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Cost structure and economic returns of Tomato (*Solanum lycopersicum* L.) cultivation across farm-size categories in Meerut District of Uttar Pradesh

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Abstract

Tomato is among the most remunerative vegetable crops grown by small and marginal farmers in the peri-urban belt of western Uttar Pradesh, yet updated, farm-level evidence on its cost of cultivation and profitability in Meerut district has been lacking for nearly a decade. The present study was undertaken to estimate the per hectare cost of cultivation and the returns from tomato cultivation across different farm-size categories in Meerut district during the Zaid season of the 2025–26 crop year. Primary data were collected from eighty tomato-growing households, selected through multi-stage purposive-cum-random sampling from two community development blocks known for concentrated tomato cultivation, and stratified into marginal, small and medium categories by net cultivated area. Cost of cultivation was estimated using the cost concepts recommended by the Commission for Agricultural Costs and Prices, progressing from the cash cost incurred by the farmer to the full economic cost inclusive of imputed charges for family labour and owned land. Total cost of cultivation increased with farm size, from about one lakh thirty-six thousand rupees per hectare on marginal holdings to about one lakh eighty-five thousand rupees per hectare on medium holdings, largely on account of a shift from family to hired labour and higher fertiliser expenditure among larger growers. Yield, however, declined marginally with an increase in farm size, so that net income and the benefit–cost ratio were both highest on marginal holdings and lowest on medium holdings, the overall benefit–cost ratio for the sample being close to four. The study concludes that tomato cultivation is profitable for growers of every farm-size category in the district, but that the return per rupee invested is distinctly higher on smaller holdings, which use family labour intensively and purchased inputs sparingly, than on larger holdings dependent on hired labour and cash inputs. Extension efforts aimed at improving the efficiency of input use, rather than simply increasing input levels, are therefore likely to benefit medium-sized tomato growers the most in this district.

Keywords: Tomato, cost of cultivation, benefit–cost ratio, CACP cost concepts, farm size, Meerut

Introduction

Tomato (*Solanum lycopersicum* L.) is the second most widely cultivated vegetable crop in the world and occupies an important place in Indian horticulture, both as a source of farm income and as a crop of high nutritional value ^[1]. India is presently the second largest producer of tomato after China, and within India, Uttar Pradesh is a significant producing state, with tomato cultivation concentrated in districts of the Western Plain Zone that lie close to the National Capital Region and its large urban markets ^[1]. Meerut district, situated in this zone, is well suited to tomato cultivation on account of its assured canal and tube-well irrigation, its fertile alluvial soils, and its proximity to the Delhi–NCR consumption market, which together allow growers to realise comparatively favourable farm-gate prices. Tomato is, however, also a demanding crop to grow profitably. It requires a comparatively high level of investment in seed, fertiliser, plant protection and labour, and

its profitability is therefore sensitive to how efficiently these inputs are combined at different scales of operation. A number of studies conducted in other parts of Uttar Pradesh and in neighbouring states have reported the cost of cultivation and profitability of tomato to vary considerably with farm size, technology adoption and market access ^[2, 3], but comparable, up-to-date evidence for Meerut district itself has been scarce. The only available benchmark for this district, reported a decade ago, placed the total cost of cultivation of vegetable crops at approximately Rs 85,453 per hectare ^[4], a figure that predates the substantial rise in input prices, the wider adoption of hybrid planting material, and the improvement in market connectivity that the district has since seen.

Given this gap, the present investigation was undertaken with the specific objective of estimating the cost structure of tomato cultivation, using the cost concepts recommended by the Commission for Agricultural Costs and Prices (CACP),

and of examining the yield, income and profitability obtained by tomato growers of different farm-size categories in Meerut district during the current cropping season. The study also examines the extent to which the findings can be understood in the light of established economic reasoning on farm size and productivity, so as to place the district-specific results within a wider analytical context.

Materials and Methods

The study was conducted in Meerut district of Uttar Pradesh, a district of the Western Plain agro-climatic zone lying approximately 70 km northeast of Delhi, with fertile alluvial soils and an extensive canal and tube-well irrigation network. Within the district, the Daurala and Jani community development blocks were purposively selected on the basis of their concentration of tomato cultivation, established mandi linkages and accessibility for repeated field visits. From each of these blocks, four villages were purposively selected to capture variation in market access, and from each village, ten tomato-growing households were selected by simple random sampling and snowball sampling, yielding a total sample of 80 tomato growers. The sample households were stratified, on the basis of net cultivated area, into marginal (< 1 ha, 52 growers), small (1–2 ha, 16 growers) and medium (2–4 ha, 12 growers) categories, following the standard land-classification norms used by the Government of India.

Primary data were collected through a pre-tested, structured interview schedule administered by personal interview during the Zaid 2025–26 tomato season, covering the full range of input-use and output particulars for the crop. The schedule was developed after a review of comparable studies, pilot-tested on a small non-sample group of farmers, and refined before final administration. Secondary data on area, production and price trends were obtained from the National Horticulture Board, AGMARKNET, and the district

Department of Horticulture.

The cost of cultivation was estimated using the cost concepts standardised by the CACP. Cost A1 comprised all actual cash and kind expenses incurred by the farmer, including the value of hired human labour, machine power, seed, manures, fertilisers, plant-protection chemicals, irrigation charges, depreciation on implements, land revenue and other miscellaneous expenses, together with interest on working capital. Cost A2 was obtained by adding rent paid for leased-in land to Cost A1. Cost B1 added interest on the value of owned capital assets, excluding land, to Cost A1. Cost B2 added the rental value of owned land to Cost B1. Cost C1 added the imputed value of family labour to Cost B1, and Cost C2 added the imputed value of family labour to Cost B2. Finally, Cost C3 was obtained by adding a further 10 per cent of Cost C2 as an allowance for the farmer's managerial function, and represents the full economic cost of cultivation used as the basis for profitability estimation in this study.

Gross income was obtained by multiplying the quantity of tomato harvested per hectare by the average price realised by the grower. From this, farm business income was derived as gross income minus Cost A2, family labour income as gross income minus Cost B2, and net income as gross income minus Cost C3. The benefit–cost ratio was computed as the ratio of net income to Cost C3, expressing the net return obtained per rupee of total cost incurred; cost of production per quintal was obtained by dividing Cost C3 by the yield obtained per hectare. All cost and income measures were computed separately for each farm-size category and compared using simple tabular and percentage analysis, which is the standard analytical procedure for cost-of-cultivation studies of this kind.

Results

The results of the cost and returns analysis are presented in Tables 1 to 3.

Table 1: Per Hectare Cost of Cultivation of Tomato by Farm-Size Category (Rs)

Cost component	Marginal (Rs)	%	Small (Rs)	%	Medium (Rs)	%	Overall%
Human labour	36,058.61	26.42	53,927.05	32.74	62,809.88	33.93	29.21
a. Family labour	24,919.23	18.26	15,150.00	9.20	10,775.00	5.82	13.95
b. Hired labour	11,139.38	8.16	38,777.05	23.54	52,034.88	28.11	15.26
Machinery/tractor charges	6,115.37	4.48	7,236.99	4.39	7,457.88	4.03	4.38
Seed cost	4,972.31	3.64	5,906.88	3.59	6,056.00	3.27	3.56
Manures and fertilizers	11,874.50	8.70	14,259.55	8.66	21,403.88	11.56	9.22
Irrigation	3,713.29	2.72	4,426.49	2.69	4,530.93	2.45	2.66
Plant protection	5,240.74	3.84	5,919.48	3.59	6,400.74	3.46	3.71
Total operational cost	67,974.83	49.81	91,676.43	55.66	1,08,659.31	58.69	52.75
Interest on working capital @ 7%	4,758.24	3.49	6,417.35	3.90	7,606.15	4.11	3.69
Rental value of owned land	50,000.00	36.64	50,000.00	30.35	50,000.00	27.01	33.46
Interest on fixed capital @ 10%	1,332.20	0.98	1,653.60	1.00	2,036.63	1.10	1.01
Sub-total (Cost C2)	1,24,065.27	90.91	1,49,747.38	90.91	1,68,302.08	90.91	90.91
Managerial cost @ 10% of sub-total	12,406.53	9.09	14,974.74	9.09	16,830.21	9.09	9.09
Grand total (Cost C3)	1,36,471.79	100.00	1,64,722.12	100.00	1,85,132.29	100.00	100.00

Source: Field survey data.

The total cost of cultivation (Cost C3) increased steadily with farm size, from Rs 1,36,471.79 per hectare on marginal holdings to Rs 1,64,722.12 on small holdings and Rs 1,85,132.29 on medium holdings, the overall average across the sample being Rs 1,49,420.93 per hectare. Human labour was the single largest cost component in every category, but its composition differed markedly with farm size: family labour accounted for Rs 24,919.23 of total labour cost on

marginal holdings, more than double the corresponding hired-labour cost of Rs 11,139.38, whereas on medium holdings hired labour (Rs 52,034.88) exceeded family labour (Rs 10,775.00) by close to five times. Expenditure on manures and fertilisers rose from Rs 11,874.50 per hectare on marginal holdings to Rs 21,403.88 on medium holdings, indicating a more input-intensive style of cultivation on larger farms.

Table 2: Per Hectare Cost of Cultivation as per CACP Cost Concepts (Rs)

Cost concept	Marginal	Small	Medium	Overall
Cost A1/A2	47,813.83	82,943.78	1,05,490.46	63,491.32
Cost B1	49,146.04	84,597.38	1,07,527.08	64,993.46
Cost B2	99,146.04	1,34,597.38	1,57,527.08	1,14,993.46
Cost C1	74,065.27	99,747.38	1,18,302.08	85,837.21
Cost C2	1,24,065.27	1,49,747.38	1,68,302.08	1,35,837.21
Cost C3	1,36,471.79	1,64,722.12	1,85,132.29	1,49,420.93

Source: Field survey data.

The progression across cost concepts showed a clear difference between marginal and medium growers in the share of cash to imputed cost. Cost A1/A2, representing the farmer's actual cash outlay, accounted for only 35.0 per cent of Cost C3 on marginal holdings but 57.0 per cent on medium

holdings, indicating that a considerably larger share of the marginal farmer's total cost consisted of the imputed value of family labour and owned land rather than actual cash expenditure.

Table 3: Per Hectare Yield, Income and Profitability of Tomato Cultivation

Particulars	Marginal	Small	Medium	Overall
Yield (qtl/ha)	374.00	361.31	360.58	369.45
Average price realised (Rs/qtl)	1,890.38	2,018.75	2,041.66	1,983.59
Gross Income (Rs/ha)	7,07,003.99	7,29,387.93	7,36,184.29	[object Object]
Cost C3 (Rs/ha)	1,36,471.79	1,64,722.12	1,85,132.29	1,49,420.93
Net income (Rs/ha)	5,70,532.20	5,64,665.81	5,51,051.99	5,66,436.89
Family labour income (Rs/ha)	6,07,857.95	5,94,790.55	5,78,657.20	6,00,864.36
Farm business income (Rs/ha)	6,59,190.16	6,46,444.15	6,30,693.83	6,52,366.51
Cost of production (Rs/qtl)	364.90	455.91	513.43	405.38
Benefit–cost ratio	4.18	3.43	2.98	3.85

Source: Field survey data.

Yield declined slightly with an increase in farm size, from 374.00 quintals per hectare on marginal holdings to 360.58 quintals per hectare on medium holdings, despite medium growers incurring substantially higher expenditure on fertilisers, plant protection and mechanisation. The average price realised rose marginally with farm size, from Rs 1,890.38 to Rs 2,041.66 per quintal, so that gross income still increased slightly across categories; however, because cost rose considerably faster than gross income, net income declined from Rs 5,70,532.20 per hectare on marginal holdings to Rs 5,51,051.99 on medium holdings. The cost of producing one quintal of tomato rose from Rs 364.90 on marginal holdings to Rs 513.43 on medium holdings, and the benefit–cost ratio fell correspondingly from 4.18 on marginal holdings to 2.98 on medium holdings, with an overall sample average of 3.85.

Discussion

The overall benefit–cost ratio of 3.85 obtained in this study indicates that tomato cultivation was a highly remunerative enterprise for growers of every farm-size category in Meerut district during the study period, and is markedly higher than the ratios of between 1.3 and 1.9 reported for tomato in several other production tracts of India ^[2], a difference plausibly related to the district's assured irrigation and its proximity to the price-supportive Delhi–NCR market. The total cost of cultivation recorded in this study was also considerably higher than the approximately Rs 85,000 per hectare reported for this district about a decade earlier ^[4], a rise broadly consistent with the general escalation of input prices over the intervening period.

The more notable result of this study is the consistent decline in yield, net income and benefit–cost ratio with an increase in

farm size, even though medium growers used more fertiliser, more plant-protection material and more machinery than marginal growers. This pattern is an illustration of the inverse relationship between farm size and productivity that has long been discussed in the agricultural economics literature, beginning with the observation that smaller operational holdings in India tend to record higher output per unit area than larger holdings ^[5], a relationship subsequently confirmed with farm-level data from several Indian states ^[6]. One widely accepted explanation for this relationship rests on the cost of supervising hired labour ^[7]: family labour, being directly rewarded through the household's own residual income, requires no supervision and is applied with greater care, whereas hired labour on a larger holding must be monitored, and monitoring is neither costless nor fully effective. The labour-cost data of the present study are consistent with this explanation — medium growers, who depended overwhelmingly on hired labour, incurred a distinctly higher cost per hectare without any corresponding gain in yield, whereas marginal growers, who met the greater part of their labour requirement from within the family, achieved both a lower cost of production and a higher yield. This behaviour is also consistent with the household-economy model of peasant farming, in which a family continues to apply its own labour to a limited holding well beyond the point at which a hired-labour calculation would be economical, because the true opportunity cost of family labour, in the absence of an alternative wage-earning use, is low ^[8]. The present findings therefore lend support to the view that, for a labour-intensive and closely managed crop such as tomato, family-operated marginal holdings can achieve a level of input-use efficiency that larger, hired-labour-dependent holdings do not readily match, even when

the latter apply inputs more liberally.

Conclusion

Tomato cultivation was found to be profitable for growers of every farm-size category examined in this study, with an overall benefit–cost ratio of 3.85. Profitability was, however, not uniform across farm sizes: marginal growers, who relied predominantly on family labour and used purchased inputs more sparingly, recorded both the lowest cost of production and the highest benefit–cost ratio (4.18), while medium growers, who relied more heavily on hired labour and purchased inputs, recorded the lowest benefit–cost ratio (2.98) despite incurring the highest cost of cultivation. This suggests that the scope for improving returns from tomato cultivation in Meerut district lies less in encouraging larger growers to raise their level of input use further, and more in helping them use their existing inputs — particularly hired labour and fertiliser — more efficiently, through appropriate extension guidance and closer field supervision.

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