The Pharma Innovation Journal 2023; 12(5): 2920-2928

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2023; 12(5): 2920-2928

www.thepharmajournal.com
Received: 03-03-2023
Accepted: 10-04-2023

Neelam Kumari
Department of Agricultural Economics, College of Agriculture, CCS HAU, Hisar, Haryana, India

DP Malik
Department of Agricultural Economics, College of Agriculture, CCS HAU, Hisar, Haryana, India

Corresponding Author:
Neelam Kumari
Department of Agricultural Economics, College of Agriculture, CCS HAU, Hisar, Haryana, India

Status, growth and variability of pulses in India

Neelam Kumari and DP Malik

Abstract
The present study was conducted to estimate the growth and instability of pulses production across major states in India. The time series secondary data on area, production and productivity of pulses were collected for all the major states from the period 1970-71to 2020-21. Statistical tools like compound growth rate for calculating annual growth rate and Cuddy Della Valle Index for instability index were used. Results showed that the area of pulses in Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Rajasthan and Madhya Pradesh increased at a highly significant annual growth rate but the area in Uttar Pradesh was declined at a significant rate per annum (-0.81%) during overall period. Production and productivity of pulses in Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Rajasthan and Madhya Pradesh were found to be increased at highly significant rate annually but production declined at a significant rate (-0.56%) in Uttar Pradesh. Instability of area in Uttar Pradesh, Andhra Pradesh, Karnataka, Maharashtra and Madhya Pradesh was low while in Gujarat and Rajasthan was moderate. Production instability was medium in all the major states except Uttar Pradesh (low) and Rajasthan (high).Yield instability was low in Uttar Pradesh and Madhya Pradesh while medium in Andhra Pradesh, Karnataka, Maharashtra and Rajasthan. Gujarat was the only state which showed high instability in yield. All India registered low instability in area and productivity whereas medium in production.

Keywords: Compound growth rate, instability, Cuddy-Della Valle Index, significant, production, area, and productivity

Introduction
Pulses are edible dry seeds of plants belonging to the *Leguminosae* family. The word 'pulse' comes from the Latin word 'puls' meaning thick soup. They are consumed in the form of whole seed, split grain, dehulled split grain and flour. There are two aspects of pulses that distinguish them from most other food crops. First, they are very nutritious and their consumption is associated with many health benefits. They are rich sources of proteins and minerals, have high fibre content and low fat content and without cholesterol. The carbohydrates in pulses are absorbed and digested slowly, and thus help control diabetes and obesity. Secondly, pulses have root nodules which have unique characteristics of maintaining and restoring soil fertility through biological nitrogen fixation (Saxena, *et al.* 2010, Narayan and Kumar, 2015) [8, 6].

Pulses are highly pretentious food crops globally. Pulses play a significant role in providing nutritionally balanced diet. The 68th UN General Assembly had declared 2016 as 'International Year of Pulses' with theme 'Nutritious food for a sustainable future' which showed global importance of pulses (FAO, 2016). It is an established fact that a human body requires a daily intake of about 55 to 60 g of protein. Out of the 22 amino acids required in the human diet, the body supplies 14 amino acids and remaining eight have to come from food. ICMR has recommended an average daily consumption of 50 gm of pulses daily. Pulses contain 20-24 percent *i.e.*, about 2.5 times more amount of protein than in cereal grains and hence, offers the most practical means of eradicating malnutrition in India (Annual Report, 2018) [3].

In 2020, pulses accounted for 93.18 million ha of global crop area producing 89.82 million tonnes of grain with average yield of 964 Kg ha^{-1}. Asia dominates in pulses production with 43 percent of regional contribution followed by Africa (23%), Americans (21%), Europe (11%) and Oceania (2%).

Although pulses are cultivated in all the continents around the world, India (26.02%), Canada (9.09%), China (5.34%), Myanmar (4.48%), Nigeria (4.13%), Russia (3.84%), Brazil (3.40%), USA (3.37%), Australia (2.13%) and Tanzania (1.87%) are the major pulses producing countries, in 2020 (FAO, 2022). Pluses occupy a unique position in every system of Indian farming as a main, catch, cover, green manure and intercrop. They have played very important role in human diet of our country as a source of protein (24.04%), carbohydrate (60%), fat (1.5%), amino acids, phosphoric acids, vitamins and minerals consumed in the form of "dal". India is one of the major pulse producing countries contributing about 33 percent of world area and 25 percent of world production of pulses. However India's rank in yield is low, 24th in chickpea, 9th in pigeon pea, 23rd in lentil and 98th in total pulses (Reddy, 2004) [7]. Pulses are also an important component of Indian agricultural economy next to food grains and oilseeds in terms of acreage, production and economic value (Choudhary, *et al.* 2009) [4]. More than 2/3rd of area and production has been obtained from the six states of India *viz*., Madhya Pradesh, Rajasthan, Maharashtra, Karnataka, Andhra Pradesh and Uttar Pradesh (Shukla and Mishra, 2020). Major pulses grown in India are chickpea (Bengal gram or gram), pigeonpea (red gram or tur or arhar), lentil (massor), black gram (urdbean), mungbean (green gram) (Agarwal and Yadav, 2017) [1]. Madhya Pradesh is the largest pulses producing state in India. The pulses production in the country has gone up from 11.82 to 25.46 million tonnes during last five decades (1970-2021), registering a two-fold increase in production. During the same period, the area augmented from 22.53 to 28.78 million ha, the yield has steadily increased from 524 kg ha^{-1} to 885 kg ha^{-1}.

Materials and Methods

Study area and crops

The pulses growing states were selected based on their contribution sharing 80 percent to area during 2020-21. As per the above criteria, states like Uttar Pradesh, Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Rajasthan and Madhya Pradesh were selected. To study temporal variations in pulses production, the study period was divided into the following five periods: 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 pulses cultivation over time, the states were grouped into four zones based on their geographical location. The northern zone comprises of Haryana and Uttar Pradesh; the southern zone included Andhra Pradesh and Karnataka while the western zone included Gujarat, Maharashtra and Rajasthan. The central zone has only two states, Madhya Pradesh and Chhattisgarh. Also, the states which were bifurcated after 1970-71 were merged with the parent states. Chhattisgarh was bifurcated from Madhya Pradesh on 1st November 2000. Hence, area and production of Chhattisgarh was combined with Madhya Pradesh.

Period and source of data

The present study is based on secondary data and the required time series data were collected from Directorate of Economics and Statistics. The period of the study is from the year1970-71 to 2020-21.

Statistical tools

Statistical tools like compound growth rate and Cuddy-Della Valle Index were used to analyze growth rates and instability in area, production and productivity of major pulses producing states India respectively.

Compound growth rate

C.G.R. (%) = (Antilog b – 1) *100
Where, b = regression coefficient

Cuddy Della Valle Instability index

Cuddy and Della Valle 1978 is a modification of coefficient of variation to accommodate trend present in the data, which is commonly present in economic time series data. This method is superior over the scale dependent measures such as standard deviation. The Cuddy Della Valle index (CDVI) is calculated as follows:

$$\text{Cuddy - Della Valle Index (\%)} = \text{C.V.} * \sqrt{(1-R^2)}$$

Where, C.V. = Coefficient of Variation
R^2 = Coefficient of multiple determination

The ranges of CDVI (Sihmar, 2014) are given as follows:
Low instability = 0 to15
Medium instability = greater than 15 and lower than 30
High instability = > 30

Results and Discussion

In India pulses are cultivated under rain fed as well as irrigated conditions in winter, summer and rainy seasons. Pulses cultivation is spread all over the country but seven (07) states *viz*, Uttar Pradesh, Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Rajasthan and Madhya Pradesh were the major pulses cultivating states in India. Uttar Pradesh was the second largest pulses cultivating state in TE-1973 with an area share of 16.40 percent, showed declining trend in cultivated area and reached to a minimum area share in TE-2021(8.19%). The share of Andhra Pradesh in pulses cultivation was 6.31 percent in TE-1973, attended a maximum share of 8.50 percent in TE-2006, after that showed decline in area and reached to 6.33 percent in TE-2021. Karnataka's share was 5.41 percent in TE-1973, which showed increased share in cultivated area and confirmed maximum share in TE-2021 (11.17%).Gujarat's share was only 1.88 percent in TE-1973, which reached to 3.68 percent in TE-1991and slightly declined to 3.45 percent in TE-2021. Maharashtra's shares was 9.75 percent in TE-1973, attained a maximum share of 16.79 percent in TE-2001, after that showed decline in area and touched 14.81 percent in TE-2021.

Table 1: Share of major total pulses producing states in India: 1970-2021

	Period	Northern zone		Southern zone		Western zone			Central zone	All India
		Haryana	Uttar Pradesh	Andhra Pradesh	Karnataka	Gujarat	Maharashtra	Rajasthan	Madhya Pradesh	
Area	TE1973	5.21	16.40	6.31	5.41	1.88	9.75	15.95	19.72	21866.67 100.00)
	TE1976	4.37	13.99	6.13	5.89	1.64	11.97	16.68	20.05	23301.67 (100.00)
	TE1981	3.71	12.90	6.19	6.64	2.40	12.10	14.30	20.45	22791.00 (100.00)
	TE1986	3.16	12.53	5.96	6.83	3.39	12.31	15.60	20.42	23437.00 (100.00)
	TE1991	2.93	12.71	6.66	6.95	3.68	14.03	13.57	20.94	23474.67 (100.00)
	TE1996	1.75	12.66	7.55	8.15	3.52	15.29	14.26	21.37	22269.34 (100.00)
	TE2001	1.13	12.90	8.09	9.12	3.46	16.79	14.95	22.22	21157.47 (100.00)
	TE2006	0.84	12.15	8.50	8.78	3.42	15.11	16.01	20.90	22639.10 (100.00)
	TE2011	0.68	10.05	8.13	10.25	3.35	14.62	16.62	21.88	23926.05 (100.00)
	TE2016	0.45	8.87	6.85	10.36	2.70	14.80	15.51	23.31	24561.95 (100.00)
	TE2021	0.27	8.19	6.33	11.17	3.45	14.81	21.41	24.07	28642.14 (100.00)
Production	TE1973	6.36	27.16	3.44	3.38	1.33	5.70	12.46	20.11	10939.67 (100.00)
	TE1976	5.47	20.24	3.73	5.28	1.32	9.64	13.08	20.71	11020.67 (100.00)
	TE1981	6.17	20.44	3.66	5.50	2.20	9.25	12.44	21.30	10460.67 (100.00)
	TE1986	3.65	20.90	4.44	4.42	3.80	9.26	12.63	15.94	12739.00 (100.00)
	TE1991	4.01	19.14	5.05	3.81	4.11	11.98	10.98	18.18	13657.33 (100.00)
	TE1996	2.37	19.11	6.43	5.46	3.65	14.23	11.18	21.63	12779.66 (100.00)
	TE2001	1.44	19.32	7.32	6.96	3.35	16.64	11.09	24.01	12218.67 (100.00)
	TE2006	1.03	17.03	8.05	4.86	3.93	12.93	12.90	23.77	14017.50 (100.00)
	TE2011	0.86	12.45	10.40	7.63	4.25	16.03	9.30	25.52	14663.27 (100.00)
	TE2016	0.57	9.99	8.01	7.76	3.43	13.75	11.69	23.56	18251.52 (100.00)
	TE2021	0.31	10.01	6.56	8.34	3.77	13.85	16.54	23.41	23505.81 (100.00)
Yield	TE1973	22.21	65.78	-45.63	-38.23	-29.22	-42.09	-22.35	2.07	499.67 (100.00)
	TE1976	24.42	51.74	-38.74	-16.35	-17.37	-20.93	-20.42	-2.69	458.67 (100.00)
	TE1981	70.50	59.21	-40.86	-17.04	-8.08	-23.23	-14.42	-4.81	457.67 (100.00)
	TE1986	13.82	67.86	-24.92	-34.92	11.97	-16.90	-18.75	-21.41	540.33 (100.00)
	TE1991	37.57	52.35	-23.19	-44.58	12.70	-13.68	-18.09	-11.25	575.00 (100.00)
	TE1996	34.34	50.96	-15.28	-33.49	3.19	-7.14	-21.97	0.96	573.90 (100.00)
	TE2001	11.42	43.30	-13.90	-27.25	-10.98	-5.30	-34.14	2.76	604.33 (100.00)
	TE2006	17.97	40.85	5.25	-35.49	17.58	-9.07	-32.23	71.14	603.00 (100.00)
	TE2011	33.18	25.20	45.86	-25.35	15.86	1.36	-29.95	87.27	660.00 (100.00)
	TE2016	1.26	-8.38	120.68	-23.38	30.41	-14.30	-21.38	81.04	715.67 (100.00)
	TE2021	17.44	26.73	114.60	-23.65	41.83	2.03	-17.36	103.16	821.67 (100.00)

Note: TE 1973: (1970-71, 1971-72, 1972-73); TE 1976: (1973-74, 1974-75, 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).

Source: Agriculture statistics at a glance, GOI, New Delhi

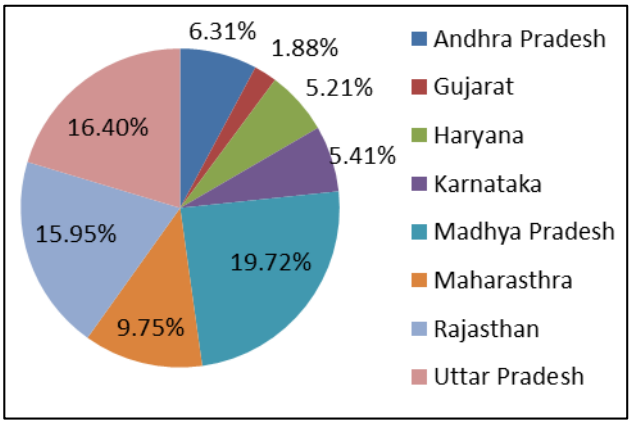

Fig 1: Area of major pulses cultivating states in TE-1973

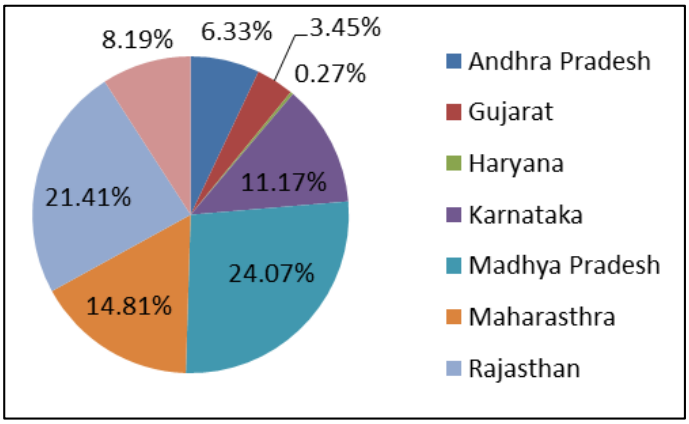

Fig 2: Area of major pulses cultivating states in TE-2021

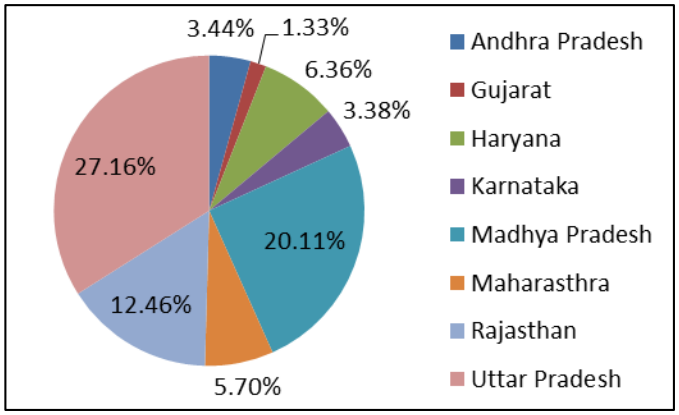

Fig 3: Production of major pulses cultivating states in TE-1973

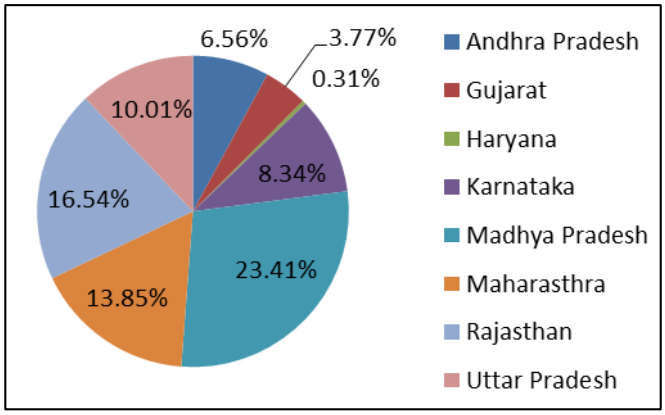

Fig 4: Production of major pulses cultivating states in TE-2021

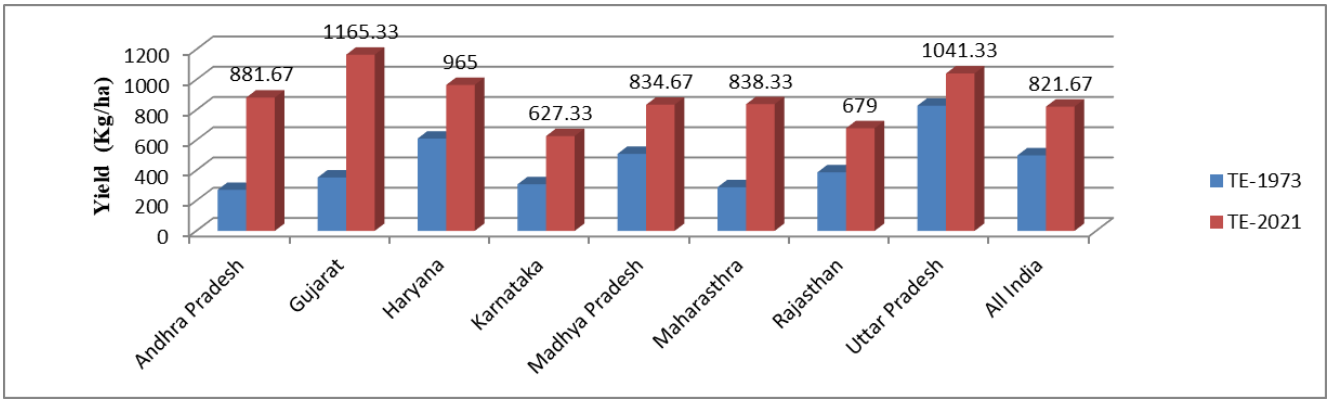

Fig 5: Yield of major pulses cultivating states in India (TE-1973, TE-2021)

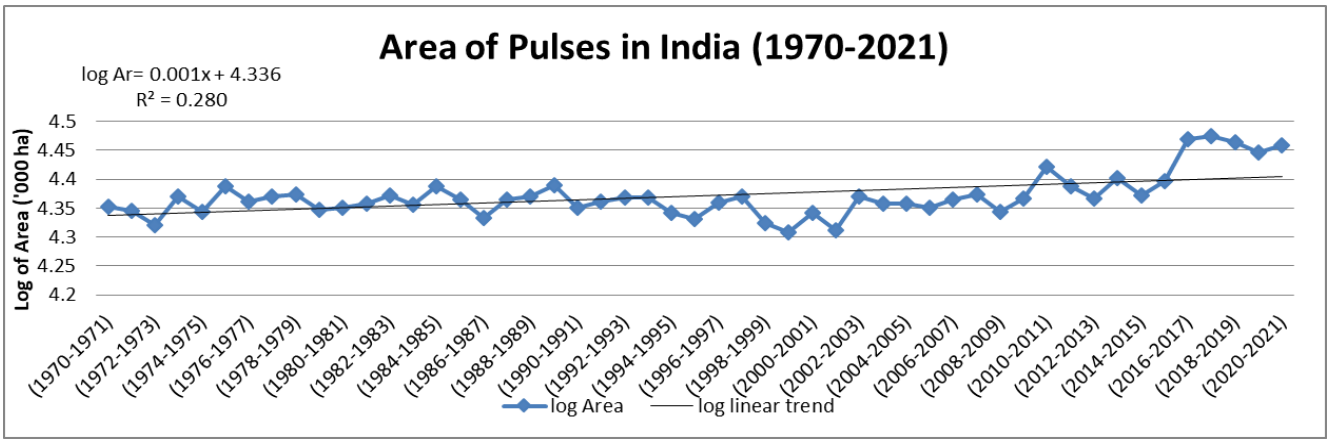

Fig 6: Trends in Area of pulses in India (1970-2021)

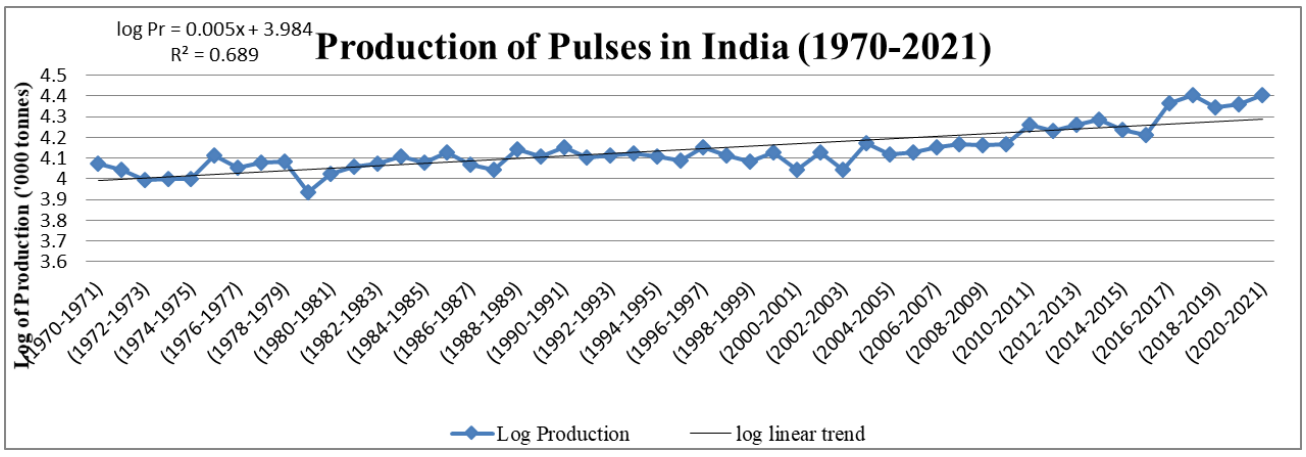

Fig 7: Trends in Production of pulses in India (1970-2021)

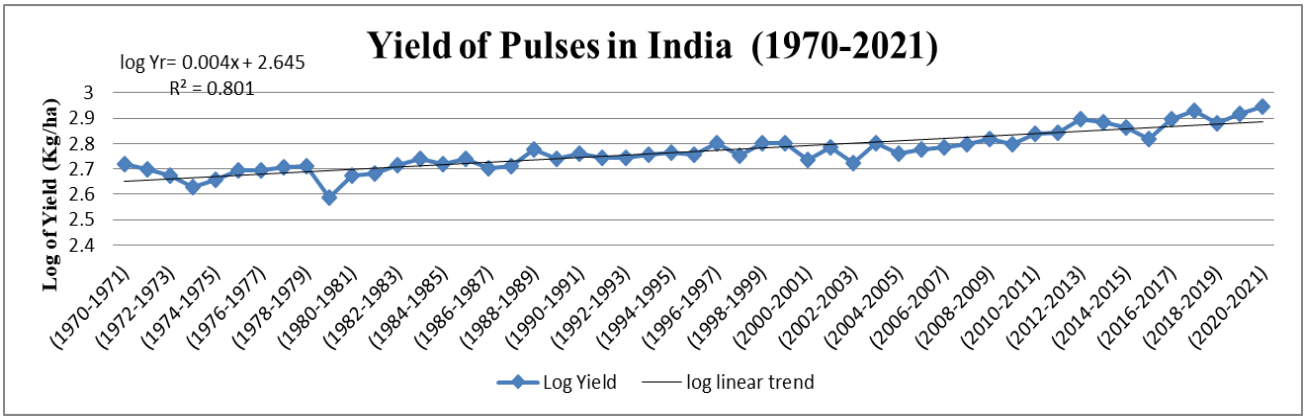

Fig 8: Trends in yield of pulses in India (1970-2021)

Rajasthan was the third largest pulses cultivating state in India in TE-1973 with a share of 15.95 percent, which increased to 16.62 percent in TE-2011. With a share of 21.41 percent in TE-2021 it ranked second in pulses producing states in the country. Madhya Pradesh was the largest pulses cultivating state throughout the study period with highest contribution of 24.07 percent in TE-2021.The highest reduction in pulses area share was recorded in Haryana from 5.21 percent in TE-1973 to 1.13 percent in TE-2001 and touched a minimum to 0.27 percent in TE-2021 whereas, Karnataka, Gujarat, Maharashtra, Rajasthan and Madhya Pradesh showed significant expansion during the study period. In Indian scenario, pulses area recorded marginal increase from 21866.67 thousand ha in TE-1973 to 28642.14 thousand ha in TE-2021and the maximum coverage under pulses was attained in TE-2021.

State-wise share of pulses production showed that Uttar Pradesh was the largest pulses producing state in TE-1973 with a production share of 27.16 percent and reached to a minimum share in TE-2016 (9.99%) and after that showed slight increase in TE-2021 (10.01%). Share of Andhra Pradesh in pulses production was 3.44 percent in TE-1973, attained a maximum share of 10.40 percent in TE-2011, after that showed decline in production to 6.56 percent in TE-2021. Karnataka's share was 3.38 percent in TE-1973, which showed increased share in cultivated area and confirmed maximum share in TE-2021 (8.34%). Gujarat's share was only 1.33 percent in TE-1973, which reached to 4.25 percent in TE-2011and slightly declined to 3.77 percent in TE-2021. Maharashtra's share was 5.70 percent in TE-1973, attained maximum share of 16.64 percent in TE-2001, after that showed decline in production and reached to 13.85 percent in TE-2021. Rajasthan was the third largest pulses producing state in TE-1973 with a share of 12.46 percent, which increased to 12.90 percent in TE-2006. With a share of 16.54 percent in TE-2021 it becomes the second largest pulses producing state in the country. Madhya Pradesh was the second largest pulses producing state in TE-1973 with a contribution of 20.11percent, attained a maximum share of 24.01 percent in TE-2001while it was the largest pulses producing state in TE-2021 with a share of 23.41percent. The highest reduction in pulses production share was recorded in Haryana from 6.36 percent in TE-1973 to 1.03 percent in TE-2001 to a minimum of 0.31 percent in TE-2021 whereas, Karnataka, Gujarat, Maharashtra, Rajasthan and Madhya Pradesh showed increase in production of pulses. In Indian context, net increase of 12566 thousand tones over five decades could be observed with the highest production of 23506 thousand tunes in TE-2021.

Large variation in yield across states was prevalent during the study period. Over the period, yield improvement has been witnessed in all the states and highest yield was recorded in Andhra Pradesh (1763 kg ha^{-1}) in TE-2021. Haryana and Uttar Pradesh recorded yield of pulses higher than national average during last five decades. Yield of Karnataka and Rajasthan states was lower than national average throughout the study period. Yield of Andhra Pradesh was lower than national average till TE-2001 (520.33 kg ha^{-1}), but showed remarkable improvement in the recent years. Pulses Yield in Maharashtra improved in recent years. Gujarat showed a mixed trend of yield but after TE-2001 (572.33 kg ha^{-1}); its yield was higher than national average. After TE-2006 (1032.00 kg ha^{-1}), Madhya Pradesh showed tremendous improvement in pulses yield and touched 1669.33 kg ha^{-1} in TE-2021. Average yield of pulses in India as a whole increased from 499 kg ha^{-1} in TE-1973 to 821 kg ha^{-1} in TE-2021.

Trends in performance of pulses in India (1970-2021)

From figure 6-8 the trends in area (Figure 6), production (Figure 7) and yield (Figure 8) of pulses were 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 (0.28), production (0.68) and yield (0.80) suggested that 28, 68 and 80 percent of variation in the respective trends were predicted by the independent variable (time) were highly significant (p<0.01).

Growth trends in area, production and yield of pulses in India

State-wise trends of pulses area, production and yield have been depicted in table 2. During Period-I, Karnataka (2.47%), Gujarat (3.37%) Maharashtra (3.10%), Rajasthan (0.11%) and Madhya Pradesh (1.42%) exhibited positive growth rates in area but the growth was non-significant except Maharashtra and Madhya Pradesh. Uttar Pradesh (-2.64%) and Andhra Pradesh (-0.32%) confirmed negative acreage growth rates, but the change was significant only for Uttar Pradesh. India experienced non-significant positive growth of 0.60 percent per annum. During Period-II, Rajasthan (-3.61%) and Madhya Pradesh (-0.55%) experienced negative growth rate and other major states showed positive growth rates; Maharashtra

(2.13%) exhibited highest growth followed by Gujarat (1.74%), Karnataka (1.17%), Andhra Pradesh (0.58%) and Uttar Pradesh (0.34%). Karnataka and Maharashtra were the only states exhibited significant growth rates. India attained positive growth rate of 0.42 percent per annum. During Period-III, pulses area in Uttar Pradesh (-1.32%) demonstrated negative and significant growth rate but the change was non-significant in Gujarat (-0.40%) while Andhra Pradesh (0.41%), Karnataka (1.48%), Maharashtra (1.10%), Rajasthan (1.38%) and Madhya Pradesh (0.42%) showed positive growth rates. Karnataka and Maharashtra acreage growth under pulses was significant. India exhibited statistically significant negative growth rate of 0.93 percent per annum.

Table 2: Compound growth rates of area, production and yield of total pulses in major producing states in India: 1970-2021

	Period	Northern zone		Southern zone		Western zone			Central zone	All India
		Haryana	Uttar Pradesh	Andhra Pradesh	Karnataka	Gujarat	Maharashtra	Rajasthan	Madhya Pradesh	
Area	Period-I	-3.03^{NS}	-2.64***	-0.32^{NS}	2.47^{NS}	3.37^{NS}	3.10*	0.11^{NS}	1.42***	0.60^{NS}
	Period-II	-5.42^{NS}	0.34^{NS}	0.58^{NS}	1.17**	1.74^{NS}	2.13***	-3.61^{NS}	-0.55^{NS}	0.42^{NS}
	Period-III	-12.05**	-1.32***	0.41^{NS}	1.48**	-0.40^{NS}	1.10**	1.38^{NS}	0.42^{NS}	-0.93*
	Period-IV	-0.52^{NS}	-1.75*	-0.42^{NS}	2.31**	2.20^{NS}	-0.10^{NS}	4.55*	1.82*	0.67^{NS}
	Period-V	-11.66***	-0.53^{NS}	-4.16*	3.55**	-0.26^{NS}	2.04*	4.88**	1.62^{NS}	2.15**
	Overall	-5.74***	-0.81***	0.90***	1.80***	1.37***	1.03***	0.58**	0.75***	0.31***
Production	Period-I	0.54^{NS}	-4.37*	-1.32^{NS}	5.85^{NS}	3.99^{NS}	6.31**	0.92^{NS}	-1.96^{NS}	-0.39^{NS}
	Period-II	-0.27^{NS}	0.38^{NS}	5.10***	0.33^{NS}	0.05^{NS}	7.15***	-4.27^{NS}	1.55^{NS}	1.51^{NS}
	Period-III	-12.33**	-1.12^{NS}	1.36^{NS}	3.75^{NS}	0.73^{NS}	3.91^{NS}	2.13^{NS}	-2.69^{NS}	-0.43^{NS}
	Period-IV	1.28^{NS}	-2.80**	4.54***	4.82*	10.43**	3.10^{NS}	3.48^{NS}	4.16*	2.71**
	Period-V	-9.05***	1.17^{NS}	-2.26^{NS}	5.13**	3.17^{NS}	3.05^{NS}	5.91*	3.91^{NS}	3.72**
	Overall	-4.98***	-0.56***	3.59***	2.92***	3.51***	2.95***	1.41***	2.29***	1.37***
Yield	Period-I	5.22*	-1.76^{NS}	-1.05^{NS}	3.10^{NS}	0.63^{NS}	3.01**	0.82^{NS}	-3.49**	-1.02^{NS}
	Period-II	5.45^{NS}	0.03^{NS}	4.49***	-0.82^{NS}	-1.67^{NS}	4.65**	-0.68^{NS}	2.42***	1.57**
	Period-III	-0.32^{NS}	0.21^{NS}	0.94^{NS}	2.24^{NS}	1.13^{NS}	2.78^{NS}	0.73^{NS}	2.93***	1.34**
	Period-IV	2.87NS	-0.25NS	4.98***	-0.23^{NS}	6.33*	3.22**	-4.19^{NS}	2.10*	1.63**
	Period-V	2.95NS	1.71NS	3.08^{NS}	1.51^{NS}	3.44***	0.98^{NS}	0.97^{NS}	0.72^{NS}	1.53*
	Overall	0.74***	0.24NS	4.07***	1.21***	2.14***	1.90***	0.89***	3.30***	1.09***

Note: 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).
Source: Agriculture statistics at a glance, GOI, New Delhi
***, ** and * are significant at 1, 5 and 10 percent respectively. NS: Non Significant

Uttar Pradesh (-1.75%), Andhra Pradesh (-0.42%) and Maharashtra (-0.10%) exhibited negative growth trend in area during period-IV and other major producing states confirmed positive growth rate of 4.55 percent in Rajasthan followed by Karnataka (2.31%), Gujarat (2.20%) and Madhya Pradesh (1.82%). But the change was significant only in case of Uttar Pradesh, Karnataka, Rajasthan and Madhya Pradesh. India revealed a negative growth rate of 0.67 percent per annum. During Period-V, growth trends in area was negative in Uttar Pradesh (-0.53%), Andhra Pradesh (-4.16%) and Gujarat (-0.26%), other major states *viz.*, Karnataka (3.55%), Maharashtra (2.04%), Rajasthan (4.88%) and Madhya Pradesh (1.62%) enjoyed remarkable positive growth rates. Growth rates of Andhra Pradesh, Karnataka, Maharashtra and Rajasthan were significant. And as a result of these trends in major pulses producing states India also experienced significant positive growth rate of 2.15 percent per annum. Haryana exhibited negative growth rate with highest in period-III (12.05%), followed by period-V (-11.66%), period-II (-5.42%), period-I (-3.03%) and period-IV (-0.52%), with overall period growth of 5.74 percent per annum. Acreage growth in Period-III, Period-V and overall period was significant. During Overall Period, all the major pulses producing states except Uttar Pradesh (-0.81%) enjoyed positive growth rates; Andhra Pradesh (0.90%), Karnataka (1.80%), Gujarat (1.37%), Maharashtra (1.03%), Rajasthan (0.58%) and Madhya Pradesh (0.75%). India as a whole also exhibited annual increase (0.31%) in last five decades. The growth in all the major states as well as India was found significant.

Pulses production in Period-I was marked by positive growth rate in Karnataka (5.85%), Gujarat (3.99%), Maharashtra (6.31%) and Rajasthan (0.92%) but Uttar Pradesh (-4.37%), Andhra Pradesh (-1.32%) and Madhya Pradesh (-1.96%) indicated negative growth rate. Growth was found significant in Uttar Pradesh and Maharashtra. However, India experienced negative growth of 0.39 percent. During Period-II, all the major pulses cultivating states except Rajasthan (-4.27%) exhibited positive growth rates, with highest growth (7.15%) in Maharashtra followed by Andhra Pradesh (5.10%), Madhya Pradesh (1.55%), Uttar Pradesh (0.38%), Karnataka (0.33%) and Gujarat (0.05%). Andhra Pradesh and Maharashtra were the states with significant growth rate. India also enjoyed positive growth rates of 1.51 percent per annum. Pulses production in Period-III showed negative growth in Uttar Pradesh (-1.12%) and Madhya Pradesh (-2.69%) and positive growth rates in Andhra Pradesh (1.36%), Karnataka (3.75%), Gujarat (0.73%), Maharashtra (3.91%) and Rajasthan (2.13%). The production of pulses in India experienced negative growth rate (0.43%).

During Period-IV, India demonstrated positive growth rate of 2.71 percent per annum. Andhra Pradesh (4.54%), Karnataka (4.82), Gujarat (10.43%), Maharashtra (3.10%) Rajasthan (3.48%) and Madhya Pradesh (3.91%) showed remarkable growth in production while, Uttar Pradesh (-2.80%) experienced negative growth rate. Growth rates of Uttar Pradesh, Andhra Pradesh, Karnataka, Gujarat, Madhya Pradesh and all India were found significant. Period-V enjoyed positive growth rates in pulses production with highest growth attained by Rajasthan (5.91%) trailed by

Karnataka (5.13%), Madhya Pradesh (4.34%), Gujarat (3.17%) and Maharashtra (3.05) while negative in Andhra Pradesh (-2.26%). Growth was significant in Karnataka and Rajasthan. India also attained significant positive growth rate of 3.72 percent. Haryana experienced negative growth rate during Period-II (-0.27%), Period-III (-12.33%) and Period-V (-9.05%) and overall (-4.98%) and it experienced positive growth rates in Period-I (0.54%) and Period-IV (1.28%). Production growth in Period-III, Period-V and overall period was significant. In Overall Period, statistically significant positive growth (1.37%) in pulses production was recorded in India which was contributed by significant increase in production in Andhra Pradesh (3.59%), Karnataka (2.92%), Gujarat (3.51%), Maharashtra (2.95%), Rajasthan (1.41%) and Madhya Pradesh (2.29%). Uttar Pradesh was the only state which confirmed negative growth rate (-0.56%).

During Period-I, the yield of pulses experienced negative growth rate in Uttar Pradesh (-1.76%), Andhra Pradesh (-1.05%) and Madhya Pradesh (-3.49%) meanwhile Karnataka (3.10%), Gujarat (0.63%), Maharashtra (3.01%) and Rajasthan (0.82%) exhibited positive growth rates. Maharashtra and Madhya Pradesh production growth was significant during this period. At the same time India experienced a negative growth rate (1.02%). During Period-II, increasing trend in yield was observed in Uttar Pradesh (0.03%), Andhra Pradesh (4.49%), Maharashtra (4.65%) and Madhya Pradesh (2.42%) while Karnataka (-0.82%), Gujarat (-1.67%) and Rajasthan (-0.68%) revealed negative growth rates. Yield increase in Andhra Pradesh, Maharashtra and Madhya Pradesh was found significant. As a result, pulses yield on all India bases increased significantly with positive growth rate of 1.57 percent per annum. Period-III was marked with prevalent tenuous positive growth rates in Uttar Pradesh (0.21%), Andhra Pradesh (0.94%), and Rajasthan (0.73%) while Karnataka (2.24%), Gujarat (1.13%), Maharashtra (2.78%) and Madhya Pradesh (2.93%) showed considerable positive growth rate. India showed positive growth rate of 1.34 percent per annum. Madhya Pradesh and India showed significant growth.

During Period-IV, Andhra Pradesh (4.98%), Gujarat (6.33%), Maharashtra (3.22%) and Madhya Pradesh (2.10%) exhibited positive growth rates while Uttar Pradesh (-0.25%), Karnataka (-0.23%) and Rajasthan (-4.19%) confirmed negative growth rate. But the growth in yield was significant in Andhra Pradesh, Gujarat, Maharashtra and Madhya Pradesh. At the same time, India experienced positive growth rate of 1.63 percent per annum and was statistically significant.

During Period-V, positive growth rates were observed in all the major pulses producing states *viz,* Uttar Pradesh (1.71%), Andhra Pradesh (3.08%), Karnataka (1.51%), Gujarat (3.44%), Maharashtra (0.98%), Rajasthan (0.97%) and Madhya Pradesh (0.72%). India experienced positive growth of 1.53 percent per annum. Yield growth in Gujarat and all India was significant. Except period-III (-0.32%) Haryana enjoyed positive growth rates in yield with highest growth rate during period-II (5.45%), followed by period-I (5.22%), period-V (2.95%), Period-IV (2.87%) and overall period (0.74%). Yield improvement in Period-I and overall period was found significant. Yield in Overall Period augmented in all the major states Uttar Pradesh (0.24%), Andhra Pradesh (4.07%), Karnataka (1.21%), Gujarat (2.14%), Maharashtra (1.90%), Rajasthan (0.89%) and Madhya Pradesh (3.30%). India recorded positive growth of 1.09 percent per annum during overall period. The increase in output growth is mainly driven by increase in yield which could be attributed to improved technology, adoption of good agronomic practices and input use. Except Uttar Pradesh all the major pulses cultivating states and India as a whole exhibited significant growth rates.

Instability in area, production and yield of Pulses in India

Variation in area under pulses occurs mainly in response to distribution and quantum of rainfall as pulses cultivation confined to rainfed area. Further, yield is also affected by outbreak of diseases, insect-pests, adoption of pulses cultivation in new areas and use of quality seeds. Variability in pulses production may consist of variability in area and yield and their interactions.

In northern zone, Haryana showed higher instability in production. In Haryana, Instability index of pulses for area had shown an increase during period-I to period-III from 17.8 to 27.5 percent, declined to 14.2 percent in period-IV and showed slight increase in period-V (15.4%) while yield showed an increase during period-I (18.7%) to Period-II (25.7%) but declined in period-III (11.1%) then showed increase in period-IV(18.2%) and declined to 14.4 percent in period-V. Production exhibited the same pattern as yield during first three periods *i.e.* increased during period-I (36.3%) to Period-II (39.6%) and declined in period-III (30.7%) but declined in period-IV(23.3%) and period-V(21.8%). Results showed that variation in area (31.7%) and production (48.6%) registered high instability whereas productivity registered variation with medium instability of 19.9 percent during overall period. In Uttar Pradesh, instability index for area shown increase from period-I (2.5%) to period-II(3.7%), declined to 2.6 percent in period-III then increased from 7.0 to 7.2 percent from period-IV to period-V while instability index in case of yield showed a decrease during period-I (16.2%) to Period-III (7.1%) but showed gain in period-IV(11.1%) to period-V (18.3%). Instability index of production shown decrease during period-I to period-III from 15.1 to 5.1 then showed increase from period-IV (9.1%) to period-V (21.7%). In Uttar Pradesh CDVI results depicted that variation in area (5.9%), production (14.4%) registered low instability and productivity (13.4%) registered low instability during overall period.

In southern zone, Karnataka exhibited more instability in production than Andhra Pradesh. In Andhra Pradesh, instability index for area shown increase from period-I (4.1%) to period-V (14.2%), while instability index in case of yield showed a decrease during period-I (8.9%) to Period-II (7.9%) but showed gain in period-III (12.7%) declined in period-IV (9.8%) and increased to 14.8 percent in period-V. Instability index of production shown decrease during period-I to period-II from 12.1 to 6.9 then showed increase in period-III (16.3%) then declined to10.4 percent in period-IV and increased to 27.9 percent in period-V. In Andhra Pradesh CDVI results depicted that variation in area (10.8%) registered low instability whereas production (24.1%) productivity (15.1%) registered medium instability during overall period. In Karnataka, instability index for area shown decrease from period-I (11.0%) to period-II (3.6%) then increased from period-III (5.1%) to period-V (9.0%) while instability index in case of yield showed a decrease during period-I (16.8%) to Period-II (10.9%) but showed slight gain in period-III

(11.1%) and period-I(14.55%) and declined to 13.8 percent in period-V. Instability index of production shown decrease during period-I to period-II from 22.3 to 13.7 then showed increase in period-III (15.4%) and period-IV (17.8%) then declined to 15.3 percent in period-V. In Karnataka CDVI results depicted that variation in area (10.8%) registered low instability whereas production (29.2%) productivity (20.6%) registered medium instability during overall period.

In Western zone, Rajasthan showed highest instability index. In Gujarat, instability index for area shown an increase from period-I (13.8%) to period-II (16.3%) then declined in period-III (9.9%) and increased in period-IV (11.8%) and period-V (19.0%) while instability index in case of yield showed an increase during period-I (11.6%) to Period-II (26.7%) but showed declined in period-III (10.7%) and gain in period-IV(19.3%) and declined to 5.7 percent in period-V. Instability index of production shown increase during period-I to period-II from 21.1 to 38.1, then showed decline in period-III (20.3%) and slight increase in period-IV (21.6%) then declined to 19.3 percent in period-V. In Gujarat CDVI results depicted that variation in area (20.9%) and productivity (19.1%) registered medium instability whereas production (39.0%) registered high instability during overall period. In Maharashtra, instability index for area shown a decrease from period-I (10.9%) to period-III (3.1%) then increased in period-IV (7.6%) and period-V (8.9%) while instability index in case of yield showed an increase during period-I (9.0%) to Period-III (14.4%) but declined in period-IV (11.2%) and gained in period-V (18.3%). Instability index of production shown decrease during period-I to period-II from 17.9 to 13.9 and shown increase in period-III (16.3%), period-IV (18.1%) and period-V (24.8%). In Maharashtra CDVI results depicted that variation in area (8.2%) registered low instability whereas production (24.2%) and productivity (15.8%) registered medium instability during overall period. In Rajasthan, instability index for area shown an increase from period-I (12.1%) to period-III (19.8%) then declined in period-IV (16.9%) and period-V (16.4%) while.

Table 3: Instability in area, production and yield of total pulses in major producing states in India: 1970- 2021

Period	Northern zone						Southern zone						Western zone									Central zone			All India		
	Haryana			Uttar Pradesh			Andhra Pradesh			Karnataka			Gujarat			Maharashtra			Rajasthan			Madhya Pradesh					
	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y	A	P	Y
Period-1 (1970-1980)	17.8	36.3	18.7	2.5	15.1	16.2	4.1	12.1	8.9	11.0	22.3	16.8	13.8	21.1	11.6	10.9	17.9	9.0	12.1	31.9	24.2	2.9	10.8	9.8	4.1	12.2	8.7
Period-2 (1980-1990)	26.7	39.6	25.7	3.7	6.3	7.1	4.3	6.9	7.9	3.6	13.7	10.9	16.3	38.1	26.7	4.7	13.9	12.2	16.0	28.6	20.5	4.2	7.6	5.7	3.6	7.2	5.1
Period-3 (1990-2000)	27.5	30.7	11.1	2.6	5.4	5.1	5.4	16.3	12.7	5.1	15.4	11.1	9.9	20.3	10.7	3.1	16.3	14.4	19.8	33.3	14.5	4.3	28.3	6.8	4.0	5.4	3.9
Period-4 (2000-2010)	14.2	23.3	18.2	7.0	9.1	11.1	7.4	10.4	9.8	6.9	17.8	29.1	11.8	21.6	19.3	7.6	18.1	11.2	16.9	43.5	37.1	6.5	14.7	7.7	3.6	7.1	4.9
Period-5 (2010-2020)	15.4	21.8	14.4	7.2	21.7	18.3	14.2	27.9	14.8	9.0	15.3	13.8	19.0	19.3	5.7	8.9	24.8	18.3	16.4	23.2	9.2	12.2	21.8	13.5	6.9	10.9	6.8
Overall (1970-2021)	31.7	48.6	19.9	5.9	14.4	13.4	10.8	24.1	15.1	10.8	29.2	20.6	20.9	39.0	19.1	8.2	24.2	15.8	23.0	42.7	23.6	11.1	26.5	11.9	7.7	16.5	8.6

Instability index in case of yield showed a decline during period-I (24.2%) to Period-III (14.5%) but increased in period-IV (37.1%) and again declined in period-V (9.2%). Instability index of production shown decrease during period-I to period-II from 31.9 to 28.6 and shown increase in period-III (33.3%) and period-IV (43.5%) but declined in period-V (23.2%). In Rajasthan CDVI results depicted that variation in area (23.0%) and productivity (23.6%) registered medium instability whereas production (42.7%) registered high instability during overall period.

In Central zone, instability index of Madhya Pradesh for area shown an increase from period-I (2.9%) to period-V (12.2%) while instability index in case of yield fluctuates showed a decrease during period-I (9.8%) to Period-II (5.7%) but showed increase in period-III (6.8%), period-IV (7.7%) and period-V (13.5%). Instability index of production shown decrease during period-I (10.8%) to period-II (7.6%) from, showed increase in period-III (28.3%), declined in period-IV (14.7%) and increased in period-V (21.8%). In Madhya Pradesh CDVI results depicted that variation in area (11.1%) and productivity (11.9%) registered low instability whereas production (26.5%) registered medium instability during overall period.

At all India Level, instability index for area, yield and production shown fluctuating pattern, an decrease from period-I (4.1, 8.7 and 12.2%) to period-II (3.6, 5.1 and7.2%) then declined in period-III (4.0, 3.9 and 5.4%) and declined in period-IV (3.6, 4.9 and 7.1%) and increased in period-V (6.9, 6.8 and 10.9%). All India CDVI results depicted that variation in area (7.7%) and productivity (8.6%) registered low instability whereas production (16.5%) registered medium instability during overall period. It is clear from the above discussion that except Haryana where area has shown higher instability than yield, pulses showed higher instability in yield than area in all the other state and all India as well. The results are in conformity with the results of Inbasekar, 2014 [11].

Conclusion

Pulses play a vital role in food and nutritional security of the country. The results concluded that Uttar Pradesh, Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Rajasthan and Madhya Pradesh were major pulses producing states contributing 80 percent of total pulses area. The area of pulses in Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Rajasthan and Madhya Pradesh increased at a highly significant compound growth rate but the area in Uttar Pradesh was declined at a significant rate per annum (-0.81%). Production and productivity of pulses in Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Rajasthan and Madhya Pradesh exhibited positive growth rate except Uttar Pradesh (0.56%) because of the shifting of the area under pulses. Instability in area of pulses in Uttar Pradesh, Andhra Pradesh, Karnataka, Maharashtra and Madhya Pradesh was low while in Gujarat and Rajasthan was moderate. Production

instability was moderate in all the major states except Uttar Pradesh with low instability and Rajasthan with high instability. Yield instability was low in Uttar Pradesh and Madhya Pradesh while medium in Andhra Pradesh, Karnataka, Maharashtra and Rajasthan. Fluctuations in production and yield of pulses were noticed in majority of states as pulses cultivated in rain fed and dependent on monsoon. Gujarat was the only state which showed high instability in yield. All India registered low instability in area and productivity whereas medium in production. Production and yield of pulses at all India level were performed well and instability index was found moderate and low.

References

1. Agarwal PK, Yadav P. Scenario of Pulses Production in India: A Growth Decomposition Approach. Trends in Biosciences. 2017;10(29):6230-6236.
2. Agricultural Statistics at a Glance. Department of Agriculture, Cooperation and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India, New Delhi. https://eands.dacnet. nic.in/.
3. Annual Report. Pulses revolution from food to nutritional security. Crop Division, Government of India, Ministry of Agriculture and Farmer's Welfare, Department of Agriculture, Co-operation and Farmer's Welfare, Krishi Bhawan, New Delhi, India; c2018.
4. Choudhary AK, Yadav DS, Singh A. Technological and extension yield gaps in oilseeds in Mandi district of Himachal Pradesh. Indian Journal of Soil Conservation. 2009;37(3):224-9.
5. Food and Agriculture Organization of the United Nations, http://www.fao.org/faostat/en/#data
6. Narayan P, Kumar S. Constraints of growth in area production and yield of pulses in India: An analytical approach to major pulses. Indian Journal of Agricultural Research. 2015;49(2):114-124.
7. Reddy AA. Consumption pattern, trade and production potential of pulses. Economic and Political Weekly. 2004;39(44):4854-4860.
8. Saxena BK, Kumar RV, Sultana R. Quality nutrition through pigeonpea—a review. Scientific Research Journal. 2010;2(11):1335- 1344.
9. Shukla UN, Mishra ML. Present scenario, bottlenecks and expansion of pulse production in India: A review. Legume Research. 2020;43(4):461-469.
10. Sihmar R. Growth and Instability in Agricultural Production in Haryana: A District level Analysis. International Journal of Scientific and Research Publications. 2014;4(7): 1-12.
11. Inbasekar K. Pulses Production in India: Challenges and Strategies. Economic Affairs. 2014;59(3):403-414.