Original Research Article

Economic Profitability of Rice Cultivation in Punjab and Uttar Pradesh: A Cost-Based Assessment

Abstract

Aims: The main objective of this study is to analyse the profitability of paddy in Punjab and Uttar Pradesh and investigate the factors influencing the cost structure of paddy farming.
Study design: This studyutilized secondary data from the Directorate of Economics & Statistics, the Department of Agriculture & Farmers' Welfare (DA&FW), and the Commission for Agricultural Costs and Prices (CACP)
Place and Duration of Study: The study was mainly focused on Punjab and Uttar Pradesh. Since 2001-02, every 4th year was selected, and the last year was also included. Finally, the selected points of years were 2001-02, 2005-06, 2009-10, 2013-14, 2017-19, and 2020-21.
Methodology: This study employs various cost concepts and the Hausman test to select between fixed and random effects models. A Panel Instrumental Variable (IV) regression analysis is conducted to assess the cost structure.
Results: The study findings revealed that Punjab demonstrates the highest rice yield per hectare, while Uttar Pradesh's profit ratio for paddy is minimal, indicating challenges in profitability. Farmers in Punjab benefit from market prices that consistently exceed the Minimum Support Price (MSP), preventing negative net returns.
Conclusion: The results indicate a significant disparity in profitability between Punjab and Uttar Pradesh and highlight that total costs significantly impact technology adoption and price movements, with last year's market conditions influencing current production costs.

Keywords: Paddy, profitability, Punjab, Uttar Pradesh.

1. INTRODUCTION

India is the fifth-largest economy in the world, with a population of 1.41 billion people. Around 60 per cent of this vast population relies on the agricultural sector for their livelihoods, either directly or indirectly (Government of India, 2024). The Economic Survey for 2023-24 highlighted that agriculture contributes 18.2 per cent to the nation's GDP, reflecting its critical role in the economy. Rice, a staple food for more than half of the global population holds immense importance in India and across numerous Asian countries. India ranks second in both rice cultivation and consumption, following China. Paddy cultivation is particularly labour-intensive, offering millions of individuals vital employment and livelihood opportunities (Suresh Kumar, 2019). India accounts for approximately 27.1 per cent of the global rice-growing area (Singh *et al.,* 2012). Moreover, as the largest rice exporter globally, India commands over 40 per cent of the international market share, playing a pivotal role in ensuring food security around the world. Rice is cultivated during both the Rabi and Kharif seasons, with some regions remarkably managing to grow it up to three times in a single year. The major rice-producing states in India showcase the agricultural diversity of the country, including West Bengal, Uttar Pradesh, Bihar, Punjab, Haryana, Odisha, Chhattisgarh, Andhra Pradesh, Telangana, Tamil Nadu, Kerala, and Assam. Since the transformative Green Revolution of the 1960s, Punjab has witnessed rapid advancements in rice cultivation, further solidifying its status as a rice powerhouse (Chanana, 2001).

In 2006, Bhatia conducted an insightful study focusing on the sustainability and profitability trends within Indian agriculture. His study findings revealed that during the period from 1996-97 to 2002-03, the farm business income per hectare for paddy production in Andhra Pradesh saw a notable increase, indicating a positive shift in agricultural profitability in that region. In contrast, West Bengal experienced a different trajectory; the farm business income per hectare during the same timeframe exhibited a decline, punctuated by only a few brief spikes of improvement around 1998-99. To illustrate this trend more clearly, Bhatia noted that in West Bengal, the farm business income per

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hectare at current prices fell from Rs 10788 in 1996-97 to a mere Rs 5,737 by 2003-04, highlighting the challenges faced by farmers in that state compared to their counterparts in Andhra Pradesh.Narayanamoorthy (2013) carried out an extensive investigation into the profitability of crop cultivation in India, utilizing a comprehensive dataset from the CACP spanning from 1975 to 2006. This research specifically examined key agricultural years to assess the financial viability of major crops, which included paddy, wheat, gram, cotton, groundnut, and sugarcane. The results of the study revealed a concerning trend: Many farmers faced either negligible profit margins or substantial financial losses while growing most of the crops analysed. This insight underscores the challenges that the agricultural sector in India faces, highlighting the need for more sustainable and viable farming practices.Dhawan (2018) explored the profitability of agriculture in the Indian state of Punjab, drawing insights from the Cost of Cultivation Surveys. The research highlighted a significant upward trend in profits over the A_1 and C_2 cost categories between the years 1981-82 and 2010-11. Specifically, the study found that wheat farming experienced a profit increase of 10.82 per cent over A_1 costs and 12.45 per cent over C_2 costs. Similarly, paddy cultivation also showed impressive growth, with profits rising by 9.92 per cent over A_1 costs and 11.36 per cent over C_2 costs. A study conducted by Paul (2019) explored the profitability of paddy cultivation and the perceptions of farmers in West Bengal. It was found that the annual cost of paddy cultivation in West Bengal has risen by 12.1 per cent, while the profit margin for farmers has steadily decreased over time.Monga and Sidana (2021) conducted a study on the changes over time in the cost structure and profitability of wheat and paddy crops in India. They found that the percentage margin of the MSP over Cost A_2+FL was highest for wheat in Punjab at 169.6 per cent, while it was lowest in Uttar Pradesh at 67.8 per cent. Additionally, they noted that the margin of MSP over Cost A_2 plus factor cost plus 50 per cent would be advantageous for some states but not for all. In the 2015-16 period, this margin exceeded 100 per cent in Punjab, Haryana, and Madhya Pradesh, whereas it was approximately 70 per cent in Bihar and Uttar Pradesh.Mandal (2024) conducted an in-depth analysis of the economic factors surrounding paddy cultivation in Eastern India, focusing on the trends and patterns of costs and profitability in this vital agricultural sector. His research revealed that Jharkhand emerged as the leading state in terms of profitability, boasting the highest average profit-to-cost ratio (A_2) among the regions studied. Following Jharkhand, West Bengal, Bihar, and Odisha displayed varying levels of profitability, reflecting the diverse agricultural dynamics and challenges faced by farmers in these areas. His study findings provided valuable insights into the economic landscape of paddy farming, highlighting the factors that influence success in this important industry.

Paddy cultivation is a cornerstone of Indian agriculture, providing sustenance to millions of farmers and contributing significantly to the country's food security. However, despite its importance, the profitability of paddy cultivation in India is increasingly under pressure. Farmers face challenges such as rising input costs, volatile market prices, climate-induced risks, and stagnant productivity levels. Average cost inflation reached a record high of 13 per cent, with over half of this attributed to rising labour costs. While the use of physical inputs has only marginally increased, a significant share of the rise in cultivation costs is due to escalating input prices (Srivastava, 2017). Between 2013 and 2019, farmers' incomes rose by 30 per cent, but their debt surged by approximately 58 per cent (Sharma, 2021). Furthermore, the rate of farmer suicides increased from 4.3 per cent in 2014 to 6.6 per cent in 2021 (NCRB, 2021). Price fluctuations and ongoing farmer agitations for fair prices remain critical issues. Given these circumstances, there is an urgent need to evaluate the profitability of the farming sector through scientific evidence. This study aims to analyse the profitability of paddy in Punjab and Uttar Pradesh and examine the underlying factors influencing the cost structure.

2. MATERIAL AND METHODS

Paddy was selected for the study based on the highest area. Cost of cultivation data from the reports of CACP has been collected from 2001 to 2019 and estimated the profit ratio over Cost A_2 + FL, Cost C_2, and Cost C_3 by selecting the states with the highest area, highest yield, and lowest yield at selected points of six years. Since 2001-02, every 4th year was selected, and the last year was also included. Finally, the selected points of years were 2001-02, 2005-06, 2009-10, 2013-14, 2017-19, and 2020-21.

3.1Cost concepts:CACP has been using nine different cost concepts. They are as follows:

Cost A_1 = All actual expenses in cash and kind incurred in production by the owner.
Cost A_2 = Cost A_1 + rent paid for leased-in land.
Cost A_2+ FL = Cost A_2 + imputed value of family labour.
Cost B_1 = Cost A_1 + interest on value of owned capital assets (excluding land).
Cost B_2 = Cost B_1 + rental value of owned land (net of land revenue)

Cost C_1 = Cost B_1 + imputed value of family labour.
Cost C_2 = Cost B_2 + imputed value of family labour.
Cost C_2* = Cost C_2 estimated by taking into account statutory minimum or actual wage whichever is higher.
Cost C_3 = Cost C_2* + 10 per cent of cost C_2* on account of managerial functions performed by farmer.

Panel Instrumental Variable (IV) regression analysis was done to determine Paddy's cost structure. The Hausman test was done to select the appropriate results between fixed and random effects. Cost C_2 is taken as the dependent variable, the previous year's farm price is the independent variable and crop yield isthe endogenous variable, which is influenced by seed, fertilizer, human labour, animal labour and manure, time series data has been taken for six years i.e., from 2014-15 to 2019-20 and cross-sectional data is taken for nine states of Paddy *viz*, Punjab and Uttar Pradesh. The Panel IV regression model will be as follows

$$C_{it} = \alpha O_{it} + \beta X_{it} + y_{it} + \varepsilon_{it}$$

Where C- Cost per ha; O_i- Yield (endogenous); X_i- Price
The appropriate models selected after the Hausman test werePaddy- 2SLS random effects IV regression

3. RESULTS AND DISCUSSION

3.1Trend in Profitability of Major Crops:

The normal estimates of the area, production, and yield of major field crops for the period from 2016-17 to 2020-21 are presented in Table 1. Among these crops, rice stands out as the most prominent, occupying an impressive area of 44.27 million hectares (M ha). Following rice, wheat claims a substantial 30.44 M ha, making it the second most cultivated crop. Cotton, another crucial agricultural staple, covers 12.55 M ha, while soybean is cultivated over 11.55 M ha. In addition to these leading crops, gram and maize also play significant roles in the agricultural landscape, with areas of 9.85 M ha and 9.50 M ha, respectively. Besides these prominent crops, a variety of other important agricultural products are grown throughout the country. For instance, bajra, mustard, and groundnut are cultivated on considerable tracts of land alongside urad, jowar, sugarcane, and red gram.

Table1Area, production and yield of major field crops in India – Normal estimates(Average 2017-18 to 2021-22)

Crops	Area (M.ha)	Production (000' tons)	Yield (kg/ha)
Foodgrains			
Rice	44.73	120.39	2692
Wheat	30.38	105.73	3480
Maize	9.57	30.12	3149
Jowar	4.42	4.40	995
Bajra	7.32	9.77	1335
Nutri/Coarse Cereals			
Tur	4.63	4.01	866
Gram	10.11	11.57	1145
Total Pulses	29.29	24.66	842
Total Food Grains	127.85	298.82	2337
Oil Seeds			
Groundnut	5.23	9.26	1770
Soyabean	11.74	12.21	1039
Sunflower	0.25	0.23	890
Rapeseed & Mustard	6.73	9.80	1456
Other Cash Crops			
Sugarcane	4.89	400.13	81893
Cotton@	12.87	32.66	431
Jute & Mesta	0.69	9.85	14311

Source: Authors computed using the data from the Directorate of Economics & Statistics, DA&FW

Given that paddy utilizes the largest agricultural area in India, we undertook an analysis of the profitability trend associated with rice crops. As illustrated in Table 2, we presented average estimates regarding the area, production, and yield of rice for the top 10 rice-producing states in the country. The cultivation of paddy spans a total area of 46.28 M ha throughout India, yielding an impressive production figure of 129.47 (000' tons) during 2021-22. Among the states, Uttar Pradesh stands out with the largest share of paddy area, closely followed by West Bengal. However, when it comes to production, West Bengal surpasses all others, taking the lead over Uttar Pradesh in overall rice output. Punjab demonstrates remarkable efficiency, boasting the highest yield of rice per hectare in the nation. Chanakya and Nandi (2024) demonstrate that paddy cultivation is the most lucrative in Punjab, highlighting profit margins through an insightful profitability assessment. This achievement can be attributed to several factors, including the state's extensive and reliable irrigation facilities, the cultivation of high-yielding varieties of both basmati and non-basmati rice and the widespread adoption of mechanisation in farming practices (Kumar *et al*., 2018). On the other hand, Odisha lags in productivity, having recorded the lowest yield of rice in the country. It is noteworthy that both Punjab and Odisha focus their rice cultivation efforts exclusively during the Kharif season, a vital time for paddy planting. In this study for analyzing profitability, we have taken Uttar Pradesh and Punjab because formal has the highest area under cultivation and the latter one is having high productivity.

Table2Area, production and yield of rice in India in major producing states along with coverageunder irrigation during 2021-22 and 2022-23

S. No.	State/ UT	Area (M.ha)		Production (000' tons)		Yield (kg/ha)	
		2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
1	Uttar Pradesh	5.70	5.90	15.27	16.14	2678	2737
2	Telangana	3.65	4.66	12.41	15.88	3395	3406
3	West Bengal	5.59	5.07	16.73	15.48	2995	3057
4	Punjab	2.97	3.10	12.89	12.99	4340	4193
5	Chhattisgarh	3.76	3.77	8.02	9.81	2134	2602
6	Odisha	3.95	4.06	9.29	8.25	2353	2030
7	Andhra Pradesh	2.29	2.13	7.76	7.94	3392	3730
8	Tamil Nadu	2.22	2.16	7.91	7.56	3566	3500
9	Bihar	3.09	2.86	7.72	7.02	2496	2453
10	Madhya Pradesh	2.11	3.41	4.81	7.02	2283	2057
	All India	**46.28**	**47.83**	**129.47**	**135.76**	**2798**	**2838**

Source: Authors computed using the data from the Directorate of Economics & Statistics, DA&FW

Table3Profitability of rice in Uttar Pradesh state

Year	Derived Yield (Q/ha)	Cost A_2+ FL (Rs/ha)	Cost C_2 (Rs/ha)	Cost C_3 (Rs/ha)	VOP (Rs/ha)	VOP/ (Cost A_2+ FL)	VOP/C_2	VOP/C_3
2001-02	32.99	12120	15844	17429	14549	1.20	0.92	0.83
2005-06	34.37	13866	20557	22613	19386	1.40	0.94	0.86
2009-10	37.58	21337	32328	35561	36978	1.73	1.14	1.04
2013-14	42.41	30983	45357	49893	59154	1.91	1.30	1.19
2017-18	37.06	44083	61382	67520	51364	1.17	0.84	0.76
2021-22	36.15	55810	74657	82122	57564	1.03	0.77	0.70

Source: Authors computed using the data from the Directorate of Economics & Statistics, DA&FW

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Table 3 represents the profitability analysis of rice in Uttar Pradesh. Uttar Pradesh has the highest average area of rice cultivation in the country. In the 2021-22 agricultural year, the total cost at Cost C_3 was Rs. 82,122 per hectare, with a derived yield of 36.15 Q/ha. The profit ratio at Cost C_3 was either slightly below or just above one for all selected years. A similar situation was noted at Cost C_2, indicating that there was no marginal profit at either Cost C_2 or C_3. At Cost A_2 + FL, the profit ratio was highest at 1.91 in 2013-14, which was due to a higher yield of 42.41 Q/ha and a higher average market price of Rs. 1,497 per quintal compared to other years. However, during the years 2017-18 and 2021-22, net returns were negative, and the average price received by farmers was below the MSP, as illustrated in Figures 1 and 2.

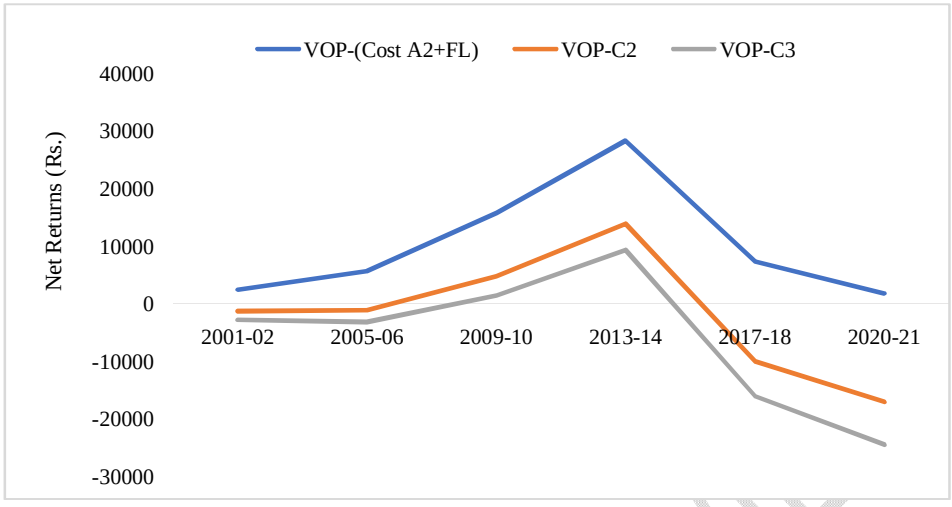

Fig. 1:Trend in net returns of paddy in Uttar Pradesh

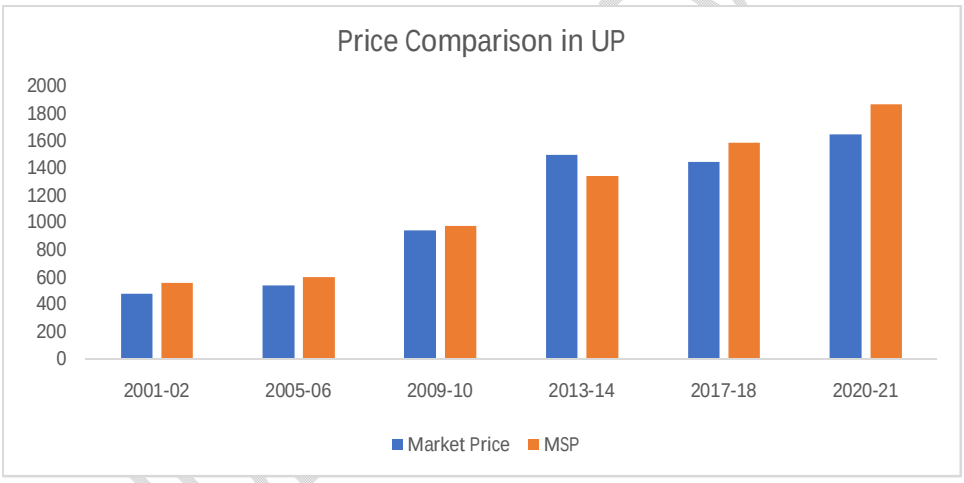

Fig. 2:Comparison of market price and MSP of paddy in Uttar Pradesh

Punjab has achieved remarkable agricultural success, boasting the highest average yield in the nation at an impressive 4,179 kg/ha during the 2021-22 farming season. The Cost C_3 is Rs. 111478/ha, and the net returns stand at Rs. 30,641/ha (Table 4). The profit ratio exceeds two for all selected years when using Cost A_2+FL, signifying that farmers are earning more than double their input costs—representing a profit margin greater than 100 per cent. Furthermore, at both Cost C_2 and C_3 assessments, the profit ratios are consistently above one across all monitored years, highlighting sustained profitability in agricultural practices. Throughout the analysis, it is noteworthy that no negative net returns have been reported, suggesting a robust economic environment for farmers (Figure 3). Additionally, the market prices received by farmers consistently outpace the MSP across all evaluated years, underscoring the financial benefits farmers are reaping in Punjab's agricultural sector (Figure 4).

Table 4Profitability of rice crop in Punjab state

Year	Derived Yield	Cost A_2+ FL	Cost C_2 (Rs/ha)	Cost C_3 (Rs/ha)	VOP (Rs/ha)	VOP/ (Cost	VOP/C_2	VOP/C_3

	(Q/ha)	(Rs/ha)				A_2+ FL)		
2001-02	59.48	14380	23577	25935	33516	2.33	1.42	1.29
2005-06	61.15	17247	30007	33008	37154	2.15	1.24	1.13
2009-10	64.70	29032	50650	55715	70622	2.43	1.39	1.27
2013-14	64.90	39687	68383	75221	98255	2.48	1.44	1.31
2017-18	74.90	42465	81378	89516	123161	2.90	1.51	1.38
2021-22	69.80	58782	101344	111478	142119	2.40	1.40	1.27

Source: Authors calculated using the data from the Directorate of Economics & Statistics

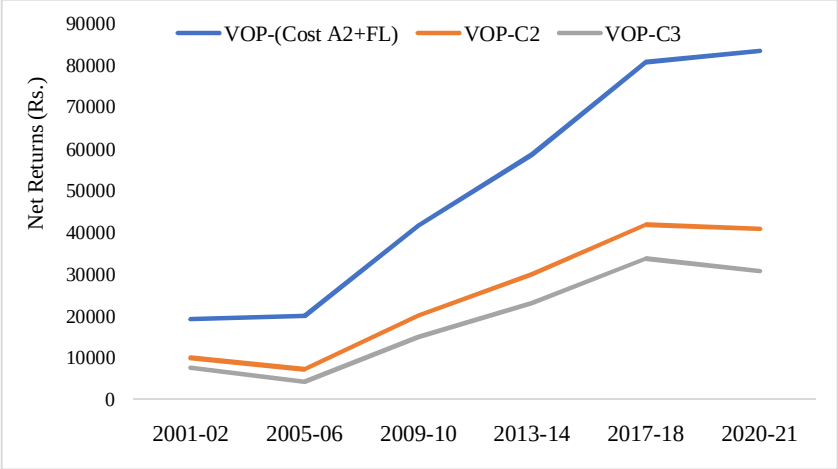

Fig. 3: Trend in net returns of paddy crop in Punjab, from 2001-02 to 2020-21

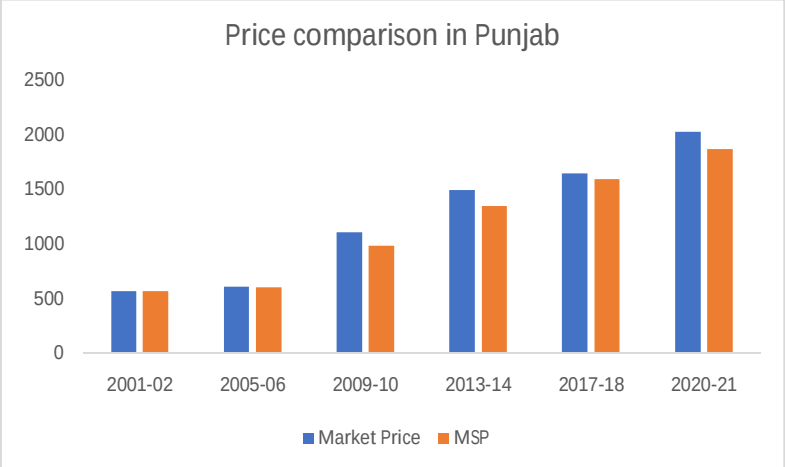

Fig. 4:Comparison of Market Price and MSP of Paddy in Punjab

Table 5 presents a detailed analysis of profit distribution across different cost structures. At Cost A_2 + FL, it is noteworthy that profits exceeded 30 per cent in 32 out of 36 instances, indicating a strong performance with no observed losses during the evaluation period. In contrast, at Cost C_2, the results showed a more varied outcome: profits fell below the 30 per cent threshold 18 times, while instances of profits exceeding 30 per cent and losses occurred 9 times. The situation at Cost C_3 was less favourable, with losses recorded 16 times out of 36 evaluations. Additionally, profits under the 30 per cent mark were observed 18 times, while only two occurrences of profits surpassing 30 per cent were noted. This highlights a significant disparity in profitability across the different cost categories examined.

Table 5Analysis of profit distribution by rice farmers at various cost concepts

Cost Concepts	Punjab	Uttar Pradesh
Cost A_2 + FL		
Profit <30 %	0	3
Profit > 30 %	6	3
Loss	0	0
Cost C_2		
Profit <30 %	1	1
Profit > 30 %	5	1
Loss	0	4
Cost C_3		
Profit <30 %	4	2
Profit > 30 %	2	0
Loss	0	4
Total Time Points	6	6

3.2 Determination of cost structure:

The first objective of the study highlighted that the total cost is the most significant factor affecting the profitability of crop cultivation. Several critical elements are integrated into the model to understand better how they impact total costs. Among these, price movements and the technology adopted by farmers emerge as key contributors. Price movements are reflected by the prices that farmers received during the previous year, providing a historical context for current economic conditions. Meanwhile, the technology utilized by farmers is evaluated through the yields they achieve, which serve as an indicator of agricultural efficiency and innovation. Yield itself is classified as an endogenous variable because it is influenced by multiple external factors, including the quality of seeds, the availability and effectiveness of human and animal labour, as well as the types and amounts of fertilizers and manures used.

Table 6Paddy- Results of the Hausman test

	Coefficients		b-B	Sqrt (Diag(V_b-V_B))
	Fixed Effects (b)	Random Effects (B)	Difference	S.E.
Yield	796.62	641.10	155.52	653.59
Price	40.73	34.28	6.45	2.97

b= consistent under H_0 and H_a; obtained from xtivreg; B = inconsistent under H_a, efficient under H_0; obtained from xtivreg; Chi^2(2) = (b-B)`[(V_b-V_B)^ (-1)] (b-B) = 5.11; Prob>chi^2= 0.077

Given its complex nature, yield is treated as an endogenous variable in the analysis and is instrumented accordingly, with the previously mentioned influencing factors serving as instruments. To validate the model's findings, a Hausman test was conducted, yielding a p-value greater than 0.05. This result suggests that the random effects model is suitable for analyzing the data, as indicated in Table 6.

The Panel IV regression analysis was performed to explore the factors affecting the total cost of Paddy (Cost C_2). The analysis revealed that Cost C_2 is significantly influenced by two key variables: the yield of the crop and the price from the previous year's harvest. Specifically, for every quintal increase in yield, Cost C_2 rises by Rs. 641. This underlines the direct relationship between higher yields and increased costs associated with production. Furthermore, the analysis showed that if the price of Paddy from the previous year increases by Rs. 100, there is a corresponding increase of Rs. 34 in Cost C_2 for each quintal. This finding suggests that the previous year's market conditions play a crucial role in determining current production costs. The model's effectiveness is also reflected in its R^2 value of 0.51, indicating that 51 per cent of the variation in Cost C_2 can be explained by the explanatory variables included in the analysis. This demonstrates a moderate level of predictability of Cost C_2 based on the factors considered in the regression model.

Table 7.Paddy-Results of Panel IV regression analysis

Cost C2	Coefficients	Standard Error	P-value	95% Confidence Interval	
Yield	641.10	308.41	0.038	36.62	1245.58
Price	34.28	10.07	0.001	14.55	54.02
Constant	-11071.24	14044.85	0.431	-38598.64	16456.15
R2	0.51				
Wald Chi2	32.90**				

** represents P-value<0.001

Numerous studies have thoroughly investigated the profitability of farms, the income generated by agricultural businesses, and the various factors that determine input usage in farming. These studies focus on specific crops cultivated in certain Indian states that are recognized for their significant production and exceptional yield. By analyzing detailed data on cultivation costs published by the CACP, researchers have been able to track trends and make comparisons over different periods. Key contributions to this body of research include the works of Narayanamoorthy (2013) and Mandal (2024), each providing valuable insights into the economic dynamics of farming in India.

Conclusion

Paddy cultivation is vital to Indian agriculture, supporting millions of farmers and contributing to food security. This study examines the profitability of major crops in India and the factors influencing their cost structures. Uttar Pradesh has the most significant area for paddy cultivation, followed by West Bengal. Punjab is noted for its high efficiency, boasting the highest rice yield per hectare. In Uttar Pradesh, the profit ratio for paddy cultivation is around one at Cost C_3, indicating minimal profitability. However, Punjab farmers experience no negative net returns, as market prices often exceed the MSP, enhancing their financial returns. The analysis reveals a significant profitability disparity between farmers in Punjab and Uttar Pradesh. A random effect model G2SLS was used, and the Panel IV regression indicated that total costs significantly impact the technology adopted and price movements. Higher yields are linked to increased production costs, suggesting last year's market conditions influence current costs.

The study's findings on paddy cultivation in India highlight several policy implications that could help improve farmers' profitability, especially in states like Uttar Pradesh.

1. Strengthening MSP Mechanisms: Policymakers should enhance the MSP system to ensure that all farmers, especially in regions with higher cultivation costs like Uttar Pradesh, receive adequate financial support to cover their production expenses.

2. Investment in Technology: Encouraging the adoption of advanced agricultural technologies can help improve yield efficiency. Investments in training programs for farmers on modern farming practices and technology utilization could bridge the productivity gap between states.

3. Infrastructure Development: Improving irrigation and transportation infrastructure can reduce production costs and minimize post-harvest losses. Better access to markets would enable farmers to achieve better prices for their produce.

4. Financial Support and Insurance: Implementing comprehensive financial support schemes, including credit facilities and crop insurance, could provide farmers with the necessary stability to manage costs and reduce risks associated with market price fluctuations.

5. Research and Development: Increased funding for agricultural research focused on developing high-yield and pest-resistant paddy varieties can lead to better performance in regions with lower yields.

6. Regional Policy Differentiation: Given the substantial disparities in profitability and market conditions, regional policies tailored to the specific challenges of different states can help create a more equitable agricultural sector.

7.Market Access and Information: Establishing robust market information systems can help farmers make informed decisions regarding planting and selling, ultimately impacting their profitability positively.

8. Sustainability Practices: Encouraging sustainable farming practices can lead to long-term benefits for farmers, including cost reductions and improved soil health, which can enhance future yields.

By addressing these areas, policymakers can foster an environment that enhances the profitability of paddy cultivation across different regions of India, ultimately supporting rural livelihoods and contributing to national food security.

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