Growth and Instability Trade-Offs of Chickpea Cultivation in India

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Abstract

In a populous developing country like India, pulse crops play a pivotal role in nutritional security of the country. Production of pulses depends on many factors like rainfall, market price, acreage, productivity, technology, fertilizer consumption *etc*. Although India ranks first globally in terms of area and production of pulses, it is not yet self-sufficient and remains a net importer of pulses. In this present study it is an attempt to assess scientifically the compound growth rates, variability (using Coppock's Instability Index) and their trade-off for major producing states in India and country as a whole using time series data on area, production and yield pertaining to the period from 1992-93 to 2017-18. The results recorded that in chickpea (bengal gram) the highest positive significant growth rate with respect to production (2.71 % / annum) was mainly due to the higher significant positive growth in its area (1.59 % / annum) and productivity (1.10 % / annum). In case of instability the bengal gram in production showed the highest variability compared to area and yield.

Keywords: Compound growth rate, growth pattern, instability, chickpea, India

Introduction

Pulses as commodities are key indicators of not only the country's nutritional profile but also of its sovereignty since a country as large as India, with an estimated population of 135 crores in 2019-20 and an expected population of 146 crores by 2029-30 which again is at least 30 per cent predominantly vegetarian and even among the rest of the non-vegetarians as much as 85 per cent being occasionally non-vegetarian, would not be able to afford neither deep imports nor a steep hike in market price of pulses. The prevailing COVID-19 pandemic has out again proved that plant based products would always be preferred over the rest when it comes to health and the consumption of pulses has certainly increased among the masses as a subsequent effect of the pandemic (Cariappa, 2020) as a means towards immunity building. Thereby, the future supply-demand scenario of pulses has to be strategized in order to reduce supply deficit and effectively manage distribution anomalies.

India is the world's largest producer and consumer of a wide variety of pulses of tropical and sub-tropical nature such as bengal gram (chickpea), black gram (urad bean), red gram (pigeon pea), green gram (mung bean) etc. The share of pulses to the total food grain basket in the country was more than 16 per cent during 1950-51 and the same trend continued till the early 1970s. With the advent of green revolution, the productivity levels of cereals vastly improved and the share of cereals in food grains started rising. In case of pulses, the yield levels were stagnant and were hovering around 600 kg/ha till 2000s and their share in total food grains also came down to 6 per cent. However, pulse production in the country is stagnating due to long standing problems. This disturbs nutritional balance of the population especially of poor and weaker sections who cannot afford other expensive source of proteins.

As of triennium ending (TE) 2017-18, total area under pulses was 28.12 million hectares with a production of 21.57 million tonnes and the productivity level was 767 kg /ha, while demand was about 24.32 million tonnes (DES, 2018). After accounting for seed, feed and wastage (SFW), the per capita availability of pulses during TE 2017-18 was around 38 grams per day which was less than the recommended daily requirement of 52 grams per capita of the Indian Council of Medical Research, New Delhi (IIPR, 2016). As India’s population is expected to reach 1.68 billion by 2050 the pulse requirement (demand) is also projected to reach 39 mt by 2050 (i.e. 32 mt for consumption and 7 mt for SFW) with an anticipated required annual growth rate of 4.3 per cent. Thus, there is a need to increase production and productivity of pulses in the country by more intensive interventions. Then the Union Government as well as various state governments implemented various pulse development programmes, especially to address stagnating/declining yield levels, the most significant among the various pulse development programmes is the Integrated Scheme of Oilseeds, Pulses, Oil Palm and Maize (ISOPOM) introduced in the year 2004 among the fourteen influential pulse growing states. This scheme can be touted as the precursor to other pulse-oriented programmes. Even being the largest producer of pulses, the persistent and growing demand–supply gap has been an issue of concern leading to hike in prices. Hence, in the present formulated study, the growth trend of bengal gram in terms of area, production and productivity of both spatially as well as temporally will be assessed which shall help to investigate and develop suitable supply-demand relations.

Materials and Methodology:

The study was conducted using secondary time series data on demand and supply indicators of the bengal gram under study in major producing states in country as well as India as a whole from the year 1992-93 to 2017-18 to capture the growth on pulses sector after the implementation of ISOPOM. The study period was further be classified into: Pre-ISOPOM period (1992-93 to 2004-05) and Post-ISOPOM period (2005-06 to 2017-18) and Overall Period (1992-93 to 2017-18). The secondary data was collected from various government published sources (DES, Ministry of Agriculture and Farmers' Welfare, Government of India). Different economic and statistical techniques were applied to analyse the objectives of the study as given below:

Growth rate:

Growth rate can be defined as the rate of change of the underlying variable per unit time. It is used to measure the past performance of the economic variables in question and describe the trends in those variables over time. In the present study, compound growth rates were estimated using exponential model as given below:

$$\mathbf{Y_t = ab^t u^t} \qquad \text{... (1)}$$

Taking log on both the sides will transform the equation (1) as:

$$\mathbf{\log(Y_t) = \log b_o + t * \log b_1 + \log u_t} \qquad \text{... (2)}$$

Where,

$\log(Y_t)$ = Log of time series data of demand and supply indicators,

$\log b_0$ = Constant term,

t = Time trend,

$\log u_t$ = Error term, and

$\log b_1$ = Regression coefficient to be estimated.

The following are the demand and supply indicators to be taken up in the study,

Demand indicators: Per capita consumption of pulses / year; per capita income / year; and population / year of major states.

Supply indicators: Area, production and productivity of bengal gram under study.

Subsequently, compound growth rate (%) was calculated using following equation,

$$\textbf{Compound Growth Rate } (\hat{g}) = (\hat{b} - 1) \times 100 \qquad \text{... (3)}$$

Where,

$\hat{g}$ =Compound growth rate in percentage per annum,

$\hat{b}$ = Antilog of $\log \hat{b}$

$\log \hat{b}$ = Estimated value of log b

The standard error of the growth rate $Se(\hat{g})$ was subsequently estimated by:

$$Se(\hat{g}) = \frac{100\,\hat{b}}{\log_{10}e}\sqrt{\frac{[\Sigma(\log Y)^2-(\Sigma \log Y)^2/N]-[\Sigma t^2-(\Sigma t)^2/N](\log \hat{b})^2}{(N-2)[\Sigma t^2-(\Sigma t)^2/N]}}$$

$\log_{10}e$ = 0.4343

N =Number of observations; and

Other terms in the standard error specification have their usual meanings as already discussed.

The significance of the estimated compound growth rate ($\hat{g}$) was determined by the Student's t-test with the following formula:

$t_{n-2} = \hat{g} / Se(\hat{g})$; wherein the n-2 represents the degree of freedom of 't'.

Growth pattern:

In order to estimate the pattern of growth and to determine whether there is acceleration, deceleration or stagnation in pulses production in the study area, quadratic equation in time trend variable was fitted as follows:

$$\text{Log } Y_t = \beta_0+\beta_1 t_i+ \beta_2 t_i^2 +U_t \qquad \dots (4)$$

All variables are same as defined in equation (2), wherein β_0, β_1 and β_2 are parameters to be estimated. The quadratic time variable (t^2) allows for the possibility of determining whether there was acceleration, deceleration or stagnation in pulses production during the period as suggested by Nmadu *et al*. (2009). In determining the pattern of growth, the main concern is on β_2 (i.e. coefficient of t_i^2) which reveals a measure of the growth pattern suggested.

Thereby,

If $\beta_2 > 0$ and statistically significant, then there is acceleration in growth,

If $\beta_2 < 0$ and statistically significant, then there is deceleration in growth,

If β_2 is positive or negative but insignificant refers to stagnation.

Coefficient of Variation (CV):

It is the popular measure in instability. It is defined as

$$CV = \frac{\left[\frac{1}{N-1} S(X_t - \bar{X})^2\right]^{1/2}}{\bar{X}}$$

Where,

N = Numbers of years

X_t = Area/production/productivity in the year 't'

$\bar{\bar{X}}$ = Mean of Area/ production/productivity

S = Standard deviation.

Coppock's Instability Index:

Instability or variability is an inherent characteristic of agriculture everywhere. CII was employed in the present study since it is a close approximation of the average year to year percentage variation adjusted for trend (Coppock, 1962). CII is also called as log variance method and it is expressed algebraically in the following form:

$$\textbf{CII} = (\text{Antilog}\sqrt{\log V}-1) * 100) \quad \ldots (5)$$

Wherein, V log was obtained using the following formula:

$$V = \frac{1}{N}\sum_{t=1}^{n-1}\left(\log\left(\frac{X_{t+1}}{X_t}\right) - m\right)^2 \quad \ldots (6)$$

And the arithmetic mean, 'm' is given by

$$m = \frac{1}{N-1}\sum[\log\frac{X_{t+1}}{X_t}] \quad \ldots (7)$$

Where,

X_t = Demand and supply indicators in time period t;

N = Number of years in the series;

m = Mean of the difference between logs of X_{t+1}, X_t and

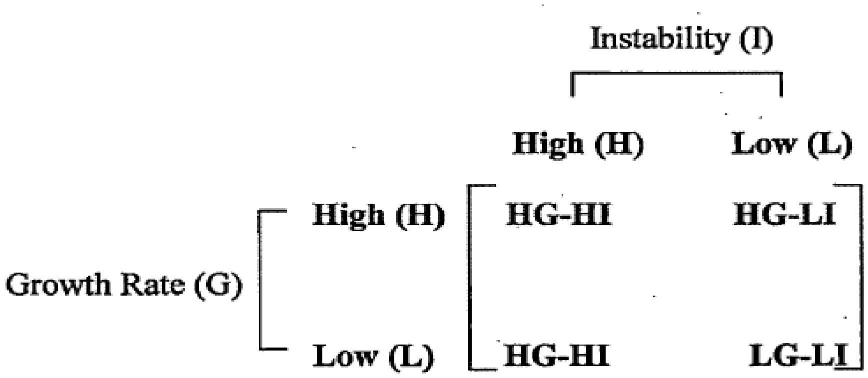
log V = Logarithmic variance of the series.

A higher value of CII will represent greater instability (Reddy and Mishra, 2006).

Growth - instability trade-off:

Growth rate and Instability indices in isolation will explain respectively the growth performance and variability of the crop over a period of time. But, by taking combination of both the growth and instability then only we can know the crop's performance is stabilized higher growth rate or instabilized lower growth rate.

Based on variations in growth rates and instability indices the variables under consideration will be classified into a four-fold typology as follows: (Rao and Raju, 2005)



So, this enables the development of state specific strategies. For stating the state as high or low growth rates and instability, compound growth rate (CGR) and Coppock's instability index (CII) of India were taken as critical point. Further, the analysis was carried out for the overall period and discussion was proceeded according to the categories with most desirable to not desirable as given below.

1. **High Growth-Low Instability (HG-LI):** The variables with growth rate higher than the critical point and the instability level lower than the critical point **(Most Desirable Indicator);**
2. **High Growth-High Instability (HG-HI):** The variables with growth rate higher than the critical point and the instability level greater than the critical point **(Desirable Indicator);**
3. **Low Growth-Low Instability (LG-LI):** The variables with growth rate lower than the critical point and the instability level lower than the critical point **(least Desirable Indicator);**
4. **Low Growth-High Instability (LG-HI):** The variables with growth rate lower than the critical point and the instability level higher than the critical point **(Not Desirable Indicator).**

Results and Discussion:

Chickpea is a major pulse in India which contributes about 35 percent of area and 45 percent of total pulse production, on an average. As of 2017-18, the seven major states in India that have contributed more than 90 per cent in gram production include the following: Madhya Pradesh (4.60 mt), Maharashtra (1.78 mt), Rajasthan (1.67 mt), Karnataka (0.72 mt), Andhra Pradesh (0.59 mt), Uttar Pradesh (0.58 mt) and Gujarat (0.37 mt).

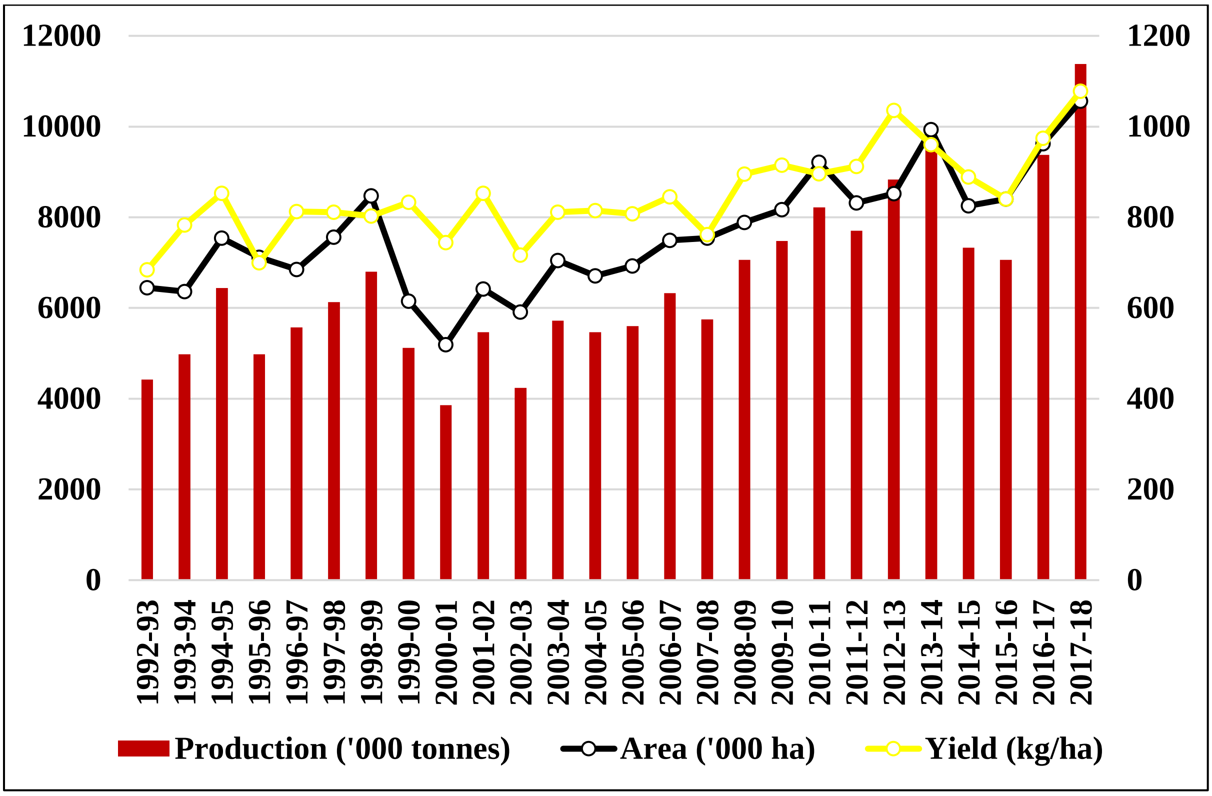


Fig. 1: Time-plot of area, production and yield of bengal gram in India

Besides, chickpea contributes the single largest share in India's export basket of pulses registering 80.12 per cent share in the total pulses export during 2017-18 (Anon., 2018). It can be seen from the Figure 1 that the trend in area, production and yield of bengal gram in India as whole varied over the study period. the lowest production of 38.6 lakh tonnes of gram was observed in the year 2000-01 and then there was continuous increasing trend was observed with highest production incurred in the year 2017-18 (113.79 lakh tonnes). As area was noted to have an increasing tendency comparably the production and yield portrayed increasing inclination over the periods.

Table 1: State-wise growth dimensions of bengal gram in India

State	Period I (1992-93 to 2004-05)		Period II (2005-06 to 2017-18)		Period III (1992-93 to 2017-18)	
	Mean	**S D**	**Mean**	**S D**	**Mean**	**S D**
Madhya Pradesh						
Area	25.35	2.19	29.63	3.26	27.49	3.49
Production	22.14	3.55	30.89	7.23	26.52	7.14
Yield	872.3	88.09	1031.53	147.26	951.96	143.94
Maharashtra						
Area	7.62	0.92	14.09	3.22	10.85	4.04
Production	4.40	0.92	11.28	3.84	7.84	4.44
Yield	575.30	81.61	786.92	114.35	681.11	145.31
Rajasthan						
Area	13.57	6.31	13.21	3.17	13.39	4.90
Production	9.77	5.29	10.61	4.24	10.19	4.72
Yield	706.84	97.19	786.07	194.22	746.46	155.79
Karnataka						
Area	3.73	0.88	8.97	2.66	6.35	3.30
Production	1.86	0.59	5.31	1.73	3.58	2.17
Yield	504.30	108.90	589.46	89.19	546.88	106.75
India						
Area	67.52	8.33	82.25	10.42	76.39	12.93
Production	53.23	8.53	78.19	16.37	65.71	18.04
Yield	786.15	56.73	908.46	88.02	847.31	95.67

Note: Area in lakh ha, production in lakh tonnes and yield in kg/ha.

Talking about the mean and standard deviation (S.D.) of area, production and yield of bengal gram in overall India along with top four major growing states was given in the Table 1. In period II (after the implementation of ISOPOM), it was seen that increased averages in all the three-growth dimension (i.e. area, production and yield) of bengal gram production in India than compared to period I, it may be due to technological interventions, high yielding varieties of bengal gram or may be training given to the farmers for betterment in the cultivation practices.

Growth rate analysis of bengal gram in India:

The State-wise trend in the growth dimension of area, production and productivity of Bengal gram in India during the study period is presented in the Table 2. The results from the analysis revealed that the states Madhya Pradesh and Karnataka was found to have a positive significant growth rate in all the three growth parameters in period I. Whereas, Rajasthan was found to have negative yet significant growth rate in terms of area (-6.12 % / annum) and production (-5.45 % / annum). Similarly, the state Maharashtra was found to have negative significant growth rate of productivity (-0.54 % / annum) but on the positive note the area and production was shown to be have positive growth rate in period I.

Table 2: State wise growth analysis of bengal gram production in India

Sl. No.	States	Period I (1992-93 to 2004-05)		Period II (2005-06 to 2017-18)		Period III (1992-93 to 2017-18)	
		CGR (%)	SE (ĝ)	CGR (%)	SE (ĝ)	CGR (%)	SE (ĝ)
1	**Madhya Pradesh**						
	Area	0.44***	0.09	2.37***	0.06	1.24***	-0.08
	Production	1.13***	0.17	5.11***	0.15	2.63***	0.17
	Yield	0.77***	0.10	2.66***	0.11	1.37***	0.11
2	**Maharashtra**						
	Area	1.76***	0.10	4.12***	0.16	4.27***	0.14
	Production	1.22***	0.22	4.91***	0.27	6.20***	0.28
	Yield	-0.54***	0.15	0.76***	0.15	1.84***	0.16
3	**Rajasthan**						
	Area	-6.12**	0.43	2.50***	0.22	-0.20**	0.07
	Production	-5.45*	0.50	7.56***	0.33	0.96**	0.48
	Yield	0.70***	0.14	4.94***	0.21	1.17***	0.20
4	**Karnataka**						
	Area	4.97***	0.17	7.37***	0.16	6.68***	0.17
	Production	6.44***	0.29	8.61***	0.20	8.15***	0.24
	Yield	1.44***	0.23	1.15***	0.15	1.30***	0.18
5	**India**						
	Area	-0.17***	0.02	2.59***	0.07	1.59***	0.12
	Production	-0.48***	0.17	4.32***	0.12	2.71***	0.17
	Yield	0.63***	0.07	1.69***	0.07	1.10***	0.07

Note:

1. *, ** and *** indicate significance at 10 %, 5 % and 1 % levels, respectively;
2. CGR – Compound Growth Rate; SE(ĝ)-Std. error of CGR (ĝ)
3. Period I, Period II and Period III are Pre-ISOPOM, Post-ISOPOM and Overall periods of the study, respectively.

In period II, the growth rate of area, production and productivity of all the major states of bengal gram was found to be significantly positive at 1 per cent level of significance. In connective to the results, the compound growth rate of area, production and yield showed significantly positive growth rate at various level of significance in all the major producing states in India except Rajasthan (-0.20 % / annum) reported significant negative growth in area at 5 per cent level of significance during period III. In a similar study taken up by Devegowda *et al.* (2018) revealed similar mixed findings in India thereby, refurbishing the findings of the present study.

Overall, the country as a whole recorded significant growth rates in terms of area, production and productivity of bengal gram in all the three study periods. To be precise, the growth rate of area (-0.17 % / annum) and production (-0.98 % / annum) were found to be significant but negative growth in period I whereas, in period II the growth rate of area (2.59 % / annum) and production (4.32 % / annum) were found to be positively significant at 1 per cent level of significance. In terms of productivity the growth rate was found to be positively significant in both periods at 1 per cent level of significance. On a positive note, the growth rate of area (1.59 % / annum), production (2.71 % / annum) and productivity (1.10 % / annum) of bengal gram in India was found to be significantly positive in the overall study period at 1 per cent level of significance. Similar results were seen in study done by Rijoy and Bhat (2017) were it showed that highest significant growth rate of bengal gram with respect to production was mainly due to the higher significant positive growth in its area and productivity.

Growth Pattern:

In case of bengal gram, Madhya Pradesh, Rajasthan states and India as whole taken up for the study was found to have acceleration growth pattern at 5 per cent level of significance while the states Maharashtra and Karnataka reported stagnation pattern of growth.

Table 3: Type of growth pattern of bengal gram in India for the period 1992-93 to 2017-18:

Sl. No	States	Type of growth pattern
1.	Madhya Pradesh	Acceleration**
2.	Maharashtra	Stagnation
3.	Rajasthan	Acceleration**
4.	Karnataka	Stagnation
10.	India	Acceleration**

*Note: *, ** & *** indicate significance level at 10 %, 5 % and 1 % respectively.*

State-wise Instability analysis of bengal gram in India:

The results of instability analysis for major four bengal gram growing states in India as well as the country as a whole is represented in Table 4. During period I of the study period, it was revealed that the bengal gram area under Rajasthan had the highest CII index of 26.41 per cent among the other states followed by Karnataka (14.60 %), Maharashtra (11.05 %) and Madhya Pradesh (5.03 %). Similarly, the instability in production Rajasthan recorded the highest instability with 45.90 per cent followed by Karnataka (26.88 %), Maharashtra (19.67 %) and Madhya Pradesh (12.95 %). At the same time, the productivity was found to be highly instable in Karnataka with CII value of 19.00 per cent followed by Rajasthan (10.34 %) and Madhya

Pradesh (9.78 %) and Maharashtra (7.94 %). And for the India as a whole, instability analysis in period I revealed a CII of 6.29 per cent of area, 15.37 per cent for production and 6.35 per cent for productivity.

Table 4: State wise instability analysis of bengal gram in India

Sl. No.	Major Producing States	Period I (1992-93 to 2004-05)		Period II (2005-06 to 2017-18)		Period III (1992-93 to 2017-18)	
		CV (%)	CII (%)	CV (%)	CII (%)	CV (%)	CII (%)
1.	**Madhya Pradesh**						
	Area	8.65	5.03	11.03	6.90	12.69	10.29
	Production	16.04	12.95	23.41	22.88	26.94	16.09
	Yield	10.09	9.78	14.27	11.27	15.12	7.66
2.	**Maharashtra**						
	Area	12.18	11.05	22.90	20.99	37.21	19.52
	Production	20.97	19.67	34.08	28.63	56.72	45.21
	Yield	14.18	07.94	14.53	11.51	21.33	16.08
3.	**Rajasthan**						
	Area	46.52	26.41	24.04	23.88	36.59	24.70
	Production	54.22	45.90	39.96	18.55	46.32	34.01
	Yield	13.75	10.34	24.70	13.92	20.87	15.65
4.	**Karnataka**						
	Area	23.62	14.70	29.69	25.87	52.06	24.56
	Production	31.82	26.88	32.70	27.53	60.49	36.68
	Yield	21.59	19.00	15.13	13.79	19.52	10.80
5.	**India**						
	Area	12.33	06.29	12.22	9.80	16.93	10.94
	Production	16.03	15.37	20.93	15.65	27.46	19.26
	Yield	7.21	6.35	9.68	9.37	11.29	10.74

Note: 1. CV- Coefficient of Variation (%), CII- Coppock's Instability (%),

2. ˆ-Non-significant values whereby only CV (%) is to be considered for instability.

During period II concerning with the Post-ISOPOM period, the instability of area of bengal gram was found to be highest in Karnataka with CII of 25.87 per cent followed by Rajasthan (23.88 %), Maharashtra (20.99 %) and Madhya Pradesh (6.90 %). Similarly, the instability in production Maharashtra recorded the highest instability with CII of 28.63 per cent followed by Karnataka (27.53 %) and Madhya Pradesh (22.88 %) and Rajasthan (18.55 %). The instability in productivity was found to be highest in Rajasthan with CII of 13.92 per cent followed by Karnataka (13.79 %), Maharashtra (11.51 %) and Madhya Pradesh (11.27 %). In terms of India as a whole, the instability of area, production and productivity were found to be low CII value of 9.80 per cent, 15.65 per cent and 9.37 per cent, respectively. The CV (%) results of India in all the three study periods were on par with the results reported by Patil *et al.* (2016) on chickpea in India in all the three periods of their study.

However, the bengal gram acreage revealed highest levels of instability in period III in Rajasthan with CII of 24.70 per cent followed by Karnataka (24.56 %), Maharashtra (19.52 %) and Madhya Pradesh (10.29 %). Similarly, the instability in production Maharashtra recorded the highest instability with CII of 45.21 per cent followed by Karnataka (36.68 %), Rajasthan (34.01 %) and Madhya Pradesh (16.09 %). The instability in productivity was found to be highest in Maharashtra with CII of 16.08 per cent followed by Rajasthan (15.65 %), Karnataka (10.80 %) and Madhya Pradesh (7.66 %). The India as a whole was found to be composed of low instability with values of area and yield of 10.94 and 10.74 per cent, respectively while production was observed to be slightly instable on the higher end with CII index of 19.26 per cent. Bengal gram had the highest variation of 23.76 per cent in production compared to area and productivity in the overall period of 1990-91 to 2015-16 stated by Rijoy and Bhat (2017). Reddy and Mishra (2006) recorded similar results in the overall study period in India of chickpea in all the three growth parameters (area, production and yield).

Growth – instability trade-off for bengal gram in India

The findings of growth-instability trade-off matrix in the table 4 represents that the in case of area and yield particular Maharashtra and Karnataka state were found in high growth-high instability (desirable situation), Madhya Pradesh was found in least desirable situation category and Rajasthan state was found in not desirable category. Similarly, the all the four major bengal gram grown states i.e. Maharashtra, Karnataka, Rajasthan and Madhya Pradesh were found to fall under the desirable category.

Table 4: Growth-instability trade off in area, production and yield of bengal gram in India during 1992-93 to 2017-18

Area Particular	**High growth**	**Low growth**
High instability	Maharashtra (**4.27**, *37.21*) Karnataka (**6.68**, *52.06*)	Rajasthan (-**0.20**, *36.59*)
Low instability	-	Madhya Pradesh (**1.24**, *12.69*)
Production Particular	**High growth**	**Low growth**
High instability	Maharashtra (**6.20**, *56.72*) Karnataka (**8.15**, *60.49*)	Rajasthan (**0.96**,*46.32*)
Low instability	-	Madhya Pradesh (**2.63**, *26.94*)
Yield Particular	**High growth**	**Low growth**
High instability	Maharashtra (**1.84**, *21.33*) Karnataka (**1.30**, *19.52*) Madhya Pradesh (**1.37**, *15.12*) Rajasthan (**1.17**, *20.87*)	-
Low instability	-	-

Note:

1. Value in bold and italics indicate growth (%) and instability (%), respectively.
2. Criteria for classification: CGR of area (*1.59*%), production (*2.71* %) & yield (*1.10* %) for bengal gram in India during 1992-93 to 2017-18; and
3. Criteria for classification: CV of area (*16.93* %), production (*27.46*%) &yield (*11.29* %) for bengal gram in India during 1992-93 to 2017-18.

Conclusion:

With the advent of the COVID-19 pandemic, pulses are going to be the major plant based products set to be greeted with escalated demand the world over. India is the pulse hub of the world being the largest producer, consumer and exporter. But pulses are the "neglected crops" of green revolution and their yield levels are more or less stagnant and non-comparable to the yield rise of either cereal or commercial crops. Like other crops, several different public schemes have been introduced in the country for improving the productivity of pulses. In this study, the impact of ISOPOM was analysed and was found to have positive bearing when the overall pulse scenario is concerned. The study makes it clear that the performance of pulse production had been quite satisfactory after launch ISOPOM. Besides, the growth pattern for major pulses across the major producing states and the country as well revealed either significant acceleration or stagnation but not deceleration. This is a positive sign capable enough of indicating success of public intervention schemes. The impact of ISOPOM on pulse production (4.32 % / annum) can clearly be seen in period II by positive significant growth in area (2.59 % / annum) and yield (1.69 % / annum) of chickpea (Table 2) which shows that there is need for extra technological intervention to make a India as a better pulses production country. The variability in the overall period of India reported that the variability has increased in production of chickpea than in area and yield. This phenomenon can possibly be attributed to technological changes in pulse production after launch ISOPOM in 2004. Low instability indices of area and yield under chickpea indicate that its area and yield remained almost stable during the entire period under study. In case of matrix association between growth instability the states Maharashtra and Karnataka were found in the desirable situation of high growth and high instability. Thereby, it is to be suggested that both area and production specific interventions are to be given to maintain bengal gram cultivation in these key areas.

Conflict of interest:

All the authors declare that there is no conflict of interest.

References:

Avinash CS, 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**: 2097-2102.

Cariappa AG, Acharya A, Kamlesh K, Chaitanya A, Sendhil R, Ramasundaram P, (2020) Pandemic Led Food Price Anomalies and Supply Chain Disruption: Evidence from COVID-19 Incidence in India (August 27, 2020). Available at SSRN: https://ssrn.com/abstract=3680634.

Coppock JD (1962) International Economic Instability. McGraw-Hill, New York.

DES (2018). Directorate of Economics and Statistics, Department of Agriculture, Cooperation and Farmers' Welfare, Ministry of Agriculture and Farmers' Welfare, Government of India.

IIPR (2016). Vision 2050. Indian Institute of Pulses Research, Kanpur, Uttar Pradesh, India.

Nmadu JN, Ojo MA, Ibrahim FD (2009) Prospects of sugar production and imports: Meeting the sugar demand of Nigeria by year 2020. Russian Journal of Agricultural Socio-Economic Sciences **2**: 15-25.

Patil RS, Deshmukh RG, Deshmukh PS, Jahagirdar SW (2016) Performance of growth and instability of chickpea (*Cicer arietinum*) in India. Asian Journal of Agricultural Extension, Economics & Sociology **14**: XXX-XXX.

Rao IVY, Raju VT (2005) Scenario of agriculture in Andhra Pradesh. Daya Publishing House, New Delhi, India.

Reddy A, Mishra D (2006) Growth and instability in chickpea production in India: A state level analysis. Agricultural Situation in India **14**: 230-245.

Rijoy T, Bhat ARS (2017) Growth analysis of area, production and productivity of pulses in India. Journal of Farm Sciences **30**: 557-559.