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Study on Growth and Instability in PulsesProduction in Bihar: A Decomposition Analysis

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ABSTRACT
An assessment of changes in the area, production, and productivity of the pulse crops is considered helpful for their management and policy-making to ensure the nutritional security of the ever-growing population. The results revealed that the annual growth rates of production and productivity of lentils were comparatively high to other pulses. Instability indices for the area, production, and productivity of green gram were 7.04, 10.84, and 9.34, respectively, lower than other pulse crops grown in the state. The decomposition analysis revealed thatthe yield effect of red gram was negative. Low productivity and its cultivation by the marginal and small farmers under rain-fed conditions with poor crop management practices could be the probable reason for the negative yield effect. The results showedthat the area mainly influenced production, and productivity did not play anyrole in the state.The study emphasized the need to expand the area under pulse crops and increase their production through technological interventions.

Keywords: Compound annual growth rate, decomposition analysis, dietary pattern, instability.
JEL Codes:Q10**,** Q18, Q19

INTRODUCTION

Ensuring food and nutritional security by providing a balanced diet to everyone is the major challenge faced globally. Overcoming hunger and malnutrition means increasing food quantity and quality by enhancing production efficiency and maintaining sustainability. Pulses have been an integral part of the human diet for centuries. Nevertheless,the nutritional value is not generally recognized, and their consumption is frequently under-appreciated. As such pulses have long been considered as poor man's only source of protein in India and play a crucial role in providing a healthy diet to the poor masses.

The rain-fed regions support more than 40 percent of the human population and two-thirds of the country's livestock.More than 80percent of total pulses are grown in this region. Pulses, historically, are a vital constituent of cropping and consumption patterns and the only rich source of protein (20-25percent) for 43 percent of vegetarians (48 percent urban and 41percent rural). Besides, pulses enhance soil fertility by fixing 72 to 350 kg per ha per year atmospheric nitrogen to N-compounds to the soil.

With the twin objectives of achieving food and nutritional security vis-à-vis enhancing the income of the farmers ofrain-fed regions, the government decided to harness the potential of pulses. During 2015-16, various farmer-centric strategies and programmes such as Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), Pradhan Mantri Fasal Bima Yojana (PMFBY), Prampragat Krishi Vikas Yojana (PKVY), Soil Health Mission(SHM) and Soil Health Card (SHC), Electronic National Agriculture Market(e-NAM) were initiated to achieve the targeted outcomes. From 2016-17, distribution of pulses seed mini-kits, incentives forproducing quality seeds, seed hubs, enhanced breeder seed production, and cluster frontline demonstrations through 578 KVKs were also initiated to enhance the production and productivity of pulses in the country. Massive awareness campaign in conformity with International Year of Pulses (IYOP – 2016) coupled with the implementation of Price Support Scheme(PSS) at enhanced Minimum Support Price (MSP); provision of Processing and Storage Facilities(PSF), imposing import duties (30, 50 and 10 percent on gram/lentil, yellow pea, and Tur) had paid dividends both to consumers and pulse growers. As a result,productivity enhanced during 2017-18 and witnessed a record pulse production of 25.23 million tonnes, a grand success story and revolution in pulses self-sufficiency(Department of Agriculture, Cooperation and Farmers Welfare, 2017-18)

India has about 35 percent share in the area and production of pulse crops and is the largest producer and consumer of pulses globally. Improvement in pulses production technologies could reduce the cost of production and hence prices. It would create increase in demand for pulse crops. The intervention under NFSM realized a positive impact; consequently, an area under pulses increased to 19percent, production 34percent, and yield 13 percent during 2017-18, resulting in increased per capita availability of pulses.

In Bihar, pulses are grown in both the season Kharif and Rabi. The area under Rabi pulses during 2017-18 was 4.39 lakh ha with a national share of 2.76 percent, and production was 3.74 lakh tonnes, and production share was estimated to be 2.36 percent during the same year. The area under Kharif pulses was about 0.55 lakh ha with a production of 0.63 lakh tonnes during 2017-18. State average yield of total pulses during 2017-18 was reported 9.54 q/ha. The average state yield of major pulses like red gram (arhar), gram, lentil, and green gram (moong) were 15.48, 11.54, 10.68, and 7.43 q/ha. The national average yield of total pulses was 8.41 q/ha, and average yields of arhar, gram, lentil, and moong were reported to be 9.60, 10.63, 10.34 q/ha, and 4.72 q/ha during the same period. The yield of all the pulse crops under study reported comparatively high to that of the national average yield (Directorate of Economics and Statistics, 2018).

A large proportion of the malnourished population resides in the state. Protein-energy malnutrition and micronutrient deficiencies can be combated by increasing pulses' consumption, a rich source of proteins, minerals, iron, and fibre. After accounting for seed, feed, and wastage, the per capita availability of pulses in 2014 was around 38 gm per day, progressively declining from 65 gm a day in 1961. It is lower than the recommended daily requirement of 40 gm per day. After considering the imports of 3.5 million tonnes, the net availability reached a level of 44 gm, which is above the recommended daily requirement. For a country that faced persistent protein inflation and preferred a vegetarian diet, pulses would help to address the scourge of pervasive malnutrition caused by protein deficiency among the large sections of the Indian population (Kumar & Singh, 2016).

Despite rich natural resource availability, the recurring gap between supply and demand of the pulses was an issue of concern leading to a spike in prices, further resulting in a good source of protein that is generally inaccessible to the poor. The dismal performance of pulses production in the state and at the national level resulted into increasing deficit, on the one hand, and depletion of foreign currency reserves by soaring import bills, unpredictable price rise, and lower net profit compared to competing crops, on the other hand (Joshi & Saxena, 2002, Srivastava, Sivaramane & Mathur, 2010). Pulses in the state were caught in a vicious circle of lowand uncertain productivity. The lower per hectare returns, resulting in farmers' least preference to grow pulses on irrigated and fertile parcels of land (farmers preferred to grow pulses on marginal land with no use of production input), thereby leading to unstable and low yields (Singh, Shahi, & Singh, 2016, Lingareddy, 2015).The technological progress in these crops slow as compared to cereals and other cash crops due to a host of factors. The crops have to compete with the superior cereals and cash crops for natural and research resources and infrastructure (Ramasamy & Selvraj, 2002; Singh, Singh, Prakash, Kumar, & Dwivedi, 2015; Jain et al., 2016; Ahmad, Sinha, & Singh, 2018). Pulses are considered secondary to cereal crops and relegated to marginal soils as they are perceived to be low-yielding and less remunerative crops. Under these backdrops, the present study focused on growth andinstability in the area, production, and productivity of majorpulses in Bihar.

METHODOLOGY

Data Sources

The present investigation was based on secondary data obtained from official websites and different published sources of the government of Bihar and India from 1985-86to 2015-16.

To assess the acreage position of pulses in the state of Bihar cropping pattern of the state was calculated and defined as the distribution of acreages expressed in percentages of total cropped area (Ramasubban, 1963).

The compound annual growth rates (CAGR), instability, and decomposition analysiswere carried out for major pulseslike red gram, gram, lentil, and green gram for a period of 30 years (1985-86 to 2015-16) to examine the increase or decrease and their causes in the area, production, and productivity. The period was subdivided into three sub-periods (Period-I: 1985-86 to 1994-95, Period-II: 1995-96 to 2004-05, and Period-III: 2005-06 to 2015-16) to investigate the decadal changes.

Exponential trend equation: In order to find out the compound growth rates with respect to area, production and productivity, an exponential function was used

Instability: Instability is the deviation from trend, and many of the researchers used the coefficient of variation (CV percent) as a tool of instability.The instability index was calculated using the better measure of variability suggested by Cuddy-Della Valle index (Cuddy & Della, 1978).

Decomposition of production growth: To measure the relative contribution of area and yield to the total output change for the individual crop, the component analysis model was used. The model is

$$\Delta P = A_0 \Delta Y + Y_0 \Delta A + \Delta A \Delta Y$$

Change in production= Yield effect + Area effect + Interaction effect

ΔP = Change in production

A_0 = Area in base year

A_n = Area in current year

Y_0 = Yield in base year

Y_n= Yield in current year

ΔA = Change in area ($A_n - A_0$)

ΔY = Change in yield ($Y_n - Y_0$)

Thus, the total change in production could be decomposed into yield, area, and the interaction effects due to change in yield and area.

RESULTS AND DISCUSSION

Acreage Positions of Pulses inthe Cropping Pattern of Bihar

The perusal of Table 1 indicated that despite the emphasis on the need to increase acreage on pulses for ensuring nutritional security, there was a gradual decrease in the acreage under total pulses. It decreased from 11.36 percent in TE-1985 to 6.70 percent during TE-2016. Individual crops like red gram, gram, lentil, pea, and lathyrus also showed a decline in the area from TE-1985 to TE-2016. During the last decades, unfavorable climatic change was noticed, resulting in scanty rainfall. The incidence of disease-pest attack on the crop may be the reason for the decrease in area under pulse crops.

Table 1.Acreage positions of pulses in cropping pattern of Bihar

(000' ha)

Crops	TE-1985	TE-1995	TE-2005	TE-2016
Red gram	53.66 (0.67)	49.13 (0.63)	36.22 (0.47)	21.39 (0.28)
Gram	149.03 (1.86)	136.02 (1.75)	70.96 (0.93)	59.89 (0.78)
Lentil	163.14 (2.04)	172.06 (2.22)	176.66 (2.30)	151.02 (1.98)
Pea	30.65 (0.38)	25.48 (0.33)	29.87 (0.39)	17.16 (0.22)
Lathyrus (Khesari)	329.15 (4.11)	172.76 (2.23)	131.43 (1.71)	59.50 (0.78)
Total pulses	908.55 (11.36)	726.45 (9.36)	635.04 (8.28)	511.45 (6.70)
Total food grains	7101.59 (88.78)	6967.43 (89.79)	7100.52 (92.56)	6713.7 (87.93)
Gross cropped area	7999.13 (100.00)	7760.01 (100.00)	7670.94 (100.00)	7635.72 (100.00)

Figure in parentheses indicates percentage value.

Major Pulse Crops: Area, Production,and Productivity

Assessing changes in the area, production, and productivity of the major pulse crops was considered helpful for further management and policymakers to ensure nutritional security because the population of the state in particular and the nation, in general, was going up. The changes pulses crop pertaining to area, production, and productivity of majorwere computed at two reference points (2005 over 1995 and 2016 over 2005, decadal percentage changes) are presented in Table 2.

Table2. The changes in area under principal crops and their production, and productivity in Bihar

Sr. No.	Crop	Bihar				
		Year ending 1995	Year ending 2005	Year ending 2016	Decadal change 2005 over 1995 (Percent)	Decadal change 2016 over 2005 (Percent)
	Area in (000' ha)					
1	Gram	140.21	80.92	60.19	-42.29	-25.62
2	Red gram	48.76	40.61	25.24	-16.70	-37.85
3	Lentil	190.32	171.33	161.18	-9.98	-5.93
4	Green gram	194.45	184.04	164.52	-5.35	-10.61
	Production in (000' tonnes)					
1	Gram	123.89	78.53	64.35	-36.61	-18.05
2	Red gram	59.53	51.95	38.24	-12.73	-26.40
3	Lentil	137.69	151.03	152.78	9.69	1.16
4	Green gram	107.74	103.52	97.78	-3.92	-5.54
	Productivity (tonnes/ha)					
1	Gram	0.88	0.97	1.07	10.23	10.30
2	Red gram	1.22	1.28	1.54	04.91	20.31
3	Lentil	0.74	0.88	0.95	18.91	07.95
4	Green gram	0.55	0.56	0.59	01.81	05.35

The perusal of Table 2 revealed there was a substantial change in the area, production, and productivity of pulse crops grown in Bihar through time. The area under pulse crops like gram, red gram, lentil, and green gram declined over both the referenced point of time (2005 over 1995 and 2016 over 2005). The only production observed wasa positive increase in the case of lentilcrops. Lentil is the main pulse crop of Bihar and grown in comparatively larger areas than other pulse crops. It could probably be the reason for the positive increase in the production of this crop. Productivity of all pulses cropsunder investigation registered a positive trend at both the referenced points of time, indicating that technological changes like a good variety of seeds and agronomical practices was adopted in the state to some extent.

Growth and instability of different pulses in Bihar

Growth rates were worked out to examine the tendency of the variable to increase, decrease or be stagnant over time. It also indicated the magnitude of the rate of change in the variable under consideration per unit of time. The compound annual growth rate in the area of red gram in Bihar was found negative and significant in all the periods except Period-I. In the case of production, the CAGR was found negative and significantfor the state as a whole (-) 0.96 percent per annum for the overall period.The productivity of red gram for an overall

period in the state (0.45 percent per annum) was found to be positive and significant statistically.

Instability indices for the area, production, and productivity of red gram for the overall period for the state as depicted in Table 3 were 10.33, 11.96, and 14.50, respectively. The results revealed that the variation in area, production, and productivity of the crop were lower in Period-II. It may probably be due to cultivators' mindset, emphasizing rice-wheat cropping system as the knowledge on modern inputs (high yielding variety of seeds), were advocated to increase the productivity of rice and wheat during and after Green Revolution. Cultivators could not find the pulse crops more remunerative than cereals.

Table 3.Compound annual growth rate and Instability indices of area, production, and productivity of red gram in Bihar

(Percent)

Bihar	**Area**	**Production**	**Productivity**
Compound annual growth rate			
Period I	-0.04	-1.16	-1.12**
Period II	-1.24*	-1.35**	-0.11
Period III	-2.09*	-0.90	1.22***
Overall	-1.40*	-0.96*	0.45*
Instability Indices			
Period I	8.18	12.52	8.84
Period II	3.80	9.39	8.83
Period III	8.54	12.73	15.42
Overall	10.33	11.96	14.50

****, ** and *** Significant at 1, 5, and 10 percent level.***

The perusal of Table 4 showed that CAGRs of gram area during the period under study were found to be negative in the state. In the case of production and productivity, CAGRs were negative for most of the periods in the state. Area and production of gram were unstable during the period under investigation for the state. The highest instability index was estimated to be 14.00 in the area for the overall period.The period-wise analysis showed that the area under gram was affected due toa change in cropping preference of farmers. From yield data, it was observed that there wasa slight increase, but production sharply declined due to a rapid decrease in the area, as evident from the instability indices.

Table 4.Compound annual growth rate and Instability indices of area, production, and productivity of gram in Bihar

(Percent)

Bihar	Area	Production	Productivity
Period-I	-0.33	-0.63***	-0.30
Period-II	-2.08*	-2.38*	-0.30
Period-III	-0.18	0.59	0.77
Overall	-1.65*	-1.28*	0.38*
Instability Indices			
Period-I	8.78	16.71	12.59
Period-II	8.09	12.70	11.89
Period-III	4.46	14.58	14.02
Overall	14.00	19.77	13.40

****, ** and *** Significant at 1, 5, and 10 percent level.***

Lentil is the most important pulse crop in Bihar, but it is still grown in marginal areas(Table 5). Area growth of this crop also had a mixed picture and declined by 0.34 percent per annum during the last 30 years. However, there was positive growth in production and productivity except in Period-II.Lentil is the only pulse crop whose area remained more or less stagnant over the years with some fluctuations. CAGRs of production (0.20 percent) and productivity (0.55 percent) of lentil cropsweremore than other pulse crops.CAGR for the overall period (1985-2016) of green gram in area, production, and yield showed (-) 0.32, (-) 0.17 and 0.15 percent, respectively, for the state as a whole (Table 6).

Table 5. Compound annual growth rate and Instability indices of area, production, and productivity of lentil in Bihar

(Percent)

Bihar	Area	Production	Productivity
Period I	-0.92	0.37	1.30
Period II	0.01	-0.99	-1.01
Period III	-0.58**	0.82	1.40**
Overall	-0.34*	0.20	0.55*
Instability Indices			
Period I	19.89	13.80	17.80
Period II	3.64	12.80	11.57
Period III	4.28	14.31	12.52
Overall	12.37	14.43	15.72

****, ** and *** Significant at 1, 5, and 10 percent level.***

Instability indices for the area, production, and productivity of green gram for the overall period in the state were 7.04, 10.84, and 9.34, lower than other pulse crops grown in the state.Green gram in the state is generally grown in the summer season, and required more irrigation. Hence, the area in the state was comparatively less than that of other crops.

Table 6.Compound annual growth rate and Instability indices of area, production, and productivity ofgreen gram in Bihar

(Percent)

Bihar	**Area**	**Production**	**Productivity**
Period I	-0.35	-0.43	-0.09
Period II	0.13	-0.05	-0.17
Period III	-0.04	0.66	0.71
Overall	-0.32*	-0.17***	0.15***
Instability Indices			
Period I	8.06	11.75	9.21
Period II	7.44	6.50	5.58
Period III	4.29	12.34	11.08
Overall	7.04	10.84	9.34

****, ** and *** Significant at 1, 5 and 10 percent level.***

Decomposition analysis of pulse crops of Bihar

In order to find out the contribution of area, production, and productivity and the interaction effect in pulse production, decomposition analysis was carried out.The decomposition analysis of major pulse crops presented in Table 7 showed that yield effects of a red gram were comparatively low in the state. Interaction effects also exhibited mixed trends. The results of a decomposition analysis of gram revealed that area effect was found negative only for Period-III (-) 94.87 for the state as a whole. For the rest of the periods in the state area, effects on the production of gram were positive. The results revealed that the yield effect was also found to be negative for the state as a whole. It was noticed that yield effects in the lentil cropinthe state were found comparatively higher and positive for the overall period in the state.The results of a decomposition analysis of green gram during Period-I and II, area effects were positive for the state. Area and interaction effects showed fluctuating trends for all the periods. The results indicated that area and production both were unstable in the state. The productivity was found to increase which could be due to the adoption of high-yielding varieties, and crop management technologies were undertaken for pulse crops production in the state. The encouraging impact on production was also reflected in the various pulses programmesrecently launched by the government.

Table 7. Decomposition of production growth of different pulses crop in Bihar

(Percent)

Particulars	Yield effect	Area effect	Interaction effect
Red gram			
1994-95 over 1985-86	71.62	41.28	-12.90
2004-05 over 1995-96	-110.70	182.12	28.58
2015-16 over 2005-06	-166.88	210.27	56.62
2015-16 over 1985-86	-25.53	109.94	15.59
Gram			
1994-95 over 1985-86	61.11	51.20	-12.32
2004-05 over 1995-96	23.74	86.02	-9.77
2015-16 over 2005-06	211.00	-94.87	-16.12
2015-16 over 1985-86	-71.65	128.67	42.98
Lentil			
1994-95 over 1985-86	-505.30	377.02	228.28
2004-05 over 1995-96	89.19	14.07	-3.27
2015-16 over 2005-06	187.50	-63.18	-24.32
2015-16 over 1985-86	633.76	-208.81	-324.95
Green gram			
1994-95 over 1985-86	59.17	45.83	-5.00
2004-05 over 1995-96	-65.28	161.33	3.96
2015-16 over 2005-06	108.72	-6.62	-2.10
2015-16 over 1985-86	407.91	-278.63	-29.27

CONCLUSIONS

It was observed that the percentage change in area and production under pulse crops declined during both the referenced periods. Only the production of lentils was observed inclined.The results further revealed that growth rates of area and production of all the pulse crops except lentil registered negative growth.Nevertheless,the growth rate of productivity for all the pulse crops under investigation was registered positive during the investigation period.Instability indices for the area, production, and productivity of green gram for the overall period in the state were found to be comparatively low to that of other pulse crops grown in the state.Decomposition analysis revealed that the area mainly influenced gram production, and productivity did not play an importantrole in the state. The area under the lentil was more or less stagnant.The study emphasized the need to expand the area under pulse crops and increase the pulses production through technological intervention to meet the growing demand.

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