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Cost and Return Analysis of Bajra Crop in Bundelkhand Region of Uttar Pradesh, India

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ABSTRACT

The present study aims to evaluate the cost structure and return profile of Bajra (pearl millet) cultivation across different sample farms in the Bundelkhand region, a semi-arid zone in central India known for its challenging agro-climatic conditions. Using primary data collected from marginal, small, medium, and large-scale farms through structured interviews and field surveys, the study analyzes key cost components including fixed and variable costs as well as gross and net returns per hectare. The findings reveal significant variability in cost efficiency and profitability across farm sizes, with larger farms benefiting from economies of scale, better access to inputs, and mechanization. In contrast, smallholder farms exhibit higher cost-to-return ratios due to limited resources and traditional farming practices. The report also identifies critical obstacles that affect productivity and profitability, such as inconsistent rainfall, insufficient irrigation infrastructure, and high input costs. In the paper's conclusion, policy recommendations are made to improve input delivery, loan accessibility, and capacity-building programs in order to increase farm-level efficiency and support sustainable Bajra farming.

Keywords Bundelkhand, Farm size, Cost and return analysis, Bajra.

INTRODUCTION

With over half of the workforce employed and a major contribution to rural livelihoods, agriculture remains the foundation of the Indian economy. Among the many crops grown throughout India, millets also known as "nutri-cereals" have become more well-known because of their high nutritional content, minimal input needs, and ability to withstand dry weather (Meena *et al.* 2023). One of the most significant millet crops, bajra (pearl millet), is widely cultivated in India's semi-arid and desert regions. It has great promise for tackling the problems of farmer sustainability, climate resilience, and food security (Chaturvedi *et al.* 2022). The Bundelkhand region, which includes portions of northern Madhya Pradesh and southern Uttar Pradesh, is characterized

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by low rainfall, frequent droughts, poor soil fertility, and semi-arid conditions. The majority of people still rely on agriculture as their primary source of income despite these difficulties. Bajra is the perfect crop to grow in Bundelkhand because of its resistance to drought and ability to adapt to marginal lands. Chitrakoot, Banda, and Jalaun are among the districts in this region that are crucial for Bajra cultivation. However, despite its benefits, farmers frequently find it difficult to generate sufficient profits because of things like low productivity, weak marketing connections, inadequate irrigation, and restricted access to agricultural supplies (Lal *et al.* 2020).

An essential tool in agricultural economics for determining the economic feasibility and profitability of crop production is cost and return analysis. It entails a thorough analysis of the many expenses incurred throughout the production process as well as the profits made from the final product (Tandel *et al.* 2018). By highlighting the financial advantages and disadvantages of crop techniques across various farm types and sizes, this kind of study offers crucial information to farmers, policymakers, and extension agents. In order to increase productivity and profitability, it also helps determine how efficiently resources are being used and pinpoint areas that require assistance (Choudhary and Kumar 2023).

Due to differences in size, resource consumption, financial availability, technological adoption, and climate, Bajra cultivation's economic success varies greatly amongst farms. Important trends and differences in farm profitability can be found in this context by examining the cost and return structure of several sample farms that grow Bajra in Bundelkhand. Additionally, it can assist in discovering more efficient farm models and best practices that can be implemented in other areas with comparable agroclimatic conditions (Kumar *et al.* 2023). In the districts of Chitrakoot, Banda, and Jalaun in the Bundelkhand region, the current study intends to provide a thorough cost and return analysis of Bajra farming across various farm sizes. To understand the cost structure and returns in relation to farm size, the sample farms have been divided into marginal, small, medium, and large farms depending on their operational landholding. By gathering primary data through structured interviews and questionnaires, the study aims to capture the real situation. It focuses on both fixed and variable expenses, including labor costs, labor costs for machines and animals, seeds, fertilizer, irrigation, depreciation, and interest on working capital (Sreedhar *et al*. 2021).

The study assesses the benefit-cost ratio, net return, and gross return in addition to the cost components. These are important measures of farm profitability. The economies of scale in Bajra production can be better understood by comparing these metrics across other farm categories. For example, smaller farms may mostly rely on family labor and low-cost methods, whereas larger farms may profit from mechanization and input efficiency (Vennila *et al.* 2022). The overall sustainability and economic feasibility of Bajra farming are impacted by the interaction of these variables. The socio-economic background of the farmers is also taken into account in this study because it has a significant impact on judgments about output, resource allocation, and risk management techniques. To determine how they affect farm-level results, the availability of institutional assistance for farmers—such as financing, input subsidies, and market information is evaluated (Gowri and Shivakumar 2020). The study also considers the difficulties that farmers encounter, such as unpredictable rainfall, a lack of extension services, fluctuating prices, and losses that occur after harvest. Numerous government initiatives targeting water conservation, agricultural growth, and drought mitigation have been concentrated on the Bundelkhand region. Nevertheless, the advantages of these initiatives are frequently still not equally shared. In order to direct future planning and investment in a more focused and inclusive way, a region-specific cost and return analysis becomes crucial. The study's findings can help formulate evidence-based policies and allocate resources in a way that best serves farmers' needs in this ecologically fragile area (Kumar and Singh 2023).

MATERIALS AND METHODS

The present study was carried out in the Bundelkhand Region of Uttar Pradesh during the *kharif* season of the 2023–2024 crop year. Three districts in Bundelkhand Region, Chitrakoot, Banda, and Jalaun

chosen for the study based on the highest area under millet crops. Two blocks from each district and three villages from each block have been selected for the current study based on the largest area under Bajra and Jowar. Based on the size of their operational land holdings, all grower-farmers in Jowar and Bajra have split into four groups. With operational land holdings of less than one hectare, one to two hectares, two to four hectares, and more than four hectares, respectively, the farmers have been categorized as marginal, small, medium, and large farmers. Next, based on the probability proportion to the number of families in each group, a random sample of 20 growers of Bajra and Jowar was selected from each village. A total of 360 millet crop (Bajra + Jowar) respondents were chosen from three districts. Ultimately, 226 Bajra growers from 18 villages were selected as a sample out of 360 responders. Consequently, 53, 48, 82, and 43 farmers in the marginal, small, medium, and large land holding categories were included in the sample. Table 1 shows the distribution of farmers' land sizes by type.

Cost concept

The Commission for Agricultural Cost and Price (CACP) standard method of cost ideas was utilized to determine the cost of cultivation (COC). There are costs associated with it, including A1, B1, B2, C1, C2, and C3.

Cost A1 = Cost A1 includes all of the owner's real out-of-pocket and in-kind expenditures during production.

These 14 cost items are included:

(i) Hired human labor (permanent and casual),
(ii) Owned bullock labor,
(iii) Hired bullock labor,
(iv) Owned machinery labor,
(v) Hired machine labor,
(vi) Fertilizers,
(vii) Manure (produced on farm and purchased),
(viii) Seed (both farm-produced and purchased),
(ix) Insecticides, pesticide and fungicides,
(x) Irrigation charges,
(xi) Canal-water charges,
(xii) Land revenue, cesses and other taxes,
(xiii) Depreciation on farm implements and
(xiv) Interest on the working capital.

Cost A2 = Cost A1 + The rent for the rented land.

Cost B1 (not including land) is = to Cost A2 + Interest on the value of owned fixed capital assets.

Cost B2 = Cost B1 + The land's rental value,
Cost B1 + Family labor (imputed value) = Cost C1
Cost C2 = Cost B2 + Family labor (imputed value).
Cost C3 = Cost C2 + 10% of Cost C2.

These days, the Indian government sets the minimum support price (MSP) at 1.50 times the cost of A2 + Family labor, but farmers always seek MSP at 1.50 times the cost of C2.

Therefore, it has been possible to compare MSP and production costs in both ways. Measures of farm income: Crop profitability and return on investment at different stages are evaluated using farm income metrics. The key indicators of income are:

Gross income (GI): Both primary and secondary revenue are included in gross income.

GI = Value of main product + Value of by-product
$GI = Q_{mp} \times P_{mp} + Q_{bp} \times P_{bp}$.

Where,

G_I = Gross income.
Q_{mp} = Quantity of main product,
P_{mp} = Price of main produc,.
Q_{bp} = Quantity of by-product,
P_{bp} = Price of by-product.

Profit at Cost A2: It is also termed as farm business income (FBI). Gives farmers an estimate of the returns on their labor, investment, and profit.

FBI = Gross income - Cost A2.

Profit at Cost B2: It is also termed as family labor income (FLI). It gives the farmer an estimate of the profit and labor returns.

Table 1. Distribution of respondents' agricultural land holdings by Bajra-grown area.

Farm size	Marginal (119)	Small (86)	Medium (108)	Large (47)	Total (360)
Bajra grown (ha)	20.75	26.5	68.5	63	178.75
	(11.61)	(14.83)	(38.32)	(35.24)	(100)
Total land holdings (ha)	91.75	151	333.75	275.5	852
	(10.77)	(17.72)	(39.17)	(32.34)	(100)
Average size of holdings (ha)	0.78	1.75	3.09	5.86	2.37

FLI = Gross income - Cost B2.

Profit at Cost C2: It is also known as net income (NI). It provides an estimate of returns to the farmers purely of profit.

Net income = Gross revenue - Total expenses (Cost C3).

Return per rupee: It is defined as follows:

$$\text{Return per rupee} = \frac{\text{Gross income}}{\text{Cost C3}}$$

RESULTS AND DISCUSSION

Cost of bajra cultivation

Out of the 852 ha of total land, 178.75 ha are designated as Bajra grown area in Table 1. It supplied 20.75 hectares from marginal farms, 26.5 ha from small farms, 68.5 ha from medium farms, and 63 ha from large farms. The bajra crop is grown on a larger percentage of medium farms (38.32%), large farms (35.24%), small farms (26.5%), and minimum marginal farms (11.61%) in this table.

The cost of Bajra agriculture per hectare is displayed in the Table 2. It was discovered that the total cultivation cost for the entire category is 27630.11, which is made up of 10041.96 in fixed costs and 17588.16 in variable costs. According to the breakdown of cultivation expenses by component, fixed costs made up 36.34% of the entire cost, while variable costs made up 63.66%. The most significant variable cost was found to be machine labor, which accounted for around 18.56% of the total cost of

Table 2. Bajra crop cultivation vost per hectacre for various farm group sizes.

Sl. No.	Particulars	Size group of farms				Overall
		Marginal	Small	Medium	Large	average
1	Human labor	6310	5860.00	4358.00	3994.00	5362.06
		(22.81)	(21.65)	(15.61)	(14.31)	(19.41)
	a Family labor	4460	3400.00	2169.00	1456.00	3220.38
		(16.12)	(12.56)	(7.77)	(5.22)	(11.660)
	b Hired labor	1850	2460.00	2189.00	2538.00	2141.68
		(6.69)	(9.09)	(7.84)	(9.10)	(7.75)
2	Machinery Charges/ tractor charges	5419.00	4992.00	4981.00	4803.00	5128.41
		(19.59)	(18.44)	(17.84)	(17.21)	(18.56)
3	Seed cost	1342	1176.00	1188.00	1130.00	1236.04
		(4.85)	(4.34)	(4.26)	(4.05)	(4.47)
4	Manures and fertilizers	1837	2340.00	4495.00	5322.00	3101.58
		(6.64)	(8.64)	(16.10)	(19.07)	(11.23)
5	Irrigation	1600	1584.00	1600.00	1600.00	1596.18
		(5.78)	(5.85)	(5.73)	(5.73)	(5.78)
6	Plant protection	619.00	648.00	585.00	518.00	611.29
		(2.24)	(2.39)	(2.10)	(1.86)	(2.21)
7	Total working capital	12667.00	13200.00	15038.00	15911.00	13815.18
		(45.79)	(48.76)	(53.87)	(57.02)	(50.00)

Table 2. Continued.

Sl. No.	Particulars	Size group of farms				Overall
		Marginal	Small	Medium	Large	average
8	Interest on working capital @ 4%	506.68	528.00	601.52	636.44	552.61
		(1.83)	(1.95)	(2.15)	(2.28)	(2.00)
9	Rental value of owned land	6000.00	6000.00	6000.00	6000.00	6000.00
		(21.69)	(22.16)	(21.49)	(21.50)	(21.72)
10	Interest on fixed capital	1515.00	1481.00	1569.00	1363.00	1530.13
		(5.48)	(5.47)	(5.62)	(4.88)	(5.54)
11	Sub-total	25148.68	24609.00	25377.52	25366.44	25118.28
		(90.91)	(90.91)	(90.91)	(90.91)	(90.91)
12	Managerial cost @ 10%	2514.87	2460.90	2537.75	2536.64	2511.83
	of sub-total	(9.09)	(9.09)	(9.09)	(9.09)	(9.09)
	Gross Total	27663.55	27069.90	27915.27	27903.08	27630.11

growing Bajra. The research region uses the equipment for harvesting, planting, and plowing. With respective percentages of 4.47, 19.41, 2.21, and 11.23% of the overall cost, seeds, labor, plant protection chemicals, and fertilizers are the next largest variable cost elements. Since there was no labor cost associated with bullocks, no farmer in the study area utilized bullock power for sowing or soil preparation. This demonstrated the interest in mechanization among farmers. The primary contributors to total fixed expenses, which make up roughly 21.72 and 14.63% of total costs, respectively, are the rental value of owned land and the depreciation of farm equipment and implements. It was discovered that medium farmers have the greatest overall cultivation costs per hectare, followed by large, marginal, and small farmers, with respective costs of 27915.27, 27903.08, 27663.55, and 27069.90. The cost of hired human labor is highest among large farmers, followed by small and medium farmers, due to the more mechanized nature of farming compared to marginal farmers. As the size of the land holding increased, so did the total labor cost. For the application of manure and fertilizer, large farms paid the highest prices, followed by marginal, small, and medium farmers. The results of the study suggest that as household land size rose, the overall cost fell. For both fixed and variable costs, this held true for all land size groups. The percentage of paid labor, total labor, and machine labor rose as land size categories grew, whereas family labor showed the opposite tendency.

Standard cost concepts

Table 3 displays the standard cost principles. The estimated total cost per hectare, or the direct cost of growing Bajra, is 14486.32. According to the calculations, the costs for B1, B2, C1, and C2 are 15989.55, 21989.55, 19116.84, and 25116.84, respectively. 27628.52 is the Cost C3, which accounts for the managerial role that farmers play. Medium-sized farmers have comparatively higher costs than large, marginal, and small farmers. Costs are reduced since there is no need to hire machinery because the farm mechanized equipment that large farmers own is used consistently season after season. Large farmers pay the most (1378.61), followed by small farmers (1361.66), medium farmers (1319.87), and marginal farmers (1318.57). The total cost of producing Bajra is 1337.09 per quintal. As land size categories shrank, so did the expense of cultivating bajra.

Measures of farm income of bajra cultivation

A number of farm efficiency metrics, including net farm income (NI), family labor income (FLI), and farm business income (FBI) from Bajra production, are summarized in Table 3. 64084.53 is the expected gross income per hectare. Large farmers (62746), small farmers (615632), marginal farmers (65042), and medium farmers (65565) earn the most gross revenue. Gross income is a useful metric for evaluating the efficiency of agricultural businesses, but it is not a reliable indicator of their success. As a result, net income—an additional metric that represents surplus over total costs—is projected. A higher net income indicates how successful the farm business Medium farmers have the highest net income (37649.73), followed by marginal farmers (37378.45), large farmers

Table 3. Bajra's profitability and cost per hectare (Rs).

Sl. No.	Particulars		Size group of farms				Overall average
			Marginal	Small	Medium	Large	
1	Cost A1/A2		13173.68	13728.00	15639.52	16547.44	14486.32
2	Cost B1		14688.68	15209.00	17208.52	17910.44	15989.55
3	Cost B2		20688.68	21209.00	23208.52	23910.44	21989.55
4	Cost C1		19148.68	18609.00	19377.52	19366.44	19116.84
5	Cost C2		25148.68	24609.00	25377.52	25366.44	25116.84
6	Cost C3		27663.55	27069.90	27915.27	27903.08	27628.52
7	Yield (qtl/ha.)	(a) Main product	20.98	19.88	21.15	20.24	20.67
		(b) By product	62.96	59.66	63.45	60.73	62.03
8	Gross income	(a) Main product	52450.00	49700.00	52875.00	50600.00	51679.03
		(b) By product	12592.00	11932.00	12690.00	12146.00	12405.51
		Gross income	65042.00	61632.00	65565.00	62746.00	64084.53
9	Net income		37378.45	34562.10	37649.73	34842.92	36456.01
10	Family labour income		44353.32	40423.00	42356.48	38835.56	42094.98
12	Farm business income		51868.32	47904.00	49925.48	46198.56	49598.22
12	Farm investment income		47408.32	44504.00	47756.48	44742.56	46470.93
13	Cost of production (Rs/Qtl)		1318.57	1361.66	1319.87	1378.61	1337.09
14	Input - Output ratio						
a.	On the basis of Cost A1		4.94	4.49	4.19	3.79	4.46
b.	On the basis of Cost B1		4.43	4.05	3.81	3.50	4.03
c.	On the basis of Cost B2		3.14	2.91	2.83	2.62	2.92
d.	On the basis of Cost C1		3.40	3.31	3.38	3.24	3.35
e.	On the basis of Cost C2		2.59	2.50	2.58	2.47	2.55
f.	On the basis of Cost C3		2.35	2.28	2.35	2.25	2.32
15	B:C ratio		1.35	1.28	1.35	1.25	1.32

(34842.92), and small farmers (34562.10), with an average of 36456.01. Increased spending on contemporary agricultural equipment like hybrid seeds, tractors, reapers, threshers, and so forth may be linked to medium farmers' greater output values. Family labor revenue, which is 42094.98 per hectare and represents the returns to both farmer-owned and family labor, is a gauge of farm efficiency. Farm business income, which is 49598.22 per hectare, is another metric that shows the return on owned resources including land, labor, and capital. It is determined that the overall benefit-cost ratio is 1: 1.32.

CONCLUSION

As the study's findings make clear, the component-by-component breakdown of cultivation expenses showed that fixed costs and variable costs made up 36.34 and 63.66% of the total cost, respectively. Machine labor and human labor are the most costly aspects of agriculture, accounting for over 18.56% of the entire cost. One quintal of Bajra is produced for a cost of 1337.09, which drops as the amount of land held increases. The Government of India has declared the minimum support price for Bajra, which is the cost of production. A net profit of 36456.01 per hectare was obtained from Bajra farming.

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