Growth Performance of Soybean Production Across Districts of Malwa Plateau Zone (M. P.)

THESIS

Submitted to

Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

In partial fulfillment of the requirements for

the Degree of

MASTER OF SCIENCE

In

AGRICULTURE

(AGRICULTURAL ECONOMICS)

By

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Jawaharlal Nehru Krishi Vishwa Vidyalaya,

Jabalpur, 482004 (MP)

2022

CERTIFICATE - I

This is to certify that the thesis entitled **"Growth Performance of Soybean Production Across Districts of Malwa Plateau Zone (M. P.)"** submitted in partial fulfilment of the requirement for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **Agricultural Economics** of Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur is a record of the bonafide research work carried out by **Mr. Ankit Tiwari** under my guidance and supervision. The subject of the thesis has been approved by the Student's Advisory Committee and the Director of Instruction.

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

Place: Jabalpur

Date: **(Dr. Anil Mishra)**

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LIST OF ABBREVIATION

FAO	:	Food and Agriculture Organization
AM	:	Arithmetic Mean
AC	:	Absolute Change
RC	:	Relative Change
SD	:	Standard Deviation
CV	:	Coefficient of Variation
TA	:	Trend Analysis
SGR	:	Simple Growth Rate
AR	:	Area Effect
YE	:	Yield Effect
IE	:	Interaction Effect

INTRODUCTION

Soybean (*Glycine max*) occupies an important position in the farming system of India**.** Soybean also called soja bean or soya bean is an annual legume of the pea family (Fabaceae) and has edible seeds. Soybean is economically the most important bean in the world, providing vegetable protein for millions of people and ingredient for hundreds of chemical products. Soybean is mainly grown for their seeds and is the second largest oil seed after groundnut in India. Soybean, being full of nutritional value, contains about 45- 50% high quality protein and 20- 22 % oil. Soybeans also have some essential amino acids (5%), carbohydrates, vitamins (thiamine and riboflavin) and minerals.

Soybean is numero uno oil seed crop in India as well as in the world. With the introduction and inception of commercial cultivation in India in late 60's, the crop is being cultivated in around 11.8 million hectare with production of 13.5 million ton (2020-21 estimate). In a very short period of time, the crop was adopted by farmers as major kharif crop in MP and afterwards the acreage increased in Maharashtra, Rajasthan, Chhattisgarh, Northern Karnataka, Gujarat and Northern Telangana.

Presently soybean is contributing 42 per cent share of total oil seed and 22 per cent to total oil production in the country. With increase in population the demand of edible oil is increasing and 40% of the demand is being fulfilled by different oil seed crops and rest 60% demand is being made up by import. The cost of import of edible oil put a high pressure on our foreign exchange. Among all the oil seed crops, soybean is having the highest potential to meet the challenge of being self sufficient in production of edible oil. The national productivity of soybean (~1 ton/ha) is quite lower than the world average (2.76ton/ha). Source: iisrindore.icar.gov.in

1.1 ORIGIN

Soybean originated in South East Asia and were first domesticated by Chinese farmers around 1100 BC. The oldest records of soybean cultivation appear in bronze inscriptions and in early writings that date not much earlier than1100 BC. By the first AD, soybeans were grown in Japan and many more countries. Soybean as a crop is cultivated over a vast area throughout the globe and its history has been discussed well by various researchers (Hymowitz 1970; Guo 1993; Singhand Hymowitz 1999; Guo *et al.* 2010). Evidences suggest that soybean emerged as domesticate during the Shang dynasty in the eastern half of northern China during 1700–100 bc (Singh and Hymowitz 1999). Source: https://ncsoy.org

1.2 Soybean's Scenario

- The total cultivated area under Soybean in world is 1269.52 lakh hectares with production of 3534.64 lakh ton and productivity of 2.78 tonnes per hectare. Brazil occupies the first position in production with (37.86%) followed by USA (28.48%), Argentina (14.38%), China (5.33%), India (2.74%).

  (Source: https://www.sopa.org) (2019-2020 estimate)
- In India Soybean are grown on total area of 121.00 Lakh hectare, with a total production of 112.26 Lakh ton & with average productivity 0.93 tonnes/ha.
- Madhya Pradesh is the largest Soybean producing state with a total area of 6,194 '000 hectares and production of 3856 '000 Metric ton & with average productivity 0.63 Mt/ha.
- Malwa Plateau zone of Madhya Pradesh occupies the maximum area under soybean cultivation which is (48.94%). (2019-2020 estimate).

In light of the foregoing, the current study titled "Growth performance of Soybean production across districts of Malwa Plateau Zone of Madhya Pradesh" was carried out with the following goals in mind.

Objectives

The following are the study's specific goals:

1. To examine the absolute change and relative change along with variability in area, production, and productivity of soybean across districts of Malwa Plateau Zone of Madhya Pradesh.
2. To evaluate the trend and growth rate of soybean production, area, and productivity.
3. To find out the role of area, yield, and interaction effects towards change in production of soybean.
4. To recommend policy implication based on the study's findings.

Study’s limitations

1. The data's legitimacy cannot be questioned because the research is based on secondary information (data) acquired from a multiple sources, including public records, Madhya Pradesh Govt. Official Website (Directorate of Economic & Statistics), and research papers.
2. The study's findings are confined to Madhya Pradesh’s Malwa Plateau Zone and cannot be extrapolated to the rest of the state or country.
3. Due to restricted data availability, time duration, and other restricting considerations, the secondary data was only investigated for 15 years (2005-2006 to 2019-2020).

Thesis Outline

The study is divided into six chapters: the first is a basic introduction part about the study, followed by a review of the literature in the second

chapter, Materials and Methods in the third chapter, Results and Discussions in the fourth chapter, Summary and conclusion, recommendations, and policy implications in the fifth chapter, and bibliography in the final chapter.

RIVIEW LITERATURE

Any scientific inquiry has a solid foundation thanks to thorough and significant assessments of earlier research investigations and publications. Its primary purposes include identifying prior research, aiding in the definition of problem areas, offering insight into the techniques and processes used by certain scientists to suggest adjustments there, and serving as the foundation for the analysis of results.

Bisaliah (1984) finished an examination of changes in soybean area, production, and yield, with the goal of providing a thorough overview of the crop's evolution. Four conclusions are drawn from these trends in area and production: (a) Despite the fact that India is not classified as a "Soybean Country" in the global context, soybean acreage expanded from 0.03 to 0.80 million hectares in just 13 years, a twenty-five-fold growth. During the same time period, output climbed from roughly 0.01 to 0.58 million MT, a record forty-twofold rise. During the same time period, the state of M.P. had an eighty-fold expansion in area and a fifty-sevenfold increase in production. Uttar Pradesh, another key soybean-producing state in the country, saw its acreage rise by twenty-seven times and its production increased by thirty-three times. (c) Maharashtra State, which had started successfully in the early 1970s with an extent of 18.16 thousand hectares, witnessed a significant reduction in area over the next five years and was nearly wiped out.

Sharma (1991) reported that Madhya Pradesh had 233.03 thousand hectares of land in 1978-88, up 420 percent over the previous decade (1987-88). During this time, soybean production climbed by 1230% and productivity by 70%. The rice zone of Madhya Pradesh, i.e. zone (722%), rice-wheat zone (550.70%), and cotton-jowar zone (550.70%), all saw the highest percentage rise in soybean area (267 percent). The study also revealed that the percentage rise in soybean production was greater than the percentage increase in soybean area over the same time period, indicating that soybean

productivity rised to some extent in the state as a result of enhanced technology adoption, with 104.84 percent and 86.66 percent, respectively.

Singh (1991) examined the growth pattern and factors affecting soybean output in Madhya Pradesh from 1974-75 to 1983-84 and found that, in the lack of increasing yield expectations from the crop, the area allotted to it in the cropping pattern, both in actual and relative terms, decreased over time. Similarly, output growth has slowed over time, with area reduction emerging as the primary cause. However, the state's positive and considerable growth rate of yield has more than outweighed the negative impact of area. Furthermore, it was discovered that crop productivity is the most essential component that has a major impact on production.

Bisen *et al.* (1993) conducted research in the Raisen district (Madhya Pradesh) to assess the development and variability of crop production components throughout the pre- and post-Green Revolution periods. The Green Revolution had a positive influence on wheat, chickpea, tur, and soybean productivity, according to the research.

Billore and Joshi (1998) assessed the trend in the growth rate of area output and productivity of soybean in India for different states from 1982 to 1994. Madhya Pradesh, Maharashtra, and Rajasthan grew the most in terms of area, production, and productivity. The yield effect was dominating in Gujarat, Himachal Pradesh, and Meghalaya, with major contributions from both the area and yield effects only in Andhra Pradesh and Mizoram, while the remainder of the states was dominated by the area effect.

Kumar and Gupta (2004) looked at the increase rates of soybean acreage, production, and yield district-by-district and zone-by-zone in Madhya Pradesh state of India, from 1990/91 to 1999/2000. Overall, the findings show that both area and output growth were considerable, although yield growth was found to be tiny and inconsequential.

Sharma and Nahatkar (2004) found that the relative change in Glycine max (Soybean) area, production, and productivity in Madhya Pradesh from 1981 to 1990 was higher greater than from 1991 to 2001 because the soybean revolution occurred between 1981 and 1990 due to an industrial revolution for soybean processing, particularly in the Malwa region of the Madhya Pradesh. Soybeans spread in kharif season under fallow areas and also by partially replacing less profitable crops including green gram, black gram, peanuts, maize, sorghum, and cotton between 1981 and 1990From 1991 to 2001, the soybean crop had become well established in the cropping pattern, slowing the rate of increase of soybean area.

Ahirwar *et al*. (2005) investigated relative change, growth and variation in area, production, and productivity of important oilseeds. The research relies solely on secondary data on the area, production, and productivity of important oilseed crops such as rapeseed, mustard, and soybean. The data was gathered over a 32-year period, from 1970-71 to 2003-2004. Soybean growth rates, production, and productivity were calculated to be 18.91, 20.87, and 1.65, respectively. Rapeseed and mustard growth rates were determined to be 1951 in area, 3.807 in production, and 2.079 in productivity, with 59.09, 66.96, and 68.05 percent in counter correspondingly.

Ahirwar *et al.* (2006) looked at the concerns of soybean area growth, production, productivity, and supply response in several districts of Malwa plateau of Madhya Pradesh. The results showed that soybean production increased in Dhar, Mandsaur, Ratlam, Dewas, and Rajghar districts, although only marginally, with the exception of Dewas, where growth in area was positive and substantial for all districts of Malwa Plateau.

Thakur (2008) stated that the relative change in soybean area, production, and productivity in Madhya Pradesh state in the year (2007) was +47.07, +55.39, and +4.79 percent greater than the base year. The change in soybean (Glycine max) area in different agro-climatic zones showed that it increased in other regions (excluding the four major soybean growing regions)

and was determined to be 101.90% greater than the base year. Over the base year, the Central Narmada Valley (47.72%), Malwa Plateau (45.22%), and Vindhyan Plateau (41.28%) saw the biggest increase in area amongst the key soybean growing regions.

Rai (2010) showed that the area of soybean increased by 59.56 percent in the Sehore district over a 15-year period (i.e. 1992-93 to 2006-07), followed by wheat (28.55 percent) and gram (25.08 percent). It was also discovered that the area under jowar (79.23%) and other kharif crops (71.08%) switched towards soybean. It could be because the soybean has discovered a much more profitable and desirable crop in the area, and as a result, it became a preferred cash crop.

Rajarathinam and Parmar (2011) used several parametric and non-parametric models to analyse the trends in the acreage, production, and productivity of the castor crop grown from 1950 to 2008 in the Anand district in central Gujarat (India). Based on R2 and modified R2, the statistically most suitable parametric variables are chosen for the coupled model to forecast relative growth rates of area, production, and productivity trends.

Vanita *et al.* (2015) in their study for the period 1991-92 to 2010-11 found out that during overall period of study, the area effect (33.10 %) was most responsible for increasing soybean production in Amravati division with positive yield and interaction effect of 2.66 and 64.24 per cent, respectively. The area effect was found highest in Yavatmal district (50.60 %). The yield effect was found highest for Amravati district (9.17 %) and the interaction effect was found highest in Buldhana district (63.81 %).

Ahmad *et al.* (1998) investigated how agricultural patterns have changed in the districts of Madhya Pradesh, India's Mahakoshal area. In order to identify the change in cropping pattern, data on the acreage, production, and yield of kharif crops were gathered and examined during a 21-year period. In all districts other than Narsinghpur, paddy exhibited a positive absolute change in the area, with Chhindwara showing the highest relative

change of 48.92%. Sorghum and Kodo-kutki showed declining patterns in both absolute and relative changes in area. Among pulses and oilseeds, soybean area was growing quickly, with relative changes ranging from 307.62% to 3484.61% in various areas.

Jain et al. (1996), found that an effort was made to analyse the relationship between agricultural production and the trend in area expansion. The analysis showed that expanding the area under oilseed crops will not solve the problem of ramping up production, but sufficient attention must be paid to improving the yield of the oilseed crops. Additionally, in perspective of the significant contributors of soybean in Guna and groundnut in Shivpuri, the zone as a whole shows that the impact of area to production was more obvious than the yield.

Singh and Agarwal (1993), rervealed that the output of oilseeds in Haryana had extraordinary increase throughout the course of the previous 25 years, from 1966–1967 to 1990–1991. This growth rate was 8% per year. Rapeseed and mustard have had respective increases in area, output, and yield of 4.8, 6.8, and 3.96 percent. The acreage and output of oilseeds like groundnut and linseed have been steadily declining. Once more, the study attempted to analyse the growth in area, production, and yield of oilseed crops in India from 1970 to 1971 to 1988 to 1989, and it discovered that the higher growth rate of production and yield of oilseeds was observed during the period 1980 to 1981 to 1989 to 1990 in comparison. Rapeseed and mustard have demonstrated a higher level of response to the Technology Mission on Oilseeds activities than any other oilseed crops.

Rahone and Joshi (1993) looked at the area, production, and productivity of five key oilseed and pulse crops in Maharashtra between 1966–1967 and 1991–1992, they found that sesame, sunflower, gramme, and tur had all expanded considerably in size, output, and productivity. However, there was just an increase in groundnut output and productivity. Due mostly to the development of irrigation infrastructure, superior technology, and high

yielding cultivars, gram output has expanded dramatically at a pace of 4.18 percent per year, with equal contributions from an increase in area and productivity.

Pal (1989), concluded that area expansion was the primary driver of output growth, which was also accompanied by disturbingly high levels of production instability. In the cases of mustard and rapeseed, the rise in yield resulted in a rise in output with only moderately high levels of instability. The reason for this was that during the Rabi season, the irrigated northern states grew wheat alongside rapeseed and mustard. Increased volatility is lessened in groundnut and sesame crops thanks to the expansion of agriculture on marginal and sub-marginal areas and high yield susceptibility.

Sodhiya (1988) looks at patterns in the production of pulses and oilseeds in the Sagar region of Madhya Pradesh, India, from 1956/57 to 1982/83. He also looks at trends in the increase of land. Gram, lentils, linseed, til, and soybeans were the crops taken into consideration in a simple regression study using data on acreage, yield, and production obtained from official sources. According to the data, output of pulses and oilseeds increased by 92% in 1982–1983 compared to 1956–1957, while overall acreage increased by 64.7%. The area under til cultivation, however, decreased by 49.5%, and its yield decreased by 55.4%, within the same time period.

Pal and Sirohi (1988) studied “source of growth and instability in the production of commercial crops in India” and conclude that the growth and stability in the production of commercial crops were complementary, rather than competitive process, in intensively irrigated regions. There was no change in the frequencies of short fall in production. However, the intensity of short fall had increased over time, and groundnut was the worst affected crop. Instability was more prominent in production at the state level and may be much Output uncertainty was more pronounced at the state level and could be far more pronounced at the farm level.

MATERIAL METHODS

In light of the aforementioned aims, the current chapter provides a succinct summary of the data gathering and analysis methodologies used. The specific approaches concern the analysis of time series data on soybean acreage, production, and productivity in the Malwa Plateau Zone of Madhya Pradesh, in order to show production trend analysis.

The research methodology has been thoroughly explored under the following headings:

3.1 Profile of the study area

3.2 Nature, source of data and study period

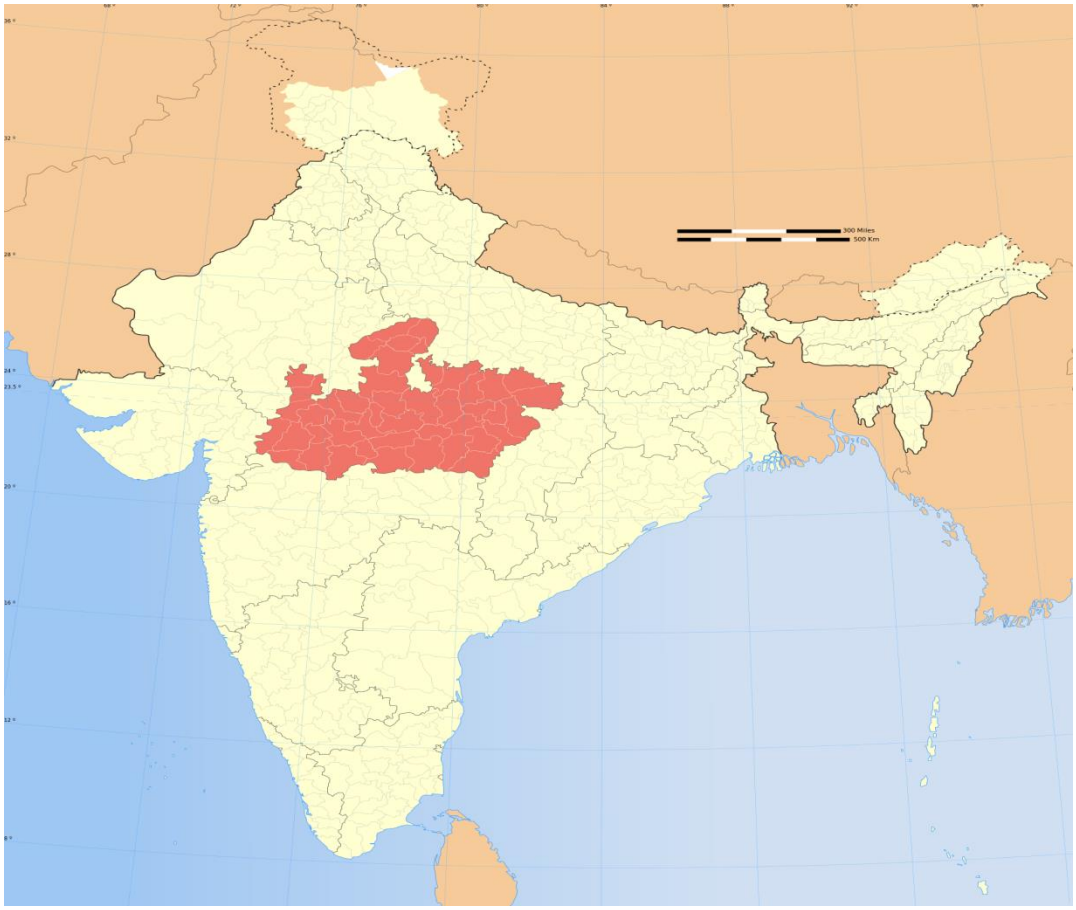
3.3 Analytical procedure

3.1 Profile of the study area

The study area's profile is based on the state of Madhya Pradesh.

3.1.1 General Profile of Madhya Pradesh

Madhya Pradesh, state of India. As its name implies—madhya means “central” and pradesh means “region” or “state”—it is situated in the heart of the country. The state has no coastline and no international frontier, It is bounded by the states of Uttar Pradesh to the northeast, Chhattisgarh to the southeast, Maharashtra to the south, Gujarat to the southwest, and Rajasthan to the northwest. The capital is Bhopal, in the west-central part of the state. It’s position in the globe is- latitude 21°06’N to 26.30°N and longitude 74°09′ to 82°49′E. It is the second largest Indian state by area {119,016 square miles (308,252 square km)}.and the fifth largest state by population with over 75 million residents (Population 72,597,565) (2011 census).




THE SOYA STRETCH
MALWA
Madhya
Pradesh
Bhopal

Table 3.1 General description of Madhya Pradesh.

Area	236,286 sq.km
Population	72,597,565 (2011 census)
Principal official Language	Hindi
Climate	Summer - March to June (Max. Temp. 45 deg. C) Winter - Nov. to Feb. (Min. Temp 5 deg. C)
Capital	Bhopal
Members of Lok Sabha	29
Legislature	Unicameral
Major Cities	Indore (largest city), Bhopal, Jabalpur, Gwalior, Ujjain, Sagar.
Festivals	Khajuraho Festival of Dance, Tansen Music Festival, Gwalior, Shivratri Mela, Pachmarhi, Navratri Festival (Ujjain), Malwa Utsava Ujjain and Indore
Economy Size	US$ 85 billion), 70% of total working population depends on agriculture sector.
Literacy	69.72%
Districts	51
Sex Ratio (as per 2011 census)	931 per thousand
Principal Folk Dances	Matki, Gangaur, Badhai, Baredi, Naurata, Bhagoria
Principal Rivers	Narmada, Betwa, Tapti, Chambal, Sone, Mahanadi, Shipra, Sindh and Indravati
Principal Minerals	The state has the largest reserves of diamond and copper in India. Other major mineral reserves include those of coal, coal-bed methane, manganese and dolomite.
Tourist & Historical Places	Khajuraho, Mandu, Chachai Falls, Bhimbetka, Sanchi, Gwalior, Panchmadhi, Chanderi, Orchha, Caves Of Bagh, Omkareshwar, Maheshwar, Ujjain, Amarkantak

About one-fifth of the people in Madhya Pradesh are officially classified as members of Scheduled Tribes (a category embracing indigenous peoples who fall outside the predominant Indian social hierarchy). Among the most prominent of these tribes are the Bhil, Baiga, Gond, Korku, Kol, Kamar, and Maria. Non-Scheduled peoples, who hold a higher status within the Indian social system, make up most of the remaining four-fifths of the state's population. The state's primary industry is agriculture. Approximately 73 percent of the state's population lives in rural areas and is dependent on agriculture, either directly or indirectly. As a result, the agriculture industry forms the backbone of the state's economy. Agriculture and related services account for around 44 percent of the GDP, while agriculture employs 78 percent of the workforce.

3.1.2 Population

As per details from Census 2011, Madhya Pradesh has population of 7.27 Crores, an increase from figure of 6.03 Crore in 2001 census. Total population of Madhya Pradesh as per 2011 census is 72,626,809 of which male and female are 37,612,306 and 35,014,503 respectively. In 2001, total population was 60,348,023 in which males were 31,443,652 while females were 28,904,371. The total population growth in this decade was 20.35 percent while in previous decade it was 24.34 percent. The population of Madhya Pradesh forms 6.00 percent of India in 2011. In 2001, the figure was 5.87 percent. Out of total population of the state more than 75% lives in villages where agriculture is the major source of income, while the remainder of the population lives in cities. The most populous district is Indore. The state has 919 females per thousand males (sex ratio), while the literacy rate is 69.32 percent.

Source: (https://www.britannica.com/place/Madhya-Pradesh/Education)

3.1.3 Land

Madhya Pradesh is the second largest Indian Sate in size with an area of 3,08,000 sq.km. Madhya Pradesh lies over a transitional area between

the Indo-Gangetic Plain in the north and the Deccan plateau in the south. Its physiography is characterized by low hills, extensive plateaus, and river valleys. The elevation of Madhya Pradesh ranges from 300 to 3,900 feet (90 to 1,200 metres). In the northern part of the state the land rises generally from south to north, while in the southern part it increases in elevation toward the west. Important ranges of hills are the Vindhya Range, in the west, and its northern branch, the Kaimur Hills, both of which reach elevations of 1,500 feet (460 metres), and the Satpura, Mahadeo, and Maikala ranges, in the south, which have elevations of more than 3,000 feet (900 metres). The Dhupgarh Peak (4,429 feet [1,350 metres]), near Pachmarhi in south-central Madhya Pradesh, is the state's highest point. Northwest of the Vindhya Range is the Malwa Plateau (1,650 to 2,000 feet [500 to 600 metres]). Other features include the Rewa Plateau, in the rugged eastern region of the Vindhya Range, the Bundelkhand Upland, north of the Vindhyas, the Madhya Bharat Plateau, in the extreme northwest, and the Baghelkhand Plateau, in the northeast.

3.1.4 Climate and Temperature:-

The climate in Madhya Pradesh is governed by a monsoon weather pattern. The distinct seasons are summer (March through May), winter (November through February), and the intervening rainy months of the southwest monsoon (June through September). The annual rainfall received in the state varies from 700mm. to 1600mm. in the Eastern Districts; it ranges between 1500 to 1600mm, in the northern districts from 700 to 900mm. and in the western and central districts between 1000 to 1200mm, with average rainfall of the state 1142.6mm. Mostly, the rains are received during monsoon month's 25 to 55 rainy days. Very little rains are received in winter (October to March) ranging from 60 to 80 mm. The summer is hot, dry, and windy; in Bhopal, low temperatures average in the upper 70s F (about 25 °C), while high temperatures typically reach the low 100s F (about 40 °C). Winters are usually pleasant and dry, with daily temperatures normally rising from about 50° (about 10 °C) into the upper 70s F (about 25 °C). Temperatures during

the monsoon season usually range from the low 70s F (low 20s C) to the upper 80s F (low 30s C).

3.1.5 Drainage and soils:-

Madhya Pradesh contains the source of some of the most important rivers in the Indian peninsula: the Narmada, the Tapti (Tapi), the Mahanadi, and the Wainganga (a tributary of the Godavari). The Chambal forms the state's northern border with Rajasthan and Uttar Pradesh. Other rivers include tributaries of the Yamuna and the Son (itself a tributary of the Ganges [Ganga]).

Soils in Madhya Pradesh can be classified into two major groups. Fertile black soils are found in the Malwa Plateau, the Narmada valley, and parts of the Satpura Range. Less-fertile red-to-yellow soils are spread over much of eastern Madhya Pradesh.

3.1.6 Pattern of Land Use

Land use statistics, in general, show how much land is utilised for various purposes. Because land is a limited resource, it must be well-managed to benefit the human population that depends on it for survival. Table 3.3 depicts the overall land use pattern in Madhya Pradesh. Madhya Pradesh's Net Sown Area (152.25 lakh acres) accounted for over half of the state's total land area (308.25 lakh ha) Non-agricultural uses accounted for 7.08 percent of total land area (21.83 lakh hectares), while total uncultivated land (excluding fallow) accounted for 7.55 percent (23.28 lakh ha). Cultivated wasteland, permanent pastures, grazing areas, land under tree crops, and groves not included in the net sown area make up this category.4.36 percent of the land was unusable for agriculture (13.44 lakh acres). 3.18 percent of the land was used for agriculture (9.81 lakh ha). The land use pattern in Madhya Pradesh is visually depicted in Figure 3.3.

Table-3.3 Land Use Classification of Madhya Pradesh

S. No.	Land Use	Area (lakh ha.)	Percent
1.	Forest	86.92	28.20
2.	Net sown area	152.28	49.40
3.	Area on Non-agriculture use	21.83	7.08
4.	Total cultivated land excluding fallow land	23.28	7.55
	I. Cultural waste land	10.02	3.25
	II. Permanent pasture and grazing lands	13.06	4.24
	III. miscellaneous	0.20	0.06
5.	Barren and Uncultivable land	13.44	4.36
6.	Total fallow land	9.81	3.18
	I. Current fallow	5.00	1.62
	II. Other fallow land	4.81	1.56
7.	Reporting area for land use statistics	307.56	99.78
8.	Geographical area	308.25	100

Source: https://www.census2011.co.in

3.1.7 Operational Holdings

The state has a total of 8873 land holdings with a total area of 15835.87 hectares, according to the 2011 agricultural census. A landholding was on average 1.78 hectares in size. The area accounted for the majority of the holdings (8.84%). (Table 3.4)

Table-3.4 Number of area of operational Holdings

Particulars	Number of land holdings (in thousands)	Area ('000ha.)
Marginal	3891.02(43.86%)	1915.35(12.10 %)
Small	2448.65(27.60%)	3466.14(21.89%)
Semi-medium	1654.83(18.65%)	4510.22(28.48%)
Medium	789.14(8.89%)	4544.53(28.70%)
Large	88.73(1.00%)	1399.63(8.84%)
Total	8872.38(100%)	15835.87(100%)

Source: https://www.census2011.co.in

3.1.8 Irrigation

Madhya Pradesh has a wealth of water resources, including multiple major rivers such as the Narmada. The Chambal, Betwa, Ken, Sone, Tapti, Pench, Wainganga, and Mahi rivers all begin and end in the state. These rivers are the most major irrigation sources in terms of area. Wells and tubewells (67 percent) are the most prevalent irrigation sources, followed by canals (18 percent), tanks (3 percent), and other sources (12 percent). The state's total irrigated land area is 113.94 lakh hectares. Source: **(mpinfo.org)**

Table 3.5 Source of Irrigation of Madhya Pradesh

S. No.	Name of Source	Area (%)
1	Tube Wells	67
2	Canals	18
3	Tank	3
4	Other Source	12

3.1.9 Consumption of fertilizers

In comparison to India, Madhya Pradesh consumed 8.17 percent more nitrogenous, 10.66 percent more phosphatic, and 3.66 percent more potassic fertilisers.

Table 3.6 Fertilizers consumption in the state and India ('000 tons)

Particulars	India	Madhya Pradesh	(%) share to all India level
Nitrogenous Fertilizers	17628.2	1440.4	8.17
Phosphatic Fertilizers	6967.9	742.9	10.66
Potassic Fertilizers	2779.1	101.6	3.66
Total Fertilizers	27375.2	2284.9	8.35

Source: Agricultural statistics at a glance 2019

3.1.10 Cropping pattern of major kharif crops of M.P.:-

The main crops grown in *kharif* season are Soybean, Paddy, Maize, Bajara and Tur etc. The total area under Kharif crops in the state is 104 lakh ha. Among Kharif crops, soybean has been sown on over 58 lakh ha, against the target of 56.50 lakh ha. Last year, soybean crops were sown on an area of 55.46 lakh hectare. The area, productivity and production of soybean registered positive significant growth in M.P. and Malwa plateau agro climatic zone of Madhya Pradesh. However, high level fluctuations in production during the period under study revealed that measures like timely application of recommended contingent practices during aberrant weather conditions in climate change scenario must be popularize. **(Source: https://farmech.dac.gov.in)**

3.2 Research Methodology:

3.2.1 Selection of Area

This study examines the expansion of soybean area, production, and productivity in Madhya Pradesh's Malwa Plateau Zone, which encompasses the following districts viz. Ujjain, Rajgarh, Dewas, Dhar, Mandsaur, Ratlam, Shajapur (Agar-Malwa), Indore, and Neemuch throughout the study period and covers 48.94 percent of the state's geographical area under soybean cultivation.

3.2.2 Nature, source of data and period of study

To provide a complete view of change and trend in soybean area, production, and productivity over the previous 15 years, time series secondary data was gathered (2005-06 to 2019-20). The Directorate of Economics and Statistics, mpkrishi.mpgovt.in, DAC&FW, and the Food and Agriculture Organization's websites were utilised to compile secondary data for this study.

Agro climatic region of Madhya Pradesh:

i. Chhattisgarh plain: This region covers Balaghat district only.
ii. Northern Hill Region of Chhattisgarh: This regions covers Shahdol, Anuppur, Singroli, Sidhi, Mandla and Dindori districts.
iii. Kaymore Plateau and Satpura hills: This plateau covers the districts of Panna, Satna, Rewa, Katni, Seoni and Umariya.
iv. Central Narmada Valley: This valley covers Jabalpur, Hoshangabad, Narsinghpur and Harda districts.
v. Vindhyan Plateau: This plateau covers Bhopal, Rajgarh, Guna, Ashoknagar, Vidisha, Sagar, Damoh, Raisen and Sehore districts.
vi. Gird Region: The region covers districts Morena, Bhind, Gwalior, Sheopur, and Shivpuri.
vii. Bundelkhand Region: The region covers districts Datia, Tikamgarh and Chhatarpur.
viii. Satpura Plateau: The region covers Betul and Chhindwara districts.

ix. Malwa Plateau: This plateau covers Neemuch, Mandsour, Ratlam, Ujjain, Shajapur(Agar Malwa), Dewas, Dhar, Indore and Rajgarh districts.

x. Nimar Valley: This valley covers districts of Khandwa, Burhanpur and Khargone Barwani.

xi. Jhabua Hills: This area covers Jhabua and Alirajpur district.

3.3: Analytical procedure:

Time series data cannot be fully explained by a single statistical approach. Economic and statistical science provides a number of approaches for diving further into the variables. The study's tools are discussed in detail in the next section.

(a) Absolute change, Relative change and Coefficient of variation

(b) Trend and growth rates analysis

(c) The component analyses

3.3.1. Absolute change:

Absolute change as well as relative change was included in the present study.

Absolute change = Y n - Y o

=Current Year-Base Year

Where,

Y n = Mean value (area production and productivity) For the last triennium ending

Y o = Mean value (area production and productivity) for the first (base) triennium ending

3.3.2. Relative change

$$\text{Relative change (\%)} = \frac{Yn - Yo}{Yo} \times 100$$

Where,

Yn = Mean value (area, production and productivity) for the last triennium ending

Y0 = Mean value (area, production and productivity) for the first (base) triennium ending

3.3.3. Coefficient of variation

The coefficient of variation was determined using the following formula to determine the degree of variability in soybean area, production, and productivity.

$$\text{C.V. (\%)} = \frac{S.D.}{\bar{X}} \times 100$$

Where,

Mean, (x) = Mean value of the variate

S.D.(σ) = Standard deviation of the variate

3.3.4. Trend Analysis

Trend analysis is a commonly used statistical technique for identifying patterns of behaviour in time series data. When data is gathered over time or at different degrees of flexibility, trend analysis is frequently utilised, especially when a single individual variant, or feature, is analysed to consider its influence on dependent variability.

Y = a + b x (Linear Function)

$$b = \frac{\sum xy - \frac{\sum x \sum y}{N}}{\sum X^2 - \frac{(\sum X)^2}{N}}$$

Where,

Y = Dependent Variable (area, yield, production)

a = Constant / Intercept Value

b = Regression coefficient (Trend Value)

X= Independent variable (time in years)

N =Number of Observation.

3.3.5. Simple Growth Rate (%)

The Present study is intended to Work out the growth rates and for that a simple growth rates of Area, Production and Productivity of Soybean crop where calculation with the following formula given below:-

SGR (%) = b/y × 100

Where:-

b = Regression co-efficient.

Y = Average of Area/Production/yield (Y = Σy /n)

3.3.6. Student t- Test

$$t = \frac{\hat{b}}{SE(\hat{b})}$$

Where:-

t= test statistics

b= Regression Coefficient

SE (b)= Standard Error of b

t-calculated> t -tabulated (Significant)

t-calculated< t- tabulated (Non- Significant)

3.3.7. The following decomposition modal (Sharma 1997 and Narula and Vidya Sagar 1973)

The following decomposition model was used to assess the contribution of area, yield, and their interaction to changes in Soybean output over time. The model (Sharma1977) was utilised in this study.

a) Area effect (AE): Shows the percentage share of the area in total Production**.**

Area effect (%) = $AE = \frac{(An - Ao)Yo}{Pn - Po} X\ 100$

b) Yield effect (YE): Shows the percentage share of yield in the total production.

Yield effect (%) = $$YE = \frac{(Yn - Yo)Ao}{Pn - Po} X\ 100$$

c) Interaction effect (IE): Shows the percentage share of area and yield interaction in the total production.

Interaction effect (%) = $$IE = \frac{(An - Ao)(Yn - Yo)}{Pn - Po} X\ 100$$

Where,

Ao, Po and Yo = Triennium average from 2005-06 to 2007-08 (baseyear) for the area, production and productivity of Coriander

An, Pn and Yn = Triennium average from 2017-18 to 2019-20 (current year) for the area, production and productivity of the Soybean

Yo=Po/Ao

Yn=Pn/An

RESULT AND DISCUSSION

The Ongoing chapter has been involved in analysing the economic investigation and the followings are conferred in tabular form for the time period of 15 years. An attempt was made to demonstrate the soybean crop of Malwa Plateau Zone of Madhya Pradesh making suggestion to the behaviour of procedures regarding emphasis laid by them with respect to area, production, and yield of the mentioned crops using measurements such as arithmetic average, absolute and relative change, variability. Simple growth rate and decomposition analysis are few of the additional statistical tools that has been used to reveal the degree of variation in acreage, production and yield.

The following four key headings were used to organise the chapter:

1. To examine the absolute change and relative change along with variability in area, production, and productivity of soybean across districts of Malwa Plateau Zone of Madhya Pradesh.
2. To evaluate the trend and growth rate of soybean production, area, and productivity.
3. To find out the role of area, yield, and interaction effects towards change in production of soybean.
4. To recommend policy implication based on the study's findings.

4.1 To examine the absolute and relative change along with variability in area, production and productivity of soybean across districts of Malwa Plateau Zone

The level of change in soybean output, area, and yield among districts in the Malwa Plateau Zone of Madhya Pradesh was initially assessed using a simple assessment measuring absolute change, relative change, and coefficient of variation.

4.1.1 Absolute change in area, production and productivity of Soybean Crop

The change in area, production, and productivity of the soybean crop across districts of the Malwa Plateau in the Madhya Pradesh state have been evaluated over the research period, from 2005–2006 to 2019–20, and these results are shown in Table 4.1.1.

Table 4.1 Current year and base year for area, production and productivity for the period of 15 years (2005-06 to 2019-20)

District's Name	Area (000' ha.)		Production (000' tonnes)		Productivity (tonne/ha)	
	Base year	Current Year	Base year	Current Year	Base year	Current Year
Ujjain	427.91	485.63	474.90	450.67	1.11	0.93
Rajgarh	272.27	369.54	273.00	301.22	1.00	0.86
Dewas	286.43	364.13	351.41	351.89	1.23	-0.97
Dhar	247.82	297.83	318.32	373.06	1.28	1.25
Mandsaur	250.88	273.50	196.42	208.46	0.78	0.99
Ratlam	189.33	257.35	210.67	275.72	1.11	1.14
Shajapur (AgarMalwa)	342.05	364.42	359.66	413.74	1.05	1.13
Indore	220.05	233.20	275.89	306.53	1.25	1.30
Neemuch	122.00	131.23	83.76	107.21	0.69	0.82
MalwaPlataeu	2358.74	2776.84	2544.02	2788.50	1.08	1.01
Other Districts	2459.68	2764.16	2437.48	2207.42	0.99	0.82
Madhya Pradesh	4818.42	5541.00	4981.50	4995.92	1.03	0.92

4.1.1.1 area:

It was reported from the table that the absolute change in area for Soybean Crop was found positive in all districts viz. Rajgarh, Dewas, Ratlam, Ujjain, Dhar, Mandsaur, Shajapur(Agar Malwa), Indore, Neemuch and Over all Malwa Plateau Zone, which shows an increase in the area under the Soybean crop by 97.27, 77.70, 68.03, 57.72, 50.02, 22.62, 22.38,13.15, 9.23, 418.11 thousand hectare, respectively.

4.1.1.2 Production:-

It was revealed from the table that the absolute change in production for Soybean Crop was found to be positive for Ratlam, Dhar, Shajapur(Agar Malwa), Indore, Rajgarh, Neemuch, Mandsaur, Dewas, and overall Malwa Plateau Zone which shows an increase in the production under the Soybean crop by 65.06, 54.74, 54.08, 30.64, 28.22, 23.44, 12.05, 0.48, 14.43 and thousand tonne respectively and absolute change was negative in Ujjain district which was (-24.30) thousand tonne.

4.1.1.3 Absolute change in productivity:-

It was mentioned in the table that the absolute change in productivity for Soybean Crop was found to be positive in Mandsaur, Neemuch, Shajapur (Agar Malwa), Indore, Ratlam which shows an increase in the productivity under the Soybean crop by 0.21, 0.13, 0.08, 0.05, 0.03 metric tons/ha, respectively and absolute change was negative in Dhar, Rajgarh, Ujjain, Dewas and overall Malwa Plateau which shows decrease in the productivity under Soybean crop by -0.03, -0.15, -0.18, -0.26 and -0.06 tons/ha respectively.

Table 4.1. (A): Absolute change in area, production and productivity of Soybean Crop across Districts of Malwa Plateau zone of Madhya Pradesh.

District's Name	Abosulute Change		
	Area ('000ha)	Production ('000MT)	Productivity (MT/ha)
Ujjain	57.72	-24.23	-0.18
Rajgarh	97.27	28.22	-0.15
Dewas	77.70	0.48	-0.26
Dhar	50.02	54.74	-0.03
Mandsaur	22.62	12.05	0.21
Ratlam	68.03	65.06	0.03
Shajapur (AgarMalwa)	22.38	54.08	0.08
Indore	13.15	30.64	0.05
Neemuch	9.23	23.44	0.13
MalwaPlataeu	418.11	244.48	-0.06
Other Districts	304.48	-230.06	-0.17
Madhya Pradesh	722.58	14.43	-0.12

Thus it could be discussed that for soybean crop Area wise highest absolute change in Malwa plateau zone was found to be highest for Rajgarh district which was 97.27 thousand hectare and lowest was for Neemuch district which was 9.23 thousand hectare. Similarly if we look into the absolute change for production, it was found to be highest for Ratlam district which was found to be 65.06 thousand metric tonne and it was lowest for Ujjain district which was -24.23 thousand metric tonne. Now we look into absolute change for productivity it was found to be highest for Mandsaur district which was 0.21

tonne per hectare and was lowest for Dewas district which was -0.26 tonne per hectare.

4.1.2 Relative change in area, production, productivity of Soybean Crop

The changes in Soybean area, production, and productivity from the current year to the base year have been interpreted in terms of relative change and are shown in Table 4.1.2.

4.1.2.1 Area:-

Ratlam, Rajgarh, Dewas, Dhar, Ujjain, Mandsaur, Neemuch, Shajapur (Agar Malwa), and Indore all had positive relative changes in area for Soybean Crop, with increases of 35.93%, 35.73%, 27.13%, 20.18%,13.49%, 9.02%, 7.56%, 6.54%, and 5.98%, respectively and it was also positive for overall Malwa Plateau zone 17.73%.

4.1.2.2 Production:-

In Ratlam, Neemuch, Dhar, Shajapur(Agar Malwa), Indore, Rajgarh, Mandsaur, Dewas and overall Malwa Plateau, the relative change in production for the Soybean Crop was found to be positive, indicating an increase in production under the Soybean Crop. It was found to be 30.88%, 27.99%, 17.20%, 15.04%, 11.11%, 10.34%, 6.13%, 0.14%, 9.61% but the relative change was found to be negative in the Ujjain district (-5.10%).

4.1.2.3 Productivity:-

As far as the relative change in productivity of Soybean Crop is concerned , it was found positive in Neemuch, Shajapur (Agar Malwa), Indore, Ratlam, Mandsaur which shows increase in the productivity under the Soybean crop. It was observed to be 18.97%, 8.07%, 4.02%, 2.94%, 0.77%%, but relative change was negative in Dhar, Rajgarh, Ujjain, Dewas which shows deccline in the productivity by (-2.52%),(-14.84%), (-15.80), (-20.91%) Changes respectively, it was also negative and hence decreasing for overall Malwa Plateau which was (-5.90%).

Table 4.1. (B): Relative change in area, production and productivity of Soybean crop across districts of Malwa Plateau Zone of Madhya Pradesh.

District's name	Relative change (In Percent)		
	Area	Production	Productivity
Ujjain	13.49	-5.10	-15.90
Rajgarh	35.73	10.34	-14.84
Dewas	27.13	0.14	-20.91
Dhar	20.18	17.20	-2.52
Mandsaur	9.02	6.13	0.77
Ratlam	35.93	30.88	2.94
Shajapur (Agar-Malwa)	6.54	15.04	8.07
Indore	5.98	11.11	4.02
Neemuch	7.56	27.99	18.97
Malwa Plateau Zone	17.73	9.61	-5.90
Other districts	12.38	-9.44	-17.47
Madhya Pradesh	15.00	0.29	-11.13

Thus from the above table a discussion can be put that the highest relative change for area in Malwa plateau zone was found to be highest for Ratlam district which was 35.93 percent and lowest was for Shajapur (Agar-Malwa) district which was 6.54 percent. Similarly if we look into the relative change for production, it was found to be highest for Ratlam district which was found to be 30.88 percent and it was lowest for Ujjain district which was -5.10 percent. If we look into relative change in productivity it was found to be highest for Neemuch district which was Neemuch which was 18.97 percent and was lowest for Dewas district which was -20.91 percent.

4.1.3. Variability in area, production and productivity of Soybean

The statistical measures for variability in variables such as area, production, and productivity of the soybean crop have been utilised in terms of Co-efficient of variation for the whole research period (2005-2006 to 2019-2020) and are shown in the following section.

Table 4.1.3 shows the coefficient of variation for area, production, and productivity of the Soybean crop across districts in Madhya Pradesh's Malwa Plateau Zone.

4.1.3.1 Area:

During the overall study period, the highest variability for area of soybean crop was found in Ratlam district (14.10 %), followed by Rajgarh (12.99 %), Dewas (9.79 %), Dhar (7.10 %), Mandsaur (6.30 %), Neemuch (6.28 percent), Ujjain (5.28 %), Indore (3.63 %), Shajapur (Agar-Malwa) (3.21 %), and for overall Malwa Plateau Zone it was (6.85%).

4.1.3.2 Production:

During the overall study period, the highest variability of production of soybean crop was observed in Neemuch district (39.88 %), followed by Mandsaur (37.20 %), Ujjain (29.69 %), Rajgarh (27.29 %), Dewas (26.94 %), Ratlam (22.60 %), Shajapur (Agar Malwa) (20.71 %), Dhar (17.93 %), and for overall Malwa Plateau Zone (19.67%)

4.1.3.3 Productivity:

During the total study period, the pattern of variability for soybean crop productivity in selected districts was found to be highest in Neemuch district (37.41 %), followed by Mandsaur (36.54 %), Ujjain (29.25 %), Rajgarh (29.09 %), Dewas (27.09 %), Ratlam (25.78 %), Indore (22.09 %), Shajapur (Agar Malwa) (20.43 %), Dhar (15.68 %), and for overall Malwa Plateau Zone it was (20.20%).

Table 4.1.(C): Variability in area, production and productivity of Soybean Crop of Malwa Plateau Zone of Madhya Pradesh.

District's name	Co-efficient of variation (In Percent)		
	Area	Production	Productivity
Ujjain	5.28	29.69	29.25
Rajgarh	12.99	27.29	29.09
Dewas	9.79	26.94	27.09
Dhar	7.10	17.93	15.68
Mandsaur	6.30	37.20	36.54
Ratlam	14.10	22.60	25.78
Shajapur (AgarMalwa)	3.21	20.71	20.43
Indore	3.63	23.58	22.09
Neemuch	6.28	39.88	37.41
Total Malwa Plateau	6.85	19.67	20.20
Other districts	14.92	25.80	22.52
Madhya Pradesh	9.94	19.89	19.10

Thus form above table it could be discussed that extent of variability in area was maximum for Ratlam district (14.10%) and was minimum for Shajapur (Agar Malwa) (3.21%). If we look into the variability in production, it was maximum for Neemuch district (39.88) and it was found to be lowest for Dhar district (17.93%). Now the variability in productivity was maximum for Neemuch district (37.41%) and was found to be lowest for Dhar district (15.68%).

4.2 To analyse the trend and Simple growth rate in area, production and productivity of Soybean.

The time series data of essential variables such as area, production, and productivity, with a focus on the soybean crop, were compiled using simple statistical methods such as absolute change, relative change, and variability in the preceding section of the chapter. Now this part uses precise statistical methods, such as trend and simple growth rate, to continue the compilation of data from the Soybean crop. The trend value and simple growth rate were calculated using a linear trend.

4.2.1 Trend Analysis:-

Table 4.2.1 shows the regression coefficients for area, production, and productivity of soybean crop in districts of Madhya Pradesh's Malwa Plateau Zones.

4.2.1.1 Area:-

In Rajgarh, Dewas, Ratlam, Ujjain, Dhar, Shajapur (Agar Malwa), Neemuch, Indore, and the Overall Malwa Plateau Zone, the value of the regression coefficient of area in Soyabean crop was found positive and significant at 1 percent and 5 percent level of highly significant, indicating an increase in the area under the Soybean crop by (b=7.84), (b=5.84), (b=4.89), (b=4.08), (b=4.00), (b=2.21), (b=1.26), (b=0.95), (b=32.85) thousand hectare, respectively and it was found positive but non-significant for Mandsaur district which was (b=1.76) thousand hectare.

4.2.1.2 Production:-

In the districts of Ratlam, Dhar, Shajapur (Agar Malwa), Neemuch, Rajgarh, Mandsaur, Indore, and the overall Malwa Plateau Zone, the value of the regression coefficient of Production in Soybean Crop was found positive and non-significant at both the 1 percent and 5 percent level of significance, indicating an increase in production under the Soybean crop by (b=4.02), (b=3.31) (b=2.74), (b=2.43), (b=2.12), (b=0.79), (b=0.32), (b=4.62) thousand metric tonnes respectively and It was shown to be negative but non-significant

for Dewas (b= -2.63) and (b= -8.48) thousand metric tonnes for Ujjain, respectively.

4.2.1.3 Productivity:-

In Neemuch, Shajapur (Agar Malwa), Mandsaur, and Ratlam, the value of the regression coefficient of Production in Soybean Crop was found to be positive and non-significant at the 1% and 5% level of significance, indicating an increase in productivity under the Soybean crop of (b=0.01), (b=0.008), (b=0.0035), and (b=0.001) tonne per hectare, respectively, and Dhar, Rajgarh, Ujjain, Dewas, and the overall Malwa Plateau Zone were reported to be negative and non significant which were (b=-0.01), (b=-0.03), (b=-0.03), (b=-0.004), and (b=-0.01) tonnes per hectare, respectively.

4.2(A):Trend in area, production and productivity of Soybean

District's name	**Trend Analysis (b Value)**		
	Area	**Production**	**Productivity**
Ujjain	4.08**	-8.48	-0.03
Rajgarh	7.84**	2.12	-0.01
Dewas	5.84**	-2.63	-0.03
Dhar	4.00**	3.31	-0.01
Mandsaur	1.76	0.79	0.0035
Ratlam	4.89**	4.02	0.001
Shajapur (Agar-Malwa)	2.21**	2.74	0.008
Indore	0.95**	0.32	- 0.004
Neemuch	1.26**	2.43	0.01
Malwa Plateau Zone	32.85**	4.62	-0.01
Other districts	30.33	-23.43	-0.02
Madhya Pradesh	63.19*	-18.81	-0.01

Degree of freedom = 15-2=13

Significant at 1% (3.012) = **, Significant at 5% (2.160) = *

Thus, the trend value for area was found to be extremely significant and positive for Rajgarh, Ujjain, Dewas, Dhar, Ratlam, Shajapur (Agar-Malwa), Indore, and the whole Malwa plateau zone, but it was non significant for Mandsaur district, as shown in the table given. If we look at the production trend value, it was positive and non-significant in Neemuch, Shajapur (Agar-Malwa), Mandsaur, Ratlam, and was negative in Dhar, Rajgarh, Ujjain, Dewas, and Indore. Ratlam, Dhar, Shajapur (Agar-Malwa), Neemuch, Rajgarh, Mandsaur, and Indore had positive and considerable output, whereas Dewas and Ujjain had negative and non-significant production. In case of productivity, the trend value of none of the district were found to be significant ie. were found to be non significant.

Fig.4.2.(A).Trend of area, Production and Productivity of Soybean in Ujjain district.

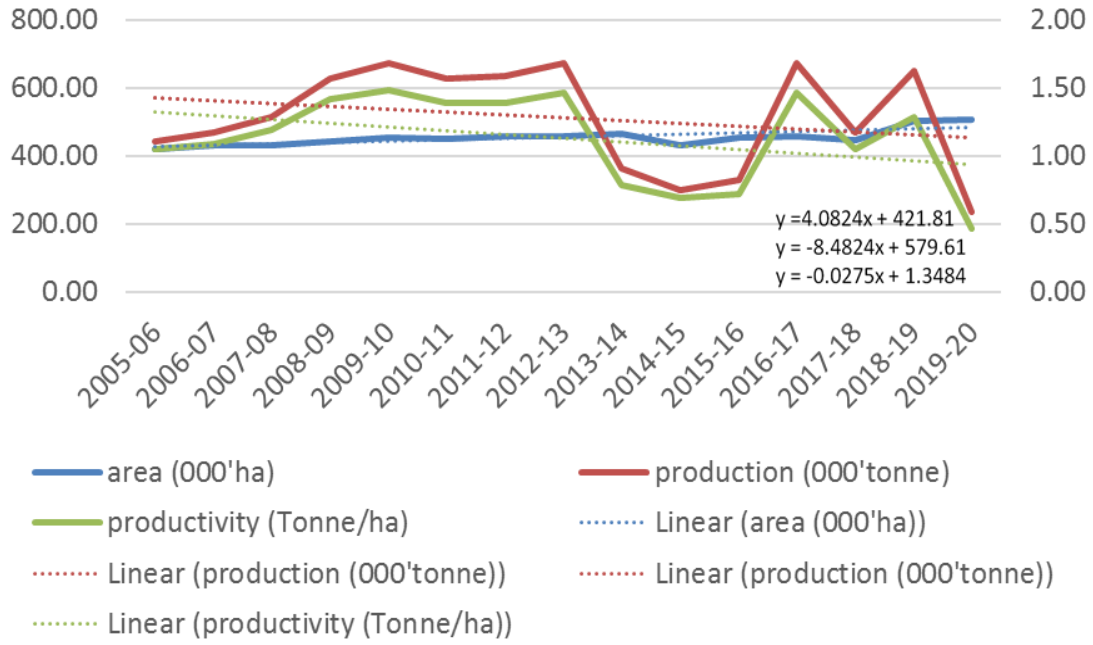


Fig.4.2.(B).Trend of area, Production and Productivity of Soybean in Rajgarh District.

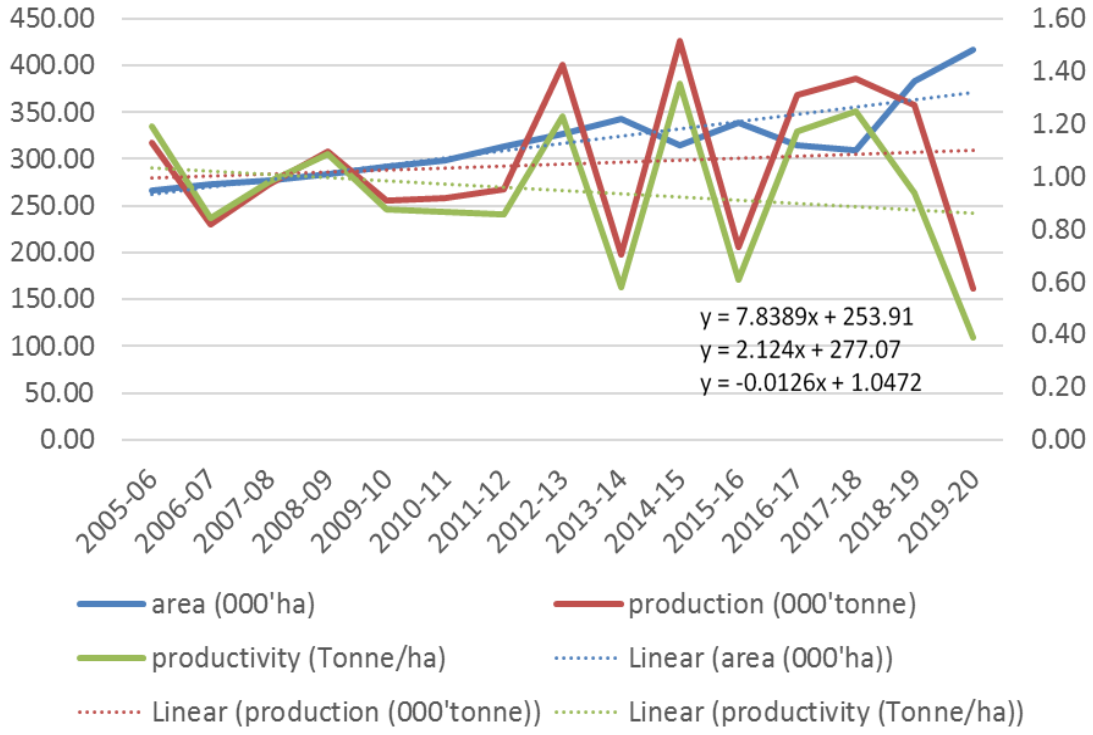


Fig.4.2.(C). Trend of area, Production and Productivity of Soybean in Dewas District.

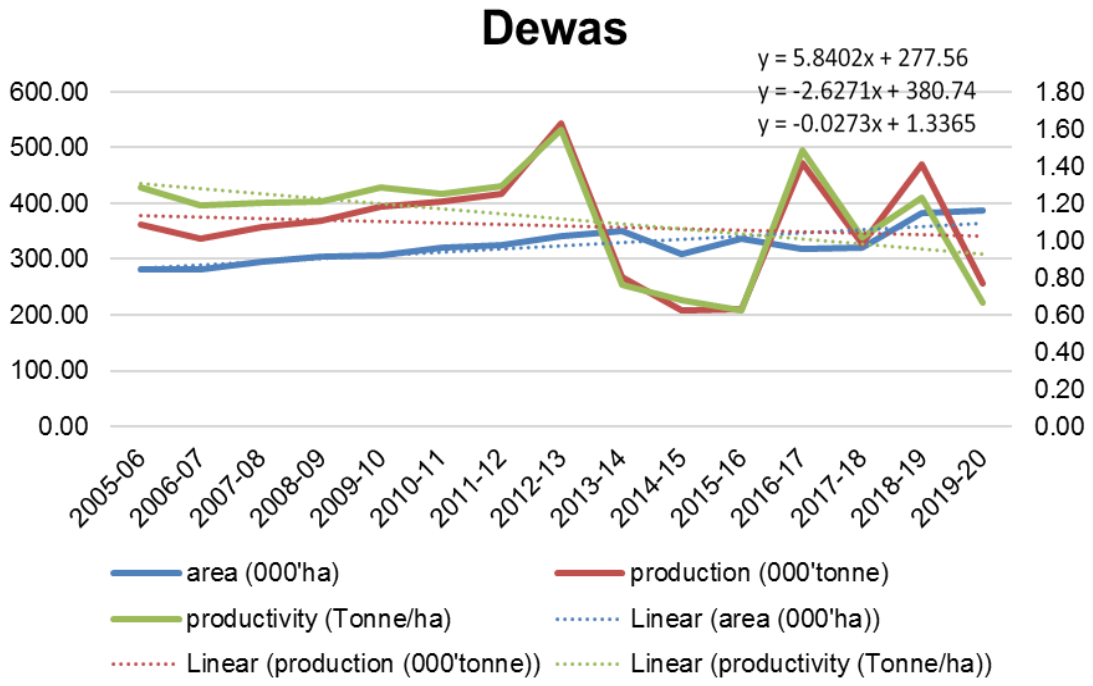


Fig.4.2.(D). Trend of area, Production and Productivity of Soybean in Dhar District.

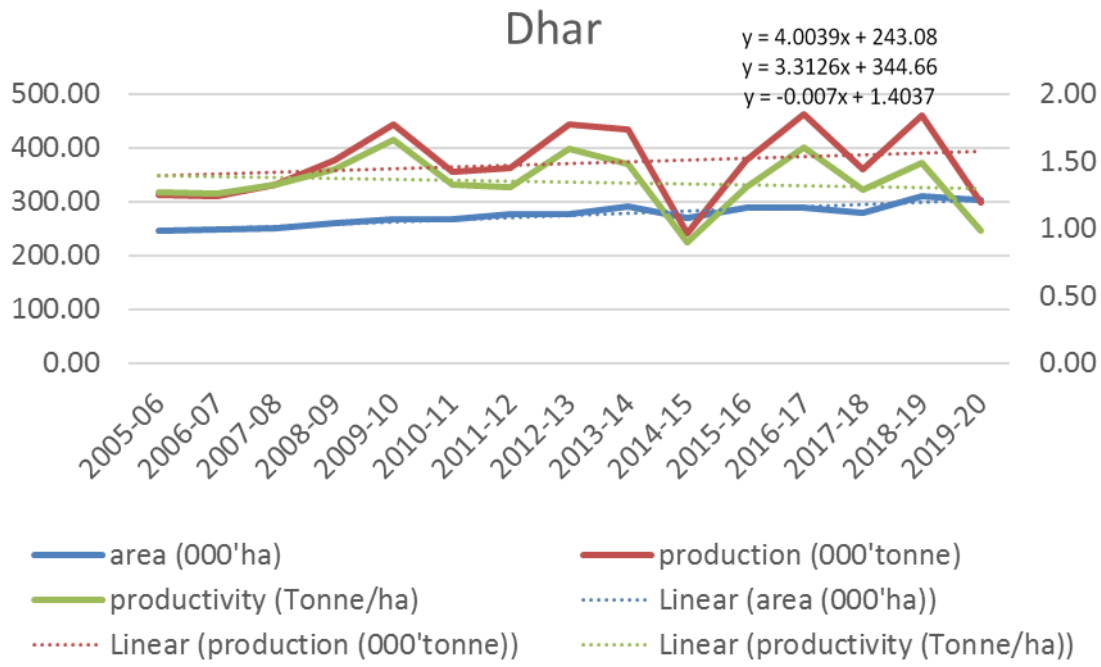


Fig.4.2.(E). Trend of area, Production and Productivity of Soybean in Mandsaur district.

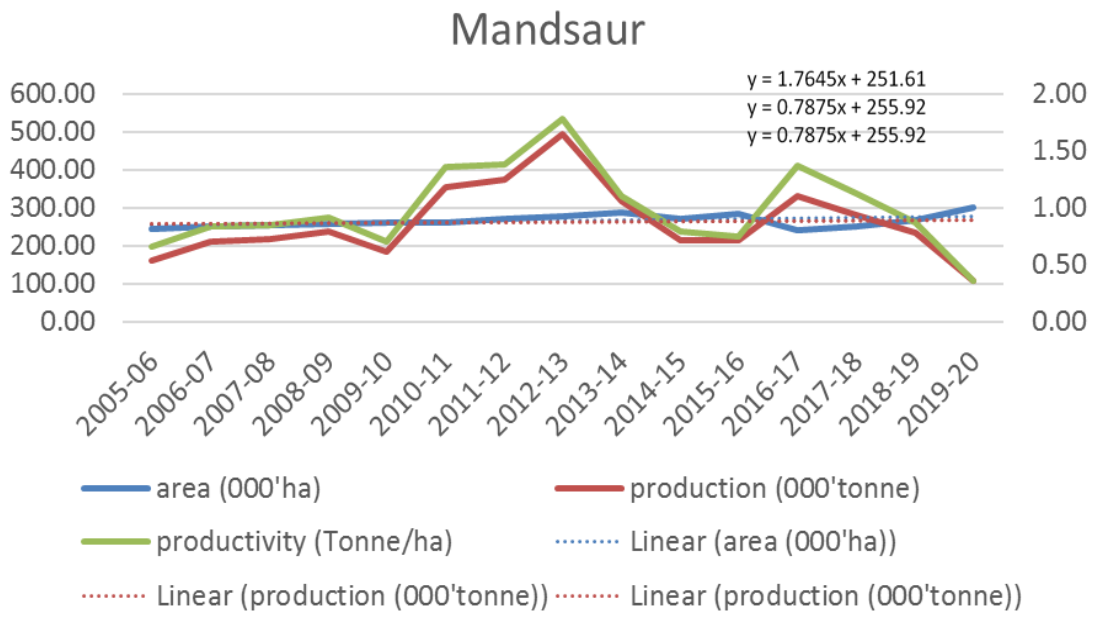


Fig.4.2.(F). Trend of area, Production and Productivity of Soybean in Ratlam District .

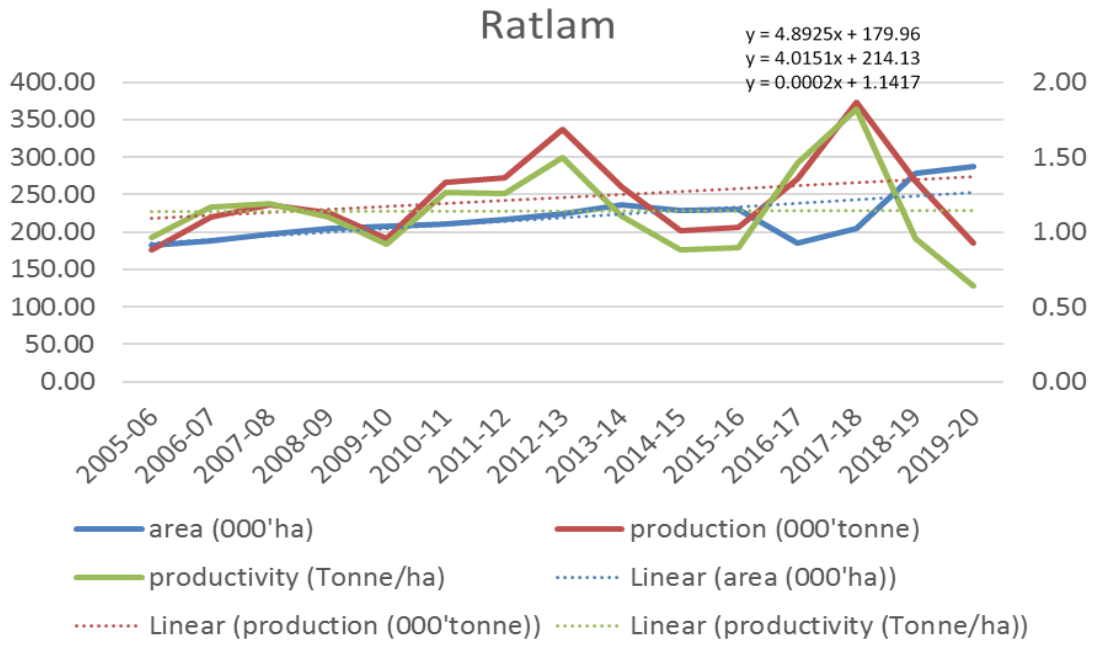


Fig.4.2.(G). Trend of area, Production and Productivity of Coriander in Shajapur(Agar malwa) District.

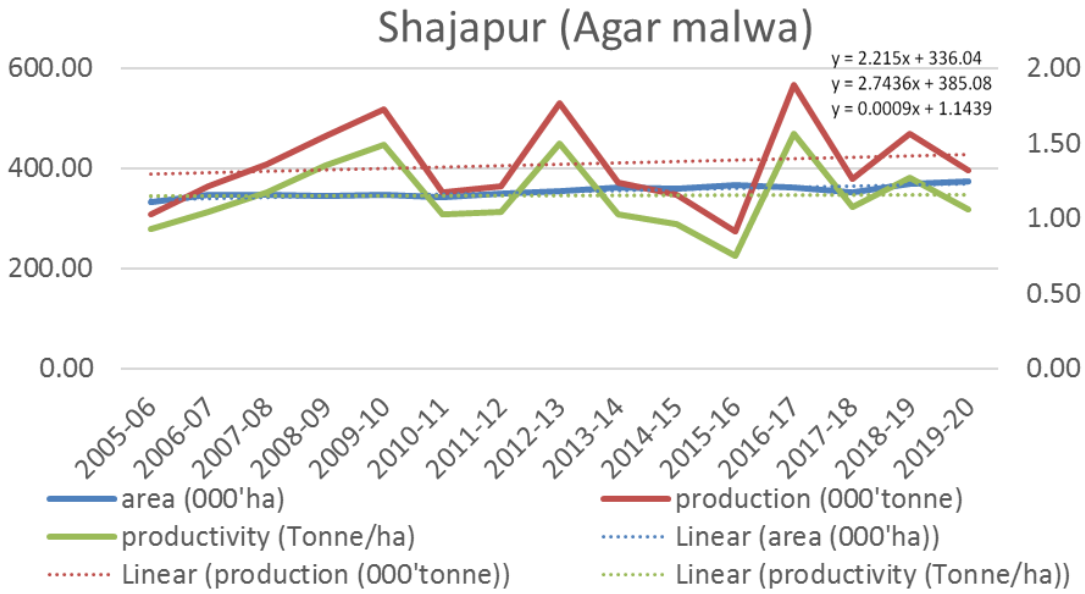


Fig.4.2.(H). Trend of area, Production and Productivity of Soybean in Indore District .

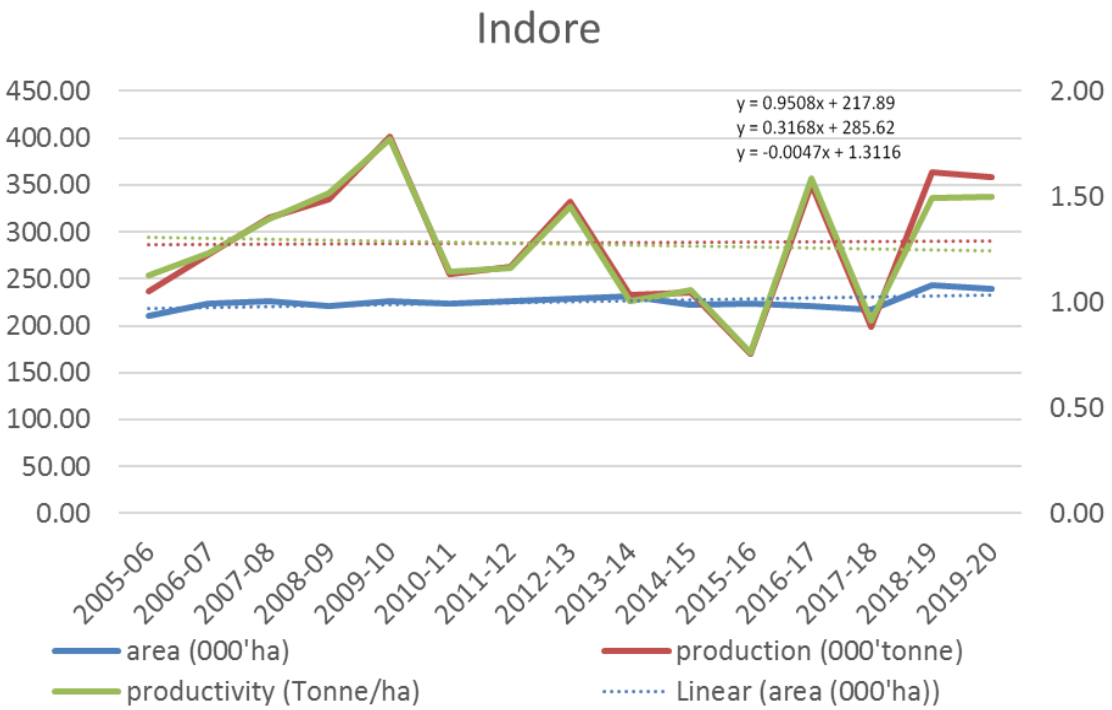


Fig.4.2.(I). Trend of area, Production and Productivity of Soybean in Neemuch district .

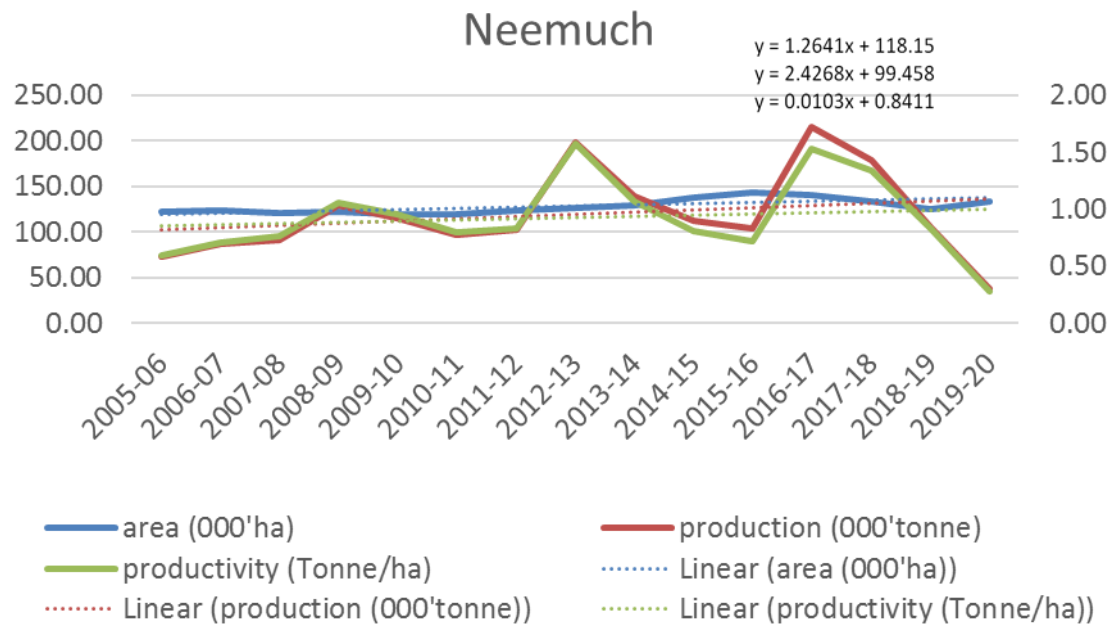
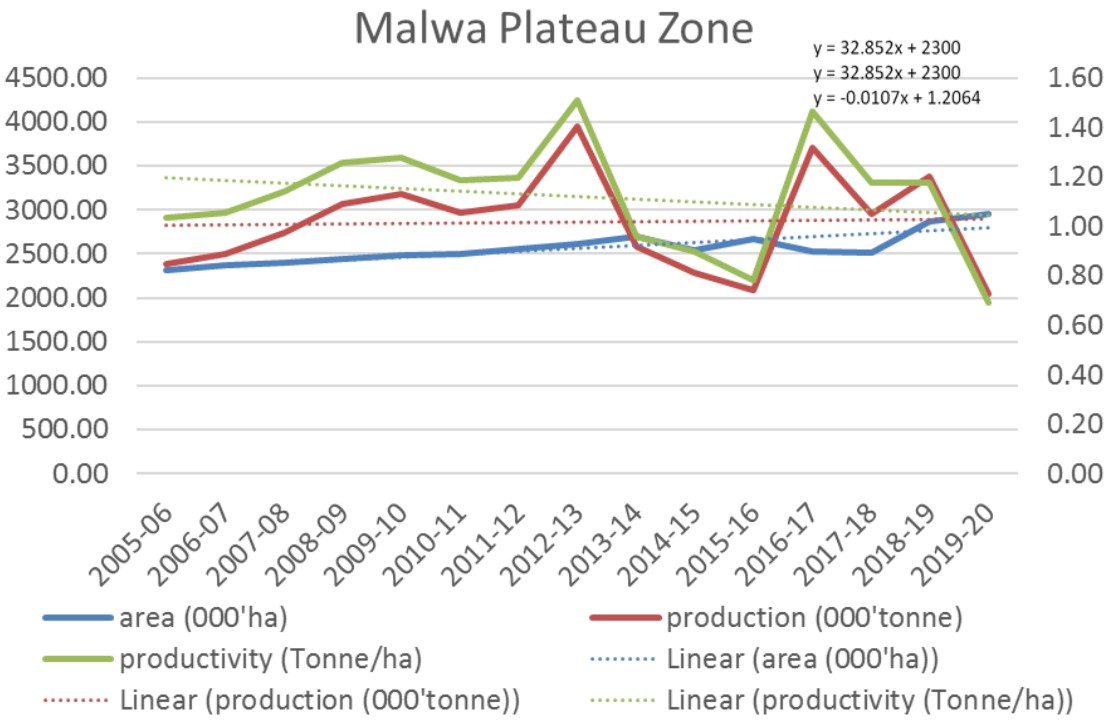


Fig.4.2.(J). Trend of area, Production and Productivity of Soybean in overall Malwa Plateau zone.



4.2.2. Simple growth rate of area, production and productivity of Soybean Crop

Table 4.2.2 shows the simple growth rate for soybean crop area, output, and productivity throughout Madhya Pradesh's Malwa Plateau Zone districts.

4.2.2.1 Area:-

Table 4.2.1 shows the simple growth rate for soybean crops in districts across the Malwa Plateau zone. According to the data, there was a positive and significant Simple Growth Rate in the area of Soybean crop in Rajgarh, Ratlam, Dewas, Dhar, Neemuch, Ujjain, Mandsaur, Shajapur (Agar Malwa), Indore, which shows an increase in area under the Soybean crop by (2.48%), (2.23%), (1.80%), (1.46%), (0.99%), (0.90%), (0.66%), (0.63%), (0.42%) respectively and for overall Malwa Plateau Zone was (1.28%).

4.2.2.2 Production:-

Simple growth rate of production was found to be positive for the districts of Neemuch, Ratlam, Dhar, Rajgarh, Shajapur (Agar Malwa), Mandsaur, Indore and the overall Malwa Plateau Zone of Madhya Pradesh, indicating an increase in production under the Soybean crop of (2.04 %), (1.63 %), (0.89 %), (0.72 %), (0.67 %), (0.30 %), (0.11%), (0.16%) and It was found to be negative for Dewas and Ujjain districts, respectively, indicating a decline in Soybean crop production of (-0.73 %) and (-1.66 %).

4.2.2.3 Productivity:-

Likewise the Simple Growth Rate for Productivity, it was found positive in Neemuch, Shajapur (Agar-Malwa), Mandsaur, and Ratlam, indicating an increase in Productivity under the Soybean crop of (1.12%), (0.07%), and (0.03%), respectively (0.02%) and it was shown to be negative for Indore, Dhar, Rajgarh, Ujjain, and Dewas, with decreases in production under the soybean crop of (-0.37%), (-0.52%), (-1.33%), (-2.43%), and (-2.44%), respectively, and it was also found to be negative and deteriorating for the total Malwa Plateau zone as well ie. (-0.95%).

Table 4.2.2: Simple Growth rate in area, production and productivity of Soybean Crop in Major Districts of Madhya Pradesh.

District's name	Simple Growth rate (In Percent)		
	Area ('000ha)	Production ('000MT)	Productivity (MT/ha)
Ujjain	0.90	-1.66	-2.43
Rajgarh	2.48	0.72	-1.33
Dewas	1.80	-0.73	-2.44
Dhar	1.46	0.89	-0.52
Mandsaur	0.66	0.30	0.03
Ratlam	2.23	1.63	0.02
Shajapur(AgarMalwa)	0.63	0.67	0.07
Indore	0.42	0.11	-0.37
Neemuch	0.99	2.04	1.12
Malwa Plateau Zone	1.28	0.16	-0.95
Other districts	1.03	-0.82	-1.73
Madhya Pradesh	1.15	-0.33	-1.30

As a result, we may infer that Rajgarh (2.48 %) has the highest simple growth rate for area, while Indore has the lowest (0.42 %). Similarly, in terms of production, Neemuch district (2.02 %) had the highest simple growth rate while Ujjain district had the lowest (-1.66 %). When we look at the basic growth rate for productivity, we find that it is highest in Neemuch and lowest in Dewas district (-2.44%).

4.3. Decomposition Analysis

To determine the area, yield, and interaction effect on soybean production.

It is commonly acknowledged that productivity and area influence production. In addition to area and yield, their interactions have an impact on output as a whole. The three impacts of the soybean crop on the study region are summarized in Table 4.3.1

4.3.1. Area effect, yield effect and interaction effect for area, production and productivity of Soybean crop across Major Districts of Madhya Pradesh

Decomposition analysis was carried out to find the contribution of area, yield and interaction effect across districts of Malwa Plateau zone of Madhya Pradesh.

It was observed that for ujjain district area effect was (-296.45%), yield effect was (349.33%) and interaction effect was (47.12%), Rajgarh district had area effect (229.22%) yield effect (-95.21%) and interaction effect was (-34.01%), Dewas district had area effect (5012.60%) yield effect (-3864.35%) and interaction effect (1048.25%), for Dhar district area effect was seen to be (-750.89%) yield effect (726.03%) and interaction effect was (124.86%), Mandsaur district had area effect (91.50%) yield effect (7.80%)and interaction effect was (0.70%), Ratlam district had area effect (89.98%) yield effect (7.37%) and interaction effect was (2.65%), for Shajapur (Agar Malwa) area effect was found to be (43.20%), yield effect (53.31%) and interaction effect was (3.49%), Indore had area effect (58.35%) yield effect (39.30%) and interaction effect was (2.35%), whereas for Neemuch district area effect was seen to be (27.05%) yield effect (67.82%) and interaction effect (5.13%). Now if we look into overall Malwa Plateau zone, it had area effect of (164.48%) yield effect (-54.77%) and interaction effect was (-9.71%).

Table 4.3: Area Effect, Yield Effect and Interaction Effect in area, production and productivity of soybean Crop in Major Districts of Madhya Pradesh.

District's name	Decomposition analysis			
	Area Effect (%)	Yield Effect (%)	Interaction Effect (%)	Absolute Change in Production ('000MT)
Ujjain	- 296.45 (64.03)	349.33 (-75.45)	47.12 (-10.17)	-24.23
Rajgarh	229.22 (97.69)	-95.21 (-40.57)	-34.01 (-14.49)	28.22
Dewas	5012.60 (95.36)	-3864.35 (-73.51)	-1048.25 (-19.94)	0.48
Dhar	-750.89 (0.22)	726.03 (-0.21)	124.86 (-0.03)	54.74
Mandsaur	91.50 (17.68)	7.80 (1.50)	0.70 (0.13)	12.05
Ratlam	89.98 (75.48)	7.37 (6.18)	2.65 (2.22)	65.06
Shajapur (Agar-Malwa)	43.20 (23.49)	53.31 (28.98)	3.49 (1.89)	54.08
Indore	58.35 (16.44)	39.30 (11.07)	2.35 (0.66)	30.64
Neemuch	27.05 (6.33)	67.82 (15.89)	5.13 (1.20)	23.44
Malwa Plateau	164.48 (450.67)	-54.77 (-150.07)	-9.71 (-26.60)	244.48
Other district	-170.70 (320.92)	240.98 (-427.46)	29.82 (-52.91)	-230.06
Madhya Pradesh	680.74 (747.15)	-505.27 (-554.27)	-75.73 (-83.12)	14.43

Magnitude Value in brackets

Thus from above observation we can discuss the following outcome:

Area Effect

The area effect was positive and maximum for Dewas district (5012.60%), and it was also positive for Rajgarh (229.22 %), Mandsaur (91.50 %), Ratlam (89.98 %), Indore (58.35 %), Shajapur(Agar Malwa) (43.20 %), Neemuch (27.05 %), and was negative and minimum for Ujjain (-296.45 %), and it was negative and minimum for Dhar district (164.48 %).

Yield Effect

It was found positive and maximum for Dhar district (726.23%) followed by Ujjain (349.33%), Neemuch (67.82%), Shajapur (Agar Malwa) (53.31%), Indore (39.30%), Mandsaur (7.80%), Ratlam 97.37%) whereas it was negative for (-95.21%) and (-3864.35%).

Interaction Effect

It was found to be positive and maximum for Dhar district followed by Ujjain (47.12%), Neemuch (5.13%), Shajapur (Agar Malwa) (3.49%), Ratlam (2.65%), Indore (2.65%), Mandsaur (0.70%) and was negative for Rajgarh (-34.01) and Dewas (-1048%).

SUMMARY AND CONCLUSION

Soybean (*Glycine max*) is the world's most important seed legume, which contributes to 25 % of the global edible oil, about two-thirds of the world's protein concentrate for livestock feeding. Soybean meal is a valuable ingredient in formulated feeds for poultry and fish. The soybean is an erect branching plant and can reach more than 2 metres (6.5 feet) in height. The self-fertilizing flowers are white or a shade of purple. Seeds can be yellow, green, brown, black or bicoloured, though most commercial varieties have brown or tan seeds, with one to four seeds per pod. Source: https://link.springer.com

It is considered major kharif crop Madhya Pradesh and has super headed economic potential. Madhya Pradesh has highest share when it comes to area (51.66%) under Soybean crop followed by Maharastra (33.21%), Rajasthan(8.74%) respectively but in terms of production Maharastra holds first position with 6262.96 '000 tonnes (49.67%) and Madhya Pradesh holds second position with 4264.69 '000 tonnes (33.82%) and when it comes to productivity surprisingly Madhya Pradesh ranks sixth position witch is 639.00 kg/hectare (Source:Ministry of Agriculture and Farmers Welfare, GOI) 2020-21.

It was seen that Malwa Plateau zone of Madhya Pradesh occupies the maximum area which was 3031.19 '000 hectare (48.94%) and also had maximum production which was found to be 1867.80 '000 tonnes (48.44%) and productivity of 11.05 tonne per hectare. (Source: Department of Farmer Welfare & Agriculture Development, M.P)

In Madhya Pradesh there are 11 Agroclimatic Zones out of these Malwa Plateau Zone was selected for study as it occupied highest area under Soybean. In the ongoing study 9 district of Malwa plateau zone were chosen viz. Ujjain, Rajgarh, Dewas, Dhar, Mandsaur, Indore, Ratlam, Shajapur (Agar-

Malwa), Neemuch and contributed 48.94% of total area under soybean of the state.

This study was based on secondary time series data for a period of 15 years from 2005-06 to 2019-20 which was obtained from the official website of Department of Agriculture Development and Farmer Welfare, M.P, Directorate of Economics & Statistics, DAC & FW, Food and Agriculture Organization.

The soybean area in M.P. is steadily rising, yet crop productivity is more or less stagnant and also was found to be decreasing in some districts of Malwa plateau zone necessitating the current study to provide explanations. What is the explanation for this? What are the farm's motivations? Do they keep up with soybean production technology at the farmer level? As a result, the current research aims to look at the following goals:

1. To examine the absolute change and relative change along with variability in area, production, and productivity of soybean across districts of Malwa Plateau Zone of Madhya Pradesh.
2. To evaluate the trend and growth rate of soybean production, area, and productivity.
3. To find out the role of area, yield, and interaction effects towards change in production of soybean.
4. To recommend policy implication based on the study's findings.

In order to diagnose the flowing objective making use of secondary time series data, econometrics and statistical tools such as absolute change, relative change, coefficient of variation, standard deviation, mean, trend, simple growth rate, and decomposition analysis were employed for the study.

Conclusion:

The study's findings are as follows:

- From ongoing result it could be concluded that 9 districts of Malwa Plateau Zone were selected for study of soybean crop.
- If we look into the absolute change and relative change, the area of soybean was found to have increased in all districts of Malwa Plateau Zone, but absolute change for production and productivity was not in increasing value means it was found to be decreased in some districts over the total study period.
- The highest increase of absolute change in area was in the Rajgarh district 97.27 '000 hectare whereas highest relative change and coefficient of variation in area was seen in Ratlam district 35.73% and 14.10% respectively over the total study period.
- Now we look into absolute change, relative change in production it was found to be positive and maximum for Ratlam which was 65.06 '000 hectare and 30.88% but coefficient of variation was highest for Neemuch district (39.88%).
- Absolute change and relative change for production was found to be negative and declining only for Ujjain district which was -24.23 '000 hectare and -5.10% respectively whereas variability was minimum for Dhar district (17.93%).
- Absolute change in productivity was maximum for Mandsaur district (0.21) tonne/hectare, relative change and Coefficient of variation was seen maximum for Neemuch district which was 18.97% and 37.41% respectively.
- Surprisingly absolute change and relative change for productivity were found to be negative in districts viz. Dhar, Rajgarh, Ujjain, Dewas district (-0.03, -0.15, -0.18, -0.26) '000 hectare (-2.52%, -14.84%, -15.90%, -20.91%) respectively.

- For overall Malwa Plateau Zone absolute change for area, production and productivity was 418.11 ‘000 hectare, 244.48 ‘000 metric tons, -0.06 tons/hectare respectively. Whereas relative change for area, production and productivity was (17.73%, 9.61%, -5.90%) respectively and coefficient of variation for area, production and productivity was 6.85%, 19.67%, 20.20%.
- The value of regression coefficient and growth rate of area for the soybean crop were highly significant and positive at 1% and 5% in all the 8 districts out of selected 9 districts, whereas it was non-significant for Mandsaur district.
- Although value of regression coefficient and growth rate of area was positive and significant but if we look into the value of regression coefficient and growth rate for production and productivity it was surprisingly found to be non significant for all the district and negative for some district.
- For production regression coefficient and growth rate was positive and non significant for 7 districts out of 9 selected districts viz. Ratlam, Dhar, Shajapur (Agar-malwa), Neemuch, Rajgarh, Mandsaur, Indore and for other 2 district it was negative and non significant namely Dewas and Ujjain.
- Now from the productivity point of view value of regression coefficient and growth rate was non-significant and posive for Neemuch, Shajapur (Agar-malwa), Mandsaur, Ratlam district but it was non significant and negative for rest 5 districts.
- Now if we look into the decomposition analysis under Area, Yield and Interaction Effect were calculated for change in production.
- Highest area effect was seen for Dewas district (5012.60%) whereas lowest was for Dhar district (-750.89%).
- Yield effect and interaction effect was found to be highest for Dhar

district (726.03%, 124.86%) and lowest was seen for Dewas district (-3864.35%, -1048.25%).

- Area, Yield and Interaction Effect for overall Malwa Platau Zone was (164.48%), (-54.77%), (-9.71%) respectively

5.4 Policy implication & Suggestions

- Due to changes in weather and rainfall conditions, soybean production in the state is fraught with significant levels of uncertainty. However, because of inherent risk and price fluctuations, soybean is also subject to risk and unpredictability in terms of returns, so farmers should be given crop insurance by the government, new resistant varieties should be developed distributed to farmers.
- High yields and yield stability, along with guaranteed selling facilities are crucial elements in deciding the shift of area under alternative crops if the intended increase in soybean production is achieved and the price guarantee scheme for this commodity is made more effective. Therefore, soybean pricing should not only be fair but also enticing enough to prevent the area from switching to other crops suddenly.
- Soybean cultivation has been taking place for the past 35 years that has resulted in a decline in the quality of the seeds. They are prone to seedling disease. There has been a decline in yield. It is going to be loss making venture means earlier soybean used to be boon for farmers now it is bane, so government should start encouraging farmers to shift to other cash rich kharif crops like pulses or other horticultural crops to gain profit.
- The desired increase in the production of soybean is attained and the price guaranty programme for this crop is made more effective then, high yields and stability in yields together with assured marketing facilities are important factors in determining the shift of area under different crops. Hence, prices offered to soybean should not only be reasonable but also

be attractive enough so that area switch over to other crops can be checked.

- The relevant agencies may conduct a thorough investigation to pinpoint the unique issues affecting soybean production in the various agroclimatic zones and various districts of the state. Additionally, it is recommended that thorough problem-focused research procedure is carried out so that suitable and financially viable packages of cultivation practices can be developed and strongly suggested for different soybean producing districts individually, taking into account the fluctuation in the climatic and soil nature and available resource with the soybean producers.
- Since there is no way to expand area, it is advised that average soybean output and productivity be enhanced by offering training and demonstrations. The average soybean area was found to rise over the research period, but production and productivity tended to drop.
- As farmers can't switch to other crops suddenly they should be taught the technological advancements and new techniques so that till the time they switch to other crops they survive by gaining decent amount of profit in soybean cultivation.

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APPENDICES

SD	Standard Deviation
Σ	Summations
SE (b)	Standard error of b
±	Plus Minus
i.e	There fore
%	Percentage
et al.,	And others
Ha.	Hectare
MT	Metric tons
MT/ha	Metric Tons Per hectare
( )	Brackets
Kg	Kilogram
Kg/ha-1	Kilogramperhectare
Per Annum	By The Year
3√x	Cuberoot
√2	Squareroot
&	And

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- Agricultural Production Economics

For the partial fulfillment of the master's degree programme, I was allotted a research problem on ***"*Growth Performance of Soybean Production Across Districts of Malwa Plateau Zone (M. P.)*"*** which has been conducted by me and being submitted in the form of the thesis.