Agro Economist - An International Journal
Citation: AE: **9**(04): 251-257, December 2022
DOI: 10.30954/2394-8159.04.2022.3
Peer Reviewed Journal

Growth and Instability of Major *Kharif* Pulse crops in Madhya Pradesh State of India

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

[1]*Department of Agricultural Economics, RVSKVV, Gwalior, Madhya Pradesh, India*
[2]*Department of Agricultural Economics, College of Agriculture, Indore, RVSKVV, Gwalior, Madhya Pradesh, India*
*Corresponding author: mshalini209@gmail.com

Received: 07-09-2022 **Revised:** 30-11-2022 **Accepted:** 07-12-2022

ABSTRACT

The study was conducted to evaluate the growth rate and instability in area, production and productivity of major *Kharif* pulse crops *viz*., pigeon pea, green gram and black gram in Madhya Pradesh. The study was solely based on secondary time series data, collected from various sources: e-pulses data book (ICAR), State Pulses Board (M.P.), Directorate of Economics and statistics (DES), GoI. The compound growth rate and variation in area, production and productivity of major *Kharif* pulse crops in Madhya Pradesh were calculated by using exponential trend function and Cuddy-Della Valle Index for the last thirty years had been segmented into four periods namely period-I (1991-92 to 2000-01), period-II (2001-02 to 2010-11), period-III (2011-12 to 2020-21) and overall period (1991-92 to 2020-21). The results of growth performance had been shown that the area of pulse crops was continuously increased over the years. In overall study period, the growth rate in area, production and productivity of pigeon pea were seen significantly increasing pattern accounts for 0.69, 2.33 and 1.62 per cent, respectively. However, area of green gram seen declined non-significant growth at the rate of -0.69 per cent while, production and productivity were increased significantly at the rate of 2.09 and 3.04 per cent, respectively. And in Black gram, the area, production and productivity were increased significantly at the rate of 9.14, 13.76 and 4.23 per cent per annum, respectively. The study revealed that the instability analysis showed almost all pulse crops as well as total pulse crops grown in Madhya Pradesh were observed more variation in terms of production and least variation in productivity as compared to area. Crop wise analysis during entire study periods showed that in case of production, the highest instability was observed in green gram (63.94%), followed by black gram (62.00%) and pigeon pea (43.32%), respectively. And similar instability pattern was observed in case of area of pulse crops. However, least variation was observed in productivity of pigeon pea (17.35%), followed by black gram (26.17%) and green gram (19.18%) during overall period.

Keywords: Exponential trend function, Compound growth rate, Cuddy-Della Valle Index and Instability.

Production of pulse crops plays an important role in Indian agriculture after cereals and oilseed crops. Pulse crops comprises of pigeon pea, green gram, black gram, cowpea, horse gram, moth bean in *Kharif* and chickpea, lentil, pea, lathyrus in *Rabi* seasons with high nutritive value in quality protein complementing with cereals in the country. Pulses are generally known as "Poor man's meat" and "rich man's vegetable" because pulse crops provide proteins, vitamins and minerals especially for vegetarian diets in India. Pulse crops enrich the

How to cite this article: Mishra, S., Balai, H.K. and Malviya, P.K. (2022). Growth and Instability of Major *Kharif* Pulse crops in Madhya Pradesh State of India. *Agro Economist - An International Journal*, **09**(04): 251-257.
Source of Support: None; **Conflict of Interest:** None

soil fertility by fixing the atmospheric nitrogen to make soil more porous in nature and tap root system with less water requirement helps to withstand in sever conditions as a resultant decline in pulses consumption leads to increase in malnutrition due to decline in protein intake. To aware peoples about nutritional benefits of pulses as a part of sustainable food production aimed at food security and reduces malnutrition. The UN declared 2016 as "International Year of Pulses (IYP)" (Balai *et al.* 2021).

The production of pulses was 26.96 million metric tonnes from an area of 30.37 million hectares with an average yield of 888 kg per ha on global basis (Press Information Bureau, 2022). Pulses accounts for around 20% of area and contribute around 7-10% of total food grain production in the country. Though pulse crops grown in both *Kharif* and *Rabi* seasons, only *Kharif* crops contribute more than 60% of the total production. Major five leading pulses producing states namely Madhya Pradesh (more than 8 million tonnes), Maharashtra (more than 3 million tonnes), Rajasthan (more than 3 million tonnes), Uttar Pradesh (more than 2 million tonnes) and Karnataka (2 million tonnes) etc., all together contributes more than 70% of total pulses production of the country. Among all the major *Kharif* pulses, only pigeon pea accounts at 15-20% i.e. production of 4.25 million tonnes and area of 4.43 million hectares with the productivity of 960 kg/ha, green gram reported an area of 4.26 million hectares, production of 2.01 million tonnes and productivity of 472 kg/ha and in black gram, area and production reported 5.44 million hectares and 3.56 million tonnes with the productivity of 655 kg/ha at around 8-10% (*Kharif* + *rabi*) each (Anonymous, 2020-21).

Madhya Pradesh holds first rank in pulses production with an area of 4867 thousand hectares followed by Rajasthan, Maharashtra, Karnataka and Uttar Pradesh at the rate of 6145, 4529, 3126 and 2380 thousand hectares as well as in production, Madhya Pradesh accounts 5295 thousand tonnes followed by Rajasthan, Maharashtra, Uttar Pradesh and Karnataka at the rate of 4252, 4321, 2476 and 2065 thousand tonnes, respectively (Anonymous, 2020-21). To examine the growth rates and variation in area, production and productivity of *Kharif* pulse crops viz., pigeon pea, green gram and black gram in Madhya Pradesh were observed an important part to understand how outputs changes over time. Any change in production of crop in physical terms depends fundamentally on the change in the harvested area and its average productivity under the particular crop. The compound annual growth rate (CAGR) of pulses production was stagnant as compared to population growth rate of 4.42 per cent had led to progressive decline in per capita availability of pulses. There are many studies conducted such as Bairwa, *et al.* (2020) and Balai *et al.* (2021) were presented growth performance and instability of pulses at national level.

MATERIALS AND METHODS

The study confined to secondary data collected from different sources i.e., Directorate of Economics and Statistics, Ministry of Agriculture, Government of India, Directorate of pulses development board, Bhopal, Madhya Pradesh, e-pulses data book published by ICAR, New Delhi etc. The time series data of area, production and productivity of major *Kharif* pulse crops had been taken for 30 years from 1991-92 to 2020-21. The entire study period had been further segmented into four periods namely; period-I (1991-92 to 2000-01), period-II (2001-02 to 2010-11), period-III (2011-12 to 2020-21) and overall period (1991-92 to 2020-21). Two different analysis had been carried out in the study *viz.*, compound annual growth rates of area, production and productivity of selected *Kharif* pulse crops was calculated decade wise as well as for entire study period to analyze the growth performance by fitting exponential trend model and instability analysis of individual pulse crops by Cuddy-Della Valle index. The study was restricted to major *Kharif* pulse crops (pigeon pea, green gram, black gram) which were accounted more than 45-40 per cent of total cropped area and production in Madhya Pradesh (Anonymous, 2021).

Compound Annual Growth Rate

Compound annual growth rates were estimated to know the growth pattern on area, production and productivity of major selected pulse crops grown in Madhya Pradesh by using exponential trend model (Balai, *et al.* 2021);

Exponential trend equation: $Y = ab^t$

Logarithmic form of the equation as;

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

Where,

Y = area/production/ productivity

a = Intercept

b = regression coefficient / (1+r)

t = Year

$r = CGR / (Antilog\ b) - 1$

Per cent CGR (r) was given as follows;

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

Student 't' test was used for testing the level of significance of growth in area, production and productivity of selected 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 CGR was calculated by using the following formula; (Rao, 1981)

$$SE(CGR) = \frac{100b}{1n10} \times SE(\ln b)$$

Cuddy-Della Valle Index (CDI)

An index of instability was computed for examine the nature and degree of variation in area, production and productivity of major pulse crops. Simple coefficient of variation did not explain properly the trend component inherent in the time series data so, the instability index was calculated by using better measure of variability suggested by Cuddy-Della Valle index (Cuddy and Della, 1978). The estimable equation drawn as follows;

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

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 instability were shown as follows (Balai *et al.* 2021);

Low instability: (0-15)

Medium instability: (>15 and <30)

High instability: (>30)

RESULTS AND DISCUSSION

Compound annual growth rate: The growth rates in area, production and productivity of *Kharif* crops i.e. pigeon pea, green gram and black gram for the study period from 1991-92 to 2020-21 were calculated and depicted in Tables given below;

Table 1: CAGR in area, production and productivity of pigeon pea in Madhya Pradesh (In per cent)

Particulars/ Periods	Period-I (1991-2000)	Period-II (2001-10)	Period-III (2011-20)	Overall Period (1991-2021)
Area	-6.24* (0.008)	7.89** (0.011)	-20.38** (0.040)	0.69* (0.006)
Production	-9.22** (0.016)	-1.14 (0.021)	-6.03 (0.057)	2.33** (0.008)
Productivity	-3.17 (0.005)	-8.59 (0.009)	18.03* (0.063)	1.62** (0.007)

Source: Computation of author's own compiled time series data; **Note:** Figures in Brackets indicates standard error of growth model; *Significant at 1% level of significance and **Significant at 5% level of significance.

Pigeon pea: It was revealed from the above table that during overall period, the growth performance in area, production and productivity were seen significantly increased with the magnitude of 0.69, 2.33 and 1.62 per cent, respectively. At the same time, significant increase in production and productivity were observed due to expansion in area over the years. During period-I, growth performance in area and production under pigeon pea was declined

significantly with annual compound growth rate of -6.24 and -9.22 per cent in Madhya Pradesh whereas, productivity was recorded declined non-significant growth pattern at the rate of -3.17 per cent per annum. At the same time, decline in production and productivity of pigeon pea caused by decrease in growth pattern in area. During period-II, significant increase in growth was observed in area for about 7.89 per cent while, declined non-significant growth rate were found in production and productivity at the rate of -1.14 and -8.89 per cent per annum, respectively. During period-III, the significant decrease in growth rate was recorded in production (-6.03%) while, declined and non-significant growth pattern was reported in area with the magnitude of -20.38 per cent and significant increased growth rate was found in productivity (18.03%) of pigeon pea. At the same time, area and production under pigeon pea might be declined due to remarkable improvement seen in area and production of its competitive crop *viz.,* black gram. This period was characterized positive growth rate in productivity of pigeon pea. In overall period similar findings were found by Balai *et al.* (2021) in his research based on growth and decomposition analysis of *Kharif* pulse crops in Rajasthan during 1988-2018 and Maharjan (2017) revealed in analysis of trends in pulses production in India with special reference to Punjab.

Green gram: It was revealed from the study that the area of green gram in Madhya Pradesh were declined non-significantly at the rate of -0.69 per cent per annum in the entire study period whereas, the production and productivity were increased significantly at the rate of 2.09 and 3.04 per cent, respectively. During period-I, the area under green gram seen declined non-significant growth pattern i.e. -9.22 per cent whereas, growth in production and productivity were recorded decreased significantly with the annual rates of -10.26 and -1.14 per cent, respectively. At the same study period, the production of green gram could be declined due to decrease in area. During period-II, the growth rate in all aspects *viz.,* area, production and productivity of green gram were reported increased significantly at the rate of 0.23, 2.80 and 2.80 per cent per annum, respectively. At the same time, production of green gram could be enhanced due to expansion in area. During period-III, the area and production under green gram were recorded declined significantly with the magnitude of -6.46 and -5.81 per cent per annum while, in case of productivity, the annual growth rate was recorded increased significantly at the rate of 0.69 per cent. In the similar study period, the production of green gram might be declined due to decrease in area of this particular crop. In the meantime, similar results were observed by Balai, *et al.* (2021) in area, production and productivity of mung bean in Karnataka during 1988-2018.

Black gram: It was indicated from the above table that in entire study period, all aspects *viz.,* area, production and productivity of black gram were increased significantly at the rate of 9.14, 13.76 and 4.23 per cent per annum, respectively. At the same time, production of black gram might be increased due to significant expansion in area of this crop. During period-I, the growth performance in area and production of black gram were declined non-significantly at the rate of -2.95 and -2.73 per cent while, productivity was increased non-significantly at the rate of 0.23 per cent per annum in Madhya Pradesh. In the similar study period, the production of black gram could be declined due to decrease in area. During period-II, the growth performance in area and production were found to be increased non-significantly with the magnitude of 0.46 and 4.71 per cent. Further, the productivity of black gram

Table 2: CAGR in area, production and productivity of green gram in Madhya Pradesh (In per cent)

Particulars/Periods	Period-I (1991-2000)	Period-II (2001-10)	Period-III (2011-20)	Overall period (1991-2021)
Area	-9.22 (0.005)	0.23* (0.009)	-6.46** (0.063)	-0.69* (0.007)
Production	-10.26** (0.018)	2.80** (0.012)	-5.81** (0.090)	2.09** (0.011)
Productivity	-1.14** (0.013)	2.80* (0.008)	0.69** (0.032)	3.04* (0.004)

Source: Computation of author's own compiled time series data; **Note:** Figures in brackets indicates standard error of growth model; *Significant at 1% level of significance and **Significant at 5% level of significance.

Table 3: CAGR in area, production and productivity of black gram in Madhya Pradesh (In per cent)

Particulars/Periods	Period-I (1991-2000)	Period-II (2001-10)	Period-III (2011-20)	Overall Period (1991-2021)
Area	-2.95 (0.010)	0.46 (0.014)	39.96* (0.030)	9.14 (0.007)
Production	-2.73 (0.020)	4.71 (0.017)	35.83** (0.062)	13.76 (0.009)
Productivity	0.23 (0.014)	4.23** (0.009)	-2.95 (0.043)	4.23* (0.005)

Source: Computation of author's own compiled time series data; **Note:** Figures in brackets indicates standard errors of growth model; *Significant at 1% level of significance and **Significant at 5% level of significance.

Table 4: Measure of instability in area, production and productivity of pigeon pea in Madhya Pradesh (In per cent)

Particulars/Periods	Period-I (1991-2000)	Period-II (2001-10)	Period-III (2011-20)	Overall Period (1991-2021)
Area	6.67	8.50	23.69	29.35
Production	13.32	**16.80**	37.37	43.32
Productivity	8.84	**18.32**	14.39	17.35

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

was noticed positive and significant growth rate for about 4.23 per cent per annum. At the same time, production might be increased due to expansion in area of black gram in Madhya Pradesh and the area under black gram might be increased due to drastic expansion in area of its competitive crop i.e. pigeon pea in the state. During period-III, the area and production of black gram were observed increased significant growth pattern for about 39.96 and 35.83 per cent per annum. However, the declined non-significant growth rate was observed in productivity at the rate of -2.95 per cent. At the same time, production was reported remarkable and significant improvement due to increase in area in Madhya Pradesh. Thus, the study reported that the area and production of black gram were highest with drastic change in the period-III. At the same time, the production of black gram could be increased due to expansion in area. Similar findings were noticed by Balai *et al.* (2021) in his research based on growth and decomposition analysis of *Kharif* pulse crops in Karnataka during 1988-2018 and Bairwa, *et al.* (2020) observed in period-II and overall period, an increased growth pattern in area, production and productivity of black gram in India during period 1998-2017.

Instability Analysis: The results of instability in area, production and productivity of *Kharif* pulse crops were indicated in Table 4.

Pigeon pea: The results of instability depicted that in case of pigeon pea in Madhya Pradesh, throughout the study period, all aspects *viz.*, area, production and productivity were found to be 29.35, 43.32 and 17.35 per cent variation, respectively. During period-I, instability in area, production and productivity of pigeon pea were observed 6.67, 13.32 and 8.84 per cent variation, respectively. During period-II, the variation in area, production and productivity of pigeon pea were found to be 8.50, 16.80 and 18.32 per cent, respectively.

Table 5: Measure of instability in area, production and productivity of green gram in Madhya Pradesh (In per cent)

Particulars/ Periods	Period-I (1991-2000)	Period-II (2001-10)	Period-III (2011-20)	Overall Period (1991-2021)
Area	4.15	6.14	**32.83**	**37.74**
Production	11.40	9.47	**48.51**	**63.94**
Productivity	6.85	6.19	17.45	19.18

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

In the meantime, the highest variation was found in productivity of pigeon pea in competing crops like green gram and black gram in the state. In case

of period-III, variation in area (23.69%), production (37.37%) and productivity (14.39%) of pigeon pea were confirmed. Similar findings were observed by Balai *et al.* (2021) in his work titled instability and its causes in production of major pulse crops in Karnataka during the period of 1988-2018.

Green gram: In case of green gram in Madhya Pradesh, 37.74, 63.94 and 19.18 per cent variation were observed in area, production and productivity, respectively, during the entire study period. During period-I, 4.15, 11.40 and 6.85 per cent variation was accounted in area, production and productivity of green gram, respectively. During period-II, variation in all aspects *viz.* area, production and productivity was reported at the rate of 6.14, 9.47 and 6.19 per cent of green gram, respectively. During period-III, variation in area (32.83%), production (48.51) and productivity (17.45%) were observed in green gram. In the same study period, the maximum variability was observed in area and production of green gram in comparison with pigeon pea and black gram in Madhya Pradesh state. Similar findings were observed by Balai *et al.* (2021) in his work titled instability and causes of instability of major pulse crops in Karnataka during the study period from 1988 to 2018.

Table 6: Measure of instability in area, production and productivity of black gram in Madhya Pradesh (In per cent)

Particulars/ Periods	Period-I (1991-2000)	Period-II (2001-10)	Period-III (2011-20)	Overall Period (1991-2021)
Area	**7.91**	**12.10**	26.01	34.40
Production	**14.90**	14.88	46.01	62.00
Productivity	**10.22**	6.85	**23.58**	**26.17**

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

Black gram: During overall study period, all aspects *viz.*, area, production and productivity of black gram in Madhya Pradesh were reported at the rate of 34.40, 62.00 and 26.17 per cent, respectively. During period-I, 7.91, 14.90 and 10.22 per cent variation was accounted in area, production and productivity of black gram, respectively. At the same time, the highest variability was found in all aspects *viz.*, area, production and productivity of black gram in Madhya Pradesh state in competing with pigeon pea and green gram crops. During period-II, variation in area, production and productivity of black gram were observed with the magnitude of 12.10, 14.88 and 6.85 per cent, respectively. At the same time, more variation was found in area of black gram in comparing with both the crops. In case of period-III, the variation in area production and productivity of black gram were recorded at the rate of 26.01, 46.01 and 23.58 per cent, respectively. During similar study period, the highest variability was reported in productivity of black gram than the pigeon pea and green gram. Similar findings were observed by Balai *et al.* (2021) in his work titled instability and its causes in production of major pulse crops in Karnataka during the period of 1988-2018.

Crop wise analysis showed that in case of production under all the three pulse crops, the highest instability was observed in green gram (63.94%), followed by black gram (62.00%) and pigeon pea (43.32%). Similar trend was observed in case of area of pulse crops. The least variation was observed in productivity of pigeon pea (17.35%), followed by green gram (19.18%) and black gram (26.17%) during overall period. The variation in productivity was observed lower than the area and production. It might be due to effective implementation of various programs by government, such as demonstration on improved technology, distribution of certified improved seeds, mini-kits and subsidies on sprayers in order to encourage the productivity of pulse crops.

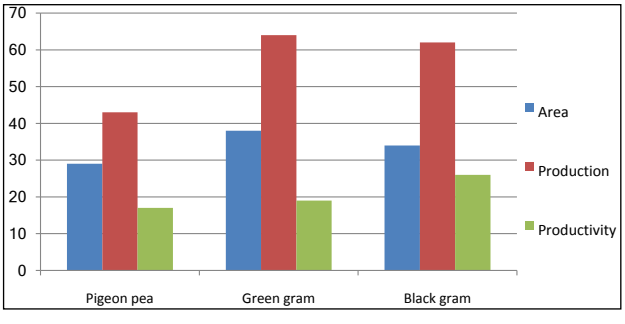

Fig. 1: Instability in area, production and productivity of Major pulse crops in Madhya Pradesh

CONCLUSION

The present study was found that throughout the study period, the growth performance in area, production and productivity were seen increased

significantly in pigeon pea and black gram whereas, in green gram area was declined non-significantly in Madhya Pradesh state. The results of instability analysis revealed that all pulse crops, namely, pigeon pea, green gram and black gram as well as total pulse crops grown in the state seen more variation in terms of production and least in terms of productivity. In order to enhance pulses production, government took various initiatives like distributing 4 kg kits (free-of-cost) to the farmers, conduct training camps for farmers and demonstrate the use of latest techniques for sowing pulse crops.

REFERENCES

Anonymous, 2018. Pulses revolution from food to nutritional security. Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare. Government of India.

Anonymous, 2022. Press Information Bureau, Ministry of Information and Broadcasting, Ministry of Agriculture and Family Welfare, GoI.

Anonymous, 2020-21. Directorate of Economics and Statistics (DES), Ministry of Agriculture and Farmers Welfare (DAC), Government of India.

Anonymous, 2020-21. FAO Report on State Food Security and Nutrition in World.

Ahlawat, P.S., Sharma, P. and Singh, U. 2016. Production, demand and import of pulses in India. *Indian Journal of Agronomy,* **61**(4): 33-41.

Bairwa, K.C., Balai, H.K., Meena, G.L., Prasad, D., Kumari, Y., Singh, H. and Yadav, A. 2020. Inter-temporal production performance of pulse crops: In Indian context. *Economic Affairs,* **65**(3): 01-08.

Balai, H.K., Singh, H., Bairwa, K.C., Yadav, A. and Meena, G.L. 2021. To Study Growth and Decomposition of Major Pulse Crops in Karnataka. *Astha foundation: frontier in crop improvement,* **8**(9): 3583-3591.

Balai, H.K., Singh, H., Bairwa, K.C., Meena, G.L. and Meena, M.L. 2021. To Study the Instability and Causes of Instability of Major Pulse crops in Karnataka. *Astha foundation: frontier in crop improvement,* **8**(9): 3368-3372.

Cuddy, J.D. and Valle, P.D. 1978. Measuring the instability of time series data. *Oxford bulletin of economics and statistics,* **40**(1): 79-85.

Maharjan, N.K. 2017. Analysis of Trends in Pulses Production in India with Special Reference to Punjab (Doctoral dissertation), Punjab Agricultural University, Ludhiana.

Mohanty, S. and Satyasai, K.J. 2015. Feeling the pulse: Indian pulses sector, NABARD rural pulse department of economic analysis and research (DEAR), NABARD, Mumbai: (Vol. 10).

Rao, A.U. 1981. *Agricultural Situation in India*, **35**: 171-173.

Shalendra., Gummagolmath, K.C., Sharma, P. and Patil, S.M. 2013. Role of pulses in the food and nutritional security in India. *Journal of Food Legume,* **26**(3): 124-129.

Sharma, M.K., Sisodiya, B.V.S. and Lal, K. 2016. Growth and trends of pulse production in India. *Journals of Food Legume,* **26**: 86-92.

Singh, P., Shahi, B. and Singh, K.M. 2016. Pulses Production in Bihar: an Overview of Constraints and opportunities. *Journal of Agri search,* **3**(3): 176-184.