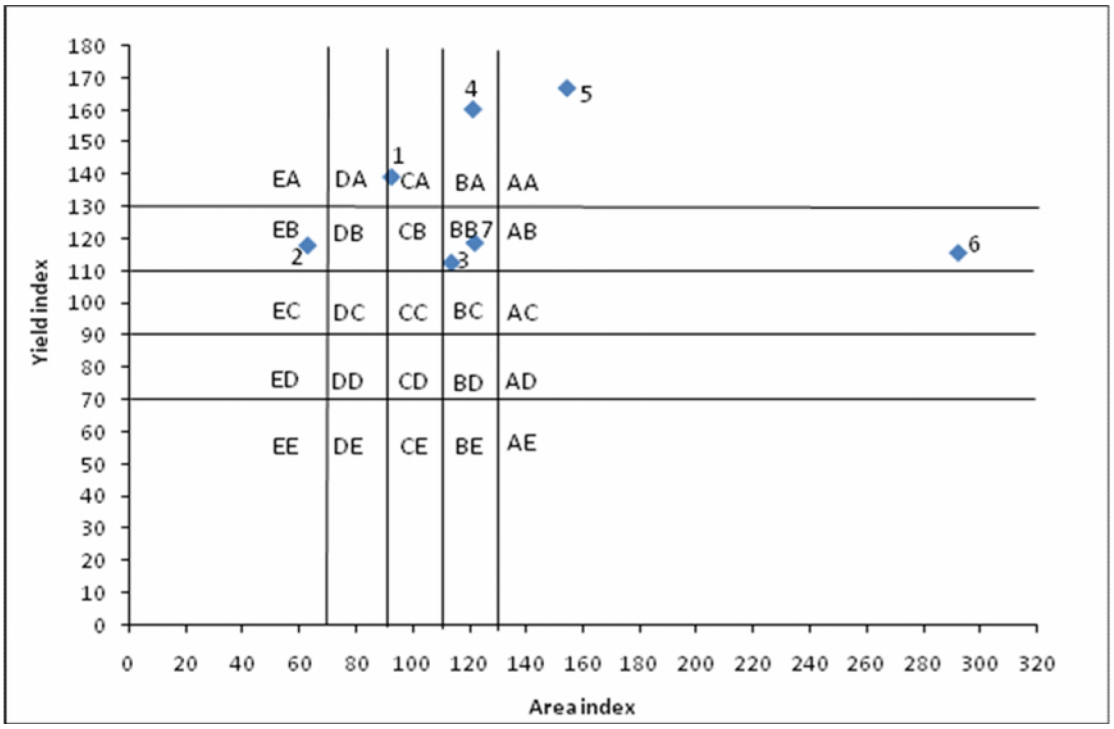

Fig. 4.5.6: Placement of districts of Malwa plateau according to crop adjustment categories

Malwa plateau: - Districts (1) Neemuch (2) Mandsour (3) Rajgarh (4) Ratlam (5) Dewas (6) Ujjain (7) Shajapur

Table 4.5.6b: Placement of districts of Malwa plateau according to crop adjustment categories

Particulars	Category					Total
	I	II	III	IV	V	
Area dominating districts	Dewas, Rajgarh, Shajapur	Ujjain	-	-	-	4
Yield dominating districts	-	Ratlam	Neemuch	Mandsour	-	3
% of maize area in the region	44.74	26.76	12.12	16.51	-	100
% of maize area in the state	12.34	7.38	3.34	4.56		27.60

4.5.7 Nimar valley

In Nimar valley, the percentage of maize area to gross cropped area is 6.75 percent. The data presented in the table 4.5.7a shows that in this region Khargone and Barwani district had high area and yield index. The districts of the region show domination of area during the study period. Barwani is well-adjusted with share of 61.09 per cent as observed from the Table 4.5.7a. The cultivation of maize is sufficiently–adjusted in Khargone district and shared 38.91 percent.

Table 4.5.7a: Area and yield index of maize in Nimar valley

Name of districts	Area ('000 ha)	Yield (kg/ha)	GCA ('000 ha)	% of maize area to GCA	Area index	Yield index
Khargone	20.56	1051.56	508.34	4.05	124.25	105.88
Barwani	32.28	1113.07	275.04	11.74	111.57	117.95
Nimar Valley	52.84	1077.97	783.38	6.75	116.18	83.18

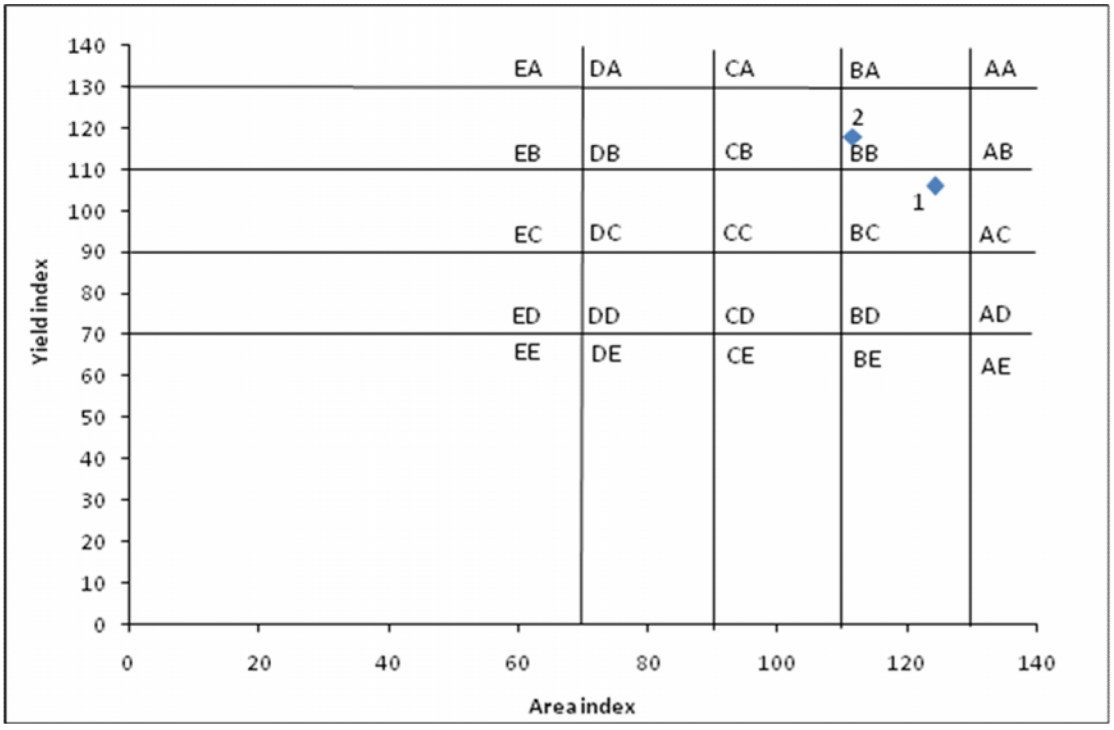

Fig. 4.5.7: Placement of districts of Nimar valley according to crop adjustment categories

Nimar Valley: - Districts (1) Khargone (2) Barwani

From the above results of crop performance and crop adjustment of maize crop in Nimar valley, it can be concluded that in this region, the

production of maize can be further increased by raising acreage rather than productivity.

Table 4.5.7b: Placement of districts of Nimar valley according to crop adjustment categories

Particulars	Category					Total
	I	II	III	IV	V	
Area dominating districts	Barwani	Khargone	-	-	-	2
Yield dominating districts	-	-	-	-	-	-
% of maize area in the region	61.09	38.91	-	-	-	100
% of maize area in the state	3.89	2.48	-	-	-	6.36

4.5.8 Jhabua hills

The districtwise maize crop performance and its localization in Jhabua hills region is dealt in tables 4.5.8a and 4.5.8b respectively. The area index is higher in Dhar district as compared to Jhabua district while yield index is lower in Dhar district compared to that of Jhabua district. In Jhabua hills as a whole, yield index is higher than area index.

Table 4.5.8a: Area and yield index of maize in Jhabua hills

Name of districts	Area ('000 ha)	Yield (kg/ha)	GCA ('000 ha)	% of maize area to GCA	Area index	Yield index
Dhar	61.31	1240.58	782.23	7.84	103.75	97.33
Jhabua	70.46	1205.37	231.29	30.46	67.69	114.55
Jhabua hills Region	131.37	1221.83	1013.52	12.96	80.75	83.98

In Dhar district, the tendency of localization of maize crop is low, as nearly 50 percent of area of this region is well-adjusted with domination of area. Jhabua district which is yield dominating, is poorly-adjusted and shared 53.64 percent area in the cropping pattern of Jhabua hills region.

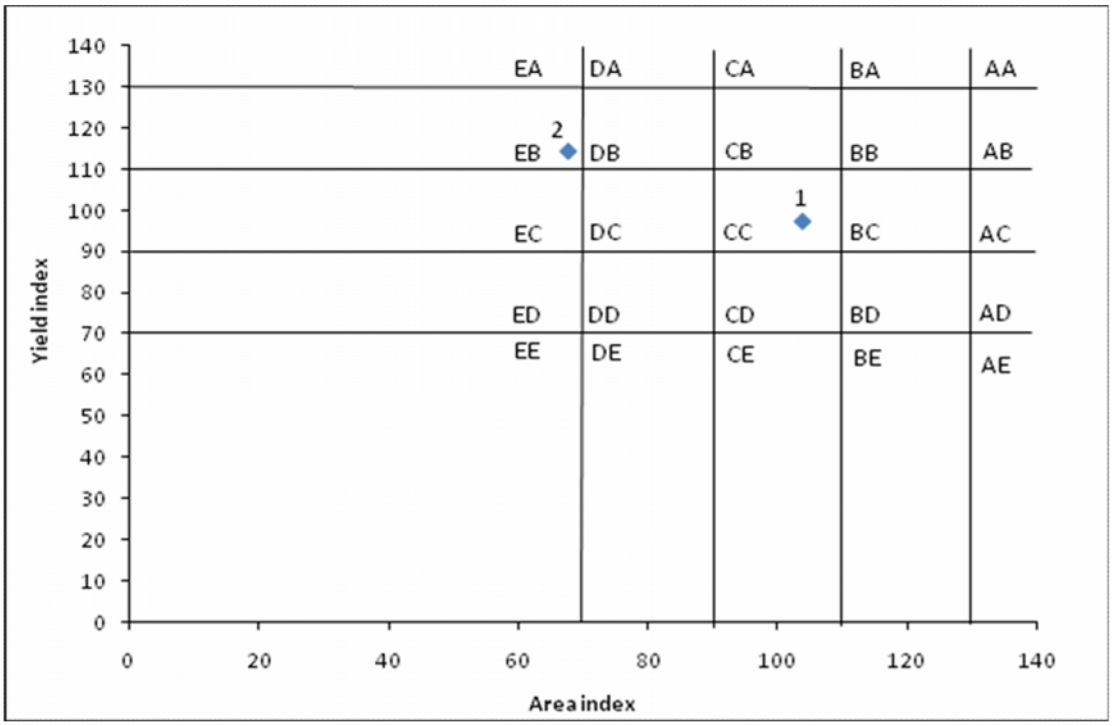

Fig. 4.5.8 Placement of districts of Jhabua hills according to crop adjustment categories.

Jhabua hills: - Districts (1) Dhar (2) Jhabua

Table 4.5.8b: Placement of districts of Jhabua hills according to crop adjustment categories.

Particulars	Category					Total
	I	II	III	IV	V	
Area dominating districts	Dhar	-	-	-	-	1
Yield dominating districts	-	-	-	Jhabua	-	1
% of maize area in the region	46.67	-	-	53.64	-	100
% of maize area in the state	7.38	-	-	8.48	-	15.87

SUMMARY AND CONCLUSION

5.1 Summary

Agriculture in India, one of the most successful sectors of the national economy in terms of productivity growth, had more than compensated for the rapid growth in demand for the past few decades. Agriculture sector plays a major role in the progress of the economy in achieving the developmental goals of eradication of poverty, faster and sustainable growth and modernization of society. Agriculture is the backbone of the country's development and life-line for 65 percent of the population in rural area. Approximately more than 58 percent of the population is still dependent on agriculture for their livelihood. Maize in India occupies fourth place in average area and ranks sixth in production in the world. It is grown in 23 states with an area of 8.78 million hectares and production of 21.59 million tons during 2011-12. In Madhya Pradesh, agriculture continues to be the main stay of the economy. Generally crops, especially maize plays an important role in agricultural development but still there are regional disparities due to coverage of area, production and productivity of this crop (maize) in the state. Madhya Pradesh is one of the traditional and potential maize growing states in India.

This investigation was confined to twenty three selected districts of eight agro climatic regions of the state. The selection of these districts was based on the area under the cultivation of maize crop.The districts that allocated 10,000 and above hectares of land for the cultivation of maize crop in the state were selected purposively. The time series secondary data for the period of 22 years (1990-91 to 2011-12) were collected on area production and productivity of maize crop.

For the purpose of analysis of collected secondary time series data, different statistical and econometrical tools were used. The growth pattern

was insured interms of coefficient of variation and the simple growth rate, the contribution of acreage and productivity towards total increase/decrease in maize crop production was examined through decomposition model. For estimation of likely projection of maize crop production by 2025 -26, Auto-regressive Integrated Moving Average (ARIMA) model was used. The localization and adjustment of the maize crop in the cropping pattern of selected districts was observed through crop adjustment model. After the analysis of data, keeping the objectives of the study in mind, the following major findings were obtained.

The Relative change in area, production and productivity of maize crop was found positive in Malwa plateau and Gird region while negative in Northern hill region of Chhattisgarh, Kaymore plateau and Satpura hills and Jhabua regions. Relative change in area and production were positive in Satpura plateau and Vindhya plateau while in Nimar valley relative change was negative for production and productivity. In Madhya Pradesh as a whole relative change was found to be negative for both area and production while it was positive for productivity.

Maize crop had positive growth in area, production and productivity in Malwa plateau and Gird region. In Nimar valley, Satpura plateau and Vindhya plateau, the growth rate is positive for area and productivity. There is negative growth in area, production and productivity in Northern hill region of Chhattisgarh, Jhabua hills and Kaymore plateau and Satpura hills. Madhya Pradesh experienced negative growth in area and positive growth in production and productivity.

The result of the decomposition analysis in the selected districts show that in some cases the growth in production is due to increase in acreage while in some, the yield effect was observed to be dominating in the total production. Both area and yield effect were observed, but only varied from district to district. The contribution of area towards increase in the production of maize crop was found to be higher than productivity in Jhabua hills, Satpura plateau, Gird region, Kaymore plateau and Satpura hills and Vindhya plateau while in Northern hill region of Chhattisgarh, Malwa plateau,

Nimar valley and Madhya Pradesh as a whole, contribution of yield was higher than area.

The data on projected production of maize crop shows that the maximum increase in production is expected in Malwa plateau followed by Satpura plateau. The production of maize crop is likely to touch a level of 1407.0 thousand tons over the present level of 1290.0 thousand tons in 2011-12 with expected decrease in acreage in the subsequent years in the state.

It was found out that maize crop was area dominating in Northern hill region of Chhattisgarh, Malwa plateau, Nimar valley, Satpura hills and Vindhya plateau while Jhabua hills and Kaymore plateau and Satpura hills were found to be yield dominating. Only in Gird region both area and yield had almost equal shares (i.e. area; 50.79 and yield; 49.21).

5.2 Conclusion

- The relative change in maize production in general was found to be higher in base year as compared to current year and this change in production was mainly attributed to increase in productivity as compared to acreage.

- The growth over time in maize production was higher in the current year and this can be attributed to positive growth in productivity. As a result of this, it can be concluded that with the passage of time, maize production commercialization will increase the marketed surplus.

- Total increase in maize production was enhanced by yield and the percentage contribution of yield was higher towards increase in maize production as compared to contribution of acreage and this leads to conclusion that maize producers are adopting production technologies to some extent and replacement of traditional varieties by hybrids.

- The projection of maize crop production by 2025-26 was estimated around 1407.0 thousand tons but this can be increased, if the present decline in acreage which is expected to be 826.0 thousand hectares by

2025-26 as against 841.0 thousand hectares in 2012-13 turns from declining and the growth in productivity is maintained by expansion of area under hybrid maize.

- The results of placement of maize crop in the cropping pattern shows that this crop was still sufficiently and tolerably adjusted in the cropping pattern and this leads to think over the possibility of further increase in maize production in the state by bringing more industries for production of maize based products.

5.3 Recommendations

- The acreage and productivity of maize crop at the districts, region and state level had decreased. This indicates that farmers have not adopted the recommended technology to the fullest extent which has resulted in poor profiting from maize. The impact of improved scientific technology is clearly not observed in maize crop production due to low adoption. Its downward trend in area allocation and production cause for concern. Therefore, all attempts should be required to extend the available improved technology to the farmers and change its adoption.

- A comprehensive survey may be undertaken by the competent agencies to identify the problem faced in cultivation of maize crop in the selected districts of the state.

- Intensive problem oriented research should be planned and conducted for maize crop so that appropriate and economically sound package of cultivation practices can be developed and recommended for each district separately with the consideration of variation in the climate, soil type and available resources.

- In case of expansion of maize crop acreage, a definite plan should be made considering adjustment in cropping pattern and make adjustment of this crop in the cropping pattern in different districts so that the total production can be increased at the desire level to meet out the

consumption need and to create potential exportable surplus as bird and animal feed.

- Efforts should also be made to intensify maize production especially in those districts where the productivity levels at present is poor.

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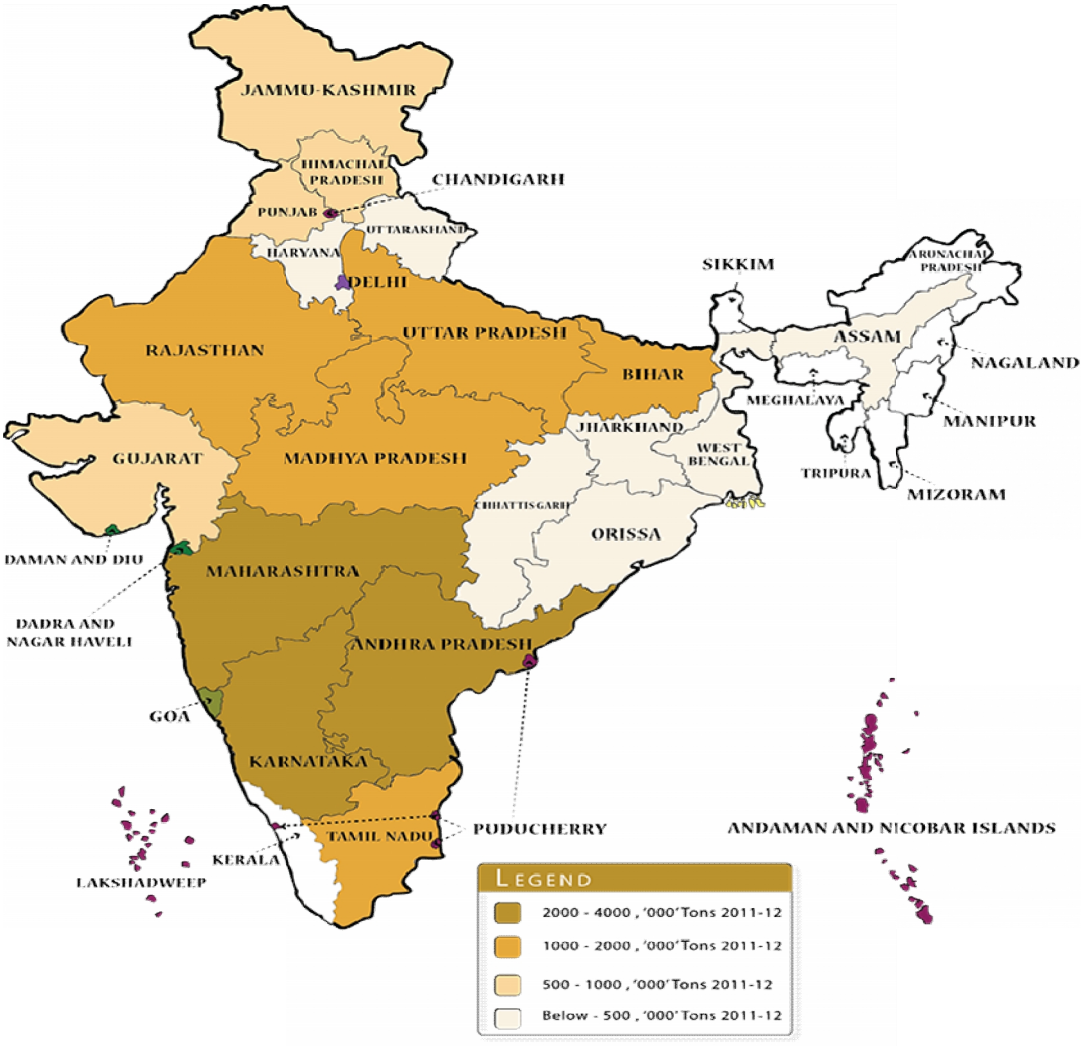


Fig 1: Map of India showing major maize growing states

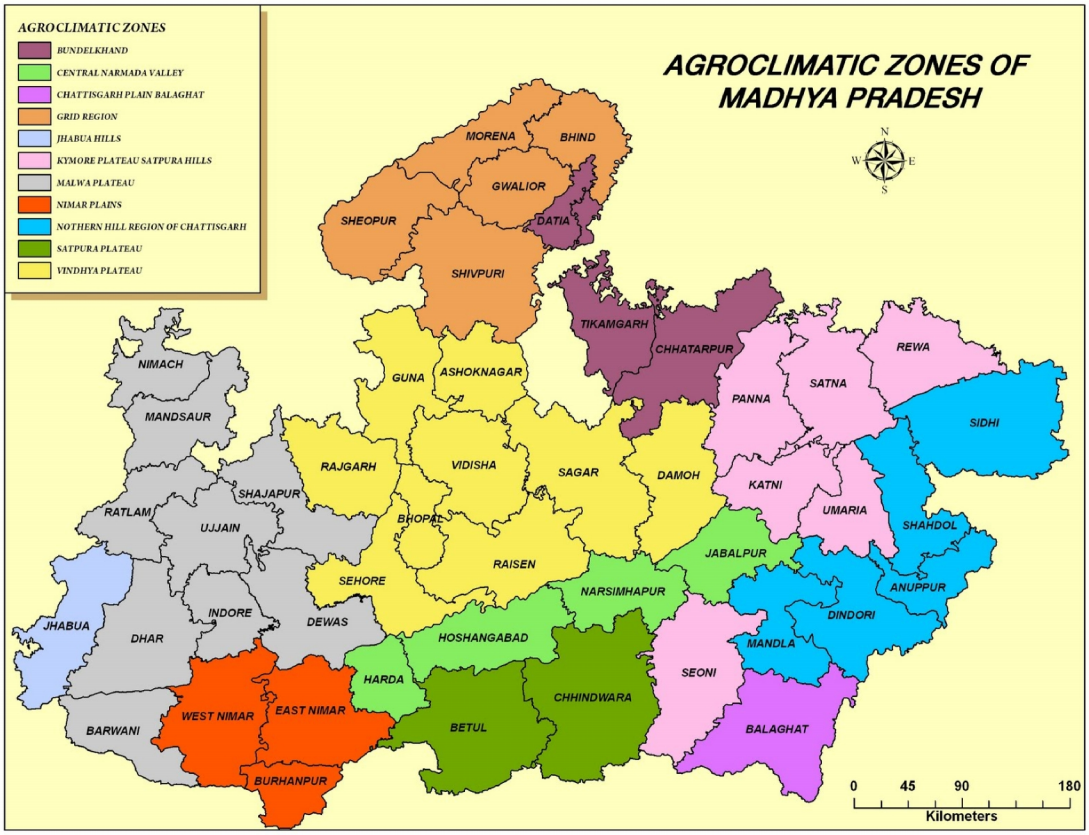
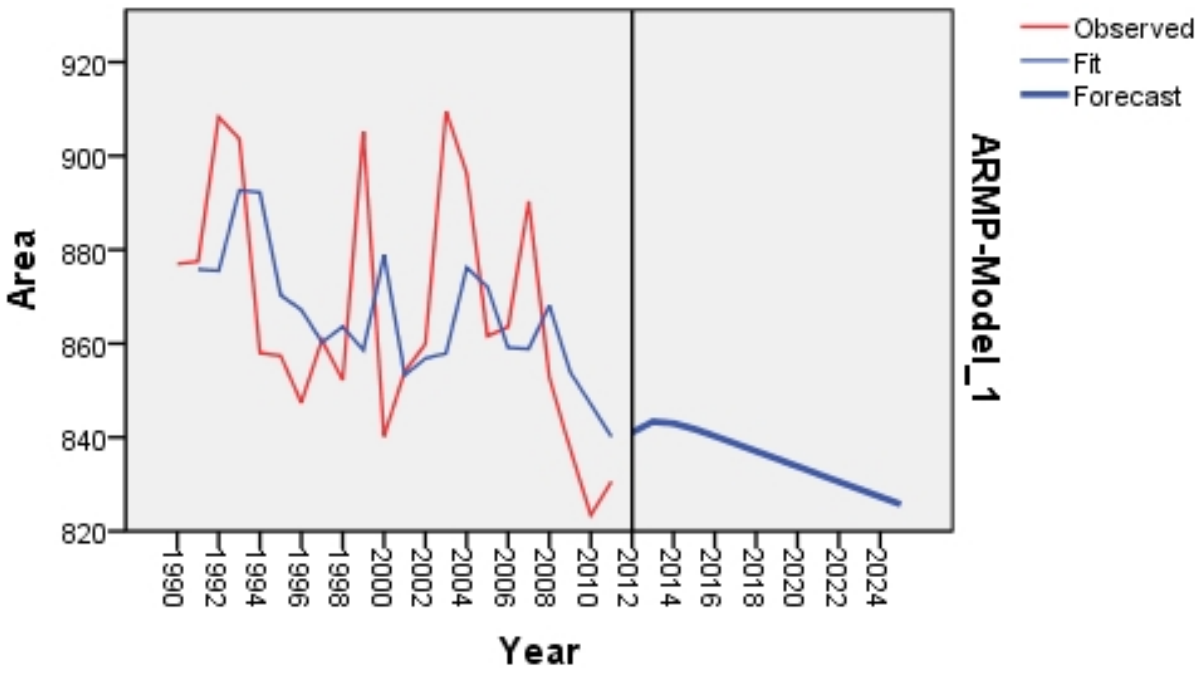
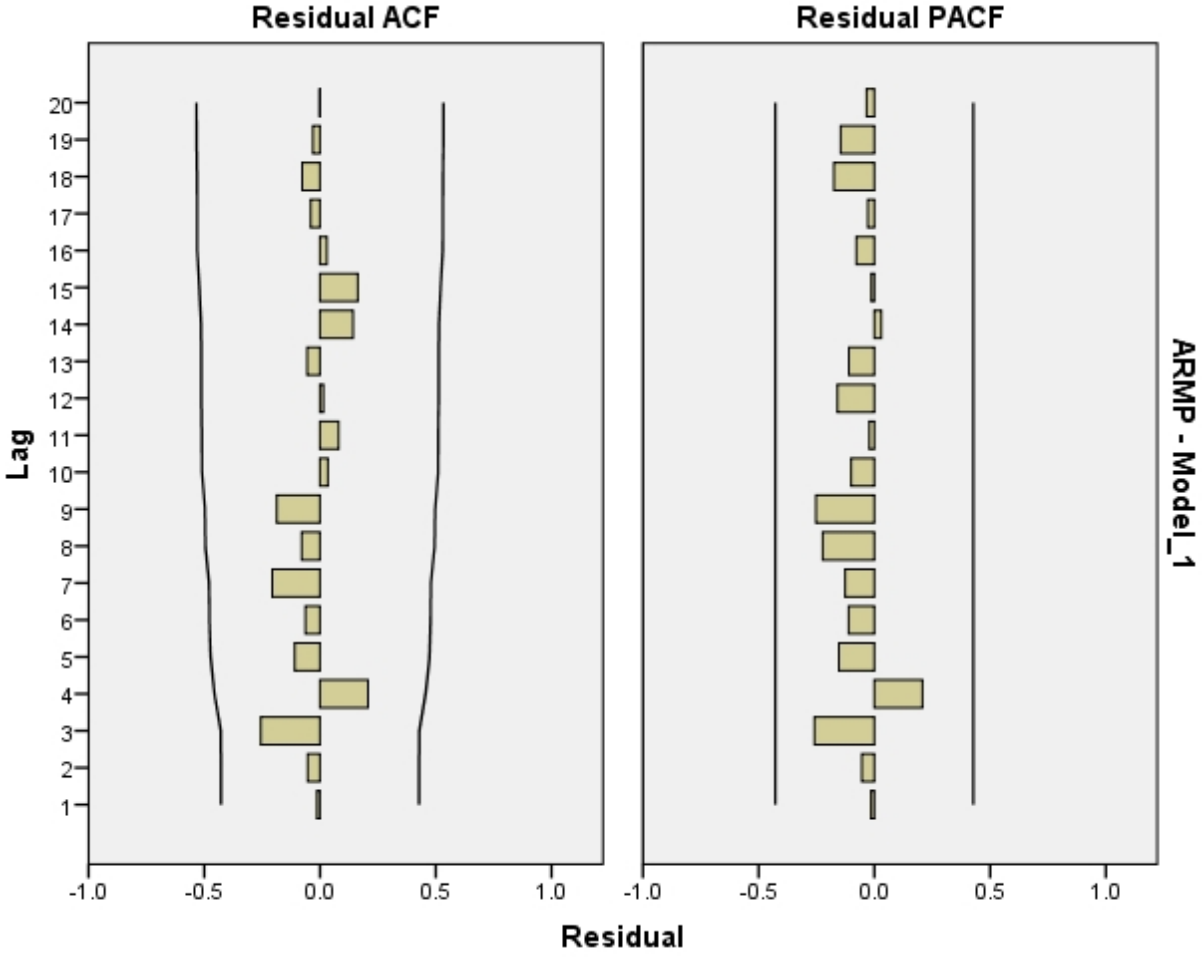


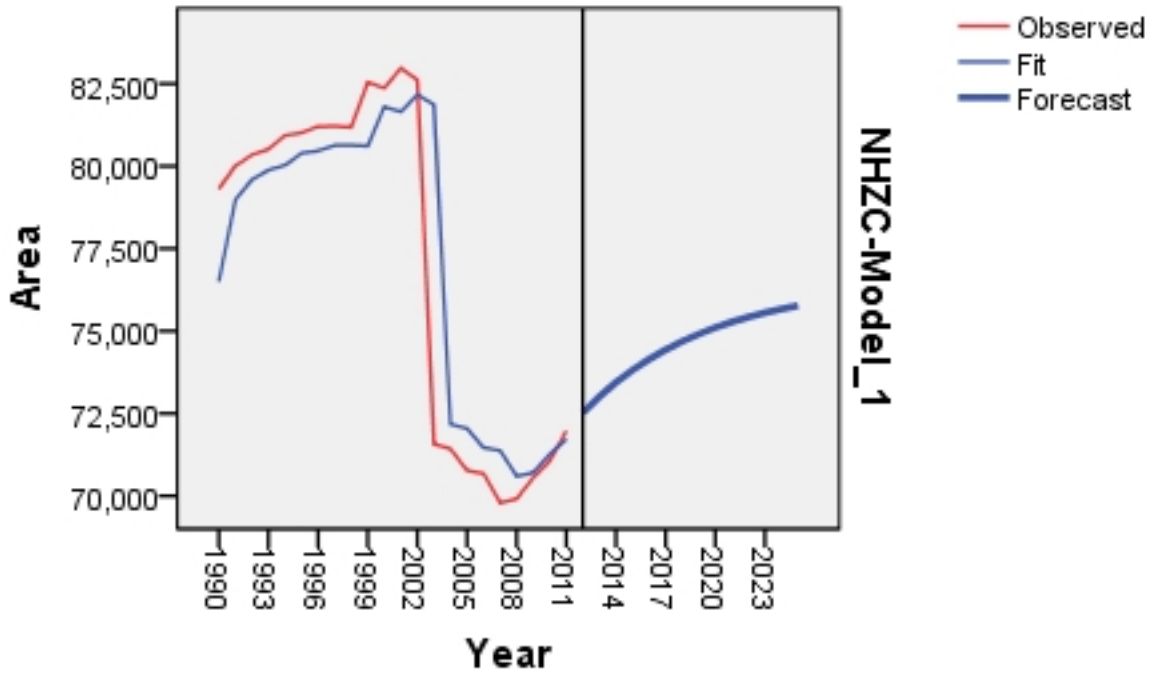
Fig 2: Map of Madhya Pradesh showing agroclimatic zones

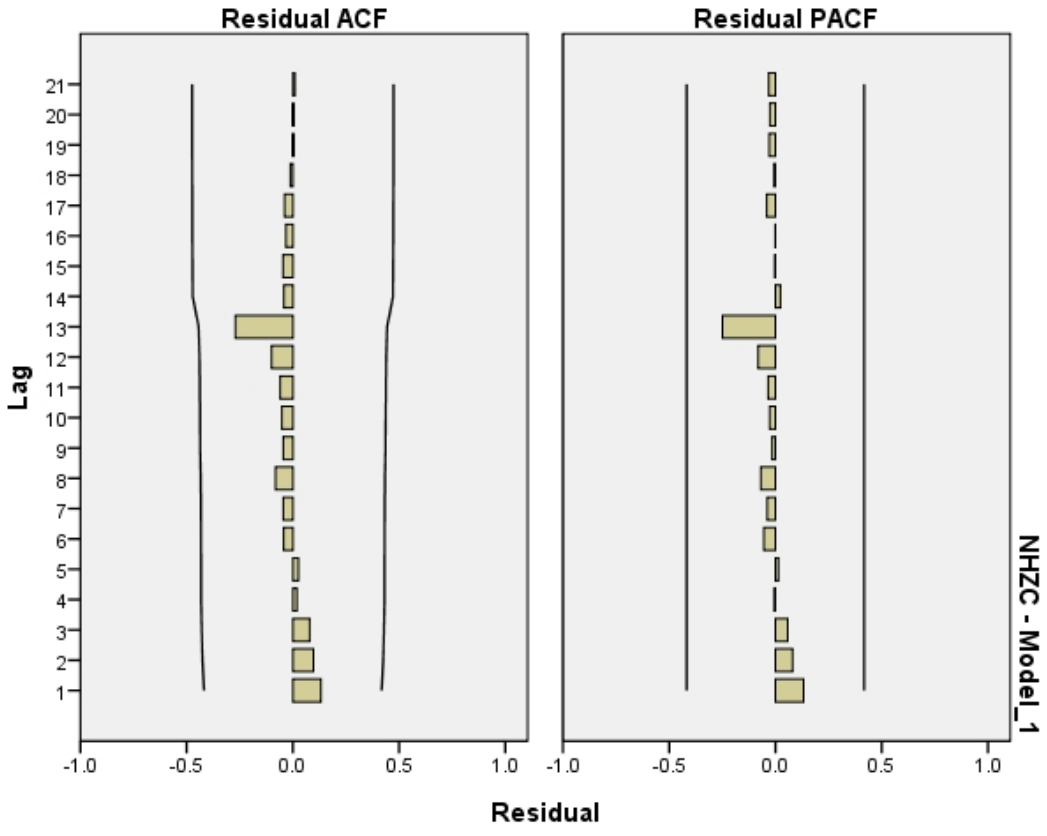
Area Projection for Madhya Pradesh



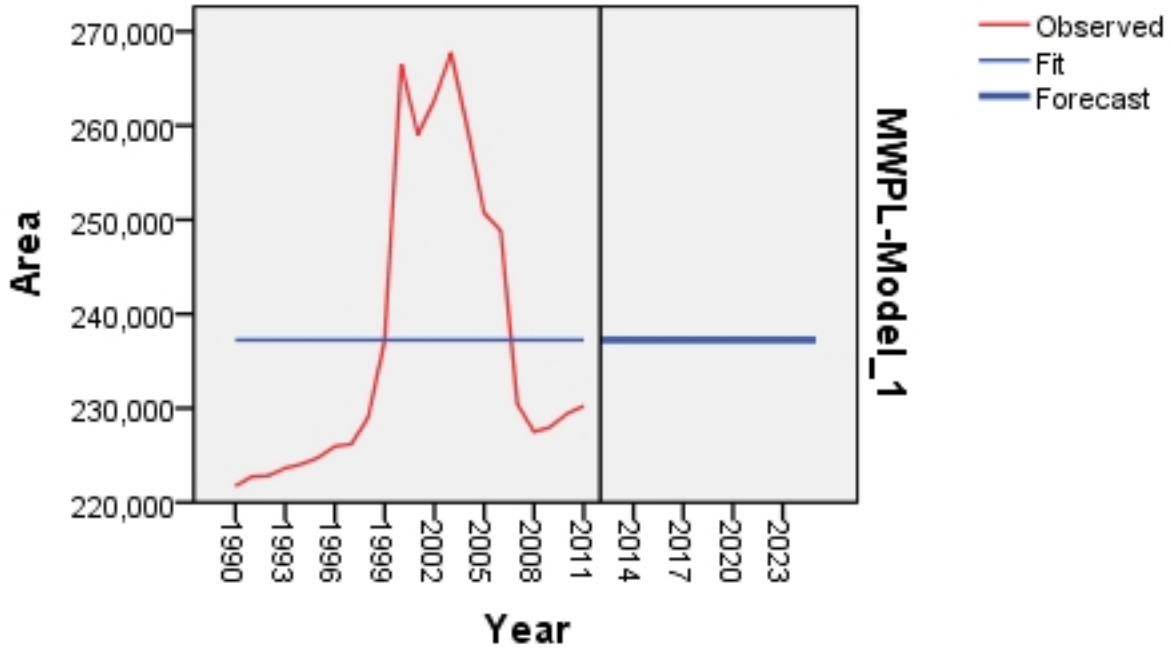


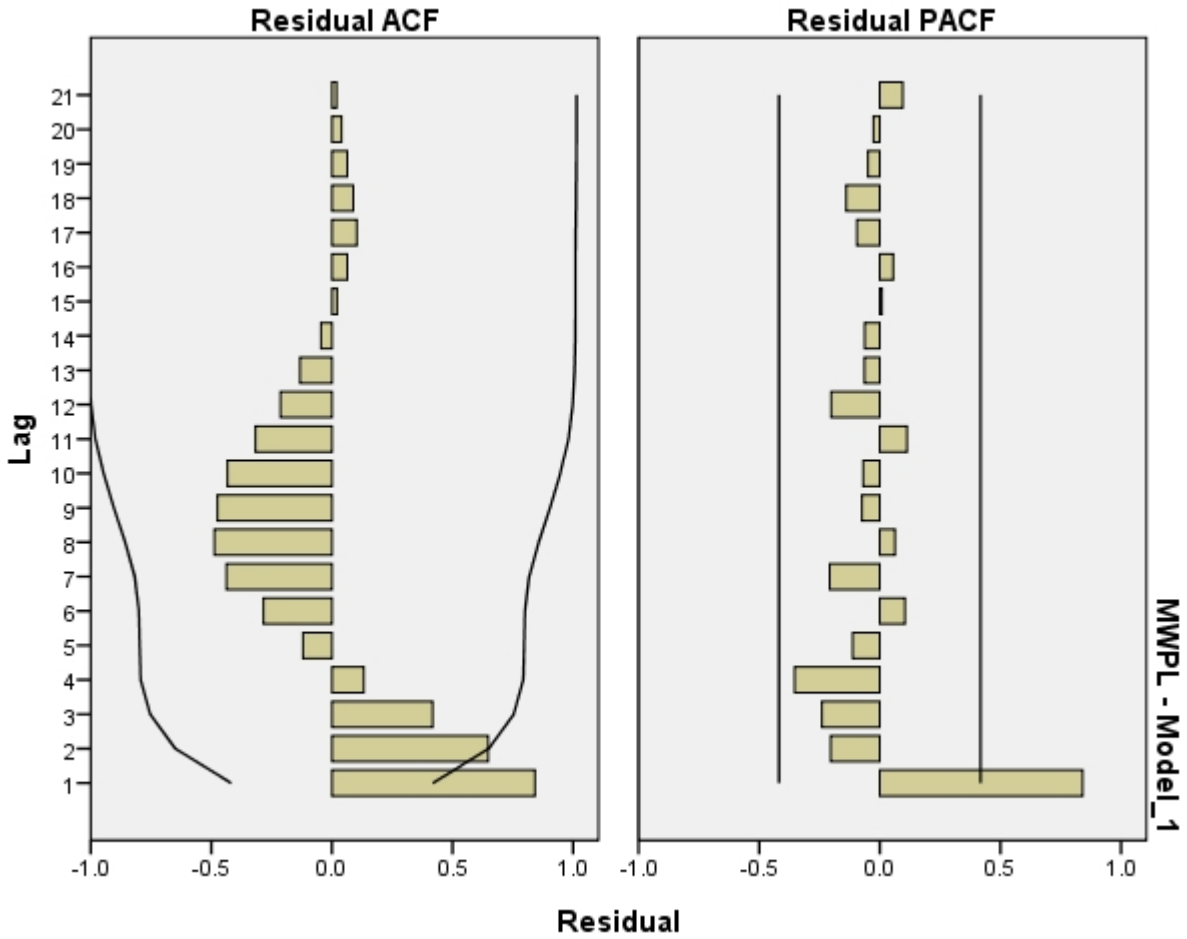
Area Projection for Northern hill region of Chhattisgarh



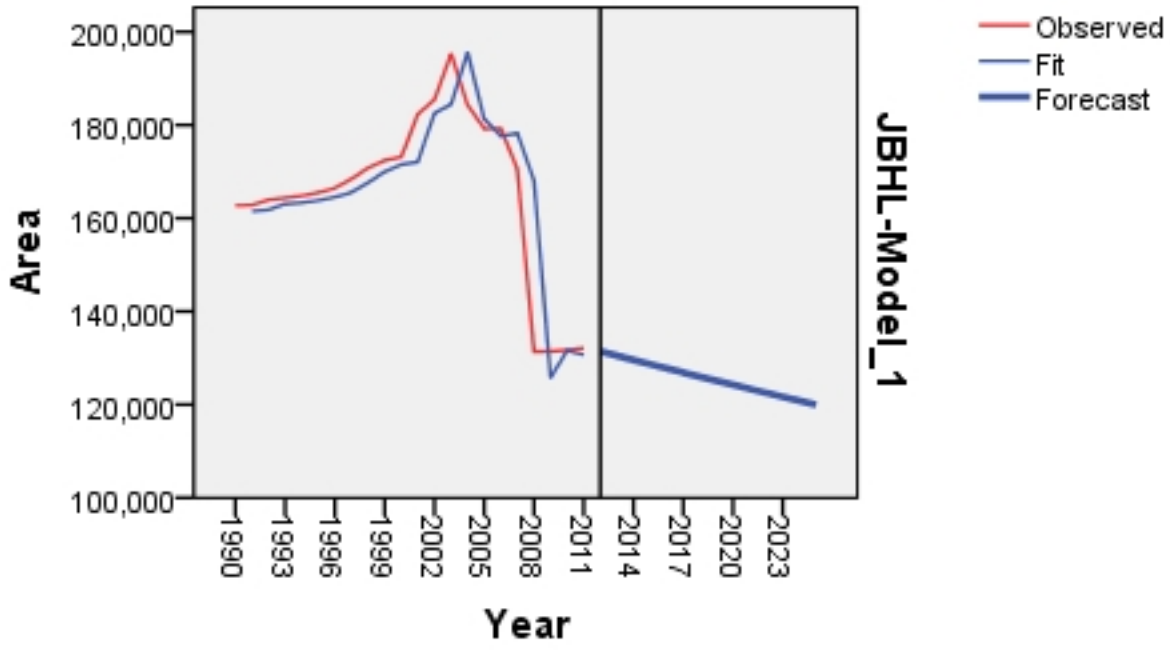


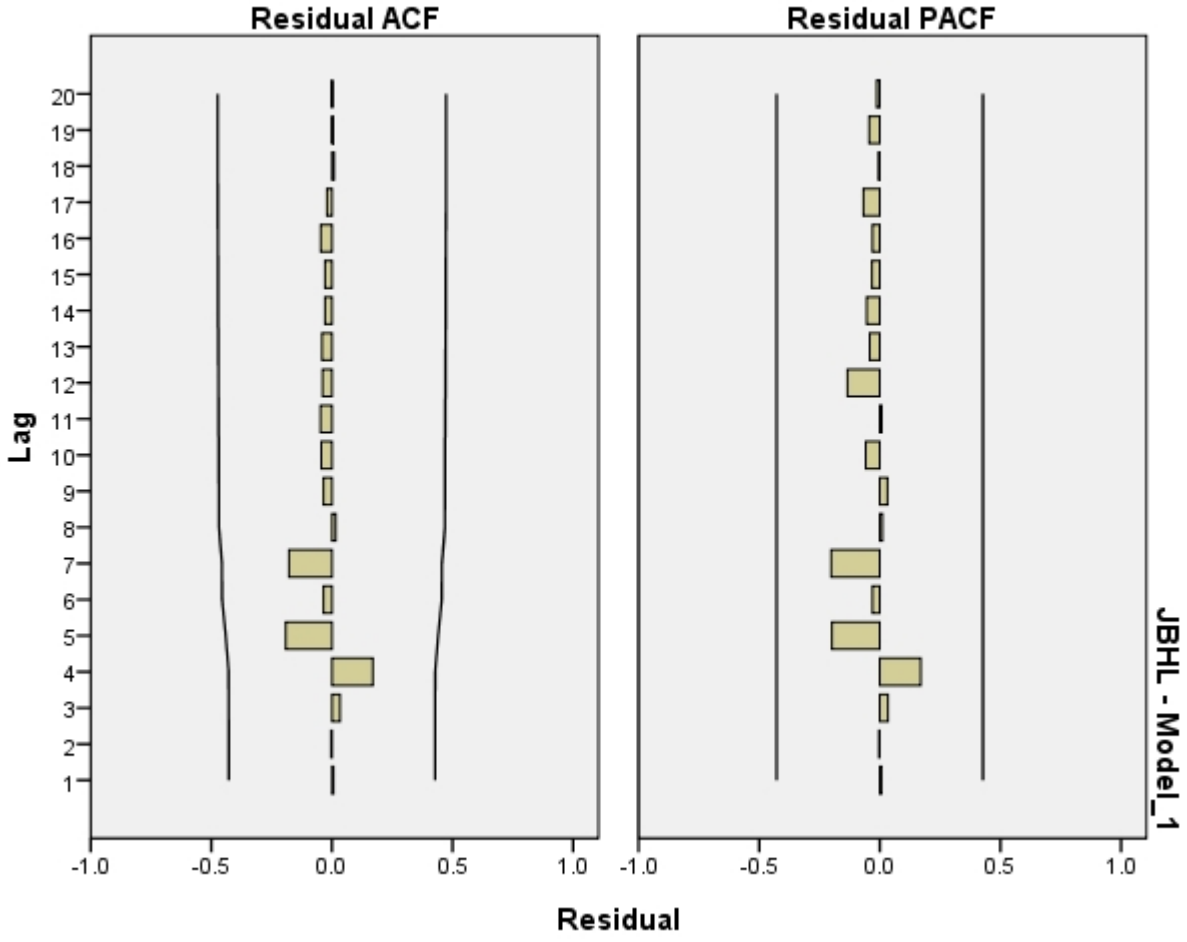
Area Projection for Malwa plateau

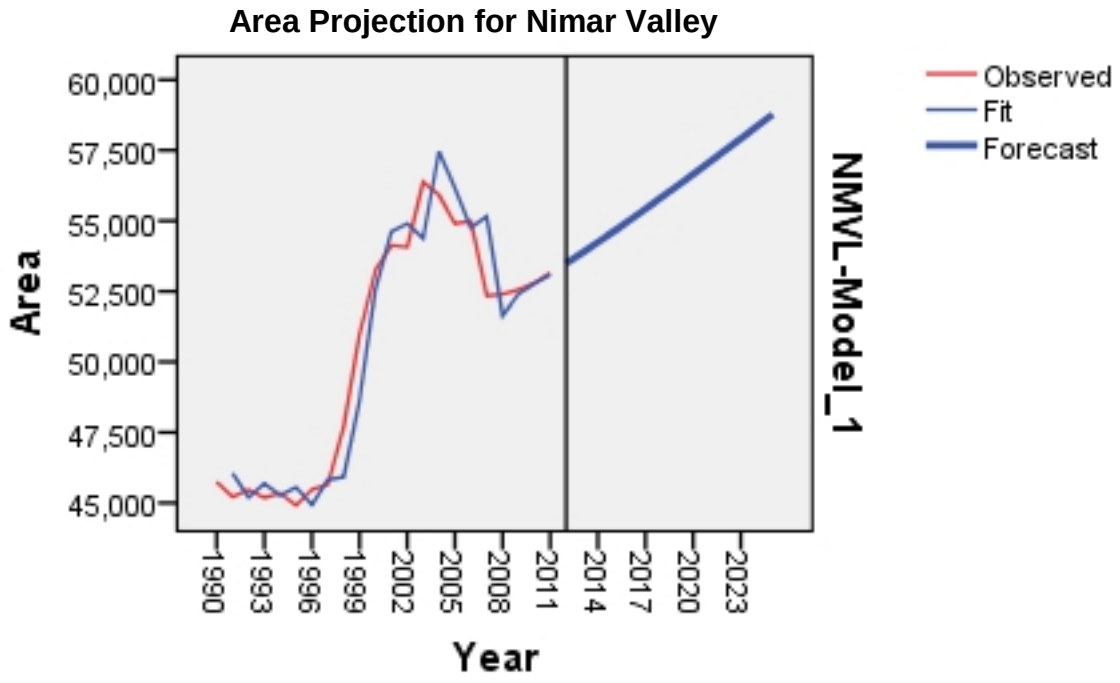


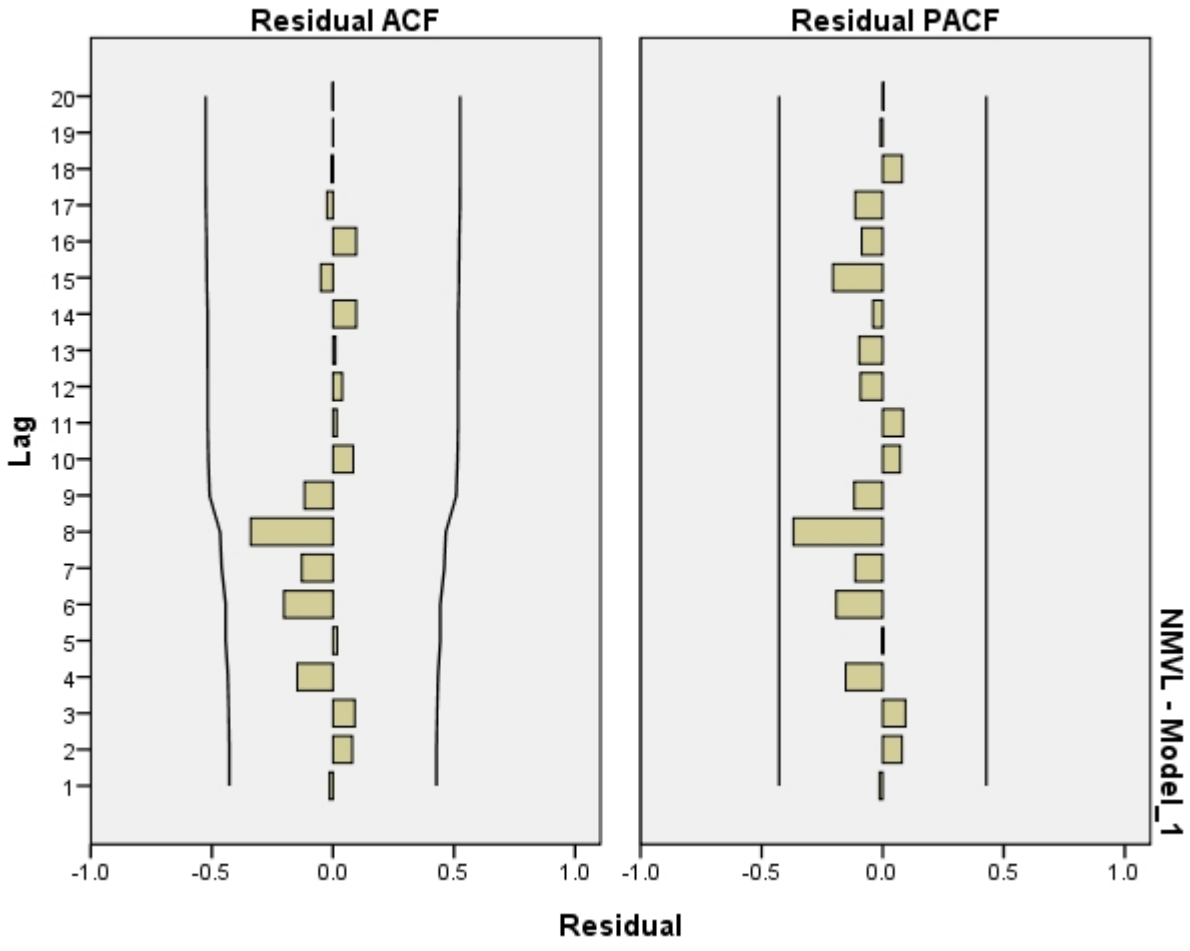


Area Projection for Jhabua Hills

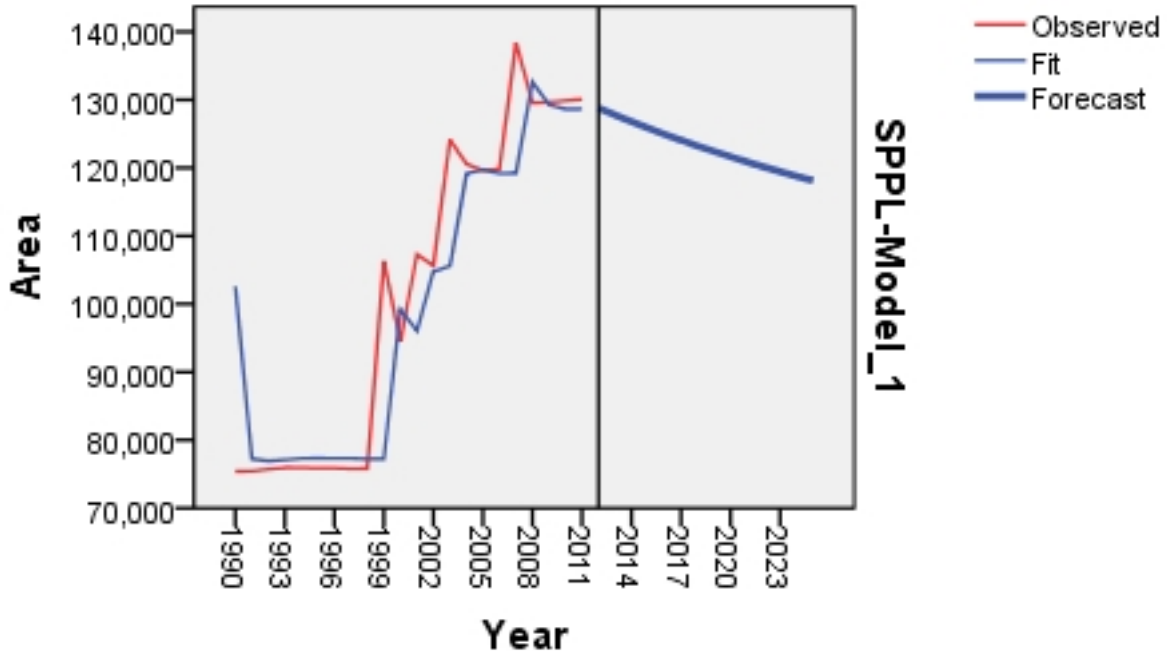


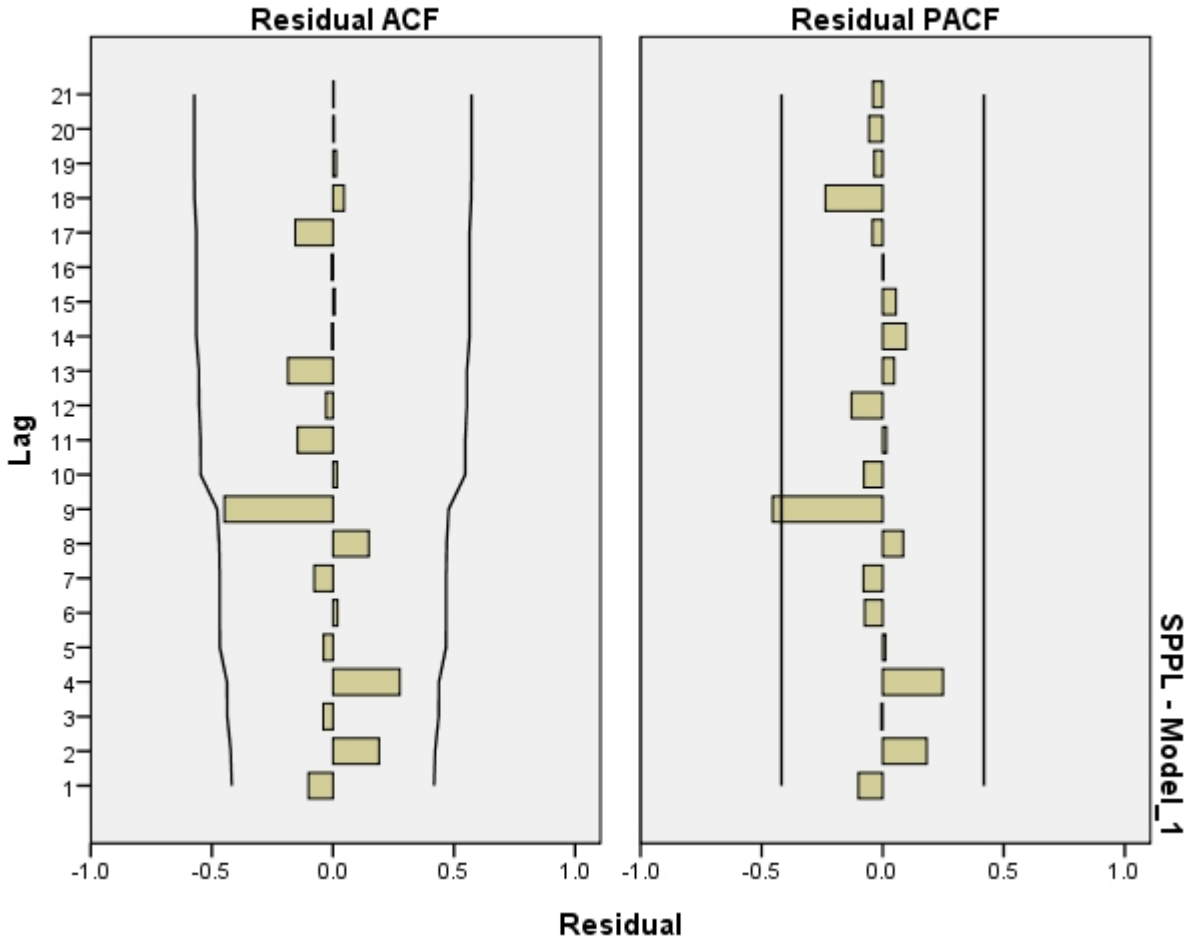



Area Projection for Nimar Valley
Observed
Fit
Forecast
NMVL-Model_1
Area
60,000
57,500
55,000
52,500
50,000
47,500
45,000
1990
1993
1996
1999
2002
2005
2008
2011
2014
2017
2020
2023
Year

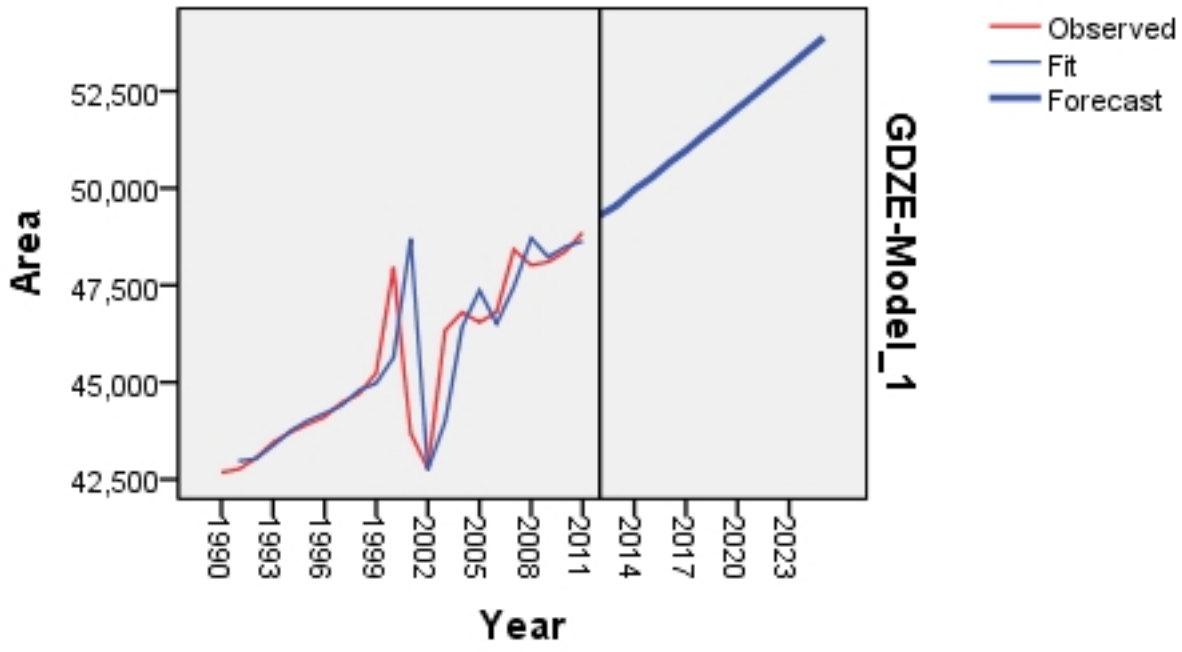

Residual ACF
Residual PACF
Lag
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
-1.0
-0.5
0.0
0.5
1.0
Residual
NMVL - Model_1

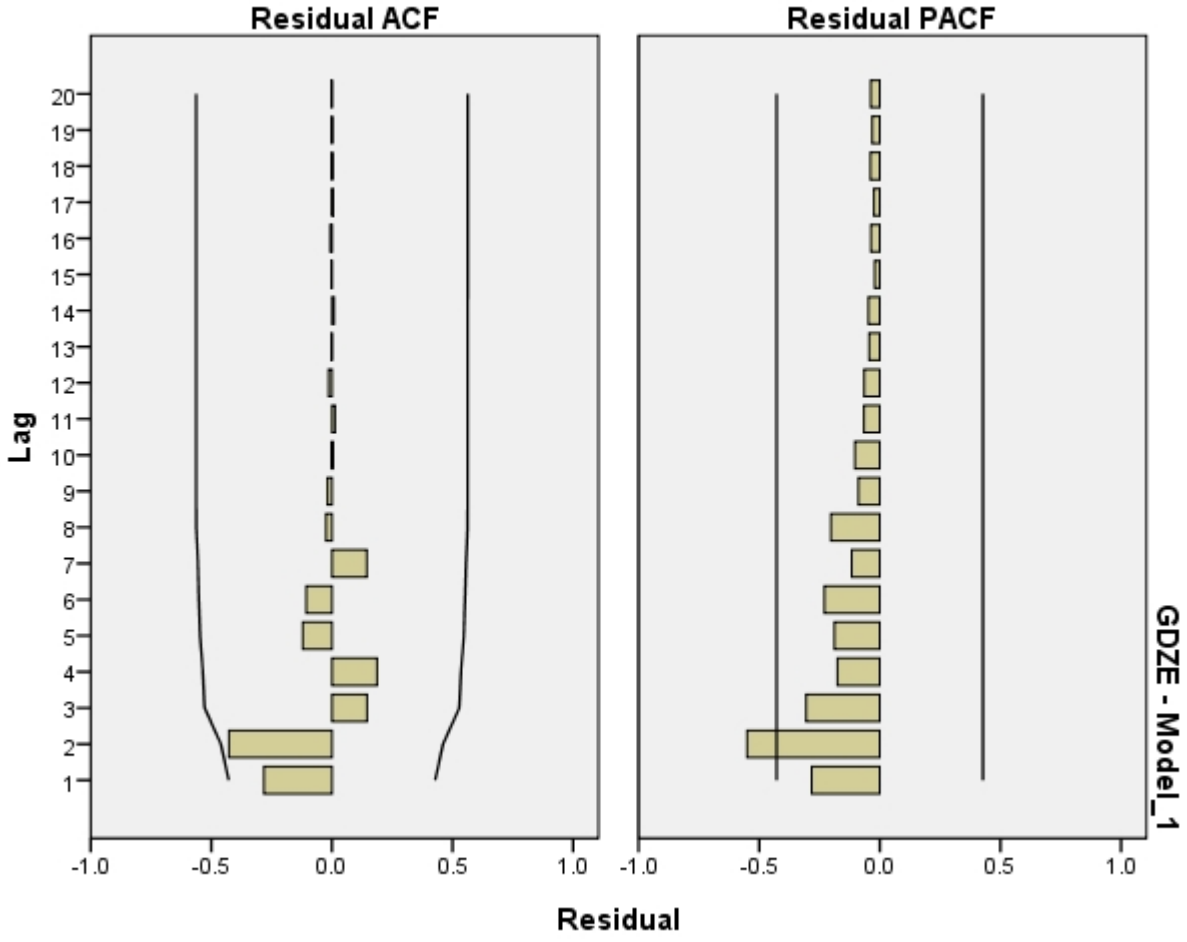
Area Projection for Satpura Plateau



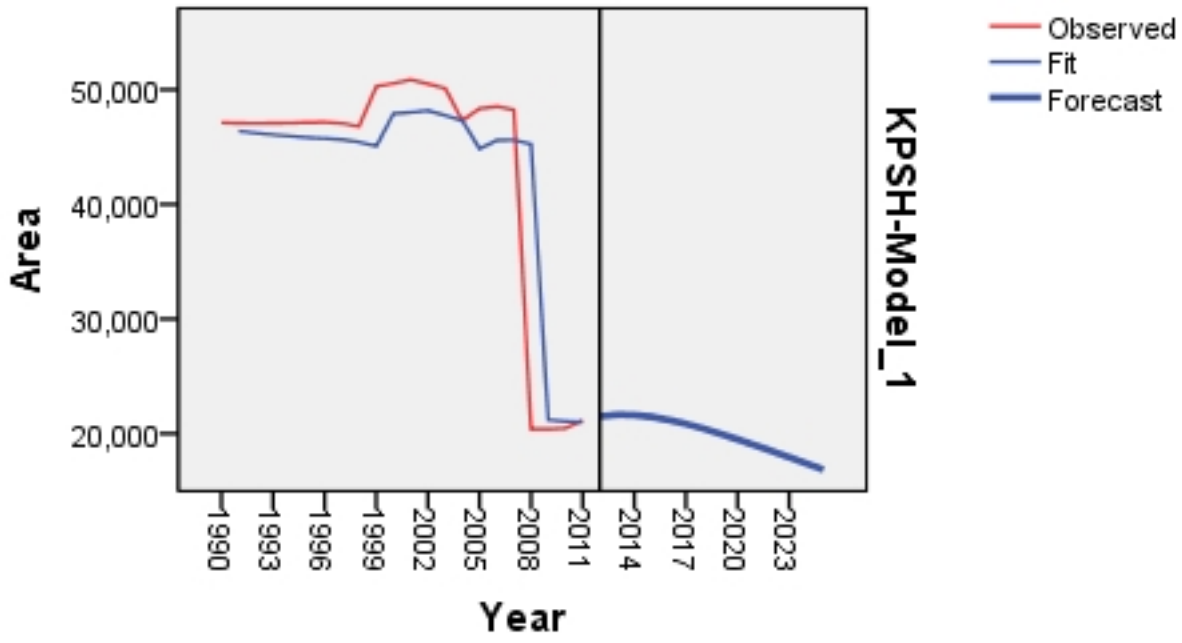


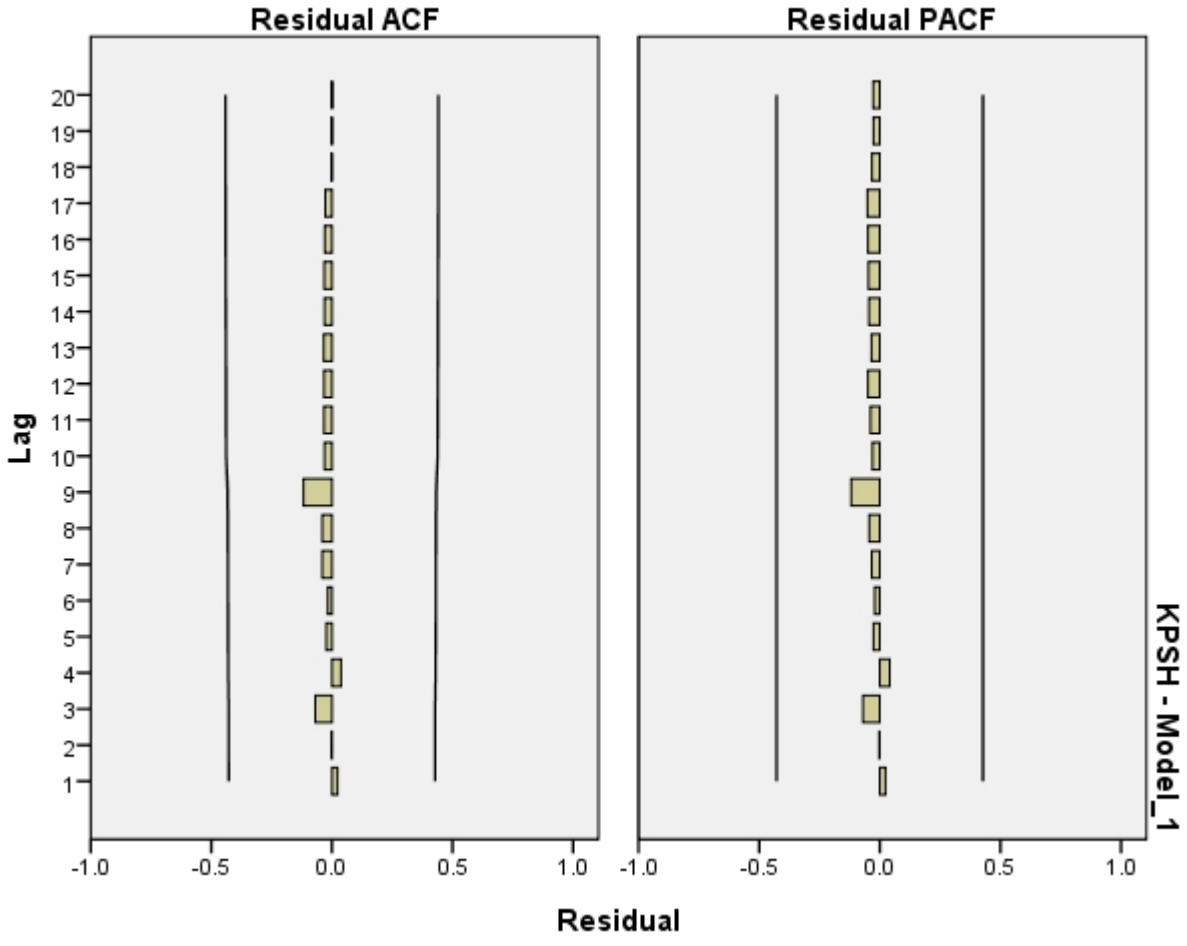
Area Projection for Gird region



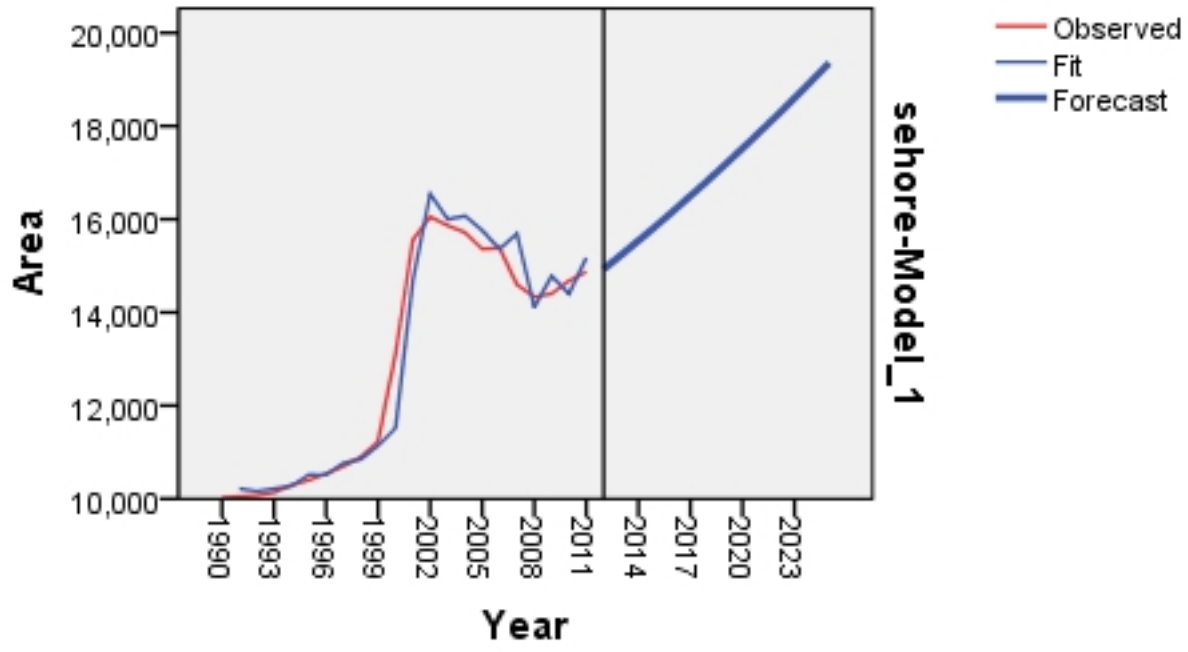


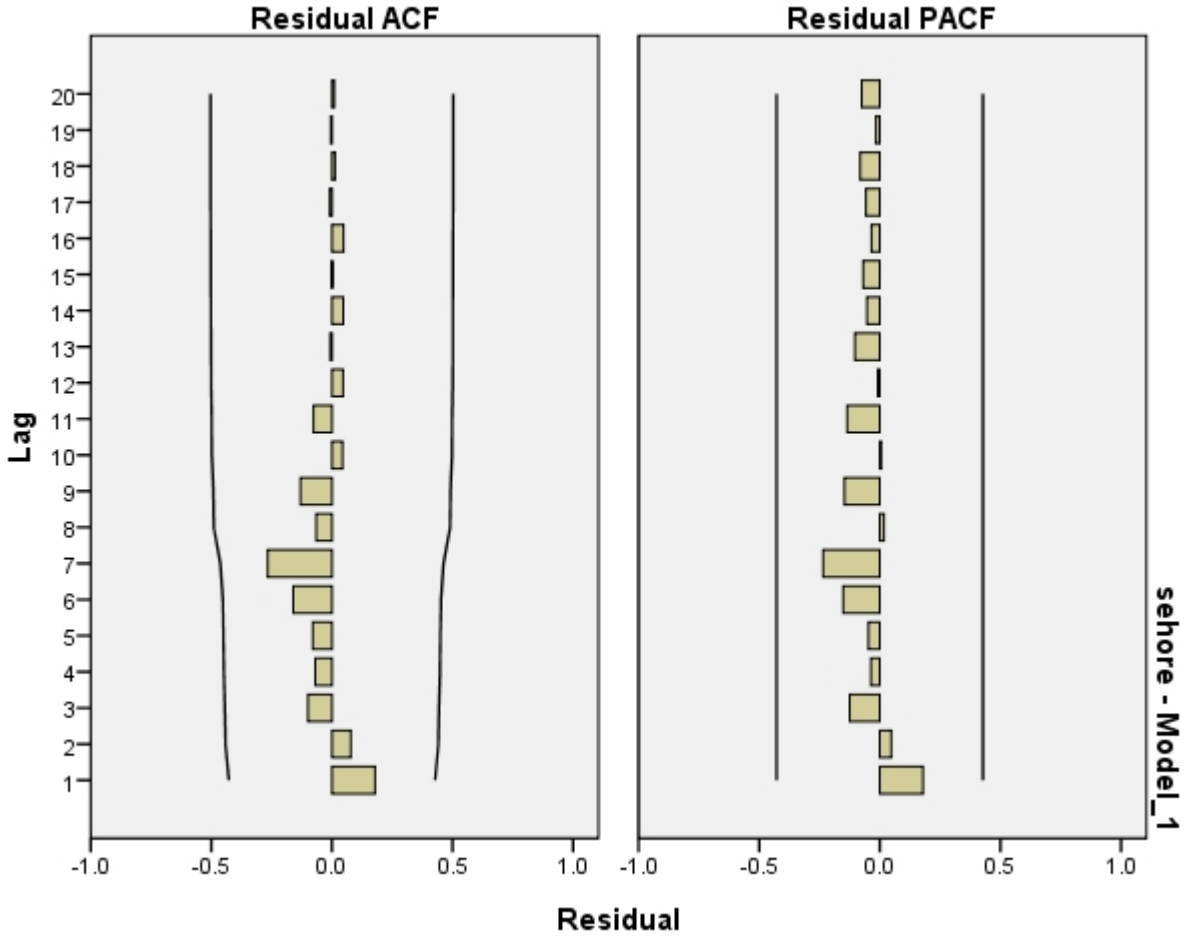
Area Projection for Kaymore Plateau and Satpura Hills



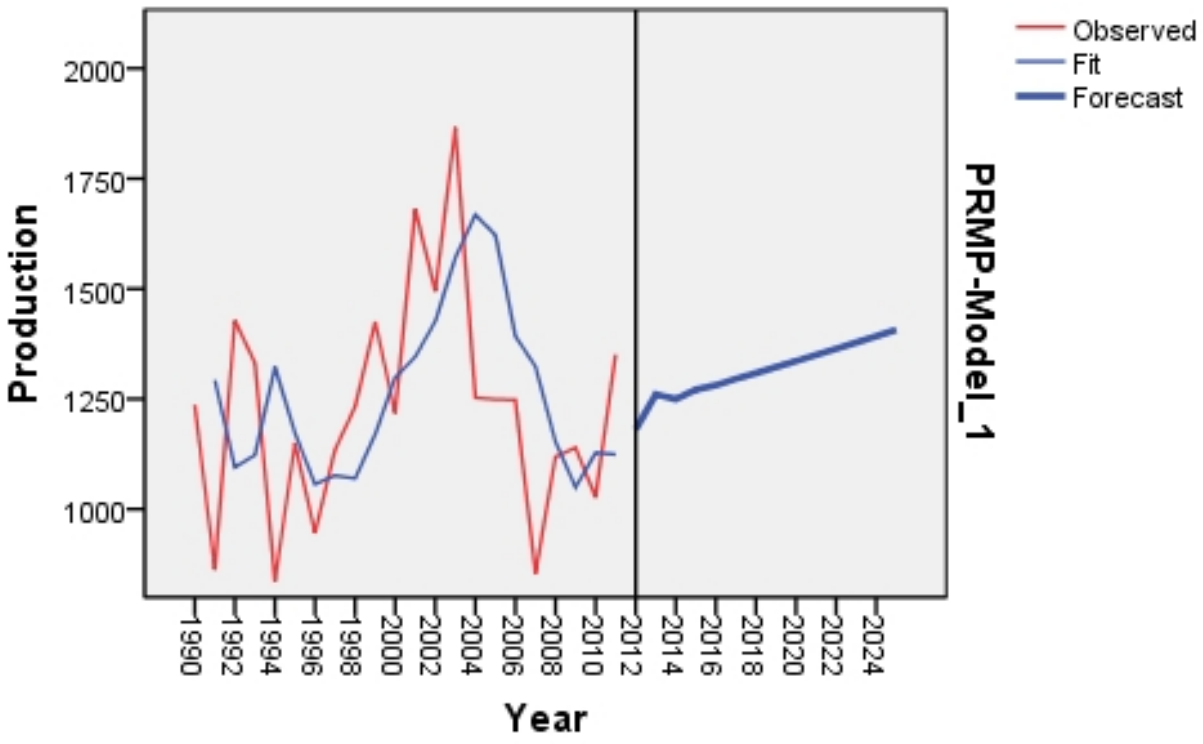


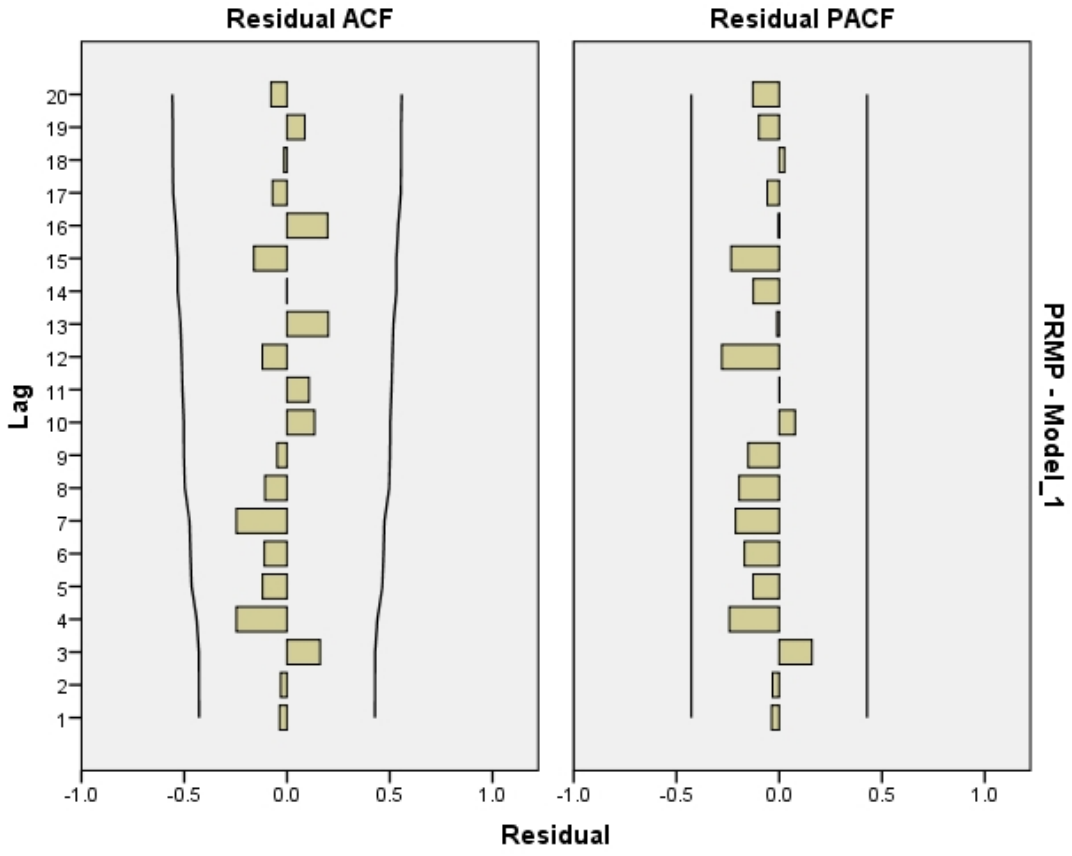
Area Projection for Vindhya Plateau



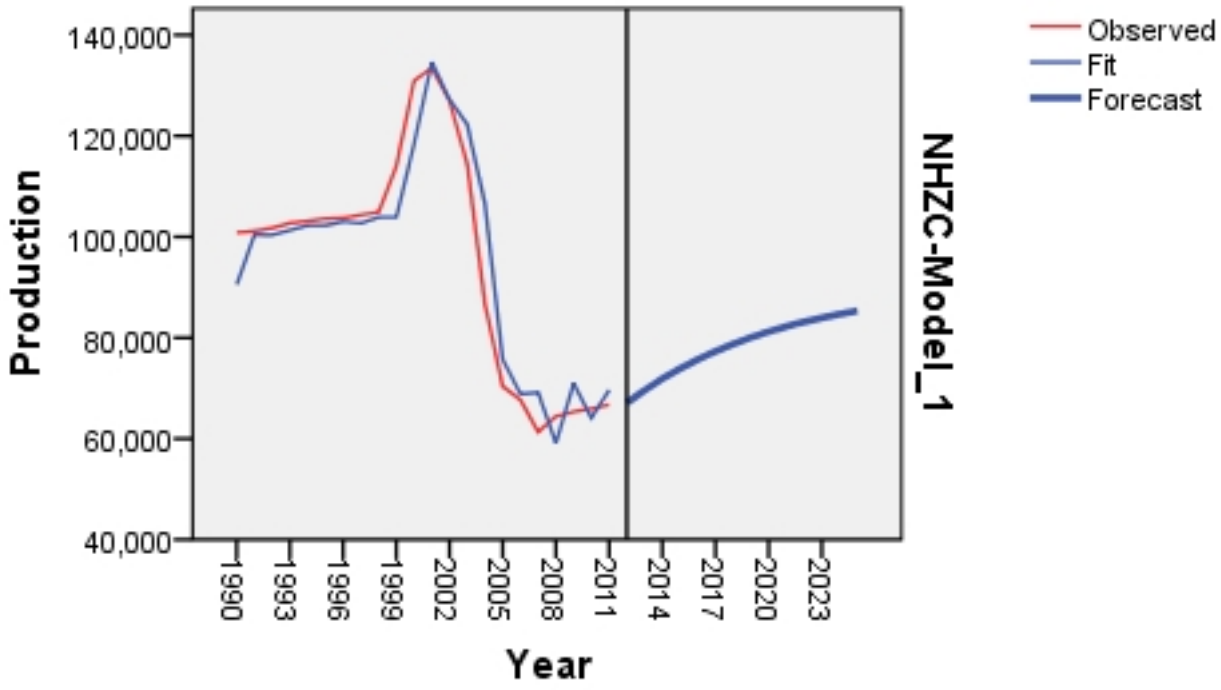


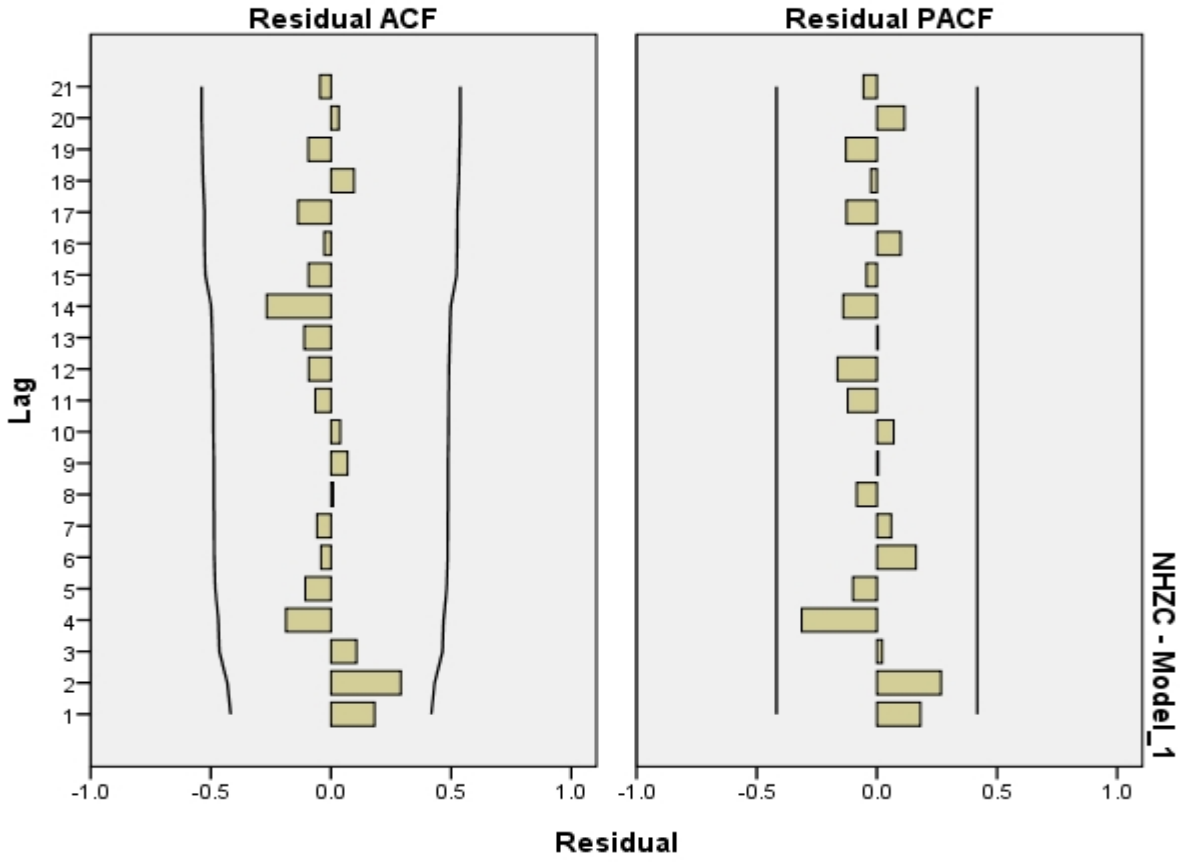
Production Projection for Madhya Pradesh



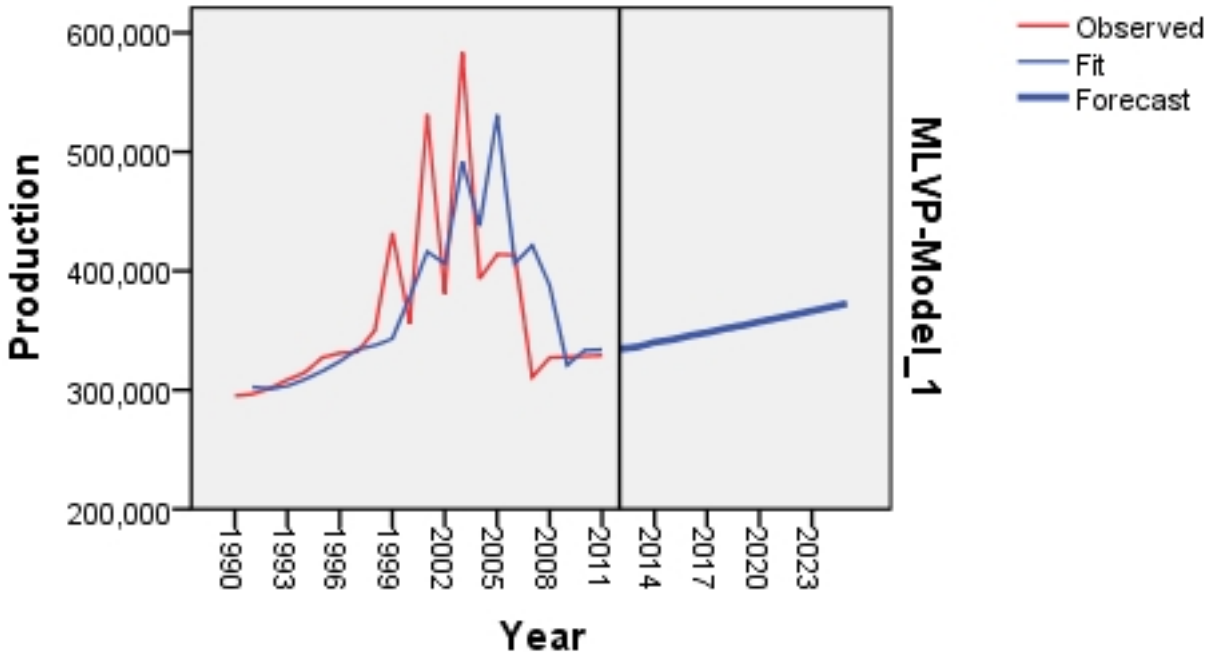


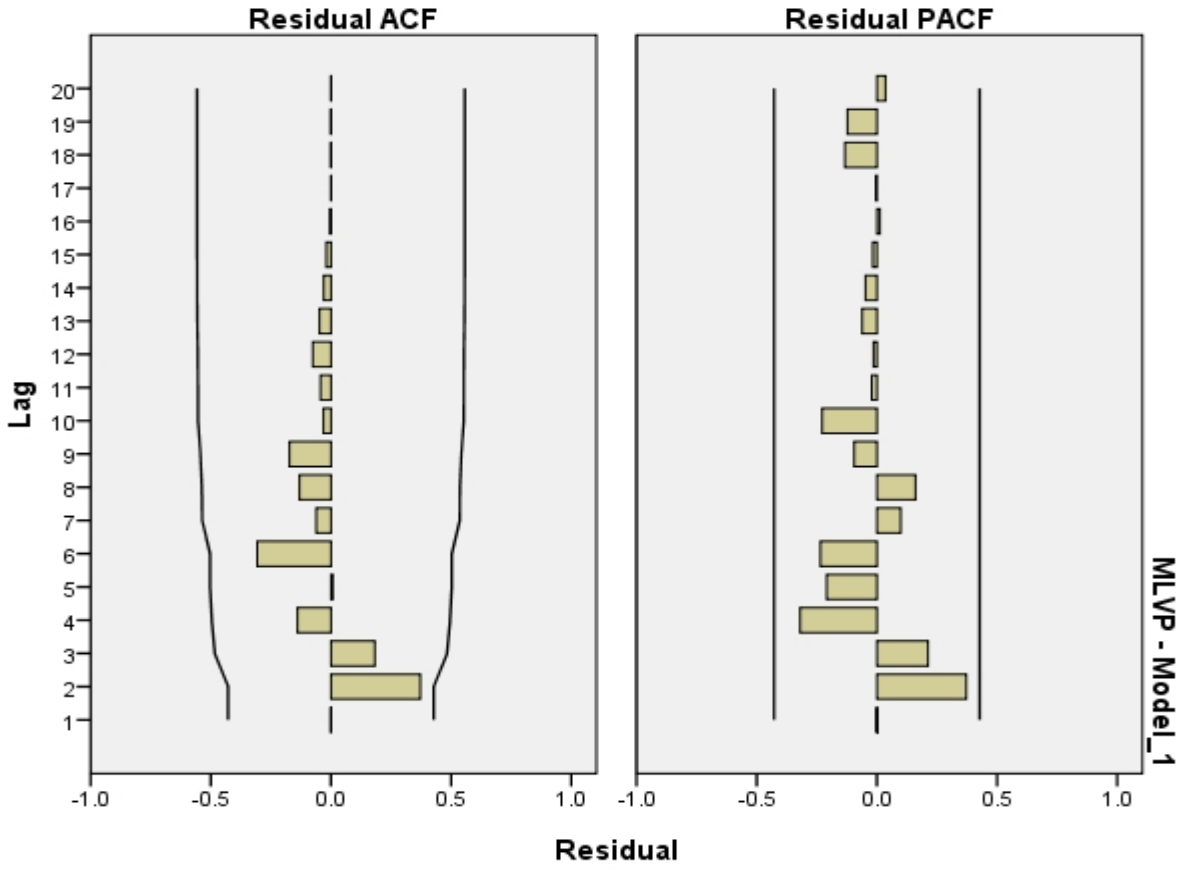
Production Projection for Northern hill region of Chhattisgarh



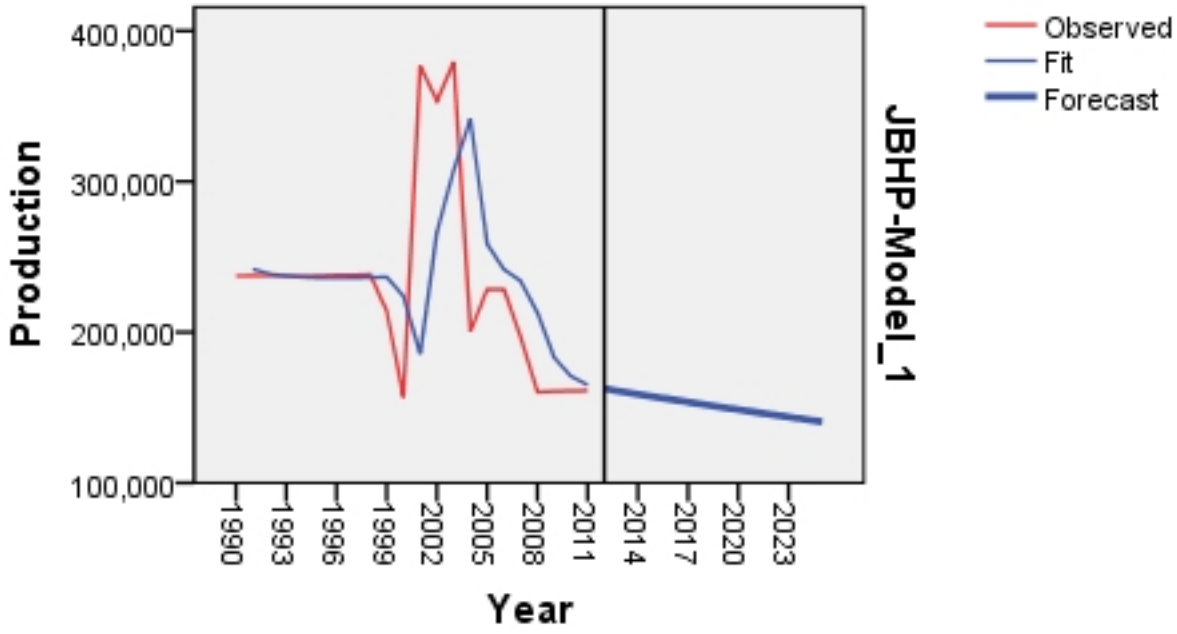


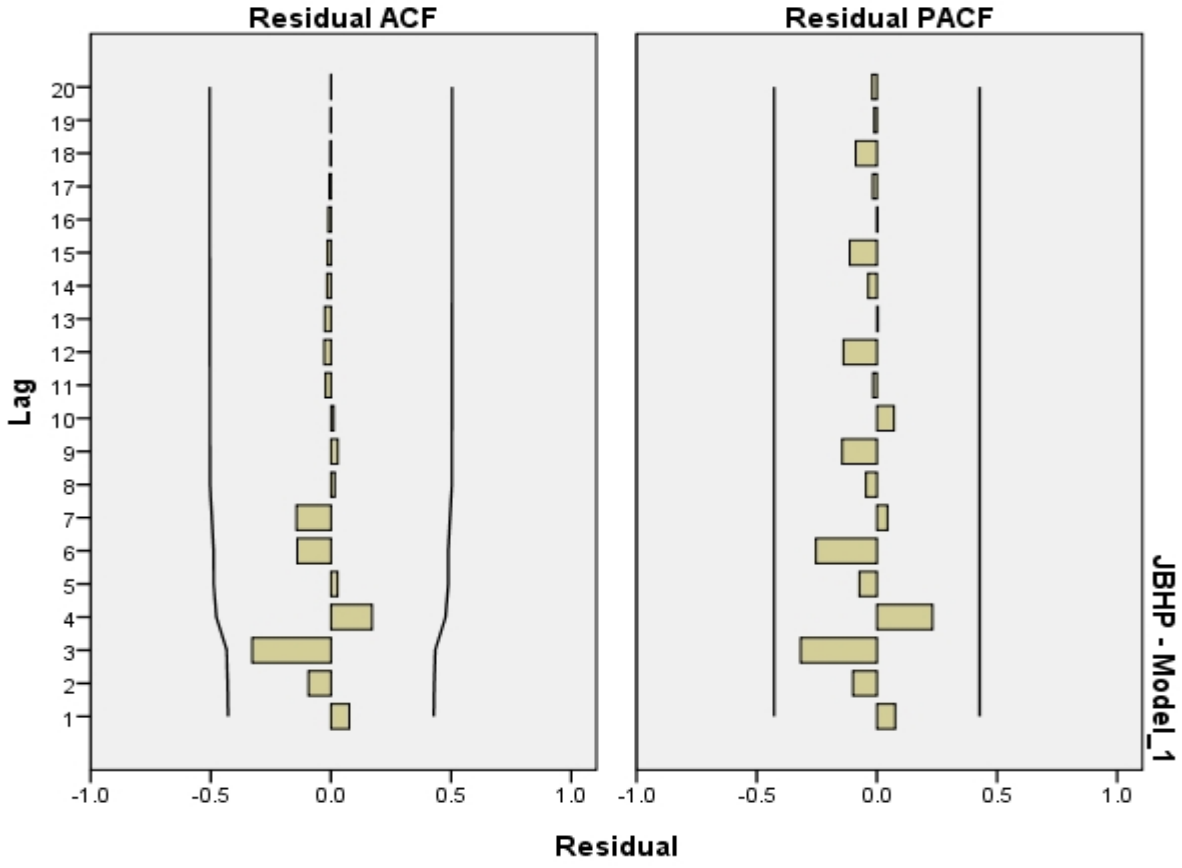
Production Projection for Malwa Plateau



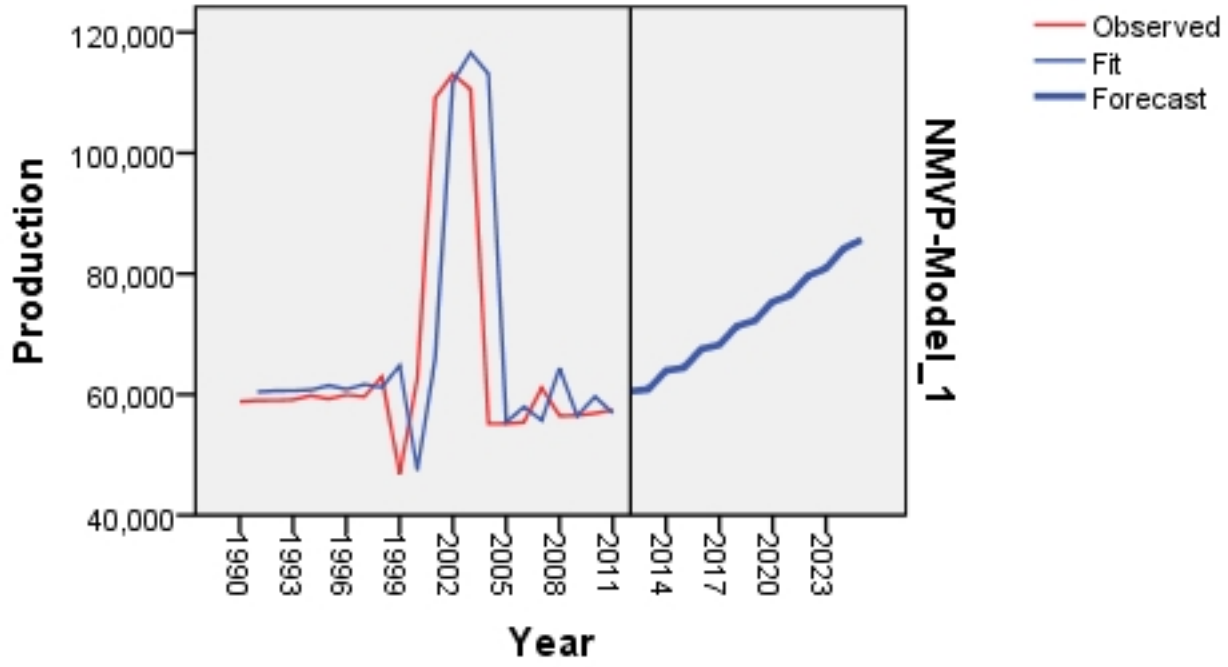


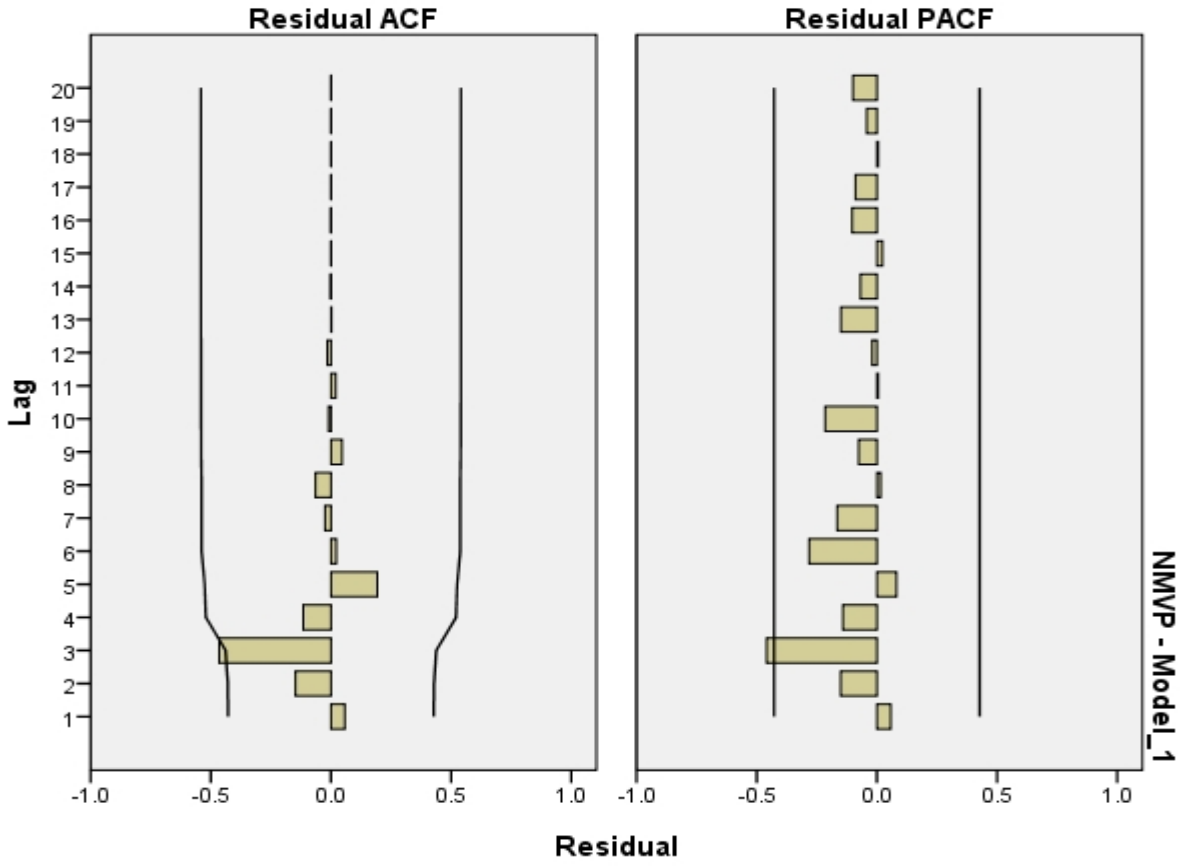
Production Projection for Jhabua Hills



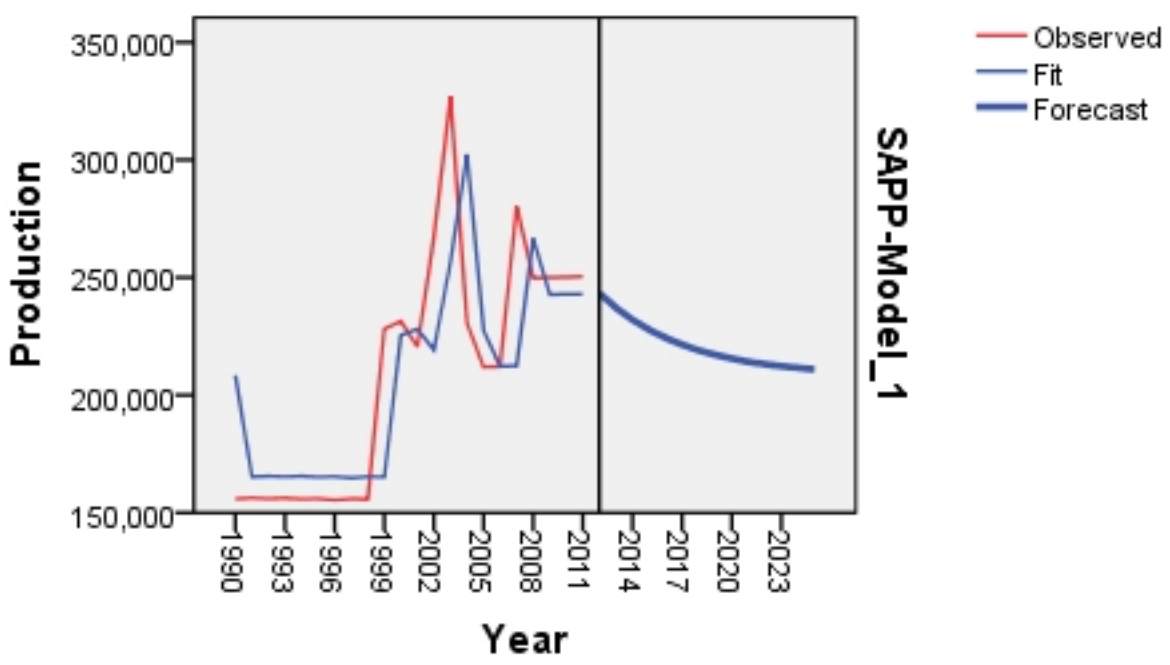


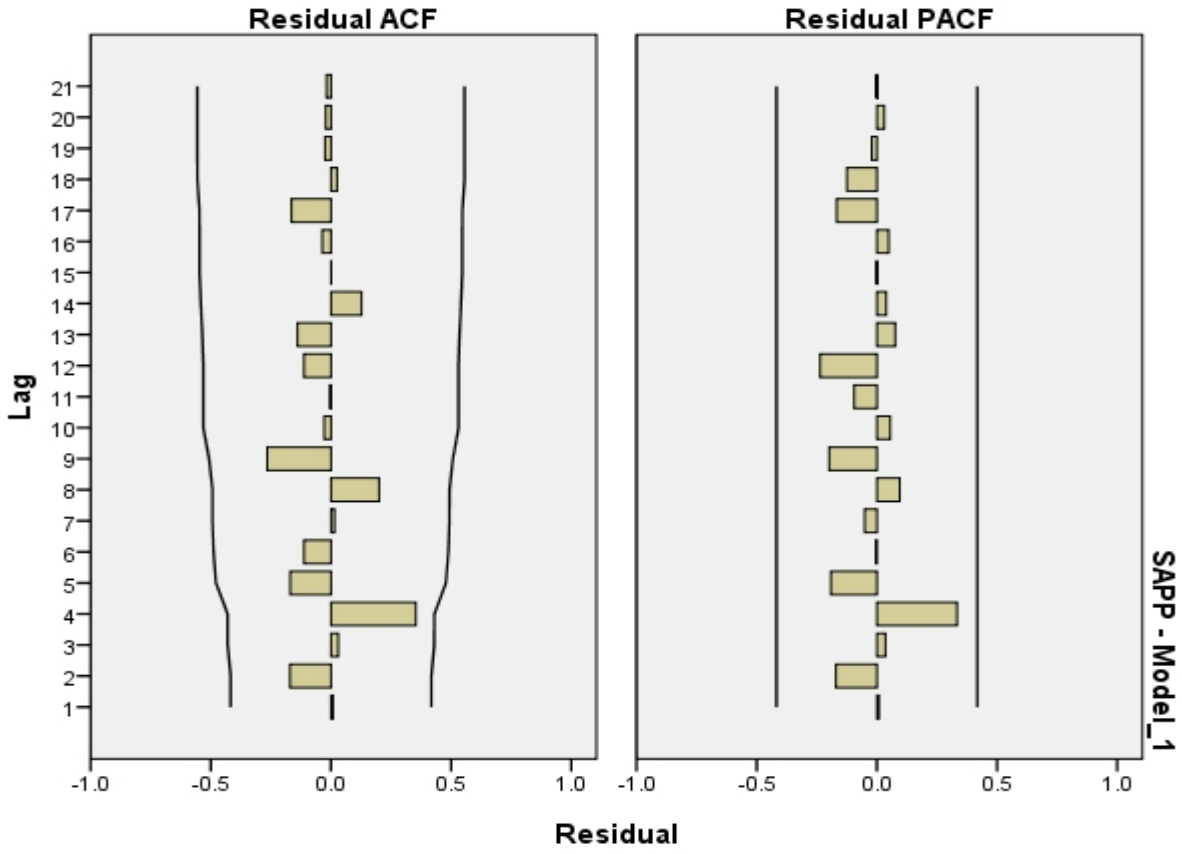
Production Projection for Nimar Valley



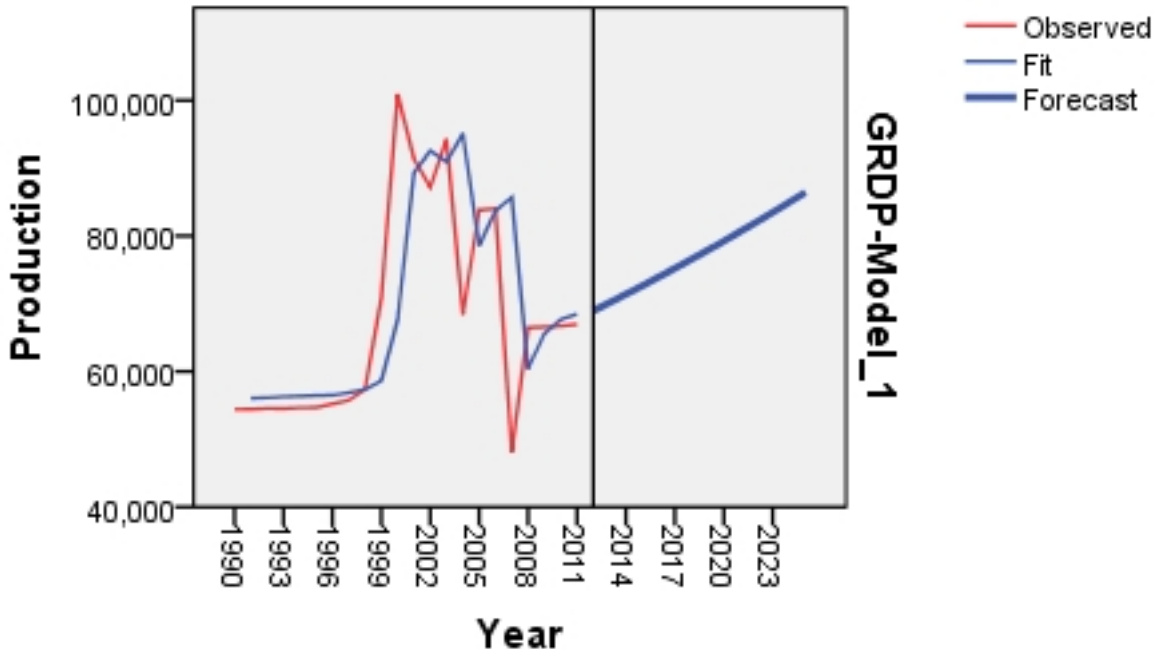


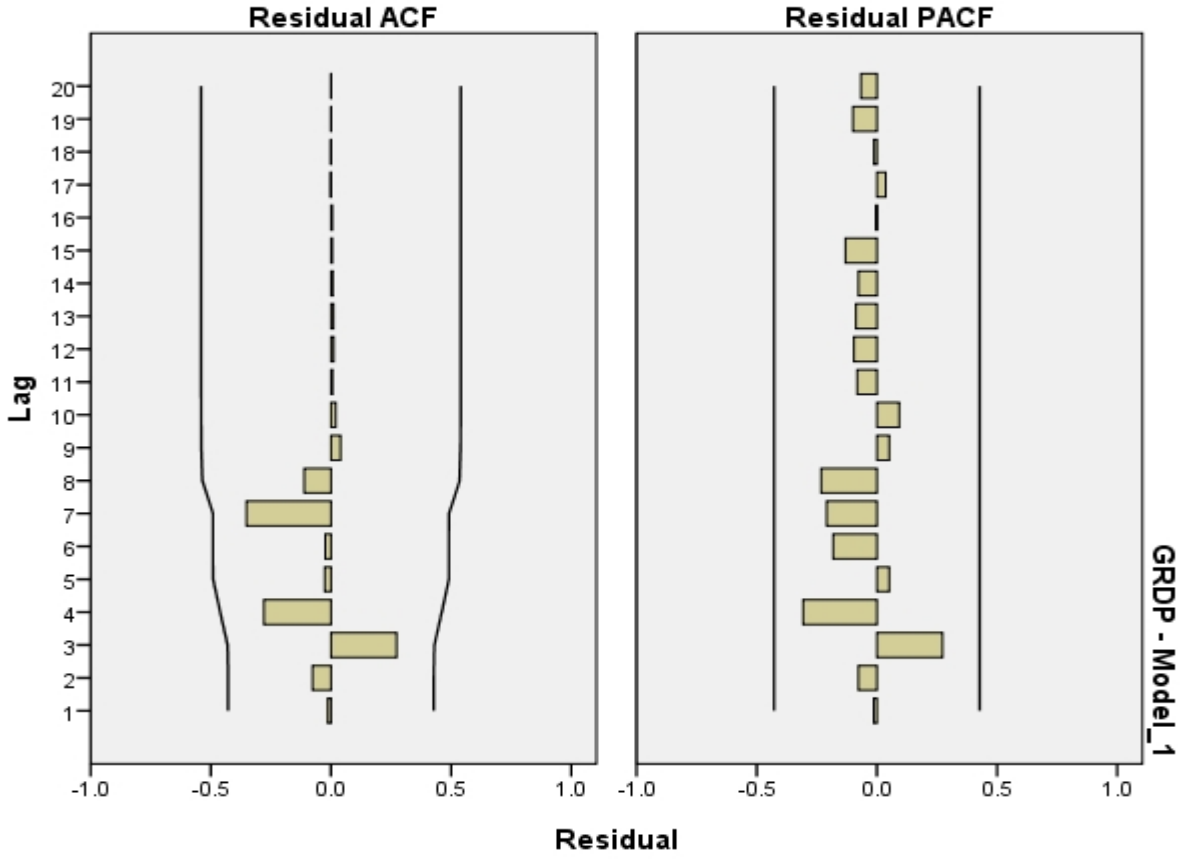
Production Projection for Satpura Plateau



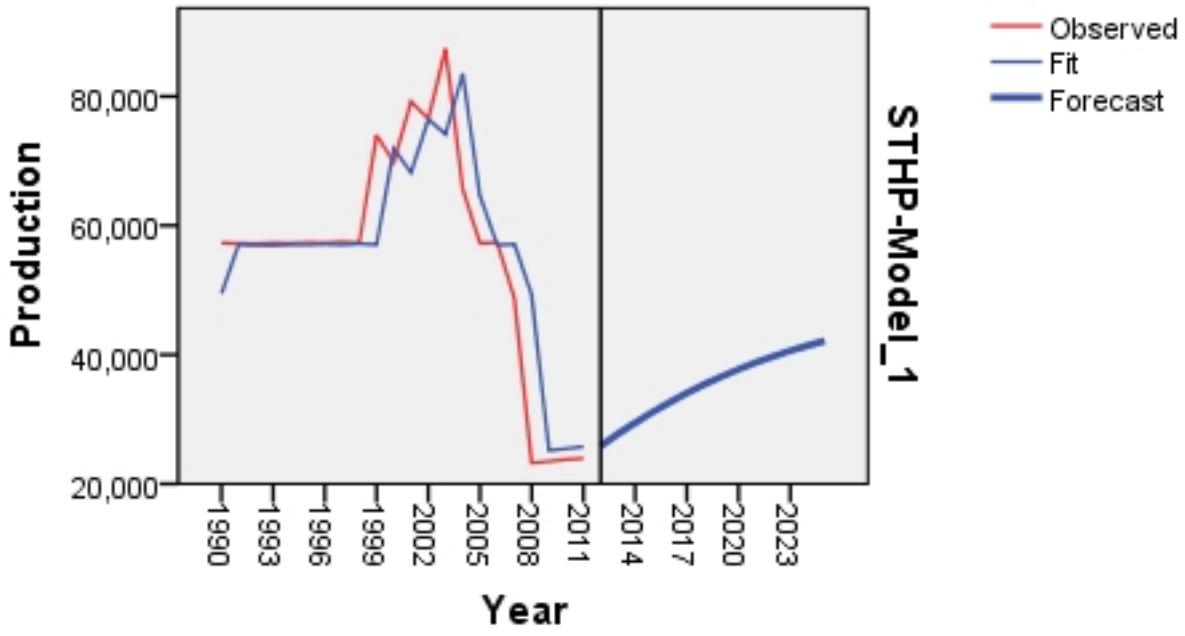


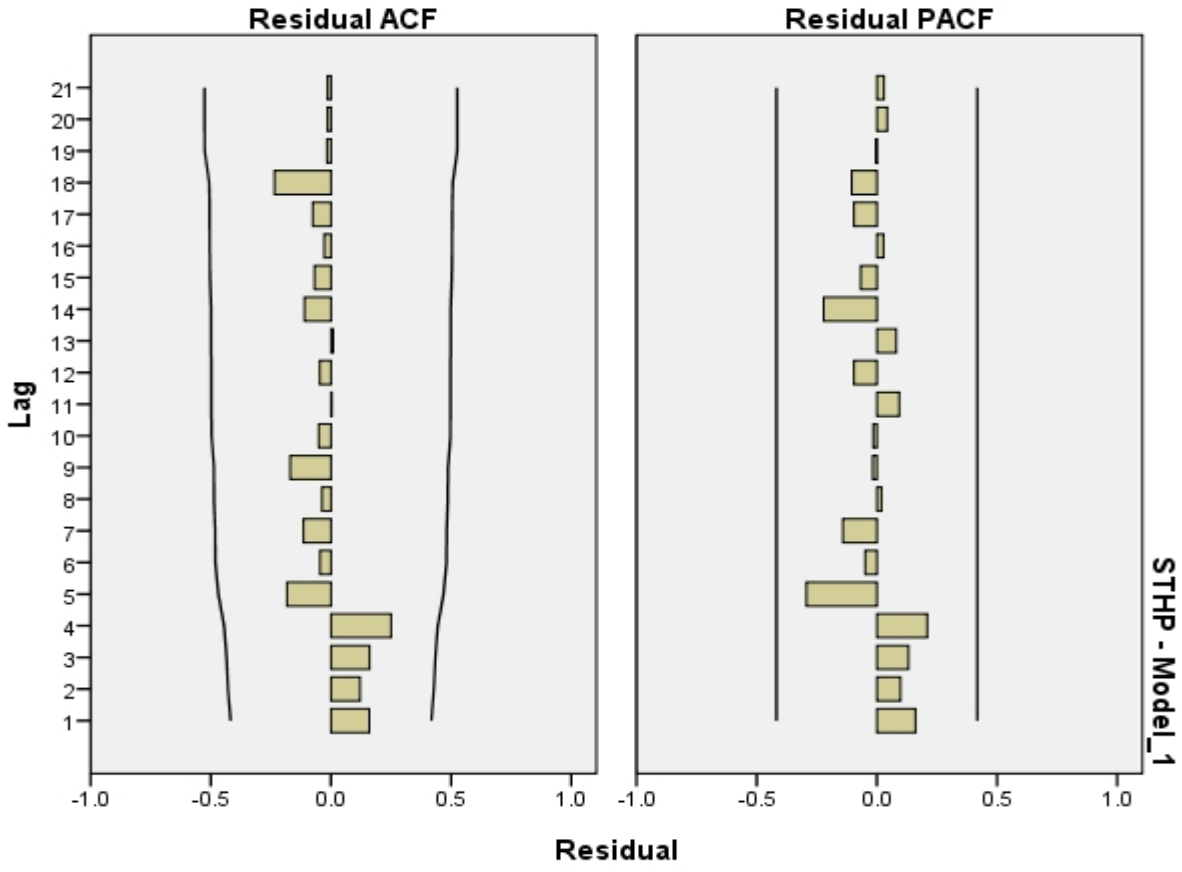
Production Projection for Gird region



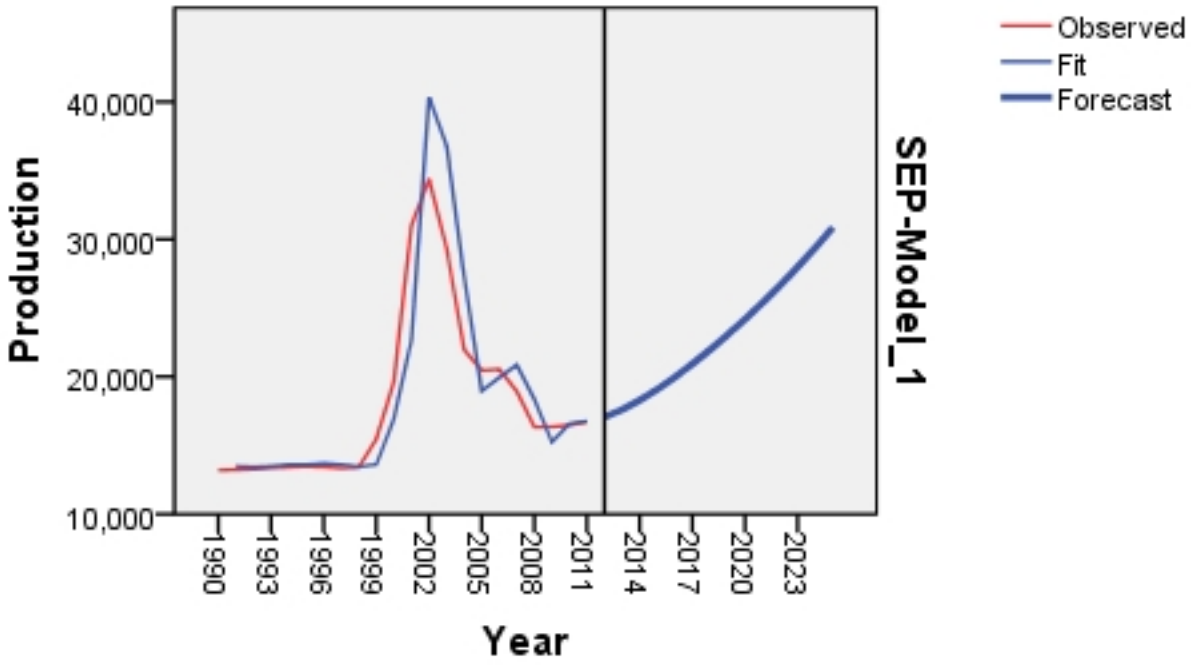


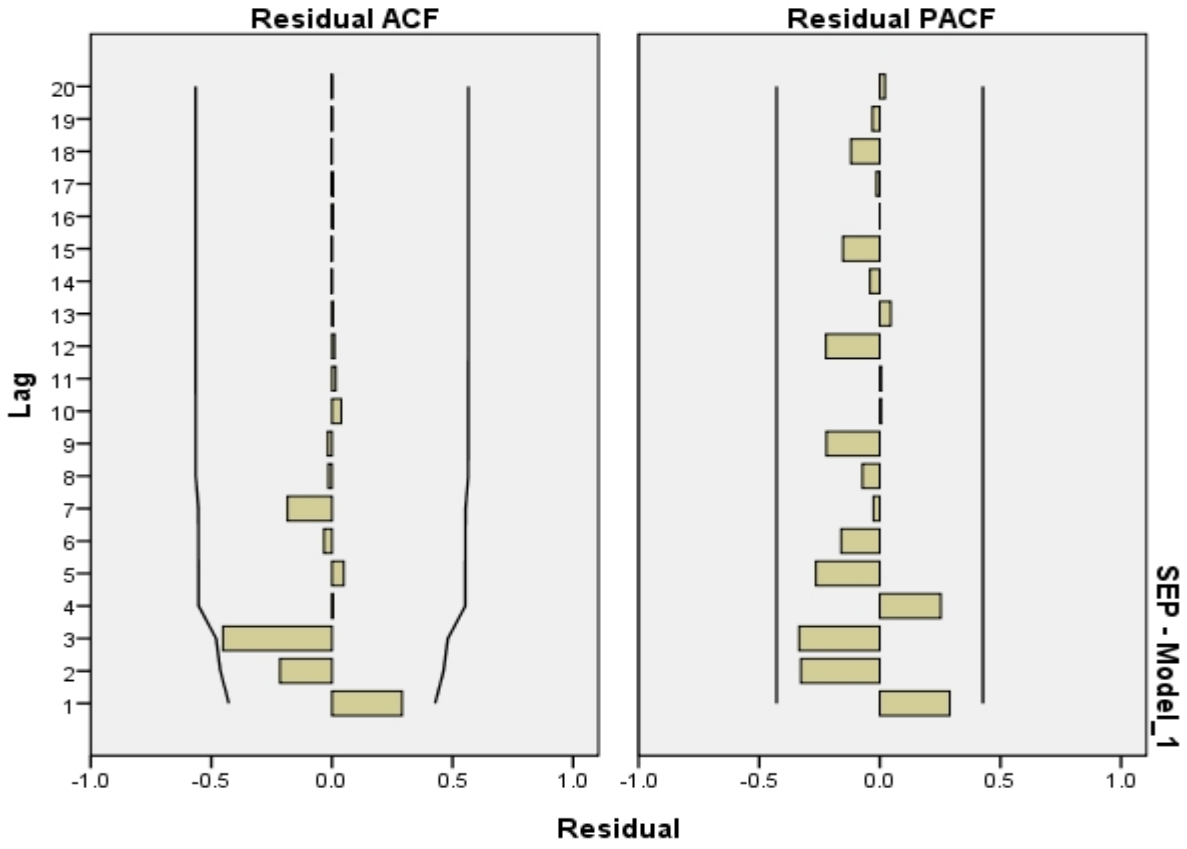
Production Projection for Kaymore Plateau and Satpura Hills





Production Projection for Vindhya Plateau





ABSTRACT

Title of the thesis	**:**	***"Growth Pattern and Production Projection for Maize Crop in Madhya Pradesh"***
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Degree to be awarded	**:**	**Master of Science in Agriculture**
Year of award of degree	**:**	**2014**
Major subject	**:**	**Agricultural Eco. & Farm Management**
Total no. of pages in the thesis	**:**	**81**
Number of words in the abstract	**:**	**340**

(S.B. Nahatkar) **(N. K. Raghuwanshi)** **(*Ayodeji 'Seun Ogunleke*)**

Signature of Major Advisor | Signature of professor & Head | Signature of Student

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 very low being one of the maize growing states. Looking at the overall problem of maize production, its potential and future requirement, it is pertinent to study its growth pattern in the state and make projection for future production. The research entitled “Growth Pattern and Production Projection for maize crop in Madhya Pradesh” was carried out to study growth pattern, contribution of area and yield towards maize production, production projection and adjustment in cropping pattern and to make recommendations. The growth pattern of maize crop was estimated by computing the relative change, coefficient of variation and simple growth rate. Projection was made by the use of ARIMA model, contribution of area and yield towards maize production was done by decomposition analysis and adjustment in cropping pattern was estimated by calculating index level.

The study revealed that relative change and coefficient of variation of area, production and productivity are -6.43, -0.28, 6.38, 2.98, 20.75 and 19.65 respectively. Growth of area, production and productivity overtime were found to be -0.19, 0.28 and 0.48 respectively. It was also revealed that area contributed 19.68 percent and yield, 78.52 percent towards maize production in the current year over the base year. Forecast result showed that maximum value of area is 843.0 thousand hectares which would be expected in 2013-14 while minimum value is 826.0 thousand hectares which is likely to occur by the year 2025-26. Production forecast revealed maximum value of 1407.0 thousand tons which would be expected by 2025-26 and the minimum value of 1181.0 thousand tons in 2012-13. According to the data, maize crop is sufficiently and tolerably adjusted in the cropping pattern which means there is possibility of further increase in maize production in the state which can be achieved by bringing more industries for production of maize based products. The extension service delivery system must also be improved in order to achieve the desired results.

CURRICULUM VITAE

The author, Ayodeji 'Seun Ogunleke, was born in Ejigbo, Osun State, Nigeria on the 21st April, 1978. He joined Jawaharlal Nehru Krish Vishwa Vidyalaya in 2012 to study Masters of Science in Agricultural Economics & Farm Management under African-Indian Fellowship Program. He graduated from Ladoke Akintola University of Technology, Ogbomoso, Oyo State, Nigeria with double honour in Agricultural Economics & Extension in the year 2005. He passed his Senior School Certificate Examination (SSCE) from Agbonran Grammar School, Ede, Osun State, also in Nigeria.

The author is a recipient of African-Indian Fellowship Program given to some outstanding Africa students to study Agricultural related courses in India. This thesis is submitted in partial fulfillment of the requirement for the degree of Masters of Science in Agricultural Economics and Farm Management of Jawaharlal Nehru Krish Vishwa Vidyalaya, Jabalpur, Madhya Pradesh, India.