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Economic Viability and Productivity Dynamics of Finger Millet Cultivation in Karnataka- An Empirical Analysis

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Abstract

Finger millet production in India has decreased in recent decades, primarily due to challenges such as drought, inadequate market support, and cultural barriers. Against this backdrop, the present study examines the economic viability of finger millet cultivation in Karnataka, the state with the largest share of finger millet production. Specifically, it examines (i) the cost of cultivation, returns, and profitability; (ii) the relationship between inputs and output through the application of the Cobb-Douglas production function and decomposition analysis, The study is based on the cost of cultivation survey data published by the Commission of Agricultural Costs and Prices (CACP) and the Indian Institute of Millet Research (IIMR) for 2001–2020. Results revealed that the total cost of cultivation increased sharply from ₹13,125.17/ha in 2001 to ₹79,025/ha in 2020, primarily driven by escalating labour and input expenses. Although gross income rose substantially during the same period, profitability under comprehensive cost (C2) remained negative, reflecting persistent cost pressures. Break-even analysis indicated that actual yield remained below the threshold level in most years. The highest negative deviation was observed in 2011, with the actual yield (20.15 q/ha) falling 15.05 q/ha (-42.75 percent)

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short of the break-even yield (35.20 q/ha), underscoring the vulnerability of rainfed systems to climatic shocks and drought conditions. The total cost of cultivation increased sixfold from ₹13,125/ha in 2001 to ₹79,025/ha in 2020, mainly driven by sharp rises in human labour (785%), seed (599%), and rental values (706%). Although gross income rose to ₹73,014/ha by 2020, profitability remained negative under comprehensive cost (C2), with losses reaching –₹6,011/ha. The Cobb–Douglas production function explained 61 percent of the output variation, identifying seed, fertilizer, human labour, and animal labour as significant contributors to yield, with fertiliser having the highest positive effect of 0.35. The sum of input elasticities (1.06) indicated increasing returns to scale, suggesting potential efficiency gains through integrated input use. Decomposition analysis revealed that total factor productivity (TFP) contributed 46.73 percent to output growth, underscoring the significant role of technological advancements and improved management practices. The study concludes that profitability cannot be sustained without reducing labour costs, strengthening value chain incentives, and promoting climate-resilient and mechanised cultivation practices. Policies supporting processing, MSP revision, and input-efficient technologies are essential to revive finger millet production under rainfed conditions.

Introduction

Crop diversification is necessary due to the growing population's concerns about nutrient-sufficient diets and the agricultural sector's susceptibility to climate change. In this case, millet is considered a viable option due to its significant properties, including its climate resilience, low input requirements, and a rich nutritional profile. Among millet, finger millet is considered superior to other millets.[1] It is extremely climate-adaptable and tolerant to both biotic and abiotic stressors; it requires few inputs and can adapt to severe weather conditions. The crops thrive in tropical areas of Africa and India, where the average minimum temperature seldom falls below 18°C and the average maximum temperature approaches 27°C.[2] Although it can tolerate 300-400 mm of precipitation, it typically requires 500 mm of rainfall annually.

Further, due to its high content of dietary fibres, iron, zinc, calcium, phosphorus, potassium, vitamin B, and essential amino acids, finger millet is more nutritious than rice and wheat.[3] Its crude fibre (4.3 percent of fibre)[4] and mineral content (25 to 35 percent) significantly surpass that of wheat (1.2 percent of fibre and 1.5 percent of minerals) and rice (0.2 percent of fibre and 0.6 percent of minerals).[5] Due to its increased starch content and distinctive characteristics, it possesses significant potential as a sustainable, gluten-free source for edible starch in the food sector, thereby improving the shelf life and quality of food items.[6] Compared to other millets and grains, it has a higher methionine content (194 mg/100 g). These essential amino acids lower the risk of cancer, obesity, and high cholesterol.[7]

With regards to finger millet production, India is a major contributor with 2.2 million tonnes, followed by Africa, which produces roughly 2 million tonnes. Karnataka leads in both area (641,000 hectares) and production (1,164,000 tonnes) followed by Maharashtra (82.22'000 hectares of area, 87.24'000 tonnes of production, 1061 kg/ha yield) and Uttarakhand (84.00'000 hectares of area, 120.12'000 tonnes of production, 1430.00 kg/ha yield).[8] Other major area of cultivation includes Andhra Pradesh, and Tamil Nadu, as well as in hilly northern areas, Himachal Pradesh. Despite its smaller area under cultivation (84.54 hectares), Tamil Nadu records the highest yield at 3247.00 kg/ha, whereas Karnataka has a yield of 1816.00 kg/ha.[9] Finger millet is the staple food for the majority of the population in South Karnataka and is mainly cultivated by small and marginal farmers as a rainfed and irrigated crop. Mandya, Mysore, Bengaluru Rural, Tumakuru, Ramanagara, Kolar, Hassan, Chitradurga, Chikkamagaluru, and Devanagara are significant areas where finger millet is cultivated.[10]

Although Karnataka still occupies the first position in millet production in India, the crop area has drastically decreased from 1.02 million hectares in 2001 to 0.64 million hectares in 2020; and production has decreased from 1.87 million tonnes to 1.16 million tonnes during the same period. This decline in associated with extreme agrarian distress in Karnataka, standing second in the farmers' suicide rate.[11] Between 2018 and 2022, 10974 farmers committed suicide in Karnataka. Mandya district, which is prominent for finger millet cultivation alone, reported 620 farmer suicides during 2014-15 to 2024-25,[12] with 38 deaths in 2023-24.[13] While in the Mysore district, another significant region for finger millet cultivation, 32 farmer suicides were reported in the 2023-24 fiscal year. These alarming statistics underscore the economic pressure faced by finger millet farmers and highlight the need for a deeper understanding of vulnerabilities at the farm level.

Despite its nutritional, significance, finger millet cultivation in Karnataka is facing economic vulnerabilities due to rising input costs, fluctuating productivity, market uncertainties and a steady decline in cultivation area. This can also be related to the problems faced by them. As Saxena, Singh and Singh[14] point out, for the better growth and development of finger millet, finger millet is required to be supplied by balanced nutrition. Insufficient or inadequate application of fertiliser leads to lower yield and increased susceptibility to disease. Further, climate change also affects the productivity of finger millet. For instance, severe drought has a negative impact on the yield of finger millet.[15] Higher temperatures, especially in the reproductive stage, affect the finger millet negatively.[16] Finger millet is also more or less susceptible to pest attack.

Although earlier research on finger millet in Karnataka primarily focused on growth and production trends,[10,17,18] there is a lack of empirical evidence on the microeconomic aspects of finger millet cultivation at the local level. Specifically, there is still a crucial research gap in understanding the profitability of crops because areas such as the cost of cultivation, farm returns, and break-even points remain unexplored. Therefore, a systematic economic assessment is necessary to understand whether finger millet cultivation remains viable for farmers in the state. The study specifically addresses the following research question.

1. What are the trends in the cost of cultivation and farm returns of finger millet in Karnataka from 2001 to 2020?
2. What are the growth patterns of major input variables such as labour, seed, fertiliser, and manure?
3. What are the break- even levels of finger millet, and how do they vary over time?
4. How do input factors influence output, as examined through the Cobb- Douglus production function and decomposition analysis?

Accordingly, the present study aims to thoroughly investigate the economics of finger millet cultivation in Karnataka using secondary data from 2001 to 2020. It aims to estimate the cost of cultivation and farm returns, growth rates of primary inputs, including labour use and fixed costs. Further, it also aims to determines break-even points, and analyse input-output relationships through the Cobb-Douglas production function and applies decomposition analysis to capture the contributions of input changes.

Material and Methods

Data Sources and Sampling Technique

The present research is based on secondary data regarding the area, production, productivity, and cost of cultivating finger millet in Karnataka from 2001 to 2020. A purposive selection method was employed, wherein Karnataka was selected because it is the largest producer of finger millet in India.9 Time series data spanning from 2001 to 2020 were taken from two primary sources.

- Indian Millet Research Institute[19] for area, production, and productivity, and
- Commission for Agricultural Costs and Prices (CACP) cost of cultivation surveys for cost components

These datasets from IIMR and CACP were again validated with the publication of the Directorate of Economics and Statistics (DES), Government of Karnataka, to ensure there is no missing value and maintain the reliability of the series. All variables were standardised into annual observations before applying trend, profitability, production function, and decomposition analysis.

Cost and Returns concepts

Cost of finger millet cultivation during the period 2001- 2020 were calculated using specific cost concepts. The different cost concepts and list of items which fall under each category of cost were given below. This concept was employed by Verma, Bhagat, Khoisnam, *et al*.[20]

Cost A1 includes totality of all expenditure incurred by the farmers for production in both cash and kind such as a) value of hired human labour; b) value of hired bullock labour; c) hired machinery labour; d) owned bullock labour; e) owned machinery labour, f) seeds (purchased and owned); g) value of insecticide and pesticides; h) value of fertilizers; i) value of manure (owned an purchased); j) depreciation on equipment and farm building; k) irrigation cost; l) land revenue, and cess; m) interest on working capital; n) miscellaneous expenses

Cost A2= Cost A1 + amount paid as rent for leased land
Cost B1= Cost A2 + imputed value of owned land + interest on owned capital assets (excluding land)
Cost B2= Cost B1 + rental value of owned land and rent paid for leased in land
Cost C1= Cost B1 + imputed value of family labour
Cost C2= Cost B2 + imputed value of family labour
Cost C3= Cost C2 + 10 percent of Cost C2

Finally, total cost of production = (Value of by product)/(Yeild)

In the present investigation, cost C2 was employed for estimating the profitability. All the variable and fixed cost 21 are included in the C2. Hence,

Profitability = Gross value of output- Cost C2
The return was estimated using the following measures.

- Farm business income = Gross return- Cost A2
- Family-owned labour income = Gross return- Cost B2
- Net income = Gross return- Cost C2
- Farm investment income = Farm business income- Imputed value of family labour
- Return per rupee investment = (Gross return)/(Cost C2)

Break Even Analysis

A break-even analysis was applied to examine the profitability of expenses in a market-based agricultural business. The formula BEA employed in the study was adopted from existing literature, such as Sahu, Nahatkar, and Kolar.[22]

BEY =(Total fixed Cost ₹)/(Average revenue (₹ per q^{-1}) -Average variable cost (₹ per q^{-1})

Where,
Average revenue (₹/q^{-1}) = Farm harvest price (₹q^{-1})
Average variable cost(₹/q^{-1}) = Operational cost (₹q^{-1})

Yield difference (YD) = Actual Yield – BEY
Percent difference = YD/(BEY) x 100

2.4 Cobb- Douglas Production Function

The Cobb-Douglas production function is one type of production function that is frequently employed to examine the relationship between inputs and outputs. It was developed by Cobb and Douglas[23] and discussed in 'A Theory of Production'. Compared to other production functions, this one has several advantages, including (a) computational manageability in its algebraic form and (b) providing details related to returns to scale. It has been widely employed in studies related to agricultural production.[24]

Cobb Douglas (C-D) production is expressed as follows.

$$Y= A.K^{\alpha}.L^{\beta} \quad ...(1)$$

Where,
Y= total production or output of a firm
Y is a function of A which denotes technology; K and L signify capital and labour respectively, and α and β denotes the parameters of C-D production function.
The Cobb- Douglas production function employed in the present study is given below.

$$Y= A.\ X_1^{\beta 1}.\ X_2^{\beta 2}.\ X_3^{\beta 3}.\ X_4^{\beta 4}.\ X_5^{\beta 5} \quad ...(2)$$

For estimating the values of β1 to β2 given in equation (2), log linear functional form was employed which is expressed as.

$\ln Y = \ln A + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5$ ...(3)

where,
Y = Finger millet production (tonnes)
A = Constant
X1 = Seed (kg)
X2 = Fertilizer (kg)
X3 = Manure (kg)
X4 = Human labour (Man hrs)
X5 = Animal labour (Pair hrs)

Decomposition Model

The decomposition of output growth divided into the contribution of factor inputs and the residual productivity component is based on the growth accounting methodology given by Solow.[25] In his foundational study, Solow[25] illustrated that by differentiating an aggregate production function (typically modelled as Cobb-Douglas) concerning time, one can articulate the output growth rate as the weighted sum of input growth plus a residual which he designated as the “Solow Model”. This residual has been regarded as an indicator of total factor productivity (TFP) encompassing technological variables. This model was exclusively employed in agricultural economics to elucidate the origins of sources of productivity growth, especially in the research work by Hayami and Ruttan.[26] Decomposition analysis can be expressed as given below by differentiating equation with respect to time (t) yield the growth rate form.

$(d(\ln Y))/(dt) = (d(\ln A))/(dt) + \beta_1 (d(\ln X_1))/(dt) + \beta_2 (d(\ln X_2))/(dt) + \beta_3 (d(\ln X_3))/(dt) + \beta_4 (d(\ln X_4))/(dt) + \beta_5 (d(\ln X_5))/(dt)$ ...(3)

By regressing that each derivative in equation (3) which represents a growth rate, we obtain the decomposition identity.

$g_y = \beta_1 gX_{1d} + \beta_2 gX_{2d} + \beta_3 gX_{3d} + \beta_4 gX_{4d} + \beta_5 gX_{5d} + g_A$ ...(4)

where,
g_y = growth rate of output
g_A = TFP growth (residual)

gx_1d, gx_2d, gx_3d, gx_4d, and gx_5d represent the growth rates of seed, fertilizer, manure, human and animal labour. β_1, β_2, β_3, β_4, β_5 are the elasticities of inputs (measured form regression)

In empirical application the contribution of each input is calculated by multiplying its growth rate by its elasticity, while TFP growth is obtained as the residual.

$g_A = g_y - (\beta_1 gx_{1d} + \beta_2 gx_{2d} + \beta_3 gx_{3d} + \beta_4 gx_{4d} + \beta_5 gx_{5d})$

This enables to quantify how much of output growth is attributable to input accumulation (seed, fertilizer, manure, human and animal labour) versus productivity improvement.

Results

Cost and Returns

Table 1 shows the changes in costs and profitability of finger millet cultivation in Karnataka between 2001 and 2020. The cost of cultivation (A1, A2, B1, B2, C1, C2, and C3) exhibits a steady upward trend over time, indicative of growing input prices and inflationary pressure. The total cost has increased from ₹13,125.17/ha in 2001 to ₹79,025/ha in 2020. The increased use of human labour, fertilizer, and machinery can be a significant reason for such an rise. The gross income showed a parallel rise from ₹7886.54/ha in 2001 to ₹73,013.73/ha in 2020, showing a nominal income expansion due to output growth and market price for produce.

Table 1: Cost and Returns

Cost of Cultivation (Rs./Hectare)		2001	2005	2010	2015	2020
	A1	8281.92	10187.53	16852.48	36520.52	47083.95
	A2	8281.92	10187.53	16852.48	36520.52	47083.95
	B1	8968.34	10636.34	19279.17	39510.82	47794.07
	B2	10848.02	12831.95	23482.66	49428.35	62949.24
	C1	11245.49	13263.81	24938.30	49924.39	63869.99
	C2	13125.17	15459.41	29141.79	59841.92	79025.14

C2 Revised	13125.17	15969.47	29141.79	60128.51	79299.73
C3	14437.69	17566.42	32055.97	66141.36	87229.70
Value of Main Product (Rs./Hectare)	6256.23	7252.83	14297.89	37035.60	64605.49
Value of By- Product (Rs./Hectare)	1630.31	2912.52	4717.62	6863.51	8408.24
Gross Income	7886.54	10165.35	19015.51	43899.11	73013.73
Net income over cost A2	-395.38	-22.18	2163.03	7378.59	25929.78
Net income over cost C2	-5238.63	-5294.06	-10126.28	-15942.81	-6011.41
Return over variable cost	3156.95	5456.48	8830.45	25670.42	35060.43
Farm Business Income (FBI)	-395.38	-22.18	2163.03	7378.59	25929.78
Family Labour Income (FLI)	-2961.48	-2666.60	-4467.15	-5529.24	10064.49
Farm Investment Income (FII)	-5238.63	-5804.12	-10126.28	-16229.40	-6286.00
Return per Rupee (on Cost A2)	0.95	1.00	1.13	1.20	1.55
Profit (VOP-C2)	-5238.63	-5804.12	-10126.28	-16229.40	-6286.00
Profit (VOP- C3)	-6551.15	-7401.07	-13040.46	-22242.25	-14215.97
Profit (VOP/C2)	0.60	0.64	0.65	0.73	0.92
Profit (VOP/C3)	0.95	1.00	1.13	1.20	1.55

Break Even Analysis

The break-even analysis results are displayed in Table 2. During the study period, the actual yield consistently remained below the break-even yield, with negative yield differentials ranging from -4 percentage points up to nearly -43 percentage points, except in 2016, when the actual yield (16.85 q/ha) slightly exceeded the break-even yield (16.01 q/ha), resulting in a positive differential of 0.84 q/ha (5.24 percent).

Change and Growth in Labour, Input and Fixed Cost

Data on differences in labour, inputs, and fixed costs in finger millet production over the time period 2001-2020 were displayed in Table 3. In terms of labour use, the absolute expenditure on human labour has increased sharply from ₹4,468.42/ha to ₹39,563.77/ha, showing a relative percentage change of 785.41. Input cost structure experienced significant changes between 2001 and 2020. There is an increased use of seed which registering a relative change of 599.27 percent, though the share of fertiliser remain highest (68.96 percent) in input components. The analysis of fixed cost components of finger millet cultivation from 2001 to 2020 indicated an overall increase in fixed cost expenses, primarily driven by a sharp increase in land rental values. The rental value increased by 706.26 percent.

Table 2: Break Even Analysis

Year	AVC (₹/q)	AR (₹/q)	Total Cost (₹/ha)	Break-Even Yield (q/ha)	Actual Yield (q/ha)	Differential Yield (q/ha)	Percent Difference (percent)
2001	558.24	426.72	13125.17	30.76	18.48	-12.28	-39.91
2002	419.6	450.92	9479.37	21.02	16.14	-4.88	-23.2
2003	928.32	890.49	11853.35	13.31	9.31	-4	-30.03
2004	836.99	771.3	12315.98	15.97	11.27	-4.7	-29.42
2005	647.83	523.81	15969.47	30.49	19.41	-11.08	-36.35
2006	694.19	919.18	17727.59	19.29	18.38	-0.91	-4.7
2007	1049.16	899.5	18237.14	20.27	13.47	-6.81	-33.59
2008	839.77	1129.92	22595.14	20	17.97	-2.03	-10.13
2009	1041.78	1218.88	23940.15	19.64	16.58	-3.07	-15.61
2010	1293.58	1108.76	29141.79	26.28	17.15	-9.13	-34.75
2011	1322.33	990.84	34876.68	35.2	20.15	-15.05	-42.75
2012	1438.88	1567.64	35938.2	22.93	18.71	-4.22	-18.4

2013	2033.31	2281.45	40061.43	17.56	15.12	-2.44	-13.91
2014	2452.69	2005.55	54947.43	27.4	17.59	-9.81	-35.8
2015	2530.37	2394.5	60128.51	25.11	18.33	-6.78	-26.99
2016	1989.56	3087.23	49413.86	16.01	16.85	0.85	5.28
2017	3383.37	3304.68	61775.72	18.69	14.36	-4.33	-23.16
2018	2596.64	3369.37	63268.36	18.78	16.53	-2.25	-11.97
2019	4113.92	4681.6	68346.3	14.6	12.85	-1.75	-11.98
2020	3467.83	4020.58	79299.73	19.72	18.16	-1.56	-7.93

Source: Author's own evaluation

Table 3: Change and growth in labour, input and fixed cost

Change and Growth Rate of Labour Use in Finger Millet Production (₹ /ha)

Particulars	Human Labour	Bullock Labour	Machine Labour	Total Labour use
2001-02 (BY)	4468.42	2908.24	488.34	7865
(Percent)	56.81	36.98	6.21	100.00
2020-21 (CY)	39563.77	4397.92	9418.38	53380.07
(Percent)	74.12	8.24	17.64	100
Relative Change	785.41	51.22	1828.65	578.70
(Percent)				
	-17.30	28.74	-11.43	

Change and Growth rate of Input costs used in Finger Millet ((₹ /ha)

Particulars	Seed	Fertilisers	Insecti -cides	Irrigation Charges	Miscella -neous Charges	Interest on work -ing capital	Input Cost
2001-02 (BY)	138.9	1906.32	0	163.53	0	243.64	2452.39
(Percent)	5.66	77.73	0.00	6.67	0.00	9.93	100.00
2020-21 (CY)	971.28	6391.39	0	483.79	0	1421.2	9267.66
(Percent)	10.48	68.96	0.00	5.22	0.00	15.34	100.00
Relative Change	599.27	235.27	0.00	195.84	0.00	483.32	277.90
(Percent)							
	-4.82	8.77	0.00	1.45	0.00	-5.40	

Change and Growth rate of fixed costs used in Finger Millet

Particulars	The rental value of land	Rent paid for leased inland	Land Revenue, Taxes, Cesses	Depreciation of farm assets	Interest in fixed capital	Total fixed cost
2001-02 (BY)	1879.68	0	7.55	234.13	686.42	2807.78
(Percent)	66.95	0.00	0.27	8.34	24.45	100
2020-21 (CY)	15155.17	0.00	18.38	165.60	710.12	16049.27

(Percent)	94.43	0.00	0.11	1.03	4.42	100
Relative Change	706.263	0	143.443	-29.270	3.4526	471.599
(Percent)	3001		7086	06364	966	9829
	-27.48	0.00	0.15	7.31	20.02	

Source: Author's own evaluation

Cobb Douglus Production Function- Application

The findings of the Cobb-Douglas Production Function are shown in Table 4a and 4b. With an R^2 value of 0.606, the estimated Cobb-Douglas production function for finger millet cultivation in Karnataka has a reasonably good fit, indicating that the selected input variables explain 61 percent of the variation in output. It was further revealed that all the input factors except manure such as seed, fertiliser, human labour, animal labour effect positively and significantly.

Table 4a: Regression Statistics

Regression Statistics	
Multiple R	0.7784
R Square	0.6060
Adjusted R Square	0.5841
Standard Error	3.8155
Observations	20.0000

Source: Author's own evaluation

Table 4b: Cobb Douglus Production Function

	Coefficients	Standard Error	t Stat
Intercept	3.37287	2.69242	1.25273
LnX_1	0.3194	0.3117	1.0246
LnX_2	0.2355	0.0788	2.9864
LnX_3	0.3517	0.9574	0.3673
LnX_4	0.0721	1.7456	0.0413
LnX_5	0.0801	0.1354	0.5920

Source: Author's own evaluation

Decomposition Analysis

The decomposition analysis results, presented in Table 5, reveal the contribution of key input factors to output growth of finger millet cultivation. The primary drivers of output change during the study period were the total factor productivity (TFP) component, which accounted for 46.73 percent of the total growth. This indicates that nearly half of the observed growth in output was attributable to technological progress, improved efficiency, and better management practices.

Table 5: Decomposition Analysis

Input / Factor	Mean Contribution	Standard Deviation	Share (percent)
Seed	0.0128	0.2041	15.12
Fertilizer	-0.0132	0.212	17.13
Manure	-0.0084	0.1209	5.89
Human Labour	-0.0239	0.2466	14.21
Animal Labour	0.0081	0.011	0.92
TFP	0.0355	0.6236	46.73

Source: Author's own evaluation

Discussion

The cost and return analysis reveal that though the gross income has been increased. the net income over C2 was negative, indicating unprofitable returns. A positive turnover appeared in 2010 (₹2163.03/ha), reflecting the gradual improvement in market realisation. Thereafter, profitability improved significantly, reaching ₹ 7,378.59/ha in 2015 and ₹ 25,929.78/ha in 2020, implying a substantial recovery in net farm income under A2 cost cultivation. When assessed under comprehensive cost (C2), the net income remained negative throughout the study period, indicating that full cost recovery, which includes imputed family labour and fixed capital interest, remained elusive. The loss under C2 rise significantly from ₹5238.63/ha in 2001 to ₹6,011.41/ha in 2020. This pattern highlights that while nominal revenues have increased, escalating costs continue to erode profitability under the full-cost accounting framework.

From ₹3156.95/ha in 2001 to ₹35060.43 in 2020, the return over the variable cost improved steadily, demonstrating the increasing economic efficiency of variable inputs. Similarly, return per rupee invested (on cost A2) increased from 0.95 in 2001 to 1.55 in 2020, signifying that every rupee invested yielded ₹1.55 of output value. Furthermore, the profit-to-cost ratios (VOP/C2 and VOP/C3) improved, indicating increased market viability despite structural cost pressures. The farm business income (FBI), family labour income (FLI), and farm investment income (FII) were all consistently negative. Thus, the analysis emphasises how profitability in the rainfed millet system has been constrained by cost escalation, which has outpaced real income growth. The continuation of negative income at C2 suggests that, even after considering imputed costs, remunerative viability remains marginal, despite recent positive returns over A2 expenses. However, the gradual increase in gross income and return per rupee indicates a better price support mechanism and technological adoption, which leads to improved economic performance during 2010. This trend indicates that maintaining profitability under full-cost conditions requires increases in market connectivity and productivity. Hence, value chain strengthening, prioritising cost realisation, and promoting climate-resilient technologies need to be considered.

In the case of break-even yield, highest negative deviation was observed in 2011, with the actual yield (20.15 q/ha) falling 15.05 q/ha (-42.75 percent) short of the break-even yield (35.20 q/ha), indicating a severe loss scenario. Similarly, the years 2001, 2005, and 2014 also reported a wide gap between actual and break-even yields (-39.91 percent, -36.35 percent, and -35.80 percent, respectively). On the other hand, during 2006, 2008, 2009,2012, 2018, 2019, and 2020, the present shortfall ranged between -4 percent and -18 percent.

The significant negative yield differentials observed in 2001, 2005, 2011, and 2014 are best explained by the interaction of climatic and structural factors that disproportionately affect the rain-fed finger millet (ragi) systems in Karnataka. According to a study by Nageswara Rao, Nageswara Rao, Shobha, Ramesh, and Somashekhar.[27] an evaluation based on remote sensing-based identify that Karnataka experienced severe agricultural drought conditions in the early 2000s, particularly from 2001 to 2002, with a spatially extensive reduction in end-of-season vegetation cover. The shortage in 2005, for which statewide drought data is less evident, likely resulted from a confluence of cost pressure, and lack of proper market management. In 2011, despite the presence of an official drought declaration, localised rainfall shortages, irregular monsoon distribution, and delayed sowing periods hindered crop growth, resulting in a significant yield shortfall.[28] In 2014, Karnataka was experiencing its fourth consecutive year of drought, with 125 out of 176 taluks officially declared drought-hit. The southwest monsoon underperformed by around 12 percent relative to the long-term average.[29,30] The susceptibility of finger millet to drought and leading to reduction in yield were mentioned in the study by Mudu *et al*.[15]

Furthermore, studies by Murari *et al*.[31] state that the yield of ragi is not only impacted by rainfall deficits but also by exposure to extreme heat (extreme degree days); as taluk-level panel estimates indicate that exposure to extreme temperature has a greater detrimental impact on yield than variation in seasonal rainfall.[31] During drought years, farmers frequently reduce fertilizer and pesticide usage or postpone sowing, thereby exacerbating yield losses.[32] Further, inadequate irrigation, escalating input costs, and credit limitations consistently reduced farmers' ability to maintain optimal inputs.[10]

While analysing the change and growth of labour, it is identified that the share of human labour increased from 56.81 percent to 74.12 percent, indicating that an increased wage rate and a persistent reliance on manual operations, such as sowing, weeding, and harvesting. Bullock, on the other hand, saw a marginal increase in absolute terms, increasing from ₹ 2908.24/ha to ₹ 4397/ ha (51.22 percent). However, its share fell sharply from 36.98 to 81.24 percent from 2001 to 2020, indicating a gradual shift away from animal power owing to modernisation. This shift is more evident as the share of machines has increased from 6.21 percent to 17.64 percent, rising its expenditure from ₹488.34/ha to ₹9418.38/ha, a staggering 1,828.65 percent rise. It can be inferred that there is a higher reliance on machine and human labour which indicates a structural shift in labour use, partial mechanisation, and declining animal labour, which together have critical implications for profitability and long-term viability.

This was in line with Choudhar, Lohar, Thombare, Jadhav and Hadolikar.[33] who reported that in physical inputs, the share of human labour accounts was highest followed by machine and bullock while analysing finger millet cultivation in Maharashtra. The majority of human labour was employed for harvesting, followed by threshing, weeding, irrigation, nursery work, and transplanting.[34] Employment of human labour was significant under irrigated conditions due to the transplanting technique of sowing and irrigation practices, resulting in elevated yields which in turn necessitated greater labour for harvesting and post-harvest operations. This finding contradicts the study by Mandal, Mishra and Rout.[35] They, while analysing the economics of finger millet cultivation in Odisha, found that machine labour was used more in finger millet production (with a total of 11.97 percent) than the hired labour usage of 10.87 percent in the total cost of cultivation per hectare. However, increased employment of the labour leads to reduced margins or even higher level of financial losses to the farmer.[36]

The input cost share analysis reveals that, there is an increase in the use of certified seed which is indicated by a significant increase in seed expenditure from ₹138.9/ha to ₹971.28/ha, and increasing its share in total input cost from 5.66 percent to 10.48 percent. Although its share declined from 77.73 to 68.96 percent, fertilizer remained an important component, suggesting considerable diversification in input spending. A similar trend of declining in the share in total input cost was reported for irrigation also, although its expenses increased from ₹163.53/ha to ₹483.79/ha.

The share of interest on working capital increased from 9.93 to 15.34 percent, which indicates a rising cost of credit and reliance on borrowed resources for finger production. Miscellaneous costs remained negligible. Overall, the total cost increased by 277.90 percent between 2001 and 2020. This pattern highlights the intensification and growing cost pressure in finger millet production, with more substantial reliance on improved seeds and credit, the continued dominance of fertilisers, and a modest rise in irrigation expenses.

While analysing the fixed cost component, there is an increase in the percentage share of land rental values in the total fixed cost from 66.95 to 94.93 percent, indicating the increased dominance of land-related expenditure. The fact that the rent for leased property was nil, while factors such as land revenue and taxes only increased slightly, suggests that cultivation was mainly carried out on owned land. Despite a slight nominal increase, the percentage share of interest on fixed capital in fixed input component decreased from 24.25 to 4.42 percent. In comparison, depreciation on farm assets decreased by 29.27 percent, showing limited renewal or replacement of farm equipment. The overall fixed cost increased by 471.60 percent, indicating a cost structure primarily driven by rising land values rather than capital or asset-related investments. This was contradicted by Mandal, Mishra and Rout,[35] who reported that interest on working capital has the highest share, followed by depreciation, land revenue, and taxes.

Cobb Douglus Production function reveals that seed (X_1) has a positive and significant impact on finger millet production, with a coefficient value of 0.31 percent, indicating that a one percent rise in seed results in a 0.32 percent rise in output. In finger millet, where plant population and crop stand are susceptible to seed-related practices, this emphasises the significance of seed quality and optimal seed rate. As Ren, Chen, Liu *et al.*[37] suggested that improved seed breeds that are tolerant or resistant to dry conditions increase the yield of finger millet. In the case of fertilizer (X_2), it has a positive and significant impact with a coefficient value of 0.24. This suggests that grain filling, panicle initiation, and tillering are all enhanced by balanced fertilizer treatment, resulting in a positive impact on productivity.

Another important factor that affects finger millet output is human labour (X_3), which has the highest coefficient value of 0.35 percent. This indicates that cultivating finger millet is the labour-intensive process which includes specific tasks, such as gap filling, weeding, and harvesting. This was mentioned in an earlier study by Upreti, Shakya, Vaidya and Riley,[38] noted that among the total family or exchange labour employed for millet production,[62] to 70 percent of the labour were employed for finger millet cultivation. As Adikari[39] pointed out that more work is undertaken by women labour (either family or exchange labour) than by men. As Bhandari, Subedi, Gyawali *et al*.[40] noted, women labourers were mainly involved in the harvesting of straw and heads of finger millet.

Regarding animal labour (X_4), it has a statistically significant and positive impact, highlighting its role in land preparation and transferring inputs and outputs, particularly in regions with limited mechanisation.[41] The positive and significant impact of seed, fertilizer, human labour, and animal labour on finger millet has been in line with the study by Adikari 39 while analysing the production and marketing of finger millet in Nepal.

Manure (X5), on the other hand, shows a positive but statistically insignificant correlation (r = 0.07). This outcome can be attributed to the fact that farmyard manure varies in quality, is limited in availability, decomposes slowly, and is often applied too late. Manure is applied in combination with chemical fertilisers, which may cause multicollinearity and diminish its isolated effect in the model. These indicate that although organic sources are still important for long-term soil health, their immediate yield contribution is less evident than that of inorganic fertilisers.

By adding the input elasticities, the value equals 1.06, which is greater than one, indicating increasing returns to scale. This suggests that when all inputs are increased proportionately, the output increases more than proportionately. Practically, farmers can achieve efficiency using integrated input packages, which include high-quality seed, balanced fertilizer usage, and efficient human resource management. This also necessitates policy interventions that enhance manure management, encourage mechanisation to reduce labour intensity, and support integrated input strategies to capitalise on scale efficiencies.

Decomposition analysis reveals that the marginal productivities of traditional inputs have decreased over time, as evidenced by the negative mean contributions of manure (-0.0084), fertilizer (-0.0132), and human labour (-0.0239). Fertiliser's negative elasticity indicates overuse and input application (as evident from the change in input use in Table 3). Similarly, the adverse effects of human labour indicate a labour shortage and diminishing labour productivity, which have been extensively documented in the dryland agriculture of Karnataka. The adverse contribution of manure shows that conventional organic sources are insufficient to sustain yield without supplemental nutrient management techniques. In contrast, seed (0.0128) and animal labour (0.0081) contributed positively, though their relative shares were modest, at 15.12 percent and 0.92 percent, respectively. The adoption of improved short-duration varieties has increased resilience and yield stability.

Conclusion

The present study analysed the production performance, cost structure, and profitability trends of finger millet cultivation in Karnataka from 2001–2020. Profitability analysis showed a significant nominal rise in gross income; however, under comprehensive cost (C2), net returns remained negative throughout, suggesting that full-cost recovery including imputed expenses was unattainable. Positive returns over A2 costs during 2010–2020, reflected partial economic recovery aided by initiatives like *Bhoochetana*, improved price realisation, and technological adoption. Break-even analysis revealed that, actual yields remained below the threshold, signalling economic non-viability under prevailing cost conditions. Large yield shortfalls in drought years (2001, 2005, 2011, and 2014) emphasise the vulnerability of rainfed finger millet systems to climatic adversities such as rainfall deficits and extreme temperatures and structural constraints, including limited irrigation, rising input prices, and credit access issues.

The temporal analysis of costs indicated a structural transformation in input use, marked by rising dependence on human labour, mechanisation, and improved seed. Labour expenditure increased sharply, driven by escalating wage rates and partial mechanisation, whereas animal labour's share declined significantly, reflecting a gradual shift from traditional practices. The Cobb–Douglas production function results revealed that seed, fertilizer, human labour, and animal labour significantly and positively influenced output, with human labour emerging as the dominant factor, reflecting the finger millet's labour-intensive nature. Increasing returns to scale (1.06) suggest that finger millet cultivation could benefit from integrated input use and better resource management practices.

Decomposition analysis indicated that total factor productivity (TFP) contributed nearly half of total output growth (46.73 percent), implying notable gains from technological improvements and better management rather than input intensification. However, declining marginal productivity of labour and fertilizer signalled inefficiencies, resource overuse, and diminishing input effectiveness in the long run. It is inferred that Karnataka is undergoing a transitional phase characterised by partial mechanisation, and technological adaptation. To ensure long-term sustainability and economic viability, policy measures should focus on improving input-use efficiency and drought-resilient varieties, strengthening market linkages, and supporting cost-reducing technologies. Integrated soil fertility management, mechanisation support, and targeted credit access can enhance the competitiveness and stability of finger millet cultivation in Karnataka.

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Author Contributions
- **Reshma Vattekkad:** Conceptualization, Methodology, Writing – Original Draft
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- **Reji Krishna and Dhanya Krishna:** Visualization, Supervision, Project Administration.
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Reference

1. Kaur, S., Kumari, A., Seem, K., Kaur, G., Kumar, D., Verma, S., Singh, N., Kumar, A., Kumar, M., Jaiswal, S., Bhardwaj, R., Singh, B. K., & Riar, A. Finger millet (*Eleusine coracana* L.): From staple to superfood—a comprehensive review on nutritional, bioactive, industrial, and climate resilience potential. *Planta*. 2024; 260(3). https://doi.org/10.1007/s00425-024-04502-2
2. Sood, S., Joshi, D. C., Chandra, A. K., & Kumar, A. Phenomics and genomics of finger millet: Current status and future prospects. *Planta*. 2019; 250(3); 731-751. https://doi.org/10.1007/s00425-019-03159-6
3. Parameswaran, K. P., & Sadasivam, S. Changes in the carbohydrates and nitrogenous components during germination of proso millet, *Panicum miliaceum. Plant Foods for Human Nutrition.* 1994: 45(2); 97-102. https://doi.org/10.1007/bf01088466

4. Rathore T., Singh, R., Kamble, D. B., Upadhyay, A., & Thangalakshmi, S. Review on finger millet: processing and value addition. *The Pharma Innovation Journal.* 2019; 8(4); 283-291.
5. Mishra, P., & Padhan, S. R. Finger millet: A sustainable approach for nutritional security and its Biofortification. *Millets and Other Potential Crops.* 2024; 127-143. https://doi.org/10.1201/9781003531937-9
6. Sharma, R., Gautam, N., Giribabu, G., Kumar, R., & Yadav, S. Synergistic effect of plasticizer and cross-linking agent on the properties of finger millet starch-based film. *Starch – Stärke*. 2023; 75(9-10). https://doi.org/10.1002/star.202200251
7. Maharajan, T., Antony Ceasar, S., Ajeesh Krishna, T. P., & Ignacimuthu, S. Finger millet [*Eleusine coracana* (L.) Gaertn]: An orphan crop with a potential to alleviate the calcium deficiency in the semi-arid tropics of Asia and Africa. *Frontiers in Sustainable Food Systems.* 2021; 5. https://doi.org/10.3389/fsufs.2021.684447
8. ICRISAT. (2024). Finger Millet overview. Retrieved September 25, 2025, from https://www.icrisat.org/crops/finger-millet/overview
9. Indian Institute of Millet Research. *Finger millet (Ragi) – Millet statistics.* Millet Statistics by ICAR (Indian Council of Agricultural Research) & IIMR (Indian Institute of Millet Research). 2025; Retrieved September 14, 2025, from https://www.milletstats.com/finger-millet-ragi/
10. Bellundagi, V., Umesh, K., & Ravi, S. Growth dynamics and forecasting of finger millet (Ragi) production in Karnataka. *Economic Affairs.* 2016; 61(2); 195. https://doi.org/10.5958/0976-4666.2016.00027.9
11. Government of India. (2021). *State/UT-wise Suicides by Farmers from 2017-2021*. Open Government Data (OGD) Platform India. https://www.data.gov.in/resource/stateut-wise-suicides-farmers-2017-2021
12. The Hindu. (2025, August 2). *620 farmers died by suicide in Karnataka's Mandya district in 10 years.* Retrieved September 25, 2025, from https://www.thehindu.com/news/national/karnataka/620-farmers-died-by-suicide-in-karnatakas-mandya-district-in-10-years/article69886898.ece
13. Shrinivasa M. (2024, June 23). *38 farmers died by suicide in Mandya in 2023-24*. The Times of India. Retrieved September 25, 2025, from https://timesofindia.indiatimes.com/city/mysuru/38-farmers-died-by-suicide-in-mandya-in-2023-24/articleshow/111199175.cms
14. Saxena, D., Singh, J., & Singh, S. Integrated pest management in changing climate. In: Climate Change and Insect Pests. *CABI.* 2016; 231-246.
15. Mude, L. N., Mondam, M., Gujjula, V., Jinka, S., Pinjari, O. B., Yellodu Adi Reddy, N., & Patan, S. S. Morpho-physiological and biochemical changes in finger millet [*Eleusine coracana* (L.) Gaertn.] under drought stress. *Physiology and Molecular Biology of Plants.* 2020; 26(11); 2151-2171. https://doi.org/10.1007/s12298-020-00909-9
16. Opole, R. A., Prasad, P. V., Djanaguiraman, M., Vimala, K., Kirkham, M. B., & Upadhyaya, H. D. Thresholds, sensitive stages and genetic variability of finger millet to high temperature stress. *Journal of Agronomy and Crop Science.* 2018; 204(5); 477-492. https://doi.org/10.1111/jac.12279
17. Vennila M., & Murthy C. Trend analysis of area, production and productivity of finger millet (Ragi). *Journal of Pharmacognosy and Phytochemistry.* 2021; 10(2); 84-90.
18. Nidhi, & Kumar, K. V. Temporal dynamics of finger millet in Karnataka - non parametric statistical approach. *The Pharma Innovation Journal.* 2022; 11(5); 802-808.
19. MILLET STATS. (2024). *Area, production & yield statics of millets.* Millet Statistics by ICAR (Indian Council of Agricultural Research) & IIMR (Indian Institute of Millet Research). | Millet Statistics. Retrieved September 25, 2025, from https://www.milletstats.com/apy-stats/
20. Verma, D. K., Bhagat, V., Khoisnam, N., Maisnam, G., Subba, R., Awatade, S. C., & Dulal, J. P. Cost of cultivation is rising or profitability rising for major pulse crop? A case from Rajasthan, India. *Legume Research.* 2024; 47(10); 1700-1705. https://doi.org/10.18805/lr-5298
21. Sood, S., Singh, H., & Soumya, C. Temporal changes in economics of pulses and their comparative advantage in Rajasthan.

Agricultural Science Digest - *A Research Journal*. 2019; 38(4). https://doi.org/10.18805/ag.d-4828

22. Sahu, A., Nahatkar, S., Vani, G. K., & Kolar, P. Study on profitability of wheat in major wheat producing states of India. *Asian Journal of Agricultural Extension, Economics & Sociology.* 2021; 1-7. https://doi.org/10.9734/ajaees/2021/v39i730603
23. Cobb, C. W., & Douglas, P. H. A Theory of Production. *The American Economic Review*. 1928; 18(1); 139-165. http://www.jstor.org/stable/1811556
24. Ghoshal, P., & Goswami, B. Cobb-Douglas production function for measuring efficiency in Indian agriculture: A region-wise analysis. *Economic Affairs*. 2017; 62(4); 573. https://doi.org/10.5958/0976-4666.2017.00069.9
25. Solow, R. M. Technical Change and the Aggregate Production Function. The Review of *Economics and Statistics.* 1957; 39(3); 312-319. https://doi.org/10.2307/1926047
26. Hayami, Y., & Ruttan, V. W. *Agricultural development: An international perspective,* 1971; Johns Hopkins University Press.
27. Nageswara Rao, P. P., Shobha, S. V., Ramesh, K. S., & Somashekhar, R. K. Satellite-based assessment of agricultural drought in Karnataka state. *Journal of the Indian Society of Remote Sensing.* 2005; 33(3); 429-434. https://doi.org/10.1007/bf02990014
28. Singhal, N., Khanna, M., Singh, M., Prajapati, V. K., Gupta, L., Singh, D. K., Kumar, S. N., & Sehgal, V. K. Drought assessment through multiple indicators for Karnataka state, India. *Environmental Monitoring and Assessment.* 2024; 196(12). https://doi.org/10.1007/s10661-024-13373-9
29. Indian Meteorological Department. *Monsoon-A Report 2014.* Indian Institute of Tropical Meteorology. 2015. https://www.tropmet.res.in/~kolli/MOL/Monsoon/year2014/Monsoon-2014-NEW.pdf
30. Times of India. (2014, July 12). *Karnataka reeling into fourth year of drought, Bengaluru news - Times of India.* The Times of India. https://timesofindia.indiatimes.com/city/bengaluru/karnataka-reeling-into-fourth-year-of-drought/articleshow/38228347.cms?utm
31. Murari, K. K., Mahato, S., Jayaraman, T., & Swaminathan, M. Extreme temperatures and crop yields in Karnataka, India. *Review of Agrarian Studies.* 2018; 8(2); 92-114. https://doi.org/10.25003/ras.08.02.0005
32. Ceasar, S. A., Maharajan, T., Ajeesh Krishna, T. P., Ramakrishnan, M., Victor Roch, G., Satish, L., & Ignacimuthu, S. Finger millet [*Eleusine coracana* (L.) Gaertn.] improvement: Current status and future interventions of whole genome sequence. Frontiers in Plant Science. 2018; 9. https://doi.org/10.3389/fpls.2018.01054
33. Choudhar, P. A., Lohar, S. S., Thombare, R. A., Jadhav, V. G., & Hadolikar, S. B. Economic evaluation of finger millet cultivation in Kolhapur district of Maharashtra: a costs & returns approach. *Indian Journal of Agriculture and Allied Sciences.* 2024; 10(4); 1-4.
34. Ravi, S., Umesh, K., & Bellundagi, V. An econometric analysis of resource use efficiency of finger millet (*Eleusine coracana* L.) production in Karnataka. *Economic Affairs.* 2017; 62(3); 495. https://doi.org/10.5958/0976-4666.2017.00061.4
35. Mandal, B. K., Mishra, S. N., & Rout, R. K. Economic Analysis of Production of Finger Millet (*Eleusine coracana* L.) in Perspective of Nutritional Security in the Western Undulating Agroclimatic Zone of Odisha, India. *African Journal of Biological Sciences.* 2024; 6(13); 3207- 3223. https://doi.org/10.48047/AFJBS.6.13.2024. 3207-3223
36. Giller, K. E., Delaune, T., Silva, J. V., Descheemaeker, K., Van de Ven, G., Schut, A. G., Van Wijk, M., Hammond, J., Hochman, Z., Taulya, G., Chikowo, R., Narayanan, S., Kishore, A., Bresciani, F., Teixeira, H. M., Andersson, J. A., & Van Ittersum, M. K. The future of farming: Who will produce our food? *Food Security.* 2021; 13(5); 1073-1099. https://doi.org/10.1007/s12571-021-01184-6
37. Ren, X., Chen, Z., Liu, Y., Zhang, H., Zhang, M., Liu, Q., Hong, X., Zhu, J., & Gong, Z. ABO3, a WRKY transcription factor, mediates plant responses to abscisic acid and drought tolerance in Arabidopsis. *The Plant Journal.* 2010; 63(3); 417-429. https://doi.org/10.1111/

j.1365-313x.2010.04248.x

38. Upreti, R. P., Shakya, P. B., Vaidya S., & Riley, R. W. *A study on finger millet in Nepal: Importance, nutrition, utilization and farming system in a socio economic and ecological context* [Paper presentation]. 1991; Second international small millet workshop , Zimbabwe.
39. Adhikari, R. K. Economics of finger millet (*Eleusine coracana* G.) production and marketing in Peri urban area of Pokhara Valley of Nepal. *Journal of Development and Agricultural Economics.* 2012; 4(6). https://doi.org/10.5897/jdae11.119
40. Bhandari B B., Subedi, A., Gyawali, S., P Baral, K., Chowin, K. R., Shrestha, P., & Staphit, B. Promotinng Neglected and Underutilized species in Nepal: a case of finger millet. In Minor Millets in South Asia: Learnings from IFAD-NUS Project in India and Nepal. *Ed M Bhag, S Padulosi and S Bala Ravi). Biodiversity International, Italy and MS Swaminathan Resarch Foundation, India.* 2010; 147-175.
41. Tripathi, A. & Bhandari, A.K. Amomum subulatum Roxb. (*Angiosperms; Zingiberaceae*): A species that can change the livelihood of mountain inhabitants of Uttarakhand, Himalaya: Research Article. *PhytoTalks.* 2025; 2(3): 484–489. https://doi.org/10.21276/pt.2025.v2.i3.6.