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High-tech tomato farming: A study on economics and profitability in Chhattisgarh

[1]Bhashkar Sahu and [2]Hulas Pathak

[1]Ph.D. Research scholar, Department of Agriculture-Business and Rural Management, Indira Gandhi Krishi Vishwavidhalaya, Raipur, Chhattisgarh, India

[2]Professor and Head, Department of Agriculture-Business and Rural Management, Indira Gandhi Krishi Vishwavidhalaya, Raipur, Chhattisgarh, India

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Corresponding Author: Bhashkar Sahu

Abstract

The present study investigates the economics and profitability of tomato cultivation under high-tech farming conditions in the Chhattisgarh Plains. Using data from 240 sample farms across varying farm sizes, detailed cost and return analysis was conducted to assess economic viability. The overall cost of cultivation per hectare was estimated at Rs.286641.75 with variable costs comprising around 69.79 percent mainly contributed by manures and fertilizers, plant protection, and labour inputs. Fixed costs accounted for 30.24 percent, including depreciation and rental value of owned land. Among labour inputs, hired labour formed the major cost component. The total cost of cultivation varied slightly across farm sizes, with large farms incurring Rs.285714.08 per hectare and small farms Rs.288576.08 per hectare. Gross returns from tomato cultivation under high-tech conditions were calculated at Rs.936495 per hectare, resulting in a net return of Rs.713480/per hectare and an output-input ratio of 4.19. Break-even analysis revealed that the required yield to cover total cost was 148.68 quintals per hectare, while actual yields averaged 624.33 quintals per hectare. Offering a significant margin of safety at 76.19 percent. Profitability improved with scale, as larger polyhouses demonstrated higher economic efficiency. The study concludes that tomato cultivation under protected structures such as polyhouses and use high-technologies under farming highly profitable and economically sustainable, particularly when supported with proper input management and scale optimization.

Keywords: Economics, profitability, high-tech vegetables farming, break even analysis, marketing participation

Introduction

Vegetables are a vital component of Indian agriculture, contributing significantly to nutritional security and economic development. India's diverse agro-climatic conditions and seasonal variability enable year-round cultivation of a wide array of vegetable crops. With nearly one-third of the Indian population adhering to a vegetarian diet, vegetables play a crucial role in supplying essential nutrients such as vitamins, minerals, dietary fiber, and plant-based proteins. Rising consumer demand for fresh, high-value produce and shifting dietary patterns have spurred rapid growth in the vegetable sector. Moreover, the integration of modern technologies including improved hybrids, integrated nutrient and pest management (INM/IPM), better farmer training, and supportive policy frameworks has further enhanced productivity and quality across the country. Protected cultivation, in particular, has emerged as a transformative solution, allowing for year-round vegetable production by mitigating adverse environmental conditions and maximizing resource use efficiency.

Chhattisgarh, with its bio-geographical diversity and availability of small fragmented landholdings, presents a unique niche for high-tech and off-season vegetable cultivation. The state has increasingly adopted protected cultivation technologies such as polyhouses, shed nets, drip irrigation, and mulching to promote sustainable and profitable farming. According to recent data from the Department of Horticulture and Farm Forestry, Government of Chhattisgarh, the 49178.33-hectare area under protected cultivation, including shed net houses and playhouses, has expanded to cover several hectares. These initiatives are further supported by central and state schemes like the National Horticulture Mission, which provide subsidies and infrastructure development to encourage adoption. In this context, high-tech vegetable farming holds immense potential for enhancing farmer incomes, improving produce quality, and ensuring a stable supply of vegetables even under adverse climatic conditions.

Materials and Methods

Sampling Procedure and Sample Size

Chhattisgarh state comprises of 33 districts, each contributing to the state diverse agricultural economy. Among them, Raipur, Durg, Mahasamund, Bilaspur and BalodaBazar has been selected purposively for study purpose based on highest area covered under Chhattisgarh plain.

Nature and Source of Data Primary data

Primary data

Primary data for the study was collected directly from high-tech vegetable growers across five selected districts in the

Chhattisgarh Plains agro-climatic zone. A percentage proportionate sampling method was employed to ensure adequate representation of the grower population in each district. Specifically, 30% of the total high-tech vegetable growers in the selected districts were sampled for the survey. In total, 240 farmers practicing high-tech vegetable cultivation were selected using this method. The district-wise distribution of the sample households was as follows: Raipur 63, Durg 45, Mahasamund 69, Bilaspur 32, and Baloda Bazar 31.

Secondary data
Secondary data was collected from research papers, books, journals, and reports from government and non-government agencies to support and complement the findings.

Analytical tools
Cost and Return Analysis
The cost and return analysis of tomato cultivation under high-tech farming in the Chhattisgarh Plain zone was conducted using the Cost of Cultivation methodology prescribed by the CACP.
The Commission of Agricultural Costs and Prices (CACP), concept was used for estimation of Cost concepts. Under this method, the cost of cultivation and production was computed by using the 7 Cost concepts, which are known as cost A_1, cost A_2 cost B_1, cost B_2 and cost C_1, cost C_2, and cost C_3.
Cost A1: Consist of following 16 items of costs:
1. Value of hired human labour (permanent and casual).
2. Value of bullock labour (owned & hired).
3. Value of owned machinery labour (owned & hired).
4. Value of fertilizers, insecticides and fungicides.
5. Value of seed (both farm-produced and purchased).
6. Irrigation charges and land revenue.
7. Interest on the working capital.
8. Depreciation on farm implements.

Cost A2 = Cost A1 + Rent paid for Leased in Land.
Cost B1= Cost A1+ Interest on value of Owned fixed Capital assets (excluding land)
Cost B2 = Cost B1 + Rental value of owned land
Cost C1= CostB1+ImputedvalueofFamilyLabour.
Cost C2= Cost B2 + Imputed value of Family labour.

- **CostC_3**=Cost C_2 +10 percent of cost C_2 taking as managerial allowances.

1. Input-Output Ratio
Input-output ratio indicates the efficiency of input.

2. Income Analysis
a) Family labour income: It is measured on earning of a farmer and his family for his labour and managerial work. It is equal to gross income minus total expenses excluding wage of unpaid family labour.

Family labour income = Gross income Cost B

b) Farm business income: It is a measure of earning of farmer and his family for his capital investment, labour and managerial work.

Farm business income = Gross income Cost A1

c) Farm investment income: This is the sum of net income, rental value of owned land and interest on fixed capital.

Farm investment income = Farm business income Imputed value of family labour.

3. Returns: Returns were noted in quintals and the monetary values were calculated at prevailing market prices.

4. Benefit-Cost ratio analysis
It is a ratio between the value of net return and the cost of cultivation at different cost concepts. This is the ratio which represents returns obtained per rupee of investment. It was worked out by dividing net return by the total cost.

5. Break Even Point Analysis
The point at which the two curves, i.e., total cost curve and total revenue curve intersect is called the break-even point (BEP) which indicates the level of production at no profit no loss. In other words, the quantity at which all costs allocated to a product are equal to all revenue from its sale is known as break- even point (Sahu *et al*., 2020; Singh and Singh, 1999; Sunil Kumar *et al*., 2010)).

BEP=F/ (P-AVC)

Where, BEP	=	Break Even Point in terms of physical units of production.
F	=	Total Fixed Cost(Rs.)
AVC	=	Average variable cost of vegetable crop production (Rs.)
P	=	Price of the output (Rs.)

Disposal pattern
To examine the marketing pattern of major crops at different categories of farms, simple analysis was done.

Marketable surplus
To estimate the marketable surplus of produce, total quantity used for different purposes is deducted from total production of crop.

Marketable Surplus = Total quantity produced - Total quantity used for consumption
Where,
MS=Marketable Surplus, P = Total Production
C=Family member's consumption S=Quantity retained for seed.

Price Spread

Price Spread = Price Received by the Farmer / Retail Price Paid by the Consumer×100 Review literate

Economics and Profitability of Tomato Production under High-tech Conditions

Costs and return of tomato cultivation is essential to understand that how much cost incurred for different inputs and whether farmers are receiving the profit or not. It is therefore, the cost and return of tomato cultivation under high-tech was estimated in per hectare, which is given in table 4.17. The total cost of cultivation of tomato of sample farms at overall was Rs
286641.75 Per hectare. total variable cost was 69.79 per cent and the share of cost manure and fertilizer 30.24 per cent cost was maximum followed by materials imputed plant protection 13.59 per cent human labour (hired and family labour) and found to be 12.62 per cent, interest on working capital 5.6 per cent, seed 4.16 per cent, machine power cost (machine) 1.96 per cent. Total fixed cost was 30.24 per cent, Depreciation was 17.49 percent, rental value of owned land was 10.13 per cent and interest on fixed capital was 2.23 per cent. Among all the input cost human labour was noticed to be the major cost. In which, inputted value of hired labour cost was shared comparatively more than that of family labour cost i.e. 11.27. The total cost of cultivation of tomato under high-tech was increasing with respect to farm size of holdings and found to be maximum under large farms Rs 285714.08 per hectare and minimum at small farms Rs
288576.08 Per hectare.

Table 1: Cost of cultivation of tomato under high-tech farming in the study area.
(Rs/ha)

Particulars	Small	Medium	Large	Overall
A. Material cost				
Seed	12000.05	13500.02	13800.05	13100.06
	(4.24)	(4.78)	(4.85)	(4.62)
Manures and fertilizer	87000.02	86400.04	86450.01	86617.07
	(30.38)	(30.19)	(30.2)	(30.24)
Plant protection	40000.05	38500.04	38200.06	38900.08
	(14.02)	(13.45)	(13.38)	(13.59)
Irrigation charges	5000.05	5000.03	5000.03	5000.01
	(1.79)	(1.83)	(1.79)	(1.78)
Total material cost	144000.02	143400.05	143450.03	143617.04
	(50.12)	(50.05)	(50.23)	(50.14)
B. Human labour cost				
Family labour	15500.08	13645.04	13800.04	14315.04
	(5.43)	(4.82)	(4.86)	(5.07)
Hired labour	22200.08	21750.08	21500.04	21817.03
	(7.82)	(7.65)	(7.58)	(7.62)
Total human labour cost	37700.03	35395.06	35300.01	36132.04
	(13.1)	(12.4)	(12.35)	(12.62)
C. Power use cost				
Bullock labour	0	0	0	0
Machine power	5200.06	5380.07	5500.07	5360.03
	(1.78)	(1.93)	(1.96)	(1.93)
Total power use cost	5200.02	5380.04	5500.03	5360.05
	(1.9)	(1.91)	(2.2)	(1.96)
Interest on working	14952.05	14734.02	14740.02	14808.75
Capital @8%	(4.98)	(5.57)	(5.21)	(5.20)
(I). Total Variable Cost	201852.02	198909.03	198990.06	199917.79
(A + B + C + Int.)	(69.86)	(69.79)	(69.81)	(69.79)
D. Fixed cost				
Depreciation	50000.08	50000.08	50000.08	50000.07
(Polyhouse, Drip, etc.)	(17.33)	(17.36)	(17.46)	(17.49)
Land revenue	300.06	300.06	300.08	300.08
	(0.16)	(0.15)	(0.15)	(0.14)
Rental value of land	30000.04	30000.02	30000.02	30000.08
	(10.53)	(10.54)	(10.55)	(10.53)
Interest on fixed working	6424.09	6424.08	6424.06	6424.05
capital @8%	(2.23)	(2.21)	(2.24)	(2.3)
(II). Total Fixed Cost	86724.04	86724.07	86724.09	86724.06
	(30.24)	(30.26)	(30.28)	(30.24)
Total Cost	288576.08	285633.01	285714.08	286641.75
(A + B + C + D)	(100)	(100)	(100)	(100)

Note: - Figures in parentheses indicate percentages of the total cost

Costs obtain on the basis of different cost concept of tomato crop in under high-tech farming

Cost of cultivation of tomato of sample farms in the high-tech farming area has been worked out and presented in table 4.19. It is envisaged that Cost A1 as designated the variable cost and it was found to be Rs 143617.97 per hectare on overall basis, indicates the interest on fixed capital imputed with Cost B1 Rs 157932.18 per hectare rental value of own land Rs 30000.08 per hectare prevailed in the study area.

Table 2: Cost estimates of tomato under high-tech cultivation in the study area (Rs/ha)

Particulars	Small	Medium	Large	Overall
Cost A1	144000.82	143400.33	143450.9	143617.97
	(64.02)	(64.60)	(71.01)	(64.39)
Cost B1	159500.15	157045.77	157250.62	157932.18
	(70.92)	(70.75)	(77.85)	(70.81)
Cost B2	189500.42	187045.39	187250.14	187932.95
	(84.26)	(84.27)	(92.70)	(84.26)
Cost C1	174452.77	171779.92	171990.04	172741.53
	(77.56)	(77.39)	(85.14)	(77.45)
Cost C2	204452.23	201779.92	201990.11	202741.12
	(90.90)	(90.90)	(90.90)	(90.90)
Cost C3	224897.70	221957.52	222189.011	223015.63
	(100)	(100)	(100)	(100)

Note: - Figures in parentheses indicate percentages of the total cost

Normally, farmers are cultivating the crop in their own land but it has imputed rental value of land of Rs 30000.08 per hectare notified Cost B2 was Rs 157932.18 per hectare. The Cost C1 found to be Rs 172741.53 per hectare, includes the value of Cost B1 and imputed value of family labour was found to be Rs 14315.04/ha, The Cost C2, found to be Rs 202741.12 per hectare, includes the value of Cost B2 and imputed value of family labour and The Cost C3, found to be Rs 223015.63 per hectare, imputed value of managerial allowances at 10 per cent of Cost C2.

Table 3: Farm profitability of tomato under protected cultivation in the study area (Rs/ha)

Particulars	Small	Medium	Large	Overall
Yield (qtls)	622.15	623.1	627.75	624.33
Gross Returns	933050.25	934545.50	941889.25	936495.00
Farm Business Income	7890 25.10	791105.15	798504.75	792878.33
Family Labour Income	743525.20	747470.15	754694.65	748563.33
Net Income (Farm Income)	708120.25	712540.15	740009.25	713556.55
Farm Investment Income	728570.10	732720.15	739974.75	733755.00
Output-Input Ratio	4.15	4.21	4.66	4.2

Farm profitability of tomato under high-tech farming

The economics of tomato cultivation presented in table 4.14. It has been observed from empirical findings that overall output input ratio were found to be 4.19, On an overall basis Gross returns (total income) was observed to the Rs 936495.00 per hectare, while net returns was found to be Rs 713556.55 per hectare and overall production of tomato under high-tech was
624.33 quintal per hectare.

Break-even analysis and margin of safety

Table 4 presents the results of break-even analysis and margin of safety for tomato under protected cultivation. The results revealed overall that 475.65 quintals respectively. The breakeven yield, returns and percent of total output, increased with size of polyhouse. The margin of safety in protected cultivation of tomato was almost thrice and twice of small to large respectively. The margin of safety for small (472.07 q), medium (475.03q) and large (493.34q) sized polyhouses was also estimated. Further, the overall percent margin of safety under protected cultivation of tomato in 76.19 percent.

Table 4: Break-even analysis of tomato under protected cultivation. (Rs/ha)

Particulars	Small	Medium	Large	Overall
Cost of Cultivation (Rs.)	224897.20	221956.90	201990.00	216281.37
Yield (qtls)	622.15	623.1	627.75	624.33
Break-Even Yield (qtls)	149.93	147.97	134.66	144.19
Gross Returns (Rs.)	9,33,000.00	9,34,500.00	9,42,000.00	936500.00
Net Returns (Rs.)	7,08,102.80	7,12,543.10	7,40,010.00	720218.63
Break-Even Returns (Rs.)	2,24,897.20	2,21,956.90	2,01,990.00	216281.37
Margin of Safety (qtls)	472.07	475.03	493.34	480.15
Margin of Safety (Rs.)	7,08,102.80	7,12,543.10	7,40,010.00	720218.63
Margin of Safety (% of total yield)	(75.90)	(76.25)	(78.56)	(76.90)

Conclusion

The economic analysis of tomato cultivation under high-tech conditions demonstrates its high profitability and strong financial viability. With a total cultivation cost of Rs 286641.75 per hectare and gross returns of Rs936495.00 per hectare, farmers achieved a substantial net return of Rs.713556.55 and an output-input ratio of 4.19. Variable costs made up the majority of total expenses, with manures and fertilizers being the largest component, followed by plant protection and human labour. The break-even yield was calculated at 475.65 quintals per hectare, significantly lower than the actual average yield of 624.33 quintals, resulting in a wide margin of safety at 76.19 percent. These results indicate that high-tech tomato cultivation is not only productive but also economically secure, offering a lucrative option for farmers seeking to enhance income through protected horticulture.

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