Growth, Variability and Decomposition Analysis of Rice in Major States of India

ABSTRACT

The present paper analysed the growth rate and decomposition analysis of area, production and yield of Rice in major states of India for the period 2010-11 to 2021-22. The major states included Uttar Pradesh, West Bengal, Andhra Pradesh, Punjab and Tamil Nadu. For the analysis the data was obtained from the official website of DES (Directorate of Economics and Statistics).The findings of the study showed that Tamil Nadu and Punjab were among the high-producing states of India, while decline in area under Rice was observed in states like Uttar Pradesh and West Bengal. Area under Rice increased for India as a whole during the study period. Variability varied across the states with Tamil Nadu showing highest variability.

Keywords: Area, Production, Yield, Decomposition, Variability, Growth rate

INTRODUCTION

In India, Agriculture stands as a central heartbeat of its economy which plays a vital role in the socioeconomic progress of the country. It constitutes approximately 19 percent of the country's GDP and approximately two-third of the population depends on agriculture for their livelihood. In recent decades, India has become self-reliant in food grain production, thus, marking a significant milestone for its agricultural sector and the broader economy as well. Presently, India holds first rank in sugar production and second rank in Rice production globally (Ministry of Agriculture & Farmers Welfare, pib release, 2022).

Rice stands as a principal grain in India, where it occupies the largest cultivated area among crops. It serves as a primary staple food, dominating the production in agricultural sector across the country. India ranks among the top producer of Rice globally because of the suitability of Rice to thrive in tropical climate characterized by heat and humidity (Wikipedia, 2024). Not only India ranks amongst the largest producers of Rice globally but also occupies first rank in its exports too. Both basmati and non-basmati Rice constitutes a predominant portion of India's total cereal exports accounting for almost 80 percent with countries like Bangladesh, Saudi Arabia, Iran, UAE being the major export destinations (APEDA, 2023).

As per the 4th Advance Estimates for 2021-22, the food grain production in the country was estimated to be 315.72 million tonnes in which the total Rice production was estimated to be 130.29 million tonnes and the area under Rice cultivation was estimated to be 46.38 million hectare with a total productivity of 2809 kg per hectare during the year 2021-22 (Annual Report, Department of Agriculture & Farmer's Welfare, Government of India, 2022-23). Amongst the chief Rice producing states in India, Madhya Pradesh occupies a significant place accounting for about 3.40 million hecatre area under cultivation and approximately 13.57 million tonnes of production (mpkrishi, 2021).

Decomposition analysis demonstrates how changes in both area and productivity, their interaction effect as well, impact the production of crops in agricultural sector. Minhas and Vaidyanathan in 1965 introduces the concept of decomposition analysis to study growth trend which involved estimation of fluctuations in value of agricultural production by breaking down the changes in four primary factors, i.e., area, yield, cropping pattern and the interaction amongst the factors considered (Pattnaik and Shah, 2015). Jahannath *et al.* (2013) studied the growth rate and examined the effect of change in area and productivity on production of crops namely, jowar, cotton and soybean from 1985-86 to 2006-07 which showed that area effect was responsible for increase in production of both soybean and jowar whereas yield effect was responsible for increase in production of cotton. In this study, we try to explore the application of decomposition analysis on production of Rice in Madhya Pradesh from 2010-11 to 2021-22. Through systematic breakdown of the driving factors, we endeavor to recognize their individual impact on productivity of Rice.

This study aims to contribute more insight on Rice production and decomposition analysis by offering empirical evidence and methodological understandings that can enlighten future researchers and help

policymakers to formulate effective policies. The following section includes, methodology employed for the decomposition analysis, the empirical findings achieved, discussion related with the results obtained and ultimately recommendations for policymakers and stakeholders.

LITERATURE REVIEW

Pattnaik and Shah (2015) studied the trend of agricultural growth and decomposition of production of fifteen major crops in Gujarat from 1990-91 to 2009-10. The study period was divided into two phases and decomposition analysis with respect to area, cropping patter, yield and price was taken into consideration. The results showed that the price effect alone had increased throughout the period but the yield effect had declined. In the first phase, negative interaction between price and are effect was observed which became positive in the second phase. Similarly, in the second phase, the yield- price interaction showed a positive effect. The study thus concluded that for majority of crops taken under study, a significant increase in price showed suitable changes in area and yield in the second phase.

Laitonjam *et al. (*2018) analyzed the decomposition of production Rice crop with respect to area, yield and their interaction effect from 1980 to 2014. The result showed that yield effect majorly contributed in increased production of Rice crop in India. Overall, the yield and area effect had a positive impact on the production of Rice during the period under study which might be due to collective efforts to increase the production of Rice by all the farmers across the country owing to the rise in its demand.

RESEARCH METHODOLOGY

The study is based on secondary data. The major Rice growing states including West Bengal, Uttar Pradesh, Punjab, Tamil Nadu and Andhra Pradesh were selected for the study. The study period is from 2012-13 to 2021-22. The following are the statistical tools applied in the study.

Analysis of data

Absolute Change

The absolute change was calculated for three variables: area, production and yield. The calculation method was used in the study by Singh et.al (2014) involved taking the average of the base year, which is the average of the values from 2012-13 to 2014-15. similarly, the average of current year was taken, which the average of values from 2018-19 to 2021-22. absolute change was calculated by subtracting the base year average from the current year average. The absolute change was calculated by:

Absolute change= $Y_n - Y_o$

where,

Y_n = average of the current three years

Y_o = average of the beginning three years

Relative Change

The relative change is a measure used to analyze and compare changes across different variables within each crop, as described in the study by Singh et.al (2014). The following formula was used to calculate relative change:

$$\textbf{Relative change} = \frac{Yn - Yo}{Yo} \times 100$$

Compound growth rate (CAGR)

Compound growth rate of area, production and yield were calculated by using the following formula:

$$Y_t = ab^t$$

Compound annual growth rate (%) = (Antilog b-1) × 100

Where,

Y= Area, production, and yield in the year 't' for which the growth rate is estimated

t= Time in year

b = Regression coefficient

Coefficient of variation- The coefficient of variation was used to estimate the fluctuations in area, production and yield of Rice crop in the major states of India and for overall country as well.

Coefficient of variation = $\frac{Standarddeviation}{Mean}$ ***100**

Decomposition Analysis- To analyse the contribution of area, yield and their interaction towards change in production of Rice, decomposition analysis was used.

Area effect: It indicates the percentage share of area in total production and is given by the following formula:

$$AE=\frac{(At-Ao)Yo}{Pt-Po}*100$$

Yield effect: It shows the percentage share of yield in the total production.

$$YE=\frac{(Yt-Yo)Ao}{Pt-Po}*100$$

Interaction effect: It shows the combined effect of area and yield in total production and is given as following:

$$IE=\frac{(Yt-Yo)(At-Ao)}{Pt-Po}*100$$

Where,

At, Yt and Pt= Triennium average from 2019 to 2021(Current year)for the Area, Production and Yield

Ao, Yo and Po= Triennium average from 2010 to 2012 (Base year) for the Area, Production and Yield

RESULT AND DISCUSSION

Table 1. Absolute and Relative change in Area, Production and Yield of Rice in major states of India

States	Particulars	Base year	Current year	Absolute change	Relative change (%)
West Bengal	Area	5.44	5.55	0.11	2.01
	Production	15.02	16.38	1.35	9.01
	Yield	2,759.13	2,948.33	189.20	6.86
Uttar Pradesh	Area	5.91	5.71	-0.20	-3.37
	Production	13.74	15.44	1.70	12.35
	Yield	2,326.17	2,705.33	379.16	16.30
Punjab	Area	2.86	2.94	0.08	2.64
	Production	11.25	12.48	1.23	10.96
	Yield	3,929.26	4,246.67	317.41	8.08
Tamil Nadu	Area	1.67	2.05	0.38	22.88
	Production	5.04	7.32	2.28	45.16
	Yield	3,001.11	3,568.33	567.22	18.90
Andhra Pradesh	Area	2.35	2.30	-0.04	-1.91
	Production	7.02	8.10	1.08	15.38
	Yield	2,993.22	3,516.67	523.45	17.49
India	Area	43.21	45.24	2.03	4.69
	Production	102.17	124.24	22.07	21.60
	Yield	2,364.45	2,745.67	381.22	16.12

Base year – Triennium average for 2012-13 to 2014-15

Current year- Triennium average for 2019-20 to 2021-22

Table 1 presents the results of absolute and relative changes in the area, production and yield of Rice in major states of India. The major Rice producing states in India are West Bengal, Uttar Pradesh, Punjab, Tamil Nadu and Andhra Pradesh. In West Bengal, area under Rice cultivation increased from 5.44 m ha in the base year to 5.55 m ha in the current year, indicating a rise of 0.11 m ha. Rice production in the state

has seen a positive trend with an absolute increase of 1.35 m tonnes and a relative change of 9.01 per cent. The yield increased from 2759 kg/ha in base year to 2948 kg/ha in the current year.

Uttar Pradesh witnessed a decline in area under Rice cultivation, as it decreased from 5.91 m ha in the base year to 5.71 m ha in the current year. This shows a decrease of 0.20 m ha, resulting in a relative change of -3.37 per cent. However, Rice production has increased by 1.70 m tonnes in the state with a relative change of 12.35 per cent. The yield has significantly increased by 379.16 kg/ha, showing a relative change if 16.30 per cent.

In Punjab, area under Rice cultivation has increased by 0.08 m ha, indicating a relative change of 2.64 per cent. The Rice production has increased by 1.23 m tonnes, resulting in a relative change of 10.96 per cent. Moreover, the yield has increased by 8.08 per cent with an increase of 317.41 kg/ha.

Tamil Nadu has seen a substantial increase in the area under Rice cultivation with an increase of 0.38 m ha, showing a relative change of 22.28 per cent. The Rice production also experienced an significant increase of 2.23 m tonnes and a relative change of 45.16 per cent. The yield per hectare has increased by 567.22 kg/ha, indicating a relative change of 18.09 per cent.

Andhra Pradesh has seen a decrease in area under Rice by 0.04 m ha, resulting in a relative change of -1.91 per cent. However, the Rice production in the state has increased by 1.08 m tonnes. The yield has increased from 2993 kg/ha in the base year to 3516 kg/ha in the current year. The yield has increased by 17.49 per cent.

On a national level, India has witnessed an overall increase in the area under Rice cultivation, with an increase of 2.03 m ha. Rice production in the country has increased substantially by 22.07 m tonnes and by 21.06 per cent in relative terms. The yield has displayed a relative increase of 16.12 per cent with a rise of 381.22 kg/ha. These results shows that while some states witnessed growth in area, production and yield, others experienced declines. The country overall demonstrated positive growth in Rice cultivation, contributing to the increase in national product and yield.

Table 2. Variability and Compound growth rate of Rice in major states of India

States	CV (%)			CGR (%)		
	Area	Production	Yield	Area	Production	Yield
West Bengal	2.51	4.48	3.27	0.21	1.15***	0.94***
Uttar Pradesh	1.88	8.96	10.15	-0.49***	1.68	2.19***
Punjab	2.89	6.7	4.68	0.48	1.64***	1.15***
Tamil Nadu	13.14	28.44	20.04	2.95**	5.81	2.77
Andhra Pradesh	4.85	7.54	9.52	-0.08	1.98***	2.07**
India	2.33	8.57	6.71	0.46***	2.23***	1.76***

Note: Significance Code: * for 0.1 %, ** for 0.05 % and *** for 0.01% level of significance

Table 2 provides information on the variability and compound growth rate (CGR) of Rice in major states of India. The coefficient of variation (CV) is a measure of variability, indicating the extent of fluctuations in the data. Meanwhile, growth rate represents the annual growth rate over a specific time period. The results of coefficient of variation and compound growth rate are presented in the Table 2. In West Bengal, the CV for area, production, and yield of Rice cultivation was 2.51 per cent, 4.48 per cent and 3.27 per cent, respectively. In the state, the area has seen a positive but insignificant growth of 0.21 per cent while production and yield has increased by 1.15 per cent and 0.94 per cent respectively.

Uttar Pradesh has exhibited a CV of 1.88 per cent for area, 8.96 per cent for production, and 10.15 per cent for yield. The area has seen a negative and significant growth of -0.49 per cent while growth rate for production was insignificant. The yield has seen a positive and significant growth of 2.19 per cent.

Punjab had a CV of 2.89, 6.7 and 4.68 per cent for area, production and yield respectively. The growth rate for area was 0.48 per cent, while production and yield showed growth rates of 1.64 and 1.15 per cent, respectively.

Tamil Nadu exhibited higher variability, with CV of 13.14 per cent for area, 28.44 per cent for production, and 20.04 per cent for yield. The growth rate for area was 2.95 per cent, while production and yield showed growth rates of 5.81 per cent and 2.77 per cent, showing a significant positive growth.
In Andhra Pradesh, the CV for area, production and yield of Rice cultivation was 4.85, 7.54, and 9.52 per cent, respectively. The growth rate witnessed a slight decline of -0.08 per cent, while production and yield showed growth rates of 1.98 and 2.07 per cent respectively.
At the national level, India had a CV of 2.33 per cent for area, 8.57 per cent for production, and 6.71 per cent for yield. The growth rate for area was 0.46 per cent, while production and yield showed growth rates of 2.23 and 1.76 per cent respectively.

Table 3. Decomposition of output growth of Rice in major states of India (2012-13 to 2021-22)

States	Area effect (m tonnes)	Yield effect (m tonnes)	Interaction effect (m tonnes)
West Bengal	341.40	4,787.36	-1,375.95
Uttar Pradesh	-4,861.59	13,130.25	-1,862.79
Punjab	1,256.85	6,155.82	-932.53
Tamil Nadu	15,172.55	12,447.05	2,458.72
Andhra Pradesh	-2,359.93	14,474.83	-992.10
India	-5,604.54	-738.38	-9,954.96

The results of decomposition analysis of Rice output growth in major states of India from 2012-13 to 2021-22 are presented in Table 3. In West Bengal, the area effect contributed positively to output growth, with an increase of 341.40 million tonnes. Also, the yield effect contributed 4787.36 million tonnes to the growth. However, there was a negative interaction effect of -1375.95 million tonnes, which may have hindered the overall output growth in the state.
Uttar Pradesh has seen a substantial yield effect, contributing 13130.25 million tonnes to output growth. However, the area effect and interaction effect had a negative impact of -4861.59 and -1862.79 million tonnes, respectively.
In Punjab, both the area and yield effect contributed positively to the output growth. The area effect contributed 1256.85 million tonnes, while the yield effect contributed 6155.82 million tonnes. However, the negative interaction effect of -932.53 million tonnes somehow offset the positive contributions. In Tamil Nadu, all three effects were positive. The area effect, yield effect and interaction effect contributed 15172.55, 12447.05, and 2458.72 million tonnes, respectively.
In Andhra Pradesh, the area and interaction effect had a negative impact on output growth with a decrease of -2359.93 and -992.10 million tonnes, respectively. However, the yield effect had a positive impact of 14474.83 million tonnes.
Overall, for the entire nation, the area effect had a negative impact of -5604.54 million tonnes, which shows a decrease in the cultivated area. Similarly, the yield effect and interaction effect had a negative impact, with a reduction of -738.38 and 9954.96 million tonnes respectively.

CONCLUSION

From the ongoing discussion it emerged that in Uttar Pradesh and Andhra Pradesh there was slight decrease in area under Rice cultivation, however the states witnessed positive growth in production and yield of Rice. In West Bengal the area under Rice increased slightly leading to increase in production as well as yield, however interaction effect was observed to be negative.Punjab and Tamil Nadu witnessed positive growth in all aspects of Rice cultivation including area, production and yield and Tamil Nadu emerged as a high-performing state in terms of Rice production. For India as a whole there was increase in area under Rice cultivation resulting in significant growth in Rice production as well as yield. The

variability varied across the states during the period with Tamil Nadu exhibiting the highest variability among all states.

POLICY IMPLICATIONS

1. Policies should be aimed at increasing area under Rice in states such as Uttar Pradesh and Andhra Pradesh through providing incentives, improved infrastructure and farmer trainings.
2. Efforts should be made to increase the yield by encouraging the adoption of advanced technologies, improved irrigation facilities and promotion of high yielding seeds.
3. In states where high variability was observed efforts should be made to develop climate resilient farming practices, crop insurance schemes and other measures.

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