



Regional Growth Analysis of Sugarcane Production in Uttar Pradesh

Aobakwe Gababolokwe^{1, *}, Hubba Lal Singh¹, Rakesh Kumar Singh²

¹Department of Agricultural Economics, College of Agriculture, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut, India

²Department of Agricultural Economics and Statistics, Chandra Shekhar Azad University of Agriculture and Technology, Kanpur, India

Email address:

agabolokwe@gmail.com (Aobakwe Gababolokwe), hlsingh123@gmail.com (Hubba Lal Singh),

raks.csau@gmail.com (Rakesh Kumar Singh)

*Corresponding author

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Abstract: This study was conducted in Uttar Pradesh (U.P.) over a period of 1985-86 to 2015-16. It was based on secondary data of area, production and productivity of sugarcane crop grown in four regions of different agro-economic region of the state namely Western, Central, Bundelkhand and Eastern. The linear and compound growth rate models were fitted to examine growth rate in area, production, and productivity of sugarcane crop to calculate the growth levels. The linear and compound growth rates of area under sugarcane increased by 1.11 and 1.12 percent respectively in the state during phase I. The growth rate in area was estimated at 1.71 and 1.37 percent respectively in phase II. In phase III, both models recorded growth rates of 0.41 and 0.31 percent correspondingly. The overall compound growth rate of area in the state stood at 1.14 percent per annum. Across the regions highest growth rate was found in central region (2.47 percent) followed by Bundelkhand, Eastern and Western region. The linear growth rate of sugarcane production in U.P. was highest in phase I estimated to be 3.84 percent and lowest in second phase by 0.92 percent. The overall compound growth rate in sugarcane production of the state was 1.71 percent per annum. The highest compound growth rate (3.46 percent) was observed in phase I and lowest (0.62 percent) in phase II. Across regions highest growth rate was found in Central and lowest in Western region. The linear and compound growth rates in productivity of state were positively increased in all phases except phase II in which they were negatively increased by (-0.87) and (-0.74) percent per annum correspondingly. The overall compound growth rate was observed highest in Eastern and lowest in Bundelkhand region.

Keywords: Sugarcane, Production, Productivity, Area, Linear Growth Rate, Compound Growth Rate

1. Introduction

Sugarcane is one of the important cash crops of the tropical, sub-tropical countries and the main source of sugar in the world. It is the world's largest crop cultivated on about 23.8 million hectares with a worldwide harvest of 1.69 billion tons [1]. India occupies second position in the production of sugarcane after Brazil [2]. India stands first in area and productivity of sugarcane with an area of 47.74 lakh hectares, production of 3550.90 lakh tons and productivity of 74.4 tons/ha (2017-18), among sugarcane growing countries of Asia [3, 4]. Sugarcane is an important agro-industrial crop

in India. It plays a pivotal role in national economy by contributing 1.90 percent to GDP and providing employment to millions of people in the rural sector [5]. Sugarcane is used as the main input for the manufacture of sugar, sugar industry is greatly dependent much on the states that lead in the cultivation of sugarcane namely Andhra Pradesh, Tamil Nadu, Gujarat, Karnataka, Maharashtra, and Uttar Pradesh [6].

In Uttar Pradesh sugarcane is valued as an essential cash crop. It has dominated the farming system in this region for a long time. The production capacity of sugarcane stands at 1623.38 lakh tons cane having area of about 22.34 Lakh hectares in Uttar Pradesh [7]. Climatic conditions of India are

satisfactory for sugarcane cultivation hence the production of sugarcane is stretched across the country [8]. Uttar Pradesh is the leading state in area and production of sugarcane crop but the productivity in this state is very low, hence the study with the objective; regional growth analysis of sugarcane production in U.P., aims to analyze and check the progress of sugarcane production and its productivity, given some incentives like introduction of high yielding varieties of sugarcane seeds, for example CO-0238 variety which was introduced in 2012 in Uttar Pradesh which produces nearly half of India's sugarcane today, Sugarcane Development Programme under National Food Security Mission - Commercial Crops (NFSM-CC), fair and remunerative price which is announced before sowing season by central government etc.^{i,ii}

2. Methodology

This study was based on time series data of area, production and productivity for sugarcane crop grown in Uttar Pradesh. The state was divided into four regions viz., Western (30 districts), Central (11 districts), Bundelkhand (7 districts) and Eastern (27 districts). The time series data on the area, production, and productivity of the sugarcane crop from 1985-86 to 2015-16 were collected from Directorate of Agricultural Statistics and Crop Insurance, Lucknow. The data was divided into three phases, viz., phase I (1985-86 to 1994-95), phase II (1995-96 to 2004-05) and phase III (2005-06 to 2015-16), to examine the objective of the study, the statistical tools i.e., linear and compound growth rate in area, production, and productivity of sugarcane, were estimated, [9-12]. The base period selected for study was 1985-86.

2.1. Linear Growth Rate

For computing linear growth rate, linear regression equation between three variables, (area, production & yield) and time (year) was fitted as given here below:

$$Y = a + b_t (t = 1, 2, \dots, n)$$

a = Constant

b = regression coefficient

y = Index number of area, production and productivity of

sugarcane

Ordinary Least Square technique was applied, after regression between y and t, values of a and b were estimated. Linear growth rate with respect to base year and, estimated Y_1 were worked out.

$$\text{Linear growth rate} = (b/Y_1) * 100$$

The t-test was applied to test the significance of b

2.2. Compound Growth Rate

To compute the growth rate of area, production, and productivity of sugarcane in the state, the exponential function of the following form was fitted:

$$Y = a b^t, \text{ Taking log on both sides}$$

$$\text{Log } Y = \log a + t \log b$$

Assuming $\log Y = y$

$\log A = a, \log B = b$

We get, $y = a + b t (t = 1, 2, \dots, n)$

After regression between y and t, we have value of a and b.

a = Constant, b = Coefficient

As $b = 1 + r$, Hence, $r = b - 1$

r = Compound growth rate,

$r = (\text{antilog of } b - 1) * 100$

t = Time variable ($t = 1, 2, \dots, n$),

b = Regression coefficient

y = Index number of area, production and productivity of sugarcane.

The t-test was applied to test the significance of b.

3. Results

Growth in area, production and productivity of sugarcane provides the status of the crop, computed region wise and the state, from 1985-86 to 2015-16. The significant growth in area, production and productivity of sugarcane was observed to be 4.59, 10.44 and 3.38 percent per annum respectively in linear growth model presented in table 1 while in compound growth model, the highest increase in area, production and productivity was 2.47, 3.55 and 2.24 percent per annum subsequently shown in table 2.

Table 1. The phase wise linear growth rate of area, production, and productivity of sugarcane crop in regions of the State and the State (in percent).

Particulars	Area			Production			Productivity		
	Phase I	Phase II	Phase III	Phase I	Phase II	Phase III	Phase I	Phase II	Phase III
Western	0.65	0.88	-0.24	3.72**	-0.26	1.65	2.98	-1.09	1.62*
Central	3.07**	4.47**	2.92*	5.28	5.62**	10.44**	1.72**	0.14	3.28**
Bundelkhand	-2.4	2.03*	4.59	-1.73	5.31*	7.83	0.94	2.52	2.13
Eastern	1.31	2.57**	0.72	3.33**	2.25*	4.11**	1.86**	-0.51	2.38**
State	1.11	1.70*	0.4	3.84**	0.92	3.19**	2.55	-0.87	2.00**

Note: * Significant at 5 percent and ** Significant at 1 percent.

Table 2. Overall compound growth rate of area, production, and productivity of sugarcane crop in regions of the State and the State (in percent).

Particulars	Area	Production	Productivity
Western	0.65	1.24	0.59
Central	2.47	3.55	1.05

Particulars	Area	Production	Productivity
Bundelkhand	2.33	2.03**	-0.29
Eastern	1.25	3.51	2.24
State	1.14	1.71	0.57

Note: * Significant at 5 percent and ** Significant at 1 percent.

4. Discussion

4.1. Growth in Area of Sugarcane

The growth in area of sugarcane regarding linear growth model in table 1 was highest in Bundelkhand region in phase III recording 4.59 percent per annum. The Central region was second highest region recording 4.47 percent per annum and highly significant at 1 percent level of significance in phase II. The first phase in Central region recorded significant increase in area for sugarcane cultivation, the linear growth rate was estimated to be 3.07 percent per annum and highly significant at 1 percent level of significance in phase I. The state recorded the highest increase in area in phase II, estimated to be 1.70 percent annually and significant at 5 percent.

The compound growths in table 2 across all regions and the state were almost similar to linear growths, the growth level in a state stood at 1.14 percent per annum. The highest growth rate was observed in Central region (2.47 percent annually), followed by Bundelkhand and Eastern regions with 2.33 and 1.25 percent per annum. The least growth rate was recorded in Western region, estimated to be 0.65 percent annually.

4.2. Growth in Production of Sugarcane

The linear growth rates of production in table 1 had a significant and positive increase across all the regions and phases except in Western region phase II and Bundelkhand region phase I, where growth rates were found negative estimated at -0.26 and -1.73 percent per annum. The highest growth was found in Central region phase III, recording 10.44 percent per annum and highly significant at 1 percent level of significance followed by Bundelkhand region in phase III, Eastern region in phase III and Western region in phase I, recording 7.83, 4.11 and 3.72 percent annually respectively and highly significant at 1 percent level of significance across all regions except in Bundelkhand region where it was found non-significant. The state had significant and positive increase across all phases, but the slow growth was observed in phase II, estimated at 0.92 percent per annum. Phase I and III recorded 3.84 and 3.19 percent per annum increase singly and they were both highly significant at 1 percent level of significance shown in table 2.

4.3. Growth in Productivity of Sugarcane

The linear growth rates in productivity of sugarcane displayed in table 1 were positive in all regions and the state across all phases except in Western, Eastern regions and the state in phase II where productivity increased negatively by -1.09, -0.51 and -0.87 percent annually correspondingly.

Productivity had highest increase in Central region; phase III, estimated at 3.28 percent per annum and highly significant at 1 percent level of significance. It was followed by Western region and the state in phase I both recording 2.98 and 2.55 percent annually in growth respectively. Phase III had a significant positive increase across all regions and the state. The Central region recorded highest increase in this phase followed by Eastern, Bundelkhand, the State and Western regions. The compound growth model recorded positive growth rate in all regions and the state except in Bundelkhand region where productivity negatively increased, recording -0.29 percent. The table 2 further revealed that Eastern region had the highest increase compared to all regions and the state recording increase of 2.24 percent, followed by Central, Western regions and the State.

5. Conclusion

The study reveals a positive slow growth rate in area, production, and productivity of sugarcane across all regions and the state for the past 30-year period, though the region is the leading state in area and production of sugarcane crop, the production is not up to the potential level and the productivity is low. We conclude that high yielding varieties of sugarcane (example CO-0238 variety) with greater tolerance to different biotic and abiotic pressures to the farmers should continuously be availed to meet the required production and productivity [13]. The fair and remunerative price which is announced before sowing season by central government should be implemented mostly in favour of the farmers to encourage farmers to adopt new farm technology and further expansion in farming area, production and consequently improve productivity. Sugarcane crop is the most valued cash crop in Uttar Pradesh hence that should also reflect with satisfying results of its production and productivity. Less investment in technology is one of the bulging factors for the poor technical change and low technical efficiency is due to management and incentive problems associated with poor information distribution to the end users [14]. Extension/outreach programmes should be strengthened to create awareness to farmers to optimize their production and productivity with available modern technology. [15].

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