

Research Paper

# Growth and Variability in Selected Cereal Crops in Madhya Pradesh

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## ABSTRACT

The present study assessed the performance of selected cereal crops viz., wheat and rice in state in terms of growth and variability over 30 years' time period from 1991-92 to 2020-21. Further these periods are divided into four sub-periods. The study is entirely based on secondary data obtained from the Directorate of Economics and statistics, ministry of Agriculture, Government of India, New Delhi. To obtain this, exponential growth model and Cuddy-Della Valle index (CDVI) were used. The study concluded that, the area, production and productivity of wheat reported positive compound annual growth rate. However, a positive and significant growth rate were seen across the sub-period II and III. In terms of variability, it was found that in both the crops wheat and rice reported highest variation in production when compared to area and productivity.

## HIGHLIGHTS

- Growth rates were observed highest in production for wheat while for rice in productivity.
- Wheat and rice showed greater variation in production in comparison to area and productivity.

**Keywords:** Variability, compound growth rate, Cuddy-Della Valle index, rice, wheat

Wheat and rice are the leading cereal crops in the world. Together, they supply more than 30% intake to human population (DES). In India rice cultivation is very popular in agriculture. It is core crop in India and millions of people love to eat it every day. "Rice is life" for more than half of the community. 2004 was designated as the 'International Year of rice' by the United Nations (FAO). Rice is fully loaded with protein, carbohydrates, vitamins like thiamine, niacin and minerals like zinc, phosphorus. India is the second-largest producer and exporter of rice in the world. Rice is grown almost in Madhya Pradesh, Tamil Nadu Chhattisgarh, Andhra Pradesh, Assam, etc., states in India.

Wheat is one of the most popular staple foods in India. It compares well with other cereal in nutritive value. It has good nutrition profile with 12.1 per cent protein, 1.8 per cent lipids, 1.8 per cent ash, 2.0 per cent reducing sugar, 6.7 per cent pentose, 59.2 per cent starch with good source of mineral of vitamin and nicotinic acid (Agam *et al.* 2017). It is processed in different forms like flour, suji, maida and being eaten by number of consumers in different ways as porridge (Halwa), chapati, bread

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and biscuits etc. Besides that, wheat straw and wheat bran are also good source of feed for animals (Sahu *et al.* 2020). India is the world's second largest producer of wheat. India's top wheat-producing states include Uttar Pradesh, Punjab, Haryana, Madhya Pradesh, Rajasthan, Bihar and Gujarat. The second-largest wheat producer in India is Madhya Pradesh.

Since, wheat and rice are largely produced and consumed by large population there is necessity to increase production as it plays key role in enhancing income of the farmer. As wheat and rice being major crops in Madhya Pradesh, it is important to find out current status with relation to growth and variability. Examining growth and instability is important for improving the livelihood of the majority small-scale farmers who accounts for the majority of the food grains produced in the country. Instability in agricultural production raises risk in farm production, which in turn affects farmer's incomes and possibly their decisions for investment on new technology (Abu *et al.* 2017). Owing to the importance, the present research attempted to investigate growth and variability for wheat and rice in Madhya Pradesh.

## METHODOLOGY

The study is merely based on secondary time series data obtained from directorate of economics and statistics department from the period of 1991 to 2021 i.e., 30 years for area, production, and productivity. Moreover, this study is categorised in four sub-periods i.e., Period I (1991-2000), Period II (2001-2010), Period III (2011-2020), Overall (1991-2020). Statistical tools like exponential growth model and Cuddy-Della Valle index (CDVI) were applied for the confined study. The study was bounded to selected cereal crops viz., wheat and rice.

### Compound growth rate

The compound growth rate for wheat and rice in area, production and productivity was evaluated by using exponential growth model entire the study period. The growth model was fitted as follows (Balai *et al.* 2021):

$$\text{Exponential trend equation: } Y = ab^t$$

The compound growth rate was obtained for the logarithmic form of the equation as below:

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

Where,

$Y$  = area/production/productivity

$a$  = Intercept

$b$  = regression coefficient /  $(1 + r)$

$t$  = Year

$r$  = Compound growth rate /  $(\text{Antilog } b) - 1$

The percent compound growth rate  $\text{\textcircled{R}}$  will be as,

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

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

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

Where,

't' = Student 't' test

CGR = Compound growth rate

SE (CGR) = Standard error of Compound growth rate

Standard error of Compound growth rate is calculated by using following formula (Rao *et al.* 1981);

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

### Coefficient of variation

An index of instability was computed to examining the nature and degree of instability in area, production, and productivity of selected cereal crops. Simple coefficient of variation does not explain properly the trend component inherent in the time series data so the instability index was calculated using better measure

of variability suggested by Cuddy-Della Valle index (Cuddy and Della, 1978);

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

$$CV = \frac{\text{Standard Deviation}}{\text{Arithmetic Mean}} \times 100$$

$R^2 = ESS/TSS$  i.e., ratio of explained variation to total variation.

Where,

CV – Coefficient of Variation

$R^2$  – Coefficient of Determination

ESS – Variation explained by explanatory variable.

TSS – Total Variation.

The ranges of variability are given as follows (Balai *et al.* 2021):

Low instability – Between 0 to 15

Median instability – Greater than 15 and lower than 30

High instability - Greater than 30

## RESULTS AND DISCUSSION

### Growth performance in wheat and rice

The compound growth rate in area, production and productivity of wheat and rice was analysed from the period 1991-91 to 2020-21 and represented in Table 1. Wheat is one of the most important cereal crops of

Madhya Pradesh. It was found that, the CAGR in area, production and productivity of wheat was increased at the rate of 3.75, 10.15 and 6.17 per cent per annum, respectively. At the same time, non-significant growth rate was found during overall period. During period I, the growth rates in area, production and productivity was accounted as 2.80, 6.17 and 3.28 per cent per annum, respectively. Similar results were observed as in overall period. During period II, the compound growth rate of wheat in area was increased by 3.51 per cent per annum with increase in growth of production and productivity by 7.15 and 3.51 per cent per annum, respectively. It was reported significant growth at 5% level of significance. In case of period III, similar findings were observed as in period II. Agam *et al.* (2019) reported similar findings in her study on growth performance of wheat in Amravati district during 1983-84 to 2012-13 and Sahu *et al.* (2020) also reported similar findings in her research work on growth in production of wheat in India during 2000-01 to 2017-18.

In Madhya Pradesh rice is cultivated in the area of 2117.00 thousand ha with the production of 4413.79 thousand tons and yield of 2085 kg/ha (Source; annual report; DES, 2021). From the table 1, it was reported that the CAGR in area and production were declined at the rate of -8.80 and -2.95 per cent per annum, respectively. Although maximum growth was found in productivity with the magnitude of 6.41 per cent per annum and it was recorded non-significant growth performance as in overall period. During period I, the growth performance of area, production and productivity was observed declined at the rate of -12.30, -19.65 and -8.38 per cent per

**Table 1:** Compound growth rate of selected cereal crops in Madhya Pradesh

Crop	Particulars	Period I (1991-2000)	Period II (2001-2010)	Period III (2011-2020)	Overall (1991-2020)
Wheat	Area	2.80 (0.013)	3.51** (0.007)	4.71** (0.007)	3.75 (0.003)
	Production	6.17 (0.022)	7.15** (0.015)	11.69* (0.011)	10.15 (0.005)
	Productivity	3.28 (0.010)	3.51** (0.008)	6.66* (0.006)	6.17 (0.003)
Rice	Area	-12.30 (0.037)	-2.95** (0.005)	4.71** (0.009)	-8.80 (0.008)
	Production	-19.65 (0.056)	2.33 (0.021)	18.85 (0.011)	-2.95 (0.013)
	Productivity	-8.38 (0.022)	5.68 (0.019)	13.24 (0.007)	6.41 (0.006)

**Source:** Author's computation from compiled time series data; **Note:** Figures in Brackets indicates standard error of growth model. \*Significant at 1 % level of significance, \*\* significant at 5 % level of significance.

**Table 2:** Variability in selected cereal crops in Madhya Pradesh (In Per Cent)

Crops	Particulars	Period I	Period II	Period III	Overall
		(1991-2000)	(2001-2010)	(2011-2020)	(1991-2020)
Wheat	Area	1.68	6.20	6.22	10.2
	Production	6.05	12.3	7.85	17.8
	Productivity	5.01	6.97	3.39	9.74
Rice	Area	2.74	3.82	5.66	28.2
	Production	7.51	16.8	4.83	31.2
	Productivity	5.98	14.4	6.40	13.1

*Source: Author's computation.*

annum, respectively. During period II, the CAGR in area of rice was declined significantly for about -2.95 per cent per annum at 5 % level of significance. While, growth rates in production and productivity were observed positive and non-significant with the magnitude of 2.33 and 5.68 per cent per annum, respectively. In the mean time similar results were observed in period III showed the growth rates in area, production and productivity at the rate of 4.71, 11.69 and 6.66 per cent per annum, respectively.

### Variability in wheat and rice

Instability analysis of area, production and productivity of wheat and rice during the study of 1991-91 to 2020-21 was presented in table 2 for overall basis and four periods wise. The variability was estimated by using Caddy- Della Valle Index. During the whole study period, highest variation in wheat was reported in production (17.80%) as compared to area (10.20%) and productivity (9.74%). During period I, the more variation in production (6.05%) followed by area of 1.68 per cent (lowest) and productivity (5.01%). Similar results were registered in period II and period III. During period II the highest variation was found in production (12.30%) as compared to productivity (6.97%) and area (6.20%). In case of period III, the variation in production was observed highest variation than area (6.22%) and productivity (3.39%).

In rice, variability analysis depicted that the area showed increased variability with 28.20 per cent and

production was found to be high variability of 31.20 per cent while, productivity reported 13.10 per cent lowest variability in overall period. During period I, the more variation was observed in production (7.51%) followed by productivity (5.98%) and area of 2.74 per cent (lowest). During period II, variability in production and productivity were registered rose with 16.80 and 14.40 per cent, respectively. However, little variation was found in area at the rate of 3.82 per cent. During period III, lowest variation was reported 4.83 per cent in production whereas, the maximum variation was registered in productivity i.e., 6.40 per cent and variation in area was observed 5.66 per cent per annum.

### CONCLUSION

Analysing the entire study period, it can be confined that the area, production and productivity for wheat crop registered positive growth rate. However, in sub-period II and III the area, production and productivity under wheat crop registered positive and significant growth rates. The area, production and productivity for rice showed mixed pattern over the study period. For sub-period II and III area showed inverse and significant relationship. Although, rice crop showed non-significant growth rates it was important to increase the production by using high yielding varieties, improved advance technologies for cultivation of crops.

In variability, greater extent of variation was registered in production as compared to area and productivity in both the crops i.e., wheat and rice.

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