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Dynamics of area, production and productivity of major food crops in Chhattisgarh: A temporal study

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Abstract

The study was conducted to examine the growth pattern, area, production, and productivity of major crops in Chhattisgarh, namely rice, wheat, maize, and sugarcane, during 2013–2023. Compound annual growth rate (CAGR), trend analysis, coefficient of variation (CV), and decomposition analysis were used to assess growth performance, variability, and the contribution of area and yield to production change. The results revealed distinct growth patterns among crops. Rice and sugarcane production growth was mainly yield-driven, while wheat production growth was primarily influenced by expansion in cultivated area. Decomposition analysis showed that yield effect contributed 92.72 per cent to rice production growth, whereas area effect contributed 81.29 per cent in wheat. Maize exhibited balanced contributions from area, yield, and interaction effects. The study highlights the need for crop-specific strategies focusing on productivity enhancement, efficient resource management, and climate-resilient agricultural practices to ensure sustainable agricultural growth in Chhattisgarh.

Keywords: Chhattisgarh, crop productivity, CAGR, decomposition analysis, rice, wheat, maize, sugarcane, agricultural growth, yield variability

Introduction

Agriculture is one of the most important sectors of the Indian economy, contributing significantly to food security, employment generation, and rural development. In India, agriculture contributes nearly 16–18 per cent to the Gross Domestic Product (GDP) and provides livelihood to around half of the population. The agricultural sector recorded a growth of 3.5 per cent during 2022–23, highlighting its continued importance in the national economy (FAO, 2023; Gogoi *et al.*, 2022) [3, 4].

Over the past few decades, global crop yields have shown an overall increasing trend; however, considerable spatial and temporal variations persist across regions and time periods. (Eck *et al.*, 2020, Ray *et al.*, 2012, Surendran *et al.*, 2021) [2, 9, 12].

In terms of both area and population, the State of Chhattisgarh is ranked ninth and seventeenth in India. Chhattisgarh is predominantly an agrarian state where nearly 80 per cent of the population depends on agriculture for livelihood. The state is popularly known as the “Rice Bowl of Central India” due to the dominance of paddy cultivation. Besides rice, maize, wheat, and sugarcane are also important crops contributing to the agricultural economy of the state.

During the last decade, considerable changes have been observed in the area, production, and productivity of major crops in Chhattisgarh. Rice is the principal food crop occupying the largest cultivated area in the state. The production of paddy in India increased from 84.98 million tonnes in 2000–01 to 118.87 million tonnes in 2019–20, while in Chhattisgarh it increased from 2.37 million tonnes to 8.57 million tonnes during the same period, showing an increase of more than 261 per cent in the state. Districts such as Raipur, Balod, Bijapur, and Janjgir-Champa recorded comparatively higher productivity, whereas Jashpur and Kabirdham showed lower productivity levels. These regional disparities indicate differences in irrigation facilities, technological adoption, and resource utilisation across districts (Chaudhary *et al.*, 2022) [1].

After paddy, maize is the second most important crop in Chhattisgarh in terms of both production and area. Due to its high potential for genetic production, the crop is frequently

grown during the kharif season and is referred to as the "Queen of Cereals." From just 1.73 million tons in 1950–51 to 24.17 million tons in 2014–15, India's maize production more than quadrupled. With a typical yield of 2.56 tons per hectare, it currently occupies 9.23 million hectares (Sinha *et al.*, 2019) ^[11]. While districts like Durg, Rajnandgaon, Mahasamund, and Raipur shown lower productivity levels, districts like Balrampur, Bastar, Bijapur, Dantewada, Kondagaon, and Sukma were found to be effective maize-growing zones with relatively better productivity. Variations in climate, soil fertility, irrigation availability, and input usage efficiency are all reflected in these inter-district discrepancies. (Chaudhary *et al.*, 2022) ^[1].

Wheat is another important rabi crop cultivated in the plains of Chhattisgarh. The development of irrigation systems and the adoption of improved varieties have led to a steady growth in wheat production and area throughout time. India's wheat production increased by more than 54% from 69.68 million hectares in 2000–01 to 107.86 million hectares in 2019–20. India's and Chhattisgarh State's wheat yields increased by more than 27% and 14%, respectively, in 2019–20 compared to 2000–01. Durg had the maximum production under wheat among other districts during the 20-year study period (Wasnik *et al.*, 2022) ^[13]. The overall growth in wheat productivity in Chhattisgarh indicates a gradual improvement in crop management practices and agricultural modernisation.

A significant commercial crop that supports Chhattisgarh's agro-based economy is sugarcane. With over 4.94 million hectares under cultivation and an average output of 68.6 tonnes per hectare, India is the second-largest producer of sugarcane in the world after Brazil. In Chhattisgarh, sugarcane cultivation has shown considerable growth during the past decade due to the establishment of sugar factories and improved cultivation practices. With 20.93 thousand hectares of land, 1046 million tons of production, and a productivity of 78.42 tonnes per hectare, Kawardha district had the most acreage, production, and productivity. Surajpur district came in second with 71.13 tonnes per hectare. Over time, sugarcane productivity in the Durg district likewise saw a discernible improvement. However, due to variations in irrigation, climate, and resource use, regional disparities in productivity continue to exist. (Jaiswal *et al.*, 2017; Sahu, 2016) ^[6, 10].

Overall, the trends in area, production, and productivity of rice, maize, wheat, and sugarcane during the past decade indicate substantial growth in agricultural development in Chhattisgarh. However, considerable inter-district variations and productivity instability still exist due to differences in resource availability, technological adoption, and agro-climatic conditions. Therefore, a comprehensive analysis of crop trends is essential for improving agricultural planning, enhancing productivity, and ensuring sustainable agricultural development in the state.

Materials and Methods

Compound annual growth rates: The compound annual growth rate (CAGR) was computed to examine the growth pattern in area, production, and productivity. Regressing time variable on A/P/Y, the procedure to estimate compound growth rates. $Y =$

a.bt Where, $Y = \text{Area/Production/Yield of crops}$, $t = \text{Time (independent variable)}$, $b = \text{Regression coefficient}$ and $a = \text{Intercept}$. The above equation can be written as, $\log Y = \log a + t \log b$. The average annual compound growth rates 'r' will be computed by using the following formula: $\text{CAGR (r)} = [\text{Antilog}(\log b) - 1] \times 100$.

Decomposition Analysis: To measure the effect of area, yield and their interaction towards increasing production of the crop concern, the method state that if A_0 , P_0 and Y_0 , respectively area, production and productivity in base year and A_n , P_n and Y_n are values of the respective variable in nth year item. (Jagannath *et al.* 2013) ^[5].

$$\text{Area effect (\%)} = \frac{Y_0 \cdot \Delta A}{\Delta P} \times 100$$

$$\text{Yield effect (\%)} = \frac{A_0 \cdot \Delta Y}{\Delta P} \times 100$$

$$\text{Interaction effect (\%)} = \frac{\Delta A \cdot \Delta Y}{\Delta P} \times 100$$

The change in production was decomposed into area, yield, and interaction effects using the identity:

$$\Delta P = Y_0 \Delta A + A_0 \Delta Y + \Delta A \Delta Y.$$

The relative contribution of each component was estimated as a percentage of total production change."

Coefficient of Variation (CV) is expressed as:

$$\text{CV} = \frac{\sigma}{\bar{X}} \times 100$$

Results and Discussion

To comprehensively evaluate crop performance, indexed trend analysis was first carried out to examine the relative changes in area, production, and yield over time, enabling a normalized comparison of growth patterns across years. The temporal dynamics are depicted through indexed trend plots (Figures 1–4), which provide a clear visualization of changes across the study period.

Subsequently, the compound annual growth rate (CAGR) was used to quantify long-term changes in area, production, and productivity. The trend coefficient derived from linear regression, along with its associated t-statistic and p-value, provided insights into the direction and statistical significance of temporal trends.

Further, decomposition analysis was employed to partition changes in production into area, yield, and interaction effects, thereby identifying the dominant sources of growth. The coefficient of variation (CV) was used to assess inter-annual variability and stability. Together, these measures provide a comprehensive understanding of growth dynamics, underlying drivers, and system consistency.

Rice

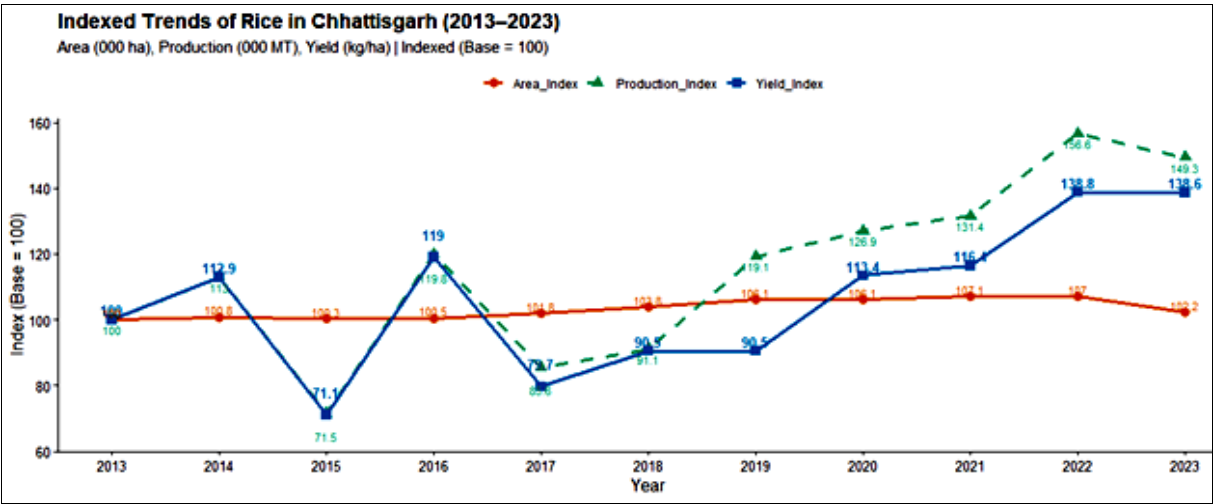


Fig 1: Indexed trends of area (000 ha), production (000 MT), and yield (kg ha⁻¹) of rice in Chhattisgarh (2013–2023) with base year 2013 = 100.

The indexed trend analysis (Fig. 1) indicated that the area under rice cultivation in Chhattisgarh remained largely stable during 2013–2023, suggesting limited scope for horizontal expansion. In contrast, yield exhibited a consistent upward trend, particularly after 2016, reflecting improvements in crop productivity. This improvement may be attributed to increased adoption of high-yielding varieties, better nutrient management, and expansion of irrigation facilities. Production closely followed the trajectory of yield, indicating that output growth was primarily driven by productivity gains rather than area expansion. The inter-annual fluctuations observed in certain years may be linked to variability in monsoon rainfall and water availability, which are critical determinants of rice productivity in the region.

Table 1: Trend, growth, variability, and decomposition analysis of area, production, and yield of rice in Chhattisgarh

Parameter	Trend Coefficient	t-value	p-value	CAGR (%)	CV (%)	Contribution to Production Change (%)
Area	24.66	3.48	0.007	0.22	2.75	5.26
Production	396.05	3.34	0.009	4.09	22.88	—
Yield	73.04	2.17	0.058	3.32	20.87	92.72
Interaction Effect	—	—	—	—	—	2.03

The results of trend, growth, variability, and decomposition analyses for rice are presented in Table 1. The estimates indicate that the area under rice remained largely stagnant over the study period, while production and yield exhibited a clear increasing tendency. The statistically significant trends observed for area and production suggest a consistent upward movement, whereas the comparatively weaker significance of yield indicates moderate stability in productivity gains. The pattern of growth further suggests that improvements in productivity played a central role in enhancing output, rather than expansion of cultivated area. This is substantiated by the decomposition results, which highlight the dominant contribution of the yield component to total production change, with only a marginal role of area and minimal interaction effect. Such a pattern reflects the influence of technological advancements and improved crop management practices in driving production growth. The variability pattern shows a high degree of stability in area, while production and yield exhibit moderate fluctuations over time. This indicates that although productivity improvements have contributed significantly to growth, they are not entirely stable and may be influenced by climatic variability and input-

related factors.

Wheat

The indexed trend analysis (Fig. 2) revealed that wheat area remained relatively stable during the initial period (2012–13 to 2017–18), followed by a marked expansion after 2020–21, indicating a recent shift toward increased cultivation. Yield, however, showed only moderate fluctuations without a consistent upward trend, suggesting limited technological progress in productivity enhancement. Production trends closely mirrored those of area, particularly in recent years, indicating that output growth was largely driven by expansion in cultivated area. These patterns may reflect increased irrigation availability and favourable market conditions encouraging area expansion. The results of trend, growth, variability, and decomposition analyses for wheat are presented in Table 2. The estimates indicate a pronounced increase in area and production over time, while yield exhibited only a marginal change. The statistically significant trends observed for area and production confirm consistent expansion, whereas the non-significant trend in yield reflects limited progress in productivity.

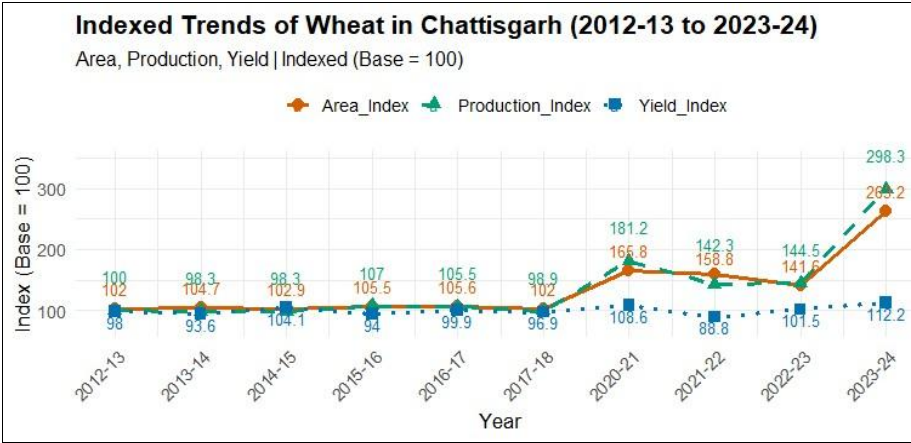


Fig 2: Indexed trends of area (000 ha), production (000 MT), and yield (kg ha⁻¹) of wheat in Chhattisgarh (2013–2023) with base year 2012-13 = 100.

Table 2: Trend, growth, variability, and decomposition analysis of area, production, and yield of wheat in Chhattisgarh

Parameter	Trend Coefficient	t-value	p-value	CAGR (%)	CV (%)	Contribution to Production Change (%)
Area	13.42	3.43	0.0089	9.12	38.65	81.29
Production	22.09	3.12	0.0143	10.45	45.87	—
Yield	12.5	1.16	0.2795	1.21	6.99	7.16
Interaction Effect	—	—	—	—	—	11.55

The growth pattern clearly indicates that expansion of cultivated area has been the primary driver of wheat production. This is further supported by decomposition analysis, which shows a dominant contribution of area to total production change, with relatively minor contributions from yield and interaction effects. Such a pattern suggests that production gains have been largely extensive rather than intensive in nature. Variability analysis reveals substantial fluctuations in area and production, whereas yield remains relatively stable over time. This indicates that while productivity levels are consistent, the overall production system is influenced by variability associated

with expansion dynamics.

Maize

The indexed trend analysis (Fig. 3) showed that maize area increased gradually, with a more pronounced expansion after 2017–18. Yield exhibited a strong upward trend during the same period, reflecting significant improvements in crop productivity, possibly due to adoption of hybrid varieties and improved crop management practices. Production followed a pattern influenced by both area and yield, indicating a combined effect of expansion and productivity gains.

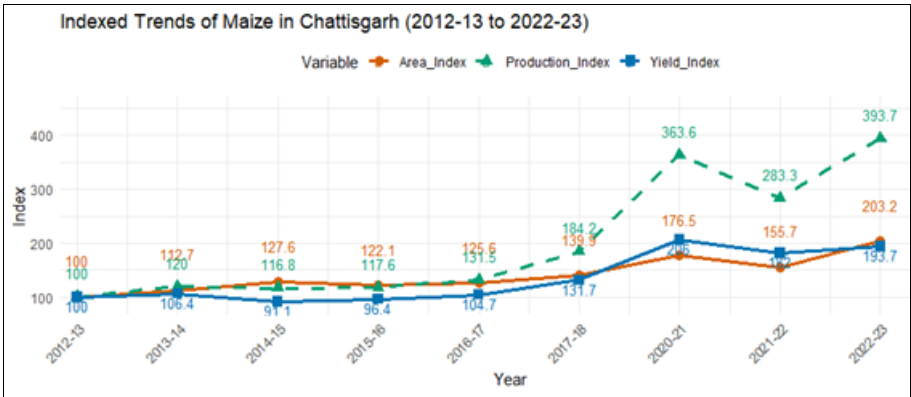


Fig 3: Indexed trends of area (000 ha), production (000 MT), and yield (kg ha⁻¹) of Maize in Chhattisgarh (2013–2023) with base year 2012-13 = 100.

The results of trend, growth, variability, and decomposition analyses for maize are presented in Table 3. The estimates indicate that area, production, and yield exhibited a clear increasing tendency over the study period, reflecting strong

growth across all components. The statistically significant trends observed for all three parameters confirm a consistent upward movement in maize cultivation and output.

Table 3: Trend, growth, variability, and decomposition analysis of area, production, and yield of maize in Chhattisgarh

Parameter	Trend Coefficient	t-value	p-value	CAGR (%)	CV (%)	Contribution to Production Change (%)
Area	5.71	2.57	0.0302	6.66	23.36	35.15
Production	37.29	7.55	0	13.27	57.29	—
Yield	169.89	5.4	0.0004	6.2	34.31	31.91
Interaction Effect	—	—	—	—	—	32.94

The pattern of growth suggests a combined influence of both area expansion and productivity improvements. This is supported by the decomposition results, which show a nearly balanced contribution of area, yield, and their interaction to production change. Such a distribution indicates that maize production growth is not driven by a single factor but rather by the simultaneous improvement of multiple components. However, the variability pattern reveals considerable fluctuations in production and yield, along with moderate variation in area. This indicates that despite strong growth performance, maize production is subject to notable instability, likely influenced by climatic variability and input sensitivity.

Sugarcane
The indexed trend analysis (Fig. 4) revealed a steady increase in sugarcane area over the study period, indicating gradual expansion in cultivation. Yield exhibited pronounced fluctuations with sharp peaks and declines, reflecting significant variability in productivity, possibly due to variations in water availability, input use, and pest incidence. Production closely followed the pattern of yield, indicating that output was largely influenced by productivity changes rather than consistent area expansion.

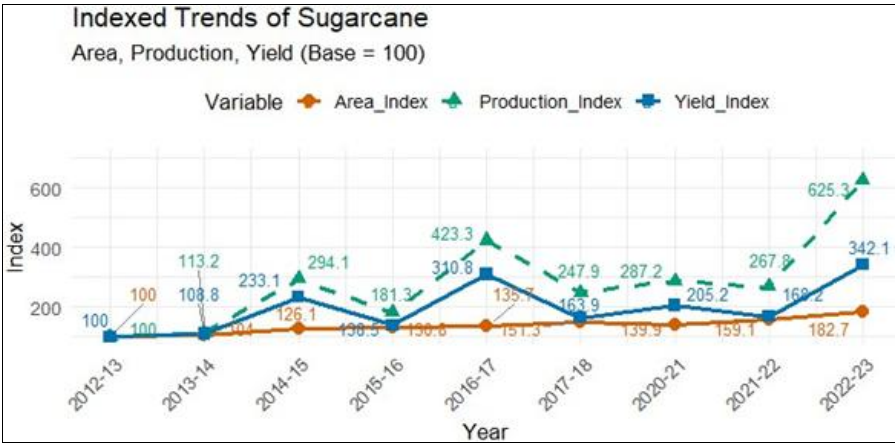


Fig 4: Indexed trends of area (000 ha), production (000 MT), and yield (kg ha⁻¹) of Maize in Chhattisgarh (2013–2023) with base year 2012-13 = 100.

The results of trend, growth, variability, and decomposition analyses for sugarcane are presented in Table 4. The estimates indicate a strong increasing tendency in production and yield, compared to a relatively moderate increase in area. The statistically significant trends observed for area and production confirm sustained growth, while yield shows comparatively moderate consistency. The growth pattern suggests that improvements in productivity have played a major role in driving sugarcane production. This is reinforced by decomposition analysis, which highlights the

dominant contribution of yield, followed by interaction effects, with a comparatively smaller role of area. This indicates that production growth has been largely influenced by productivity gains supported by combined effects. The variability pattern shows moderate stability in area but considerable fluctuations in production and yield. This suggests that although productivity improvements have contributed significantly to growth, they are not consistently stable and may be influenced by external factors such as climatic variability and management practices.

Table 4: Trend, growth, variability, and decomposition analysis of area, production, and yield of sugarcane in Chhattisgarh

Parameter	Trend Coefficient	t-value	p-value	CAGR (%)	CV (%)	Contribution to Production Change (%)
Area	2.09	8.58	0.0001	5.63	19.03	15.76
Production	11.3	2.87	0.0239	18.13	57.56	—
Yield	209.08	1.98	0.0884	11.83	43.24	46.1
Interaction Effect	—	—	—	—	—	38.14

A comparative assessment across the four crops reveals clear differences in growth dynamics and underlying drivers. Rice and sugarcane production growth was largely productivity-driven, as evidenced by the dominant contribution of yield in decomposition analysis. In contrast, wheat growth was predominantly area-driven, with expansion of cultivated land serving as the primary source of increased production. Maize exhibited a balanced growth structure, with nearly equal contributions from area, yield, and their interaction, reflecting a combined influence of expansion and productivity improvements. Despite these differences, a common feature across all crops is the presence of considerable variability in production and yield, as indicated by relatively higher CV values. This suggests that although growth has been achieved, it is not consistently stable and remains susceptible to inter-annual fluctuations.

The contrast between productivity-driven and area-driven systems highlights important implications for sustainability. While productivity improvements in crops such as rice and sugarcane indicate progress in technological and agronomic interventions, the persistence of variability suggests the need for greater stability in these gains. Conversely, the reliance on area expansion in wheat raises concerns regarding long-term feasibility under limited land resources. The balanced but variable growth observed in maize further underscores the importance of stabilizing both expansion and productivity components. Collectively, these findings emphasize that future strategies should prioritize not only enhancing production but also improving the stability and resilience of productivity, through better crop management, efficient resource use, and adaptation to climatic variability.

Conclusion

Overall, the growth performance of major crops in Chhattisgarh exhibited distinct patterns across crops. Rice production growth was predominantly yield-driven, supported by technological advancements, although it remained vulnerable to climatic variability, necessitating strategies for stabilizing productivity under changing climate conditions. In contrast, wheat production growth was largely area-driven with limited contribution from yield improvement, indicating the need to enhance productivity through improved varieties and better agronomic practices. Maize production growth reflected a balanced contribution of both area expansion and yield improvement; however, considerable variability in productivity emphasized the importance of resilient agronomic interventions. Similarly, sugarcane production growth was mainly yield-driven with a strong interaction effect, but high instability highlighted the need for efficient water management and effective pest control measures. Collectively, the findings suggest that crop-specific strategies focusing on productivity enhancement, climate resilience, and resource-use efficiency are essential for ensuring sustainable agricultural growth in Chhattisgarh.

References

1. Chaudhary JL, Thakur G, Dalai MM, Murari K, Unjan D. Evaluating the efficiency of kharif crops by productivity indices in Chhattisgarh State, India. *International Journal of Environment and Climate Change*. 2022;12(12):1843-1850.
2. Eck MA, Murray AR, Ward AR, Konrad CE. Influence of growing season temperature and precipitation anomalies on crop yield in the southeastern United States. *Agricultural and Forest Meteorology*. 2020;291:108053.
3. Food and Agriculture Organization of the United Nations. The state of food and agriculture 2023. Rome: FAO; 2023.
4. Gogoi J, Buragohain R, Deka N. What motivates rice farmers to adopt hybrid rice technology in Assam, India. *Indian Journal of Extension Education*. 2022;58(3):74-77.
5. Jagannath TPM, Nandeshwar NS, Shende NV, Mallesh, Vinodakumar SN. Decomposition analysis of agricultural growth. *Ecology, Environment and Conservation*. 2013;19(4):1-6.
6. Jaiswal U, Sonwani KD, Seth KM. An economic analysis of production of sugarcane in Surajpur district of Chhattisgarh. *Journal of Pharmacognosy and Phytochemistry*. 2017;1:202-205.
7. Li X, Kato T, Kongsurakan P, Nakagawa T, Suzuki A. Long-term crop yield dynamics, stability and sensitivities to large-scale climate oscillations across India. *Field Crops Research*. 2026;342:110462.
8. Patel PK, Chandrakar MR, Atree N. Trend in growth of area, production and productivity of selected crops in Chhattisgarh with special reference to Raigarh district. *Economic Affairs*. 2022;67(3).
9. Ray DK, Ramankutty N, Mueller ND, West PC, Foley JA. Recent patterns of crop yield growth and stagnation. *Nature Communications*. 2012;3:1293.
10. Sahu AK. An economic analysis of production, marketing and processing of sugarcane in Balod district of Chhattisgarh State.
11. Sinha SK, Sinha AK, Thakur D, Lakra A, Tripathi AK. Maize research in Chhattisgarh: status and progress. *International Journal of Current Microbiology and Applied Sciences*. 2019;8(3):2210-2230.
12. Surendran U, Raja P, Jayakumar M, Subramoniam SR. Use of efficient water saving techniques for production of rice in

India under climate change scenario: a critical review. *Journal of Cleaner Production*. 2021;309:127272.

13. Wasnik S, Pandey S, Patel P, Patel M, Choudhary V. Trends in area, production, and yield of paddy, wheat and gram in Chhattisgarh State: a critical analysis. *The Pharma Innovation Journal*. 2022;11(6):1397-1402.