Journal of Food Legumes
37(2): 224-231, 2024
DOI: 10.59797/jfl.v37.i2.199

Research Paper

Growth and instability in mungbean production in India

Neelam Kumari* and Dharmpal Malik

Department of Agricultural Economics, College of Agriculture, CCS HAU, Hisar 125 004 (Hariyana), India

***Corresponding author e-mail:** luhachneelam12@gmail.com*

***Received:** 8 May 2024*
***Accepted:** 12 June 2024*

Handling Editor:
Dr. Jitendra Kumar, ICAR-Indian Institute of Pulses Research, Kanpur

ABSTRACT

Mungbean is mainly cultivated in East Asia, Southeast Asia, and the Indian subcontinent. It is the third important pulse crop of India grown in nearly 18 percent of the total pulse area. The paper delves into the current state of mungbean in India, examining the shift of the area of mungbean across zones and its underlying reasons. The study has been carried out based on secondary data and the data was collected for the period from 1970-71 to 2020-21. Compound annual growth rate and instability index were computed. The results showed that mungbean area and production declined in the eastern zone but showed considerable growth in the southern zone. Production in all the major states increased with a positive growth rate except Odisha. In Odisha, Rajasthan and Madhya Pradesh areas have shown higher instability than productivity, but Karnataka, Maharashtra, and all of India's productivity was found more unstable. Therefore, it is necessary to promote the adoption of conservation practices, harvesting of rainwater by creation of structures like farm ponds as well as to expand irrigation facilities to overcome variability in productivity.

Key words: Area, Growth rate, Instability, Mungbean, Production and Productivity

INTRODUCTION

Mungbean (*Vigna radiata* L. Wilczek) is an important cultivated species in the family of Leguminosae. It is popularly known as "Mung Dal or Green gram" and is a tiny circular-shaped bean that is green in colour. It is a rich source of proteins, vitamins, and minerals and it is the poor's vegetarian diet in developing and under-developing countries. Germinated seeds of mungbean contain anti-carcinogenic, antibacterial, and antifungal properties which neutralize the toxicity. Mungbean is a legume grown mainly in Asia and has spread to countries outside Asia primarily because of its multiple uses *i.e.* nutrient source for humans, soil fertilization, animal forage crop, and even medicinal component (Wang *et al.* 2022). It has the fantastic property of fixing the atmospheric nitrogen by forming symbiotic relations with *Rhizobium* bacteria which is also beneficial for the succeeding crop (Ali 2010).

Mungbean is mainly cultivated in East Asia, Southeast Asia, and the Indian subcontinent. It is the third important pulse crop of India grown in nearly 18% of the total pulse area (Anonymous 2021). It is a cheap source of dietary protein (24-25%) and carbohydrates (56%) for human consumption (FAOSTAT 2016). In hundred-gram grains, it contains 345 kcal energy, 25.0 g protein, 1.10g fat, 62.60 g carbohydrate, and 16.30 percent total dietary fiber (Agarwal and Yadav 2017). Mungbean is prominent in Asia, especially in India, Myanmar, Bangladesh, China, Pakistan, Thailand, and Sri Lanka (Singh *et al.* 2019). Mungbean is grown in northern, central, and western India in the summer season (March– June) in the *Kharif* season (June–September), and in the southeastern parts of India in the *Rabi* season (November–April). *Kharif* season accounts for about 70% of the total production and it is mostly grown as a *Kharif* crop in Rajasthan, Maharashtra, Gujarat, Karnataka, Andhra Pradesh, Madhya Pradesh, and Uttar Pradesh. But in Tamil Nadu, Odisha, Punjab, Haryana, and Bihar it is grown as a summer crop (FAOSTAT 2019).

Mungbean in India occupies nearly 5.13 million ha area with 3.08 million tonnes of production (Anonymous 2021). It is also considered a cheap source of protein and other minerals. In human food, whole grains and split grains of green gram are used as daal and curry. Rajasthan (48.86%) and Madhya Pradesh (14.73%) are the two major mungbean producer states of the country contributing about 64% of total production. Maharashtra (6.98%),

Karnataka (5.78%), and Odisha (4.78%) are other major mungbean-producing states of the country. These states together contribute at least 80% of the area under mungbean. Mungbean is sharing 18 and 12% of the national pulses acreage and production, respectively. The mungbean production in the country has gone up from 0.70 to 3.08 million tonnes from 1970-71 to 2020-21 as the crop finds a new niche in the marginal lands of major states. During the period area increased from 2.06 to 5.13 million ha and the productivity increased nearly two times (from 339 kg ha^{-1} to 601 kg ha^{-1}) and this might be due to the increased availability of high-yielding varieties and irrigation facilities. The present study discusses the current state of mungbean in India and examines the shift of area of mungbean across zones and its underlying reasons.

MATERIALS AND METHODS

The study was based on secondary data *i.e.* time series data on the area, production, and productivity of mungbean in major states and at all India level. Time-series data of area, production, and productivity of selected pulses and oilseeds was collected from Agricultural Statistics at a Glance, Ministry of Agriculture & Farmers Welfare, Government of India, New Delhi, Handbook of Statistics on Indian Economy, Reserve Bank of India, Mumbai. Data related to global area, production, and productivity of selected crops was collected from the website of FAOSTAT. The mungbean growing states were selected based on their contribution of at least 80 % share with respect to area in 2020-21. As per the above criteria Karnataka, Odisha, Maharashtra, Rajasthan, and Madhya Pradesh were selected. To study temporal variations in mungbean production, the overall study period (1970-71 to 2020-21) was divided into five sub-periods, as period-I (1970-71 to 1979-80), period-II (1980-81 to 1989-90), period-III (1990-91 to 1999-2000), period-IV (2000-01 to 2009-10) and period-V (2010-11 to 2019-20). To study the spatial movement of mungbean cultivation over time, the states were grouped into four zones. The southern zone includes Karnataka; the eastern zone includes Odisha while the western zone includes Maharashtra and Rajasthan. The central zone has only two states, Madhya Pradesh and Chhattisgarh. Hence, the area and production of Chhattisgarh were combined with Madhya Pradesh as it was bifurcated from Madhya Pradesh on 1 November 2000.

Growth rate

Growth rates refer to the percentage change of a specific variable within a specific period. Growth rates can be positive or negative, depending on whether the size of the variable is increasing or decreasing over time. Growth rates can be beneficial in assessing variables' performance and predicting future performance. The compound annual growth rate (CAGR) is a variation in the growth rate that is often used to assess a variable's performance. The CAGR calculation assumes that growth is steady over a specified period of time. CAGR is a widely used metric due to its simplicity and flexibility. The functional form is;

$$Y_t = ab^t \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

Y_t = area, production and productivity of pulses in the year t

a = intercept

b = regression coefficient

t = time variable

The equation (1) was transformed into log-linear and written as

$$\text{Log } Y = \log a + t \log b \ldots\ldots\ldots\ldots\ldots (2)$$

Equation (2) was estimated by using Ordinary Least Square (OLS) technique.

The compound growth rate (r) was then estimated by using the equation (3)

$$r = (\text{antilog } b - 1)\ 100 \ldots\ldots\ldots\ldots\ldots (3)$$

Where,

r = Estimated compound growth rate per annum in percentage.

b = Antilog of regression coefficient value

The significance of the growth rate was tested by applying Student 's-test statistics.

Instability Index

Variability in agricultural production consists of variability in area and productivity and their interactions. Variation in area under a crop occurs mainly in response to distribution, timeliness, and variations in rainfall and other climatic factors, expected prices, and availability of crop-specific inputs. All these factors also affect the variations in productivity. Further, productivity is also affected by outbreaks of diseases, pests, and other natural or man-made hazards like floods, droughts, fires, and

many other factors. Different events may affect area and productivity in the same, opposite, or different ways.

An analysis of fluctuations in crop output, apart from growth, is important as wide fluctuations in crop output result in wide variations in the disposable income of the farmers. The magnitude of fluctuations depends on the nature of crop production technology, its sensitivity to weather, economic environment, availability of material inputs, and many other factors. High production growth accompanied by a low level of instability for any crop is desired for the sustainable development of agriculture. Instability analysis represents the uncertainty, with the help of indicators like Coefficient of variation, Standard deviation, instability index, etc.

Instability analysis in the area, production, and productivity of selected pulses and oilseeds crop was studied using CDI (Cuddy-Della Valle index), even though the coefficient of variation (CV) is the simplest measure of instability, it over-estimates the level of instability in time series data which are characterized by long-term trends. Alternatively, the coefficient of variation around the trend (CV_t) rather than the coefficient of variation around the mean (CV) was suggested by Cuddy and Della (1978) as a better measure of variability. The Cuddy-Della Valle Index de-trends the time series data and shows the exact direction of the instability. Hence, it is a better measure to capture instability in an agricultural area, production, and productivity of crops. A low value of this index indicates low instability and vice-versa. The formula for the Cuddy-Della Valle index is given below.

$$CDI = CV_{Trend} = (CV) \times \sqrt{1 \times Adj.R2}$$

Where,

$$CV_{Mean} = (SD/Mean) \times 100$$

$$Adj.\ R^2 = \frac{\frac{(RSS)}{(r-k)}}{\frac{TSS}{n-1}}$$ *i.e.* ratio of explained variation

to total variation.

ESS = Variation explained by the explanatory variable.

TSS = Total Variation.

Based on value of CDI, the range has been divided in three categories (Sihmar, 2014) *i.e.* low instability (0 to 15), Medium instability (>15≤ 30) and high instability (> 30).

RESULTS AND DISCUSSION

Area, production and productivity of mungbean in India

The share of major mungbean-producing states to total area, production, and productivity of India over the periods is presented in Table 1. The cultivation of mungbean is spread across large parts of the country. Despite that, five states *viz,* Karnataka, Odisha, Maharashtra, Rajasthan and Madhya Pradesh together covered at least 80% mungbean area. The highest reduction in mungbean area share was recorded in Odisha from 17.34% in TE-1973 to 8.72% in TE-1996 and further declined to 4.78% in TE-2021 followed by Maharashtra from 18.29% in TE-1973 to 15.00% in TE-2011 and further declined to 8.77 in TE-2021; Rajasthan showed significant expansion in area from 13.02% in TE-1973 to 50.78% in TE-2021. Maharashtra was the largest mungbean cultivating state in TE-1973. The share of Madhya Pradesh was 11.30 % in TE-1973, which continuously declined till TE-2011 (3.17%) and then showed an increase in the recent past *i.e.* TE-2016 (8.96%) and TE-2021 (8.31%). Karnataka exhibited an irregular trend during the study period. During TE-1973, the state's share was 4.11 percent, which showed a constant increase till TE-1991 (7.32%) and after that slightly declined in TE-1996 (6.44%). Again its share doubled in TE-2001 (13.05%) and after that declined continuously till TE-2021 (8.68%). In the Indian scenario, the mungbean area recorded almost two and a half times increase from 1955.33 thousand ha in TE-1973 to 4821.89 thousand ha in TE-2021 and this was the record highest mungbean area till date.

State-wise share of mungbean production indicated that the share of Odisha was highest in TE-1973 (30.08%), which declined to 24.57 percent in TE-1976 then increased and attained the highest share of 36.43 percent in TE-1981, and after that, it followed an irregular trend and its share declined to a minimum of 2.61 percent in TE-2021. Maharashtra was the second largest producer of mungbean with a share of 11.65 percent in TE-1973, its share increased to a maximum value of 29.88 percent in TE-1996, after that followed a declining trend till TE-2021 (6.98%). Rajasthan emerged as the largest mungbean-producing state with a share of 48.86 percent in TE-2021, while its share was 11.82 percent in TE-1973, which further declined to a minimum of 3.64 percent in TE-1981. After that showed a continuous increase till TE-1996 (7.85%), showing a slight decline in TE-2001 (5.49%), it showed a

tremendous increase in the coming years and became the largest producer of mungbean in the country.

Madhya Pradesh followed the same trend in production as in the case of the area. Starting from a share of 10.10% in TE-1973, it attended its lowest of 2.70% in TE-2006 then continued to increase till TE-2021 (14.73%). The share of Karnataka was irregular throughout the study period with a minimum share of 2.86 percent in TE-1973 and a maximum share of 11.86 percent in TE-2001. In the Indian context, a four-time increase (2088.20 thousand tonnes) in production was observed with the highest production of 2683.20 thousand tonnes in TE-2021.

Large variation in productivity across states was prevalent during TE-1973 with the highest of 429.67 kg ha^{-1} in Odisha and the lowest one *i.e.* 191.00 kg ha^{-1} in Maharashtra among the selected states. Over the period, productivity improvement was witnessed in all the states, and the highest productivity increase was observed in Maharashtra and Rajasthan. As productivity across major mungbean cultivating states increased, average productivity in India also touched 555 kg ha^{-1} in TE-2021, which was 311.67 kg ha^{-1} in TE-1973. Madhya Pradesh was the only state with productivity lower than the national throughout the study period. Karnataka also recorded lower productivity than the national average except for TE-1976. Odisha demonstrated higher productivity than the national average till TE-1991 after that showed lower productivity than the national average. Maharashtra's productivity was lower than the national average till TE-1991, after that it showed higher productivity till TE-2011 but again became lower than the national average. Rajasthan's productivity was lower than the national average except for TE-1991 and TE-2011.

Growth in area, production, and productivity of mungbean in India

State-wise trends of mungbean area, production, and productivity have been depicted in Table 2. In the first period (1970-80), acreage and production registered a significant acceleration in India. However, in the second period, there was a significant increase in area and production, which was lower than in the first. Decreasing growth was found in the third and fourth periods as with Ahlawat *et al.* (2016) and Devegowda *et al.* (2018). There was a very slow growth in the area planted with mungbean in the country, while production and productivity showed declining growth between 2000-01 and 2005-06 and the growth slowed down between 2007-08 and 2010-11 in terms of area. However, production and productivity still showed a decreasing growth rate. Growth performance was also a similar trend with Ahlawat *et al.* (2016). It has surpassed an increasing growth rate in the last period, which was the highest growth rate in various decades. Of the three particulars (area, production, and productivity) productivity growth was stagnant in all periods.

In Karnataka, production registered negative growth rates in period III (-6.40%) and IV (-1.86%) corresponding to negative growths in productivity in period III (-8.71%) and area (-1.32%) as well as productivity (-10.13%) in period IV. Productivity (-0.60%) growth was found negative and non-significant in the overall period but area (3.12%) and production (2.37%) were positive and significant. Similar growth trends were reported by Acharya *et al.* (2012). Odisha registered a negative growth rate in production in period II (-0.86%) and III (-20.72%) due to negative growth in productivity (-1.40%) in period II and area (-10.80%) as well as productivity in period-III (-11.07%). In the overall period, all the particulars reflected negative growth. This indicated the dominance and increased importance of paddy in the state (Reddy 2013). Maharashtra registered negative growth in production in period IV (-7.85%) and period V (-6.29%). This might be attributed to shrinkage in the area under crop and productivity stagnation. As area registered negative growth in period III (-2.03%), IV (-5.54%), V (-1.45%) and overall period (-0.19%) but productivity registered negative growth rates in period IV (-2.41%) and V (-4.94%). But productivity improvement was significant in periods I and II. As soybean area registered tremendous area expansion in the state by replacing other low profitability crops.

Rajasthan exhibited positive growth rates in production except for period I (-13.31%) and III (-1.69%) due to negative growth in the area (-2.72%) as well as productivity (-10.90%) in period-I and productivity in period-III (-8.82%). Sood *et al.* (2020) observed similar trends in area, production, and productivity in the state in the 2000s. Madhya Pradesh demonstrated a large positive change in production in period V (31.20%) due to area expansion (17.06%) and productivity improvement (9.61%). In the rest of the periods, the change was either negative (in periods II, III, and IV) or non-significant because of area shrinkage and stagnant productivity of the crop in the state. This might be due to tremendous growth in soybean area in the state as soybean was introduced during the mid-

Table 1. Area, production and productivity of mungbean in India (1970-2021) **(Per cent)**

	Period	Southern Zone	Eastern Zone	Western Zone		Central Zone	India
		Karnataka	Odisha	Maharashtra	Rajasthan	Madhya Pradesh	
Area	**TE1973**	4.11	17.34	18.29	13.02	11.30	1955.33(100.00)
	TE1976	4.56	16.71	22.50	13.72	9.67	2398.00(100.00)
	TE1981	5.07	24.62	20.00	7.29	8.50	2661.67(100.00)
	TE1986	6.21	18.69	17.47	8.26	7.39	2966.67(100.00)
	TE1991	7.32	19.13	23.01	9.39	4.96	3332.33(100.00)
	TE1996	6.44	8.72	25.62	14.64	4.53	2852.33(100.00)
	TE2001	13.05	6.24	22.88	16.02	3.63	2990.33(100.00)
	TE2006	12.01	7.09	19.21	23.84	3.13	3332.67(100.00)
	TE2011	11.05	8.51	15.00	29.96	3.17	3181.33(100.00)
	TE2016	9.10	8.18	10.87	32.04	8.96	3409.87(100.00)
	TE2021	8.68	4.78	8.77	50.78	8.31	4821.89(100.00)
Production	**TE1973**	2.86	30.08	11.65	11.82	10.10	595.00 (100.00)
	TE1976	6.01	24.57	20.52	9.26	8.50	749.00 (100.00)
	TE1981	3.68	36.43	15.08	3.64	5.64	851.00 (100.00)
	TE1986	4.39	26.80	14.57	4.45	5.28	1199.00(100.00)
	TE1991	6.79	23.14	23.02	7.93	3.61	1374.00(100.00)
	TE1996	4.92	7.33	29.88	7.85	3.89	1104.33(100.00)
	TE2001	11.86	3.46	28.82	5.49	2.88	1087.33(100.00)
	TE2006	5.83	4.59	22.10	22.91	2.70	1235.33(100.00)
	TE2011	5.41	6.24	17.43	29.69	2.86	1201.33(100.00)
	TE2016	3.78	5.94	7.68	30.82	8.81	1566.67(100.00)
	TE2021	5.78	2.61	6.98	48.86	14.73	2683.20(100.00)
Productivity	**TE1973**	-31.28	41.49	-37.10	-9.33	-9.88	303.67 (100.00)
	TE1976	33.90	47.49	-8.66	-33.69	-12.19	311.67 (100.00)
	TE1981	-27.17	47.96	-24.24	-51.72	-33.65	319.00 (100.00)
	TE1986	-29.67	43.06	-16.53	-43.39	-28.68	403.33 (100.00)
	TE1991	-8.97	21.16	-0.16	2.02	-27.46	412.67 (100.00)
	TE1996	-23.19	-18.02	16.03	-46.47	-14.22	386.67 (100.00)
	TE2001	-12.02	-44.50	26.79	-65.60	-17.25	363.33 (100.00)
	TE2006	-50.95	-35.15	14.08	-4.18	-20.07	367.00 (100.00)
	TE2011	-51.76	-25.43	12.89	30.39	-10.01	369.67 (100.00)
	TE2016	-58.17	-27.86	-32.40	-3.74	-15.59	463.00 (100.00)
	TE2021	-33.33	-45.41	-20.06	-3.54	23.18	555.00 (100.00)

Note 1: TE= Triennium ending, **Note 2: TE 1973**; (1970-71to 1972-73); **TE 1976**: (1973-74 to 1975-76); **TE 1981**: (1978-79, 1979-80,1980-81); **TE 1986**: (1983-84, 1984-85, 1985-86); **TE 1991**: (1988-89, 1989-90, 1990-91); **TE 1996**: (1993-94, 1994-95, 1995-96); **TE 2001**: (1998-99, 1999-00, 2000-01); **TE 2006**: (2003-04, 2004-05, 2005-06); **TE 2011**: (2008-09, 2009-10, 2010-11); **TE 2016**: (2013-14, 2014-15, 2015-16); **TE 2021**: (2018-19, 2019-20, 2020-21)., **Note 3**: Area and production represented as percentage share of states to all India and productivity of state as percentage changes over productivity at all India level.

1970s (Sharma *et al*. 2015). The results for major states conformed with Avinash and Patil (2018).

The production in all the major states increased except Odisha. In Karnataka, production increase was mainly governed by area expansion as productivity registered negative growth in the overall period. In Maharashtra and Madhya Pradesh production increase was yielded by productivity improvements. In Rajasthan and all India levels, production gain was attributed to both area and productivity enhancement. In Odisha, area, production, and productivity registered negative growth rates during the overall period.

Trends in performance of mungbean in India

From Figure 1-3 the trends in area (Figure 1), production (figure 2), and productivity (Figure 3) of mungbean are presented. The trends showed annual upward movement throughout the entire study period based on log-linear graphs, nonetheless, a deliberate reflection of all the data pointed out that, there were variations in the upward movement in data sets. The R^2 values of area (0.66), production (0.55) and productivity (0.30) suggested that 66, 55, and 30% of the variation in the respective trends were predicted by the independent variable (time) were highly significant ($P<0.01$).

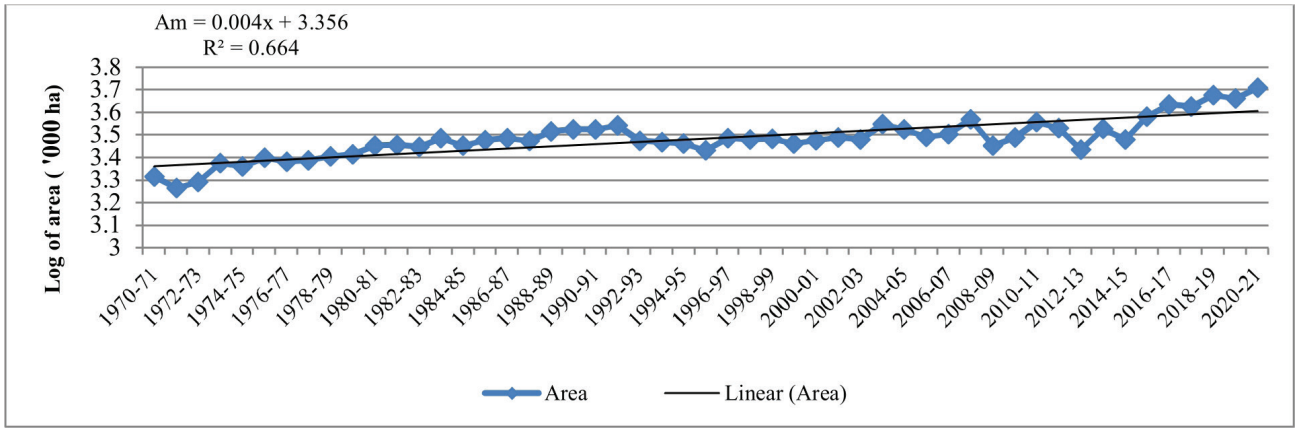

Fig. 1. Trends in the area of mungbean in India

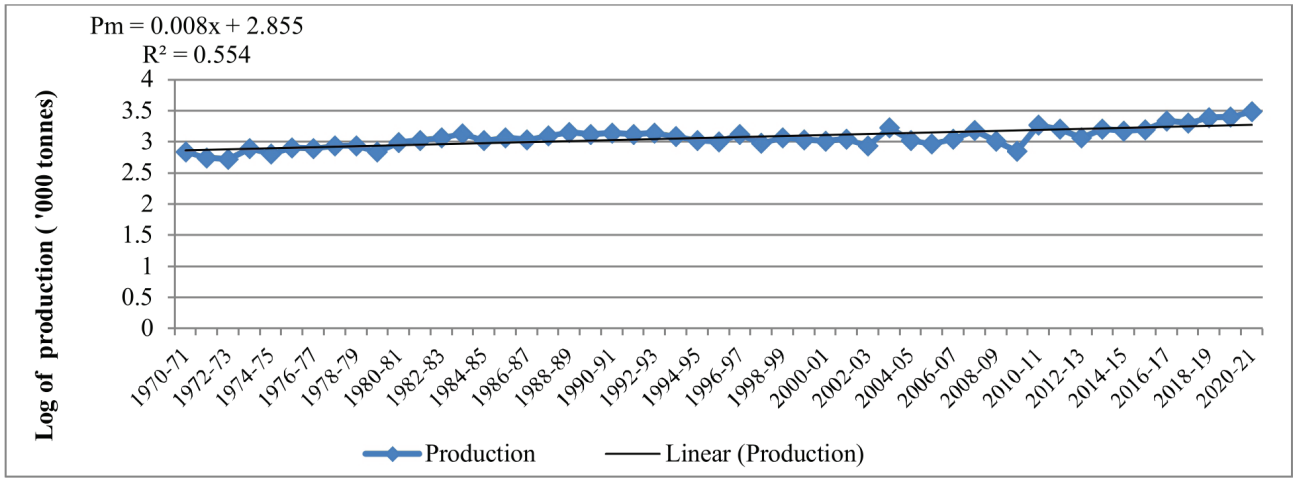

Fig. 2. Trends in the production of mungbean in India

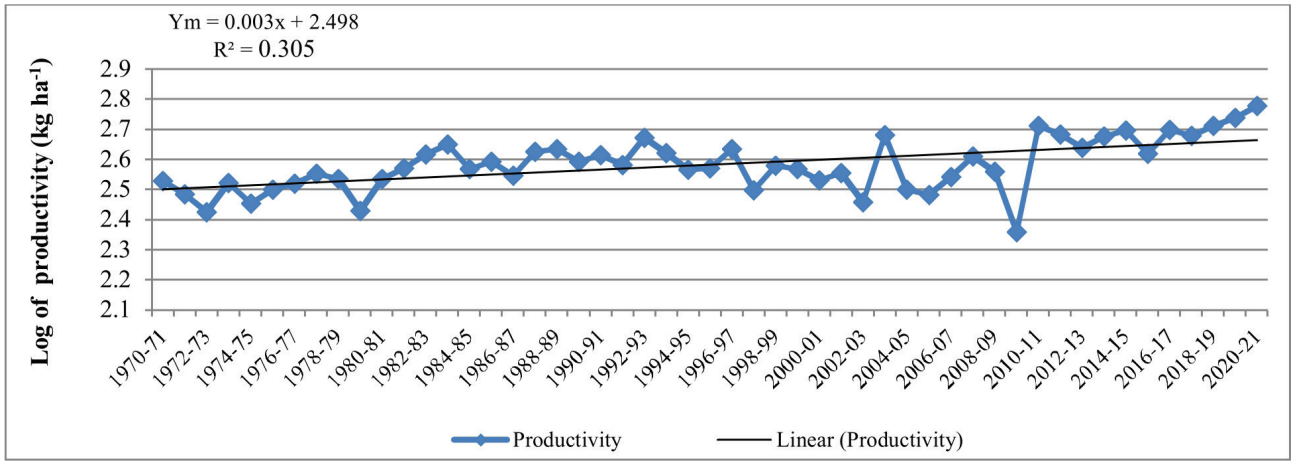

Fig. 3. Trends in productivity of mungbean in India

Instability in area, production, and productivity of mungbean in India

The results of instability in area, production, and productivity of mungbean during the study period are presented in Table 3. In India, the variability of the area under the mungbean increased over time but the variability of its productivity and production increased and fluctuated. Due to

Table 2. Growth in area, production, and productivity of mungbean in India (1970-2021) **(Per cent)**

	Period	Southern Zone	Eastern Zone	Western Zone		Central Zone	India
		Karnataka	Odisha	Maharashtra	Rajasthan	Madhya Pradesh	
Area	Period-I	6.24***	7.82***	4.98***	-2.72	0.12	3.41***
	Period-II	5.13***	0.55	5.02***	2.44	-4.16***	1.75***
	Period-III	2.59	-10.80**	-2.03***	4.97**	-3.87***	-1.27
	Period-IV	-1.32	5.67***	-5.54***	7.11***	-1.40***	0.21
	Period-V	4.51	-1.00	-1.45	11.17**	17.06***	4.79***
	Overall period	3.12***	-1.88***	-0.19	4.64***	-0.18	1.13***
Production	Period-I	7.77	5.02**	10.27**	-13.31*	-3.03	3.60*
	Period-II	6.84*	-0.86	12.84***	5.72	-2.72*	2.81**
	Period-III	-6.40	-20.72***	0.39	-1.69	-2.52	-3.01**
	Period-IV	-1.86	8.23***	-7.85*	5.70	10.04	-1.44
	Period-V	7.87	1.10	-6.29	12.06**	31.20***	5.71**
	Overall period	2.37***	-3.39***	1.02**	6.77***	1.41*	1.89***
Productivity	Period-I	1.43	1.87	5.02**	-10.90**	-3.16	0.18
	Period-II	1.95	-1.40*	7.45***	3.20	1.43	1.03
	Period-III	-8.71**	-11.07**	2.46	-8.82	1.28	-1.77
	Period-IV	-10.13	2.31***	-2.41	10.93	2.03	-1.64
	Period-V	3.23	2.08	-4.94	0.81	9.61***	0.87
	Overall period	-0.60	-1.31***	1.21***	2.29***	1.26***	0.75***

Note 1: Period-I: (1970-71 to 1979-80); **Period-II**: (1980-81 to 1989-90); **Period-III**: (1990-91 to 1999-2000); **Period-IV** (2000-01 to 2009-10); **Period-V** (2010-11 to 2019-20) and **Overall period** (1970-71 to 2020-21).

Note 2: *, **,** and * are significant at 1, 5 and 10 % respectively

these opposite factors, the variability in mungbean production in the total period remained around 28.29 percent. Among the two (area and productivity), productivity contributed relatively more to the variability in every period except for the fifth period. Bisht and Kumar (2018) observed similar trends in the 2000s. It should be noted that the variability around the trend in the case of the area was relatively low compared to the productivity for the study period. The highest uncertainty was found in the overall period and the lowest in period II. The variability during 1990-00 and 2000-10 was almost the same with Devegowda *et al*. (2019).

In Karnataka, productivity was found highly unstable with fluctuating patterns, also area and production instability increased over time except for period V (area 20.14%, production 32.81%, and productivity 23.79%). In Odisha, production increased over time but the trend was very irregular corresponding to area and productivity trends. In the overall period, all the particulars were found highly unstable. In Maharashtra productivity

Table 3. Instability in area, production, and productivity of mungbean in major producing states in India: 1970- 2021 **(Per cent)**

Period	Southern Zone			Eastern Zone			Western Zone						Central Zone			All India		
	Karnataka			Odisha			Maharashtra			Rajasthan			Madhya Pradesh					
	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y
Period-I	10.51	40.52	39.28	12.27	20.73	27.68	14.42	24.24	14.35	24.11	43.09	32.95	5.82	17.62	15.08	5.59	13.26	10.18
Period-II	10.36	25.46	20.75	11.34	10.76	6.28	12.38	17.77	13.31	13.60	73.14	71.37	2.75	11.68	10.34	3.45	9.43	8.30
Period-III	25.79	53.07	30.76	41.23	66.61	26.47	4.91	29.55	26.90	16.47	65.13	55.66	3.86	14.76	13.00	6.19	10.08	9.53
Period-IV	21.15	66.25	72.48	12.63	15.09	5.26	10.41	32.80	24.15	13.55	70.87	45.63	3.49	26.35	10.45	8.37	26.44	19.45
Period-V	20.14	32.81	23.79	13.85	21.87	10.58	14.43	38.83	29.11	21.32	32.03	19.31	32.33	27.49	12.93	10.80	15.40	7.52
Overall period	27.77	54.33	43.36	38.98	58.09	30.66	24.06	44.72	28.20	49.86	90.92	45.92	52.14	114.97	25.85	12.75	28.29	16.21

Note 1: Period-I: (1970-71 to 1979-80); **Period-II**: (1980-81 to 1989-90); **Period-III**: (1990-91 to 1999-2000); **Period-IV**: (2000-01 to 2009-10); **Period-V (**2010-11 to 2019-20) and **Overall period** (1970-71 to 2020-21).

Note 2: A=Area, P=Production, Y= Productivity

became moderately unstable after period II while the area registered low instability throughout the study period. Production instability was moderate in the initial period but became highly unstable in periods IV and V due to an increase in area and productivity instability. In Rajasthan, productivity was highly unstable except for period-V (19.31%) and area instability was low to moderate but fluctuating. As a result of area and productivity instability in the state production registered high instability in the state. Sood *et al.* (2020) observed similar results in the 2000s. In Madhya Pradesh productivity instability declined over the years with a fluctuating pattern but the area was very stable except for period V (32.33%). Production was found moderately unstable in the state with the highest instability in period-V (27.49%). In Odisha, Rajasthan, and Madhya Pradesh, the area has shown higher instability than productivity, but Karnataka, Maharashtra, and all of India showed higher instability in productivity.

CONCLUSION

Mungbean is a legume grown mainly in Asia and has spread to countries outside Asia primarily because of its multiple uses *i.e.* nutrient source for humans, soil fertilization, animal forage crop, and even medicinal component. The results showed that the mungbean area and production declined in the eastern zone (Odisha) but showed considerable growth in the southern zone (Karnataka). In the western zone, its area and production declined in Maharashtra but increased considerably in Rajasthan. In the central zone (Madhya Pradesh) area declined but production share increased in recent years due to productivity enhancements. The growth rates in area, production, and productivity of mungbean (1.13%, 1.89% and 0.75%, respectively) in India from 1970-2021 showed an increasing trend. But productivity increase in mungbean was also very low. In mungbean (16.21%) productivity was found more unstable than area. Therefore, it is necessary to promote the adoption of conservation practices, harvesting of rainwater by creation of structures like farm ponds as well as to expand irrigation facilities to overcome variability in productivity.

REFERENCES

Anonymous. 2021. Agricultural Statistics at a Glance. Ministry of Agriculture & Farmers Welfare, Government of India, New Delhi.

Acharya SP, Basavaraja H, Kunnal LB, Mahajanashetti SB and Bhat ARS. 2012. Growth in area, production and productivity of major crops in Karnataka. Karnataka Journal of Agricultural Sciences **25**(4): 431-436.

Agarwal PK and Yadav P. 2017. Scenario of pulses production in India: a growth decomposition approach. Trends in Biosciences **10**(29): 6230-6236.

Ahlawat IPS, Sharma P and Singh U. 2016. Production, demand and import of pulses in India. Indian Journal of Agronomy **61**(4th IAC Special issue): S33-S41.

Ali MA, Abbas G, Mohy-ud-Din Q, Ullah K, Abbas G and Aslam M. 2010. Response of mungbean (*Vigna radiata*) to phosphatic fertilizer under arid climate. Journal of Animal and Plant Sciences **20**(2): 83-86.

Avinash CS and Patil BL. 2018. Trends in area, production and productivity of major pulses in Karnataka and India: An economic analysis. Journal of Pharmacognosy and Phytochemistry **7**(4): 2097-2102.

Bisht A and Kumar A. 2018. Growth and instability analysis of pulses production in India. International Journal of Agriculture Sciences **10**(14): 6722-6724.

Devegowda SR, Singh OP, Kushwaha S and Nagaveni M. 2019. Analysis of variability on pulses in India. The Pharma Innovation Journal **8**(4): 440-444.

FAOSTAT 2016. The International Year of Pulses Final Report. FAO Statistics accessed on 20.08.2022 at *https://www.fao.org/faostat/en/#data.*

FAOSTAT 2019. The Global of Economy Pulses, 56. FAO Statistics accessed on 10.08.2022 at *https://www.fao.org/faostat/en/#data.*

FAOSTAT 2022. FAO Statistics accessed on 15.08.2022 at *https://www.fao.org/faostat/en/#data.*

Reddy AA. 2013. Agricultural productivity growth in Orissa, India: Crop diversification to pulses, oilseeds and other high value crops. African Journal of Agricultural Research **8**(19): 2272-2284.

Sharma P, Patel RM and Dupare BU. 2015. Profitability of soybean *vis-à-vis* major kharif crops in Madhya Pradesh. Soybean Research **13**(2): 65-77.

Sihmar R. 2014. Growth and Instability in Agricultural Production in Haryana: A District level Analysis. International Journal of Scientific and Research Publications **4**(7): 1-7.

Singh V, Sharma SK, Thakral SK and Sharma MK. 2019. Effect of phosphorus on the performance of greengram (*Vigna radiata L*) varieties during summer. Legume Research **42**(2): 247-249.

Sood S, Singh H and Sethi D. 2020. Growth performance and instability of pulses in the state of Rajasthan. Indian Journal of Agricultural Research **54**(5): 646-650.

Wang L, Wang S, Gaoling Luo G, Zhang J, Chen Y, Chen H and Cheng X. 2022. Evaluation of the Production Potential of Mung Bean Cultivar "Zhonglv 5". Agronomy **12**: 1-7.