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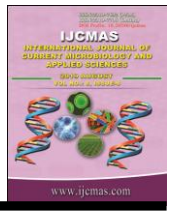

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Assessing Pulse Production in India – Application of Decomposition and Instability Analysis

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A B S T R A C T

Pulses are the smart foods provide high quality proteins are important in achieving sustainable development goals. India ranks first with respect to pulse area (35.81 %) and production (28.21 %). Present study has taken up to analyse instability in area, production and productivity of pulses over different time periods and find out contribution of area, productivity and there interaction effects to total pulse production. Growth rates of area, production and productivity are highly significant in the period 2003-2017. Higher instability or variation in area is observed in the period after National Food Security Mission (2003-2017) that is to the extent of 6.13. Higher instability in production was observed during post green revolution period (1964-176) that is to the extent of 11.45. Higher instability in productivity was observed during pre-Economic liberalization period (1977-90) that is to the extent of 7.83. Decomposition analysis has showed significant changes in the contribution of area, productivity and interaction effects, which resulted in increased production of pulses at national level from 12.85 mt to 16.38 mt and at state level from 0.68 mt to 1.26 mt. Hence there is a need to implement programmes and policies which doubles the production and farmers income as well.

Introduction

Pulses are an important commodity group of crops that provide high quality protein complementing cereal proteins for pre-dominantly substantial vegetarian population of the world. They are called as smart foods which are important in achieving sustainable development goals. The greatest challenge to the agriculture in the years to come is to provide adequate food to burgeoning population in order to combat with hunger and malnutrition. We will have to feed more people with scarce water resources, recurring droughts, global warming, degrading lands and difficult access to energy. In this direction pulse crops play a key role in addressing future global food security, nutrition and environmental sustainability needs.

The total world acreage under pulses as recorded during 2017-18 is about 82.38 mha with production of 81.8 mt and productivity of 909 kg / ha. India ranks first with respect to pulse area and production. It contributes about 35.81 per cent (29.5 m ha) of the global pulse area and 28.21 per cent (23.13 m tones) of the global pulse production. Pulses are grown in

all three seasons in India. The pulses under irrigation are cultivated in about 37 per cent of the area while 63 per cent of pulses are grown under rain-fed conditions. Gram (Chick pea) has higher share of 41 per cent in total pulse production followed by tur (21 %), urad (11 %) and mung (9 %).

In India, total pulse area and production during 2017-18 is 29.50 m ha and 23.13 m tonnes respectively. Madhya Pradesh has a prime status in pulse production registering a remarkable 23 per cent of the country's pulse area with 27 per cent of production, thereby ranking first both in area and production. This is followed by Rajasthan in respect of area (18 per cent) and Maharashtra in case of total production (16 %). Karnataka stands in fourth place with respect to area (10.03 %) and fifth place with respect to production (1.73 %). Total pulses productivity is highest in Delhi (2120 kg/ha) followed by Dadra and Nagar Haveli (2035 kg/ha).

With this background the present study has taken up to analyse instability in area, production and productivity of pulses over different time periods and find out contribution of area, productivity and there interaction effects to total pulse production.

Materials and Methods

The data used in this study were collected from secondary sources. Data on area, production and productivity used for various analyses is collected from indiastat.com website for the period 1950 to 2017, Directorate of Pulse Development (DPD, Bhopal) and Directorate of Economics and Statistics (DES).

Growth and instability analysis

Instability is an inherent characteristic of agriculture everywhere. Being dependent on weather conditions, the area, yield and production of crops are liable to substantial changes from year to year. It is one of the important decision parameters in the context of agricultural development, estimating trend to know the growth performance and calculating coefficient of variation of residuals from the trend apparently take note of both the trend and fluctuations. In this context, present study has been taken up to analyze the growth and instability in the area, production, and productivity of total pulses in Karnataka and India.

To estimate the growth and instability in area, production and productivity of pulses, the study period (1950-51 to 2016-17) has been subdivided into five periods as follows;

Pre- Green revolution period (1950-51 to 1963-64)

Post – Green revolution period (1964-65 to 1976-77)

Pre-Economic Liberalization period (1977-78 to 1991-92)

Post-Economic Liberalization period (1992-93 to 2006-07)

National Food Security Mission (NFSM) Period (2007-08 to 2017)

The exponential growth function was used to estimate the growth rates of the selected economic variables, and the model is,

$Y = a\, b^t\, e$

Y = Dependent variable for which the rate of increase is estimated (area, production, and productivity of ragi).

a = Intercept
b = Regression coefficient

t = Time variable (1950-51 to 2016-17)
e = Error term

The compound growth rate was obtained from the logarithmic form of the equation Y= a bt e as below

ln Y = ln a + t ln b

The % compound growth rate (y) was derived using the relationship

y = (Anti ln of b – 1) X 100

Instability analysis

The coefficient of variation was used as a measure to study the variability in the area, production and productivity of Pulses. The coefficient of variation (CV) was computed using the following formula.

CV = (SD/ Mean)*100

Linear trend was fitted to the original time series data on area, production and productivity for five sub-periods. The formula suggested by Cuddy and Della (1978) was used to compute the degree of variation around the trend, means coefficient of variation was multiplied by the square root of difference between unity and coefficient of determination (R2). A high degree of instability index signifies great changes.

Instability Index = $[CV^* (1- R^2)^{0.5}]$

Decomposition analyses

Intensive Pulse Development Programme (IPDP); National Pulse Development Programme (NPDP); Integrated scheme of Oil seeds, Pulses and Maize (ISOPOM); Integrated scheme of Oil seeds, Pulses and Maize (ISOPOM); Rashtriya Krishi Vikas Yojana (RKVY) and Bringing Green Revolution in Eastern India (BGREI) are some of the major pulses development programmes implemented in India and have contributed to the overall increase in the pulse production. Impact of these can be explicitly analysed through production viz, 23.13 mt of pulses in 2017, but how these policies and programmes have implicitly helped in horizontal and vertical expansion of pulses can be known through the Decomposition analysis.

Decomposition analysis given by Minhas and Vaidyanathan (1965) is used to measure the contribution of area and productivity to total production. The observed increase in production of a crop could be decomposed into different components, i.e. (i) change in area, (ii) change in productivity (iii) interaction between area and productivity. The decomposition analysis measures the contribution of area, productivity and their interaction effects in changing production of pulses during the period from 1990 to 2017. The contribution of area, productivity and their interaction in pulse production were estimated as below by dividing over all period in to two sub periods from 1990 to 2003 and 2004 to 2017, because major policy interventions in pulses were taken place from 2004 to 2017 as compared to period 1990 to 2003.

Change in production = Area effect + productivity effect + Interaction effect (area and productivity)

$$\Delta P = Y' \Delta A + A' \Delta Y + \Delta A \, \Delta Y$$

Where,

ΔP = Different in production from the base year to last year (periods)

ΔY = Difference in productivity from the base year to last year (periods)

ΔA = Difference in area from the base year to last year (periods)

A' = Area in the base year (of each period)

Y' = Productivity of rice crop during base year (of each period)

Results and Discussion

Area, production and productivity of pulse in India

It is observed that area, production and productivity under pulse crops in India are increasing over the years with the compounded annual growth rate of 1.19 per cent, 3.70 per cent and 2.31 per cent respectively (Table 1). Highest productivity of 789 kg / ha was recorded in 2013-14 as against the world average productivity of 909 kg / ha. Significant growth in area and production has been recorded during the last few years (i.e. 2010-2011 to 2017-18).

Gram (Chick pea) has the highest area under rabi pulses contributing to 33 per cent to the total pulse area and production of 10.52 m tones contributing to 46 per cent of the total pulse production. Tur (Redgram) is the main pulse crop grown in kharif along with mung bean, urd and other kharif pulse crops. Tur has 18.14 per cent share in total pulse area and contributes about 18 per cent to total pulse production. Total kharif pulses are grown in the area of 14.36 mha (48.78 %) and have production of 9.58 mt (41.42 %) (Table 2). Total rabi crops are grown in the area of 15.08 mha (51.22 %) and have production of 13.54 mt (58.54 %). On an average kharif pulses have productivity of 667 kg / ha and rabi pulses have productivity of 898 kg / ha as against overall pulses productivity of 786 kg / ha in India. Growth rates of area, production and productivity are highly significant in the period 2003-2017 and all three were insignificant in the post green revolution period that is from 1964-1976. It was because of the reason that, production technologies and most of the high yielding verities developed were focusing more on cereal crops as compared to pulses. Pulses gained less attention during the period of green revolution. Higher instability or variation in the area is observed in the period after NFSM (2003-2017) that is to the extent of 6.13. Higher instability in the production was observed during post green revolution period (1964-176) that is to the extent of 11.45. Higher instability in the productivity was observed during pre-Economic liberalization period (1977-90) that is to the extent of 7.83 (Table 3).

Growth rates of area, production and productivity of total pulses in Karnataka were non-significant in pre-green revolution period, as there was no introduction of such high yielding crop verities and technologies. Growth rate of area was highly significant in pre economic liberalization, post economic liberalization and NFSM periods. NFSM period has shown higher growth rate in production of total pulses. Higher instability in area, production and productivity were seen in post green revolution period viz, 9.55, 24.06 and 14.82 respectively. Growth rate of productivity were not that significant in all the five periods (Table 4).

Decomposition analyses

Since total pulse production is supported by two major pulses of the country i.e., Pigeon pea (Tur) and Bengal gram (Chick pea), they are considered individually for impact analysis.

In the period 1990-2003 total pulse production was mainly contributed by area effect viz., 77.06 per cent, productivity contributed to the extent of 27.62 per cent. Whereas there interaction effect was negative (-4.66 %).

Table.1 Area, production and productivity of pulse in India

Year	Area (m ha)	Production (m tones)	Yield (kg/ha)
2006-07	23.39	13.39	598
2007-08	23.76	14.11	594
2008-09	23.63	14.76	625
2009-10	22.09	14.57	660
2010-11	23.28	14.66	630
2011-12	26.4	18.24	691
2012-13	24.46	17.09	699
2013-14	23.25	18.34	789
2014-15	25.21	19.25	764
2015-16	23.1	17.16	743
2016-17	24.91	16.35	656
2017-18	29.46	23.13	786
CAGR	**1.19**	**3.70**	**2.31**

Source: DES, 2017-18

Table.2 Crop contributions to total pulse production (2016-17)

Crop	Area (mha)	% contribution to total area	Production (mt)	% contribution to total production	Productivity (kg/ha)
Gram	9.63	32.71	10.52	45.48	974
Tur	5.34	18.14	4.18	18.07	912
Urd	4.48	15.22	2.5	10.81	632
Mungbean	4.33	14.71	2.07	8.95	501
Lentil	1.46	4.96	1.22	5.27	838
Other Kharif crops	0.48	1.63	0.83	3.59	650
Other Rabi crops	3.99	13.55	1.8	7.78	725
Total Kharif crops	**14.36**	**48.78**	**9.58**	**41.42**	**667**
Total Rabi crops	**15.08**	**51.22**	**13.54**	**58.54**	**898**
Total Pulses	**29.44**		**23.13**		**786**

Source: Authors' compilation

Table.3 Instability analysis of total pulses India

Year	Pre- Green revolution period (1950-1963)		Post – Green revolution period (1964-1976)		Pre-Economic Liberalization period (1977-1990)		Post-Economic Liberalization period (1991-2003)		National Food Security Mission period (2003-2017)	
Particulars	GR (%)	II	GR (%)	II	GR (%)	II	GR (%)	II	GR (%)	II
Area	2.21^{***}	3.93	-0.12^{NS}	4.56	-0.06^{NS}	3.23	-0.93^{**}	3.83	1.25^{***}	6.13
Production	3.01^{***}	8.68	0.58^{NS}	11.45	1.48^{*}	9.84	-0.96^{NS}	7.49	3.18^{***}	9.87
Productivity	0.77^{NS}	6.41	0.55^{NS}	1.84	1.54^{**}	7.83	0.19^{NS}	6.27	1.98^{***}	6.19

Source: Authors calculations

GR Growth Rate, II- Instability Index

*** Significant at 1 per cent probability, ** significant at 5 per cent probability, * significant at 10 per cent probability, NS – non significant.

Table.4 Instability Index of total pulses Karnataka

Year	Pre- Green revolution period (1950-1963)		Post – Green revolution period (1964-1976)		Pre-Economic Liberalization period (1977-1990)		Post-Economic Liberalization period (1991-2003)		National Food Security Mission period (2003-2017)	
Particulars	GR (%)	II	GR (%)	II	GR (%)	II	GR (%)	II	GR (%)	II
Area	0.74^{NS}	7.18	0.91^{NS}	9.55	2.35^{***}	7.05	2.04^{***}	5.76	2.56^{***}	8.98
Production	0.85^{NS}	20.85	3.18^{*}	24.06	-0.96^{NS}	11.92	1.64^{*}	16.28	4.73^{***}	15.48
Productivity	0.07^{NS}	13.72	2.17**	14.82	-1.42^{NS}	12.49	1.77^{*}	14.06	0.99^{NS}	11.37

Source: Authors calculations

GR Growth Rate, II- Instability Index

***Significant at 1 per cent probability, ** significant at 5 per cent probability, * significant at 10 per cent probability, NS – non significant.

Table.5 Contribution of area and productivity in total production in India

India	Average production (mt)	Yield Effect (%)	Area Effect (%)	Interaction Effect (%)
Total pulses				
1990-2003	12.85	27.62	77.06	-4.66
2004-2017	16.38	42.95	46.09	10.96
Red gram (Tur)				
1990-2003	2.32	34.16	68.06	-2.22
2004-2017	2.86	33.93	48.48	17.58
Bengal gram (Chickpea)				
1990-2003	5.19	0.69	98.61	0.69
2004-2017	7.24	31.39	57.12	11.48

Source: Authors' Calculation

Table.6 Contribution of area and productivity in total production in Karnataka

Karnataka	Average production (mt)	Yield effect (%)	Area effect (%)	Interaction effect (%)
Total pulses				
1990-2003	0.68	71.79	17.12	11.07
2004-2017	1.26	48.23	31.35	20.34
Red gram				
1990-2003	0.18	17.28	83.28	-0.37
2004-2017	0.41	34.26	48.02	17.71
Chickpea				
1990-2003	0.17	28.45	40.61	30.93
2004-2017	0.47	30.81	39.4	29.78

Source: Authors' calculation

In the next period from 2004 to 2017 total pulse production was contributed by both area and productivity effect to the extent of 46.09 per cent and 42.95 per cent respectively. There interaction effect is also positive and contributed to the extent of 10.96 per cent to production.

In case of red gram, in first period its production was mainly contributed by area effect to the extent of 68 per cent then by productivity effect to the extent of 34 per cent. There interaction effect was negative (-2.22 %). In the next period during 2004-2017 Area effect, productivity effect and interaction effects were positive in which area (48.48 %) and productivity effects (33.93 %) contributed majorly to the red gram production.

In case of Chickpea, in first period its production was majorly contributed by area effect to the extent of 98.6 per cent. Whereas productivity and interaction effects contributed very less to total chickpea production. In the next period during 2004-2017, Chickpea production was mainly contributed by area and productivity effects to the extent of 57.12 per cent and 31.39 per cent respectively. Interaction effect is also positive and contributed to the extent of 11.84 per cent.

From the Table 5 we can infer that during the second period 2004 to 2017 considerable area and productivity expansion in the pulses has happened it is mainly attributed to objectives of NFSM, RKVY and varietal development programmes.

During the first period production of total pulses in Karnataka was mainly contributed by productivity effect to the extent of 72 per cent, followed by area and interaction effects of 17.12 and 11.07 per cent respectively. In second period area (31.35 %), productivity (48.23 %) and interaction effects (20.34 %) all were contributed considerably to the overall pulse production (Table 6).

In case of Red gram, interaction effect was negative in the first period and production was majorly contributed by area effect (83.28 %). In the second period area (48.02 %) and productivity (34.26 %) effects were mainly contributed to red gram production. Interaction effect was also positive (17.71 %) in this period.

In case of Chickpea, area and interaction effects mainly contributed to the production in first period to the extent of 30.93 per cent and 40.61 per cent respectively. Yield effect is also considerable to the extent of 28 per cent. In the second period area, productivity and interaction effects have contributed considerably to the overall Chickpea production in Karnataka to the extent of 39.4 per cent, 30.81 per cent and 29.78 per cent respectively.

These changes in contribution of area, productivity and there interaction effects were mainly because of the area and productivity expansion activities and development of high yielding varieties of pulses through various governmental programmes. Increase of all three effects has contributed to the increased production of pulses at national level from 12.85 mt to 16.38 mt and at state level from 0.68 mt to 1.26 mt. Hence there is a need for implementation of such programmes and policies which doubles the production and farmers income as well.

India has the world's largest pulses sector, producing and consuming diversity of pulses. Since majority of the consumers in India have low incomes, their reliance on pulses as a key source of protein is high. Slow growth in production of pulses in India (mere 1% per annum for the period 1970 to 2017) compared

to population growth (2% per annum) resulted in increasing demand-supply gap and in turn rising prices and declining per capita consumption. An improvement in production technology of pulses aiming towards yield improvement and resource conservation can certainly reduce cost of production and in turn prices may lead to balancing nutritional intake by reducing disproportionate use of cereals in the consumption basket. If pulses are included in public distribution system, mid-day meal schemes and welfare programmes etc. then it would provide adequate marketing support to the pulse growers.

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