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Empirical evidences on production performance and economics of pulses cultivation in Bihar

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ABSTRACT

Pulse crops are important for providing healthy diets to human being and protein-rich feed and fodder to animals. Bihar is one of the major states for pulses production in the country. The study was carried out at Patna during 2017–19 and based on secondary data for the last 37 years period obtained from published documents and reports of Government of Bihar. Despite the institutional support to increase pulses production, area and production have been declining during the period under study due to lower productivity compared to the competing cereal crops in Bihar. It is paradox that per hectare net income and other measures of income are higher in pulses cultivation than wheat production in winter season but the weaker section of farming community prefer to cultivate wheat to ensure their food security. However, there is a dearth of appropriate technology for pulses production which needs urgent attention by scientific community and policy makers to reverse the cropping pattern in favour of pulses production.

Keywords: Agro-climatic zone, Bihar, Instability, Production, Pulses

Pulses include a host of grain legumes and cultivated to provide nutritional and livelihood security to millions of people in many countries of Asia and Africa. The dry seeds of pulses are rich source of protein (22–26%) and micronutrients, and thus make a balanced food especially for the vegetarians when complemented with cereals (Kumar *et al*. 2019). Their cultivation as a component of cereal-based cropping systems of Indo-Gangetic plains of south Asia has been visualized as an efficient approach to sustain food security in these regions. Moreover, diversifying cereal-based crop rotations with grain legumes may be one of the important mitigation strategies to climate change as pulses need little nitrogenous fertilizers owing to their ability of biological nitrogen fixation in their root nodules (Choudhary *et al*. 2013, Choudhary 2018). Average annual import of pulses was 5.9 million tons during the last five years ending 2017, with the highest import of 11.3 million tons in 2016–17 (Bhosale 2019). Bihar ranks fourth in per hectare pulses productivity, but first in pigeonpea and lentil productivity (Anonymous 2017). The post-green revolution era in the state witnessed a wider adoption of rice-wheat cropping system, resulting in a sharp decline in the total area and production of pulses. In Bihar, per capita per day production of pulses declined continuously from 34 g/day in 1983–84 to 10 g/day during 2016–17. Although pulses are grown in almost all the districts but there exists a wide variability in their area, yield and productivity across different districts of the state. Keeping this in view, the present paper has attempted to analyze the regional growth and variability in area and productivity and dynamics of production of major pulses in different agro- climatic zones of Bihar. The breakthrough via high-yielding varieties (HYVs) in cereals has been accompanied by a loss of acreage under pulses, and consequently a sharp decline in the total production of pulses. Hence, a comparative evaluation of economic return in production of pulses and their main competing crop (wheat) are also undertaken.

MATERIALS AND METHODS

The study was carried out at Patna during 2017–19 and based on secondary data for the last 37 years period obtained from published documents and reports of Government of Bihar. Data were analysed by computing data for all the four agro- climatic zones of Bihar. There was substantial variation in year to year pulses production data due to influence of biotic and abiotic constraints on pulses production; hence data were made smooth by estimating series of triennium (three years average) data. In order to find out the compound growth rates of area, production and productivity of important crops, following exponential function were used:

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$Y_t = AB^t$

where, Yt, area/ production/ productivity of concerned crop in the year; A, intercept; t, year; B, 1+r/100

Percentage rate of compound growth per annum was calculated as:

r = (B-1) × 100 or (antilog B-1), which represents a rate of change from observation to observation during the period under study.

Since our objective was also to examine the fluctuations in area, production and productivity of principal pulse crops, their standard deviations were estimated for the study period and all the three specified periods. The standard deviation out of the various measures of absolute dispersion has been used in different studies, because it is most suitable for measuring deviations in time series data (Croxton *et al.* 1975). Cost of lentil and wheat cultivation estimates generated by the Commission on Agricultural Costs and Prices (CACP) for Bihar were used for analysis. Cost of cultivation data of 2014–15 and 2016–17 were used for the study. Profitability was estimated by using different profit measure tools.

RESULTS AND DISCUSSION

Decadal scenario: Modern agricultural technology has influenced the crop-mix across the country which is more prominent in Bihar. During the post-green revolution period, a decline in area under pulses was more prominent. In early sixties, pulses covered about 18.37 lakh ha in Bihar which declined to 8.53 lakh ha in TE 1981 and further to 4.89 lakh ha in TE 2017. Grass pea was the most important pulse crop in Bihar up to mid-sixties, covering about 9.24 lakh ha which was much higher than wheat area (6.29 lakh ha) in Bihar. Area under pulses observed a significant decline after drought year of 1966–67 and an increase in area under wheat and maize was observed in the state of Bihar (Singh and Ranjan 1998). Principal pulses of Bihar are chickpea, pigeonpea, lentil, greengram and grasspea, which constitute about 92% area under total pulses at TE 1981; however, share of these pulses crops remained unchanged till TE 2017 also (Table 1).

Bihar has food grains dominated cropping pattern but the importance of pulses has declined tremendously during the last forty years. Area under pulses crops constituted 10.5% of gross cropped area at TE 1981 which declined to 6.4% at TE 2017. There was drastic decline in area under pulses from 8.33 lakh ha at TE 1981 to 4.39 lakh ha at TE 2017, accounting for an annual decline of 2.23% during the period (Table 1). Among the principal pulse crops, comparatively large decline in area (86%) and production (60%) was observed in case of grass pea during 1981–2017 with an annual decline by 5.90% and 4.83%, respectively. The decline in grass pea production was primarily due to decline in demand for this crop, which was used mainly as feed and fodder for draught animals whose number declined drastically due to tractorization. Chickpea and pigeonpea followed almost similar declining trend in their production due to shift of area from low productive pulse crops to comparatively high productive cereal crops. Productivity of lentil and green gram had positive growth rate during the period under study and sub periods also, except during 2011–17. Lentil was only *rabi* pulse crop which recorded positive growth in area, production and productivity during

Table 1 Area, production and productivity of principal pulse crops in Bihar during 1981–2017

Pulse crop	Chickpea	Pigeonpea	Lentil	Greengram	Grass pea (Khesari)	Other pulses	Total pulses
Area ('000 ha)							
TE 1981	144	62	139	89	357	62	853
TE 1991	119	43	171	179	230	92	833
TE 2001	74	43	171	183	158	78	707
TE 2011	58	25	171	160	70	51	554
TE 2017	59	21	145	173	51	41	489
Production ('000 tons)							
TE 1981	104	68	87	55	205	35	553
TE 1991	117	63	149	107	180	52	661
TE 2001	74	53	159	105	144	59	595
TE 2011	65	41	161	89	82	48	438
TE 2017	64	33	145	112	52	38	445
Productivity (kg/ha)							
TE 1981	722	1099	620	622	569	564	648
TE 1991	977	1472	872	563	784	565	793
TE 2001	998	1249	927	575	912	756	841
TE 2011	1118	1653	946	554	1064	941	898
TE 2017	1087	1569	1002	649	1017	926	910

the study period except 2011–17. Productivity of all *rabi* pulse crops excluding greengram observed negative growth during 2011–17, mainly due to deficient winter rainfall in Bihar. Greengram is grown in spring/summer and *kharif* in Bihar; hence its productivity was not adversely affected by deficient winter rainfall.

Agro-climatic zone wise CAGR of pulses production revealed a decline in pulses production during the study period in all the zones of Bihar, but the decline was conspicuous for *khesari* mainly due to decline in area in all the zones during the study period. Chickpea experienced negative growth rate in almost all zones during sub-periods under study. The negative growth rate in area of chickpea could be ascribed to the occurrence of various root diseases (dry root rot, wet root rot and collar rot) including Fusarium wilt and to the severity of damage caused by gram pod borer (*Helicoverpa armigera*). Pigeonpea followed similar trend but had positive growth in production after 2001 in zone IIIA and zone IIIB, but the area still remained low in comparison to 1981. The long-duration of pigeonpea and declining area of its intercrop (maize) in *kharif* could best account for reduced area under pigeonpea in Bihar. Lentil production recorded positive growth in zone I, negative in zone II in all the sub periods, positive growth in zone IIIA and zone IIIB in first sub-periods, but negative in 2011–17. In general, the production growth rate is directly related to area under crop. The production growth rate was positive in zone I associated with positive growth rate of lentil area while negative in zone II due to decline in lentil area. Similar observations were noticed in zone IIIA and zone IIIB. There was increasing trend in lentil productivity, but it could not compensate for the production loss due to decline in area. Increase in irrigated area and relatively low price of pulses were the main reasons for declining area under pulses in Bihar.

Instability in pulses production: In order to examine the fluctuation in pulses production, annual changes in output of pulse crops and their standard deviations were estimated for the study period as well as the specified periods for all the agro-climatic zones of Bihar. Analysis of instability with respect to pulse crops during the study period showed variations ranged from 11.23% for greengram to 90.41% for chickpea in zone I (Table 2).

The comparatively high fluctuation in pulses production was observed in zone I and the least in zone IIIA. There was no trend in variations in output of pulse crops under study, but pigeonpea experienced higher fluctuation in all zones during four specified sub-periods as this crop is more sensitive to weather aberration (Singh 2010). Chickpea output fluctuation showed increasing trend, particularly in

Table 2 Instability (%) in production of principal pulse crops in Bihar during the study period

Pulse crops	Chickpea	Pigeonpea	Lentil	Greengram	Grasspea (Khesari)	Other pulses	Total pulses
Zone I							
1981- 2017	90.41	40.55	21.98	11.23	76.23	20.29	18.28
1981-1991	3.27	2.47	21.05	0.51	2583	8.33	6.93
1991-2001	38.52	17.41	7.84	6.05	29.16	11.60	1.22
2001-2011	89.66	39.45	16.96	11.92	21.26	18.35	9.80
2011-2017	146.57	24.99	33.74	12.44	33.39	7.58	12.67
Zone II							
1981- 2017	48.27	62.81	18.22	14.11	52.31	20.69	14.90
1981-1991	18.76	29.48	12.55	12.79	12.88	28.66	12.14
1991-2001	23.21	28.25	8.07	10.37	8.80	15.80	8.36
2001-2011	43.02	73.19	16.40	18.36	21.85	12.31	14.97
2011-2017	51.10	35.72	25.00	13.28	48.23	15.18	9.87
Zone IIIA							
1981- 2017	30.62	51.34	32.26	32.87	31.17	22.07	13.70
1981-1991	12.38	39.63	15.75	24.06	12.03	30.90	3.85
1991-2001	25.59	36.70	33.05	37.68	22.95	25.48	12.31
2001-2011	21.83	42.28	17.67	13.84	25.65	13.65	12.81
2011-2017	16.90	57.74	22.52	24.10	43.13	11.45	17.41
Zone IIIB							
1981- 2017	22.29	34.38	19.18	73.65	38.08	17.38	17.92
1981-1991	18.97	45.73	22.07	4.67	28.68	16.54	22.43
1991-2001	21.15	28.19	24.20	20.34	13.36	21.86	16.20
2001-2011	13.12	37.22	16.62	16.90	25.46	7.70	14.89
2011-2017	16.13	35.44	9.54	40.33	23.07	9.06	12.33

zone I and zone II due to faster decline in gram production in these two zones. Presently lentil is a major pulse in Bihar, and fluctuation in output is comparatively low in all the zones. Area under lentil was higher in zone IIIB, and the variation was almost the lowest, ranging from 9.54–24.20%. The larger variation in greengram output was observed in zone IIIB although the area under this crop is the lowest in this zone. The variation in greengram output was comparatively low in zone II where this crop is grown at a large scale. Grasspea (*khesari*) is considered a dead crop after the ban on its marketing in Bihar. The fluctuation in grasspea production was larger in zone I and zone II where its production was lower than that in the zone IIIA and zone IIIB. Output variability of any crop is caused by area and productivity variability. Declining trend of pulses area seems to be the main cause of higher variability in pulses production in Bihar. There was growth in productivity of all pulse crops. However, the increase in productivity could not compensate for the loss of output caused by decline in area of the pulse crops.

Comparative economics: Lentil is an important *rabi* pulse crop which covers about one-third of the pulses area in Bihar. However, wheat has emerged as the most important *rabi* crop in the post-green revolution period, and presently it covers around 40% of net sown area in *rabi*. It is the main competing crop to *rabi* pulses, hence the comparative economic analysis of lentil and wheat has been carried out to know the details of cost incurred in cultivation and profit earned from cultivation of these two important *rabi* crops in Bihar. The estimates of cost of cultivation of lentil and wheat for Bihar generated by the Commission of Agricultural Costs and Prices, New Delhi have been used for detailed analysis. Cost and profitability analysis was done for two points of time, that is, TE 2006–07 and TE 2016-17. Per hectare total cost of cultivation of wheat was about 83% higher than that of lentil cultivation at TE 2006–07, but the difference got narrowed down to 41% at TE 2016–17.

Earlier, farmers cultivated lentil with traditional method, whereas wheat was adopted with modern technology like, improved seed, fertilizer and irrigation at large scale in early seventies in Bihar. Cost A_2 and Cost A_2 + FL were also higher in wheat cultivation than those of lentil cultivation due to higher use of inputs in wheat cultivation. There was substantial increase in cost of cultivation ranged from 171–189% in lentil and 144–186% in wheat. It was due to increase in prices of inputs used in cultivation of these crops; however, an increase in human labour wages was the main reason for increase in cost of cultivation of these crops which increased from ₹ 7.0 per hour in 2006-07 to ₹ 32 in 2016-17.

Among various input costs, human labour cost constituted about 38% in lentil and 16% in wheat to respective operating cost of cultivation at TE 2006–07, which increased to more than 50% in lentil and about 38% in wheat cultivation at TE 2016–17. More than four-fold increase in labour cost in cultivation of these two competing crops was not due to increase in human labour use, rather due to increase in labour wage in Bihar during period under consideration. Per hectare use of fertilizer did not increase in any of these two crops during last 10 years but cost of fertilizers doubled. Price of phosphoric fertilizers increased more than that of nitrogenous fertilizers hence the increase in fertilizer cost was more in lentil cultivation because the majority of farmers use phosphoric fertilizers in lentil cultivation (Anonymous 2019). Wheat is cultivated in irrigated land, hence irrigation cost increased, whereas lentil is grown in almost rainfed situation. There was higher increase in per hectare operating cost of lentil cultivation (201%) than that of wheat due to adoption of critical inputs like modern seeds and fertilizers.

Per hectare gross income in lentil cultivation was 5.3% lower than wheat, the main competing crop at TE 2006–07; but the situation was just reverse at TE 2016–17 when gross income from lentil cultivation was higher (7.7%) to gross income in wheat cultivation. Despite significant increase in productivity of wheat (39%) over lentil (28%) during the period under consideration, increase in gross income was lower in wheat than lentil cultivation. It was due to higher increase in lentil price from ₹ 1545/q in 2006–07 to ₹ 5529/q in 2016–17 than that of wheat price which rose from ₹ 700/q to ₹ 1683/q in respective period. Similar pattern was observed in net income and income over Cost A_2+ FL, and increase in net income during the period was much higher in case of lentil cultivation due to less expenses in human labour, machine labour and irrigation as compared to wheat cultivation. Per hectare fixed cost was also higher in wheat than lentil cultivation. It could be ascribed mainly to rental value of land as lentil is still produced on inferior land, and imputed rental value is less for lentil cultivation compared to wheat cultivation. Profitability over total cost of cultivation was 65% in 2006–07 in case of lentil production which increased to 78% in 2016–17. It was due to comparatively less increase in total cost (184%) than gross income (202%) in lentil cultivation in Bihar; however, increase in gross income was not only due to increase in productivity but also due to increase in lentil prices during the period. The situation of profitability was just reverse in case of wheat production which observed declining profitability in Bihar during the period under consideration.

Bihar has witnessed significant decline in pulses area and production. This has put nutritional and environmental security, soil health and sustainability at stake. This calls for crop diversification with pulse based cropping system. Our study has shown that per ha net income and other measures of income are high in pulses. Therefore, policy makers need to revisit the existing policies to attract farmers for diverting substantial area to pulse cultivation. Distribution of quality seeds, assured price and creating marketing chain may have significant impact on pulse cultivation in Bihar.

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