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Economics of *Kharif* maize in Udaipur district of Rajasthan

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Abstract

The present study was conducted to analyze the cost of cultivation in *kharif* maize production in Udaipur district of Rajasthan during 2024-25. Two tehsils, Mavli and Vallabhnagar were purposively selected based on their highest maize area and output and a total of 100 farmers representing small, medium and large holdings were surveyed using a pre-tested structured schedule. The average total cost of cultivation was ₹43,827.21 ha^{-1} comprising 69.66 per cent variable cost and 30.33 per cent fixed cost. The cost of cultivation of maize per hectare was highest for small farm (₹45416.59) and lowest for large farm (₹42175.63) indicating economies of scale. Major cost components included the rental value of owned land, human and machine labour and seed. The gross income averaged ₹82,876.66 ha^{-1} with net income of ₹39,089.93 ha^{-1}, showed increasing trend across the farm size categories and a return per rupee of 1.89 highest for large farm (2.07).

Keywords: Maize cultivation, resource use, cost of cultivation, return per rupee, cost concepts

Introduction

Maize (*Zea mays* L.), a member of the Poaceae family, is the third most widely cultivated cereal crop globally and a cornerstone of food security and dietary energy. Originating from Central America and Mexico, maize has become a staple across tropical, subtropical, and temperate regions. In India, its cultivation dates back to the early 17th century and is now predominantly grown as a rainfed *kharif* crop, with 85 per cent of its area under monsoon conditions. Due to its ecological adaptability maize thrives in diverse agro-climatic zones from sea-level to elevations above 3000 meters and across varied soil types, particularly nutrient-rich, well-drained loams. As a fast growing C_4 plant, maize exhibits high photosynthetic efficiency, rapid biomass accumulation, and significant nutrient uptake, making it both productive and nutrient exhaustive. Maize encompasses multiple types including grain maize, sweet corn, baby corn, popcorn, waxy corn and quality protein maize. It serves as a vital resource for food, animal feed, and industrial applications. Every part of the plant holds economic value, contributing to sectors such as starch, oil, pharmaceuticals, textiles, paper, biofuels and cosmetics. In India, rising demand from poultry, livestock, aquaculture and milling industries is driving maize cultivation, even as direct human consumption declines in favor of cereals like wheat and rice. With its genetic diversity, multi-seasonal utility, and broad industrial relevance, maize remains a strategic crop for enhancing agricultural productivity and sustaining global food systems (Ferdausi *et al.* 2014) [2].

Maize is a versatile and economically significant crop that plays a vital role in enhancing farmers' income while ensuring food, feed, and nutritional security. Cultivated globally, maize surpasses wheat and rice in adaptability and utility, serving as both a staple food and a key industrial raw material. Its kernels are rich in starch, protein, and oil, making it suitable for a wide range of value-added products including snack foods, sweeteners, ethanol, and industrial goods such as pharmaceuticals, cosmetics, textiles, and paper (APEDA, 2023-24). Nutritionally, maize contributes essential dietary components—starch, fiber, antioxidants, and vitamins like B-complex, C, and pro-vitamin A, along with minerals such as phosphorus, magnesium, zinc, and iron. While naturally low in fat and sodium, it is deficient in lysine and tryptophan, necessitating its inclusion in a balanced diet. With its broad agro-industrial relevance and nutritional benefits, maize remains a cornerstone crop for sustainable development and livelihood improvement (Ramdhan *et al.*2014) and (Sureshkumar *et al.* 2014) [17].

Materials and Methods

The study was conducted in Udaipur district located in southern Rajasthan within the Mewar region. The district covers 11,724 km² of which 93 per cent is rural. The climate is sub-humid tropical monsoon with hot summers, mild winters and annual rainfall of about 600 mm mostly from July to September. Agriculture is predominantly rainfed with supplementary irrigation from wells, ponds, tanks and lakes. Soils vary from lime-rich in the north to red loams in

the south. Udaipur district was purposively selected due to its significant maize area (150,302 ha) and production (267,490 tonnes) in the year 2022-23. Two tehsils Mavli and Vallabhnagar were chosen based on highest maize area and output. From each tehsil two villages were selected, Itali and Ladani (Mavli) and Siya Kheri and Menar (Vallabhnagar). All farmers were classified into three categories *viz*., small (1-2 hectares), medium (2-4 hectares) and large farmers (>4 hectares) based on size of land holdings owned by them using cumulative square root frequency techniques. A total of 100 maize farmers were selected proportionately across size groups and villages. Primary data for the kharif season 2023-24 were collected through personal interviews using a pre-tested structured schedule. Data included household characteristics, landholding, input use, production, costs, prices and marketing details.

Analytical tools and techniques employed

The primary data was carefully examined, collected methodically, structured and organized. To accomplish the given objectives, the acquired data were analyzed using the appropriate tools and techniques which is given as below.

(1) Cost and return analysis of maize production

Cost of production

The cost of production was worked out by using following formula:

$$\text{Cost of production (₹/quintal)} = \frac{\text{Cost of Cultivation per hectare(₹)} - \text{Value of By Product (₹)}}{\text{Yield per hectare}}$$

Variable cost (VC): Variable costs are operational costs that vary with the level of production. It was calculated as follows:

Variable cost = Cost A_1 - Land revenue - Depreciation + Value of family labour

Fixed cost (FC): The fixed cost incurred irrespective of the level of production. It was computed as follows:

Fixed cost = Interest on fixed capital + Rental value of owned land + Rent paid for leased in land

Income measures

1. Gross income

It was calculated by sum of total value of main product and by product.

$GI = Q_m \times P_m + Q_b \times P_b$

Where, GI = Gross income (₹/ha) from maize cultivation,
Q_m = Quantity of maize grain (quintal),
P_m = Price of maize grain (₹/ha),
Q_b = Quantity of strover (quintal) and
P_b = Price of maize strover (₹/ha)

2. Farm business income (FBI) = Gross income - Cost A_2
3. Family labour income (FLI) = Gross income - Cost B_2
4. Net income (NI) = Gross income - Cost C_2

Results and Discussion

Resource Utilization Pattern in Maize Cultivation

The average per-hectare use of major inputs in maize cultivation is shown in Table 1. Total human labour utilization averaged 37.26 man-days/ha across all farm comprising 25.36 man-days of family labour and 11.90 man-days of hired labour. Family labour use declined with farm size with small farm using 31.40 man-days/ha compared to 20.50 man-days/ha on large farm. This inverse relationship reflects the substitution of hired machinery for human labour in larger farm and the higher dependence on family labour in small holdings to minimize cash outlays.

Hired machine labour use averaged 8.53 hours/ha increasing with farm size (6.70 hrs/ha in small farm *vs*. 10.50 hrs/ha in large farm). This is in line with findings by Patel (2019) in sorghum, Sharma *et al.* (2022) [14] on millets and Goswami *et al.* (2024) [3] in soybean where mechanization was positively associated with operational holding size. Seed rates were consistent across farm sizes at around 25.10 kg/ha with small farm slightly higher (25.50 kg/ha) due to denser sowing practices. The overall utilization of farm yard manure in cultivation of maize was found 74.26 quintal per hectare. The quantity of farm yard manure per hectare was estimated to be 75.55, 74.45 and 72.78 quintals on small, medium and large farm, respectively. The higher use in small farm due to smaller land areas allowing greater manure application from limited livestock holdings.

The fertilizer utilization, on an average, total consumption of fertilizers in cultivation of maize was found to be 79.40 kg/ha. The utilization of fertilizers was observed as highest (80.90 kg/ha) on small farm and lowest (77.57 kg/ha) on large farm. Though maize is nutrient-exhaustive the observed quantities suggest sub-optimal nutrient management, potentially affecting yield. Plant protection chemicals averaged 0.59 litres/ha increasing with farm size. This could be due to better pest surveillance and financial capacity to purchase agrochemicals in larger holdings. The pattern shows that small farm relies more on organic inputs and family labour, while larger farm lean on mechanization and chemical plant protection.

Table 1: Utilization of inputs in maize cultivation on different farm size group (per hectare)

S. No.	Farm Size Farm inputs	Small	Medium	Large	Overall
1.	Total human labour (man days)	39.50	36.70	35.60	37.26
A.	Family labour	31.40	24.20	20.50	25.36
B.	Hired labour	8.10	12.50	15.10	11.90
2.	Hired machine labour (hrs.)	6.70	8.40	10.50	8.53
3.	Seed (kg)	25.50	25.10	24.70	25.10
4.	Manures (FYM) (q)	75.55	74.45	72.78	74.26
5.	Fertilizers (kg)	80.90	79.77	77.57	79.40
6.	Plant protection chemicals (L)	0.50	0.60	0.67	0.59

Component wise costs in maize cultivation

The component wise cost in maize cultivation in Udaipur district has been in Table 2 and figure 1. It is from table that an average, per hectare total cost of cultivation of maize was estimated at ₹43827.21. Out of which, variable cost was ₹30533.18 per hectare (69.66% of total costs) and fixed cost was ₹13294.03 per hectare (30.33% of total costs). The total cost of maize cultivation was ₹45416.59, ₹43890.42 and ₹42175.63 per hectare for small, medium and large farm, respectively. Among the total costs, per hectare total variable cost were estimated as ₹31355.89 (69.04%) on small, ₹30299.92 (69.67%) on medium and ₹29944.73 (71.00%) on large farm. Whereas, total fixed costs were ₹14060.70 (30.95%), ₹13590.50 (30.96%) and ₹12230.90 (29.99%) per hectare on small, medium and large farm, respectively similar study findings by Kathirvel and Karthika (2015) [4], Singh *et al.* (2019) [16] and Singh *et al.* (2018) [15].

Total human labour cost averaged ₹8,073.33 ha^{-1} (18.42%), with ₹8,580.00, ₹7,990.00 and ₹7,650.00 ha^{-1} for small, medium and large farm. Family labour averaged ₹4,940.00 ha^{-1} (11.27%) highest in small farm (₹5,781.00; 12.83%) and lowest in large farm (₹4,151.00; 9.84%). Hired labour averaged ₹3,133.33 ha^{-1} (7.14%) ranging from ₹2,799.00 on small farm to ₹3,499.00 on large farm. Machine labour cost averaged ₹6,720.00 ha^{-1} (15.33%) with ₹6,580.00, ₹6,690.00 and ₹6,890.00 ha^{-1} for small, medium and large farm, respectively. Seed cost averaged ₹6,330.00 ha^{-1} (14.44%) ranging from ₹6,550.00 in small farm to ₹6,19.000 in large farm, similar study findings by Meena *et al.* (2024) [8] and Kumar *et al.* (2025) [5].

The cost of FYM was varied from farm (4155.25 per hectare) to farm (₹4002.90 per hectare). The cost of manure was decreased with the increase in the size of farm categories. Overall cost of fertilizer was ₹2129.51 per hectare which accounted for 4.85% of total cost. The cost of fertilizer was found highest on small farm (₹2169.74 per hectare) and lowest on large farm (₹2080.43 per hectare) Plant protection chemicals averaged ₹1,347.23 ha^{-1} (3.07%) similar findings by Murthy (2015) [9] and Meena *et al.* (2023) [7].

Interest on working capital averaged ₹1,848.78 ha^{-1} (4.21%). Rental value of owned land averaged ₹10,893.33 ha^{-1} (24.85%) highest in small farm (₹11,550.00) and lowest in large farm (₹9,950.00). Depreciation averaged ₹1,230.70 ha^{-1} (2.80%), and interest on fixed capital averaged ₹1,170.00 ha^{-1} (2.66%) similar findings by Verma *et al.* (2022) [18] and Yadav *et al.* (2023) [19].

Table 2: Component wise costs in maize, cultivation in different farm size categories (₹/ha)

S. No.	Cost items	Small		Medium		Large		Overall	
		Amount	Percent	Amount	Percent	Amount	Percent	Amount	Percent
1.	Total labor (Human)	8580.00	18.89	7990.00	18.37	7650.00	18.13	8073.33	18.42
A	Labor (Family)	5781.00	12.72	4889.00	11.13	4151.00	9.84	4940.00	11.27
B	Labor (Hired)	2799.00	6.16	3101.00	7.06	3499.00	8.29	3133.33	7.14
2.	Labor (Machine)	6580.00	14.48	6690.00	15.38	6890.00	16.33	6720.00	15.33
3.	Seed	6550.00	14.42	6250.00	14.37	6190.00	14.67	6330.00	14.44
4.	Manure (FYM)	4155.25	9.14	4094.75	9.41	4002.90	9.49	4084.33	9.31
5.	Fertilizer (Urea)	2169.74	4.77	2139.43	4.87	2080.43	4.93	2129.51	4.85
6.	Plant protection charges	1270.20	2.79	1320.60	3.00	1450.90	3.44	1347.23	3.07
7.	Interest on working capital	2050.70	4.51	1815.14	4.13	1680.50	4.02	1848.78	4.21
	Sub total (variable cost)	31355.89	69.04	30299.92	69.67	29944.73	71.00	30533.18	69.66
8.	Rental Value of owned land	11550.00	25.42	11180.00	25.47	9950.00	23.59	10893.33	24.85
9.	Depreciation on farm implements	1260.70	2.77	1230.50	2.80	1200.90	2.84	1230.70	2.80
10.	Interest on fixed capital	1250.00	2.75	1180.00	2.68	1080.00	2.56	1170.00	2.66
	Sub total (fixed cost)	14060.70	30.95	13590.50	30.96	12230.90	28.99	13294.03	30.33
	Total Cost	45416.59	100	43890.42	100	42175.63	100	43827.21	100

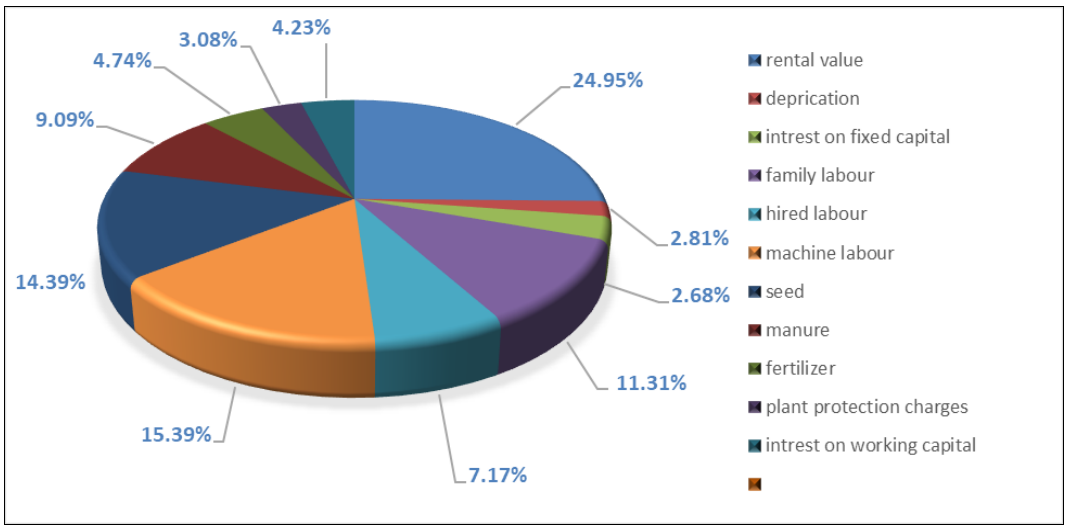

Fig 1: Component wise per cent share of cost items in maize cultivation at overall situation

Cost concepts in maize cultivation

The costs incurred in maize cultivation were categorized as Cost A_1, A_2, B_1, B_2, C_1, C_2, and C_3 (Table 3). On average, Cost A_1 was ₹26,589.01 ha^{-1} with ₹26,823.90, ₹26,501.74 and ₹26,420.40 ha^{-1} for small, medium and large farm, respectively. Since no land was leased Cost A_2 was identical to A_1. Cost B_1 averaged ₹27,759.01 ha^{-1} ranging from ₹28,079.90 on small farm to ₹27,510.40 on large farm. Cost B_2 averaged ₹38,652.34 ha^{-1} with small, medium and large farm incurring ₹39,629.90, ₹38,866.74 and ₹37,460.40 ha^{-1}, respectively. Cost C_1 averaged ₹32,699.34 ha^{-1} highest on small farm (₹33860.90) and lowest on large farm (₹31,661.40). Cost C_2 (total cost) averaged ₹43,786.73 ha^{-1} with small, medium and large farm incurring ₹45,821.60, ₹43,806.29 and ₹41,732.30 ha^{-1}, respectively. Cost C_3 averaged ₹48,165.40 ha^{-1} highest for small farm (₹50,403.76) and lowest for large farm (₹45,905.53) similar study finding by Navadkar (2012) [10].

The overall cost of production was ₹2,054.27 per quintal decreasing from ₹2,327.15 on small farm to ₹1,836.99 on large farm. Overall, variable costs contributed about two-thirds and fixed costs about one-third of the total cultivation cost. Both total cost and cost of production per quintal decreased with increasing farm size similar finding Rahul *et al.* (2023) [11] and Lone *et al.* (2022) [6].

Table 3: Cost concepts in cultivation of maize on different farm size categories (₹/ha)

S. No.	Cost items	Small	Medium	Large	Overall
1	Cost A_1/ A_2	26823.90	26501.74	26420.40	26589.01
2	Cost B_1	28079.90	27686.74	27510.40	27759.01
3	Cost B_2	39629.90	38866.74	37460.40	38652.34
4	Cost C_1	33860.90	32575.74	31661.40	32699.34
5	Cost C_2	45821.60	43806.29	41732.30	43786.73
6	Cost C_3	50403.76	48186.91	45905.53	48165.40
7	Cost of production (₹/q)	2327.15	2031.82	1836.99	2054.27

Income from cultivation of maize

Table 4 presents various income measures from maize cultivation. On average, gross income was ₹82,876.66 ha^{-1} highest on large farm (₹85,890.00) and lowest on small farm (₹80,190.00). Family business income averaged ₹56,287.65 ha^{-1} with ₹53,360.10, ₹56,044.26 and ₹59,459.60 ha^{-1} for small, medium and large farm, respectively. Family labour income averaged ₹44,224.32 ha^{-1} increasing from ₹40,560.10 on small farm to ₹48,429.60 on large farm. The net income averaged ₹39,089.93 ha^{-1} ranging from ₹34,368.40 on small farm to ₹44,157.70 on large farm. Returns per rupee invested averaged ₹1.89 highest for large farm (₹2.03) and lowest for small farm (₹1.76) similar study findings by Chowti and Basavaraja (2015) [1].

The major cost components in maize cultivation were the rental value of owned land, total labour (human and machine) and seed cost. The total cost of cultivation showed an inverse relationship with farm size, being highest on small farm and lowest on large farm. Similar trends were reported by Sharma (2022) [14] and Goswami (2024) [3].

Table 4: Income from the cultivation of maize across different farm size categories (₹/ha)

S. No.	Particulars	Small	Medium	Large	Overall
1	Gross income	80190.00	82550.00	85890.00	82876.66
2	Total cost	45416.59	43890.42	42175.63	43827.21
3	Family business income	53360.10	56043.26	59459.60	56287.65
4	Family labor income	40560.10	43683.26	48429.60	44224.32
5	Net income	34368.40	38743.71	44157.70	39089.93
6	Return per rupee	1.76	1.88	2.03	1.89

Conclusion

It can be concluded from the findings of study that averaged human labour utilization was 37.26 man-days/ha across all farm. Family labour use was declined while hired labour use was increased with farm size. Machine labour use and plant protection chemicals were increasing with farm size. Seed, manures and fertilizers use was decreased with farm size categories. The total cost of maize cultivation was ₹43,653.37 ha^{-1} decreased with farm size. The share of variable cost and fixed cost was 69.60% and 30.33%, respectively in total cost of maize cultivation. The overall cost of production was ₹2,054.27 per quintal which was found to be decreased with increases in farm size. The net income from maize cultivation was ₹39,223.28 ha^{-1} which ranged from ₹34,368.40 on small farm to ₹44,557.70 on large farm.

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