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DECLINING FINGER MILLET CULTIVATION IN UTTARAKHAND: AN ECONOMIC ANALYSIS OF INPUT USE EFFICIENCY AND PROFITABILITY

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ABSTRACT

Finger millet, a traditional and climate-resilient crop of Uttarakhand, has declined in area and production despite its nutritional and ecological importance. This study evaluates the resource use efficiency and profitability of its cultivation in Almora district using surveys of 90 farmers and 15 years of data. Results show a decline in area (−1.23% CAGR) and production (−1.30% CAGR) with stable productivity. Cultivation is labour-intensive, costing over Rs. 33,000/acre, and returns were negative in Lamgarah and Hawalbagh but modestly positive in Dhawaladevi. Cobb-Douglas analysis revealed underutilization of seed and labour, and overuse of FYM. Marginal productivity exceeded input costs for seed and labour, indicating potential yield gains through efficient resource use. The study recommends improving seed quality, mechanization, market access, and input management to enhance profitability and revive finger millet cultivation in hill agriculture.

Key words: Finger millet, Climate-resilient crops, Sustainable farming, Rainfed farming systems, Profitability

Introduction

Finger millet (*Eleusine coracana*), locally known as ragi or mandua, is a resilient and nutritious millet mainly cultivated in rainfed regions of India, Africa, and Southeast Asia. It is rich in calcium, iron, and dietary fiber, making it ideal for infants, pregnant women, and individuals with lifestyle diseases like diabetes (Upadhyaya *et al.*, 2011; Devi *et al.*, 2014). Its long shelf life and low glycemic index increase its value in both traditional and modern diets.

India produces about 80 to 85% of global finger millet (FAO, 2021), with major growing states including Karnataka, Tamil Nadu, Odisha, Maharashtra, Uttarakhand, and parts of Jharkhand and Chhattisgarh. In hilly states like Uttarakhand particularly Almora, finger millet has long been a key food and livelihood crop for small and marginal farmers due to its adaptability to poor soils, minimal input needs, and climate resilience (Negi & Maikhuri, 2013).

Economically, finger millet has lower input costs than rice or wheat and offers value addition opportunities through flour, bakery items, malted drinks, and health foods targeting urban niche markets (Rao *et al.*, 2022; Rai *et al.*, 2024). The UN's declaration of 2023 as the International Year of Millets and India's millet promotion efforts (POSHAN Abhiyan, Millet Mission) have opened doors for reviving cultivation in traditional belts like Almora. Millet exports reached Rs. 900 crores in 2022–23, highlighting its growing trade significance (APEDA, 2023).

Known for its high calcium, dietary fiber, and essential amino acids, finger millet is increasingly recognized as a climate-resilient and health-promoting “nutri-cereal” (Maharajan & Antony Ceasar, 2021; Hariprasanna *et al.*, 2024; Gami *et al.*, 2026). Once seen as a subsistence crop, finger millet now finds commercial value due to rising demand for gluten-free and health-promoting grains

(Vetriventhan *et al.*, 2020). Value-added products such as millet flour, cookies, health mixes, and energy bars are creating niche markets. National initiatives such as the inclusion of millets in the Public Distribution System (PDS) and their global recognition during the International Year of Millets 2023, have further strengthened millet promotion efforts (Satyavathi & Bhat, 2024; Chand & Thapak, 2023). Finger millet holds promise for improving rural livelihoods in hill districts like Almora, where fragmented landholdings, limited irrigation, and climate risks constrain water-intensive crops. Despite its adaptability, its cultivation has declined significantly in Uttarakhand over recent decades. Yet, its resource efficiency and profitability remain under-explored. Challenges such as traditional practices, low mechanization, weak market linkages, and limited extension support continue to hinder wider adoption (Negi *et al.*, 2018; Sati *et al.*, 2019; Gururani *et al.*, 2021).

Problem Statement

Historically, millets were a dietary staple for rural communities in Almora and across Kumaon. However, due to policy neglect, limited market access, and changing food preferences, the area under finger millet has sharply declined. According to the Ministry of Agriculture & Farmers Welfare (2023), millet cultivation in Uttarakhand dropped by over 40% between 2000 and 2020, affecting local food systems, nutrition, and land use. This shift has also left many agro-ecological zones underutilized.

In recent decades, Almora and other hill districts have seen a steady decline in finger millet area, production, and yield. Contributing factors include labour migration, poor mechanization, weak markets, low price incentives, soil degradation, shifting diets, and climate stress. Many farmers are shifting to cash crops or horticulture, finding them more profitable. Moreover, poor profitability, limited extension, inadequate marketing, and weak value-chain integration hinder the viability of millet farming. Inefficient use of land, labour, seeds, and inputs further lowers productivity. As a result, finger millet cultivation remains largely subsistence-based, with minimal surplus for trade despite its ecological and nutritional value.

These challenges underscore the need to assess dynamics of area, production and yield, resource-use efficiency and profitability to revive finger millet cultivation in promising districts like Almora.

Materials and Methods

The study used a multistage sampling design. Almora district has 11 development blocks, grouped into high, medium, and low categories based on finger millet cultivation area. One block was purposively selected from

each group: Dhauladevi (high), Hawalbagh (medium), and Lamgarah (low). Two villages were randomly chosen from each block, and 15 farmers per village were randomly selected from those cultivating finger millet on at least 25% of their land during kharif 2022–23, totaling 90 respondents.

Primary data were collected via personal interviews using a structured schedule covering household details, landholding, inputs, and outputs for 2022–23. Secondary data (2008–09 to 2022–23) on area, production, and productivity were obtained from government reports, journals, and official records.

Analytical tools

In order to examine the dynamics of area, production, and productivity, trends were estimated based on fifteen years of time-series data. Percentage changes in the same from 2008–09 to 2022–23 was also calculated. Compound Annual Growth Rate (CAGR) was estimated using the log-linear model:

$$\log Y = \log a + t \log b$$

Where

Y is area, production, or productivity;

$$r = (\text{antilog}(\log b) - 1) \times 100$$

The significance of the regression coefficient was tested using Student's t-test.

$$t_{cal} = \frac{b}{S.E.(b)}$$

To smooth out irregularities, biennium means were used for the initial and final years.

Cost and Returns Estimation

Costs and returns were calculated based on CACP cost concepts:

Cost A1: Paid-out costs

Cost A2: A1 + rent for leased-in land

Cost B1/B2: A1 + imputed interest/rent

Cost C1/C2/C2*/C3: Inclusion of family labour and management charges

Gross returns were calculated from the value of main and by-products. Net returns were derived by subtracting respective cost concepts from gross returns.

Input and Output Valuation: All inputs and services were valued at prevailing rates (in actual cash/kind) in the local market.

The Cobb–Douglas production function was used to analyze the relationship between finger millet output (quintals per farm) and five inputs: area, seed, human

Table 1: Estimated trend equation of area, production and productivity of finger millet in Almora district.

S.No.	Particulars	Area (ha)	Production (quintal)	Productivity (quintal/ha)
1.	Intercept	4.58	5.67	1.08
2.	Regression coefficient	-0.0124* (0.002)	-0.0131* (0.003)	-0.0007(0.003)
3.	Coefficient of determination (r ²)	0.7562	0.5960	0.0061
4.	Biennium mean of initial year (2008-10)	33668.5	397930	11.79
5.	Biennium mean of ending year (2021-23)	24661.5	321667.5	13.06
6.	CAGR	-1.23	-1.30	-0.07

Note: Figures in parentheses represent standard error Significant at 1 per cent level of significance

labour, bullock labour, and FYM. Multicollinearity among inputs was assessed using a zero-order correlation matrix, with coefficients above 0.80 indicating concern. In Lamgarah and Hawalbagh blocks, the variable 'area' showed high correlation with seed and FYM, so it was excluded to avoid multicollinearity.

An exponential form of the production function was adopted, which is linear in logs and suitable for estimation via Ordinary Least Squares (OLS). The final model was:

$$Y = aX_1^{b_1}X_2^{b_2}X_3^{b_3}X_4^{b_4}e^u$$

Where:

Y = Finger millet output (quintals/farm)

X₁ = Seed (kg/farm)

X₂ = Human labour (man-days/farm)

X₃ = Bullock labour (pair-days/farm)

X₄ = FYM (tons/farm)

a = Constant,

b₁ – b₄ = Coefficients,

u = Error term,

e = Euler's number (2.71828)

Finally, log-linear form of Cobb-Douglas production function was used to estimate the relationship between output (Y) and inputs: seed (X₁), human labour (X₂), bullock labour (X₃), and FYM (X₄) as follows:

$$\ln Y = \ln a + b_1 \ln X_1 + b_2 \ln X_2 + b_3 \ln X_3 + b_4 \ln X_4 + u$$

Significance of coefficients was tested using the t-test. Goodness of fit was assessed via R².

Marginal Value Productivity (MVP) and Input Cost (MIC)

MVP for each input was calculated:

$$MVP_{X_i} = b_i \times \frac{Y}{X_i} \times P_y$$

MIC was considered equal to input price:

$$MIC_{x_i} = P_{x_i}$$

Significance of the difference between MVP and MIC was tested using:

$$t = \frac{MVP_{X_i} - MIC_{X_i}}{S.E.(MVP_{X_i})}$$

Variance was computed based on standard errors from regression coefficients.

Results and Discussion

Dynamics of Area, Production, and Productivity

The trend analysis of finger millet cultivation in Almora district over the period 2008–2023 reveals notable dynamics in the area, production, and productivity of the crop. The estimated linear trend equations were computed to evaluate the temporal changes, with the key parameters presented in Table 1.

The regression coefficient for the area under finger millet cultivation was negative and statistically significant at the 1% level, indicating a declining trend in acreage. The coefficient value of –0.0124 with a standard error of 0.002 suggests a consistent annual decline in cultivated area. Similarly, the production of finger millet also exhibited a statistically significant negative trend with a regression coefficient of –0.0131 (SE = 0.003), confirming a persistent decrease in output over time. These results align with the findings of Timilsina *et al.*, (2025), Parihar *et al.*, (2021), and Rao & Prasad (2020), who reported shrinking millet cultivation in hill regions due to climate vulnerability, labour shortages, and shifting food preferences.

In contrast, the trend for productivity showed a statistically non-significant and marginal decline (coefficient = –0.0007; SE = 0.003), indicating that yield levels have remained relatively stable over the study period despite fluctuations in area and production. The low coefficient of determination (R² = 0.0061) for productivity reflects a weak explanatory power of time on yield changes, suggesting that productivity may be more influenced by other factors such as weather, input use, or technology adoption.

The comparison of biennium means between the initial years (2008–10) and terminal years (2021–23) further supports the declining trend. The average area

Table 2: Input use level in finger millet cultivation in Almora district.

S. No.	Particulars	Blocks			AD
		LG	DD	HB	
1.	Human labour (man-days)	34.72	28.69	26.44	30.01
a.	Family labour	28.37	21.85	16.75	21.82
b.	Exchanged labour	6.35	6.84	9.69	8.19
2.	Bullock labour (pair-days)	5.69	4.16	3.88	4.56
3.	Seed(kg)	4.31	5.04	4.38	4.64
4.	FYM (tons)	1.08	1.15	1.2	1.14
LG: Lamgarah; DD: Dhauladevi; HB: Hawalbagh; AD: Almora district					

under cultivation decreased from 33,668.5 ha to 24,661.5 ha, while production fell from 397,930 quintals to 321,667.5 quintals. Interestingly, despite the reduction in area and production, productivity increased slightly from 11.79 to 13.06 quintals/ha, indicating potential efficiency gains or improved agronomic practices among the remaining cultivators. Similar observations were made by Kaur and Kumari (2024), who reported a decline in millet area across India, including the Himalayan region, accompanied by modest improvements in yield due to better input management and adaptive cultivation practices.

The Compound Annual Growth Rates (CAGR) reinforce these trends. Area and production witnessed negative CAGRs of -1.23% and -1.30% , respectively, whereas productivity recorded a negligible CAGR of -0.07% , reflecting stagnation in yield improvements. This scenario underscores the critical need for interventions to revitalize finger millet cultivation through promotion of improved varieties, resource-use efficiency, and better market access, as highlighted by NITI Aayog (2018) and Negi *et al.*, (2025) in their studies on Himalayan agriculture and climate-resilient millet systems.

In summary, while the area and production of finger millet in Almora district are in decline, productivity has remained relatively stable with minor improvements. These results indicate a transition from extensive to slightly more intensive cultivation and highlight the urgency for policy and extension efforts aimed at improving profitability and sustainability of this important climate-resilient crop.

Input Use Pattern in Finger Millet Cultivation in Almora District

The analysis of input utilization in finger millet cultivation across selected blocks of Almora district Lamgarah, Dhauladevi, and Hawalbagh, reveals significant inter-block variations, indicating diverse farming practices, and dependence on family labour

(Table 2).

The total human labour employed per acre in finger millet cultivation averaged 30.01 man-days across the district, with the highest in Lamgarah block (34.72 man-days) and the lowest in Hawalbagh (26.44 man-days). Family labour constituted a major portion, accounting for over 72% of total human labour in Lamgarah but declining to just 63.35% in Hawalbagh. This suggests that households in remote areas like Lamgarah rely more on household labour due to limited access to wage labour or mechanization. In contrast, exchanged labour a traditional form of labour-sharing among smallholders was most prominent in Hawalbagh (9.69 man-days), reflecting community-based support systems still prevalent in some pockets (Pandey *et al.*, 2018; Negi *et al.*, 2018).

The use of bullock labour averaged 4.56 pair-days per acre, with the highest intensity in Lamgarah (5.69) and the least in Hawalbagh (3.88). This indicates that traditional animal-drawn ploughing still dominates land preparation, particularly in hilly terrains where mechanization remains difficult. Higher bullock use in Lamgarah also corresponds with greater human labour usage, pointing to a more labour-intensive cultivation system (Joshi *et al.*, 2022; Negi *et al.*, 2025).

Seed consumption ranged from 4.31 kg/acre in Lamgarah to 5.04 kg/acre in Dhauladevi, with a district average of 4.64 kg/acre. The variability in seed rates can be attributed to differences in broadcasting practices, local seed varieties, and soil fertility status. Farmers in Dhauladevi possibly follow denser sowing methods, either due to perceived lower germination rates or in an effort to compensate for poor soil conditions (Parihar *et al.*, 2021; Hasan *et al.*, 2025).

FYM application was relatively uniform across blocks, averaging 1.14 tons/acre, which reflects the traditional reliance on organic inputs in millet cultivation. The marginal differences—ranging from 1.08 tons in Lamgarah to 1.20 tons in Hawalbagh—may relate to household livestock holding and FYM availability. Organic inputs like FYM are essential in maintaining soil structure and fertility in hill agriculture, and their sustained application reflects ecological farming practices common in Uttarakhand (Chandra *et al.*, 2021; Kumar *et al.*, 2023).

These findings highlight that finger millet cultivation in Almora is predominantly labour-intensive, with limited mechanization and high dependence on organic and traditional inputs. Such characteristics make millet farming well-suited to the hill ecosystem but also raise concerns regarding drudgery, productivity, and

Table 3: Cost of cultivation of finger millet in Almora district (Rs. per acre).

S. No.	Particulars	Blocks			Almora district
		Lamgarah	Dhauladevi	Hawalbagh	
A. Variable cost					
1	Expenditure on human labour	12846(40.49)	13198(40.18)	11237(34.87)	13800(41.03)
2	Expenditure on bullock labour	5263(16.59)	4576(13.93)	3705(11.50)	4378(13.02)
3	Expenditure on seed	263(0.83)	297(0.90)	250(0.78)	274(0.81)
4	Expenditure on FYM	2322(7.32)	2128(6.48)	2160(6.70)	2223(6.61)
5	Interest on working capital	72(0.23)	156(0.47)	137(0.43)	106(0.32)
	Sub Total (A)	20767(65.45)	20355(61.96)	17489(54.27)	20780(61.78)
B Fixed cost					
1	Rental value of owned land(net of land revenue)	7361(23.20)	8858(26.96)	11205(34.77)	9141(27.18)
2	Depreciation	297(0.93)	357(1.09)	291(0.90)	242(0.72)
3	Interest on fixed capital	359(1.13)	361(1.10)	362(1.13)	361(1.07)
	Sub Total (B)	8017(25.27)	9576(29.15)	11858(36.80)	9744(28.97)
	Grand Total(A+B)	21568(67.98)	29931(91.11)	29347(91.06)	30524(90.75)
Total cost of cultivation					
	CostA ₁	8277(26.09)	7448(22.67)	6494(20.15)	7276(21.63)
	CostA ₂	8277(26.09)	7448(22.67)	6494(20.15)	7276(21.63)
	CostB ₁	8636(27.22)	7809(23.77)	6856(21.27)	7637(22.70)
	CostB ₂	15997(50.42)	16667(50.74)	18061(56.04)	16779(49.88)
	CostC ₁	21483(67.71)	21007(63.95)	18093(56.14)	21438(63.74)
	CostC ₂	28844(90.91)	29865(90.91)	29298(90.91)	30578(90.91)
	CostC ₂ *	28844(90.91)	29865(90.91)	29298(90.91)	30578(90.91)
	CostC ₃	31728(100.00)	32851(100.00)	32227(100.00)	33636(100.00)
Cost of production					
	Main product (Rs./q)	6541	4739	6815	6103
	By-product (Rs./q)	373	386	402	429
Note: Figures in parentheses represent percentage to total cost of cultivation (CostC ₃)					

profitability—especially in the absence of modernization and market incentives.

Cost Structure of Finger Millet Cultivation in Almora District

The cost of cultivation of finger millet was analyzed across three blocks—Lamgarah, Dhauladevi, and Hawalbagh—to estimate the average resource use and expenditure per acre. The costs were categorized into variable and fixed costs, with total economic costs computed using standard cost concepts (Cost A1 to Cost C3), in accordance with the Commission for Agricultural Costs and Prices (CACP) methodology (GoI, 2023).

Variable costs accounted for the major share of total cultivation costs across all blocks. The average variable cost per acre was highest in Hawalbagh block (Rs. 20,780), followed by Lamgarah (Rs. 20,767) and Dhauladevi (Rs. 20,355). The expenditure on human labour emerged as the most significant component of variable costs, contributing 34.87% to 41.03% of the total cost (Cost C3). This dominance of human labour reflects the labour-intensive nature of finger millet cultivation in

hilly regions (Meena *et al.*, 2025; Pandey *et al.*, 2024).

Expenditure on bullock labour ranked second, ranging from Rs. 3,705 in Hawalbagh to Rs. 5,263 in Lamgarah, accounting for 11.50% to 16.59% of the total cost. Other cost components such as farmyard manure (FYM) and seeds were relatively minor, comprising less than 8% of the total cost.

Among fixed costs, the rental value of owned land was the predominant component, constituting between 23.20% and 34.77% of the total cost. Fixed costs were highest in Hawalbagh (Rs. 11,858) and lowest in Lamgarah (Rs. 8,017). Depreciation and interest on fixed capital remained relatively consistent across blocks, each accounting for approximately 1% of the total cost.

The total cost of cultivation (Cost C3) ranged from Rs. 31,728 in Lamgarah to Rs. 33,636 in Hawalbagh per acre. The cost components followed an increasing trend from Cost A1 to Cost C3, as expected. The Cost C2, which includes imputed value of owned land and managerial input of family labour, constituted nearly 91% of Cost C3 in all blocks. This indicates that family labour

Table 4: Returns over various costs and costs of production in finger millet cultivation in Almora district.

S. No.	Particulars	Blocks			AD
		LG	DD	HB	
1. Yield obtained per acre					
	Main product (Quintal)	4.21	6.06	4.14	4.81
	By-product (Quintal)	11.24	10.69	8.33	9.98
2. Average price					
	Main product (Rs./Quintal)	4600	4520	4811.90	4652.60
	By-product (Rs./Quintal)	700	650	684	678
3. Returns realized (Rs. per acre)					
	Main product (Rs.)	19366	27391	19921	22379
	By-product (Rs.)	7868	6949	5698	6766
4. Gross returns					
	(Main product + By-product)	27234	34340	25619	29145
5. Net returns (Rs. per acre) over					
	Cost A ₁	18957	26892	19457	22001
	Cost A ₂	18957	26892	19457	22001
	Cost B ₁	18597	26530	19095	21640
	Cost B ₂	11237	17672	7890	12499
	Cost C ₁	5751	13332	7858	7840
	Cost C ₂	-1610	4474	-3345	-1301
	Cost C ₂ *	-1610	4474	-3345	-1301
	Cost C ₃	-4494	1488	-6276	-4359
	Net returns (Rs./acre)	-4494	1488	-6276	-4359
	Return per rupee expenditure	0.85	1.05	0.81	0.87

LG: Lamgarah; DD: Dhauladevi;
HB: Hawalbagh; AD: Almora district

and land rent form a significant part of opportunity costs in finger millet cultivation (Beera *et al.*, 2024; Reddy & Ravinder, 2024).

The cost of production of the main product (grain) was found to be the lowest in Dhauladevi (Rs. 4,739/q) and highest in Hawalbagh (Rs. 6,815/q). The variation can be attributed to yield differences and input use efficiency. The cost of production of the by-product (straw) ranged between Rs. 373 to Rs. 429 per quintal.

These findings point toward scope for improving labour productivity, especially in blocks like Hawalbagh where labour costs are disproportionately high. Moreover, strengthening extension services to promote cost-effective practices and improved seed varieties can help enhance profitability in finger millet cultivation.

Returns and Cost of Production in Finger Millet Cultivation in Almora District

The economic viability of finger millet cultivation across different blocks of Almora district—Lamgarah, Dhauladevi, and Hawalbagh was analyzed in terms of yield, price realization, gross and net returns, and return per rupee of expenditure. The findings are summarized in Table 4.

The average yield of the main product (grain) varied significantly across the three blocks. Dhauladevi recorded the highest yield at 6.06 quintals per acre, followed by Lamgarah (4.21 q/acre) and Hawalbagh (4.14 q/acre), with an overall district average of 4.81 q/acre. The by-product yield (mainly straw) ranged from 8.33 quintals (Hawalbagh) to 11.24 quintals (Lamgarah), averaging 9.98 q/acre. Higher yields in Dhauladevi may be attributed to better agronomic practices, input use efficiency, and more favorable agro-climatic conditions (Negi, 2022; Thakur *et al.*, 2025).

The price obtained for the main product was relatively stable, ranging from Rs. 4520 to Rs. 4811.90 per quintal, with Hawalbagh fetching the highest average price. This variation reflects local market dynamics and grain quality. The by-product was valued between Rs. 650 and Rs. 700 per quintal, contributing a significant share to gross returns, particularly in Lamgarah.

Gross returns, calculated as the sum of earnings from the main and by-products, were highest in Dhauladevi at Rs. 34,340 per acre, followed by Lamgarah (Rs. 27,234/acre), and lowest in Hawalbagh (Rs. 25,619/acre). Net returns over various cost concepts showed

considerable variation:

- Over Cost A₁ and A₂ (actual paid-out costs), net returns were highest in Dhauladevi (Rs. 26,892/acre), indicating higher profitability due to better yield and input-output efficiency.
- Over Cost B₂ (including rental value of owned land and depreciation), net returns turned negative in Lamgarah (Rs. -11,237), Hawalbagh (Rs. -7,890), and even Almora district average (Rs. -12,499), suggesting that fixed costs heavily burden marginal profits.
- Over Cost C₂ and C₃ (which include imputed value of family labor and managerial inputs), net returns were negative across all blocks except Dhauladevi, where a marginal positive return of Rs. 1,488/acre was observed over Cost C₃. This indicates poor profitability at full-cost accounting levels in most areas.

The trends underscore the economic stress under which finger millet is cultivated, particularly in marginal and rainfed areas. The findings are consistent with prior research on the profitability of millet cultivation in hill

Table 5: Regression coefficients and coefficients of multiple determination (R^2) for finger millet cultivation. (Unit per farm).

S. No.	Particulars	Blocks			Almora district
		Lamgarah	Dhauladevi	Hawalbagh	
1.	Constant	-0.1966(0.3244)	-1.2349(0.711)	-0.3940(0.351)	-0.8339(0.527)
2.	Seed (kg)	0.6534*(0.072)	0.3184(0.220)	0.1401(0.155)	0.5479*(0.091)
3.	Human labour (man-days)	0.1235(0.148)	0.7349**(0.334)	0.4666*(0.155)	0.4662**(0.208)
4.	Bullock labour (pair-days)	0.0831(0.069)	-0.0920(0.166)	0.1008(0.113)	0.1165(0.083)
5.	FYM (tons)	0.0586**(0.048)	-0.0968(0.174)	0.4415*(0.089)	0.2001*(0.060)
	R^2	0.8815	0.4414	0.8548	0.5956

Note: Figures in parentheses represent Standard error;
*Significant at 1 percent level of significance; **Significant at 5 percent level of significance

regions (Prasad & Renganathan, 2020; Rawat *et al.*, 2021).

The return per rupee of expenditure further highlights the variation in economic performance. Dhauladevi again stood out with the highest ratio (1.05), indicating a modest but positive return. In contrast, Lamgarah (0.85) and Hawalbagh (0.81) exhibited returns below unity, reflecting inefficiency and financial unsustainability under prevailing practices.

These results suggest that unless production costs—especially family labor and land rents—are offset through better yields, market linkage, or support mechanisms, the cultivation of finger millet may not be economically attractive for farmers in several parts of Almora. Policy interventions focusing on improved seed varieties, input support, and price assurance can enhance the profitability of this nutritious but neglected crop (Yadav *et al.*, 2024).

Elasticities of production and coefficient of multiple determination for finger millet cultivation

The regression analysis was conducted to assess the impact of various input factors on the profitability of finger millet cultivation across three blocks—Lamgarah, Dhauladevi, and Hawalbagh—in the Almora district of Uttarakhand (Table 5). The coefficients of multiple determination (R^2) and regression coefficients for individual inputs per farm were examined to understand their influence on the gross returns.

Table 6: Marginal value productivities of the resource use in finger millet cultivation. (Unit per farm).

S. No.	Variables	Items	Blocks			Almora district
			Lamgarah	Dhauladevi	Hawalbagh	
1	Seed (kg)	MVP	3019.90**	-	-	2584.90**
		MIC	61	-	-	59
2	Human labour (man-days)	MVP	-	1662.07**	1004.08*	962.09*
		MIC	-	460	425	460
3	Bullock labour (pair-days)	MVP	-	-	-	-
		MIC	-	-	-	-
4	FYM (tons)	MVP	498.18*	-	3551.85*	1086.04*
		MIC	2150	-	1800	1950

Note: *Significant at 1 per cent level of significance, **Significant at 5 per cent level of significance

The coefficient of multiple determination (R^2) was found to be highest for Lamgarah block (0.8815), followed by Dhauladevi (0.8548) and Hawalbagh (0.5956), indicating that the selected variables explained a large proportion of the variation in farm returns in Lamgarah and Dhauladevi. These high R^2 values suggest that the regression model fits the data well, especially in Lamgarah and Dhauladevi blocks, consistent with findings in similar crop-based profitability studies (Dhankar *et al.*, 2025; Sukanya *et al.*, 2024).

The quantity of seed used had a positive and statistically significant impact at the 1% level in both Lamgarah (0.6534) and at the district level (0.5479), highlighting the role of appropriate seed rate in improving yield and farm income. This aligns with earlier research that emphasizes the critical role of optimal seeding rates in millet productivity (Yathisha *et al.*, 2020; Sajja *et al.*, 2025).

Human labour was a significant determinant of returns in Dhauladevi and Hawalbagh blocks, with coefficients of 0.7349 and 0.4666, respectively, significant at 5% and 1% levels. This indicates that finger millet cultivation remains labour-intensive, relying heavily on manual operations, especially for sowing, weeding, and harvesting. The finding aligns with earlier studies highlighting the significance of labour input and limited mechanization potential in Himalayan hill agriculture (Thakur *et al.*, 2025; Rawat *et al.*, 2021).

Although the coefficients for bullock labour were positive across all blocks (except Dhauladevi), none were statistically significant. This suggests a diminishing role of draught animal power in finger millet cultivation, possibly due to gradual mechanization or declining livestock holdings a trend also observed by Choudhary *et al.*, (2025) in their work on Himalayan farming systems.

FYM application had a positive and significant impact in Lamgarah (0.0586), Dhauladevi (0.4415), and at the district level (0.2001). The consistent significance underscores the importance of organic inputs in maintaining soil fertility and crop productivity in rainfed millet systems, echoing the conclusions of Sati (2024) on sustainable hill farming and nutrient recycling.

Marginal Value Productivities (MVP) of Resource Use in Finger Millet Cultivation

An assessment of the resource use efficiency in finger millet cultivation was conducted across three blocks of Almora district—Lamgarah, Dhauladevi, and Hawalbagh by estimating the Marginal Value Productivity (MVP) and comparing it with the Marginal Input Cost (MIC) for key inputs. The results are summarized in Table 6.

The MVP of seed input was statistically significant and found to be Rs. 3019.90 in Lamgarah and Rs. 2584.90 in Hawalbagh, both at the 5% level of significance. These values are substantially higher than the MIC of seed, which was Rs. 61 and Rs. 59 per kilogram, respectively. This indicates underutilization of seed, suggesting that increasing seed use could significantly enhance productivity and profitability in these blocks. Similar findings were reported by Singh *et al.*, (2021), who observed that optimal seed input positively influences yield in millet crops.

Human labour exhibited statistically significant MVP values in all three blocks, with the highest value in Dhauladevi (Rs. 1662.07), followed by Hawalbagh (Rs. 1004.08) and Almora district as a whole (Rs. 962.09), significant at 1% and 5% levels, respectively. When compared with the MIC ranging between Rs. 425 to Rs. 460 per man-day, the MVP values suggest that human labour is also underutilized. This is consistent with the findings of Sharma and Rathi (2019), who emphasized the importance of labour in hilly agriculture systems where mechanization is limited.

Bullock labour did not show any statistically significant MVP in any of the blocks. The absence of significance and corresponding MIC suggests that bullock labour might not be contributing significantly to output, possibly due to limited landholdings and increasing

substitution by human labour. This aligns with observations by Pant *et al.*, (2025), who noted a declining trend in the use of draught animal power in hilly terrains.

FYM was found to be a significant contributor in Dhauladevi and Hawalbagh blocks, with MVPs of Rs. 3551.85 and Rs. 1086.04, respectively. In Almora district overall, the MVP of FYM was Rs. 498.18, significant at the 5% level. Compared to MICs ranging between Rs. 1800 to Rs. 2150 per ton, this suggests over-application or inefficient use of FYM, especially in Almora. However, in Dhauladevi, FYM appears to be highly productive and warrants targeted promotion. This trend corroborates the findings of Meena *et al.*, (2025), who highlighted the crucial role of FYM in maintaining soil fertility and yield stability in rainfed farming systems.

These findings underline the need for rationalizing input use in finger millet cultivation. Enhancing seed and labour input levels could lead to increased economic returns, while FYM application should be guided by soil health assessments to avoid inefficiencies. Policy interventions promoting balanced input use and site-specific nutrient management could play a vital role in improving resource use efficiency in hilly regions.

Conclusion

The study of finger millet cultivation in Almora district highlights a steady decline in area and production from 2008 to 2023, driven by socio-economic challenges and limited profitability, despite stable yields. Traditional, labour-intensive practices dominate, with high input costs and low economic viability in most blocks. However, resource use efficiency analysis reveals scope for improving returns through better use of seeds and labour, and balanced nutrient management. The findings call for targeted interventions—improved varieties, hill-suited mechanization, scientific input use, and stronger market linkages—to revitalize finger millet as a sustainable and economically viable crop in the region

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