

## Comprehensive Analysis of Recent Production and Productivity Trend of Major Agricultural Crops in Bihar, India

Rashmi, H.P. Singh, P.K. Singh

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### ABSTRACT

Agriculture is the backbone of economy and social well-being of people of Bihar. According to census report of 2011, about more than 80% people live in villages having agriculture as the main occupation. The present study is based on the analysis of time-series data of major agricultural commodities (Rice, Wheat, Maize, Pulses and Oilseeds) of Bihar after the bifurcation of Jharkhand state. The current research is the first study investigating the recent trend of rice yield for 20 years of data during 2000-01 to 2019-20. The production of rice registered increasing trend from 54.44 lakh tonnes in 2000-01 to 69.52 lakh tonnes in 2019-20 with a quantum jump in rice production in 2011-12, as compared to 2010-11. All major crops shows positive compound annual growth rate (CAGR) except pulses which shows negative CAGR (-1.52). The CAGR for the productivity of all major crops registered a positive trend. CAGR for pulses and oilseeds for area registered a negative trend. The productivity rate of pulses has decreased from 835 kg/ha to 731 kg/ha during the same period. Wheat registered an upward trend in all agro-climatic zones and the state as a whole. Area under wheat showed increasing rate (0.81) because of comparative remunerative than other crops.

**Keywords** Crop production, Bihar, Rice, Productivity, Agriculture.

### INTRODUCTION

Agriculture is the backbone of Bihar's economy comprising 77% of workforce and generating 21% of the state domestic product. The proportion of total land put to agricultural use is high in Bihar, compared to other states of India. This is because of its topographical nature, as it falls in the riverine plains of the Ganga basin. The fertility of soil along with abundant groundwater resources help farmers of Bihar to produce a variety of crops, both food and non-food. With increasing human population the requirement of food-grain production in near future is likely to increase (Godfray *et al.* 2010 and Tilman *et al.* 2011). The share of agriculture in Gross Domestic Product (GDP) has shown decreasing trend from 39% in 1983 to 24% in 2000–01 and its share in total employment from 63% to 57% during the same period (Mall *et al.* 2006 and Kishore 2004). The cropping of Bihar is largely rainfed from ancient times and therefore it will be acutely affected in case of unforeseen variations in monsoon trend. The change in precipitation pattern and increase in temperature has been seen as a result of climate change. Hence, there is an inescapable requirement to improve crop production to match the increasing demand (Alexandratos 1999 and Cassman 1999). The non-improvement and stationary in crop production may have serious consequences for the crop production and subsistence for many farmers (Tilman *et al.* 2002). Bihar occupies one of the important agricultural production states in India. With around 90% of the total population living in rural areas, agriculture is the source of the rural economy. Thus agriculture is one of the important factors in the

Rashmi<sup>1</sup>\*, H.P. Singh<sup>2</sup>, P.K. Singh<sup>3</sup>

<sup>1</sup>Research Scholar, <sup>2</sup>Professor, <sup>3</sup>Assistant Professor, Department of Agricultural Economics, Institute of Agricultural Sciences, Banaras Hindu University, Uttar Pradesh 221005, India

Email: rashrai.bhu@gmail.com

\*Corresponding author

development of Bihar. Agriculture in Bihar is mainly dependent on the monsoon. Since 57% of its gross cultivated area is irrigated, irrigation itself is largely dependent on the use of surface water. As claimed by United Nations Population Division (2015), India is anticipated to become the most populated country in the world leaving China around 2022 and its population is again predicted to grow to 1.74 billion by 2050. The increase in population size and accordingly, increase in demand for food consumption will result in an increased amount of crop production and yield in India. As a result of green revolution during 1966, Bihar has witnessed continuous increase in crop production, but there is constant need to improve crop production to meet the food grain consumption. With increasing population and unseen severity of the situation, researchers all over the world have come forward to undertake the crop production trend of major crops at different regional and local scale (Lin and Huybers 2012 and Ray *et al.* 2012). Above mention studies suggest that the productions of major crop are stagnating in different geographical area over the world. Brisson *et al.* (2010) reported that wheat yield is witnessing stagnant in France, while slowing growth of crop yield in Switzerland is reported by Finger (2010). Agriculture is highly exposed, as any change in climate variable impacts crop production, evaporation modelling and other management practices. Climate change impacts on agriculture are manifold average temperature, rainfall and weather extremes.

Not many studies have been conducted to track the regional variations and underlying changes in production performance of major agricultural commodities in different agro-climatic zones of Bihar after the bifurcation of Jharkhand with recent up-to-date data. In addition to this, it is essential to compound annual growth rate for major crops during the last two decade (2000-01 to 2019-20).

### Study area

Bihar is geographically located in the north-east part of the country. It falls under the agro climatic zone –IV which is known as “Middle Gangetic Plain Region”. The climate of Bihar varies from humid to sub humid. Bihar account for about 9,360,000 hectares area which is further bifurcated into four sub agro-climatic zones (Fig. 1). The detailed description of different agro-climatic zones of Bihar is given in Table 1. The main soil type found in Bihar is primarily loam and sandy loam. The whole farming operations are divided into two crop seasons i.e. *kharif* and *rabi*. The mean annual rainfall of Bihar state is about 1200 mm (Chowdary *et al.* 2008) and the average number of rainy days in a year is 52.5 days. The summers are generally quite hot and winters are fairly cool. It is located between latitude 24°-20'-10" N ~ 27°-31'-15" N and longitude 83°-19'-50" E ~ 88°-17'-40" E (GOB 2014).

### MATERIALS AND METHODS

The secondary data of major crops was obtained from



Fig.1. Index map of Bihar showing different agro-climatic zone.

**Table 1.** Agro-climatic zones of Bihar.

Sl. No	Agro- climatic zones	Type of soil	Altitude (m)	Rainfall (mm)
1.	Zone-I	Heavy textured sandy loam to clay, medium acidic, flood prone, PH 6.5-8.4	Upto 650	1122
2.	Zone-II	Light to medium textured slightly acidic, sandy loam to clay loam with saline/alkaline patches, PH 6.5-7.8	651-1800	1387
3.	Zone-III A	Old alluvium sandy loam clay, slightly alkaline patches, PH 6.8-8.0	1800-2200	1215
4.	Zone-III B	Old alluvium sandy loam to clay, slightly alkaline patches, PH 6.8-8.0	Above 2200	1234

published reports and offices of Government of Bihar. These major crops are rice, wheat, maize, pulses and oilseeds. The production of major crops of Bihar is presented in Table 2 for the period of 2000-01 to 2019-20. The productivity level of major crops in Bihar for the same period has been presented in Table 3. Rice, wheat and maize are the major cereal crops. Rice is the main monsoon crop and is cultivated in all districts of Bihar. Wheat was increasingly planted by Bihari farmers after the green revolution and it currently occupies the status of major crop of the *rabi* season. Maize is also cultivated, with an average annual production level of approximately 1.5 million tons and a steady positive trend in production. Pulses such as mung bean, peas and lentil are mostly grown in the southern parts of Bihar.

### Compound annual growth rate (CAGR)

Compound annual growth rate (CAGR) was calcu-

**Table 2.** Production trends of major crops in Bihar (Production '000 MT).

Year	Rice	Wheat	Maize	Pulses	Oilseeds
2000-01	5444.37	4437.96	1497.29	619.44	130.93
2001-02	5202.81	4391.08	1487.92	547.04	123.69
2002-03	5085.57	4040.61	1292.01	558.91	104.93
2003-04	5447.79	3688.94	1473.57	556.81	123.55
2004-05	2625.13	3279.94	1491.18	471.4	116.31
2005-06	3495.93	2763.32	1361.11	447.08	134.36
2006-07	5131.17	4149.02	1754.41	451.42	140.77
2007-08	4472.68	4974.66	1857.01	472.94	144.2
2008-09	5771.39	4638.94	1701.93	527.42	122.42
2009-10	3599.25	4570.82	1478.62	472.46	143.5
2010-11	3112.57	5094.03	2108.19	467.16	142.24
2011-12	8237.98	6530.96	2557.06	521.64	174.48
2012-13	8322.01	6174.26	2755.95	542.76	182.74
2013-14	6649.59	6134.68	2904.24	522.02	157.17
2014-15	8241.67	3570.21	2478.75	428.93	127.01
2015-16	6802.22	4736.45	2517.1	420.78	126.52
2016-17	8238.77	5985.84	3845.7	461.67	125.86
2017-18	8093.16	6104.3	3120.77	454.17	124.24
2018-19	6155.53	6465.91	3193.91	453.43	124.94
2019-20	6952.52	5579.35	3495.4	334.42	124.73

lated using the regression equation in the exponential form as:

$$y_t = ab^t$$

Where,

$y_t$  = area/ production/ yield of major crops in  $t^{\text{th}}$  period

$t$  = time variable (1, 2, 3, ..., n)

$a$  = constant,

$b = (1+r)$

$r$  = compound growth rate

After log transformation:

$$\ln y_t = \ln a + t \ln b$$

$$r = (\text{antilog}(\ln b) - 1) \times 100$$

## RESULTS AND DISCUSSION

### Production and productivity trend

Soil fertility, combined with abundant ground water resources, enables Bihar farmers to grow a wide range of crops. Bihar produces oilseeds, fibers, fruits and vegetables in addition to cereals and pulses. Bihar has conferred the Krishi Karman Award to the state on 2<sup>nd</sup> January 2020, for its achievements in production and productivity of Maize and Wheat.

### Rice

Rice is crucial for ensuring both livelihoods and food security of the rural population. The state exhibits variation in climate over different regions that tend to alter the cropping pattern. The production of rice registered increasing trend from 54.44 lakh tonnes in 2000-01 to 69.52 lakh tonnes in 2019-20 with quantum jump in rice production in 2011-12, as compared to 2010-11. The state registered 3.6% CAGR in terms of rice production. This high rise in rice production is because of the use of new 'SRI' technique and use of newer agricultural implements. With respect to rice also, there has been inconsistency in its production and productivity during the last five years.

**Table 3.** Productivity and acreage trends of major crops in Bihar (Productivity: (kgs/ha), Area : '000 hectares).

Year	Rice		Wheat		Maize		Pulses		Oilseeds	
	Area	Yield	Area	Yield	Area	Yield	Area	Yield	Area	Yield
2000-01	3656.39	1489	2042.32	2173	610.14	2454	741.84	835	175.98	744
2001-02	3551.41	1465	2126.43	2065	594.22	2504	694.21	788	147.07	841
2002-03	3583.91	1419	2131.12	1896	509.67	2535	695.16	804	136.98	766
2003-04	3577.01	1523	2094.80	1761	615.78	2393	679.87	819	140.56	879
2004-05	3318.75	791	2038.50	1609	624.45	2388	664.88	709	131.28	886
2005-06	3298.05	1060	1982.30	1394	593.85	2292	606.62	737	154.44	870
2006-07	4552.95	1127	2606.17	1592	827.55	2120	527.98	855	161.25	873
2007-08	3472.58	1288	2131.39	2334	657.81	2823	524.32	902	142.07	1015
2008-09	3495.69	1651	2103.83	2205	624.79	2724	544.86	968	130.51	938
2009-10	3213.62	1120	2193.29	2084	631.62	2341	567.18	833	138.78	1034
2010-11	2845.13	1094	2099.77	2426	651.68	3235	538.20	868	130.02	1094
2011-12	3344.69	2463	2142.00	3049	694.29	3683	526.38	991	133.39	1308
2012-13	3298.46	2523	2207.46	2797	693.32	3975	515.93	1052	127.70	1431
2013-14	3151.46	2110	2148.75	2855	732.28	3966	500.02	1044	122.89	1279
2014-15	3264.03	2525	2154.62	1657	706.60	3508	505.81	848	116.20	1093
2015-16	3232.99	2104	2110.72	2244	704.87	3571	498.55	844	119.47	1059
2016-17	3339.59	2467	2105.47	2843	720.84	5335	479.41	963	108.97	1155
2017-18	3307.38	2447	2101.31	2905	677.40	4607	476.07	954	102.85	1208
2018-19	3159.92	1948	2156.74	2998	669.44	4771	479.31	946	100.19	1247
2019-20	3096.89	2245	2150.04	2595	673.10	5193	457.48	731	113.49	1099

The falling productivity of rice could be attributed to inadequate availability of water for cultivation, because of droughts, deficient rain and floods in certain districts, along with rising input costs. Result of CAGR for production, productivity and area of rice is shown in Fig. 2.

### Wheat

Bihar is an important wheat growing state that contributes 5.7% towards national production from 8% of wheat growing area of the country. It is mainly growing in a Rabi season along with barley, lentils, and mustard. Similarly, the production levels of wheat and maize have also recorded a positive trend. The wheat production increased from 44.37 lakh tonnes in 2000-01 to 55.79 lakh tonnes in 2019-20. Result of CAGR for production, productivity and area of wheat is shown in Fig. 2.

### Maize

Maize is an important staple crop in Bihar and is largely grown under different agro-ecological zones across all the districts. It is the most suitable food and fodder crop, and increasing its production is, therefore, useful to meet the growing demand for diversified uses such as human consumption, animal feed (for poultry and livestock), and other industrial uses. The fertile Gangetic plains, and use of hybrid

seeds have enabled achieving higher yield in maize, though there are large scale fluctuations across the districts. It is important to note that production of maize has registered an increasing trend in longer period. Its production increased from 14.97 lakh tonnes in 2000-01 to 34.95 lakh tonnes in 2019-20. Productivity of maize also increased from 2454 kg/ha in 2000-01 to 5193 kg/ha in 2019-20 (Table 3). Though the area under maize has marginally increased in Bihar, there are considerable fluctuations in yield leading to instability in production. The result of CAGR for production, productivity and area of maize is shown in Fig. 2.

### Pulses

Due to the increasing awareness of significant nutritional benefits, there has been a soaring demand

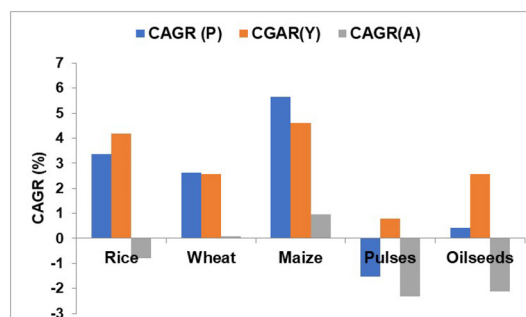


Fig. 2. Percentage CAGR of major crops in Bihar.

for pulses in Bihar, especially among vegetarians. Not only does it form an important component of nutrition, it is also crucial for achieving ecological sustainability owing to their key role in improving soil fertility. In Bihar, pulses are largely grown under rainfed conditions and, therefore, are prone to high fluctuations in yield. Pulses also lost ground in terms of area and production. The production level of pulses declined from 6.19 lakh tonnes in 2000-01 to 3.34 lakh tonnes in 2019-20. The productivity rate has decreased from 835 kg/Ha to 731 Kg/ha from during the same period. The area under pulses has been declining. Much of this increase was due to growth in Rabi pulses, mainly contributed by lentil, summer moong and gram. To streamline pulse production in the state, the State Government has undertaken various initiatives to minimize pest infestation, increase yield, and enhance price realization to the farmers. The result of CAGR for production, productivity and area of pulses is shown in Fig. 2.

### Oilseeds

In the oilseed sector, area and production decreased slightly. In 2000-01, the area was 1.75 lakh hectares and in 2019-20, the area again was 1.13 lakh hectares. Production level of oilseeds marginally decreased from 1.30 lakh tonnes in 2000-01 to 1.24 lakh tonnes in 2019-20. The productivity of oilseeds increased from 744 kg per hectare in 2000-01 to 1099 kg per hectare in 2019-20. Result of CAGR of production, productivity and area for oilseeds is shown in Fig. 2.

### CONCLUSION

The State Government has made significant efforts through promotion of zero tillage methods and system of rice intensification technique to increase rice production. To enhance the productivity of cereals, the State Government is making efforts through modernization of farms, technological adoption and investment in irrigation infrastructure and abating pest attack. Thus, assessing the trends in production and productivity of important crops in Bihar, it emerges that there is scope for increasing the yield for food grains, in both rainfed and irrigated areas of the state. Growth in production in crop sector in Bihar owes a great deal to expansion in productivity, rather than increases in area, since the scope for any additional land for cultivation is very limited in the state. Grow-

ing population has accentuated the need to step up production in the state to meet the needs of food and nutritional security.

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