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Technology and environment indices for rice, wheat and maize in different districts of Chhattisgarh

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Abstract
Studies on Technology and environment indices for rice, wheat and maize in different districts of Chhattisgarh, were carried out in the Department of Agricultural Meteorology, I.G.K.V. Raipur to capture the agricultural and climatic features which in turn help for sustainable agriculture development in Chhattisgarh. The technology indices are an indication of the impact of technology on the productivity while environment indices show the impact of environment on the production of crops. Technology index for rice in Chhattisgarh state < 4 as low, 4 - 6 as medium, 6 - 8 as high and > 8 is very high. Similarly environment index < 10, as low 10 - 20 as medium, 20 - 30 as high and > 30 is very high, Technology index for wheat crop in Chhattisgarh state -3 - -1 as low, -1 - 1 as medium, 1 - 3 as high and > 3 is very high. Similarly environment index < 5 as low 10 - 15 as medium, 15 - 20 as high and > 20 is very high. Technology index for Maize crop in Chhattisgarh state <2 as low, 2 - 4 as medium, 4 - 6 as high and > 6 is very high. Similarly environment index < 10 as low 15 - 20 as medium, 20 - 25 as high and > 25 is very high. A sustainable ladder was develop using coefficient of variation values of rice crop productivity for the period 2000 – 2010 and corresponding mean yield. According to this ladder find relation between stability and productivity of rice.

Keywords: Environmental, agro-climatic zones, technology and sustainable

Introduction
The Chhattisgarh came into existence on 1st November 2000 as a result of bifurcation of Madhya Pradesh state. Chhattisgarh is located in the central part of India between the latitudes of 17° 46'N - 24° 5' N and the longitudes of 80° 15' E - 84° 20' E. Its proximate position with the Tropic of Cancer has a major influence on its climate. It is landlocked by the states of Maharashtra and Madhya Pradesh on the west, Uttar Pradesh on the north, Jharkhand on the north-east, Orissa on the east, and Andhra Pradesh on the south Sprawled in an area of 135,194 sq km.

The climate of the state is dry sub humid type. The average rainfall of the state is around 1400 mm of which more than 90% is received during the south west monsoon (June-September). The onset of monsoon is around 10 June in southernmost tip of Bastar district and extends over the entire area by 25 June. The monsoon starts withdrawing from mid-September and by 25th September it withdraws from the entire state. Chhattisgarh is divided into three distinct Agro – climatic zones viz, Chhattisgarh plains, Bastar plateau and Northern hills and it covers 50.52%, 28.62% and 20.86% geographic area, respectively. Similarly, topographically also the state varies a lot from high elevated areas of the state makes it to differ in their climatic elements also. There is a wide variability in climatic factors also on an average a total of 1200 – 1600 mm. annual rainfall is recorded in different parts of Chhattisgarh in about 64-91 rainy days. (About 90% of rainfall in C.G. concentrated to four monsoon months i.e. June – September.) It has been recorded that 1000-1200mm, 1200-1400mm and 1400-1600mm. annual rainfall are received in Chhattisgarh plains, Bastar plateau and northern hills respectively. Similarly variations can be seen in temperature and humidity.

In view of these studies on environmental characterization for sustainable crop production in Chhattisgarh is carried out mainly to capture the important agricultural features of the districts and to analyze the long term rainfall records in order to understand the pattern of rainfall and its spatial and temporal variability. In this study, attempts are also made to examine the climate fluctuations and shifts in different districts to understand the pattern on climate variability that May influence the existing cropping pattern in the districts. Based on the historical data of crop productivity of major important crops like Rice, Wheat and Maize. The relationship between rainfall quantum and productivity were also worked out.

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Materials and Methods

The materials collected, description of the study areas, sources and methodologies adopted for research work of "Technology and environment indices for rice, wheat and maize in different districts of Chhattisgarh" are briefly presented in this chapter under the following heads.

Methodology

The basic work regarding the agro-climatic characterization of Chhattisgarh includes the screening of different agro-climatic parameters data base of the state was prepared.

Database Used

Various data sets of Chhattisgarh state were used during the study course. The basic data which were collected and using during the work, were: precipitation, wind speed, relative humidity, radiation intensity, temperature, sunshine hour, length of growing period, digital elevation map and crop data.

Technology and Environment indices

When a long term series of crop yields analyzed, the first step is to establish whether a technology trend exists or not when crop yields overall show a continual increase with years this increase is generally a result of superior technology. A high year to year variability indicates environmental flucations. The technology trend is calculated by a simple linear regression analysis of yield vs year.

The technology index is calculated using equation

$$\text{Technology index} = \frac{\text{Regression slope(b)}}{\text{Mean yield}} \times 100$$

The environmental index is calculated using equation

$$\text{Environment index} = \frac{\text{Standard error estimate(SEM)}}{\text{Mean yield}} \times 100$$

Sustainability of crop production:-

Sustainability of various crops yield data were collected from 2000-2010 of different districts of Chhattisgarh. From yield data we calculated yield mean, standard deviation (SD) and coefficient of variation (CV) through the below Equation:-

$$\text{Mean} = \frac{\sum x}{n}$$

$$\text{Standard division} = \sqrt{\frac{\sum(x - \bar{x})}{n}}$$

Where,
X = Yield data
x̄ = Mean of yield data
n = No. of years

Result and Discussion
Assessment of production status as some important crops.
For assessing the production status of important crops in different districts of Chhattisgarh the technology and environment indices have been worked out.
The technology index is an indication of the impact of technology on the productivity while environment index shows the impact of environment on the production of crops.

Table 1: The technology and environment indices are computed using productivity data for the period 2000-2010 and based on the indices the impact of technology on rice productivity is classified as follows

Technology index (%)	Productivity status
< 4	Low
4 – 6	Medium
6 – 8	High
>8	Very high

Table 2: Similarly based on the environmental index, the effect of environment on the productivity variability is classified as follows

Environment index (%)	Effect of environment
< 10	Low
10 – 20	Medium
20 – 30	High
>30	Very high

Using these indices and their classification the production status of rice in different districts is classified as shown in table, It can be seen from the table that at Jagadalpur, Koriya, Korba, Rajnandgaon and Surguja districts the technology impact is low and the environment impact is high, In Jashpur district the technology impact is medium and environment impact is also medium and in Bilaspur, Kanker, Kawardha and Raigarh districts the technology impact is medium but the environment impact is high. In Dantewada and Durg districts the technology impact is medium but the environment impact is very high. Hence it is necessary to stability the productivity of rice by minimizing the impact of environment, In Dhamtari district the technology impact is high and the environment impact is medium, In Mahasamund and Raipur districts the technology impact is high but the environment impact is also high, In Janjgir district the technology impact is very high and environment impact is medium hence it is necessary to assess the rice productivity status in each district and work out strategies for increasing either productivity or stability in the environmental impact, The status of technology indices and environment indices in Chhattisgarh state.

Table 3: Technology and environment indices for rice in different districts of Chhattisgarh

Technology Index (%)	Environment Index (%)			
	low(<10)	Medium (10-20)	High (20-30)	Very High(>30)
Low(<4)			Jagdalpur	
			Koriya	
			Korba	
			Rajnandgaon	
			Surguja	
Medium(4-6)		Jashpur	Bilaspur	Dantewada
			Kanker	DURG
			Kawardha	
			Raigarh	
High (6-8)		Dhamtari	mahasamund	
			Raipur	
Very High (>8)		Janjgir		

Table 4: For wheat the impact of technology and environment are assessed as per the following criteria

Technology index (%)	Productivity status
-3 - -1	Low
-1 - 1	Medium
1-3	High
>3	Very high

Table 5: Similarly based on the environmental index, the effect of environment on the productivity variability is classified as follows

Environment index (%)	Effect of environment
< 5	Low
10 - 1 5	Medium
15-20	High
>20	Very high

It can be seen that the technology impact on wheat the productivity is negative in Raipur and Mahasamund districts but the environment impact is medium at Raipur and very high in Mahasamund district. In Raigarh and Surguja districts the technology impact is at medium level and the environment impact is also medium. But in Janjgir, Kanker, Korba and Koriya districts the technology impact is medium but the environment impact is high. In Dantewada district the technology impact is medium and environment impact is very high. This indicates that at Dantewada the wheat productivity vary significantly from year to year. In Bilaspur district the technology impact of wheat crop is high and the environment impact is low. This shows that the productivity of wheat in Bilaspur is very stable. In Jaspur district the technology impact is high but environment impact is medium. In Durg district the technology impact is very high and environment impact is low. This indicates that the productivity of wheat crop in Durg is very high and stable, In Dhamtari, Jagdalpur and Rajnandgaon the technology impact is very high and environment impact is medium, In Kawardha district the technology impact is very high but the environment impact is high. The status of technology and environment impact is shown in the table 2: This indicates that in districts with low and medium technology impact there is a need to change from wheat to other crops in *rabi* season.

Table 6: Technology and environment indices for wheat in different districts of Chhattisgarh

Technology Index (%)	Environment Index (%)			
	Low (<5)	Medium (10-15)	High (15-20)	Very High (>20)
Low (-3- -1)		Raipur		Mahasamund
Medium (-1- 1)		Raigarh	Janjgir	Dantewada
		Surguja	Kanker	
			Korba	
			Koriya	
High (1-3)	Bilaspur	Jashpur		
Very High (>3)	Durg	Dhamtari	Kawardha	
		Jagdalpur		
		Rajnandgaon		

Table 7: For maize the impact of technology is assessed as per the following criterion

Technology index (%)	Productivity status
< 2	Low
2 – 4	Medium
4 – 6	High
>6	very high

Table 8: Similarly based on the environment index, the effect of environment on the productivity is classified as follows

Environment index (%)	Effect of environment
< 15	Low
15 – 20	Medium
20 – 25	High
>25	Very high

The status of technology index and environment index are using these indices and their classification the production status of maize in different districts is classified as shown in table, It can be seen from the table that in Bilaspur district the technology impact for maize is high and the environment impact is low. In Koriya district the technology impact is low and environment impact is medium. But in Dantewada, Dhamatari and Rajnandgaon districts the technology impact is low and the environment impact is high. It can be seen that the technology index is negative in Mahasamund district but the environment impact is very high. Hence it would be better to identify another suitable crop in these districts. In Durg, Jagadalpur, Janjgir, Jashpur, Korba, Raigarh and Raipur districts the technology impact is medium and environment impact is also medium. In Kawardha and Surguja districts the technology impact is medium and environment impact is high. In Bilaspur district the technology impact is very high and environment impact is low. In Kanker district the technology impact is very high and environment impact is medium.

Table 9: Technology and environment indices for maize in different districts of Chhattisgarh

Technology Index (%)	Environment Index (%)			
	low (<10)	Medium (15-20)	High (20-25)	Very High (>25)
Low (<2)		Koriya	Dantewada	Mahasamund
			Dhamtari	
			Rajnandgaon	
Medium (2-4)		Durg	Kawardha	
		Jagdalpur	Surguja	
		Janjgir		
		Jashpur		
		Korba		
		Raigarh		
		Raipur		
High (4-6)	Bilaspur			
Very High (>6)		Kanker		

Sustainability of rice crop production

It is hypothesized that sustainability is not a destination but it is a continuous journey. With this hypothesis a sustainable ladder was developed using coefficient of variation values of rice crop productivity for the period 2000 – 2010 and corresponding mean yield. The districts that coming above or below the sustainable ladder are identify and plotted as per the coefficient of variation and mean yield data. It is seen from the figure that Durg district is stable in rice production but the productivity level is medium. It is, therefore necessary to increase productivity level in Durg and then increase yield. Regarding Mahasamund and Dantewada districts the productivity is medium and stability is high. On the such conditions it is necessary to increase the production level of rice in the two districts and the stabilize the yield. Regarding Janjgir district the productivity level is very high and stability is high and it is necessary to increase the productivity level in Janjgir. In Kanker district too, production is high and stability is also high hence it is necessary to increase the productivity level in kanker district.

In Raipur, Jagdalpur and Bilaspur districts the production is medium and stability is also medium hence it is necessary to increase productivity level in these three districts. Regarding other districts like Rajnandgaon, Raigarh, Jashpur, Kawardha, Korba, Koriya etc. the production is low and stability is also low and it is necessary to increase productivity in these districts and simultaneously to establish the yield.
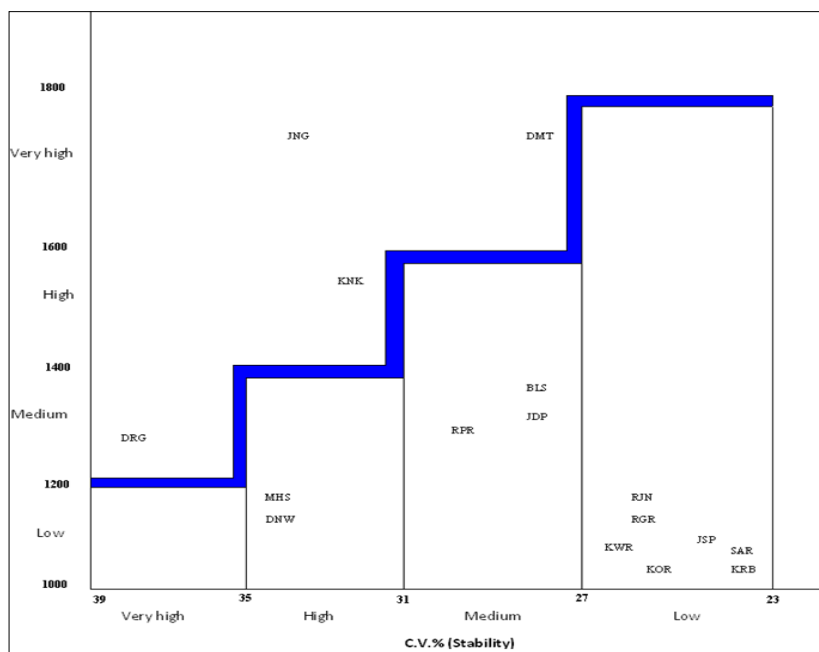

Fig 1: Sustainability of rice production in different districts of Chhattisgarh

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