



RESEARCH ARTICLE

Comparative study on cost of cultivation and net returns from major crops in eastern plain zone of Uttar Pradesh

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Abstract

The present study aimed to estimate the costs of cultivation, production, returns and profitability of paddy, wheat, mustard and sugarcane in the Eastern Plain Zone of Uttar Pradesh during the agricultural year 2022-23. On an overall average, the cost of sugarcane production was ₹132.56 per quintal, with net returns per ha, calculated by deducting Cost C₃ (total cost of cultivation) from gross income, amounting to ₹249894.90 per ha. Whereas, the cost of production for paddy, wheat and mustard was ₹1421.96, ₹1632.50 and ₹3624.49 per quintal, respectively, while their corresponding net returns per ha were ₹27134.86, ₹21413.67 and ₹24847.01. The observation indicates that sugarcane had the lowest per-quintal production cost and the highest net returns per ha, outperforming the other crops in terms of economic viability. Although all the crops studied-sugarcane, paddy, wheat and mustard-were profitable, sugarcane emerged as the most lucrative due to its superior cost efficiency and higher per ha profitability.

Keywords: cost concept; cost of cultivation; mustard; paddy; profitability; returns; sugarcane; wheat

Introduction

Agriculture has long been the cornerstone of India's economy, providing livelihoods for millions and playing a crucial role in ensuring food security and economic stability. Despite the country's increasing shift toward industrialization and the services sector, agriculture remains indispensable, contributing approximately 15 % to the nation's Gross Value Added (GVA) in the fiscal year 2022-23. This is a significant decline from 35 % in 1990-91, reflecting structural transformations in the economy. However, the sector's enduring relevance is evident in its role in feeding a growing population, supporting rural livelihoods and driving regional economic development (1).

Uttar Pradesh, one of India's most agriculturally productive states, demonstrates the importance of agriculture in regional economies. The state's rich Indo-Gangetic plains, along with a well-established irrigation system, have helped it become a pioneer in the production of staple crops like as wheat, rice, sugarcane and legumes. In 2023-24, the agriculture industry is expected to get ₹ 25.48 lakh crore in institutional loans, rather than the GDP (2). According to the Economic Survey 2023-24, ground-level credit (GLC) to agriculture increased significantly from ₹ 8.45 lakh crore in 2014-15 - ₹ 25.48 lakh crore in 2023-24, indicating increased financial support for the industry (3). The cropping pattern in Uttar Pradesh is seasonally divided into Kharif and Rabi crops. While Kharif crops, including rice and maize, are cultivated during the

monsoon season, Rabi crops, such as wheat and mustard, dominate the winter months. On a national level, food grain production for Kharif and Rabi seasons was estimated at 1541.87 and 1551.61 LMT, respectively, with Uttar Pradesh contributing significantly (4).

Despite these impressive production statistics, the profitability of crop cultivation has emerged as a persistent concern, particularly in regions like the Eastern Plain Zone of Uttar Pradesh. Farmers in this region face unique challenges, including high input costs, limited access to advanced agricultural practices and under developed market infrastructure. These issues are further compounded by regional disparities in resource allocation and support systems, which affect the net returns from crop cultivation. Although government policies such as the Minimum Support Price (MSP) aim to ensure a minimum return of 50 % over production costs, the actual benefits vary across crops and regions, leaving many farmers struggling to achieve economic viability (5).

The Eastern Plain Zone is characterized by small landholdings and resource limitations, which exacerbate the issue of low profitability. Rising input costs, stagnant or declining market prices and limited access to credit create a precarious financial situation for farmers. Previous studies have shown that poor returns from agriculture often lead to indebtedness, which has been identified as a key factor in agrarian distress, including farmer suicides (6-9). These

challenges highlight the need for a comprehensive evaluation of agricultural profitability to address systemic issues and develop targeted policy interventions. Government initiatives, such as the ₹ 70000 crore farm loan waiver scheme introduced in 2008-09, aimed to alleviate farmer distress by reducing indebtedness. However, such one-time measures have failed to address the root causes of low profitability and high production costs. The National Commission on Farmers identified inadequate returns from crop cultivation as a primary driver of the agrarian crisis, emphasizing the importance of long-term solutions that enhance farm incomes and ensure economic sustainability (10). Addressing these challenges requires a detailed understanding of the cost of cultivation and net returns across different crops, as well as the factors influencing profitability.

Agricultural research plays a vital role in improving productivity, optimizing resource allocation and addressing challenges related to profitability. However, existing studies have often focused on a narrow range of crops, such as paddy and wheat, without examining broader cropping patterns or long-term trends. The Commission for Agricultural Costs and Prices (CACP) provides rich temporal data on the cost of cultivation and output for various crops, offering valuable insights into the economic dynamics of Indian agriculture. Analyzing this data can help identify trends in profitability and inform strategies to enhance farm incomes (11). The present study aims to address this gap by focusing on the Eastern Plain Zone of Uttar Pradesh, a region with immense agricultural potential but significant structural and economic challenges. This research aims to compare the cultivation costs and net returns of major crops, including wheat, rice, mustard and sugarcane, to assess their economic viability. The objectives include estimating the profitability of these crops and identifying the most sustainable and lucrative options for farmers. By providing a comprehensive analysis of crop profitability in the region, this study aims to contribute to the development of targeted interventions that enhance agricultural sustainability and improve the livelihoods of farmers.

Materials and methods

The study was conducted in *Mau* and *Jaunpur* districts, located in the eastern region of Uttar Pradesh. Mau district is situated between 25°35' - 26°16' N latitude and 83°17' - 84°52' E longitude and is bordered by Azamgarh district to the north, Ghazipur district to the east, Ballia district to the southeast and Varanasi district to the southwest. The district headquarters, Mau city, is located approximately 120 km southeast of Varanasi. Jaunpur district lies between 25°24' - 26°12' N latitude and 82°7' - 83°5' E longitude and is surrounded by Sultanpur in the north, Azamgarh in the northeast, Ghazipur in the east, Varanasi in the southeast, Mirzapur in the south, Prayagraj in the southwest and Pratapgarh in the northwest. The district headquarters, Jaunpur city, is approximately 60 km northwest of Varanasi. Keeping in mind the objectives of the study, multi stage stratified random sampling technique was used.

The study employed a multi-stage random sampling technique across Mau and Jaunpur districts. In the first stage, five developmental blocks were randomly selected from each

district. In the second stage, 5 villages were randomly selected from each block, totalling 50 villages. In the final stage, 240 farmer households (120 from each district) were selected using a proportionate allocation based on landholding size: 135 marginal (56.25 %), 80 small (33.33 %) and 25 medium (10.41 %) farmers. A pre-tested, structured interview schedule was used for data collection, focusing on farmers cultivating paddy, wheat, mustard and sugarcane during the 2022-23 period.

Modelling

The cost of production and returns for the farmer household were calculated on a per ha basis for the several major cereal crops in each category in order to achieve this goal. The gross return from each chosen crop was calculated to estimate the crop's return (12).

$$GR_j = Y_j \times P_j \quad (\text{Eqn.1})$$

$$NR_j = GR_j - COC_j \quad (\text{Eqn.2})$$

Where, GR_j = Gross return from J^{th} crop; Y_j = Yield of j^{th} crop in quintal; P_j = Price of j^{th} crop per quintal; NR_j = Net Return from j^{th} crop; COC_j = Cost of Cultivation of j^{th} crop; j = selected crop (1, 2, 3 and 4)

$$\begin{aligned} \text{Farm investment income} &= \text{The expenditure} \\ \text{Net farm income} &+ \text{interest on fixed capital} + \text{rental value} \\ &\text{of owned land} \end{aligned} \quad (\text{Eqn.3})$$

$$\text{Family labour income} = \text{Gross income} - \text{Cost } B_2 \quad (\text{Eqn.4})$$

$$\text{Farm business income} = \text{Gross income} - \text{Cost } A_1 \text{ or Cost } A_2 \quad (\text{Eqn.5})$$

incurred on purchasing of inputs like seeds, fertilizers, plant protection chemicals, etc., were directly observed, but expenditure incurred on fixed assets (like land, machinery, implements, etc.) and imputed value of family labour (FL) were not directly observed. So cost concepts (Costs A, B, C) as given by CACP were used to give a realistic picture of the total cost incurred on cultivation of various crops.

Cost A_1 : All variable cost excluding family labours cost and including land revenue, depreciation and Interest on working capital.

Cost A_2 : Cost A_1 + rent paid for leased in land

Cost B_1 : Cost A_2 + interest on value of owned fixed capital assets (including land)

Cost B_2 : Cost B_1 + rental value of owned land.

Cost C_1 : Cost B_1 + imputed value of family labour

Cost C_2 : Cost B_2 + imputed value of family labour

Cost C_3 : Cost C_2 + 10 % of C_2 (managerial cost)

Operational costs were estimated using prevailing rates in the study area. Wages for hired labour, including cash and kind payments, were converted at market rates, while family labour was imputed similarly. Machinery costs were based on hiring charges for non-owners and fuel, repair and maintenance for owners. Material costs (seeds, manure,

fertilizers, chemicals and irrigation) were calculated per ha at prevailing prices. Owned seeds were valued at market rates. Additional costs included interest on fixed assets, working capital (4 % per annum), depreciation and rental value of land, all assessed using prevailing rates and asset utilization.

Results and Discussions

Cropping pattern

Table 1 presents the cropping pattern followed on the sample farms within the study area. It is clear from the table that wheat was the predominant food grain crop, accounting for 34.70 % of the total gross cropped area on average across all farm sizes. Paddy and mustard were observed as the second and third most significant crops, contributing 31.45 % and 11.79 % respectively, to the gross cropped area. Sugarcane emerged as the fourth major annual crop, occupying 4.91 % of the gross cropped area across farm size groups. Collectively, these four crops-wheat, mustard, sugarcane and paddy-accounted for over 82 % of the gross cropped area and, hence, are selected as the major crops for the study.

Cost of cultivation of paddy

To evaluate the economic aspects of paddy cultivation and its impact on farmers' profitability, estimating the cost of cultivation was essential. Table 2 provides a detailed analysis of the cost structure for paddy cultivation in the study area. Labour scarcity during peak agricultural periods resulted in elevated labour wages, averaging ₹ 210 per man-day, significantly increasing expenditures on hired labour. On average, human labour costs amounted to ₹ 13690.62 per ha, with expenditures on hired labour varying across farm categories- ₹ 12863.96, ₹ 14803.50 and ₹ 14593.34 per ha for marginal, small and medium farms, respectively. Other variable of the total cultivation cost, which averaged ₹ 60802.02 per ha, included machinery charges (12.46 %), irrigation expenses (9.17 %), manure and fertilizer costs (8.58 %), plant protection expenses (6.58 %) and seed costs (5.43 %). Research indicates the similar results from previous study (13). Additionally, costs related to interest on working capital, rental value of owned land, interest on fixed capital and managerial costs contributed 0.62 %, 24.67 %, 0.89 % and 9.09 % of the total cost, respectively. The rental value of owned land accounted for the largest share, amounting to ₹ 15000 per ha. This comprehensive analysis underscores the significant influence of labour costs and land rental value on the overall economics of paddy cultivation.

However, per ha Cost A_1 on marginal, small and medium farms were found to be ₹ 28871.09, ₹ 34012.10 and ₹ 37033.40 respectively. The analysis revealed that the prevailing wage rate for labour, at ₹ 210 per man-day, exceeded the statutory minimum wage rate of ₹ 205 per man-day. Consequently, the Cost C_2 and Cost C_2^* , which include the imputed value of family labour, were identical across all farm size categories in the study area (Table 3). The per ha Cost C_3 , representing the total cost of paddy cultivation inclusive of the managerial cost incurred by farmers, was also estimated. Medium-sized farms exhibited the highest expenditure on paddy cultivation at ₹ 64302.67 per ha, which was approximately 1.09 times greater than the expenditure of

Table 1. Cropping Pattern of the sample farm (ha./farm)

S. No	Crops	Average size of sample farms			Overall average
		Marginal (135)	Small (80)	Medium (25)	
1	Paddy	0.630 (41.94)	1.200 (28.53)	1.480 (24.02)	0.909 (31.45)
2	Sugarcane	0.086 (5.73)	0.191 (4.54)	0.286 (4.64)	0.142 (4.91)
3	Arhar	0.004 (0.27)	0.007 (0.17)	0.050 (0.81)	0.010 (0.34)
4	Maize	0.003 (0.20)	0.240 (5.71)	0.420 (6.82)	0.125 (4.34)
5	Wheat	0.650 (43.28)	1.280 (30.43)	2.017 (32.73)	1.002 (34.70)
6	Mustard	0.051 (3.40)	0.620 (14.74)	1.010 (16.39)	0.341 (11.79)
7	Gram	0.020 (1.33)	0.140 (3.33)	0.250 (4.06)	0.084 (2.91)
8	Potato	0.013 (0.87)	0.210 (4.99)	0.280 (4.54)	0.106 (3.69)
9	Pea	0.006 (0.40)	0.150 (3.57)	0.159 (2.58)	0.070 (2.42)
10	Onion	0.005 (0.33)	0.120 (2.85)	0.137 (2.22)	0.057 (1.98)
11	Moong	0.002 (0.13)	0.010 (0.24)	0.017 (0.28)	0.006 (0.22)
12	Other Crops	0.032 (2.13)	0.038 (0.90)	0.056 (0.91)	0.037 (1.26)
Gross cropped area		1.502 (100)	4.206 (100)	6.162 (100)	2.889 (100)
Net sown area		0.78	2.57	3.93	1.703
Cropping intensity		192.00	163.00	156.00	169.00

marginal farmers at ₹ 58745.87 per ha. On average, the cost of cultivating paddy across all farm sizes in the study area amounted to ₹ 60802.02 per ha.

Income measures of paddy cultivation

The income generated from paddy cultivation is summarized in Table 4. Per ha gross income was observed to be the lowest on marginal farms at ₹ 81897.50, followed by small farms at ₹ 94423.00 and medium farms at ₹ 99794.00. Medium farmers achieved the highest returns over the total cost (Cost C_3). The yield of paddy was also highest on medium farms (48.68 quintals per ha), with small and marginal farms yielding slightly less. During the study period, the average net return over variable costs, farm business income, family labour income and farm investment income were calculated as ₹ 27134.86, ₹ 56501.88, ₹ 40961.16 and ₹ 48203.04 per ha, respectively. The cost of production per quintal of paddy was ₹ 1470.48 for marginal farms, ₹ 1371.64 for small farms and ₹ 1320.93 for medium farms, with an overall average of ₹ 1421.96. Per ha cost of production showed a positive correlation with farm size. The benefit-cost ratio (BCR) indicated that farmers earned ₹ 1.44 for every ₹ 1.00 invested in paddy cultivation, confirming its profitability. The findings suggest that adopting proper plant protection measures, following recommended agronomic practices, securing high market prices, utilizing minimum support prices and providing adequate training to paddy growers significantly contribute to enhancing profitability across various income metrics.

Table 2. Per ha costs of different inputs used in Paddy production (Rs.)

S. No.	Particulars	Size group of farms			
		Marginal (135)	Small (80)	Medium (25)	Overall average
1	Human Labour	12863.96 (21.90)	14803.50 (23.43)	14593.34 (22.69)	13690.62 (22.52)
a.	Family Labour	8998.82 (15.32)	7880.18 (12.47)	5858.72 (9.11)	8298.85 (13.65)
b.	Hired Labour	3865.14 (6.58)	6923.32 (10.96)	8734.62 (13.58)	5391.77 (8.87)
2	Machinery Charges	7462.01 (12.70)	7648.78 (12.11)	7942.18 (12.35)	7574.28 (12.46)
3	Seed	3206.54 (5.46)	3410.34 (5.40)	3465.28 (5.39)	3301.43 (5.43)
4	Manure and fertilizer	4846.33 (8.25)	5646.77 (8.94)	5840.85 (9.08)	5216.74 (8.58)
5	Irrigation	5269.62 (8.97)	5861.54 (9.28)	6295.10 (9.79)	5573.75 (9.17)
6	Plant Protection/Intercultural	3856.45 (6.56)	4145.35 (6.56)	4330.37 (6.73)	4002.12 (6.58)
7	Total operational cost	37504.91 (63.84)	41516.28 (65.71)	42467.12 (66.04)	39358.93 (64.73)
8	Interest on working capital	365.00 (0.62)	376.00 (0.60)	425.00 (0.66)	374.92 (0.62)
9	Rental value of land	15000 (25.53)	15000 (23.74)	15000 (23.33)	15000.00 (24.67)
10	Interest on fixed capital	535.43 (0.91)	542.11 (0.86)	564.85 (0.88)	540.72 (0.89)
11	Sub total	53405.34 (90.91)	57434.39 (90.91)	58456.97 (90.91)	55274.57 (90.91)
12	Managerial Cost@10 % of sub-total	5340.53 (9.09)	5743.44 (9.09)	5845.70 (9.09)	5527.46 (9.09)
Grand total		58745.87 (100.00)	63177.83 (100.00)	64302.67 (100.00)	60802.02 (100.00)

Figures in parentheses indicates the percentage of total cost.

Table 3. Concept wise cost of cultivation of paddy crop (Rs./ha)

Cost of Cultivation	Size group of farms			
	Marginal (135)	Small (80)	Medium (25)	Overall average
Cost A ₁ /A ₂	28871.09	34012.10	37033.40	31435.00
Cost B ₁	29406.52	34554.21	37598.25	31975.72
Cost B ₂	44406.52	49554.21	52598.25	46975.72
Cost C ₁	38405.34	42434.39	43456.97	40274.57
Cost C ₂	53405.34	57434.39	58456.97	55274.57
Cost C ₂ *	53405.34	57434.39	58456.97	55274.57
Cost C ₃	58745.87	63177.83	64302.67	60802.02

Table 4. Cost of production and returns from paddy crop

Particulars	Marginal (135)	Small (80)	Medium (25)	Overall Average
Yield (q/ha.)	39.95	46.06	48.68	42.90
Gross Income (Rs./ha.)	81897.50	94423.00	99794.00	87936.89
Net Return (Rs./q) over Cost C ₃	23151.63	31245.17	35491.33	27134.86
Farm Business Income (Net Return over Cost A ₁)	53026.41	60410.90	62760.60	56501.88
Family Labour Income (Net Return over Cost B ₂)	37490.98	44868.79	47195.75	40961.16
Farm investment income (Rs./ha.)	44027.59	52530.72	56901.88	48203.04
Benefit-Cost Ratio	1:1.39	1:1.49	1:1.55	1:1.44
Cost of production (Rs./q)	1470.48	1371.64	1320.93	1421.96

Cost of cultivation of wheat

Table 5 outlines the cost of wheat cultivation per ha, detailing expenditures across various inputs and farm sizes. The total cost of cultivation was ₹ 61449.74 for marginal farms, ₹ 64152.01 for small farms and ₹ 65382.21 for medium farms, with an average of ₹ 62760.13 per ha across all farm sizes. Human labour emerged as a significant cost component, accounting for 21.38 % of the total expenditure, averaging ₹ 13416.80 per ha. Among labour costs, family labour expenses were highest on marginal farms (₹ 8847.52/ha), while medium farms recorded the highest expenditure on hired labour (₹10,275.84/ha). Other prominent cost contributors included

machinery charges, which averaged ₹ 7308.40 per ha and accounted for 11.64 % of the total cost, followed by irrigation (10.21 %), manure and fertilizer (8.25 %) and seed costs (6.66 %). Additional costs such as interest on working capital, rental value of owned land, interest on fixed capital and managerial costs were calculated as 0.65 %, 23.90 %, 0.92 % and 9.09 % of the total costs, respectively. Among these, the rental value of owned land was the largest single component, contributing ₹ 15000 per ha to the total cost of cultivation.

However, per ha Cost A₁ on marginal, small and medium farms were found to be ₹ 31449.93, ₹ 35899.08 and ₹ 39941.77, respectively. The analysis revealed that the

Table 5. Per ha costs of different inputs used in wheat production (Rs.)

S. No.	Particulars	Size group of farms			
		Marginal (135)	Small (80)	Medium (25)	Overall average
1	Human labour	13069.86 (21.27)	13769.86 (21.46)	14160.49 (21.66)	13416.80 (21.38)
a.	Family labour	8847.52 (14.40)	6832.21 (10.65)	3884.65 (5.94)	7658.78 (12.20)
b.	Hired labour	4222.34 (6.87)	6937.65 (10.81)	10275.84 (15.72)	5758.02 (9.17)
2	Machinery charges	7102.12 (11.56)	7556.34 (11.78)	7628.92 (11.67)	7308.40 (11.64)
3	Seed	4049.92 (6.59)	4333.95 (6.76)	4401.72 (6.73)	4181.24 (6.66)
4	Manure and fertilizer	5000.48 (8.14)	5329.77 (8.31)	5664.19 (8.66)	5179.38 (8.25)
5	Irrigation	6264.16 (10.19)	6589.17 (10.27)	6609.17 (10.11)	6408.44 (10.21)
6	Plant Protection/Inter-culture	4465.35 (7.27)	4665.32 (7.27)	4849.74 (7.42)	4572.05 (7.28)
7	Total working capital	39951.89 (65.02)	42244.41 (65.85)	43314.23 (66.25)	41066.31 (65.43)
8	Interest on working capital	345.59 (0.56)	486.88 (0.76)	512.19 (0.78)	410.04 (0.65)
9	Rental value of land	15000 (24.41)	15000 (23.38)	15000 (22.94)	15000.00 (23.90)
10	Interest on fixed capital	565.92 (0.92)	588.72 (0.92)	611.95 (0.94)	578.31 (0.92)
11	Sub total	55863.40 (90.91)	58320.01 (90.9)	59438.37 (90.91)	57054.66 (90.91)
12	Managerial Cost@10 % of sub-total	5586.34 (9.09)	5832.00 (9.09)	5943.84 (9.09)	5705.47 (9.09)
Grand total		61449.74 (100.00)	64152.01 (100.00)	65382.21 (100.00)	62760.13 (100.00)

Figures in parentheses indicates the percentage of total cost.

prevailing wage rate for labour, at ₹ 210 per man-day, exceeded the statutory minimum wage rate of ₹ 205 per man-day. As a result, the Cost C₂ and Cost C₂*, which include the imputed cost of family labour, were identical across all farm size categories in the study area (Table 6). The per-ha Cost C₃, representing the total cost of wheat cultivation inclusive of farmers' managerial costs, was also calculated. Medium-sized farms incurred the highest expenditure on wheat cultivation, at ₹ 65382.21 per ha, which was approximately 1.06 times greater than the expenditure by marginal farms (₹ 61449.74 per ha). On average, the total cost of cultivating wheat across all farm sizes in the study area was ₹ 62760.13 per ha. Similar observation were made in the previous research (14).

Income measures of wheat cultivation

Table 7 highlights the income generated from wheat cultivation across different farm sizes. Gross income per ha was observed to be ₹ 76041.00 for marginal farms, ₹ 93752.75 for small farms and ₹ 97438.25 for medium farms, with an overall average of ₹ 84173.80. On average, the net return over Cost C₃ amounted to ₹ 21413.67 per ha, with medium farms achieving

the highest net return of ₹ 32056.04 per ha, while marginal farms recorded the lowest at ₹ 14591.26 per ha. The average farm business income was calculated at ₹ 50356.23 per ha, with small farms reporting the highest income at ₹ 57853.67 per ha. Similarly, family labour income averaged ₹ 34777.92 per ha, while farm investment income stood at ₹ 42697.45 per ha. The Benefit-Cost Ratio (BCR) for wheat cultivation indicated profitability, with medium farms attaining the highest BCR of 1.49, followed by small farms at 1.46 and marginal farms at 1.24. The overall BCR was 1.34, signifying that farmers earned ₹ 1.34 for every ₹ 1.00 invested in wheat production. The cost of production per quintal of wheat averaged ₹ 1632.50, with medium farms demonstrating the lowest cost of production at ₹ 1526.55 per quintal, compared to ₹ 1556.71 and ₹ 1697.04 for small and marginal farms, respectively. This reflects higher efficiency in resource utilization on medium farms. The average yield was 38.57 quintals per ha, with medium farms achieving the highest yield at 42.83 quintals per ha, while marginal farms recorded the lowest yield at 36.21 quintals per ha. Thus the wheat cultivation proved to be a profitable venture across all farm sizes. Medium farms consistently demonstrated superior profitability,

Table 6. Concept wise cost of cultivation of wheat crop (Rs./ha.)

Cost of Cultivation	Size group of farms			
	Marginal (135)	Small (80)	Medium (25)	Overall average
Cost A ₁ /A ₂	31449.96	35899.08	39941.77	33817.56
Cost B ₁	32015.88	36487.80	40553.72	34395.88
Cost B ₂	47015.88	51487.80	55553.72	49395.88
Cost C ₁	40863.40	43320.01	44438.37	42054.66
Cost C ₂	55863.40	58320.01	59438.37	57054.66
Cost C ₃	61449.74	64152.01	65382.21	62760.13

Table 7. Cost of production and returns from wheat crop

Particulars	Marginal (135)	Small (80)	Medium (25)	Overall average
Yield (q/ha.)	36.21	41.21	42.83	38.57
Gross income (Rs./ha.)	76041.00	93752.75	97438.25	84173.80
Net return (Rs./q) over cost C_3	14591.26	29600.74	32056.04	21413.67
Farm business income (Net return over cost A_1)	44591.04	57853.67	57496.48	50356.23
Family labour income (Net return over cost B_2)	29025.12	42264.95	41884.53	34777.92
Farm investment income (Rs./ha.)	35743.52	51021.46	53611.83	42697.45
Benefit-cost ratio	1:1.24	1:1.46	1:1.49	1:1.34
Cost of production (Rs./q)	1697.04	1556.71	1526.55	1632.50

efficiency and productivity, underscoring the advantages of economies of scale and effective resource management. Enhancing the productivity and profitability of small and marginal farms can be achieved through targeted interventions, such as improved mechanisation, cost-reduction strategies and enhanced extension support services.

Cost of cultivation on mustard

To evaluate the economic aspects of mustard cultivation and its influence on farmers' profitability, an analysis of cultivation costs was undertaken. Table 8 presents the per-ha expenditure on various inputs involved in mustard production. Human labour represented the largest 13019.82 per ha, constituting 27.66 % of the total cost. Among labour expenses, family labour costs were highest for marginal farmers at ₹ 8957.90 per ha, while hired labour expenses increased with farm size, peaking at ₹ 9765.42 per ha for medium-sized farms. Machinery costs formed 14.96 % of the total expenditure, averaging ₹ 7041.24 per ha. for medium-sized farms. Machinery costs formed 14.96 % of the total expenditure, averaging ₹ 7,041.24 per ha. Other significant cost components included manure and fertilizers

(7.30 %), irrigation (6.95 %), seeds (2.29 %) and plant protection measures (1.14 %). Additional expenses comprised interest on working capital (0.77 %), rental value of land (28.68 %), interest on fixed capital (1.16 %) and a managerial cost allocation of 10 % (9.09 %). Among these, the rental value of owned land was the largest contributor, amounting to ₹ 13,500 per ha.

However, per ha Cost A_1 on marginal, small and medium farms were found to be ₹ 18296.48, ₹ 24242.57 and ₹ 27921.93, respectively. The analysis revealed that the prevailing wage rate of ₹ 210 per man-day exceeded the statutory minimum wage rate of ₹ 205 per man-day. As a result, the Cost C_2 and Cost C_2^* were identical across all farm size groups in the study area (Table 9). The per-ha Cost C_3 , representing the total cost of mustard cultivation inclusive of the farmer's managerial expenses, was highest for medium-sized farms, amounting to ₹ 51614.48. This expenditure was 1.16 times greater than the cost incurred by marginal farmers, which stood at ₹ 45413.48. On average, the per-ha cost of mustard cultivation across all farm categories in the study area was calculated to be ₹ 47,078.99. Research indicates the similar type of observations (15).

Table 8. Per ha costs of different inputs used in Mustard production (Rs.)

S. No.	Particulars	Size group of farms			
		Marginal (135)	Small (80)	Medium (25)	Overall average
1	Human labour	12598.11 (27.74)	13213.08 (27.26)	14678.65 (28.44)	13019.82 (27.66)
a.	Family labour	8957.9 (19.73)	5759.65 (11.88)	4913.23 (15.87)	7470.50 (15.87)
b.	Hired labour	3640.21 (8.02)	7453.43 (15.38)	9765.42 (11.79)	5549.33 (11.79)
2	Machinery charges	6572.4 (14.47)	7548.86 (15.57)	7948.63 (14.96)	7041.24 (14.96)
3	Seed	995.67 (2.19)	1160.8 (2.39)	1260 (2.29)	1078.25 (2.29)
4	Manure and fertilizer	3205.43 (7.06)	3669.8 (7.57)	3942.1 (7.30)	3436.96 (7.30)
5	Irrigation	3060.56 (6.74)	3440.34 (7.10)	3897.02 (6.95)	3274.28 (6.95)
6	Plant protection/Inter-culture	476.21 (1.05)	593.34 (1.22)	684.76 (1.14)	536.98 (1.14)
7	Total working capital	26908.38 (59.25)	29626.22 (61.12)	32411.16 (60.30)	28387.53 (60.30)
8	Interest on working capital	346.00 (0.76)	376.00 (0.78)	424.00 (0.77)	364.13 (0.77)
9	Rental value of land	13500 (29.73)	13500 (27.85)	13500 (28.68)	13500.00 (28.68)
10	Interest on fixed capital	530.6 (1.17)	563.43 (1.16)	587.09 (1.16)	547.43 (1.16)
11	Sub total	41284.98 (90.91)	44065.65 (90.91)	46922.25 (90.91)	42799.09 (90.91)
12	Managerial Cost@10 % of sub-total	4128.50 (9.09)	4406.57 (9.09)	4692.23 (9.09)	4279.91 (9.09)
	Grand total	45413.48 (100.00)	48472.22 (100.00)	51614.48 (100.00)	47078.99 (100.00)

Figures in parentheses indicates the percentage of total cost

Table 9. Concept wise cost of cultivation of Mustard crop (Rs./ha.)

Cost of Cultivation	Size group of farms			
	Marginal (135)	Small (80)	Medium (25)	Overall average
Cost A ₁ /A ₂	18296.48	24242.57	27921.93	21281.16
Cost B ₁	18827.08	24806.00	28509.02	21828.59
Cost B ₂	32327.08	38306.00	42009.02	35328.59
Cost C ₁	27784.98	30565.65	33422.25	29299.09
Cost C ₂	41284.98	44065.65	46922.25	42799.09
Cost C ₂ *	41284.98	44065.65	46922.25	42799.09
Cost C ₃	45413.48	48472.22	51614.48	47078.99

Income measures of Mustard cultivation

Income from mustard production were calculated and are given in Table 10. The per ha gross income was highest for medium farms (₹ 83588.40), followed by small farms (₹ 75868.50) and marginal farms (₹ 67430.00), with an overall average of ₹ 71926.00 per ha. The Benefit-Cost Ratio (BCR) revealed a profitable trend, with medium farms achieving the highest BCR of 1:1.62, followed by small farms (1:1.57) and marginal farms (1:1.48). The overall BCR for mustard cultivation was 1:1.53, indicating that for every ₹ 1.00 invested, farmers earned ₹ 1.53. The average net return over Cost C₃ was ₹ 24847.01 per ha, with medium farms achieving the highest net return of ₹ 31973.93 per ha. Farm business income, representing net return over Cost A₁, was ₹ 50644.84 per ha on average, with medium farms again leading at ₹ 55666.47. Family labour income (net return over Cost B₂) and farm investment income were ₹ 36597.41 and ₹ 43174.34 per ha, respectively.

The cost of production per quintal varied with farm size, averaging ₹ 3624.49 per quintal across all farms. Medium farms had a slightly lower cost of production (₹ 3445.56/q) compared to small farms (₹ 3545.88/q), while marginal farms incurred the highest cost (₹ 3704.20/q). The yield per ha increased with farm size, being highest on medium farms (14.98 q/ha), followed by small farms (13.67 q/ha) and marginal farms (12.26 q/ha), with an overall average yield of 13.01 q/ha. Thus, mustard cultivation in the study area proved to be profitable across all farm sizes, with medium farms performing the best in terms of profitability measures, yield and net returns. The findings highlight the potential for increased productivity and profitability in mustard cultivation through optimised input use, the adoption of improved agricultural practices and

enhanced market access. Proper training and support for small and marginal farmers can further improve their economic outcomes and contribute to sustainable mustard production.

Cost of Cultivation on Sugarcane

To assess the economic analysis of sugarcane cultivation and its impact on farmers' profitability, the cost of cultivation was analyzed. Table 11 depicts the per ha costs of different inputs used in sugarcane production. Human labour constituted the largest share of the variable cost, with an overall average expenditure of ₹ 30914.28 per ha, accounting for 32.73 % of the total cost. Family labour costs were higher for marginal farmers (₹ 21785.34), while hired labour costs increased with farm size, being highest for medium farms (₹ 18825.30). Seed/Planting Materials accounted for 16.37 % of the total cost (₹ 15462.54/ha), followed by manure and fertilizers (7.13 %), machinery charges (7.04 %), plant protection (1.92 %) and irrigation (1.65 %) respectively total cost of cultivation. The cost incurred for Interest on working capital, rental value of land, interest on fixed capital and 10 % managerial cost with sub-total accounted for 3.29 %, 19.06 %, 0.72 % and 9.09 % of total cost, respectively. The maximum share among these costs was rental value of owned land which was ₹ 18000 of total cost of cultivation per ha.

However, per ha Cost A₁ on marginal, small and medium farms were found to be ₹ 42008.29, ₹ 47730.29 and ₹ 59360.81 respectively. The study revealed that the actual wage rate of ₹ 210 per man-day exceeded the minimum statutory wage rate of ₹ 205 per man-day. Consequently, the Cost C₂ and Cost C₂* were identical across all farm size groups in the study area, as presented in Table 12. The per ha Cost C₃, representing the total cost of sugarcane cultivation inclusive of the farmer's managerial costs, varied among farm sizes. Medium farmers incurred the highest expenditure on sugarcane cultivation at ₹ 1,03,293.28 per ha, which was 1.13 times greater than the expenditure of marginal farmers at ₹ 90,705.48 per ha. Research indicates the similar reports from their studies (16). On average, the cost of cultivating sugarcane per ha across all farms in the study area was ₹ 50,513.12.

Income measures of sugarcane cultivation

Income from sugarcane production were calculated and are given in Table 13. The per ha gross income was highest for medium farms (₹ 290237.50), followed by small farms (₹ 263532.50) and marginal farms (₹ 234342.50), with an overall average of ₹ 249894.90 per ha. The Benefit-Cost Ratio (BCR) revealed a profitable trend, with medium farms achieving the highest BCR of 1:2.81, followed by small farms (1:2.69) and marginal farms (1:2.58). The overall BCR for sugarcane

Table 10. Cost of production and returns from mustard crop

Particulars	Marginal (135)	Small (80)	Medium (25)	Overall average
Yield (q/ha.)	12.26	13.67	14.98	13.01
Gross income (Rs./ha.)	67430.0	75868.5	83588.4	71926.00
Net return (Rs./q) over Cost C ₃	22016.52	27396.29	31973.93	24847.01
Farm business income (Net return over cost A ₁)	49133.52	51625.93	55666.47	50644.84
Family labour income (Net return over cost B ₂)	35102.92	37562.50	41579.38	36597.41
Farm investment income (Rs./ha.)	40175.62	45866.28	50753.24	43174.34
Benefit-cost ratio	1:1.48	1:1.57	1:1.62	1:1.53
Cost of production (Rs./q)	3704.20	3545.88	3445.56	3624.49

Table 11. Per ha costs of different inputs used in sugarcane production (Rs.).

S. No.	Particulars	Size group of farms			
		Marginal (135)	Small (80)	Medium (25)	Overall average
1	Human labour	29330.59 (32.34)	32411.35 (33.08)	34675.57 (33.57)	30914.28 (32.73)
a.	Family labour	21785.34 (24.02)	22656.80 (23.12)	15850.27 (15.34)	21457.59 (24.72)
b.	Hired labour	7545.25 (8.32)	9754.55 (9.96)	18825.30 (18.23)	9456.69 (8.01)
2	Machinery charges	6575.54 (7.25)	6696.75 (6.83)	6878.41 (6.66)	6647.49 (7.04)
3	Seed	15320.02 (16.89)	15580.63 (15.90)	15854.30 (15.35)	15462.54 (16.37)
4	Manure and fertilizer	6585.32 (7.26)	8860.74 (9.04)	9789.52 (9.48)	7677.56 (7.13)
5	Irrigation	1436.43 (1.58)	1652.65 (1.69)	1898.58 (1.84)	1556.64 (1.65)
6	Plant protection/Interculture	1680.39 (1.85)	1895.81 (1.93)	2265.75 (2.19)	1813.17 (1.92)
7	Total working capital	60928.29 (67.17)	67097.93 (68.48)	71362.13 (69.09)	64071.70 (67.84)
8	Interest on working capital	2865.34 (3.16)	3289.16 (3.36)	3848.95 (3.73)	3109.07 (3.29)
9	Rental value of land	18000 (19.84)	18000.00 (18.37)	18000.00 (17.43)	18000.00 (19.06)
10	Interest on fixed capital	665.90 (0.73)	688.72 (0.70)	691.90 (0.67)	676.22 (0.72)
11	Sub total	82459.53 (90.91)	89075.81 (90.91)	93902.98 (90.91)	85856.98 (90.91)
12	Managerial Cost@10 % of sub-total	8245.95 (9.09)	8907.58 (9.09)	9390.30 (9.09)	8585.70 (9.09)
	Grand total	90705.48 (100.00)	97983.39(100.00)	103293.28 (100.00)	94442.68 (100.00)

Figures in parentheses indicates the percentage of total cost

Table 12. Concept-wise cost of cultivation of sugarcane crop (Rs./ha.)

Cost of Cultivation	Size group of farms			
	Marginal (135)	Small (80)	Medium (25)	Overall average
Cost A ₁ /A ₂	42008.29	47730.29	59360.81	45723.18
Cost B ₁	42674.19	48419.01	60052.71	46399.39
Cost B ₂	60674.19	66419.01	78052.71	64399.39
Cost C ₁	64459.53	71075.81	75902.98	67856.98
Cost C ₂	82459.53	89075.81	93902.98	85856.98
Cost C ₂ *	82459.53	89075.81	93902.98	85856.98
Cost C ₃	90705.48	97983.39	103293.28	94442.68

Table 13. Cost of production and returns from sugarcane crop

Particulars	Marginal (135)	Small (80)	Medium (25)	Overall average
Yield (q/ha.)	669.55	752.95	829.25	713.99
Gross income (Rs./ha.)	234342.50	263532.50	290237.50	249894.90
Net return (Rs./q) over cost C ₃	143637.02	165549.11	186944.22	155452.21
Farm business income (Net return over cost A ₁)	192334.21	215802.21	230876.69	204171.72
Family labour income (Net return over cost B ₂)	173668.31	197113.49	212184.79	185495.50
Farm investment income (Rs./ha.)	170548.87	193145.41	215026.42	182714.13
Benefit-cost ratio	1:2.58	1:2.69	1:2.81	1:2.64
Cost of production (Rs./q)	135.47	130.13	124.56	132.56

cultivation was 1:2.64, indicating that for every ₹ 1.00 invested, farmers earned ₹ 2.64. The average net return over Cost C₃ was ₹ 155452.21 per ha, with medium farms achieving the highest net return of ₹ 186944.22 per ha. Farm business income, representing net return over Cost A₁, was ₹ 204171.72 per ha on average, with medium farms again leading at ₹ 230876.69. Family labour income (net return over Cost B₂) and farm investment income were ₹ 185495.50 and ₹ 182714.13 per ha, respectively. The cost of production per quintal varied with farm size, averaging ₹ 132.56 per quintal across all farms. Medium farms had a slightly lower cost of production (₹ 124.56/q) compared to small farms (₹ 130.13/q), while marginal farms incurred the highest cost (₹ 135.47/q). The yield per ha increased with farm size, being highest on medium farms (829.25q/ha), followed by small farms (752.95 q/ha) and

marginal farms (669.55 q/ha), with an overall average yield of 713.99 q/ha. Sugarcane cultivation in the study area proved to be profitable across all farm sizes, with medium farms performing the best in terms of profitability measures, yield and net returns.

Thus it was observed that all the major crops studied-paddy, wheat, mustard and sugarcane-proved to be profitable for farmers in the study area. Among these, sugarcane emerged as the most profitable crop, primarily due to its significantly lower per quintal cost of production compared to the other crops. These findings were similar with the observations from the previous studies (13). As shown in Fig. 1, the net returns from sugarcane were approximately 5.72, 6.25 and 7.25 times greater than those of paddy, mustard and wheat, respectively

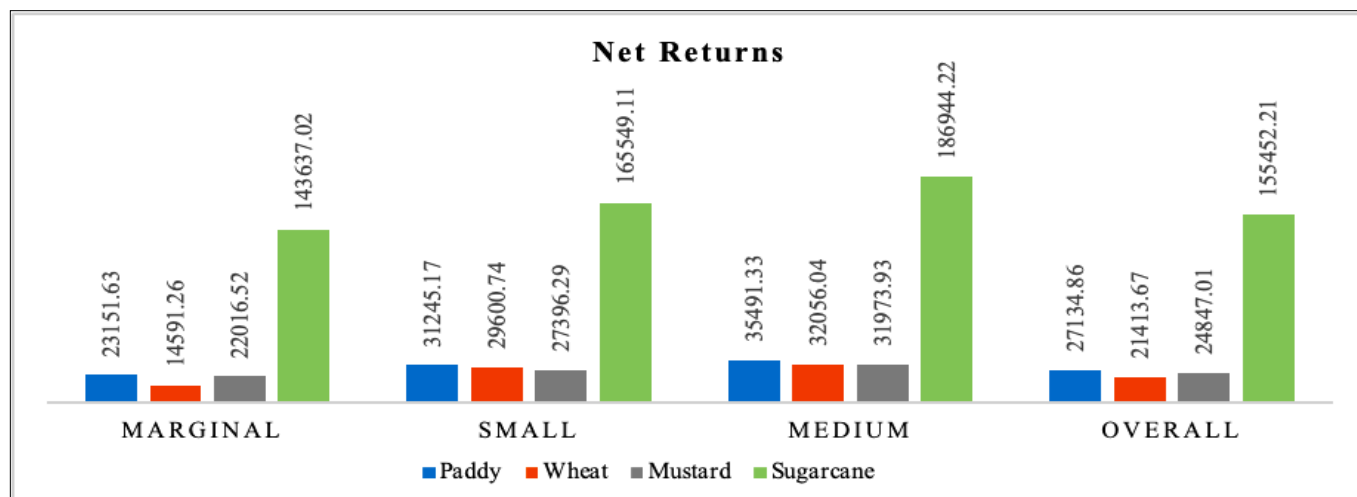


Fig. 1. Net return over C₃ of paddy, wheat mustard and sugarcane.

Conclusion

The study highlighted that the major crops selected are those grown largely in the study area, namely paddy, wheat, Mustard and Sugarcane. The study was based on primary data collected from 240 respondents across different farm size groups (marginal, Small and medium) during the agricultural year 2022-23. Wheat emerged as the major cereal crop in the study area, with a percentage share of 34.70 % in the gross cropped area. While paddy (31.45 %), Mustard (11.79 %) and sugarcane (4.91 %) crop were the second, third and fourth major crops in the study area, respectively. The cost of cultivation for mustard was ₹ 47078.99 per ha, making it the least expensive crop compared to paddy, wheat and sugarcane. However, sugarcane had the lowest cost of production at ₹ 132.56 per quintal on an overall basis. In terms of net returns per ha, sugarcane outperformed the other crops, yielding ₹ 155452.21 per ha, which was significantly higher than paddy (₹ 27134.86/ha), mustard (₹ 24847.01/ha) and wheat (₹ 21413.67/ha). This superior performance can be attributed to sugarcane being an annual crop, whereas paddy, wheat and mustard are semi-annual. Even when combinations such as paddy+wheat or paddy+mustard were cultivated together, their combined net returns failed to surpass the net returns achieved by sugarcane alone (₹ 155452.21/ha).

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Authors' contributions

S was involved in the conceptualization of the study and provided overall supervision throughout the research. PS participated in reviewing the manuscript and contributed to improving its structure and clarity. RRK assisted in editing and refining the manuscript for accuracy and coherence. PK carried out the formal analysis and contributed to the investigation phase of the study. DN conducted formal analysis, participated in the investigation, and co-wrote the original draft of the manuscript. AKT was responsible for drafting and preparing the original manuscript alongside DN. All authors read and approved the final version of the manuscript.

Compliance with ethical standards

Conflict of interest: Authors do not have any conflict of interests to declare.

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Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used Quillbot and Edit GPT to rephrase the content and remove plagiarism. Additionally, Jenni AI was used to generate ideas for writing. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

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