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**Growth in rice production: A zone wise analysis
in eastern Uttar Pradesh**

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Abstract

The paper attempts to study the growth and instability of rice production in Eastern Uttar Pradesh. The time series data on area, production and productivity of rice pertaining to the period 1980-81 to 2014-15 were used for the study. The study relates to 1980-81 to 2014-15 which is further divided into four sub-periods. The production under rice has registered positive growth rate in all three zones viz. North Eastern Plain Zone, Eastern Plain Zone and Vindhyan Zone. The area, production and productivity of rice are found to be highest in North Eastern Plain Zone. After instability analysis it was observed that there is high instability in area, production and productivity in Vindhyan Zone.

Keywords: Growth functions, Growth rate, Instability index, Trend analysis

1. Introduction

Rice (*Oryza sativa*) is the most important cereal crop in the developing world and is the staple food of over half the world's population. It is generally considered a semi-aquatic annual grass plant. About 20 species of the genus *Oryza glaberrima*, a perennial species, is grown in Africa. So-called "wild rice" (*Zizania aquatica*), grown in the great lakes region of the United States, is more closely related to oats than to rice. It is the agricultural commodity with the third – highest worldwide production (rice, 741.5 million tones in 2014), after sugarcane (1.9 billion tones) and maize (1.0 billion tones). Rice cultivation is well-suited to countries and regions with low labour costs and high rainfall, as it is labor-intensive to cultivate and requires ample water. However, rice can be grown practically anywhere, even on a steep hill or mountain area with the use of water-controlling terrace systems. Rice is now grown in over 100 countries on every continent except Antarctica, extending from 50° north latitude to 40° south latitude and from sea level to an altitude of 3000 m.

2. Materials and Methods

2.1 Materials

The time series data on area, production and productivity of rapeseed & mustard for 35 years from 1980-81 to 2014-15 has been collected from the Bulletins of Directorate of Agricultural Statistics & Krishi Bhawan Lucknow, Government of Uttar Pradesh.

2.2 Methods

2.2.1 Growth Models

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

1. Simple linear function $Y_t = a + b_t$

2. Compound growth rate function $Y_t = a(1+r)^t$

where, Y_t stands for area/production/productivity, t is time index, a and b are model parameters, and r is the compound growth rate.

2.2.2 Measure of instability in rice production

High growth and low instability in production are prerequisites for sustainable agricultural performance. It has been a great concern that technological change in rice production has increased variability, which is considered to be one of the important facts. Since the magnitude of growth and instability in rice production has serious implications for policy makers, the level of instability in the area, production and productivity has been estimated by using Cuddy Della

Valle Index, which corrects the coefficients of variations and it is given by

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

where, R^2 is the coefficient of determination from a time trend regression and cv is the coefficient of variation.

3. Results and Discussion

3.1 Changing pattern in area, production and productivity of rice crop

The triennium average of area (in thousand hectares), production (thousand tones) and productivity (kg/hectare) and its per cent change in different decadal periods for rice are depicted in the table 1 to table 3

Table 1: Triennium averages ending at year shown of area (in '000' ha.), production (in '000' tones) and productivity (in kg/ha) of rice and its changing pattern in North Eastern Plain Zone.

Crops	% change in 1990-91 over 1980-81	% change in 2000-01 over 1990-91	% change in 2010-11 over 2000-01	%change in 2014-15 over2010-11	% change in 2014-15 over 1980-81
Area	4.88	-7.35	3.60	1.04	1.72
Production	91.27	26.05	6.78	1.64	161.70
Productivity	82.36	36.05	3.06	0.60	157.26

Table 2: Triennium averages ending at year shown of area (in '000' ha.), production (in '000' tones) and productivity (in kg/ha) of rice and its changing pattern in Eastern Plain Zone.

Crops	% change in 1990-91 over 1980-81	% change in 2000-01 over 1990-91	% change in 2010-11 over 2000-01	%change in 2014-15 over2010-11	% change in 2014-15 over 1980-81
Area	12.49	4.44	-3.53	-2.97	9.96
Production	106.40	16.42	-4.42	-2.79	143.91
Productivity	83.48	11.47	8.24	0.18	121.81

Table 3: Triennium averages ending at year shown of area (in '000' ha.), production (in '000' tones) and productivity (in kg/ha) of rice and its changing pattern in Vindhyan Zone.

Crops	% change in 1990-91 over 1980-81	% change in 2000-01 over 1990-91	% change in 2010-11 over 2000-01	%change in 2014-15 over2010-11	% change in 2014-15 over 1980-81
Area	3.30	35.72	-35.11	-3.42	-12.13
Production	44.66	77.15	-30.30	11.07	98.39
Productivity	172.93	106.54	2.75	12.73	553.02

Area

The triennium average of area and its per cent change in different decadal period of rice crop in all the three zones of Eastern Uttar Pradesh. In all the three zones the area of rice decreased from 1980-81 to 2014-15. The area shows increased in first period 1980-81 to 1990-91.

Production

The triennium average of production and its per cent change has increased in all zones of Eastern Uttar Pradesh. The production has increased from 1980-81 to 2014-15. The

rainfall is heavy in 2014-15.

Productivity

The triennium average of productivity of rice crop has increased in all decades. The maximum increased has been found in the year 1980-81 to 2014-15. The production and productivity both are increased in all the zones of Eastern Uttar Pradesh in year 2014-15.

3.2 Trends and growth rate in area, production and productivity of rice crop in table 4 to table 6

Table 4: Annual average simple and compound growth rates of area, production and productivity of Rice during different periods in North Eastern plain Zone

Period		Area	Production	Productivity
1980-81 to 1994-95	S.G.R	-0.35	4.51	4.88
	C.G.R	-0.35	4.84	5.22
1995-96 to 2004-05	S.G.R	0.28	0.87	0.36
	C.G.R	0.35	0.88	0.38
2005-06 to 2014-15	S.G.R	0.29	3.33	2.91
	C.G.R	0.29	3.40	2.99
1980-81 to 2014-15	S.G.R	0.01	2.33	2.32
	C.G.R	0.01	2.52	2.52

In North Eastern Plain Zone, the area under rice has increased at the rate of 0.01 per cent annually since 1980-81 to 2014-15. Increased growth rate is prominent during the second period about 0.35 per cent. However, the first period has witnessed negative growth rate of about 0.35 per cent. The production of rice has also registered growth rate of about 2.52 per cent annually during the entire period under study. The growth rate has been found more 4.84 per cent during first period. Similar in the case of productivity, it has increased at the rate of about 2.52 per cent annually during the entire period under study. A high growth rate has been found 5.22 per cent during the first period.

Table 5: Annual average simple and compound growth rates of area, production and productivity of Rice during different periods in Eastern plain Zone

Period		Area	Production	Productivity
1980-81 to 1994-95	S.G.R	0.96	2.54	1.70
	C.G.R	0.97	3.53	2.56
1995-96 to 2004-05	S.G.R	0.65	1.10	0.51
	C.G.R	0.67	1.04	0.38
2005-06 to 2014-15	S.G.R	-0.71	2.27	2.92
	C.G.R	-0.70	2.30	3.00
1980-81 to 2014-15	S.G.R	0.47	1.41	0.99
	C.G.R	0.48	1.67	1.18

The annual growth rates of area, production and productivity of rice for different periods and for the entire periods have been computed and are presented in the table 1.2. Simple and Compound growth function have provided consistent estimates of growth rates. The production of area has also increased in the zone at the annual growth rate of about 1.67 per cent since 1980-81 to 2014-15. First period witnessed increase growth rate of 3.53 per cent as against 1.04 and 2.30 per cent during second and third period respectively. The productivity of rice has experienced upward trend and it has found to be 1.18 per cent since 1980-81 to 2014-15. The growth rate has been found to be more in first period 2.56 per cent.

Table 6: Annual average simple and compound growth rates of area, production and productivity of Rice during different periods in Vindhyan Zone

Period		Area	Production	Productivity
1980-81 to 1994-95	S.G.R	0.64	3.99	11.41
	C.G.R	0.64	4.02	11.50
1995-96 to 2004-05	S.G.R	2.01	0.13	1.39
	C.G.R	2.10	0.06	1.61
2005-06 to 2014-15	S.G.R	-3.99	2.67	7.54
	C.G.R	-3.56	2.91	7.97
1980-81 to 2014-15	S.G.R	0.42	2.52	4.72
	C.G.R	0.39	3.00	6.47

In Vindhyan Zone, the area of rice has registered positive growth rate of 0.39 per cent annually since 1980-81 to 2014-15. It can also be seen from the above table the positive growth rate of about 0.64 and 2.10 per cent is found during the first and second period respectively, while the area has declined at the rate of 0.12 per cent during the third period. The production of rice has also increased in the annual growth rate of about 3.00 per cent since 1980-81 to 2014-15. First period witnessed high growth rate of 4.02 per cent as against 0.06 and 2.91 per cent during second and third periods, respectively. The productivity of rice has experienced upward trend and it has found to be 6.47 per cent since 1980-81 to 2014-15. The growth rate has been found to be more in 11.50

per cent during first period as compared to that of 1.61 and 7.97 per cent in second and third period.

3.3 Measures of instability in area, production, and productivity of rice crop Instability index (in%) of Rice during 1980-81 to 2014-15

Table 7

Zone	Area	Production	Productivity
North Eastern Plain Zone	7.13	6.79	4.93
Eastern Plain Zone	3.17	28.76	18.42
Vindhyan Zone	17.42	36.40	31.80

In the above table high instability of rice has been found in case of area, production and productivity in Vindhyan Zone and low instability has been found in North Eastern Plain Zone.

4. Discussion and conclusion

It can be observed from the results the productivity of rice has increased annually 553.02 per cent in Vindhyan Zone. The per cent change has increased in North Eastern Plain Zone in area, production and productivity. The high growth rate has been found in second period of all zones in Eastern Uttar Pradesh. Also the highest instability has been found in Vindhyan Zone. Therefore, there is need of launching another mission- mode approach by the policy makers at the state and national level to enhance the production of rice. The farmers are also required to be given facilities and incentives for cereals production in general and rice in particular.

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