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Babita Baghel
Department of Agricultural Economics, RVSKVV, Gwalior, Madhya Pradesh, India

Shalini Mishra
Department of Agricultural Economics, RVSKVV, Gwalior, Madhya Pradesh, India

PK Makviya
Department of Agricultural Economics, CoA, Indore, RVSKVV, Gwalior, Madhya Pradesh, India

Corresponding Author:
Babita Baghel
Department of Agricultural Economics, RVSKVV, Gwalior, Madhya Pradesh, India

Sources of growth and instability of cotton and castor crops in Madhya Pradesh (India)

Babita Baghel, Shalini Mishra and PK Makviya

Abstract
The study investigates that the growth, its contribution and variation in area, production and productivity of cotton and castor crops in Madhya Pradesh. The study confined to secondary time series data from 1991-92 to 2020-21 was divided into four periods *viz*., period- I (1991-2001), period-II (2001-2011), period-III (2011-2021) and over all period (1991-2021). The data was collected from various sources *viz*., Directorate of Economics and Statistics, New Delhi, GoI., Directorate of oilseed crops, Bhopal, Agriculture Statistical yearly data books and Directorate of Agriculture, cooperation and farmer's welfare, M.P. etc. The compound growth rate and instability in area, production and productivity of cotton and castor crops were calculated by using exponential growth function and Cuddy Della Index (Cuddy and Della, 1965). It was revealed that throughout the study period, the growth performance of cotton was reported significant increase in area with the magnitude of 1.86 per cent however, production and productivity seen increasing growth rate of 18.85 and 16.68 per cent per annum whereas, in castor the compound growth rate in area, production and productivity were found to be negative and non-significant at the rate of -1.37, -2.73 and -1.37 per cent per annum, respectively in Madhya Pradesh state. It was revealed that during entire study period, yield effect in cotton crop was found to be more dominant at the rate of 558.39 per cent than the area effect (74.53%). Per cent contribution in castor was on served that the interaction effect (321.19%) was reported primary contributor than the area effect (145.83%). The results of instability analysis revealed that the highest variation was observed in production of both the crops the crops (Cotton and Castor) whereas, lowest degree of instability was found in productivity.

Keywords: Exponential function, compound growth and cuddy Della Valle index

Introduction
Cotton and castorwere the most popular textile raw materials and also the cash crops. Cotton referred to as the 'King of Fibre' or 'White Gold'. In worldwide scenario, cotton is grown in over 120 countries among which India holds the largest area (34%) and attained the status of world's largest cotton producer. Cotton plays a dominant role in the industrial and agricultural economy of the country. Globally, the area under cotton was 32.10 million hectares, production accounts for 257.71 million bales and productivity of 1370 kg/ha during 2021-22. India is also largest producer of cotton in the world and producing countries in term of both total area and production. Among the major cotton producing countries in the world, India occupied 1st position with 68.71 million bales. (Estimate report-2021). About 60 million peoples including 15 million cultivators get employment directly or indirectly in the agricultural and industrial sector related to cotton production, processing and textile. By way of cotton exports, the foreign exchanges in 2015-16 alone with amount of Rs. 12.821 crores. Madhya Pradesh tops the organic cotton producer's chart with 38% of the total production during the last 5 years followed by Odissa (20%), Maharashtra (19%), Gujarat (15%) and Rajasthan (8%) are the major organic cotton producer's (Pavithra, *et al.*, 2022) [8]. In Madhya Pradesh cotton is grown more than 404.08 thousand hectares with an annual production of 312.03 lakh tonnes 180 Kg/bales. (Anonymous, 2021-22) [1, 2]

Castor bean is one of the prominent industrial oilseed crop grown in India. It is confined to mostly Gujarat, Rajasthan and Andhra Pradesh. Cotton is also grown on a limited scale in the states of Karnataka, Tamil Nadu, Maharashtra, Orissa and Madhya Pradesh. (Padmaiah, M. 2014) Castor is a non-edible vegetable oilseed crop cultivated overall the world. Indian is the largest producer and exporter of the castor oil. Castor is an important feed stock for the chemical industry which is utilized for biodiesels. It is used for the production of lubricants, hydraulic, brake fluid, coating fertilizer, soaps, waxes and grasses. Castor oil is mostly utilized as economically important seed oil in the world. Castor seed comprises about 40-55% oil, and kernel contains 64-71% oil which is the highest among cultivated oil crops.

(Chakrabarty, *et al*., 2021) Castor crops have registered positive and high growth rates and rapeseed mustard registered higher rate of production. The higher productivity driving the production and area expansion of castor is the best situation for oilseeds cultivation.

Cotton can be cultivated in the both Kharif and Zaid season in Madhya Pradesh. Total area of cotton in Madhya Pradesh id 588.00 thousand tonnes, production 1338.56 lakh tonnes and productivity 387.00 kg/ha. (Anonymous, 2022)

Castor can be cultivated in the Kharif season in Madhya Pradesh. Total area of castor in Madhya Pradesh is 1.00 thousand tonnes, production 0.32 lakh tonnes and productivity 324 kg/ha. Castor is one of the oldest cultivated crops it contributes to only o.15 of the vegetable oil produced in the world. According to government 3rd advance estimate, all India castor production in India 2020-21 is at 17.74 lakh tonnes. (Anonymous, 2022) [2].

Methodology

The study was based on secondary time series data collected from various sources i.e. Directorate of Economics and Statistics (DES), Gol., Directorate of Agriculture, cooperation and Farmer's Welfare, Madhya Pradesh, Directorate of Cotton Development, Bhopal, E-cotton data book published by ICAR, New Delhi, etc.,of 30 years of data of area, production and productivity of cotton and castor crops had been taken from 1991-92 to 2020-21 which was further divided into four periods namely period-I (1991-2001), period-II (2001-2011), period-III (2011-2021) and overall period (1991-2021). Two different analyses had been carried out to calculate Compound Growth Rate and instability analysis decade wise to study the growth performance in area, production and productivity of cotton and castor crops and instability. Compound growth rates (CGR) of area, production and productivity of cotton and castor crops were worked out for different periods as well as for entire study period to analyse growth by fitting exponential trend function and Cuddy-Della Valle index. The study was restricted only on Kharif season and two fibre and oilseed crops i.e., cotton and castor.

Compound growth rate

Compound annual growth rate was estimated to know the growth pattern on area, production and productivity of cotton and castor crops in Madhya Pradesh. The growth rate was estimated by using exponential trend model.

Exponential trend equation: $Y = ab^t$

The logarithmic form of the equation as given below:

$$\text{Log } Y = \log a + t \log b$$

Where, Y = area/production/yield
a = Intercept
b = regression coefficient / (1 + r)
t = Time
r = Compound growth rate / (Antilog b) -1
The per cent compound growth rate (r) would be;

$$r = [(\text{Anti log of } b) - 1] \times 100$$

Student 't' test would be used for testing significance level of growth in area, production and productivity of selected oilseed crops:

$$t = \frac{CGR}{SE\ (CGR)}$$

Where,
't' = Student 't' test
CGR = Compound growth rate
SE (CGR) = Standard error of Compound growth rate
Standard error of Compound growth rate was calculated by using following formula;

$$SE\ (CGR) = \frac{100b}{\ln 10} \text{ x } SE\ (\ln b)$$

Decomposition analysis

To study the contribution of area, yield and interaction effect to words increased the cotton and castor production in Madhya Pradesh, decomposition was used as expressed below: (Minhas and Vaidyavanthan, 1965) [7].

$$\Delta P = AB^* \Delta Y + Y\Delta^*\Delta A + \Delta A^*\Delta Y$$

= (yield effect) + (area effect) + (Interaction effect)
Where,

$\Delta A = AC - BC$, $\Delta P = PC - PB$, $\Delta Y = YC - YB$

AB, PB and YB were the area, production and yield of oilseed for the base year.
AC, PC and YC were the area, production and yield of oilseed for the current year.
ΔA = change in area, ΔP = change in production, ΔY = change in yield

Instability

The instability index was calculated using better measure of variability suggested by Cuddy-Della Valle index (Cuddy and Della, 1978) [6];

$$\text{Instability Index} = CV * \sqrt{(1 - R^2)}$$

Where,
CV = Coefficient of Variation
R = Coefficient of determination

Result and Discussion

The compound growth rate analysis of area, production and productivity was examined the performance of individual commodities contributing to agricultural production. The compound growth rate of area, production and productivity of cotton crop during the period from 1991-92 to 2020-21 were computed and presented in Table No. 1.

Table 1: CAGR of area, production and productivity of cotton in Madhya Pradesh (1991-92 to 2020-21) (In per cent)

Periods	Area	Production	Productivity
Period-I (1991-2000)	-0.96 (0.006)	3.51 (0.028)	3.99 (0.030)
Period-II (2001-2010)	4.47* (0.004)	8.89 (0.024)	2.57* (0.023)
Period-III (2011-2020)	0.23 (0.010)	-5.81 (0.017)	-5.81 (0.017)
Overall Period (1991-2020)	1.86* (0.002)	18.85 (0.006)	16.68 (0.006)

Sources: Author's own computation of compiled time series data.
Note: Figures in parenthesis were standard error of selected growth model.
*Significant at 1 per cent level of significant and **Significant at 5 per cent level of significance.

During overall study period, it was revealed that the growth performance was reported significant increase in area with the magnitude of 1.86 per cent however, production and productivity of cotton was observed increasing growth rate of 18.85 and 16.68 per cent per annum, respectively. During period-I, growth performance of cotton in area showed negative and non-significant growth at the rate of -0.96 per cent while, production and productivity were observed positive and non-significant growth with the magnitude of 3.51 and 3.99 per cent, respectively. During period-II, in all the aspect *viz.*, area, production and productivity showed positive growth pattern accounts for about 4.47, 8.89 and 2.57 per cent per annum, respectively at the same time, area and productivity were found to be increased significant growth performance. During period-III, the production and productivity of cotton declined non-significantly at the rate of -5.81 and -5.81 per cent whereas, area showed positive and non-significant growth rate of 0.23 per cent per annum. Similar finding were found in study of Amod, S. (2015) [4] in his study paper named growth and variability in area, Production and yield of cotton crop, during period 1949-2012.

Table 2: CAGR of area, production and productivity of castor crop in Madhya Pradesh (1991-92 to 2020-21) (In per cent)

Periods	Area	Production	Productivity
period- (1991-2000)	-2.50 (0.061)	-24.84** (0.049)	-22.73** (0.042)
Period-II (2001-2010)	-19.09* (0.024)	-17.69** (0.033)	1.39 (0.014)
Period-III (2011-2020)	15.61 (0.112)	10.92 (0.123)	-4.06 (0.007)
Overall (1991-2020)	-1.37 (0.016)	-2.73 (0.018)	-1.37 (0.007)

Sources: Computation of author's own compiled time series data
Note: Figures in parenthesis are standard error of selected growth model
*Significant at 1 per cent level of significant and ** Significant at 5 per cent level of significance.

It was observed from the above table that during entire study period, the compound growth rate in area, production and productivity of castor was found to be negative and non-significant at the rate of -1.37, -2.73 and -1.37 per cent per annum, respectively. During study period-I, the growth performance in area, production and productivity were declined at the rate of -2.50, -24.84 and -22.73 per cent per annum, respectively. In the similar time period, area was decreased non-significant growth whereas, production and productivity were observed significant growth pattern. During period-II, the compound growth rate in area and production of castor were decreased significantly at the rate of -19.09 and 17.69 per cent per annum whereas, productivity (1.39%) was observed positive and non-significant indicates that the productivity was seen increased due to use of high yielding varieties by the farmer's. During period-III, the growth in area, production and productivity of castor were decreased at the rate of -1.37, -2.73 and -1.37 per cent per annum. Similar finding were observed by Ramoliya, *et al.*, (2022) [9] growth and instability of oilseed crops in Gujarat and Tiwari, *et al.*, (2020) reported in his research work entitled growth and instability in castor oil export from India.

Decomposition analysis

The relative contribution of area, yield and their interaction effects to the total output growth of cotton and castor crops were presented in table given below:

Table 3: Per cent contribution of area, yield and interaction effect on production of cotton in Madhya Pradesh (1991-92 to 2020-21) (In per cent)

Periods	Area effect	Yield effect	Interaction effect
Period-I (1991-2000)	44.48	28.30	27.22
Period-II (2001-2010)	88.19	7.30	4.51
Period-III (2011-2020)	-1.56	83.02	18.54
Overall (1991-2020)	74.53	558.39	-532.92

Sources: Author's own computation from complied time series data

It was observed from table No.3, during throughout the study period, yield effect was found to be more dominant at the rate of 558.39 per cent than the area effect (74.53%). During period-I, all aspects *viz.*, area effect (44.48%) was reported more dominant than the yield and interaction effects were found to be responsible factors in increasing the production of cotton at the rate of 28.30 and 27.22 per cent, respectively. During period-II, similar finding were found as in period-I, it was observed that the area effect (88.19%) was the major contributor in increasing production followed by yield effect (7.30%) and interaction effect (4.51%). During period-III, yield effect (83.02%) was found to be more instrumental as compared with interaction effect (18.56%).

Table 4: Per cent contribution of area, yield and interaction effect on production of castor in Madhya Pradesh (1991-92 to 2020-21) (In Per cent)

Periods	Area effect	Yield effect	Interaction effect
Period-I (1991-2000)	332.76	-1144.78	912.02
Period-II (2001-2010)	0.73	119.09	-19.82
Period-III (2011-2020)	145.63	1516.87	-1562.50
Overall (1991-2020)	145.83	-277.04	231.19

Sources: Author's own computation from complied time series data

Per cent contribution of area, yield and their interaction effects on production of castor crop in Madhya Pradesh was shown in Table No. 4. Throughout the study period, interaction effect (231.19%) was observed prime contributor than the area effect (145.83%). During period-I, interaction effect (912.02%) was observed more instrumental to increase the production as compared with area effect (332.76%). During period-II, the yield effect (119.09%) was found to be more dominant and area effect was recorded very little contribution with 0.73 per cent. During period-III, yield effect (1516.87%) was found to be major contributor to uplift the production followed by area effect (145.63%).

Instability analysis

Results of mean, compound growth rates and coefficient of variation were used to measure the instability in area, production and productivity of cotton and castor crops in Madhya Pradesh in four different periods had been presented and Discussion in this section.

Table 5: Instability of area, production and productivity of the cotton in Madhya Pradesh (1991-92 to 2020-21) (In per cent)

Periods	Area	Production	Productivity
Period-I (1991-2000)	47.27	50.92	33.04
Period-II (2001-2010	19.54	23.21	11.21
Period-III (2011-2020)	79.45	80.25	19.24
Overall (1991-2020)	83.45	90.53	35.08

Sources: Computation of author's own compiled time series data.

It was observed from the Table No. 5, during entire study period, instability in area, production and productivity were observed 83.45, 90.53 and 35.08 per cent, respectively. During period-I, highest variation was found in production (50.92%) followed by area (47.27%) and productivity (33.04%). The production of Cotton during the overall period (1991-2020) and period III-(2011-2020) shows the highest degree of instability at the rate of 90.53 and 80.25 per cent. Fluctuations in area and production of Cotton are interrelated as a wider area driven by greater production. But lowest variation in productivity showed due to weather conditions, technological changes, *etc.* During period-II, highest instability was found in production (23.21%) than the area (19.54%) and productivity (11.21%). Excluding the whole period, the highest instability was observed in production and lowest instability was found in productivity of Cotton in period-II and period-III (2011-2020). During period-III, maximum variation was observed in production (80.25%) followed by area (79.45%) and productivity (19.24%). During the all the periods and whole period, production reflects higher degree of instability at the same time productivity reported a remarkable degree of instability i.e. lower as compared with area and production.

Table 6: Instability of area, production and productivity of the castor in Madhya Pradesh (1991-92 to 2020-21) (In per cent)

Periods	Area	Production	Productivity
Period-I (1991-2000)	47.27	19.54	33.04
Period-II (2001-2010)	50.92	23.21	11.21
Period-III (2011-2020)	33.04	11.21	19.24
Overall (1991-2020)	83.97	90.53	35.08

Sources: Author's own computation from complied time series data.

The instability of Castor in area, production and productivity were shown in Table No. 6. During entire study period, instability in area, production and productivity were observed 83.97, 90.53 and 35.08 per cent, respectively. At the same time, production of Castor shows the highest degree of instability and lowest degree of instability was found in productivity of castor. During period-I, highest variation was observed in area (47.27%) followed by productivity (33.04%) and production (19.54%). But fluctuations in variation in area, production and productivity may be due to weather conditions, technological changes, *etc.* Excluding the whole period area and production showed the highest instability. During period-II and period-III, highest variation were observed in area at the rate of 50.92 and 33.04 per cent however, at the same time, lowest variation were observed in productivity (11.21%) in period-II and production (11.21%) in period-III.

Conclusion

The present study was found that throughout the study period, the growth performance in cotton crop was reported significant increase in area however, production and productivity were observed increasing growth rate whereas, in castor the compound growth rate in area, production and productivity were found to be negative and non-significant in Madhya Pradesh state. It was revealed that during overall study period, in cotton yield effect was found to be more dominant that the area effect and per cent contribution in castor was observed that the interaction effect was observed prim contributor than the area effect. The results of instability analysis revealed that the same time, production of castor and cotton crops show the highest degree if instability and lowest degree of instability was found in productivity.

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