

Original Research Article

Statistical Analysis of Growth Pattern of Sugarcane Production in Districts of Western Uttar Pradesh

Babu Lal^{1*}, K. K. Maurya², Ravi Prakash Gupta¹,
Manish Kumar¹ and Sunil Kumar

¹Department of Agricultural Statistics, Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, 224-229, Uttar Pradesh, India

²CSSS PG College Machhra, Meerut Uttar Pradesh India, 250-106, & Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya, 224-229, India

*Corresponding author

ABSTRACT

The present paper attempts to study the trend and growth rates of Sugarcane production in Western Uttar Pradesh. The time series data on area, production and productivity of Sugarcane pertaining to the period 2000-01 to 2015-16 were used for the study. Area seems to very close to ground reality and pro-vides useful information for further planning and corrective measures for future development of Western Uttar Pradesh's Districts. The area, production and productivity of sugarcane crop have been estimated in 22 districts of western Uttar Pradesh. The area has increased by about 15.8 per cent in 2015-16 since 2000-01 in western Uttar Pradesh. The districts Pilibhit was showed the higher percentage increasing the production and area about 50.17 percent and 34.35 percent respectively followed by the districts Bagpat and Shahjapur and decreasing the sugarcane production and area in Etah districts about 97.48 percent and 98.08 percent respectively in Western Uttar Pradesh. The growth rate of productivity has been increasing about 31.55 percent observed in Etah district followed by Muradabad and Shahjapur and decreasing the productivity of sugarcane about 13.66 percent has been observed in Mainpuri district. This means increase in area has been major factor for high production of sugarcane in the State. The productivity has been found more stable than area and production during the entire period of study. According to method of moving average the growth rate of area and production increase in Bijnor district and productivity increases in Shamali district in western Uttar Pradesh.

Keywords

Sugarcane, Growth, Tabular analysis, Linear Growth Rate (LGR), Compound Growth Rate

Introduction

Sugarcane (*saccharum sp.*) is a main source of sugar in India and holds prominent position as a cash crop. Sugarcane belongs to the genus *saccharum* in the family Gramineae. India occupies the second place in respect to area and production after Brazil.

Agriculture is most pioneer sector of any economy. An optimum fraction of population still relay on agriculture directly or indirectly all over the world. In India; agricultural geographical area has a fraction of nearly 2:5 or we can say nearly 40-50 percent. In Indian economy agriculture shares nearly 17.9 percent in GDP. India is second largest

producer of agricultural products. India accounts for 7.68 percent of total global agricultural output. According to *CIA Fact book (2014)*; total production of agriculture sector is \$366.92 billion, (*Statistical times*). Sugarcane is rich source of sucrose. Sucrose is major product extracted and used as raw material in the food industry. Also it is fermented to produce ethanol. Sugarcane accounts for 80 percent of sugar produced; most of the rest is made from sugar beets. Other than sugar, products derived from sugarcane include falernum, molasses, rum, cachaca, and bagasse. Sugarcane mature stalk is typically composed of 11-16 percent fiber, 12-16 percent soluble sugars, 2-3 percent non-sugars, and 63-73 percent water. Also it contains considerable amount of minerals in it. The average yield of cane stalk is 60-70 tons per hectare per year. Brazil is major sugarcane producing country with an area about 90.77 lakh ha and production of about 717.46 MT followed by India. Sugarcane productivity is highest in Colombia (101.32 t/ha) followed by Philippines (93.71 t/ha). Amongst 10 major producing country Colombia has the highest yield of sugarcane due to the richest biodiversity's in the world and has access to multiple climates. The yield gap of sugarcane in India with respect to 10 major sugarcane producing countries during the last 5 years is ranges 1.33 – 31.22 t/ha (Directorate of Sugarcane Development, Government of India, Ministry of Agriculture, Department of Agriculture & Cooperation).

The total production of sugarcane in India is nearly 355.00 million tonnes from an area of mha during 2017-18 (Department of Agriculture Cooperation and Farmers Welfare, India 2018). Sugarcane is a glycophyte, sucrose storing member of tall growing perennial monocotyledonous grass. Across the world 70% sugar is manufactured from sugarcane. India is the second largest

country in sugarcane production in the world. Sugarcane is a major source of raw material for sugar industries and other allied group of byproduct industries. The economic importance of the crop is much more that signified by its share in gross cropped area.

In Tropical zone Maharashtra is the major sugarcane growing state covering about 9.4 lakh ha area with production of 61.32 Million ton, whereas the productivity of Tamil Nadu is highest in tropical zones. Uttar Pradesh is the highest sugarcane producing State in sub-tropical zone having area about 22.77 Lakh ha with the production of 135.64 MT Sugarcane whereas Haryana has highest productivity of sugarcane in Sub tropical zone.

Additionally, reduced cane arrears (particularly in UP which claim to have disbursed more than 92 percent of pending cane arrears), resultant improved cash flows, strong stock holding limits for sugar producers should help improve sugar sales to bulk users and retailers particularly when consumption demand is expected to remain strong and sugar prices are likely to remain stable. According to the latest production data, MY 2016/17 sugar production is now estimated at 22.2 MMT, 320,000 metric tons above previous estimate. An additional half a million ton of commercial imports in MY 2016/17 has slightly improved sugar supply to 34 MMT and was just enough to meet consumption and stock requirement (Global Agricultural Information Network, 2017). Western Uttar Pradesh is a region Uttar Pradesh that comprises the western districts including the areas of Rohilkhand and Braj. The region has some demographic, economic and cultural patterns that are distinct from other parts of Uttar Pradesh, and more closely resemble those of Haryana and Rajasthan states. Western Uttar Pradesh has experienced rapid economic growth, in a

fashion similar to Haryana and Punjab, due to the successes of the Green Revolution. Western Uttar Pradesh shares borders with the states of Uttrakhand, Haryana, Delhi, Rajasthan, and Madhya Pradesh, as well as a brief international border with Nepal in Pilibhit district. Major cities and towns include Baghpat, Bareilly, Badaun, Agra, Mathura, Moradabad, Amroha, Ghaziabad, Noida, Bulandshahr, Meerut, Hapur, Saharanpur, Aligarh, Hathras, Muzaffarnagar, Shahjahanpur, Etah, Firozabad, Mainpuri, Shamli, Bijnor, Farrukhabad, Etawah, and Auraiya.

Agricultural production depends on large number of pre-sowing and post-sowing, roads etc. This study aims at studying the nature of important *Causal variables* harvest factors like-quality and price of inputs, cropping system, irrigation system, fertilizers, electricity like irrigation, fertilizers, cropping system, roads etc. for quantifying contribution to Agricultural growth.

Materials and Methods

In order to study the growth trends in area, production and productivity of sugarcane crop in Western Uttar Pradesh, some appropriate statistical methodologies have been used. These statistical methodologies are systematically described here. The materials used are also described.

Description of the study area

The area under cultivated sugarcane crop in U.P. is 21.62 Lakh hectares and production is 1226.28 Lakh tonnes (2011-12). Uttar Pradesh is a major sugarcane producing state after Maharashtra in India. Its share to area and production has been 42.55 and 35.26 percent of the total area and production of the country, respectively (2011-12). However, its productivity of 56.73 t/ha has been low as

compared to all India productivity of 68.46 t/ha (2011-12), due to various reasons need to be critically examined. Tamil Nadu ranked first in terms of productivity (105 t/ha) followed by Karnataka (90.3 t./ha.) and Maharashtra (81.6 t./ha.) during 2011-12.

There are many states which productivity has been above the productivity of Uttar Pradesh (2011-12).

The time series data pertaining to the period from 2000-01 to 2015-16 on area, production and productivity of sugarcane crop have been used to study the growth trends. Secondary data have been procured from the Bulletins of Directorate of Agricultural Statistics and Crop-Insurance, Krishi Bhawan, Lucknow, Government of Uttar Pradesh. A lot of efforts are made by Government of India to improve the scenario of sugarcane production in the country in the past.

Statistical Methodologies

Trend and growth rate

The trend in area, production and productivity of sugarcane will be studied by sketching line diagram over years. The moving average of area, production and productivity will be depicted over years by line diagram.

The growth rate in area, production and productivity of sugarcane have been worked out by fitting the following three different functions:

Simple linear function

$$Y_t = a + bt$$

Semi-log function

$$\log Y_t = a + bt$$

Compound growth rate function

$$Y_t = a(1+r)^t$$

where,

Y_t : Time series data on area/production/productivity of sugarcane at time t, a & b are parameters of the function to be estimated.

t : Time index (t= 1,2,...n)

r : Average compound growth rate per annum.

However, before the fitting of above functions, the time series data on area and production were smoothed by moving-average method.

After fitting the first linear trend function by least-square method, we get the estimate of b denoted by \hat{b} (say). Then, annual linear growth rate is computed as follows

$$r = \frac{\hat{b}}{\bar{Y}} \times 100$$

where, \bar{Y} is arithmetic mean of Y_t .

Second, semi log function was fitted by least square method and estimate of b as \hat{b} was obtained. The annual growth rate is then computed as

$$r = \hat{b} \times 100$$

To obtain annual compound growth rate, the third function was first linearised by taking natural log on both side, i.e.

$$\log Y_t = \log a + t \log (1+r)$$

$$\text{or } Y_t^* = a^* + bt$$

where, $Y_t^* = \log Y_t$, $a^* = \log a$ and $b = \log (1+r)$

The above linearised function was fitted by least square method and estimate of b as \hat{b} was obtained.

The annual compound growth rate is then computed as

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

All growth rates are expressed in percentage. The best fitted function was judged on the basis of R^2 (coefficient of determination) and root mean square error (RMSE) both.

Effect of change in acreage and productivity on differential production of sugarcane

An attempt has been made to the study the effect of change in acreage and productivity of sugarcane on the differential production between two points of time.

Let Y, A and P be the production, acreage and productivity of sugarcane at a given point of time. The Y can be expressed as

$$Y = P \cdot A$$

Let ΔY , ΔA , ΔP be change in production, acreage and productivity of the crop after a specific period of time. So, we have

$$Y + \Delta Y = (A + \Delta A) (P + \Delta P)$$

$$Y + \Delta Y = AP + \Delta A P + \Delta P A + \Delta P \Delta A$$

Therefore, we have

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

Thus, the total differential production is composed of three components:

Results and Discussion

P ΔA : Effect of change in acreage of the crop

A ΔP: Effect of change in productivity the crop

ΔPΔA: Interaction effect due to change in acreage and productivity of the crop

The contribution of change in acreage, productivity and their interaction to the total differential production of the crops has been worked out for each period separately and also for overall period (Fig. 1–4).

Measure of instability in sugarcane production

High growth and low instability in sugarcane production are prerequisites for sustainable agricultural performance. It has been a great concern that technological change in agricultural production has increased variability, which is considered to be one of the threats to food security. Since the magnitude of growth and instability in sugarcane production has serious implications for policymakers, the level of instability in the area, production and productivity of sugarcane crop will be estimated using suitable statistical tools. The simple coefficient of variation (c.v.) often contains the trend component and thus overestimate the level of instability in time series data characterized by long term trend. To overcome this problem, a measure of instability is estimated by using Cuddy Della Valle Index which corrects the coefficient of variations and it is given by

$$\text{Instability index} = c v \sqrt{1 - R^2}$$

Where, R^2 is the coefficient of determination from a time trend regression adjusted by the

number of degree of freedom. An attempt has been made in this section to capture a general feature of development of the sugarcane production in Western Uttar Pradesh since 2015-6 onwards.

Cropping Pattern

The cropping pattern of Western U.P. for the year 2000-01 and 2015-16 have been worked out and presented in the Table 1.

From Table 1, we observe that:

Area under wheat, potato, sugarcane and oilseeds increased.

Area under cereals other than rice and wheat increased.

Area under rice, pulses decreased.

Changing Pattern in Production, Area and Productivity of Sugarcane

Changing pattern in production, area and productivity have been worked out and presented in Tables 3, 4 and 5 respectively.

Results of Table 2

Highest percentage increase in Sugarcane production (i.e. 122.36 per cent) has been observed in Beharai district, which is followed by Sravasti and Gonda in eastern Uttar Pradesh.

Highest percentage decrease in Sugarcane Production (i.e. -46.49 per cent) has been observed in Maharajganj in eastern Uttar Pradesh. Highest percentage increase in Sugarcane production (i.e. 50.17 per cent) has been observed in Pilibhit district, which is followed by Bagpat and Shahjapur in Western Uttar Pradesh. Highest percentage decrease in Sugarcane Production (i.e. -97.48 per cent) has been observed in Etah district.

Decline in production has been observed in Maharajganj, and Varanasi,, in Eastern Uttar Pradesh

Decline in production has been observed in Muzzfarnagar, and Muradabad, Western Uttar Pradesh.

Results of Table 3

Highest percentage increase in Sugarcane Area (i.e.94.83 per cent) has been observed in sravati district, which is followed by Kusinagar and sultan in eastern Uttar Pradesh.

Highest percentage decrease in Sugarcane Area (i.e.-66.87 per cent) has been observed in Kaushambi in eastern Uttar Pradesh.

Highest per centage increase in Sugarcane Area (i.e.50.17 per cent) has been observed in Pilibhit district, which is followed by Bagpat and Shahjahpur in Western Uttar Pradesh. Highest percentage decrease in Sugarcane Production (i.e.-34.35 per cent) has been observed in Pilibhit district.

Decline in production has been observed in Kusinagar, and Sultanpur district Eastern Uttar Pradesh

Decline in Area has been observed in Bijnor, and Saharanpur Western Uttar Pradesh.

Results of Table 4

Highest percentage increase in Sugarcane Productivity (i.e. 92.97 per cent) has been observed in Bhadohi district, which is followed by Chandauli and varanasi in eastern Uttar Pradesh.

Highest percentage decrease in Sugarcane Productivity (i.e. -1.51 per cent) has been observed in Balarampur in eastern Uttar Pradesh.

Highest percentage increase in Sugarcane Productivity (i.e. 31.55 per cent) has been observed in Etah district, which is followed by Muradabad and Shahjahnpur in Western Uttar Pradesh.

Highest percentage decrease in Sugarcane Production (i.e. -13.66 per cent) has been observed in Mainpuri district.

Decline in productivity has been observed in Manipuri, and Aligarh, district Eastern Uttar Pradesh

Decline in Productivity has been observed in Bijnor, and Saharanpur Western Uttar Pradesh.

Top five Districts of Western Uttar Pradesh in Sugarcane Production based on three years moving average (2012-13-14)

Top five districts of Western Uttar Pradesh based on three years moving average have been presented through table 6 and 7.

Result of Table 5 and 6

Highest production of Sugarcane has been observed in Bijnor district, followed by Muzzfarnagar, meerut, Saharanpur and Bagapat in Sugarcane.

Highest area under Sugarcane has been observed in Bijnor district. Highest productivity followed by Shamali district in Sugarcane.

Table.1 Cropping Pattern (in percentage of gross cropped area) in Western U.P.

Crops	Years	
	2000-01 (percentage of gross cropped area)	2015-16 (percentage of gross cropped area)
Rice	36.63	32.02
Wheat	35.33	36.54
Cereals other than rice and wheat	4.00	6.00
Pulses	4.36	2.06
Oilseeds	2.89	3.64
Sugarcane	13.46	15.8
Potato	3.45	4.04
Total Percentage	100	100
Gross Cropped Area (in Hectares)	8781758	8903777

Table.2 Production (in Thousands Tons) of Sugarcane in Districts of Western Uttar Pradesh based on three year moving average

REGION	YEARS		REGION	YEARS	
WESTERN U.P.	2000-02	2014-15	WESTERN U.P.	2000-02	2014-15
MEERUT	7782.10	9562.78 (22.88%)	AMROHA	4074.07	5424.41 (33.14%)
BULANDSHAHAR	2800.88	3244.13 (15.83%)	BAREILY	4538.19	5576.58 (22.88%)
GHAZIBAD	3930.58	1516.52 (-61.42%)	BADAUN	1358.24	1550.20 (14.13%)
BAGPAT	4087.72	5717.54 (39.87%)	PILIBHIT	2930.90	4401.19 (50.17%)
SAHARANPUR	7413.81	7767.14 (4.77%)	AGRA	19.77	8.09 (-59.08%)
MUZZFARNAGAR	14042.33	12274.23 (-12.59%)	FIROZABAD	8.49	5.41 (-36.22%)
MURADABAD	3643.20	3108.04 (-14.69%)	SHAHJAHPUR	2595.92	3563.98 (37.29%)
BIJNOR	13051.12	13334.87 (2.17%)	MAINPURI	24.28	15.20 (-37.40%)
RAMPUR	1349.78	1582.86 (17.27%)	MATHURA	482.59	39.90 (-91.73%)
HATRUS	25.15	12.56 (-50.05%)	ALIGARH	579.48	393.76 (-32.05%)
G.B.NAGAR	249.01	95.37 (-61.70%)	ETAH	481.51	12.14 (-97.47%)

The values in parentheses denote percentage change from 2000-02 to 2014-015 in Western U.P. and Eastern U.P.

Table.3 Area (in Thousands Hectare) of Sugarcane in districts of Eastern and Western Uttar Pradesh based on three year moving average

REGION	YEARS		REGION	YEARS	
WESTERN U.P	2000-02	2014-15	WESTERN U.P	2000-02	2014-15
MEERUT	123.62	128.54 (3.99%)	BADAUN	22.63	26.34 (16.39%)
BULANDSHAHAR	47.77	51.95 (8.74%)	PILIBHIT	50.37	67.68 (34.35%)
GHAZIBAD	61.76	21.87 (-64.59%)	AGRA	0.40	0.15 (-63.23%)
BAGPAT	65.58	76.78 (17.07%)	FIROZABAD	0.17	0.11 (-34.93%)
SAHARANPUR	130.16	123.66 (5.00%)	SHAHJAHPUR	50.21	56.03 (11.59%)
MUZZFARNAGAR	219.84	166.08 (24.45%)	MAINPURI	0.46	0.33 (-27.32%)
MURADABAD	68.96	45.30 (-34.31%)	MATHURA	10.10	0.83 (-91.73%)
BIJNOR	215.12	205.73 (- 4.36%)	ALIGARH	9.50	7.02 (-26.12%)
RAMPUR	22.58	25.27 (11.92%)	ETAH	9.60	0.18 (-98.08%)
AMROHA	68.75	77.53 (12.77%)	HATRUS	0.48	0.20 (-57.28%)
BAREILLY	79.73	88.557 (11.07%)	G.B.NAGAR	4.05	1.33 (-67.14%)

Table.4 Productivity (in quintal/hectare) of Sugarcane in Districts of Eastern and Western Uttar Pradesh based on three year moving

REGION	YEARS		REGION	YEARS	
WESTERN U.P.	2000-02	2014-15	WESTERN U.P	2000-02	2014-15
MEERUT	629.65	763.71 (18.18%)	BADAUN	605.35	622.20 (-2.88%)
BULANDSHAHAR	586.23	648.65 (6.49)	PILIBHIT	581.19	642.76 (12.20%)
GHAZIBAD	635.45	707.92 (9.13%)	AGRA	505.14	456.03 (8.42%)
BAGPAT	623.64	759.64 (19.39%)	FIROZABAD	511.68	456.03 (-2.34%)
SAHARANPUR	569.59	648.0 (10.31%)	SHAHJAHPUR	516.95	651.99 (22.33%)
MUZZFARNAGAR	638.63	735.87 (15.73%)	MAINPURI	528.19	456.03 (-13.66%)
MURADABAD	528.49	643.69 (29.92%)	MATHURA	480.27	456.03 (0.84%)
BIJNOR	606.49	647.77 (7.02%)	ALIGARH	609.96	608.16 (-8.34%)
RAMPUR	597.32	626.40 (4.86%)	ETAH	502.88	600.72 (31.55%)
AMROHA	592.51	703.49 (18.08%)	HATRUS	528.19	528.19 (16.97%)
BAREILLY	569.76	619.56 (10.50%)	G.B.NAGAR	614.74	729.94 (16.81%)

Table.5 Production and Area of Sugarcane in Western U.P.

Districts	Area(ha)	Production (Metric tons)
BIJNOR	205731.00	13334873.00
MUZZFARNAGAR	166083.00	12274225.67
MEERUT	128544.67	9562778.00
SAHARANPUR	123655.00	7767135.67
BAGPAT	76776.00	5717544.67

Table.6 Productivity of Sugarcane of top five Districts of Western Uttar Pradesh according to production based on three years moving average

Districts	Productivity(in Q/ha)
SHAMALI	787.51
MEERUT	763.71
BAGPAT	759.64
MUZZFARNAGAR	735.87
G.B.NAGAR	729.94

Table.7 Annual average simple growth rate and compound growth rate (in percentage) of Production, Area and Productivity of Sugarcane in Western U.P.

Districts		Production	Area	Productivity
Meerut	S.G.R.	1.08	0.18	0.93
	C.G.R.	1.10	0.19	0.91
Bulandshar	S.G.R.	0.49	0.16	0.34
	C.G.R.	0.54	0.21	0.33
Ghaziabad	S.G.R.	-0.32	-7.72	0.51
	C.G.R.	-0.31	-9.02	0.46
Hapur	S.G.R.	2.27	0.19	2.46
	C.G.R.	2.31	0.20	2.48
Baghpat	S.G.R.	2.11	0.98	1.15
	C.G.R.	2.19	1.01	1.16
Saharanpuur	S.G.R.	0.23	0.17	0.43
	C.G.R.	0.25	0.18	0.43
Muzafarnagar	S.G.R.	-1.68	-2.39	0.81
	C.G.R.	-1.73	-2.51	0.79
Shamli	S.G.R.	4.02	-1.08	5.78
	C.G.R.	4.31	-1.08	6.11
Moradabad	S.G.R.	-2.01	-3.34	1.47
	C.G.R.	-2.12	-3.46	1.38
Bijnor	S.G.R.	-0.16	-0.35	0.21
	C.G.R.	-0.16	-0.35	0.19
Rampur	S.G.R.	1.28	1.12	0.09
	C.G.R.	1.21	1.13	0.08
Amroha	S.G.R.	1.83	0.76	1.06
	C.G.R.	1.81	0.77	1.03
Shambhal	S.G.R.	2.61	-1.43	2.86
	C.G.R.	2.64	-1.43	2.90
Bareilly	S.G.R.	1.68	0.87	0.74
	C.G.R.	1.63	0.89	0.73
Badaun	S.G.R.	0.83	1.14	-0.34
	C.G.R.	0.86	1.18	0.32
Pilibhit	S.G.R.	3.49	2.19	1.31
	C.G.R.	3.60	2.27	1.31
Agra	S.G.R.	-7.78	-8.30	0.37
	C.G.R.	-6.89	-7.04	0.16
Firozabad	S.G.R.	-4.06	-3.70	-0.39

	C.G.R.	-3.72	-3.31	-0.19
Shahjehanpur	S.G.R.	2.25	0.63	1.34
	C.G.R.	1.65	0.30	1.34
Mainpuri	S.G.R.	-2.90	-1.80	-1.17
	C.G.R.	-3.06	-1.91	-1.17
Mathura	S.G.R.	-14.11	-14.01	0.08
	C.G.R.	-18.41	-18.46	0.06
Aligarh	S.G.R.	-2.93	-2.77	0.17
	C.G.R.	-3.00	-2.80	0.21
Etah	S.G.R.	-19.99	-18.26	2.54
	C.G.R.	-28.36	-30.16	2.58
Hathras	S.G.R.	-5.45	-6.57	1.40
	C.G.R.	-5.58	-6.86	1.37
Kasganj	S.G.R.	-1.03	0.25	0.90
	C.G.R.	-1.06	0.25	0.98
G.B. Nagar	S.G.R.	-6.94	-7.76	1.00
	C.G.R.	-6.90	-7.82	0.99

Table.8 Regression analysis of production in Western U.P. in sugarcane with other variable

DISTRICTS	Regression coefficients						R-square
	a	b	C	d	e	f	
MEERUT	46499768.34	-3575.12	-49633.45	1371.96	-14.46	-7.04	0.54
BULANDSHAHAR	-2443500.70	20961.64	-4558.49	65.04	-4.82	-0.40	0.37
GAZIBAD	-3030598.56	-	19290.22	46.55	-39.26	-1.90	0.59
BAGPAT	398590788.34	-	-	3419.20	-29.94	-1.74	0.75
		26131.28	897412.98				
SAHARANPUR	8631728.97	-1439.35	0.00	179.96	2.53	-2.37	0.22
MUZZFARNAGAR	1493839.63	-947.04	8443.76	885.80	50.63	-	0.84
						12.60	
MURADABAD	1405244.45	-1255.99	0.00	1300.27	-5.16	-2.46	0.54
BIJNOR	34853873.52	0.00	-45328.74	-217.97	-34.68	-3.02	0.42
RAMPUR	1914864.27	-2244.09	0.00	-98.20	-5.07	11.12	0.58
AMROHA	8966677.229	-398.85	-9940.20	-229.54	21.58	4.89	0.90
BAREILY	-25291422.45	50159.73	0.00	-531.05	-3.62	-	0.70
						19.78	
BADAUN	103804.74	16.56	146715.37	-31.71	5.39	-1.80	0.21
PILIBHIT	-24336599.12	15965.66	26328.00	240.79	-0.34	-	0.72
						17.76	
AGRA	13381.25	27.51	12.57	-4.33	0.02	0.01	0.64
FIROZABAD	20858.69	4.82	-23.41	-0.60	-0.07	0.00	0.47
SHAHJAHAPUR	-2216273.25	5397.60	0.00	-18.87	-2.24	45.30	0.84
MAINPURI	-178431.48	-2.03	201.68	-2.42	0.09	-0.01	0.48
MATHURA	-2607849.34	0.00	2577.35	-390.57	5.12	0.98	0.90
ALIGARH	1632032.33	-1448.04	61.86	-58.32	0.19	-0.68	0.75
ETAH	-1591733.61	669.11	512.33	302.14	3.66	0.45	0.90
HATRUS	38869.79	-16.92	0.00	0.46	-0.19	-0.06	0.78

G.B.NAGAR	402103.77	312.12	0.00	-163.07	-1.57	0.03	0.87
------------------	-----------	--------	------	---------	-------	------	------

Table.9 Correlation coefficient for Production of sugarcane with other causal variables in Western U.P.

Districts	Area	Productivity	Govt.t.w.	Kanal length	Road length	N.P.K.	Electricity Used in Agril.
MEERUT	0.65**	0.88**	-0.28	-0.57	0.65**	-0.14	0.41
BULANDSHAHAR	0.88**	0.45	0.28	-0.07	0.15	-0.12	0.18
GHAZIBAD	0.19	0.76**	-0.19	0.02	0.34	-0.06	-0.10
BAGPAT	0.75**	-0.36	0.51	0.77**	-0.16	0.57*	0.75**
SAHARANPUR	0.67**	0.49	-0.34	0	0.20	0.05	0.00
MUZZFARNAGAR	0.91**	0.00	0.61**	0.74**	0.43	0.77**	-0.03
MURADABAD	0.84**	0.47	0.30	0	0.66**	0.64**	-0.12
BIJNOR	-0.02	0.91**	-0.16	-0.09	-0.34	-0.25	-0.16
RAMPUR	0.89**	0.54	0.48	0	0.38	0.20	0.71**
AMROHA	0.80**	0.95**	-0.62	-0.87	0.89**	-0.43	0.85**
BAREILY	0.89**	0.45	0.73**	0	0.52	0.05	0.53
BADAUN	0.84**	0.04	0.03	0.40	0.23	0.37	0.38
PILIBHIT	0.89**	0.65**	0.77**	0.81**	0.77**	0.05	0.21
AGRA	0.97**	0.06	0.35	-0.35	-0.71	-0.60	-0.56
FIROZABAD	0.97**	0.21	0.09	-0.41	-0.55	-0.45	-0.12
SHAHJAHAPUR	0.94**	0.67**	-0.38	0	0.49*	-0.45	0.91**
MAINPURI	0.96**	0.74**	-0.23	0.66**	-0.62	-0.01	-0.66
MATHURA	0.99**	0.33	0	0.82**	-0.93	-0.83	-0.48
ALIGARH	0.91**	0.01	-0.72	-0.60	-0.84	-0.72	-0.83
ETAH	0.90**	-0.75	0.90**	0.88**	-0.10	0.04	0.42
HATRUS	0.99**	-0.62	0.66**	0	-0.77	-0.74	-0.84
G.B.NAGAR	0.99**	-0.62	0.81**	0	-0.87	-0.13	0.24

Note: Significant at 0.05 level ** Significant at 0.01 level

Table.10 Productivity (in Kg/ha) of Sugarcane in 2015-2016

REGION	UTTAR PRADEH	INDIA	TOP STATE
WESTERN UP (64981) SHAMALI (78751)	67029	70720	Maharashtra(74650) Haryana(71957) Punjab(73411)

Fig.1 Cropping Pattern (percentage of gross cropped area) in Western U.P. based on the data for the year 2000-01 data

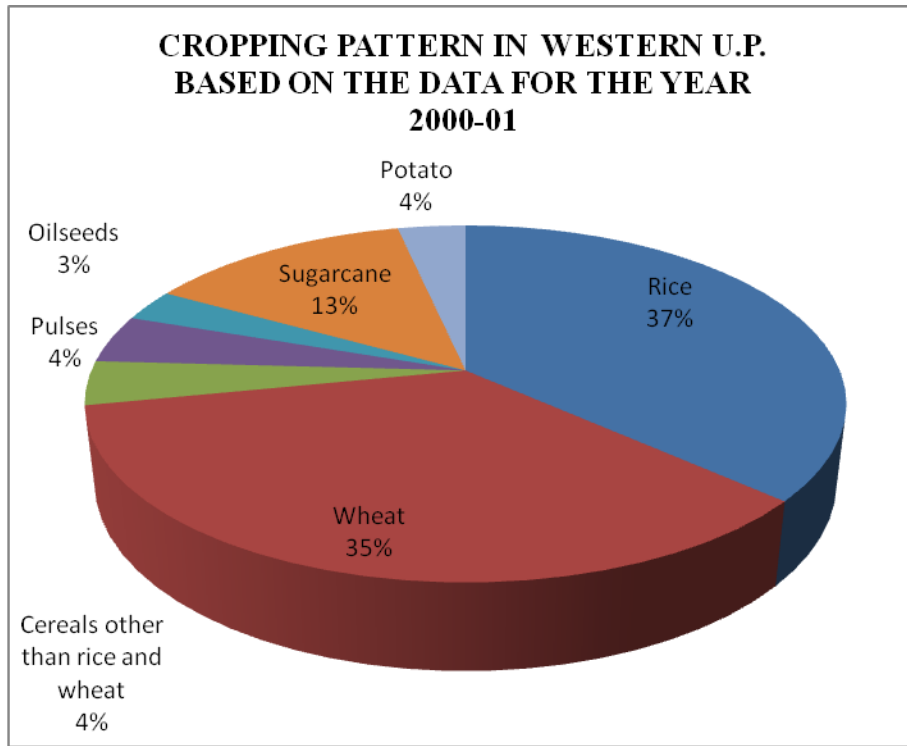


Fig.2 Cropping Pattern (Percentage of gross cropped area) in Western U.P. based on the data for the year 2015-16 data

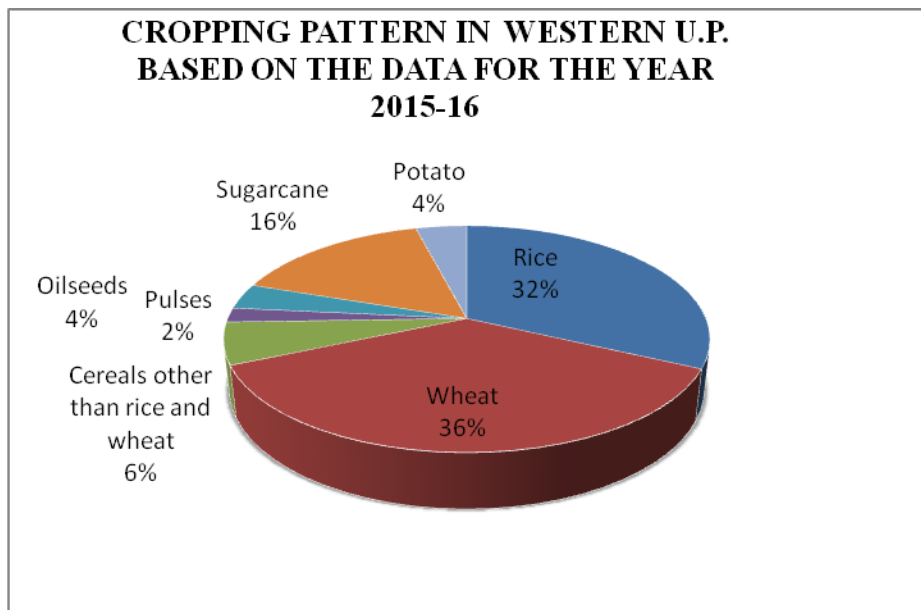


Fig.3 Production and Area of Sugarcane based on 3 years moving average for the top three districts in Western U.P.

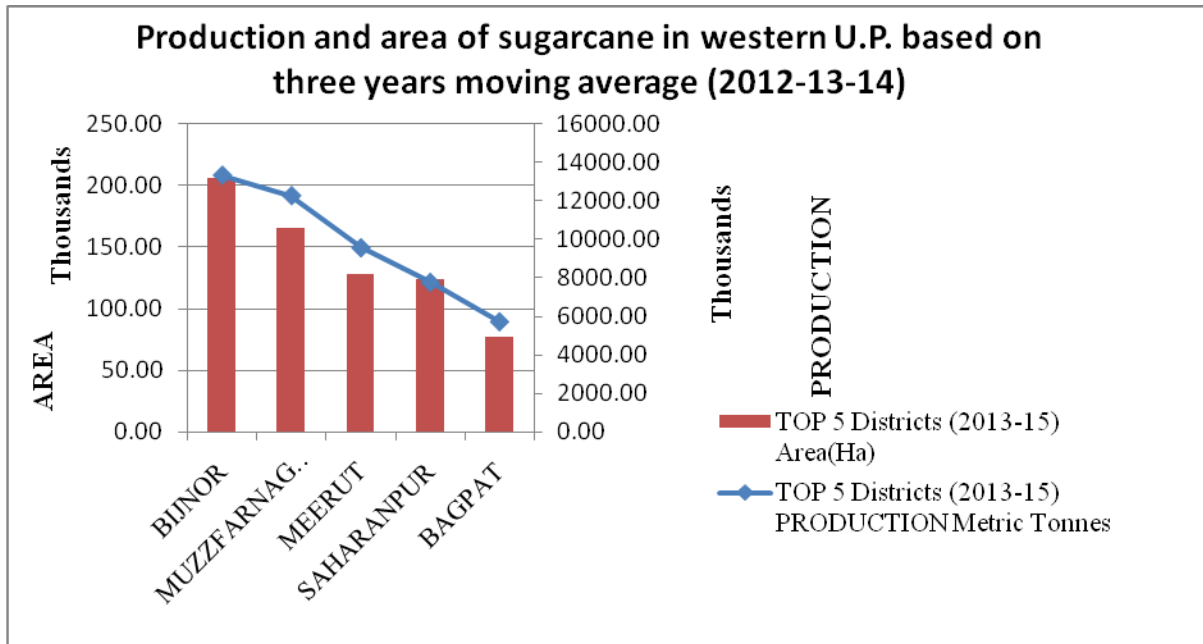
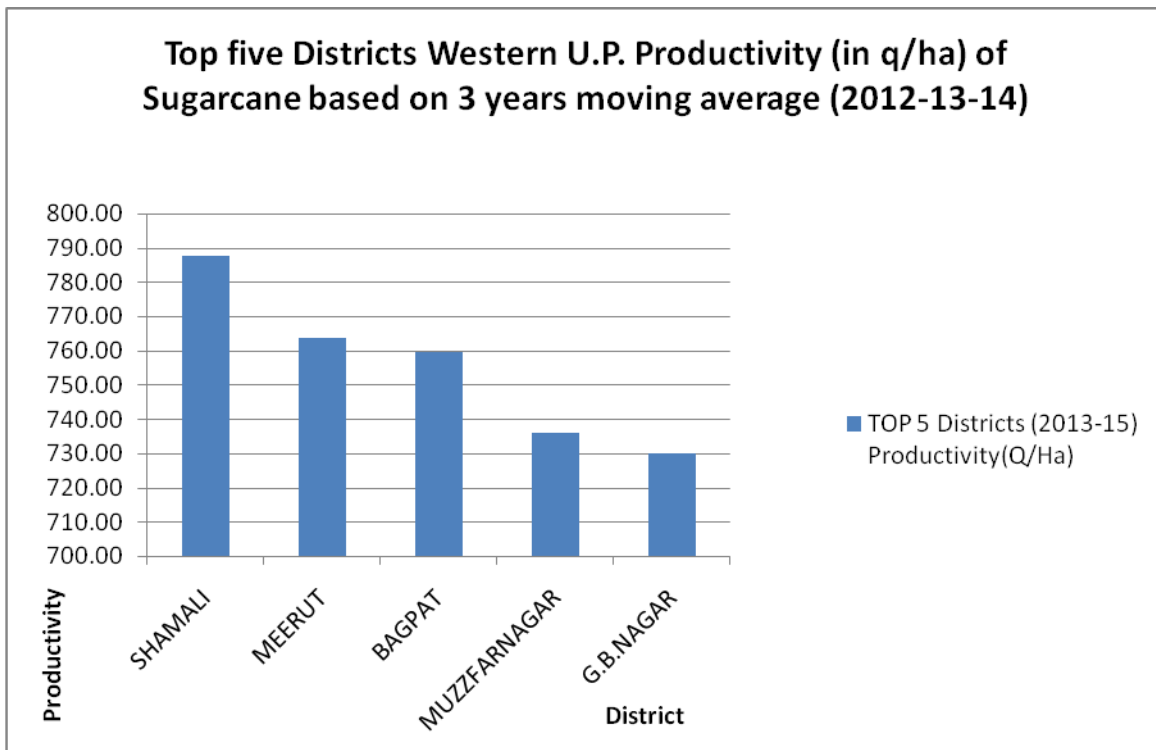


Fig.4 Productivity of Sugarcane of top five districts of Western Uttar Pradesh according to production based on three years moving average



Highest productivity of sugarcane has been observed in Shamli district.

Results of Table 7

Highest area growth rate (i.e. 2.27 per cent) has been observed in Pilibhit district, which followed by Badaun, Rampur and Baghpat in Western U.P.

Highest production growth rate (i.e. 6.11 per cent) has been observed in Shamli district, which is followed by Shambhal, Etah, and Hapur in Western U.P.

Highest productivity growth rate (i.e. 6.11 per cent) has been observed in Meerut district, which is followed by Bulandsahar, Ghaziabad and Hapur.

The fourth objective

To Identify important causal variables/factors to sugarcane production using Regression and other statistical techniques.

The multiple regression models (equation) used is:

Multiple Linear Regressions

The equation of multiple linear regressions is given as below:

$$Y = a + bX_1 + c_2X_2 + c_3X_3 + d_4X_4 + e_5X_5 + \varepsilon$$

Notations used:

a= intercept

b= coefficient of number of tube wells

c= coefficient of canal length

d= coefficient of road length

e= coefficient of fertilizer

f= coefficient of Electricity

ε = Error term

X_1, X_2, X_3, X_4, X_5 , are variables

Regression and Correlation analysis have been done presented in tables 8, 9 and 10.

Results for fifth objective

To compare the productivity of Sugarcane is compared with few States like Maharashtra, Haryana, Punjab and at all India level.

The table 10 indicated productivity in 2015-16

Productivity of sugarcane in Eastern Uttar Pradesh is lesser than of Western U.P., India, Maharashtra, Punjab and Haryana.

Productivity of Pratapgarh in Eastern U.P. is highest even greater than Western U.P., U.P., and lesser than than India, Maharashtra, Punjab and Haryana.

Productivity of sugarcane in Western Uttar Pradesh is close to U.P. and lesser than India, Maharashtra, Punjab, and Haryana.

Productivity of Shamali is highest in Western U.P. even greater than Eastern U.P., India, Maharashtra, Punjab and Haryana.

References

Awaghad P.R., Ganvir B.N. and Bhopale A.A. (2010). Growth and instability of kharif sorghum in Western Vidarbha region. *Journal of Soils and Crops*, 20(1): 111-117.

- Awaghad, P. R., Shende, N. V. and Bhopale, A. A. (2010). Growth and instability of cotton in Western Vidarbha Region. *Journal of Soils and Crops*, 20: 2, 256-260.
- Aloka Kumar Goyal and Dr. Sandeep Kumar (2013). Agricultural Production Trends and Cropping Pattern in Uttar Pradesh: An Overview, *International Journal of Agriculture Innovations and Research*, 2(2): 1473-2319.
- Prajneshu and K. P. Chandran (2005) Computation of Compound Growth Rates in Agriculture. *Agricultural Economics Research Review*, Vol. 18: 317-324.
- Chandran, K. P.; Pandit, A. and Pandey, N. K. (2005). Evaluation of models for estimating potato production trends in major states of India. *Potato Journal*, 32: 3/4, 219-220.
- Singh, J. P. and Sisodia, B.V.S. (1989). Trend and growth analysis of oilseed production in Uttar Pradesh, *Agriculture situation in India*, October, Pp. 571-573.