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Exploring Paddy Profitability Trends: A Comparative Analysis Across Five Major Growing States of India

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Abstract

This research delves into the dynamics between the market value of the product of paddy and the associated costs of its cultivation across prominent paddy producing regions in India. Drawing upon secondary data from the period 2004–05 to 2021–22, generously provided by the Commission for Agricultural Costs and Prices (CACP), this study employs growth models and profitability analyses to shed light on emerging patterns within these key states. A detailed examination reveals Punjab as leading in terms of value growth, closely followed by Andhra Pradesh and West Bengal. In contrast, the escalation in cultivation costs is most pronounced in Andhra Pradesh, with Punjab, West Bengal, and Uttar Pradesh also showing significant figures. Through an insightful profitability assessment, the study demonstrates that paddy cultivation is most lucrative in Punjab, with Andhra Pradesh, Uttar Pradesh, and West Bengal following in descending order of profit margins. This hierarchy of profitability signals an imperative for regions like West Bengal and Uttar Pradesh to elevate the quality and market value of their paddy crops to match the standards seen in Punjab and Andhra Pradesh. The comparative advantage enjoyed by farmers in Punjab and Andhra Pradesh in terms of profit margins underscores the critical importance of enhancing productivity, efficiency, and market connectivity in the lesser-performing states of West Bengal and Uttar Pradesh. Such improvements are essential for boosting profitability in paddy cultivation, thereby contributing to the overall growth and sustainability of the agricultural sector in these regions.

Keywords: CACP, efficiency, growth, profitability, productivity, sustainability

1. Introduction

Rice (*Oryza sativa* L.) occupies a paramount status as a staple commodity, deeply ingrained in cultural heritage, notably in India (Godfray et al., 2010; Mahajan et al., 2017). Nonetheless, the escalating demand for food production amid finite natural resources imposes substantial pressure on forthcoming generations. The confluence of rising input costs and inefficient resource allocation has led to diminished agricultural incomes (Udemezue, 2018). Projections indicate that by 2050, the global demand for food grains and non-food commodities is poised to surge by 75–100% (Tilman et al., 2011; Neupane et al., 2022; Yuan et al., 2022). With over 3.5 billion people relying solely on rice for over 20% of their daily caloric intake, its nutritional composition becomes pivotal, constituting approximately 62% carbohydrates, 46% protein, 8% fat, 7% calcium, and 44% phosphorus of the recommended dietary allowance (Anonymous, 2016; Alam et al., 2020). Rice not only serves as a staple food for the majority but also provides a livelihood and employment opportunities for over 200 million households in developing countries (Muthayya et al., 2014). Rice, is a versatile cereal, is integral to various diets around the world (Madugu et al., 2017).

Cultivated across 114 countries on a combined harvested area of nearly 167 million hectares, global rice production amounted to approximately 787 million metric tons of milled rice in 2021 (Anonymous, 2022). This vital crop sustains over 144 million farming families globally and commands an economic value of approximately US$206 billion (Anonymous, 2021). Its remarkable adaptability to diverse environmental stresses, spanning from hilly terrains to submerged areas and enduring drought to cold stress, underscores its significance. China leads in rice production, trailed by India, Bangladesh, and Vietnam (Mamun et al., 2021). Notably, China's productivity nearly doubles that of India, with global averages standing at 4.68 t ha^{-1} and Asian averages at 4.83 t ha^{-1} (Anonymous, 2021).

While the average paddy yield in India stands at 3.69 t ha^{-1} (Anonymous, 2022), China boasts 6.93 t ha^{-1}, Bangladesh 4.81 t ha^{-1}, Indonesia 5.41 t ha^{-1}, and Vietnam 5.58 t ha^{-1} (Anonymous, 2022). Looking ahead, USDA forecasts global rice production to attain a record 518.1 mt (milled basis) in 2023-24 (Anonymous, 2024). This upsurge, driven by various factors including alterations in production levels across different countries, underscores the dynamic nature of rice farming (Anonymous, 2024). However, productivity in India, despite having the largest area under rice cultivation, (Reddy, 2006) lags behind countries like Egypt, Japan, China, Vietnam, the USA, and Indonesia, as well as the global average (Reddy, 2007; Reddy, 2015).

Profitability stands as a linchpin for the sustainability of agricultural operations, facilitating investment in new technologies, operational expansion, enhanced quality of life for farmers' families, and contributions to community economic development. The profitability of agriculture not only ensures the livelihood of farmers but also affects the overall health and sustainability of the agricultural sector, playing a decisive role in national and global food security (Birtha, 2019). Profitability in agricultural economics hinges on various factors, including revenue generated from product sales and governmental support (Bene, 2020). Production costs, encompassing both direct and indirect expenses, profoundly impact profitability (Beckman et al., 2013). Market prices, yield, input costs, technological advancements, governmental policies, and environmental conditions are pivotal determinants (Anonymous, 2024; Anonymous, 2021). Profitability serves as a fundamental concept in agricultural economics, reflecting the financial health and viability of agricultural activities amidst a competitive and evolving economic landscape. States like West Bengal, Punjab, Uttar Pradesh, and Andhra Pradesh are prominent in rice cultivation.

2. Materials and Methods

2.1. Study area description

The present study, titled "Comparative Trend Analysis of Paddy Profitability in Five Major Growing States of India," was conducted based on secondary data released by Commission on Agricultural Costs and Prices (CACP) spanning from the fiscal year 2004–2005 to 2021–2022 focuses on examining the profitability trends in paddy cultivation across five key states based on recent data concerning cultivated area, production, and productivity. The states selected for this study, due to their significant contributions to paddy cultivation in India, include: Andhra Pradesh, Punjab Uttar Pradesh and, West Bengal.

2.2. Data sources

This analysis is underpinned by secondary data encompassing aspects such as the area under cultivation, production volumes, and productivity levels of rice in these major producing states: West Bengal, Uttar Pradesh, Punjab and Andhra Pradesh. The data for this study was sourced from the Commission on Agricultural Costs and Prices (CACP) spanning from the fiscal year 2004–2005 to 2021–2022. This data collection effort aimed to facilitate a comprehensive analysis across the principal paddy-producing regions in India.

The CACP, an autonomous body under the Government of India, was established in 1965 initially as the Agricultural Prices Commission and was renamed in 1985. Operating as an attached office of the Ministry of Agriculture and Farmers Welfare, the CACP plays a pivotal role in recommending agricultural pricing policies to the government.

Additionally, time-series data regarding the cost of cultivation and the from the years 2004–2005 to 2021–2022 were obtained from the Directorate of Economics and Statistics, Department of Agriculture and Farmers Welfare, within the Ministry of Agriculture and Farmers Welfare, Government of India. This data collection provides a foundation for assessing the profitability trends in paddy cultivation across the selected states.

2.3. Growth model

The study analyzed the trends in the growth of input prices, farm harvest prices, and the minimum support price by estimating compound growth rates for both nominal and real prices, with 2004–05 as the base year. The analysis employed a log-linear function to estimate the compound growth rates, defined by the equation:

$Y=ab^t$

Where,

Y=Price of input

a=Intercept constant

b=Coefficient

t=Time period

From the estimated compound growth rate was worked out as,

CGR=[Anti log (log b)-1]×100

The compound growth rate (CGR) was subsequently calculated using the formula:

[CGR=[{Anti log} (log b)-1]/100]

2.4. Profitability analysis

The analysis of profitability, defined as the percentage of profit or loss made over the cost, was conducted using the following formula (Guptha et al., 2014):

[{(Value of Produce/Cost of Cultivation)-1}×100

This formula facilitated the assessment of profitability by comparing the value of produce against the cost of cultivation, thereby providing insights into the economic viability and financial performance of paddy cultivation in the study area.

3. Results and Discussion

2.1. Temporal changes in value of product and cost of cultivation over the period (2004–05 to 2021–22)

The analysis of temporal changes in Value of product and cost of cultivation done by dividing overall period into three

periods viz. Period I (2004-2009), Period II (2010-2015) and Period III (2016-2021).

3.2. *Triennium average (2004–2006)*

Punjab's average Value of the product (VOP) stood at ₹ 40,393.36, indicating robust agricultural output during this period. This suggests Punjab's agricultural sector was particularly productive during these years. Cost of Cultivation (COC) averaged at ₹ 32,791.40, which was the highest among the states listed. This could imply that faced relatively higher costs associated with agricultural practices, possibly due to factors such as expensive inputs or land prices.

3.2.1. Period I (2004–2009)

Compared to the Triennium Average, there's a noticeable increase in both Value of the product (VOP) and Cost of Cultivation (COC) across all states. This suggests a period of growth in agricultural activity but also indicates higher costs associated with cultivation. Uttar Pradesh experienced the highest percentage increase in VOP at +36.48%, indicating significant agricultural development and increased productivity during this period. This could be attributed to various factors such as improved farming techniques, better infrastructure, or favorable government policies. Andhra Pradesh saw a substantial increase in both VOP (+33.96%) and COC (+27.75%). While the increase in VOP reflects growth in agricultural output, the rise in COC indicates increased expenses incurred in cultivation, which might include costs related to inputs, labor, or land. Despite the increased costs, the growth in VOP suggests that agricultural productivity also improved in Andhra Pradesh during this period (Table 1).

Table 1: Temporal changes in Value of product and cost of cultivation over the period (2004–05 to 2021–22)

	VOP				
	AP	PUN	TN	UP	WB
Triennium Average (2004–2006)	31,192.54	40,393.36	26,948.63	18,658.80	20,288.74
Period I (2004–2009)	41,786.75	52,438.93	35,582.70	25,465.40	25,052.03
	33.96	29.82	32.04	36.48	23.48
Period II (2010–2015)	71,340.83	89,207.33	65,897.68	45,639.56	45,192.78
	128.71	120.85	144.53	144.60	122.75
Period III (2016–2021)	103,459.73	119,282.74	80,096.27	54,012.73	59,658.54
	231.68	195.30	197.22	189.48	194.05
OVERALL (RS)	72,195.77	86,976.33	60,525.55	41,705.90	43,301.12

Table Continue...

	COC				
	AP	PUN	TN	UP	WB
Triennium Average (2004–2006)	29,601.53	30,720.66	32,791.40	20,138.71	25,429.87
Period I (2004–2009)	37,816.83	37,147.44	37,126.54	23,864.93	29,264.86
	27.75	20.92	13.22	18.50	15.08
Period II (2010–2015)	68,424.81	64,349.26	66,108.58	46,628.34	58,857.61
	131.15	109.47	101.60	131.54	131.45
Period III (2016–2021)	91,958.55	88,914.72	84,637.51	64,553.70	79,563.86
	210.65	189.43	158.11	220.55	212.88
OVERALL (₹)	66,066.73	63,470.47	62,624.21	45,015.66	55,895.44

3.2.2. Period II (2010–2015)

Compared to the previous period, there's a substantial leap in both Value of the product (VOP) and Cost of Cultivation (COC) across all states. This indicates a period of rapid agricultural expansion but also suggests rising costs associated with cultivation. Experienced the highest percentage increase in both VOP (+144.53%) and COC (+101.60%) among all states. This significant growth in VOP could be attributed to various factors such as technological advancements, improved irrigation methods, or favorable market conditions. However, the substantial increase in COC indicates that the state also faced rising costs during this period, which might include expenses related to inputs, labor, or land. Andhra Pradesh and Punjab maintained high growth rates in VOP during this period, indicating continued agricultural development. However, both states also experienced significant increases in costs, suggesting challenges associated with rising expenses despite the growth in output. These increased costs could

impact farmers' profitability and necessitate strategies to improve efficiency and cost management in agriculture.

3.2.3. Period III (2016–2021)

Similar to the previous periods, there's a significant increase in both Value of the product (VOP) and Cost of Cultivation (COC) across all states, albeit at a slightly slower pace compared to the previous period. This indicates ongoing growth in agricultural activity but also suggests continued challenges associated with rising costs. Uttar Pradesh experienced a notable increase in COC at +220.55%, indicating a substantial rise in expenses associated with cultivation during this period. Factors contributing to this increase could include rising labor costs, higher prices of agricultural inputs, or changes in government policies affecting farming practices. Andhra Pradesh continued to lead in VOP with a percentage change of +231.68%, showcasing sustained agricultural growth and productivity improvement over the years. This suggests that the state has been successful in implementing strategies to enhance agricultural output and capitalize on market opportunities, contributing to its continued leadership in agricultural production among the listed states.

3.3. Overall average analysis (2004–2021)

Punjab consistently maintained a strong position in terms of Value of the product (VOP), with an average VOP of ₹ 86,976.33 across all periods. This indicates a robust agricultural sector in Punjab, reflecting the state's favorable agricultural conditions, infrastructure, and farming practices. Uttar Pradesh witnessed significant growth across all periods, with noticeable increases in both VOP and Cost of Cultivation (COC). While this growth suggests opportunities in the agricultural landscape, the increasing costs, as indicated by the rising COC, pose challenges for farmers and agricultural stakeholders in managing expenses and maintaining profitability. Consistently had a high Cost of Cultivation (COC) throughout the periods, averaging at ₹ 62,624.21. This may indicate challenges in cost management or resource utilization in the state's agricultural sector, which could include factors such as high input costs, labor expenses, or inefficient farming practices. Addressing these challenges could be crucial for improving the overall efficiency and sustainability of agriculture in.

The data highlights the strengths and challenges faced by different states in their agricultural sectors. While Punjab demonstrates consistent agricultural prowess, Uttar Pradesh showcases significant growth potential but also increasing cost pressures. 's high cost of cultivation underscores the need for focused efforts to improve cost management and enhance the efficiency of agricultural practices in the state.

The data portrays a dynamic agricultural landscape with varying growth trajectories and challenges across different states and time periods. Specifically, Andhra Pradesh showcased remarkable growth in Value of the product (VOP) over the years, reflecting successful agricultural policies or technological advancements. This indicates that Andhra Pradesh has effectively leveraged its resources and implemented strategies to enhance agricultural productivity and capitalize on market opportunities. However, alongside this growth, there are also challenges faced by states such as Uttar Pradesh with increasing costs and with high cost of cultivation. Overall, the data highlights the complexities and opportunities within the agricultural sector, emphasizing the need for targeted policies and initiatives to address the diverse needs of farmers and stakeholders across different regions.

3.4. Change in value of the product over the period from 2004–05 to 2021–22

Change in Value of the product over the period from 2004–05 to 2021–22 has shown a consistent increasing pattern in all states, with the exception of Punjab in the year 2017–18. Notably, Punjab experienced a deviation from this trend during that specific year. Comparatively, Punjab has generally held the highest Value of the product over the entire period, except for the anomaly in 2017–18. On the other hand, Uttar Pradesh consistently exhibited the lowest Value of the product among the five states. Therefore, the overall trend of the Value of the product in the five states, ordered from highest to lowest, is as follows: Punjab>Andhra Pradesh>West Bengal>Uttar Pradesh (Figure 1).

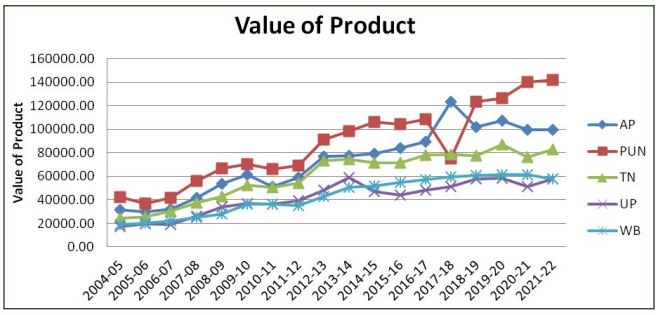

Figure 1: Change in over the period from 2004–05 to 2021–22

3.5. Change in cost of cultivation over the period from 2004–05 to 2021–22

The cost of cultivation across all five states exhibited an increasing pattern from 2004-05 to 2021-22. Comparatively, Andhra Pradesh reported the highest cost of cultivation, while Uttar Pradesh recorded the lowest. Therefore, the order of the cost of cultivation of paddy in the five major states over the period is as follows: Andhra Pradesh>Punjab>West Bengal>Uttar Pradesh (Figure 2).

3.6. Comparison between value of the product (VOP) and cost of cultivation (COC)

Comparatively, in Andhra Pradesh, Value of the product exceeds the Cost of Cultivation except in the year 2021–22. Additionally, there is a very narrow gap between value of the product and the Cost of Cultivation in Andhra Pradesh. In Punjab, except for the year 2017–18, value of the product surpasses the Cost of Cultivation throughout the period, with a wider gap compared to Andhra Pradesh. In, except for the

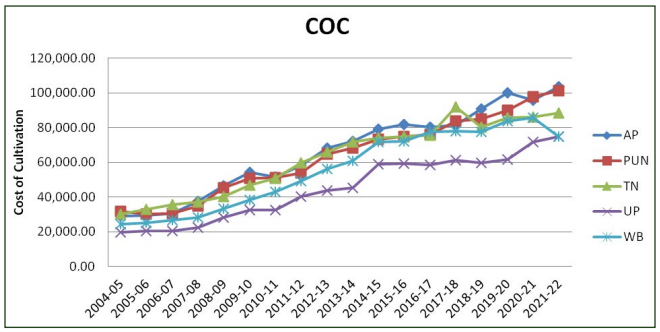

Figure 2: Change in Cost of Cultivation over the period from 2004–05 to 2021–22

periods 2008–09, 2009–10, 2012–13, 2013–14, 2016–17, and 2019–20, the remains lower than the Cost of Cultivation. Moreover, there is not much of a gap between the cost of cultivation and value of the product. In Uttar Pradesh, from the periods 2007–08 to 2010–11 and 2012–13 to 2013–14, Value of the productexceeds the Cost of Cultivation. However, for the rest of the period, Value of the product is lower than the cost of cultivation. In West Bengal, over the entire period, value of the product remains lower than the cost of cultivation, with a substantial gap between them.

In Andhra Pradesh, except for the years 2010–11 and 2021–22, the percentage change between Value of the product (VOP) and cost of cultivation (COC) is positive. Similarly, in Punjab, the percentage change is observed as positive in all years except for 2017–18. However, in the states of West Bengal, Uttar Pradesh, and mostly in, the percentage change is observed as negative (Figure 3).

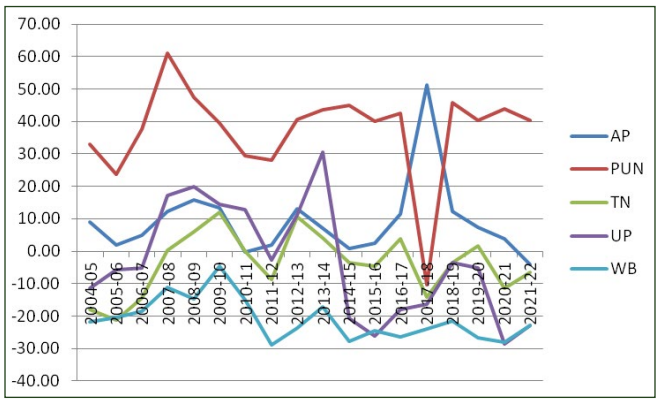

Figure 3: Percentage change between and cost of cultivation

3.7. *Relative change in value of the product and profitability over the period from 2004–05 to 2021–22*

Relative change in value of the product is highly negative in Uttar Pradesh in the year 2013–14 with -50.84% and highest positive change in Punjab in the year 2017–18 with 63.40%. It is observed fluctuating changes in all the five major states. Relative change in profitability in the state of Punjab in the year 2007–08 with 61.11% and highest negative change in the state West Bengal in the year 2011–12 with -28.84%. Except in 2021–22 every year is positive change in the state Andhra Pradesh and except in 2017–18 all the years in Punjab are with positive change.

West Bengal, Uttar Pradesh and Tamil Nadu are with negative change value. Profitability in major five states Punjab > Andhra Pradesh>Uttar Pradesh>West Bengal (Figure 4).

4. Limitations

The available data spans only 18 years, which may limit the ability to draw conclusive results. A longer time series analysis would likely provide more comprehensive insights. Although detailed categories of the cost of cultivation were available, certain data, such as the breakdown of costs attributed to diesel in hired machine labor, were missing. This limitation may affect the accuracy of the analysis, particularly in assessing specific cost components. The profitability of agriculture is influenced by numerous complex factors, but detailed information on the impact of these factors is not available for making projections. This lack of detailed information hampers the ability to forecast future trends accurately. Furthermore, since cost concepts were not implemented in project sites as part of the project efforts, there is a gap in field-level information. This gap impedes the comparability of the data with state-level averages and may affect the overall reliability of the analysis.

5. Conclusion

Comparative trend analysis of Paddy profitability in major growing states of India examines paddy cultivation economics across key states. It finds the highest profitability in Punjab, due to superior product value despite high costs, followed by Andhra Pradesh, Uttar Pradesh, and West Bengal. The latter two states face lower profits due to lesser product quality and efficiency, highlighting a need for improvements in productivity and market access to enhance profitability in paddy cultivation.

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