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Research Article

GROWTH AND INSTABILITY ANALYSIS OF PULSES PRODUCTION IN INDIA

ASHA BISHT*AND ANIL KUMAR
Department of Agricultural Economics, College of Agriculture, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, 263145, Uttarakhand, India
*Corresponding Author: Email - asha.pantnagar07@gmail.com

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Abstract: This study has examined trends in area, production and yield of major pulses in India through growth rate and instability analysis for the last 20 years from 1996-97 to 2015-16, which were further divided into two sub-periods characterising the period of before and after NFSM. The growth rates were calculated by fitting the exponential growth function and instability were analysed by generating Cuddy Della valle index for the five major pulses of India and pulses as a whole. The results have shown a highly significant but low growth rate of 2.14 percent in pulses production during this period. This growth rate is significantly higher in the sub period II. The area and yield under pulses have also shown a marginal but significant growth rate of 0.44 and 1.19 percent respectively. But yield growth rate was found higher than the growth rate in area implying that area allocation under pulses is increasing poorly even after NFSM while improvements in yield are there.

Keywords: Pulses, Growth Rate, Exponential function, Instability, Cuddy Della Valle Index

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Introduction

Pulses are the most common source of non-cereal protein in India, where the frequency of pulse consumption is higher than that of any other protein source. Although the cost of pulses has been an important driver of food price increases, pulses continue to be cheaper than several of the other sources of protein. Among Indian consumers, pulses contributed nearly 10 percent of the protein consumed in 2011-2012 [1]. These are leguminous annual crops which are not only consumed for its protein content but are also used as a fodder crop and it also contributes to healthy soils. Pulses production in India is characterized by diversity of crops and their regional specificity based on adaptation to prevailing agro-climatic conditions. This group of crops can utilize limited soil moisture and nutrients more efficiently than cereals and for that reason farmers have chosen them to grow under highly adverse conditions. The potential of pulses to help address future global food security, nutrition and environmental sustainability needs has been acknowledged through the UN declaration of the 2016 International Year of Pulses. India is the major producer, consumer and importer of pulses in the world. India produced 17.15 million tonnes of pulses from an area of 23.55 million hectare in the year 2014-15 with an average productivity of 728 kg/ha[2]. Chickpea, Pigeon pea, Black gram, Green gram and Lentil are the major pulses grown and consumed in India occupying nearly 84 percent of the area under pulses and accounting for about 85 percent of pulse production in the country. Among the various pulses, chickpea dominates, claiming a more than 40 percent share in production of all pulses grown, followed by pigeon pea (18-20 percent), green gram (11 percent), black gram (10-12 percent), lentil (8-9 percent), and other legumes (20 percent). Madhya Pradesh, Maharashtra, Rajasthan, Uttar Pradesh and Karnataka are the top five pulses producing states sharing 68 percent of total pulse production in India [2]. Pulses account for around 20 percent of the area under food grains and contribute around 7 percent of the total food grains production in India. India produces around 25 percent of global pulse production from around 35 percent of global area and yield of 659 kg per ha. The other major global producers of pulses are Myanmar, Canada, China and Brazil with yield of 1422, 2031, 1724 and 1034 kg per ha respectively. The yield of pulses in India is much lower than the world average of 909 kg/ha.

Moreover, pulse yields have been varying widely across the different areas where the crop is grown. Though India is the leading producer of pulses in the world, it is foremost consumer and largest importer, too. There exist a wide gap between demand and supply of pulses in India and about 20 % of its total demand is met by imports. Pulses account for 14 percent of total agricultural imports and are second only to edible oils in terms of import penetration in food. This inadequate supply of pulses in the country along with accelerating demand is leading to a decline in per capita availability of pulses and a spiral in prices. Considering the import burden of pulses, thin global market, and volatile prices in domestic markets, India ought to become self-sufficient in pulses. Therefore, the production of pulses needs to be increased on sustainable basis to meet the ever increasing domestic requirement and projected production of pulses of 23.50 million tonnes by 2020 and 27.5 million tonnes by 2025 [3]. A high growth rate and low instability in production are prerequisites for sustainable agricultural performance and has serious implications for policy makers. In this context it is important to study the growth and instability in pulses production. Sharma [4] has examined the growth of pulse production in India for the period 1980-81 to 2008-09 and found a positive percent change in area, production and yield of pigeon pea, chickpea and total pulses except in case of lentil. Area of pulses was found most stable with few exceptions as compared to production and yield of pulse crops. Considering the importance of pulses, the present study was carried out to examine the growth and instability in area, production and yield of pulses in India.

Methodology

The study was based on secondary data. The data related to area, production and yield of pulses at national level was compiled through the publication of Ministry of agriculture-Agricultural statistics at a glance and from the website of Indiastat for the period 1996-97 to 2016-17. This period was further divided into two sub periods: Sub period I (1996-97 to 2006-07) and Sub period II (2007-08 to 2016-17) characterising the period of before and after National food Security Mission (NFSM) for pulses. The present study was conducted for chickpea, pigeon pea, green gram, black gram and lentil that account for nearly 80 percent of total pulse production in India.

Growth rate Analysis

In the present study, Compound growth rates were calculated by exponentially fitting the time series data of area, production and yield of pulses and pulse crops at national level against time using the following formula [5]:

$$Y_t = a\, b^t\, U_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where,

Y_t = Dependent variable for which growth rate was estimate in year t

a = Intercept

b = Regression coefficient

t = Year which takes values 1, 2, ..., n.

U_t = Disturbance term in year t.

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

$$\log Y_t = \log a + t \log b + \log U_t \quad \ldots\ldots\ldots\ldots\ldots (2)$$

Equation (2) will be estimated by using Ordinary Least Square (OLS) technique. The compound growth rate (g) will be then estimated by the identity given in equation (3)

$$g = (b\text{-}1) \times 100 \quad \ldots\ldots\ldots\ldots\ldots (3)$$

Where,

g = Estimated compound growth rate per annum in percentage.

b = Antilog of regression coefficient value

Instability analysis

An analysis of fluctuations in crop output, apart from growth, is important as wide fluctuations in crop output not only affect prices and bring about sharp fluctuation in them but also results in wide variations in 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 growth in production accompanied by low level of instability for any crop is desired for sustainable development of agriculture. To measure the magnitude of variability in area, production and yield, the co-efficient of variation (%) was computed. The simple coefficient of variation (C.V.) often contains the trend component and thus overestimates the level of instability in time series data characterized by long term trend. To overcome this problem, a measure of instability is estimated by using Cuddy Della Valle Index (CDVI) which corrects the coefficient of variations and it is given by [6, 7]:

$$\text{Instability index} = cv^*(1-\bar{R}^2)^{0.5} \quad \ldots\ldots\ldots\ldots\ldots (4)$$

Where, $\bar{R}^2$ is the coefficient of determination from a time trend regression adjusted by the number of degree of freedom.

The coefficient of variation (CV) can be calculated by using the formula

$$CV = \frac{\sigma}{\bar{X}} * 100 \quad \ldots\ldots\ldots\ldots\ldots (5)$$

Where,

σ = Standard deviation of variables concerned i.e. area/ production/yield and,

$\bar{X}$ = Mean value of the variable.

Results and Discussion

Growth in area, production and yield of pulses in India

The growth rates have been computed by exponentially fitting the time series data of area, production and yield of pulses at national level against time. The growth rates estimated for area, production and yield of pulses are presented in [Table-1].

Growth in pulses production- Pulses production has shown a highly significant but low growth rate of 2.14 percent during this period. This growth rate is significantly higher in the sub period II. This may be percentage due to the price and policy initiative taken by the government recently in the form of NFSM and increase in MSP realising the importance of pulses. The results for all the major pulse crops like chickpea, pigeon pea, black gram, green gram and lentil have also revealed significant and positive but low growth rates in production during the period. The highest growth rate of 2.76 percent has been observed for chickpea followed by black gram, green gram and pigeon pea while lentil has recorded the least growth rate of 0.59 percent. The growth rates of production were much lower in sub period I for all the crops and negative for chickpea and green gram. The production has not increased by more than 0.5 percent for any pulse crop during this sub period while in sub period II all the growth rates were found positive and recorded the growth rate up to 5.0 percent.

Table-1 Growth rates in area, production and yield of pulses in India

Crops	Variable	Growth Rate [Percentage]		
		Period I (1996-97 to 2006-07)	Period II (2007-08 to 2015-16)	Overall (1996-97 to 2015-16)
Pulses	Area	-0.41	0.73	0.44**
	Production	0.50	2.44**	2.14*
	Yield	-0.24	1.70	1.19*
Chickpea	Area	-0.34	1.47	1.72*
	Production	-0.05	2.51	2.76*
	Yield	0.11	1.02	0.95*
Pigeon pea	Area	0.35	1.28	0.90*
	Production	0.14	0.79	1.17**
	Yield	-0.18	-0.49	0.27
Black gram	Area	0.63	1.90***	0.33
	Production	0.19	5.88**	1.87*
	Yield	-0.44	3.91**	1.53*
Green gram	Area	0.91**	0.31	0.53
	Production	-0.35	4.23	1.87***
	Yield	-1.25	3.91	1.33***
Lentil	Area	0.90**	-0.35	0.11
	Production	0.39	1.91	0.59***
	Yield	-0.49	2.27***	0.49

Note: * Significant at 1% level of significance, ** Significant at 5% level of significance, *** Significant at 10% level of significance

Source: Computed from DES, GOI.

Growth in pulses area- During the period, the area under pulses has also shown a marginal but significant growth rate of 0.44. The growth rate of area has been positive and higher during sub period II or after NFSM that were observed negative during sub period I (before NFSM). Narayana also found in his study that area growth was negative during 1990s and increased marginally at the rate of 1.62 during 2000s.[8] The negative growth rate of area in sub period I implies the decline of area under pulses in that period. Chickpea has also recorded highest significant growth rate of 1.72 percent in area under pulses followed by pigeon pea. The area under green gram and black gram has increased marginally at the rate of 0.53 and 0.33 percent respectively. Lentil has witnessed the least growth in area, too. It was only 0.11 percent during the period. The growth rate of area for black gram is much higher and significant in sub period II while it is significantly higher in sub period I for green gram and lentil. The area under lentil has declined in sub period II.

Table-2 Instability in area, production and yield of pulses in India

Crops	Variable	CDVI [Percentage]		
		Period I (1996-97 to 2006-07)	Period II (2007-08 to 2015-16)	Overall (1996-97 to 2015-16)
Pulses	Area	05.27	05.32	05.50
	Production	09.67	08.88	09.88
	Yield	06.29	07.42	07.62
Chickpea	Area	13.23	07.86	11.57
	Production	16.42	13.74	16.14
	Yield	05.29	08.51	07.05
Pigeon pea	Area	03.07	07.40	05.54
	Production	12.16	11.54	11.66
	Yield	11.53	10.20	10.55
Black gram	Area	06.71	06.76	07.11
	Production	06.24	11.64	12.40
	Yield	04.30	09.92	09.95
Green gram	Area	05.16	12.75	08.98
	Production	21.40	25.53	23.38
	Yield	16.29	19.93	18.87
Lentil	Area	03.70	08.29	06.18
	Production	08.30	08.17	08.13
	Yield	07.11	07.80	08.11

Instability in area, production and yield of pulses in India

The instability analysis has been carried out by generating Cuddy Della valle instability index.

The results of instability in area, production and yield of pulses during the period are presented in [Table-2].

Growth in pulses yield- Similar results were found for pulses yield, too. Yield has increased marginally at a rate of 1.19 percent. But yield growth rate was found higher than the growth rate in area implying that area allocation under pulses is increasing poorly even after NFSM while improvements in yield are there. Similar results were found in the study by Sharma [4]. Narayana in his study also found that yield growth rate was higher than the area growth rate during 1990s and 2000s [8]. Black gram and green gram has best yield performance over the period showing positive and significant growth rate of 1.55 and 1.33 percent respectively. Chickpea has also improved well registering a highly significant growth rate of 0.95 percent among pulses. The growth rate of yield in lentil was just 0.49 but the worst performer in yield was pigeon pea having a growth rate of 0.27 percent only. Thus, we observed the varying growth rates within pulses, too. It is evident from the table that fluctuations in area, production and yield of pulses are low. Area under pulses has observed the least instability during the period and it is almost same in both the sub periods. Pulses have also witnessed the least growth in area during the period. Production of pulses has the most fluctuations and these fluctuations have reduced in sub period II. Results show that yield of pulses have instability of 6.29 percent in sub period I and it has increased to 7.42 percent in sub period II. Yield of pulses has shown more fluctuations than the area under pulses. Sharma [4] has found similar results for instability in his study for the period 1995-96 to 2008-09. In general, production of all the pulse crops have higher instability than area and yield implying that production has the most fluctuations while area and yield are comparatively stable. Production has variability in the range of 8.13 percent in lentil to 23.38 percent in green gram whereas area instability ranges from 5.54 percent in pigeon pea to 11.57 percent in chickpea. Similarly, the yield instability index varies from 7.05 percent in chickpea to 18.87 percent in green gram. The yield fluctuations are more than the fluctuations in area for all the crops except chickpea. Chickpea has shown more instability in area rather to yield. But it is interesting to notice that area instability has reduced significantly in period II from Period I for chickpea while it has increased for other crops. Among pulses, chickpea has the highest area instability of 11.57 percent followed by green gram, black gram and lentil. The area under pigeon pea has the least fluctuations. The yield instability was found highest for green gram followed by pigeon pea and black gram. The yield of chickpea has been observed more or less stable as reflected by the lowest instability index. The area instability index has been found almost similar for black gram in both the periods while it is higher for all other crops in period II. The fluctuation in yield has increased significantly from period I to period II for all the crops except pigeon pea. In pigeon pea, yield instability has reduced marginally from 11.53 percent in period I to 10.20 percent in period II.

Conclusion and Policy Implications

The analysis of growth and instability of pulses has revealed that all the pulses have recorded a positive and significant growth in area, production and yield during the period but this growth is very low. The initiative taken by the government in the form of NFSM to increase the production of pulses has responded and growth rates have been found higher in the sub period II for all the pulses studied. So, more such initiatives are required to boost the pulses production. Area under pulses has also been found positive after NFSM but yield of pulses has shown better improvement thereby emphasizing the need to bring more improvement in area under pulses to meet the increasing demand and also explore the reasons for low acreage. The reversed position of pulses area from negative in sub period I to positive in sub period denotes the increasing trend of area under pulses rather than its shift to other crops. It is a positive sign. This may be due to the importance given to the pulses in recent period. Among pulses, chickpea has recorded the highest growth in area and production while lentil has least. The instability in area, production and yield of pulses are low. There are least fluctuations in the area under pulses while production of pulses has fluctuated the most leading to the increasing imports to fulfil the short term demand and volatile pulse prices. Yield of almost all the pulses has shown higher fluctuations that may be due to its vulnerability to the weather as pulses are mainly cultivated in rain fed areas. The stagnancy in the area of pulses along with the high fluctuations in yield may be the reasons for poor performance of pulses. So, Research and policy support is needed to increase the acreage and yield of pulses that will help to increase per capita availability of pulses, reducing import dependence and to some extent it will stabilize the pulse prices.

Application of research: This research will be helpful for policy makers to take decisions regarding performance of pulses in India.

Research Category: Growth and instability

Abbreviations:
NFSM: National Food Security Mission
CDVI: Cuddy Della Valle Index
DES: Directorate of Economics and Statistics
GoI: Government of India

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Research Guide or Chairperson of research: Professor Dr Anil Kumar
University: Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, 263145, Uttarakhand, India
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