Growth rate of paddy crop in 27 districts of Chhattisgarh state

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Abstract
The present study is conducted with a view to analyze growth rate of paddy crop in 27 districts of Chhattisgarh. For the purpose of study secondary data of area, production and productivity of paddy crop in 27 districts of Chhattisgarh state was downloaded from Directorate of Economics and Statistic, Department of Agriculture Ministry and Farmer Welfare, Govt. of India. The study was conducted for a period of 23 years (2000-2023). As new districts were formed in 2011 from older districts. So, we bifurcate 23 years into two decades from 2000- 2010 and 2011-2023. The compound growth rate (CGR) and Simple growth rate (SGR) were analyzed for paddy crop for the same period. In the study significant variations in the growth rate among 27 districts were observed. paddy showing highly significant increasing production and productivity in janjgir-champa district with value 10.70 and 10.21, while area exhibited non-significant for 1st decade and significantly decreasing growth rate for 2nd decade. Kabirdham district showed highly significant growth rate for area followed by Bemetara with value 3.72 and 3.33 for paddy crop. On comparison between before and after bifurcation of districts. The result also depicted that Bastar and Rajnandgaon were found significantly increasing growth rate for productivity of paddy.

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1. Introduction

Paddy is among one of the most crucial food grains not only in India but globally. Paddy first originated in East Asia over 10,000 years ago, it was domesticated and widely grown throughout Asia and later, it was made known to the rest of the world. Paddy is a staple food in many parts of Asia due to its ability to grow in a variety of climates and soil types. It is also a very versatile crop that can be used in a wide range of dishes. Additionally, Paddy is a good source of carbohydrates and other nutrients, including protein, fibre, and various vitamins and minerals. As a result, it is an important source of energy and nutrition for many people in Asia. Paddy has been a staple food in Asia for thousands of years, and it has become deeply ingrained in the region's culture and cuisine. Many traditional dishes in Asia are based around Paddy, and it is often served in large quantities at meals. Paddy grows best in warm and humid conditions, which are prevalent in many parts of Asia. The topography of the region, including many river deltas, also provides ideal growing conditions for paddy. Paddy is an affordable and accessible crop in Asia, making it a popular choice for farmers and consumers alike. It is also easy to store and transport, which makes it a reliable source of food throughout the year. (Chaturvedi *et al*., 2023) [4].

Paddy is one of the most significant Indian agricultural products for export. Rice exports from India have increased as a result of the consistent rise in production, the availability of buffer stock, and the rising demand for basmati rice on the global market (Adhikari *et al*., 2016) [1]. India is also a major exporter of rice exporting around 14.37 million tons of rice (2020- 21), according to the Agricultural and Processed Food Products Export Development Authority (APEDA). Millions of small farmers and people

in poverty choose rice not just as a source of livelihood but also for household food security (Nain *et al.*, 2019) [6]. According to the third advance estimate for the year 2024-25 by the Ministry of Agriculture of India, the production of rice was 1490.74 lakh ton. (Anonymous, 2024-2025) India is 2nd largest producer of rice after China. In India Uttar pradash has highest production 202.243 lakh ton followed by Punjab and West Bangal with 143.61 and 115.72 lakh ton. Chhattisgarh was 6th largest rice producer in India with 97.03 lakh tons. Chhattisgarh, often called "rice bowl of central India" plays a significant role in the country's rice production. The state accounts for 7.07% of India's total rice production.

The growth rate in agriculture refers to the percentage change in a key variable such as crop production, yield or cultivated area over a specific period of time. It helps in understanding how fast or slow agricultural performance is improving or declining. In agricultural research, growth rate indicates the percentage change in production, yield or area over time. It is widely used to analyze trends, make projections and evaluate the impact of government interventions" (Chandran & Prajneshu 2005) [3]. A simple growth rate shows how much a crop's production increased or decreased from one year to the next. The Compound Annual Growth Rate (CAGR) gives the average yearly growth over several years, removing the effect of short-term fluctuations. In 2 plant growth studies, Relative Growth Rate (RGR) is used to measure how fast a plant grows in relation to its size. In this thesis our paper of concern is to know the average yearly growth of several years so we calculated compound growth rate mainly. Calculating growth rate helps in performance evaluation, forecasting, policy assessment, and comparing performance across regions or crops. It also facilitates understanding of long-run growth through measures like doubling time which translates exponential growth rates into a comprehensible time frame

Materials and methods

Chhattisgarh situated in Eastern India, is located between 21º 27 ‟ N latitudes and E and 81º 86‟ E longitudes. It is surrounded in the west by Madhya pradesh and Maharastra, in the north by Jharkhand and uttar pradesh, in east by Orissa and in the south by Andhra pradesh and Telangana.

There are 33 districts (Raipur, Mahasamund, Rajnandgaon, Durg, Dhamtari, Kawardha, Bilaspur Janjgir Champa, Korba, Jashpur, Raigarh, Surguja, Koria, Kanker, Dantewada, Narayanpur, Bijapur, Blrampur, Surajpur, Balodabajar, Bemetara, Balod, Gariyaband, Kondagaon, Sukhama, Mugeli, Bastar, Mohla-Manpur-Ambagarg chowki, Sakti, Khairagarh-Chhuikhadab-Gandai, Manendragarh- Chirmiri Bharatpur, Gaurela- Pendra-marwahi). As per data availability we carried out study only on 27 districts.

Fig 1: Location Map of Chattisgarh State

District wise crop (Paddy) data (area, production and productivity) for years 2000-2023 downloaded from website of Directorate of economics and Statistic, Department of Agricultural and Farmers Welfare, Ministry of Agriculture and Farmer Welfare, Govt. of India. Some districts came in existence in 2011-12 after bifurcation from parent districts and therefore the paddy statistics of these districts (Balod, Balodabazar, Balrampur, Bemetara, Gariyaband, Kondagaon, Mungeli, Sukma and Surguja) is available since 2011-12.

Table 1: Crop production statistics for different crops in different districts of Chhattisgarh

S.No.	Crops	Districts	Year
1.	Rice	Bastar, Bilaspur, Dhamtari, Durg, jajgir, jaspur,Kabirdham, Kabirdham, Kanker, Korba, Korea, Mahasamund, Raigarh, Raipur, Rajnandgaon, Surguja	2000-01 to 2022-23
		Balod, Balrampur, Bemetara, Balodabazar,Gariyaband,Kondagaon, Mungeli, Surajpur.	2011-12 to 2022-23

Linear Regression

Regression analysis is mathematical measure of the average relationship between two or more variables in term of original data. In regression analysis independent variable is also known as regression or predictor or explanatory variable. The linear regression is -

$$Y = a + bx$$

Where,

Y = area, production or productivity, rainfall and temperature trend b = Slope
a = Intercept
x = year (time)

The following functions were used to estimate the growth rate of area, production and yield of rice crop of different districts of Chhattisgarh.

Compound Growth Rate (CGR): The compound growth rate was calculated by fitting exponential function to the index, number of areas, production and productivity.

$$CGR (\%) = (Antilog\ b - 1) * 100$$

Where,

b = Regression co-efficient (productivity)

Simple Growth Rate (SGR): The simple growth rate refers to the percent change of a particular variable over a certain period of time in a particular situation.

$$LGR = b/ Y \times 100$$

Where,

Y = area/production/productivity of crops.

Result and Discussion

The growth rate of area, production and productivity for paddy crop was computed using simple and compound growth rates for 27 districts (old and new districts) of Chhattisgarh during two period (2000-2010 to 2011-2023) before and after bifurcation of districts were presented in the table 2. As the 11 new districts were formed from 16 old districts so, we have calculated CGR and SGR of two period (2000-2010 to 2011-2023) before and after bifurcation of districts. The result before bifurcation out of 16 districts 8 districts were found significant, in which 2 districts (Bastar and Dantewada) were found significantly decreasing growth rate at 1% level of significance.Remaining 6 districts were found significantly increasing growth rate at 1% level. After bifurcation total 27 districts existed in the state during year 2011-12. Out of 27 districts 17 were found significant, in those 5 districts (Bastar, Bilaspur, Janjgir-Champa, Koriya, Raigarh) were significantly decreasing growth rate at 1% level of significance and other 12 districts were significantly increasing growth rate at same level. Rest districts were non-significant either increasing or decreasing growth rate.

Compare between these two period after and before bifurcation of districts, the result was found that 4 districts (Bilaspur, Janjgir-Champa, Raigarh and Koriya) were found significantly decreasing growth rate after bifurcation, before it was non-significant growth rate for area of paddy. 2 districts (Durg and Kabirdham) were found significantly increasing growth rate. Whereas, 3 (Bastar, kanker and Mahasamund) were found significantly decreasing growth rate at 1% level before and after bifurcation only change found in the value. Out of 11 newly formed districts 8 were found significantly increasing growth rate of rice at 1% level of significance, other remaining districts were Narayanpur, Balodabazar and Bijapur were non-significant. The SGR for area of rice crop for 27 districts shows non-significant growth rate either increasing or decreasing. The CGR of rice production for 27 districts observed that out of
16 districts (before bifurcation) except 2 Bilaspur and Koriya, all other districts were significant. In these only Dantewada was found significantly decreasing growth rate, rest districts were significantly increasing growth rate at 1% level of significance. All newly formed
11 districts were found significant, only one district Narayanpur was found significantly decreasing growth rate and other district showed significantly increasing growth rate at 1% level. Compare between before and after bifurcation of districts. The result depicted that only Bilaspur district was showed significant after bifurcation it was found increasing growth rate because of use of modern technologies and high yielding varieties seeds.

Whereas, Koriya district was found significantly decreasing growth rate after bifurcation at 1% level. 2 districts (Bastar and Korba) were found significantly increasing growth rate, whereas 11 (Dhamtari, Durg, Janjgir-champa, Jashpur, Kabirdham, Kanker, Mahasamund, Raigarh, Raipur, Rajnandgaon and Surjuga) were found significantly decreasing growth rate before and after bifurcation at 1% level. All newly formed districts were found significantly increasing growth rate at 1%, except Narayanpur which was found non significantly decreasing. The SGR for production of rice crop in 27 districts shows non-significant growth rate, increasing or stable pattern. The CGR of rice productivity observed that all 16 districts were showing significantly increasing growth rate except Koriya which showed

significantly decreasing growth rate at 1% level of significance. All newly formed districts were found significantly increasing growth rate at 1% level. Except Narayanpur which was found non significantly decreasing. Compare between before and after bifurcation of districts.

Table 2: Growth rate of area, production and productivity of rice in different districts of Chhattisgarh

Districts	Years	Area (ha)		Production (Mt)		Productivity (Kg/ha)	
		CGR (%)	SGR (%)	CGR (%)	SGR (%)	CGR (%)	SGR (%)
Balod	2011-2023	1.14**	0.00	6.66**	0.00	5.45**	1.10**
Baloda bazar	2011-2023	0.00	0.00	5.96**	0.00	5.94**	1.41**
Bijapur	2011-2023	-0.01	0.00	4.78**	0.00	3.20**	0.78
Balrampur	2011-2023	1.53**	0.00	3.42**	0.26	4.54**	0.27
Bastar	2000-2010	-1.06**	-0.01	2.54**	0.19	3.28**	0.20
Bastar	2011-2023	-0.71**	-0.01	8.18**	0.00	4.70**	1.07**
Bemetara	2011-2023	3.33**	0.00	5.49**	0.00	2.50**	0.67**
Bilaspur	2000-2010	0.14	0.01	0.05	0.25	5.34**	0.24
Bilaspur	2011-2023	-2.14**	-0.02	1.96**	0.12	4.19**	0.14
Dantewada	2000-2010	-5.94**	-0.03	-2.19**	0.23	3.99**	0.30
Dantewada	2011-2023	0.54	0.01	0.41	0.20	-0.12	0.19
Dhamtari	2000-2010	1.53**	0.02	8.42**	0.14	6.78**	0.11
Dhamtari	2011-2023	0.31	0.02	-7.73**	0.05	2.17**	0.08
Durg	2000-2010	0.70**	0.01	5.97**	0.40	5.24**	0.38
Durg	2011-2023	0.99**	0.01	-4.75**	0.07	3.09**	0.12
Gariaband	2011-2023	0.87**	0.00	6.77**	0.00	5.84**	1.42**
Janjgir champa	2000-2010	0.45	0.00	10.70**	0.20	10.21**	0.20
Janjgir champa	2011-2023	-1.90**	-0.04	-2.41**	0.00	-0.52	0.04
Jashpur	2000-2010	0.06	0.00	4.46**	0.15	4.40**	0.15
Jashpur	2011-2023	-0.01	0.00	-1.30**	0.04	1.11**	0.05
Kabirdham	2000-2010	0.52**	0.01	5.35**	0.21	4.80**	0.20
Kabirdham	2011-2023	3.72**	0.03	4.01**	0.08	0.29	0.05
Kanker	2000-2010	0.76**	0.01	6.81**	0.34	6.00**	0.32
Kanker	2011-2023	0.70**	0.01	1.11**	0.19	0.40	0.18
Kondagaon	2011-2023	1.31**	0.00	2.12**	0.00	0.79**	0.22
Korba	2000-2010	-0.02	0.00	2.78**	0.17	2.80**	0.17
Korba	2011-2023	0.38	0.00	3.12**	0.14	2.71**	0.13
Koriya	2000-2010	0.00	0.00	0.64	0.24	0.64*	0.23
Koriya	2011-2023	-1.50**	-0.03	-1.10**	0.09	0.41	0.10
Mahasamund	2000-2010	1.07**	0.01	9.51**	0.40	8.35**	0.37
Mahasamund	2011-2023	0.90**	0.01	1.36**	0.07	0.47	0.06
Mungeli	2011-2023	1.96**	0.00	2.96**	0.00	0.99**	0.20
Narayanpur	2011-2023	-0.60	0.00	-1.11**	0.00	-0.34	-0.11
Raigarh	2000-2010	-0.03	0.00	6.32**	0.22	6.35**	0.22
Raigarh	2011-2023	-1.32**	-0.03	3.31**	0.08	4.69**	0.12
Raipur	2000-2010	0.47	0.01	9.09**	0.26	8.58**	0.25
Raipur	2011-2023	0.44	0.00	6.96**	0.17	7.43**	0.16
Rajnandgaon	2000-2010	0.91**	0.01	2.17**	0.16	1.24**	0.14
Rajnandgaon	2011-2023	0.18	-0.02	1.94**	0.11	1.75**	0.11
Sukma	2011-2023	2.14**	0.00	3.43**	0.00	1.27**	0.30
Surajpur	2011-2023	0.79**	0.00	3.21**	0.00	2.41**	0.64*
Surguja	2000-2010	-0.17	0.00	1.47**	0.15	1.64**	0.15
Surguja	2011-2023	-0.25	0.00	1.02**	0.06	1.27**	0.06

** Indicate significant at 1%, * indicate significant at 5% probability level.

The result depicted that Bastar and Rajnandgaon were found significantly increasing growth rate while 8 districts (Bilaspur, Dhamtari, Durg, Jashpur, Korba, Raigarh, Raipur and Surguja) were found significantly decreasing growth rate at 1% level. The SGR for paddy productivity was showed that out of 27 districts, 4 were significant, in these 3 districts Bastar, Bemetara and Gariyaband were found significantly increasing at 1% level, only Surajpur was found significantly increasing at 5% level of significance. Rest other districts were showed non-significant growth rate either increasing or decreasing pattern. (Similar work done by Kaushal *et. al*, 2023) [5].

Conclusion

The growth trends of paddy crop in Chhattisgarh over the past 23 years (2000–2023) show mixed patterns before and after district bifurcation. The growth was measured using Compound Growth Rate (CGR) and Simple Growth Rate (SGR) for area, production, and productivity. Before bifurcation, paddy showed mostly positive growth in production and productivity, although a few districts like Dantewada and Bastar showed a significant decline in area. After bifurcation, more districts showed significant trends, both positive and negative. While 17 out of 27 districts were significant, districts like Bilaspur and Janjgir-Champa

showed a decline in area growth, due to shifting crop patterns and farmer preferences. However, productivity remained mostly positive, because of better farming methods and government support for paddy. Farmers preferred paddy due to high market demand, support policies, and modern technologies, even in areas with less area growth.

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