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Estimation of technical coefficients and economics of cultivation of major vegetable crops in Davanagere district of Karnataka

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ABSTRACT

Vegetable cultivation is an economically important but resource-intensive enterprise in Karnataka's Davanagere district, where growers face rising input costs and competing demands on scarce land, labour, groundwater and capital. This study examines the per-acre technical coefficients and the cost-return structure of eight major vegetable crops tomato, chilli, brinjal, cabbage, onion, cucumber, cauliflower and knol khol cultivated in Nyamathi and Honnali taluks of the district. Primary data were collected from 180 randomly selected vegetable growers (twenty per crop) through a pre-tested structured interview schedule, and per-acre resource-use coefficients, cost of cultivation and returns were worked out using standard cost-concept-based accounting procedures. Human labour requirement ranged from 80.00 man-days per acre in knol khol to 107.00 man-days in tomato, groundwater requirement from 11.00 to 20.16 acre-inches per acre in knol khol and chilli, respectively, and capital requirement from ₹88,343 in cucumber to ₹1,44,566 in chilli. The total cost of cultivation varied from ₹99,425 per acre in knol khol to ₹1,59,052 per acre in chilli. Chilli generated the highest gross returns (₹3,50,000/acre), net returns (₹1,90,948/acre) and return per rupee of expenditure (₹2.20), followed by tomato and cabbage (₹1.94 each), while cauliflower recorded the lowest return per rupee (₹1.78). All eight vegetable crops produced positive net returns, confirming their economic viability under the prevailing resource and price conditions, although crop selection clearly involves a trade-off between expected profitability and the physical and financial resources that have to be committed. The estimated technical coefficients and cost-return estimates provide a quantitative basis for subsequent resource-use-efficiency analysis and optimum crop-plan formulation for vegetable growers of the district.

Keywords: Technical coefficients, Cost of cultivation, Vegetable crops, Resource use, Net returns, Davanagere

Introduction

Agriculture remains central to India's economy, providing livelihoods to about 44 per cent of the workforce even as its share in Gross Value Added has gradually declined with the faster growth of non-agricultural sectors (Anonymous, 2021; Anonymous, 2025f) [1, 2]. Within agriculture, horticulture and vegetables in particular has emerged as a fast-growing, high-value sub-sector that strengthens nutritional security, generates employment and adds to export earnings (Anonymous, 2025a; Anonymous, 2025b) [3, 4]. India is presently the world's second-largest vegetable producer, with an estimated production of 205.80 million tonnes from about 11.30 million hectares in 2023-24 (Anonymous, 2024c) [5], and the sector also contributes significantly to the country's fresh-produce export basket, with onion, tomato and green chilli forming its core (Anonymous, 2025c; Anonymous, 2025e) [6, 7].

Karnataka occupies a prominent position among the vegetable-producing states of India, with about 4.12 lakh hectares under vegetables in 2023-24 (Anonymous, 2025d) [8]. Davanagere district, known for its fertile black and red soils and assured irrigation from the Bhadra Canal system, tanks and groundwater, has emerged as an important vegetable-growing region, with tomato, chilli, onion, brinjal, cabbage, cauliflower, cucumber and knol khol among the principal crops grown (Anonymous, 2024a; Anonymous, 2024b) [9, 10]. Vegetable cultivation in the district, however, is a distinctly resource-intensive enterprise: different vegetables place very different demands on human labour, machine labour, groundwater, manure, fertilizer, plant protection chemicals and working capital, and farmers operating under limited landholdings and constrained access to capital and irrigation water must decide, often without a precise quantitative basis, how to allocate these resources among competing crops.

Before resource-use efficiency can be assessed or an optimum crop plan formulated, it is first necessary to establish, with reasonable precision, the technical coefficients the physical quantities of each major input required to produce one acre of a given vegetable together with the associated cost of cultivation, yield and re

turns for each crop. Such coefficients form the essential building blocks of farm-planning exercises based on mathematical programming (Hazell *et al.*, 1986) [11] and, at the same time, provide farm-level information of direct practical value: they reveal which crops are comparatively labour-intensive, water-intensive or capital-intensive, and which combination of physical input use and market price realisation yields the greatest return per rupee invested.

Against this background, the present study was undertaken to estimate the technical coefficients and the cost-return structure of the major vegetable crops grown by farmers of Davanagere district. Specifically, the study aims to (i) estimate the per-acre requirement of human labour, machine labour, groundwater, manure and capital for the cultivation of tomato, chilli, brinjal, cabbage, onion, cucumber, cauliflower and knol khol, and (ii) work out the cost of cultivation, yield, gross returns, net returns and return per rupee of expenditure for each of these crops. The findings are expected to provide vegetable growers, extension functionaries and agricultural planners with a quantitative reference for identifying relatively input-efficient and remunerative vegetable enterprises, and to serve as the technical foundation for subsequent efficiency-assessment and optimum crop-planning exercises in the district.

Materials and methods

Description of the study area

Davanagere district, situated in the central dry agro-climatic zone of Karnataka between 13°05' and 14°50' North latitude and 75°30' and 76°30' East longitude, has a total geographical area of about 5,926 km² and comprises six taluks Davanagere, Harihar, Honnali, Nyamathi, Channagiri and Jagalur. The district experiences a semi-arid climate, with a long-period average annual rainfall of about 644 mm, and its soils predominantly red and black cotton soils, sandy loams and medium black soils together with assured irrigation from the Bhadra Canal, tanks and groundwater, make it well suited to the cultivation of a wide range of vegetable crops (Anonymous, 2024a) [9].

Sampling design

A multistage random sampling design was adopted for the collection of primary data. Davanagere district was purposively selected as the study area, after which two taluks Nyamathi and Honnali were selected at random. Villages within these taluks were then selected on the basis of the concentration of vegetable cultivation, in consultation with local horticulture officials. In the final stage, vegetable growers cultivating the selected crops were selected at random. A total of 160 vegetable growers were surveyed, comprising twenty farmers each for eight major vegetable crops, namely tomato, chilli, brinjal, cabbage, onion, cucumber, knol khol and cauliflower.

Data collection

The study is based entirely on primary data collected through personal interviews using a pre-tested, structured interview schedule. Information was recorded on the area under cultivation, the quantity and value of human labour, machine labour, groundwater, manure, seedlings, fertilizer nutrients, weedicides and plant protection chemicals used, and on the yield, prevailing market price, and cost of cultivation of each selected vegetable crop for the reference production season.

Analytical framework

Technical coefficients for each vegetable crop were derived as the average quantity of a given resource human labour, machine labour, groundwater, manure and capital used per acre, with yield treated as

the corresponding output. The cost of cultivation was worked out by the standard cost-concept approach, wherein variable costs (human and machine labour, seed and planting material, farmyard manure, fertilizers, plant protection chemicals, irrigation, other variable inputs, repairs and interest on working capital) were added to fixed costs (depreciation on implements and machinery, rental value of land, and land revenue and other fixed charges) to obtain the total cost of cultivation, expressed on a per-acre basis:

$$\text{Total Cost} = \text{Variable Cost} + \text{Fixed Cost}$$

Gross returns were obtained by multiplying the quantity of output by the prevailing market price of the respective vegetable, and net returns were obtained as the residual after deducting the total cost of cultivation from gross returns:

$$\text{Gross Returns} = \text{Quantity of Output} \times \text{Price}$$

$$\text{Net Returns} = \text{Gross Returns} - \text{Total Cost of Cultivation}$$

The return per rupee of expenditure, an index of relative profitability, was computed as the ratio of gross returns to the total cost of cultivation for each crop. All the coefficients and cost-return estimates reported in this paper were computed on the basis of the average values obtained for the twenty sample farmers cultivating each respective vegetable crop.

Results and discussion

Profile of the sample and cropping pattern

The sample vegetable growers were predominantly in the middle-age group (51.88%), with a moderate level of education about 30 per cent having completed high school and an average family size of 5.8 members, of whom 2.9 were engaged in vegetable cultivation. More than half the sample (56.87%) possessed medium experience in vegetable farming, and borewells constituted the principal source of irrigation (56.35% of irrigated area). The average operational holding was about 4 acres 19 guntas, of which roughly 1 acre 34 guntas was devoted to vegetable cultivation. In the cropping pattern followed by the sample farmers, vegetables occupied a substantial share of the gross cropped area in all three seasons, rising from 29.61 per cent in kharif to 44.01 per cent in rabi and 56.57 per cent in summer, with tomato consistently occupying the largest area among the vegetables grown in every season. This confirms that vegetable cultivation, and tomato in particular, forms a major component of the farming system in the study area, underscoring the need for a precise understanding of the resources these crops require.

Resource requirement coefficients of major vegetable crops

The average quantity of the major production resources required to cultivate one acre of each selected vegetable crop is presented in Table 1. The estimates reveal considerable variation in resource requirements across the eight crops, reflecting differences in crop duration, management intensity and input responsiveness.

Human labour requirement was highest in tomato (107.00 man-days per acre), followed by onion (103.00), brinjal (98.00), chilli (92.00), cucumber (90.00), cauliflower (89.00) and cabbage (86.00), while knol khol required the least labour (80.00 man-days per acre). The comparatively higher labour requirement of tomato and onion may be attributed to repeated harvesting, intensive intercultural operations, transplanting and post-harvest handling, since vegetables generally demand more frequent field operations, and harvesting may extend over several rounds, than most field crops (Kiran *et al.*, 2017; Paudel *et al.*, 2021) [12, 13].

Technical coefficient	Tomato (<i>n</i> = 30)	Chilli (<i>n</i> = 30)	Brinjal (<i>n</i> = 30)	Cabbage (<i>n</i> = 30)	Onion (<i>n</i> = 30)	Cucumber (<i>n</i> = 30)	Knol khol (<i>n</i> = 30)	Cauliflower (<i>n</i> = 30)
Human labour (man-days)	107.00	92.00	98.00	86.00	103.00	90.00	80.00	89.00
Groundwater (acre-inch)	17.67	20.16	13.26	15.96	14.32	16.52	11.00	14.00
Machine labour (hr)	3.50	3.50	3.00	2.50	3.50	2.50	2.50	3.00
Manure (tonnes)	11.00	9.00	7.00	14.00	14.00	7.50	6.00	8.00
Capital (₹)	1,29,370	1,44,566	90,500	98,104	1,21,282	88,343	83,590	1,05,119

Groundwater requirement ranged from 11.00 acre-inches per acre in knol khol to 20.16 acre-inches in chilli, with tomato (17.67 acre-inches) and cucumber (16.52 acre-inches) also recording comparatively high requirements. This variation is likely related to differences in crop duration, canopy development, evapotranspiration demand and irrigation frequency across crops. Because chilli combines a high groundwater requirement with high economic returns (discussed in Section 3.3), its water demand carries direct implications for the rational allocation of scarce groundwater among competing vegetable enterprises; assigning groundwater constraints an explicit role in crop-planning exercises has similarly been shown to alter the optimum crop pattern in other irrigated tracts (Kaur *et al.*, 2010) [14].

Machine labour requirement was comparatively narrow across crops, ranging from 2.50 hours per acre in cabbage, cucumber and knol khol to 3.50 hours per acre in tomato, chilli and onion, indicating that manual operations continue to account for the larger share of total labour use in vegetable cultivation in the study area, with only limited scope, at present, for further mechanization.

Manure requirement was highest in cabbage and onion (14.00 tonnes per acre each), followed by tomato (11.00 tonnes) and chilli (9.00 tonnes), while knol khol required the least (6.00 tonnes per acre). Such differences reflect crop-specific nutrient demand and biomass production and indicate that manurial recommendations for vegetable crops in the district should be crop-specific rather than uniform, an observation consistent with findings on the importance of appropriate nutrient and organic-input management in sustaining vegetable productivity without incurring avoidable expenditure (Liang *et al.*, 2019) [15].

Capital requirement, reflecting the combined cost of all inputs used per acre, was highest in chilli (₹1,44,566), followed by tomato (₹1,29,370) and onion (₹1,21,282), and lowest in cucumber (₹88,343). The comparatively high capital requirement of chilli can be related to its intensive input use in labour, irrigation and plant-protection operations. Taken together, the estimated coefficients in Table 1 indicate that the selection of a vegetable enterprise by a farmer in Davanagere district necessarily involves balancing the labour, water, manure and capital that must be committed against the crop's expected profitability a trade-off examined further in Section 3.3.

Table 1. Resource requirement coefficients of major vegetable crops (per acre)

Note: *n* = number of sample farmers for the respective crop; figures are per-acre averages computed from primary data.

Crop-wise input use and cost of cultivation

The detailed, item-wise physical quantity and value of each major input used, together with the resulting total cost of cultivation of the eight selected vegetable crops, are presented in Table 2. The disaggregated cost structure indicates that, while human labour formed the single largest cost item for most crops, the relative share of individual

cost components machine labour, manure, seedlings, fertilizer nutrients, weedicides, plant-protection chemicals and irrigation varied considerably across crops, reflecting differences in crop management practices.

Cost of cultivation, yield and returns from major vegetable crops

The total cost of cultivation ranged widely, from ₹99,425 per acre in knol khol to ₹1,59,052 per acre in chilli (Table 3). Chilli, tomato and onion formed a distinctly higher-cost group, whereas knol khol, cucumber and brinjal involved comparatively lower cultivation expenditure. The higher cost of chilli is consistent with its correspondingly higher requirement of labour, groundwater and capital noted in Section 3.2, while the high cost of tomato reflects its intensive crop management and repeated-harvest nature. Substantial differences in the cost structure of vegetable enterprises of this kind have similarly been reported in other production environments (Paudel *et al.*, 2021; Barwal *et al.*, 2023) [13, 16].

Yield also varied considerably, from 9.00 tonnes per acre in brinjal and cucumber to 17.00 tonnes per acre in tomato, with cabbage (16.00 t), chilli (14.00 t), onion and cauliflower (12.00 t each) and knol khol (10.00 t) occupying intermediate positions. Physical yield, however, did not by itself determine economic performance: chilli, despite a lower yield than tomato and cabbage, generated the highest gross returns (₹3,50,000 per acre) because of its considerably higher market price, and correspondingly recorded the highest net returns (₹1,90,948 per acre) and the highest return per rupee of expenditure (₹2.20). Tomato and cabbage followed with an equal return of ₹1.94 per rupee invested, and onion, cucumber, brinjal and knol khol recorded returns of ₹1.92, ₹1.88, ₹1.86 and ₹1.85 per rupee, respectively, while cauliflower recorded the lowest return per rupee of expenditure (₹1.78).

Importantly, all eight vegetable crops generated positive net returns, confirming the general economic viability of vegetable cultivation under the prevailing resource and price conditions in Davanagere district. Nevertheless, the variation in return per rupee of expenditure shows that the opportunity cost of allocating scarce land, groundwater and capital differs appreciably across crops: the comparatively high profitability of chilli, in particular, helps explain why this crop is likely to be treated as an attractive candidate in any subsequent crop-optimization exercise, whereas the lower return from cauliflower and knol khol suggests that these crops may be preferred by farmers mainly when their resource requirements or seasonal suitability compensate for comparatively lower returns. This finding is consistent with the broader observation that vegetable profitability is shaped jointly by cost of cultivation, resource use, yield and market-price realisation, and that market value can compensate for higher production expenditure in relatively high-value crops such as chilli (Kiran *et al.*, 2017; Paudel *et al.*, 2021) [12, 13].

Table 2. Crop-wise technical coefficients, input use and cost of cultivation of major vegetable crops in Davanagere district of Karnataka (n = 180)

Crop	Human labour (man-days)		Machine labour (hr)		Manure (tonnes)		Seedlings (no.)		Fertilizer nutrients (kg N:P:K)		Weedicides (litre)		Plant protection chemicals (kg/l)		Irrigation (acre- inch)		Total cost of cultiva- tion (₹)
	Qty	Value (₹)	Qty	Value (₹)	Qty	Value (₹)	Qty	Value (₹)	Qty	Value (₹)	Qty	Value (₹)	Qty	Value (₹)	Qty	Value (₹)	
Tomato	107	43,335	3.50	4,200	11.00	12,121	8,221	4,522	120:280:100	11,652	1.50	1,470	4.00	8,000	17.67	9,630	1,44,155
Brinjal	98	41,160	3.00	3,690	7.00	8,400	5,319	4,309	160:230:80	10,340	1.40	1,246	3.48	8,804	13.26	6,630	1,06,398
Onion	103	46,350	3.50	4,550	14.00	18,900	10,210	7,964	150:280:85	16,910	1.50	1,875	3.80	9,310	14.32	7,489	1,37,450
Cabbage	86	27,900	3.50	3,750	14.00	15,400	9,900	8,400	120:280:100	16,110	1.30	815	6.20	23,030	15.96	7,581	1,13,190
Chilli	92	41,400	3.50	4,200	9.00	10,486	8,000	6,880	85:160:70	10,875	1.20	780	5.25	12,758	20.16	11,088	1,59,052
Cucumber	90	39,150	3.00	3,690	7.00	9,800	5,319	4,309	75:150:65	11,926	1.40	1,246	3.48	9,222	16.54	8,260	1,05,294
Cauliflower	89	37,647	3.50	3,749	8.00	8,800	7,500	6,000	90:170:100	16,110	1.30	814	6.20	23,026	14.00	6,650	1,17,676
Knol khol	80	33,600	3.00	3,690	6.00	7,200	4,940	4,001	100:150:50	7,981	1.00	890	2.50	5,000	11.00	4,400	99,425

Note: NPK = Nitrogen : Phosphorus : Potassium (kg/acre); all values are per-acre averages based on primary data collected from twenty sample farmers per crop.

Table 3. Yield, cost of cultivation and returns from major vegetable crops (per acre)

Crop	Yield (t/acre)	Total cost of cultivation (₹/acre)	Gross returns ^a (₹/acre)	Net returns ^b (₹/acre)	Return per rupee of expenditure (₹)
Tomato	17.00	1,44,155	2,80,500	1,36,345	1.94
Brinjal	9.00	1,06,398	1,98,000	91,601	1.86
Onion	12.00	1,37,450	2,64,000	1,26,550	1.92
Cabbage	16.00	1,13,190	2,22,000	1,08,810	1.94
Chilli	14.00	1,59,052	3,50,000	1,90,948	2.20
Cucumber	9.00	1,05,294	1,97,618	92,324	1.88
Cauliflower	12.00	1,17,676	2,11,281	93,605	1.78
Knol khol	10.00	99,425	1,84,885	85,460	1.85

a Gross returns computed as net returns (inclusive of groundwater cost) plus total cost of cultivation. *b* Net returns are inclusive of the cost of groundwater/irrigation.

Conclusion

The technical coefficients and cost-return estimates developed in this study reveal that the major vegetable crops grown in Davanagere district differ considerably in the physical and financial resources they require and in their economic performance. Tomato required the highest human labour (107.00 man-days per acre) and recorded the highest yield (17.00 tonnes per acre), while chilli required the highest groundwater (20.16 acre-inches per acre) and the highest capital investment (₹1,44,566 per acre). Chilli also emerged as the single most remunerative crop, recording the highest gross returns (₹3,50,000 per acre), net returns (₹1,90,948 per acre) and return of ₹2.20 per rupee of expenditure, whereas knol khol, though involving the lowest cultivation cost, also recorded the lowest net returns among the crops studied, and cauliflower recorded the lowest return per rupee invested.

All the selected vegetable crops generated positive net returns, confirming their economic viability, yet the marked variation in resource requirements and profitability demonstrates that the choice of a vegetable enterprise cannot be guided by profitability alone: it must also take into account the labour, groundwater, manure and capital that a crop demands relative to what the farm household can supply. The technical coefficients and cost-return structure estimated here therefore provide the essential quantitative foundation on which the resource-use efficiency of vegetable growers can subsequently be assessed and an optimum, resource-constrained crop plan can be developed for vegetable growers of Davanagere district.

References

- Anonymous. Annual Report, Periodic Labour Force Survey (PLFS), 2019-20. National Statistical Office (NSO), Ministry of Statistics and Programme Implementation, Government of India; 2021.
- Anonymous. Statistical Report on Value of Agriculture and Allied Sectors. Ministry of Statistics and Programme Implementation (MoSPI), Government of India; 2025f.
- Anonymous. Economic Survey 2024-25. Ministry of Finance, Government of India; 2025a.
- Anonymous. Fresh fruits and vegetables: Production, area and export statistics. Agricultural and Processed Food Products Export Development Authority (APEDA), Government of India; 2025b.
- Anonymous. Third Advance Estimates of Horticultural Crops, 2023-24. Department of Agriculture and Farmers Welfare, Ministry of Agriculture and Farmers Welfare, Government of India; 2024c.
- Anonymous. Fresh onions: Production, area and export statistics. Agricultural and Processed Food Products Export Development Authority (APEDA), Government of India; 2025c.
- Anonymous. Other fresh vegetables: Production, area and export statistics. Agricultural and Processed Food Products Export Development Authority (APEDA), Government of India; 2025e.
- Anonymous. *Karnataka Economic Survey 2024-25*. Government of Karnataka; 2025d.
- Anonymous. District at a Glance, Davanagere, 2023-24. Department of Horticulture, Davanagere District Administration, Government of Karnataka; 2024a.
- Anonymous. Horticultural crop statistics and vegetable production statistics, 2023-24. Department of Horticulture, Government of Karnataka; 2024b.
- Hazell PBR, Norton RD. Mathematical Programming for Economic Analysis in Agriculture. New York: Macmillan Publishing Company; 1986.
- Kiran R, Sivakumar SD. The cost and returns structures of major vegetables under different supply chains in Bengaluru Rural district of Karnataka. *Int. J. Agric. Sci. Res.* 2017;7(6):311-320.
- Paudel A, Paudel A, Kattel RR. An economic analysis of production and marketing of major vegetables in Parsa district, Nepal. *Food Agri. Econ. Rev.* 2021;1(2):107-120.
- Kaur B, Sidhu RS, Vatta K. Optimal crop plans for sustainable water use in Punjab. *Agric. Econ. Res. Rev.* 2010;23:273-280.
- Liang Y, Jing X, Wang Y, Shi Y, Ruan J. Evaluating production process efficiency of provincial greenhouse vegetables in China using data envelopment analysis: a green and sustainable perspective. *Processes.* 2019;7(11):780.
- Barwal P, Sharma S. Cost and Return Structure of Vegetables in Different Agro-climatic Zones of Himachal Pradesh. *Indian J. Econ. Dev.* 2023;19(4):746-755.

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