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Growth Rate of Rice Crop in Varanasi Division of Eastern Uttar Pradesh, India

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A B S T R A C T

The present paper attempts to analyze the growth rate for Area, Production and Productivity of Rice crop in Varanasi Division of Eastern Uttar Pradesh. The time series data on area, production and productivity of wheat crop pertaining from "Sankhyakiya Patrika" to the period 2000-01 to 2014-15 were used for the study. The per cent change was estimated on the basis of triennium average for area, production and productivity which is increased substantially with 5.19, 15.90 and 10.20 per cent respectively. Graphical presentations have shown the trends in area, production and productivity of Rice. The growth rate was examined by Compound Annual Growth Rate (CAGR), which is 0.307 per cent for area, 1.559 per cent for production and for its productivity 1.247 per cent. Decomposition analysis shows the dominant effect of productivity for the growth in rice production.

Introduction

Varanasi division is an administrative geographical unit of Uttar Pradesh of northern India. Varanasi is the administrative headquarter of the division. Division consists of district of Varanasi, Jaunpur, Gazipur and Chandauli Varanasi district lies between latitude 25 20' N and longitude 83 00' E. The district covers an area of 1535 square kilometers. It is bounded by Jaunpur district to the north Ghazipur and Ballia district in the east, Mirzapur and Chandauli district to the south and Gyanpur to the west. According to the Department of National Economics and Statistics (2015) during 2012-13 and 2013-14,

the world production of rice has increased by 1% (472 Million Tonnes to 476 Million Tonnes), trade by 8% (38 million MT to 41 million MT) and consumption by 3% (469 million MT to 481 million MT) (Prasad *et al.*, 1996). India's rice production has increased at the rate of 3.32 percent during 2002-03 to 2013-14. Area under rice cultivation has not increased substantially during 2002-03 and 2013-14 (Sharma and Joshi, 1995). India was the largest exporter of Rice in 2013-14 followed by Thailand, Vietnam and USA. Iran is the leading importing country for Basmati rice from In Minimum temperature for sprouting is10ºC at the time of tillering; the crop requires a high temperature than for growth. Minimum temperature for flowering ranged from 22- 23ºC. Temperature requirements for blooming are in the range of 26.5to 29.5ºC. Minimum temperature for grain formation from 20-21ºC at the time of ripening the temperature should be between 20-25ºC. Photo periodically, rice is a short-day plant (Singh *et al.*, 2018). However, there are varieties, which are non-sensitive to photoperiodic condition. Rice production in India is an important part of the national economy. India is the world's second largest producer with approximately 43 million Ha planted area, accounting for 22% of the world's rice production (Tripathy, 1996). Rice is a basic food crop and being a tropical plant, it flourishes in hot and humid climate. It is grown in assured irrigated areas and in rain fed areas that receive assured annual rainfall. Hence, it can be grown in both *Kharif* & *Rabi* seasons. This paper attempts to analyze the nature and sources of growth in area, production and productivity of Rice in Varanasi Division of Eastern Uttar Pradesh with specific objectives as follows: to study the growth in area, production and productivity of rice in Varanasi division of Eastern Uttar Pradesh and to examine the contribution of area and productivity towards the growth in rice production.

Materials and Methods

Materials

The time series data of area, production and productivity of rice for 15 years from 2000-01 to 2014-15 have been used for the present study. The data have been collected from Sankhyakiya Patrika, published by Economics and Statistics Division, Planning Department, Government of Uttar Pradesh.

Methods

Growth rate

The growth rate in area, production and productivity of Rice have been worked out by fitting the compound function:

Compound function is given by the equation:

$$X_t = ab^t$$

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

Where,

X_t is the characteristic (area, production or productivity of dependent variable)
t is the time in years, independent variable
a is intercept
b is regression coefficient.
The 'a' and 'b' are calculated by applying the method of Least Squares.
Finally the compound growth rates were worked out as described below:
Compound growth rate: CGR (%) = (Antilog b - 1) x 100

Measure of instability in Rice production

The agricultural instability can be measured by different methods, such as the coefficient of variation (CV), dispersion, Cuddy Della Valle Index (CDI); the present study applies

the Cuddy Della Valle Index for measuring the instability. Cuddy Della Valle index first de-trends the given series and gives a clear direction about the instability. The use of coefficient of variation as a measure to show the instability in any time series data has some limitation. If the time series data exhibit any trend, the variation measured by CV can be overestimated, i.e. the region that has growing production are at constant rate will score high in instability of production if CV is applied for measuring instability. As against that, Cuddy Della Valle index attempts to de-trend the CV by using coefficient of determination (R^2). Thus, it is a better measure to capture instability in agricultural production. A low value of this index indicates the low instability in farm production and vice-versa. CDVI was originally developed by Cuddy and Della Valle (1978) for measuring the instability in time series data that is characterized by trend. The estimable form of the equation is as follows:

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

Where,

CV is the coefficient of variation in percent, and R^2 is the coefficient of determination from time trend regression adjusted by the number of degree of freedom

Measure the effect of change in acreage and productivity on differential production of rice crop by decomposition analysis

An attempt has been made to the study the effect of change in acreage and productivity of Rice on its differential production between two points of time. Let Y, A and P be the production, acreage and productivity of Rice at a given point of time. The Y can be expressed as

$Y = P. A$

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

$P \Delta A$: Effect of change in acreage of the Rice production
$A \Delta P$: Effect of change in productivity of the Rice production
$\Delta P\Delta A$: Interaction effect due to change in acreage and productivity of the Rice production simultaneously.

Results and Discussion

Per cent change in area, production and productivity of rice

The triennium average of area (in thousand hectares), production (thousand tonnes) and productivity (Q. /hectare) and its per cent change for Rice are depicted in the Table 1. The per cent change in area, production and productivity has increased substantially with 5.19, 15.90 and 10.20 per cent respectively during the study period. These figures have shown positive trend for Rice crop in the division.

Graphical presentation for area, production and productivity of Rice crop

The graphical presentation for area, production and productivity of Rice crop is shown in graph 1-3.

Area

Area under Rice crop shows positive trend from 2000-01 to 2008-09. The area has goes down with some ups and downs from 2006-07 to 2014-15.

Production

Varanasi division achieved highest production in year 2014-15 during the study period and positive growth trend of production is visible in Graph 2.

Productivity

In year 2012-13, the division achieved highest productivity in 2012-13. Graph 3 shows that the productivity of rice has increasing trend till 2010-11.

Annual average compound growth rate (%) of area, production and productivity of rice

The production is targeted to grow at the rate of 3-4 per cent. In respect of this the area, production and productivity of Rice in the division exhibit positive growth rate during the study period from 2000-01 to 2014-15 with 0.307 per cent, 1.559 per cent and 1.247 per cent respectively. Growth rate of production is 1.559 which is less than expected 3-4 percent (Table 2).

Measure of instability in area, production and productivity of rice crop

High growth and low instability in agricultural production are essential components for sustainable agricultural development. It is desirable that production increases with improved technological and infrastructural changes in agriculture. Instability index for area, production and productivity is given below in Table 3.

Decomposition analysis

Decomposition analysis shows the effect of changes in acreage and productivity and their interaction on differential production of rice crop. Table 4 shows the contribution of area, productivity and their interaction to the change in production over the years.

In the study period the differential production is positive which shows that the production was increases from 2000-01 to 2014-15 by 150.84 thousands tone in which the contribution of area effect, yield effect and interaction effect is 32.60, 64.07 and 3.33 per-cent respectively. Decomposition analysis shows the dominant effect of productivity for the growth in Rice production.

Table.1 Triennium average ending at year shown of area (in '000' ha.), production (in '000' tonnes) and productivity (in Q. /ha.) of Rice and its changing pattern over last 15 years

Description	2001-02	2013-14	% Change in 2013-14 over 2001-02
Area	432.03	454.46	5.19
Production	947.38	1098.21	15.92
Productivity	21.93	24.17	10.20

Table.2 Annual average compound growth rate of area, production and productivity of rice crop in Varanasi Division of Eastern Uttar Pradesh

Particulars	Overall Period (2000-01 to 2014-15)
Area	0.307
Production	1.559
Productivity	1.248

Table.3 Measures of instability index (in %) of area, production and productivity of Rice

Particulars	CV (%)	R^2	Instability (%)
Area	3.137	0.186	2.83
Production	15.555	0.172	14.15
Productivity	14.742	0.116	13.86

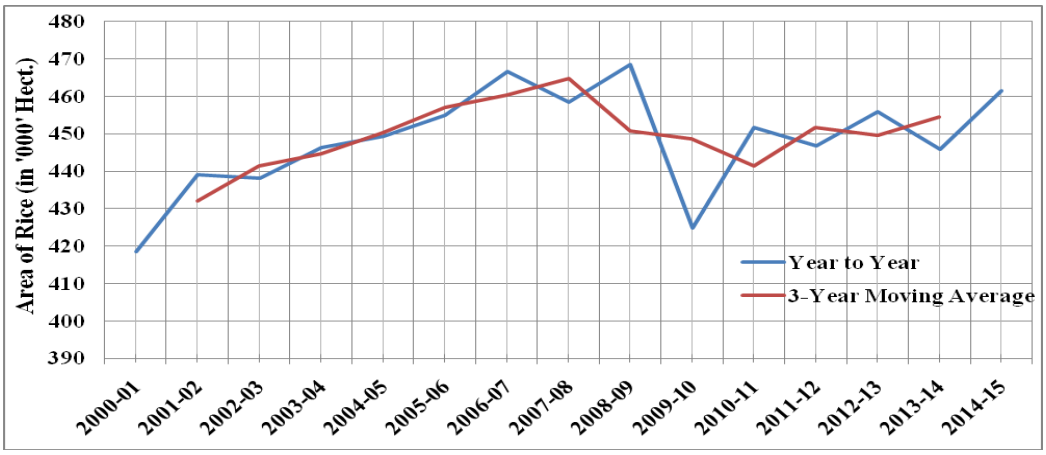
Table.4 Effect of change in acreage and productivity on differential production of rice crop in Varanasi Division of Eastern Uttar Pradesh based on triennium average

Particulars	Overall Period (2000-01 to 2014-15)
Differential Production (ΔY)	150.84 (100 %)
Area Effect (P ΔA)	49.18 (32.60 %)
Yield Effect (A ΔP)	96.64 (64.07 %)
Interaction Effect (ΔPΔA)	5.02 (3.33 %)

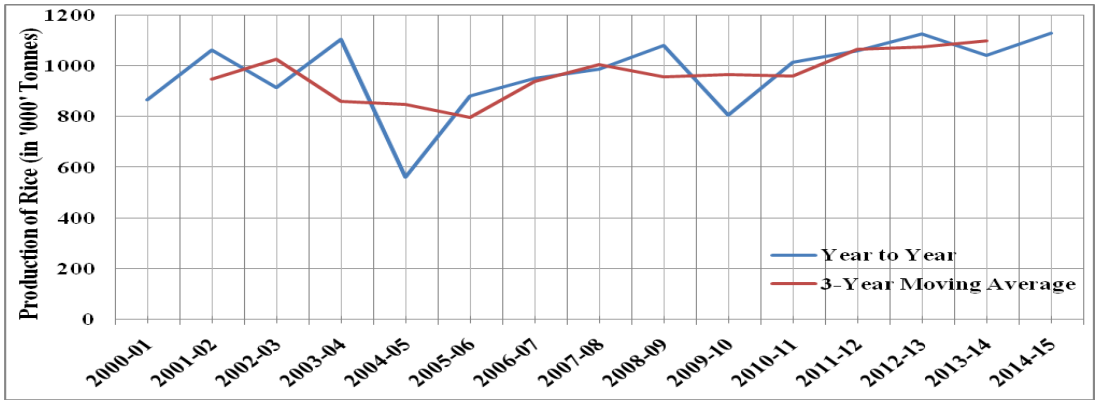
Table.5 Comparison of productivity leading state and country (Kg. /Ha) of rice crop 2000-01 to 2014-15

Particulars	Average Productivity (Kg/Ha.)
Varanasi	2178 (Max: 2444 in 2013-14)
Eastern UP	1999
UP	2277
Punjab	3103 (Leading State)
India	2750

Graph.1 Area (in '000' Hect.) of Rice in Varanasi Division of Eastern Uttar Pradesh over the period (2000-01 to 2014-15)



Graph.2 Production (in '000' Tonnes) of Wheat in Varanasi Division of Eastern Uttar Pradesh over the period (2000-01 to 2014-15)



Graph.3 Productivity (in Q./Ha.) of Rice in Varanasi Division of Eastern Uttar Pradesh over the period (2000-01 to 2014-15)

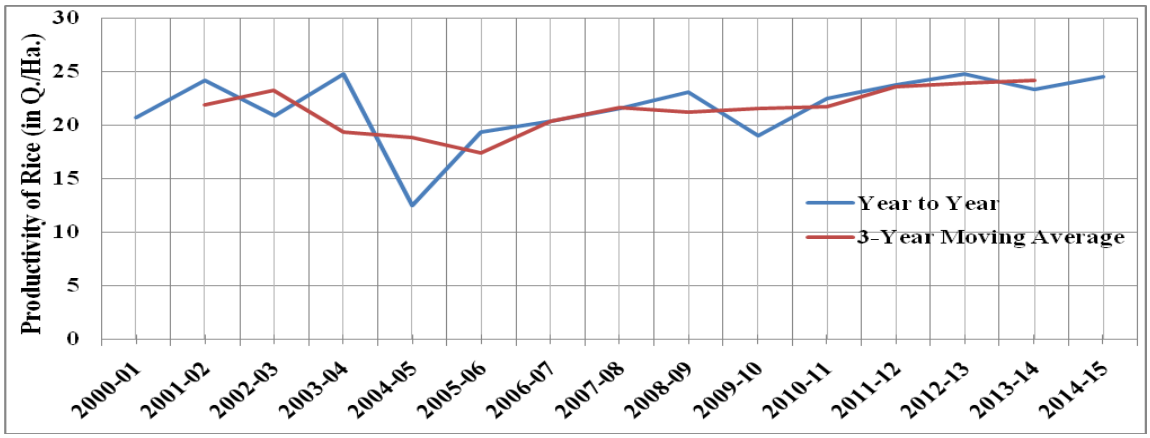


Table 5 shows that productivity of Varanasi division more Eastern UP and UP but less than Punjab and India. Growth rate in Rice production is 2.56 per cent and can further go up by intervention of Technology and improved irrigation system. This study shows that rice production and productivity of Varanasi division suffered badly in drought year which calls for strengthening of irrigation resources along with adoption of modern technological practices (Singh and Supriya, 2017).

In conclusion, the present investigation has been undertaken to evaluate the growth in area, production and productivity of Rice crop in Varanasi Division. The compound growth rates for the study period of 2000 to 2015 were estimated by compound function to the area, production and productivity of rice crop, respectively. The average area, production and productivity under rice in Varanasi Division during the study period were exhibited significantly increasing trend with the compound growth rates of 0.307 per cent, respectively for area and for the production, it was 1.559 per cent, respectively. However, the productivity of Rice exhibited a positive trend with the compound growth rates of 1.247 per cent, respectively. Among the area, production and productivity in Varanasi Division, the production exhibited higher growth rates with an increasing trend due to increased trend in growth rates of area and productivity. Normal rainfall of the Varanasi division is 1159.67 mm but actual rainfall in 2014 was very low (517.07 mm). Due to severe drought the production and productivity decreased by -30.45 and -28.41 per cent respectively in year 2014-15 over 2013-14.

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