Naveen Kumar
Teaching Assistant, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Shishir Kumar Singh
Assistant Professor, Department Of Agri. Economics, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Riyaz Ahamad
Assistant Professor, Institute of Agricultural Sciences & Technology, SRM University, Barabanki, Uttar Pradesh, India

Ayush Yadav
M.Sc. Department of Agronomy, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Arvind Sangwan
M.Sc. Agricultural Economics, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Tushar Wagh
M.Sc. Agricultural Economics, Institute of Agricultural Sciences, Bundelkhand University Jhansi, Uttar Pradesh, India

Yogendra Pratap Singh
M.Sc. Agricultural Economics, Institute of Agricultural Sciences, Bundelkhand University, Jhansi, Uttar Pradesh, India

Corresponding Author
Naveen Kumar
Teaching Assistant, Institute of Agricultural Sciences Bundelkhand University Jhansi, Uttar Pradesh, India

Statistical analysis and growth performance of rice in Bundelkhand region of Uttar Pradesh

Naveen Kumar, Shishir Kumar Singh, Riyaz Ahamad, Ayush Yadav, Arvind Sangwan, Tushar Wagh and Yogendra Pratap Singh

Abstract
Agricultural System is most important concern for reduction of poverty and providing food security for growing population under the severe limitations of land and financial resources. The deceleration in growth trends in agriculture output and yield rate is a matter of great concern in recent years In India. Agriculture is the primary source of livelihood for about more than 70 percent of India's population. The time series data pertaining to the period from 1997-98 to 2016-17 on area, production and productivity of Rice have been used to study the growth trends. The production of rice has increased with annual rate of about 1.37, and 1.35 per cent respectively, in the Uttar Pradesh during 1997-98 to 2016-17. It was more prominent during the entire Region of U.P The production of rice have decline with the rate of 0.11 per cent in India. The productivity of rice increased at the rate 0.78 per cent in Uttar Pradesh since 1997-98 to 2016-17. Rice in Bundelkhand region highly 1.82 per cent and Simple growth rate is 1.99 By the regression analysis in Bundelkhand region we examine the R^2 0.752 and adjusted R^2 0.571.The intercept of regression coefficient has -1131089.802.Highly coefficient variable is canal length.

Keywords: Trend CGR S.G.R., rice, Bundelkhand region

Introduction
Development of Agricultural System is most important concern for reduction of poverty and providing food security for growing population under the severe limitations of land and financial resources. The deceleration in growth trends in agriculture output and yield rate is a matter of great concern in recent years In India. Agriculture is the primary source of livelihood for about more than 70 percent of India's population. India ranks second worldwide in farm output. India is the world's largest producer of many fresh fruits, vegetables, milk, major spices, fresh meat, fibrous crops like jute and staple crops such as millets and castor oil seeds. Gross Value Added (GAV) by agriculture, forestry and fishing was estimated at Rs. 19.48 lakh crore (US$276.37billion) in FY20(PE).Growth in GAV in agriculture and allied sectors stood to 4 percent in FY 20.During 2019-20 crop years, food grain production was estimated to reach a record 295.67million tons (MT). In 2020-21 Government of India is targeting food grain of 298 MT.
Uttar Pradesh (UP) located in northern part of India and It is the fifth largest state in India in terms of geographical area covering roughly 240,928 square kilometers. This is nearly 7.33 percent of total area of the country. In terms of population, UP is the largest state of India with a population of about 199.8 million people (Census 2011) accounting for nearly 16.5 percent of the total population of country. UP is generally divided into 4 zones or regions- Western, Central, Eastern, and Bundelkhand. An earlier state government in 2011, had recommended breaking up of UP into 4 smaller states namely, Paschim Pradesh, Awadh Pradesh, Purvanchal and Bundelkhand, broadly based on the regions.
Two regions i.e. the central and western are comparatively much better and well developed to eastern and Bundelkhand regions. The irrigation facilities are also well developed in western and central regions. The cropping intensity, production and productivity of different crops of these two regions are also found much better in comparison to other regions of Uttar Pradesh.

Materials
The time series data pertaining to the period from 1997-98 to 2016-17 on area, production and productivity of Rice have been used to study the growth trends. These time series data have been procured from the Bulletins of Directorate of Agricultural Statistics and Crop-Insurance, Krishi Bhawan, Lucknow, Government of Uttar Pradesh and websites like updes.up.in/spatrika

and agricoop.nic.in/agristatisticsnew.htm. Therefore, the time series data has been classified into four regions of Uttar Pradesh to study the regional growth pattern of the area, production and productivity of different crops. The data on some input factors and infrastructure, *viz.* Fertilizer, power consumption in agriculture, number of Government Tube wells, Cemented Wells, Number of Pump set, Canal length and road length have been collected for 20 years (1997-98 to 2016-17) to study the effect of these factors on the crop production.

Trend and growth rate

The trend and growth rate in area, production and productivity of major food grain crops have been worked out by fitting the following five different functions:

1. Simple linear function

$$Y_t = a + b_t + \mu_t$$

2. Compound function

$\log Y_t = \log a + t \log (1+r)$ or $Y_t^* = a^* + bt$

Where,

Y_t: Time series data on area/production/productivity of different food grain crops i.e. Rice, Wheat and Gram at time t, a & b are parameters of the function to be estimated.

a: Intercept

b: Coefficient of variables

t: Time index (t= 1,2,…..n)

r: Average compound growth rate per annum.

μ_t : error term at t and is assumed to follow independently distributed

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

Computation of growth rate

1. For linear function

After fitting the 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

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

Where, $\overline{Y}$ is arithmetic mean of Y_t.

2. Compound growth rate

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

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

Result and Discussion

Annual average simple and compound growth rates of area, production and productivity of rice in Bndelkhand region of Uttar Pradesh and India (1997-98 to 2016-17).

Table 1 shows the annual growth rates of area, production and productivity of rice for different region of U.P. and India have been computed and presented during the period 1997-98 to 2016-17. Table 1 reveals that Simple and compound growth function have provided consistent estimates of growth rates.

Table 1: Production and Productivity in Bundelkhand

Period		Area	Production	Productivity
Bundelkhand	S.G.R	-0.68	1.49	1.99
	C.G.R	-0.67	1.24	1.82
All U.P.	S.G.R	0.56	1.37	0.78
	C.G.R	0.56	1.35	0.78
All India	S.G.R	-0.11	1.50	1.54
	C.G.R	-0.11	-0.11	1.55

There was absolute decrease area in Bundelkhand region of U. P. i.e. -0.68 per cent in simple growth rate. Table - 1 depicts that simple growth rate was increases at the rate of 0.56. Negative growth rate of area observed in all India -0.11 per cent.

In case of production, there was an absolute increase in simple growth rate in Bundelkhand, and U.P. Also observed that in all U.P. and all India level positive simple growth rate obtained during the period of 1997-98 to 2016-17. Bundelkhand region is 1.49 per cent. Minimum simple growth rate was obtained in all U.P.

In productivity of rice there was an absolute increase in

growth rate of Bundelkhand regions of U.P. and all U.P. level as well as in all India level during the period of 1997-98 to 2016-17.It observed that highest simple growth rate in Bundelkhand 1.99 followed by All U.P. and India

The area registered negative combined growth rate in Bundelkhandregion-0.67768. The production registered positive and increasing growth rate of 1.24, in the Bundelkhand region, of Uttar Pradesh. The productivity registered annual positive combined growth rate during the period of 1997-98 to 2016-17. Maximum annual combined growth registered in Bundelkhand region 1.82 per cent followed all U.P. and India.

Incremental R2 values of Rice production with different variables in Bundelkhand

Table 2: Rice production with different variable

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
Intercept	-1131089.802	879431.401	-1.286	0.224	-306	804525.7
Area	1.661	0.75	2.191	0.050	-0.007	3.330
Fertilizer	0.121	0.087	1.391	0.191	-0.070	0.3128
Electricity	0.048	0.103	0.465	0.650	-0.180	0.276
Cemented Tube well	-0.117	0.876	-0.133	0.896	-2.045	1.8115
Govt. tube well	81.184	135.244	0.600	0.560	-216.485	378.855
Pump set	-0.988	1.1589	-0.852	0.411	-3.539	1.562
Canal length	158.734	131.433	1.207	0.252	-130.55	448.018
Road length	-13.580	14.089	-0.963	0.355	-44.590	17.429
Model					R^2	R^2 Adjusted
$Y=-1131089.802+1.66X_1+0.12X_2+0.04X_3+-0.11X_4+81.18X_5+-0.98X_6+158.73X_7+-13.58X_8$					0.752	0.571

By the regression analysis of rice production during 1997-98 to 2016-17 in Bundelkhand region we examine the R^2 0.752 and adjusted R^2 0.571.The intercept of regression coefficient has -1131089.802.Highly coefficient variable is canal length. The production of rice has increased with annual rate of about 1.37, and 1.35 per cent respectively, in the Uttar Pradesh during 1997-98 to 2016-17. It was more prominent during the entire Region of U.P The production of rice have decline with the rate of 0.11 per cent in India.

The productivity of rice increased at the rate 0.78 per cent in Uttar Pradesh since 1997-98 to 2016-17. Rice in Bundelkhand region highly 1.82 per cent and Simple growth rate is 1.99 By the regression analysis in Bundelkhand region we examine the R^2 0.752 and adjusted R^2 0.571.The intercept of regression coefficient has -1131089.802.Highly coefficient variable is canal length.

References

1. Acharya Poudel, Saraswati Basavaraja H, Kunnal LB, Mahajanashetti SB, Bhat ARS. Growth in area, production and productivity of major crops in Karnataka. Karnataka J Agric. Sci. 2012;25(4):431-436.
2. Awaghad PR, Ganvir BN, Bhopale AA. Growth and instability of kharif sorghum in Western Vidarbha region. Journal of Soils and Crops. 2010;20(1):111-117.
3. Bhagyashree SD, Rajarathinam A. Statistical Modeling on Area, Production and Productivity Trends of Bajra Crop Grown in Gujarat State, Int. J Agricult. Stat. Sci. 2009;27(1-2):291-296.
4. Bhalla GS, Singh G. Indian Agriculture, Four Decades of Development. New Delhi, India: Sage Publications. 2001.
5. Gaddi GM, Koppad MB, Gummagolmath KC, Naik AD. An economic analysis of growth performance of oilseed crops in India. Karnataka Journal of Agricultural Sciences. 1999;12(1/4):93-98.
6. Gajbhiye S, Wankhade RN, Kakde SJ. Growth and instability of chickpea production in Vidarbha region of Maharashtra. International Journal of Commerce and Business Management. 2010;3(2):172-174.
7. Jose CT, Ismail B, Jayasekhar S. Trend, Growth Rate and Change Point Analysis: A Data Driven Approach, Communications in Statistic-Simulations and Computation. 2008;37:498-506.
8. Kannan, Elumalai. Trends in India's Agricultural Growth and its Determinants. Asian Journal of Agriculture and Development, 2014;8(2):79-99.
9. Kumaravardan RJ, Lenin V, Kumar P. Growth, instability

and acreage response of principal crops in Tamil Nadu. Agricultural Situation in India. 2009;65(12):721-728.
10. Lawwa, Rupesh, Anil Kumar. Growth Performance of Oilseeds in Rajasthan, Agricultural Situation in India, 2008;LXV(9):589-592.
11. Mahesh Kumar, Singh SP, Bharati RC, Sinha SK. Non-linear Growth Studies for Forecasting Wheat (Triticum Spp. L.) Productivity in Bihar, J Ind. Soc. Agril. Statist, 2007;61(3):316.
12. Naidu MR, Ramalinga Swamy K, Mallikarjuna Rao TKVV. Trends in Area, Production and Productivity of Major Crops in North Coastal Districts of Andhra Pradesh Agricultural Situation of India. 1994;XLIX(8):571-574.
13. Niaz Md. FR Md. Ismial Hossain, Md. Abdullah Aziz, Md. Azizul Baten and Md. Shahjahan Kabir. Prospects of Boro Rice production in Bangladesh, Advances in Environmental Biology. 2013;7(14):4542-4549.
14. Reddy VN. Growth Rates, Economic and Political weekly. 1978;13:806-812.
15. Sen A. Long-Term Prospects of Agricultural Growth-Constraints of Growth in Agriculture, Ind. J. of Agri. Econ. 1980;35(4):29.
16. Sharma M. Study on Agricultural Growth performance of Assam, Economic Affairs. 2005;50(1):38-41.
17. Shrivastava A, Saxena RR, Lakhera M, Khan I, Dwivedi S. Trend in growth and instability in maize in Chhattisgarh, Annals of Biology. 2005;21(1):119-126.