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Growth Performance and Instability Analysis of Sugarcane Cultivation in Bihar : Economic Perspectives

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ABSTRACT

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The present study initiates and analyzes the growth trends in area, production and productivity of sugarcane crop, measure the variability of sugarcane crop at the district levels in Bihar. The data obtained from secondary sources for the period of 42 years beginning from 1970-71 to 2011-12 and analyze by using simple descriptive statistics, CAGR (compound annual growth rate). Out of 38 districts of Bihar six major sugarcane growing districts have been selected on the basis of percentage area and production of sugarcane. The results of the study revealed that area, production and productivity had shown significantly positive in the third period in the selected districts. However, the growth rate in the areas of sugarcane in Bihar found negative (-0.22) during the entire period. This might be due to shift in acreages of sugarcane to other valuable cash crops. The study also revealed that coefficient of variation depicted that highest inter-annual fluctuation was observed in production (67.65 per cent) followed by variation in area and productivity 44.29 per cent and 18.44 per cent respectively during 1970-2012, and thereby indicating that instability in production of sugarcane crop in the state. The study suggests that combination of improved technology such as inter cropping, balanced use of nutrient management, drip method of irrigation, policy and institutional innovations is needed for improvement of productivity and profitability of sugarcane crops in Bihar.

Introduction

Sugarcane is an industrial and energy crop. it has great demand for various other uses like fodder, paper production and most importantly bio-fuels (ethanol) and fibre. It is also utilized

in commercial gur and khansari making. Sugar is a white gold which is extremely essential for the nation's food requirements and have generated better avenues for income and employment generation. In India there are nine states and two distinct zones (tropical and

sub-tropical), where sugarcane is grown extensively in the large area.

In India, sugarcane is grown over 5.3 million/ha with total production of 359 million tons of cane with average productivity of 64.7t/ha (ISMA, 2015). It is the second largest producer of sugar in the world after Brazil and it is produced approximately 22 million tons of sugar annually.

Sugarcane is an important commercial crop of the state occupying 0.3 million ha with a share of 4.90 per cent of the total cultivated land in the state.

In Bihar the major sugarcane districts are West-Champaran, East Champaran, Gopalganj, Sitamarhi, Siwan and Samastipur which contributes with a share of about 79.87 per cent in production of the states sugarcane crop. Sugarcane also supports two important rural and cottage industries like gur and khandsari industries.

Sugar industry is an important component of agro based industry in the state. It is estimated that about 5 lakhs farmers are engaged in the cultivation of sugarcane and approximately half a lakh as unskilled and skilled workers are engaged in sugar and allied industries particularly in ethanol and captive power generation. Out of 28 old sugar mills in the state, 16 are sick and closed and 12 are working all in the private sectors.

A considerable literature had examined the trends in growth rate in area, production and productivity in Indian agriculture. These studies have also outlined the factors that influence these trends and variations. Kalita (2011) also examined the trends of area, production and productivity of fibre crops in Assam by dividing the period 1950-51 to 2000-01. Satinder *et al.*, (2014) study has examined the trends in growth rates in area,

production and productivity of sugarcane in Haryana during the study period 2000-01 to 2009-10. Show interesting results in Haryana at the district and regional levels.

The present study initiates and analyzes the trends in growth rates in area, production and productivity of sugarcane of Bihar state at the district levels covering the most important period from 1970-71 to 2011-12.

In this view the present study is therefore undertaken to analyze the change in area, production and productivity of sugarcane with the following objectives:

To find out trend as well as growth rate of area, production and productivity of sugarcane.

To measure instabilities in production of sugarcane

Materials and Methods

The present study is based entirely on time series secondary data with respect to area, production and productivity of sugarcane crop in the North Bihar region of Bihar.

The study period for the objectives is confined with a total duration of 42 years i.e. 1970-71 to 2011-12.

The data were collected from Directorate of Economics and Statistics, Govt. of Bihar, Patna, Bihar through figures. For the present study. The period were visualized as a whole as well as by sub-dividing it into three periods as indicated below:

Period – I	:	1970-71 to 1985-86
Period – II	:	1986-87 to 1999-2000
Period –III	:	2000-01 to 2011-12

Compound growth rate (CGR)

In the present study, the compound growth rate (CGR) in area production and productivity of sugarcane in Bihar were estimated by fitting exponential types of equation.

$$y = ab^t$$

Where,

y = Area /production/productivity of sugarcane (hectars, ton, tons/ha).

a = Constant

b = Regression coefficient or trend value

t = Time variable

$$CGR(\%) = (\text{Antilog } b-1) \times 100$$

The significance of the estimated compound growth rate with be tested with the help of student's 't' test.

$$t = r/SE(r)$$

Estimation of Instability Index

To study the trend and instability of sugarcane crops production in Bihar, mean (\bar{x}), stander error (SE) and co-efficient of variation (cv) were worked out using the formula

$$c.v. (\%) = \left(\frac{\sigma}{\bar{x}}\right) \times 100$$

Where,

σ = standard deviation

\bar{x} = arithmetic mean

The co-efficient of variation was used as a measure of instability.

Performance of sugarcane growing districts

Based on the growth performance of area under sugarcane, 38 districts of Bihar were classified into three sub-heads viz (i) major (ii) minor and (iii) others growing district. Out of 38 sugarcane-growing districts, nearly 79.89 per cent were fall under category of major performing followed by minor and other

sugarcane growing districts was 16.53 and 2.6 per cent respectively.

For the present study, out of total 38 district's 6 (six) major performing sugarcane growing districts were selected for the period of 1970-2012, perform the growth trend and instability analysis.

For achieving the objectives and examine the growth rate in major sugarcane growing districts, it was pertinent the growth divide the entire study period into 3(three parts) 1970-71 to 1985-86 (first period), 1986-87 to 1999-2000 (Second period) and 2000-01 to 2011-12 (third period) and fourth period (1970-71 to 2011-12) give the idea of entire study period.

Results and Discussion

The growth rate trends in area, production and productivity depend on many factors. For instance, the agricultural productivity in most cases depends on area sown under the crops and total production of that particular crop. The production of a crop not only depends on area sown but also affected by technology adopted there in and economics of production.

Growth rates in area, production and productivity of sugarcane at district level

Table 2 and figure 1.1 showed the growth rates in area, production and productivity of sugarcane at district level. A comparative analysis of growth rates in area, production and productivity of sugarcane at district level in Bihar, showed more robust result for policy suggestion. The area under sugarcane in Bihar has been decreased at the rate of 0.22 per cent annum during the entire period of 42 years which might be due to introduction of other valuable crops in sugarcane area.

The growth rate in area of sugarcane shows negative growth rate in almost all the districts except West-Champran and Gopalganj of

Bihar, but almost significant at 1 per cent level of significance. The production of sugarcane in Bihar has been increased at the rate of 0.20 per cent per annum during the entire period. As regards the growth rates of sugarcane production in major sugarcane growing districts, the significant increase in West Champaran and Gopalganj was noticed and it was 1.09 and 0.66 per cent, per annum respectively. However in the case of East-Champaran and Siwan it was declined 0.97 and 1.20 per cent respectively and was significant.

Productivity is the most important criteria for measuring growth of any crops output. The success or failure of any improvement in the art of agriculture is measured by the resultant increase or decrease in the productivity. The growth rate was 0.42 per cent, which was found significant at 1 per cent level of significance during the overall period. The decline in productivity of sugarcane during period –II was mainly due to cultivating the

sugarcane crop on same piece of land year after year which leads to infertility condition of the soil.

As regards the growth rates of sugarcane in area production and productivity of district wise analysis at the overall level revealed that, area, production and productivity in the third period higher and positive in comparison to the second period, due to increase in adoption of high yielding varieties and better management of cultural practices in sugarcane cultivation.

Changes in area, production and productivity variability

To examine the change in area, production and productivity of sugarcane crop for major sugarcane growing districts of the states the two statistical measures used are the standard deviation which gives an absolute measures of variability and co-efficient of variation which indicates the relative change in variability.

Table.1 Classification of districts based on area under sugarcane

Name of the category	Name of districts
Major performing district	West-Champaran, Gopalganj, East-Champaran, Sitamarhi, Siwan and Samastipur
Minor performing district	Begusarai, Bhagalpur, Muzaffarpur, Madhubani, Madhepura, Sheohar, Banka, Dharbhanga, Gaya, Bhojpur, Patna, Jamui, Rohatas
Other performing district	Aurangabad, Purnea, shaharsa, Nawada, Shikpura, Araria, Saran, Buxar, Vaishali, Khagaria, Munger, Lakhisarai, Supaul and Arwal.

Table.2 Compound growth rate (CGR) in area, production and productivity of sugarcane in major sugarcane growing districts of Bihar

SI No.	Districts	CGR (%)											
		Period –I (1970-71 to 1985-86)			Period-II (1986-87 to 1999-2000)			Period-III (2000-01 to 2011-12)			Entire period (1970-71 to 2011-12)		
		A	P	Y	A	P	Y	A	P	Y	A	P	Y
1	West-Champaran	0.29	-0.07	-0.36	-0.05	0.90	0.95	1.92	1.76	-0.15	0.62***	1.09***	0.47***
2	Gopalganj	-1.01	-1.83	-0.82	-0.027	-2.03	-1.77	2.00	3.85	1.85	0.47***	0.66***	0.19
3	East-Champaran	-3.24	-2.78	0.48	0.52	-0.63	-0.11	1.81	3.39	5.49	-1.23***	-0.97***	0.26
4	Sitamarhi	0.69	-0.66	-1.34	0.10	1.11	1.01	2.04	-0.04	3.53	-0.26	0.09	0.34
5	Siwan	-1.60	-3.87	-2.31	-0.13	0.73	-2.31	-0.41	0.71	1.12	-1.05***	-1.20***	-0.15
6	Samastipur	-0.53	-0.49	0.04	0.07	0.06	-0.0036	2.05	3.65	1.57	-0.22*	-0.36	-0.14
7	Bihar	-1.54	-1.97	0.43	0.47	-0.12	0.35	2.46	3.68	1.19	-0.22	0.20	0.42***

***, * significant at 1 and 10 per cent level of significance

Source : Directorate of Economics and statistics, Patna, Indian sugarcane, Bihar through figures.
 Period I – 1970-71 to 1985-86, period-II 1986-87 to 1999-2000, period-III 2000 -01 to 2011-12.
 Entire period 1970-71 to 2011-12.

Table.3 Mean, Standard deviation and coefficient of variation of area, production and productivity of major sugarcane growing districts of Bihar

District	Area (0'000ha)				Production (thousand/tonne)				Productivity (thousand/ha)			
	Period I	Period II	Period III	% change over period-II	Period I	Period II	Period III	% change over period-II	Period I	Period II	Period III	% change over period-II
Mean												
West-Champaran	38.22	47.01	63.22	34.48	1277.14	2313.66	2965.79	28.07	33.15	49.20	44.97	-8.59
Gopalganj	15.46	17.24	22.69	31.61	580.90	924.95	995.72	7.61	37.51	52.13	43.22	-17.09
East-Champaran	20.26	11.75	8.42	-28.34	763.70	511.98	387.72	-24.27	37.81	43.33	46.62	7.59
Sitamarhi	4.41	6.09	3.60	-40.88	148.28	204.93	229.43	11.95	40.94	33.58	49.17	46.42
Siwan	9.19	5.90	4.85	-17.79	405.43	256.96	184.95	-28.02	42.31	43.66	37.19	-0.14
Samastipur	3.74	3.86	3.21	-16.83	146.09	133.32	128.26	-3.79	39.36	35.15	35.80	1.84
Bihar	136.67	117.31	128.08	9.18	4609.19	5145.81	6082.32	18.19	33.55	43.63	44.84	2.77
Standard deviation												
West-Champaran	2.82	5.29	29.03	-	303.95	518.99	1822.03	-	5.88	9.98	8.41	-
Gopalganj	2.22	2.83	4.85	-	177.17	453.75	342.11	-	9.65	21.46	9.90	-
East-Champaran	14.30	1.61	4.87	-	537.42	135.55	278.43	-	4.88	8.09	25.48	-
Sitamarhi	1.12	1.16	2.49	-	38.08	66.27	375.37	-	36.79	7.67	28.65	-
Siwan	1.63	0.43	1.78	-	218.29	64.38	92.31	-	16.49	12.84	5.99	-
Samastipur	0.46	0.84	1.20	-	49.15	31.77	107.05	-	12.89	8.86	13.88	-
Bihar	30.60	10.58	56.74	-	1227.00	1121.84	4115.08	-	3.58	7.28	8.27	-
Co-efficient of variation (CV %)												
West-Champaran	7.38	11.26	48.93	-	23.80	22.43	61.43	-	17.74	20.28	18.70	-
Gopalganj	14.39	16.42	21.40	-	30.50	49.04	34.36	-	25.74	41.17	22.92	-
East-Champaran	70.57	13.75	57.89	-	70.37	26.47	71.81	-	12.91	18.68	54.65	-
Sitamarhi	25.60	19.18	69.25	-	25.68	32.33	163.61	-	89.86	22.85	58.26	-
Siwan	17.73	7.40	36.77	-	53.84	25.05	49.91	-	38.98	24.84	16.11	-
Samastipur	12.46	21.89	37.59	-	33.64	23.83	83.47	-	32.75	19.53	38.74	-
Bihar	22.39	9.02	44.29	-	26.63	21.80	67.65	-	10.67	16.68	18.44	-

Table.4 District wise dynamics growth and instability of area, production and productivity of sugarcane in Bihar

Sl	District	CGR (%)			CV (%)		
		Entire period (1970-71 to 2011-12)			Entire period (1970-71 to 2011-12)		
		A	P	Y	A	P	Y
1	West-Champaran	0.62***	1.09***	0.47***	39.07	59.34	25.74
2	Gopalganj	0.47***	0.66***	0.19	24.83	47.29	36.30
3	East-Champaran	-1.23***	-0.97***	0.26*	75.06	70.58	35.95
4	Sitamarhi	-0.26	0.09	0.34	40.80	109.51	69.56
5	Siwan	-1.05***	-1.20***	-0.15	34.28	59.66	30.64
6	Samastipur	-0.22*	-0.36	-0.14	24.28	49.54	31.77
7	Bihar	-0.22	0.20	0.12***	29.08	47.75	20.69

***, * significant at 1 and 10 per cent level of significance

Fig. 1 Index number based on three years of moving average of area, Production and Productivity of Sugarcane in Bihar

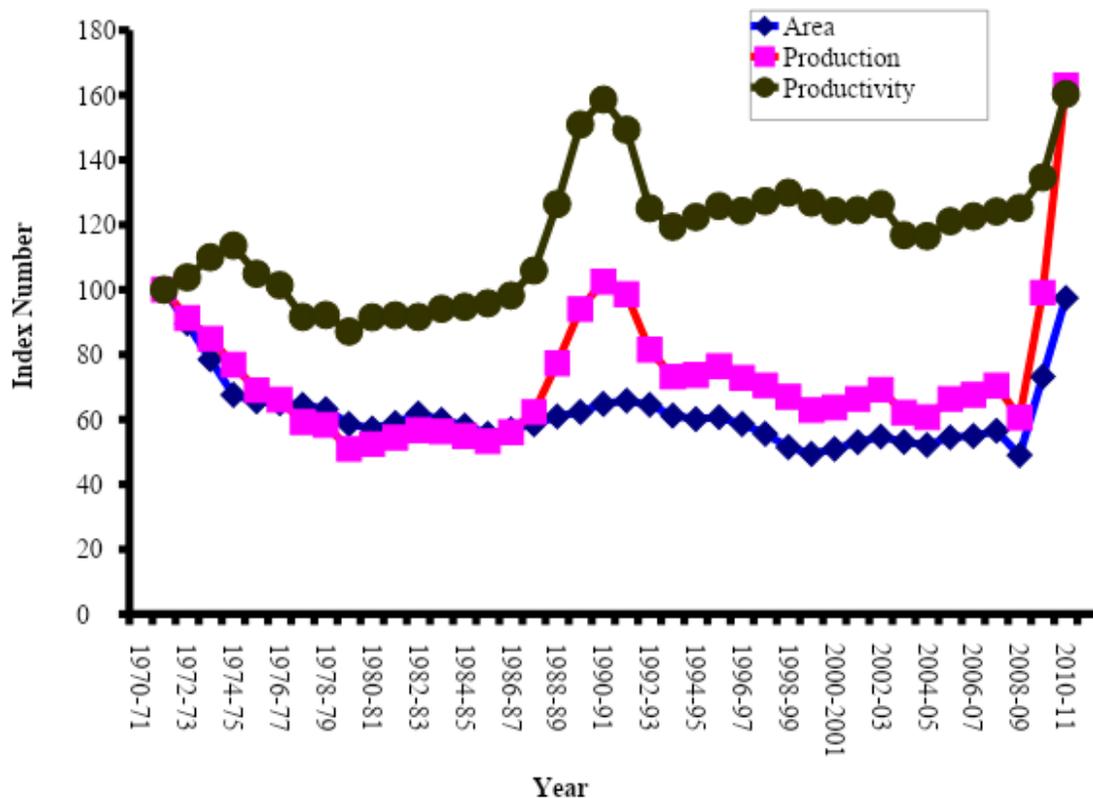


Table 3 shows that mean value of sugarcane area in the state has increased (9.18 per cent) from 117.31 thousand hectares to 128.08 thousand hectares in the third period was reported. The district wise analysis revealed that the average mean value of area under the crop in West-Champaran and Gopalganj increase by 34.48 and 31.61 per cent respectively, during the third period in one hand on the other hand East-Champaran, Sitamarhi, Siwan and Samastipur which exhibits a decreased of 28.34, 40.88, 17.79 and 16.83 per cent respectively in the same period. By examining the value of coefficient of variation, it was observed to be more in the third period as compared to second period. It clearly indicates that production technology was more stable in second period as compared to third period.

A perusal of table 3 indicates that the mean value of production under mentioned district East Champaran and Siwan had shown negative and significant change 24.27 and 28.02 per cent respectively during third period.

It was also found that West-Champaran has maximum changes in production 28.07 per cent but Samastipur had reflected a marginal decrease 3.79 per cent in production over the third period.

The value of co-efficient of variation for production was observed to more in the third period as compared to second period. The variability analysis revealed that the production of sugarcane was found to be more stable in the second period as compared to the third period.

It was evident from table 3 that mean value of sugarcane productivity in the state has increased 2.77 per cent from 43.63 to 44.84 tones per hectare in the third period. The state wise picture of changes in productivity under sugarcane revealed that at the overall level drastic decline in West-Champaran, Gopalganj and Siwan were 8.59, 17.09 and 0.14 per cent per annum respectively during the third period. The coefficient of variation shows that there is stability in the productivity in third period as compared to second period specially in West-Champaran, Gopalganj and Siwan district in Bihar.

Growth and instability in area production and productivity of Bihar

Co-efficient of variation of the area, production and productivity of the sugarcane crops were worked out for the period 1970-71 to 2011-12, these were presented in table 4. It is revealed from the table, that growing of sugarcane in the district of Sitamarhi of Bihar was more riskness as revealed by the high coefficient of variation 69.56 per cent implies highly unstable among all the major sugarcane growing district. Further West-Champaran had recorded high growth rate and stability in the area, Gopalganj had high growth with moderate instability. Further East Champaran, Siwan and Samastipur observed negative growth rate with moderate instability in the area under sugarcane cultivation.

Policy Implications

Analyzing the growth rate trends in the area, production and productivity across space and time have remained issue of significant concern for researchers as well as policy makers. It has been argued that analysis of the growth rate trends help us to identifying the changing pattern of the crops and land use pattern under different crops and rate of change in area, production and productivity of

a crop and further help in designing the appropriate agricultural policy for a region or state.

The growth rate in the area of sugarcane in Bihar was found noticeably negative during the entire period of the study. This might be due to shift in acrages and production of sugarcane to other high value cash crops. The area and production of sugarcane especially in six major sugarcane growing districts have been declined during period I and II and it has increased during the third period.

The productivity has been increased in most of the district except Siwan and Samastipur district and it was mainly due to cultivating the sugarcane crop on same piece of land year after year.

The mean value of area, production and productivity of the state increased by 9.18, 18.19 and 2.77 per cent, respectively, during the third period.

The co-efficient of variation showed that there is very high variability (more than 40 per cent) in the area and production of sugarcane in the state in the third period as compared to second period and there by indicating the more riskness and stability for cultivation on sugarcane crops in the state.

Further, the production and productivity of the crops were positive and increasing during the study period, which was due to combined effect of area and productivity. Therefore, keeping the area as constant, the productivity of sugarcane crops can be further increased by taking appropriate production technologies.

The result of the study indicated that, the stagnancy and decline in the production and productivity of sugarcane, it was mainly due to the unbalanced use of crucial inputs, such as, fertilizers, weedicides, micronutrients etc as well as traditional method of irrigation and

growing of the same crop year after year on same piece of land.

Therefore, the sugarcane growers are needed to be motivated to use the high yielding, pest and disease resistant varieties, to use improved technologies such as crop rotation, inter cropping, balanced use of organic and inorganic fertilizers, micro nutrients and drip method of irrigation etc.

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