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Research Paper

Rabi Pulse Crops Cultivation in Madhya Pradesh (India): Growth and Decomposition Analysis

Shalini Mishra[1*], H.K. Balai[2] and P.K. Malviya[2]

[1]Department of Agricultural Economics, CoA., RVSKVV, Gwalior, Madhya Pradesh, India
[2]Department of Agricultural Economics, CoA., Indore, RVSKVV, Gwalior, Madhya Pradesh, India

*Corresponding author: mshalini209@gmail.com (**ORCID ID:** 0009-0002-3317-6961)

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ABSTRACT

This study analyses growth performance and relative contribution of area, production and productivity of major *rabi* pulse crops i.e. chickpea and lentil crops in Madhya Pradesh. The secondary time series data used for the study were collected from various publications of Government departments for thirty years period from 1991-92 to 2020-21, which was further segregated decade wise into three periods namely Period-I (1991-92 to 1999-2000), Period-II (2001-02 to 2009-10) and Period-III (2011-12 to 2020-21). The exponential trend model was used to measure growth rates of area, production and productivity of *rabi* pulse crop and the relative contributions of factors of production were measured by principle decomposition model. The study indicated growth rates of area, production and productivity of chickpea at the rate of 1.62, 5.68 and 3.99 per cent, respectively, whereas, for lentil the magnitude of growth were 1.86, 7.40 and 5.44 per cent, respectively. However, growth of area only observed to be significant in both the crops (chickpea and lentil). During entire study period, it was seen that yield effect was found to be more instrumental than the area and their interaction effects to increase the total production of both the crops.

HIGHLIGHTS

- As shown in entire study period, the area of both the pulse crops i.e. chickpea and lentil was reported positive and significant growth pattern.
- Yield effect was more dominant than the area and their interaction effects to uplift the total output of both the *rabi* pulse crops i.e., chickpea and lentil.

Keywords: Compound Annual Growth Rate, Decomposition Analysis, *Rabi* Pulse Crops

A variety of crops like cereals, pulses, oilseeds, fruits, vegetables, medicinal, aromatic, spices, fiber and sugar crops etc. are produced in India out of which the most important commercial crops are the pulse crops. Main pulse crops grown in our country are chickpea, pigeon pea, green gram, black gram, lentil, horse gram, garden and field pea. Pulse crops contain useful proteins, carbohydrates, essential vitamins like A, D, E, K minerals and fatty acids that's why these are commonly known as "poor man's meat" or "rich man's vegetable" (Balai *et al.* 2021). These are having high nutritional values and traditionally integrate in the farming occupation as sustainable agriculture. Although, due to leguminous nature, it improves soil fertility by fixing atmospheric nitrogen into the soil, increases the porosity because of having tap root system, low water requirement and capacity to withstand in adverse weather conditions. (Anonymous, 2022). It is worth to note that it is of great significance for human health, the UN announces 2016 as an "International year of Pulses" and 10th of February

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began to be celebrated as "World's Pulses Day" (Balai *et al.* 2021).

In India, pulse crops were cultivated over 28.78 million hectares area along with 25.46 million metric tonnes of production and 1130 kg/ha productivity in the year 2020-21. Pulse crops accounts for about 20% of area under food grains and contributes 7-10% of total food grain production in the country. Though pulse crops grown in both *kharif* and *rabi* seasons, only *rabi* crops contribute more than 60% of the total production. Among all the major pulse crops, chickpea is the most dominant having share of around 40% (11.91 million tonnes) of the total production, productivity reported at the rate of 1192 kg/ha and area accounts for about 9.99 million hectares whereas, lentil accounts 1.49 million tonnes in production, 1.47 million hectares area with the productivity of 1014 kg/ha (Anonymous, 2021).

Madhya Pradesh state dominates in the production of pulse crops with more than 8 million tonnes production (around 20% of the total production) followed by Rajasthan (17%), Maharashtra (15%), Uttar Pradesh (10%) and Karnataka (8%). The *rabi* pulse crops namely chickpea and lentil are grown throughout the Madhya Pradesh state. The production of lentil and chickpea accounts for about 32.14 and 6.15 lakh tonnes and covered an area of 21.60 and 5.42 lakh hectares whereas, productivity reported 1488 and 1135 kg/ha, respectively. Though few studies (Balai *et al.* 2021; Sood *et al.* 2020; and Bairwa *et al.* 2020) are available, there are dearth of literature for Madhya Pradesh state to guide the researchers and policy makers to frame improved practices, varieties and technologies at the state level. Therefore, Madhya Pradesh state was selected for the study aiming to measure the growth and relative contribution of factors of production of *rabi* pulse crops.

MATERIALS AND METHODS

The research work was carried out based on secondary time series data of area, production and productivity of *rabi* pulse crops using the data collected from different sources i.e. Directorate of Economics and Statistics, Government of India, Directorate of pulses development Board Bhopal, various issues of Agricultural Statistical yearly book, E-pulses data book by ICAR, New Delhi and Agriculture Statistics at a Glance, etc. The data had been collected for 30 years during 1991-92 to 2020-21 which was decade wise segmented into three periods namely Period-I (1991-92 to 1999-2000), Period-II (2001-02 to 2009-10) and Period-III (2011-12 to 2020-21) and overall periods. CGAR (Compound annual growth rates) in area, production and productivity for fitting the exponential trend model and relative contribution of area, yield and their interaction effects towards the total change in output with respect to individual pulse crop of selected *rabi* pulse crops (like lentil and chickpea) in Madhya Pradesh were computed for various periods as well as for overall period.

Compound Annual Growth Rates

CAGR was estimated to know the growth pattern in area, production and productivity of major Rabi pulse crops in Madhya Pradesh by using exponential trend model (Balai *et al.* 2021).

Exponential trend equation: $Y = ab^t$

The CAGR was being obtained for the logarithmic form of the equation given as follows:

$$log\ Y = log\ a + t\ log\ b$$

Where,

Y = Area/production/productivity

a = Intercept

b = Regression coefficient

t = Time

Compound growth rate (r) was expressed in percentage as given below;

$$r = [(Antilog\ b) - 1] \times 100$$

Student 't' test was applied for testing the level of significance of growth in area, production and productivity of selected *rabi* pulse crops (Balai *et al.* 2021).

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

Where,

't' = Student 't' test

CAGR = Compound growth rate

SE (*CAGR*) = Standard error of compound growth rate

Standard error of CGR was estimated by using the formula (Rao *et al.* 1981):

$$SE(CAGR) = \frac{100b}{In10} \times SE(In\ b)$$

Decomposition Analysis

To examine the relative contribution in area, yield and their interaction effects towards change in the total output of selected *rabi* pulse crops production in Madhya Pradesh, a principle decomposition model was used which was given below; (Minhas and Vidhyanthan, 1965):

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

$$= (Yield\ effect) + (Area\ effect) + (Interaction\ effect)$$

Where, $\Delta A = AC - AB$

$\Delta P = PC - PB$

$\Delta Y = YC - YB$

AB, *PB*, *YB* and area *AC*, *PC*, *YC* are the area, production and productivity of selected *rabi* pulse crops for the base year and for the current year respectively.

ΔA = change in area

ΔP = change in production

ΔY = change in yield

RESULTS AND DISCUSSION

Compound Annual Growth Rates:

The CAGR in area, production and productivity of selected *rabi* pulse crops (lentil and chickpea) were analyzed during 1991-92 to 2020-21. Chickpea and lentil crops were the most important Rabi pulse crops cultivated in Madhya Pradesh state. The results of CAGR in area, production and productivity of chickpea and lentil pulse crops in Madhya Pradesh are depicted in Table 1 and 2.

It is observed from the results that the CAGR of chickpea crop showed significant increase in area with the magnitude of 1.62 per cent while the production and productivity showed positive but non-significant growth pattern at the rate of 5.68 and 3.99 per cent throughout the study period. The chickpea crop in Madhya Pradesh during period-I observed the positive but non-significant growth pattern in area and production at the rate of 0.46 and 4.71 per cent whereas, productivity growth was found to be 4.23 per cent and significant . However, in period-II the area showed significant CAGR of 4.23 per cent while production and productivity reported positive but non-significant CAGR at the rate of 6.91 and 2.57 per cent, respectively. During period-III, the area and production revealed declined rate of growth to the extent of -7.74 and -0.23 per cent in which only area showed significant growth rate while, productivity growth was positive and significant with the magnitude of 8.14 per cent. Similar findings were observed by Balai *et al.* (2021) in his research on growth performance in area and production of chickpea in India during 1998 to 2018.

Table 1: CAGR in area, production and productivity of Rabi pulse crop in Madhya Pradesh (In per cent)

Periods	Chickpea		
	Area	Production	Productivity
Period-I (1991-2000)	0.46 (0.012)	4.71 (0.019)	4.23** (0.010)
Period-II (2001-10)	4.23** (0.008)	6.91 (0.021)	2.57 (0.016)
Period-III (2011-20)	-7.74** (0.019)	-0.23 (0.018)	8.14* (0.00)
Overall Period (1991-2020)	1.62** (0.003)	5.68 (0.004)	3.99 (0.003)

Source: *Author's calculations.*

Note: *Figures in parenthesis indicates standard error of growth model.*

**Significant at 1 per cent level and **Significant at 5 per cent level.*

CAGR performance of lentil crop in Madhya Pradesh in entire study period contributes the positive significant growth in area at the rate of 1.86 per cent, while in production and productivity contributes the positive but non-significant growth with the magnitude of 7.40 and 5.44 per cent, respectively. During Period-I, the growth performance in area and production were found to be increased significantly at the rate of 10.41 and 9.90 per cent however, productivity showed decline in growth at the rate of -0.46 per cent but it was non-significant. During Period-II, the positive significant CAGR of 3.99 per cent was depicted

in area while, production indicates the positive growth rate with the magnitude of 0.46 per cent and negative growth rate with -3.39 per cent magnitude was seen in productivity in which both production and productivity showed non-significant growth pattern. During Period-III, area reported negative but significant growth at the rate of -7.32 per cent, while, production showed positive but non-significant growth with the magnitude of 14.02 per cent and productivity accounts significant increased growth rate of 23.03 per cent. Similar findings were observed by Balai *et al.* (2021) in the study based on growth and decomposition of major pulse crops in Karnataka during 1988-2018. Bairwa *et al.* (2020) in his investigation reported almost similar pattern of growth rates in area, production and productivity of chickpea in India during 1998 to 2018. Ahmad *et al.* (2018) reported in his research work based on growth rate of area of total pulse crops (lentil) in Eastern India from 2000-01 to 2015-16.

Table 2: CAGR in area, production and productivity of *rabi* pulse crop in Madhya Pradesh (In per cent)

Periods	Lentil		
	Area	Production	Productivity
Period-I (1991-2000)	10.41* (0.008)	9.90** (0.013)	-0.46 (0.007)
Period-II (2001-10)	3.99** (0.007)	0.46 (0.020)	-3.39 (0.020)
Period-III (2011-20)	-7.32** (0.015)	14.02 (0.033)	23.03* (0.021)
Overall Period (1991-2020)	1.86* (0.003)	7.40 (0.005)	5.44 (0.005)

Source: *Author's calculations.*

Note: *Figures in parenthesis indicates standard error of growth model.*

**Significant at 1 per cent level and **Significant at 5 per cent level.*

Decomposition Analysis

The relative contribution of area, yield and their interaction effects to the total output growth of chickpea crop is presented in Table 3. Throughout the study period, the yield effect was accounted more dominant at the rate of 120.39 per cent as compared with interaction effect at the rate of 21.49 per cent. During Period-I, area effect was found to be more instrumental with the magnitude of 229.48 per cent than the yield and interaction effects. During Period-II, area effect (133.50%) was reported major contributor to uplift the production than the interaction effect for about79.89 per cent. In period-III, similar results were observed as in the period-II in which area effect (1568.33%) was found to be highest contributor than the interaction effect (73.16%). Similar findings were reported by Sood *et al.* (2020) in his research work in state of Rajasthan using data from 2000 to 2018 and Moore *et al.* (2015) in Gujarat state using data from 2000 to 2018.

Table 3: Relative contribution of area, yield and their interaction effect on output growth of *rabi* pulse in Madhya Pradesh (In per cent)

Periods	Chickpea		
	Area effect	Yield effect	Interaction effect
Period-I (1991-2000)	229.48	-23.43	-106.05
Period-II (2001-10)	133.50	-113.39	79.89
Period-III (2011-20)	1568.33	-1541.49	73.16
Overall Period (1991-2020)	-41.88	120.39	21.49

Source: *Author's calculations.*

The result of decomposition analysis of output growth of lentil crop is presented in the Table 4. It is reported from the results that during overall study period, the yield effect (64.42%) was the major contributor to increase in the production of lentil crop while, interaction and area effects were reported 30.58 and 5.00 per cent, respectively. In Period-I, area effect of lentil crop accounts more dominant for about 137.91 per cent as compared to interaction effect with the magnitude of 17.42 per cent.

Table 4: Relative contribution of area, yield and their interaction effect on output growth of *rabi* pulse crop in Madhya Pradesh (In per cent)

Periods	Lentil		
	Area	Production	Productivity
Period-I (1991-2000)	137.91	-55.33	17.42
Period-II (2001-10)	-66.12	169.51	-3.39
Period-III (2011-20)	-24.88	92.12	32.76
Overall Period (1991-2020)	5.00	64.42	30.58

Source: *Author's calculations.*

During period-II, yield effect (169.51%) was obtained more instrumental to increase the production than

the area and interaction effects. In Period-III, yield effect (92.12%) was found to be more dominant than the interaction effect i.e. 32.76 per cent. Balai *et al.* (2021) reported similar results in his research work based on area, yield and their interaction effects of *rabi* pulse crops in Rajasthan state and his study based on the growth and decomposition of major pulse crops in Karnataka during 1988-2018.

Policy Implications

Following policy recommendations emerged from the study:

Positive growth in area, production and productivity of chickpea and lentil crops in Madhya Pradesh during 1991-92 to 2020-21 (overall period) were noticed because of shift in area from these crops to other competitive crops. Thus, there is a need to give more emphasis on both technological aspects as well as policy aspects (extension services and more remunerative prices) so that with increase in area and productivity of these pulse crops, production can be increased. It was observed that yield effect was more dominant compared to area and interaction effect of chickpea and lentil crops in Madhya Pradesh (overall period). Therefore, for these two crops of the selected state, technological improvement aspect can play a big role to increase production of these pulse crops.

CONCLUSION

From the above analysis it could be concluded that the results of growth and decomposition had been shown that the area of pulse crops in Madhya Pradesh state was continuously increasing. Throughout the study period, positive growth rates of area, production and productivity of chickpea were recorded at the rate of 1.62, 5.68 and 3.99 per cent, respectively. Meanwhile, in all aspects viz., area, production and productivity of lentil also observed the same growth trend with the magnitude of 1.86, 7.40 and 5.44 per cent, respectively, at the same time, only area reported significant growth pattern in both the crops (chickpea and lentil). During entire study period, the yield effect of chickpea was accounts more dominant with the rate of 120.39 per cent as compared with interaction effect at the rate of 21.49 per cent and in lentil crop, yield effect (64.42%) was the major contributor while, interaction and area effects were reported 30.58 and 5.00 per cent, respectively. At the same time, it was concluded that the yield effect was found to be responsible factor as compared with the area and their interaction effects of both the crops i.e. chickpea and lentil.

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