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Protected cultivation of bell pepper (Green capsicum) in Himachal Pradesh, India: An economic analysis

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Abstract
Protected cultivation has a special relevance for marginal and small farmers who can now think of earning higher farm income from their small land holdings which otherwise is a far-away dream for them. Protected agriculture is an appealing agricultural alternative for farmers as well as service providers in the rural region. Present study was conducted in Kullu district of Himachal Pradesh, India. Kullu area was chosen for its significant contribution to the state's vegetable production in terms of both area and output. Costs concept and capital budgeting analysis were used to analyze the financial feasibility of capsicum cultivation under polyhouse. Results concluded that capsicum cultivation under polyhouse with and without subsidy (@ 80% subsidy provided by government) was profitable, increased farmer's income and their quality of living. Farmers got higher rewards by selling the produce off seasonally. Net farm income earned was ₹ 65990.54 to ₹ 260798 for Category I and Category II. Under both the Categories NPV of the capsicum cultivation was found positive with Benefit-cost ratio 1.04 to 2.36. IRR was found sufficiently high for both the Categories. Paired t test was used to evaluate the impact of adoption of polyhouse on crop yield and the results revealed a significant increase in yield, confirmed the effectiveness of polyhouses in improving production. The results ascertained that the implementation of polyhouse cultivation constitutes a viable and lucrative enterprise, enhancing the produce quality, efficiency and financial success in farming operations.

Keywords: Protected cultivation, feasibility, efficiency, yield, reward, income

1. Introduction
Vegetables are important component of Indian agriculture and nutritional security due to their short duration, nutritional richness, economic viability, high yield and ability to engender on farm and off farm employment (Kumar *et al*., 2018) [29]. The country produces 205.80 million metric tons (MT) of vegetables on an area of 11.17 million hectares (India stat, 2023-24). With increase in consumption and production of vegetables in India, farmers are initiating their skill and new technologies to overcome the problem of climate change, to increase income and to lift up their level of affluence. In India, the concept of advanced horticultural technologies has broadened the scope of the vegetable sector (Chaudhari *et al*., 2016) [6].

Nowadays, the newsflash is farmers facing unique challenges because of climate and weather fluctuation as the farmers of India are highly dependent on open field production. Therefore, there is a massive disparity between per capita demand and supply due to less production. For each crop there are ecological targets for achievement of its production potential and to effectively mitigate abiotic & biotic stresses which direct the crop production potential and quality of produce (Swathylakshmi, 2016) [57]. To curb the constraints such as temperature extremities, duration of sunlight, deficiency or excess of water, atmospheric moisture (Relative humidity), nutrient deficiency, weeds, pests and diseases in production, examination and supervision of crop microclimate with the help of protecting the crops and maintaining the environment surrounding the plant will be necessary, and such cultivation under controlled environment conditions is termed as protected cultivation.

The production of vegetables under polyhouse makes the use of recent expansions in technology to regulate the environment for exploiting crop productivity percent area and increasing the quality of vegetables produce (Wani *et al*., 2011) [60].

The polyhouse technology can be a crucial for sustainable crop production and to attain food security in the sectors facing glitches of food scarcity (Jadhav and Rosentrater, 2017) [62]. It is no longer only a question of providing enough vegetables for a balanced diet; it is also a question of producing quality vegetables all year that are acceptable and competitive in the international market (Chaudhari *et al*. 2016) [6]. Protected farming is a kind of precision, progression, and parallel agriculture that effectively encompasses all aspects of agriculture and rather under additional scrutiny of technical significance to environments and farmers and market economics. In India, the area under polyhouse cultivation is about 25000 hactare and the greenhouse vegetable cultivation area is around 2000 hactare (Senthikumar *et al*., 2018) [29].

Capsicum is a high value vegetable crop which was brought to India by British people in 19th century. In India, it is mainly cultivated in Himachal Pradesh, Uttar Pradesh, J & K, parts of West Bengal, Maharashtra and Karnataka (Chadha, 2005) [63]. The state has 87.49 thousand hectares under vegetable cultivation, producing 1.87 million MT of vegetables (Directorate of Agriculture, Himachal Pradesh, 2022-23). In Himachal Pradesh the most widely grown crop in polyhouses is capsicum. Himachal Pradesh is leading supplier of capsicum to the plains during summer and rainy season produces 57.76 thousand tonnes of capsicum (Kumari *et al*., 2022) [64]. Solan, Kullu, Bilaspur and Mandi of mid hills (800-1500 amsl.) come up as the major capsicum producing districts under polyhouse in Himachal Pradesh. To promote protected cultivation, Govt. of Himachal Pradesh has provided the subsidy to the extent of 80 percent from April 1, 2013, thus, more and more area is being added under protected cultivation every year. It is being promoted on a large scale under different schemes for scaling-up the protected cultivation to make it as an Enterprise and innovative approach for enhancing Farmer’s income. As we know polyhouse cultivation plays a vital role in promoting human development and sustainability by enhancing agricultural productivity, conserving resources, mitigating climate risks, empowering communities, and promoting environmental friendly farming practices, therefore there is an urgent need to expand infrastructure for protected vegetable cultivation, improve marketing and value addition, and address farm-level technological gaps. Also, it is important to examine feasibility of vegetable production under polyhouses with initial capital investment and production cost. Keeping this in view, the present study aims to analyse the cost and return structure, economic feasibility of Capsicum production under protected cultivation.

1.1 Theoretical background

In this section, we examine the theoretical justification and empirical evidence related to polyhouse cultivation, emerging as a specialized production technology, a viable alternative to traditional farming methods by offering a controlled environment that enhances productivity and profitability. Enhanced financial stability improves the quality of life of farmers, primarily marginal and small farmers by providing better access to healthcare, education, and essential services. Enhanced financial stability for farmers promotes sustainability by enable the investments in eco-friendly farming practices and advanced technologies which lead to more efficient resource use, reduced environmental impact, and long-term agricultural viability. Our main objective is to review earlier studies on protected cultivation and to assess its feasibility, focusing on economic viability, environmental impact and yield improvements.

Mehta *et al*., 2020 [65], Singh *et al*., 2022 [5], mentioned that protected cultivation could play a crucial role in doubling farmers' income by enhancing crop productivity and reduce losses and a large-scale self-employment opportunity for an unemployed. Focusing on local values and indigenous knowledge strengthens the link between diversity and sustainable uses, which is a key when assessing marketability. Capsicum is an economically potential vegetable crop which is available in a variety of sizes, shapes and colo₹ Spehia, 2015 [55] showed that of all the crops under study, capsicum was the best option for getting maximum returns from polyhouses. Senthil *et al*. 2018, concluded that polyhouse cultivation of capsicum is highly remunerative. Sharma, 2012 [52] studied financial feasibility of protected cultivation and its impact on farm economy and revealed that protected agriculture had begun to make a significant contribution to gross farm revenue (50-70%) and of total household income (20-40%). Prakash *et al*., 2023 [47] concluded that without government subsidy support, bell pepper cultivation in a polyhouse is sustainable and feasible, but also government support reduces payback period substantially.

Polyhouse cultivation helps in meeting stringent export standards and certifications, enhancing marketability and revenue potential. Punera *et al*., 2017 [48] worked on economics and institutional aspects of protected cultivation, revealed that export-oriented growers could earn more revenue (150%) than farmers producing for the local market and the average price received were found higher in case of export-orinted farme₹

Polyhouse cultivation reduces input costs through efficient resource use and ensures high-quality, premium-priced yields, resulting in significant economic advantages and improved net returns to the farme₹ Mehta *et al*., 2020 [65] resulted crop productivity was approximately three times higher in comparison to the open field conditions. Jain *et al*., 2020, concluded that net returns were more than double when grown in polyhouses. Munshi and Kumar (2005) [66], Sharma and Pathania (2010) [50], Nimbrayan *et al*., 2020 and Kumar *et al*., 2021 [36] ascertained that polyhouse cultivation yields substantial returns, attributable to its capacity to enhance agricultural productivity and product quality.

Examining financial feasibility of polyhouse cultivation helps in assessing the potential profitability, determining the break-even point, and identifying the cost-benefit ratio of investment, aids in financial planning by projecting cash flows and return on investment. Murthy *et al*., 2009 [67], Sharma *et al*., 2014 [51], Kumar *et al*., 2021 [36] used project evaluation methods to examine the feasibility of vegetable production under polyhouse and have ascertained that the implementation of polyhouse cultivation constitutes a viable and lucrative enterprise with positive Net Present value, Internal rate of return and B:C Ratio greater than one. Based on the theoretical framework and the empirical evidence presented in this section, it is ascertained that polyhouse cultivation constitutes not merely a viable intervention or an enterprise but also an economically advantageous and environmentally sustainable strategy. Therefore, protected cultivation ensures a consistent supply of vegetables, despite adverse agro climatic conditions; enhance produce quality, efficiency and financial success in farming (Yadav *et al*., 2024) [61].

2. Material and Methods

2.1.1 Nature and source of data

The study was conducted in Kullu district of Himachal Pradesh, India, which is situated in the foothills of the North-Western Himalayans. Kullu area was chosen for its significant contribution to the state's vegetable production in terms of both area and output. It also offers valuable employment to families involved in vegetable cultivation. Multistage random sampling method was used to categorize the farme₹ Two development blocks namely Kullu and Naggar were selected based on highest no. of polyhouses of district Kullu. The farmers were divided into two categories Category I (250 m^2) and Category II (> 250 m^2) consisted a sample size of 100 farme₹ As there were more farmers with 250 sq. meter polyhouses compared to other polyhouse sizes, therefore, farmers were classified into only two categories: Category I (250 m^2) and Category II (> 250 m^2). Category II included polyhouse farmers with varying farm sizes, ranging from more than 250 sq. meters to 1,500 sq. mete₹ The primary data were collected with the help of pretested well-designed schedule by personal interaction with selected farme₹

2.1.2 Analytical Framework

Different analytical methods and approaches were employed to fulfill the specific objectives i.e. cost and returns structure and financial feasibility of capsicum cultivation under polyhouse.

i. Cost and returns analysis

The cost concept recommended by Commission for Agricultural Costs and Prices (CACP), Govt. of India, 2004 was employed to analyse the costs and returns of capsicum produced under polyhouse.

Cost A_1 includes

1. Cost of planting material
2. Cost of manures, fertilizers and plant protections
3. Cost of hired human labour
4. Irrigation charges
5. Depreciation on implements and polyhouse
6. Interest on working capital
7. Other miscellaneous charges

Cost A_2: Cost A_1+ Rent paid to leased in-land

Cost B_1: Cost A_1 + Interest on the fixed capital

Cost B_2: Cost B_1 + Rental value of owned land

Cost C_1: Cost B_1 + Imputed value of family labour

Cost C_2: Cost B_2 + Imputed value of family labour

Cost C3: Cost C_2+ Management cost (10%)

Table 1: Farm income measures

1	Net farm income	Gross income-Cost C3
2	Farm business income	Gross income-Cost A1
3	Family labour income	Gross income-Cost B2
4	Farm investment income	Farm business Income-Imputed value of family labour

ii. Break even 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 indicate the level of production at no profit no loss.

$$BEP = \frac{F}{P-V}$$

Where,
F = Fixed costs
P = Price per kg
V = Variable costs per kg

iii. Financial analysis: To appraise the financial feasibility of investment in polyhouse, discounted (net present value, benefit cost ratio and internal rate of return) and undiscounted methods (payback period) were used. 80 percent Subsidy was given to the farmers to promote polyhouses by the government of Himachal Pradesh. The cash inflows and outflows were worked out for the period of five yea₹

a. Net present value: The net present value represents the discounted value of the net cash inflows to the project. This is simply the present worth of the net cash flow stream.

$$NPV = \sum_{t=1}^{n} \frac{B_t - C_t}{(1+r)^t}$$

Where,
NPV = Net present value in period 't'
B_t = Benefit from polyhouse cultivation in each year
C_t = Cost of polyhouse cultivation in each year
r = Discount rate
t = 1,2,3…. n, the entire life of polyhouse across the study regions.
n = Number of years (5 years data was observed under the study)

b. Benefit cost ratio: The benefit cost ratio of an investment is ratio of the discounted value of all cash inflows to the discounted value of all cash outflows during the life of the project and computed as

$$B{:}\ C\ ratio = \frac{\sum_{t=1}^{n} \frac{B_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{C_t}{(1+r)^t}}$$

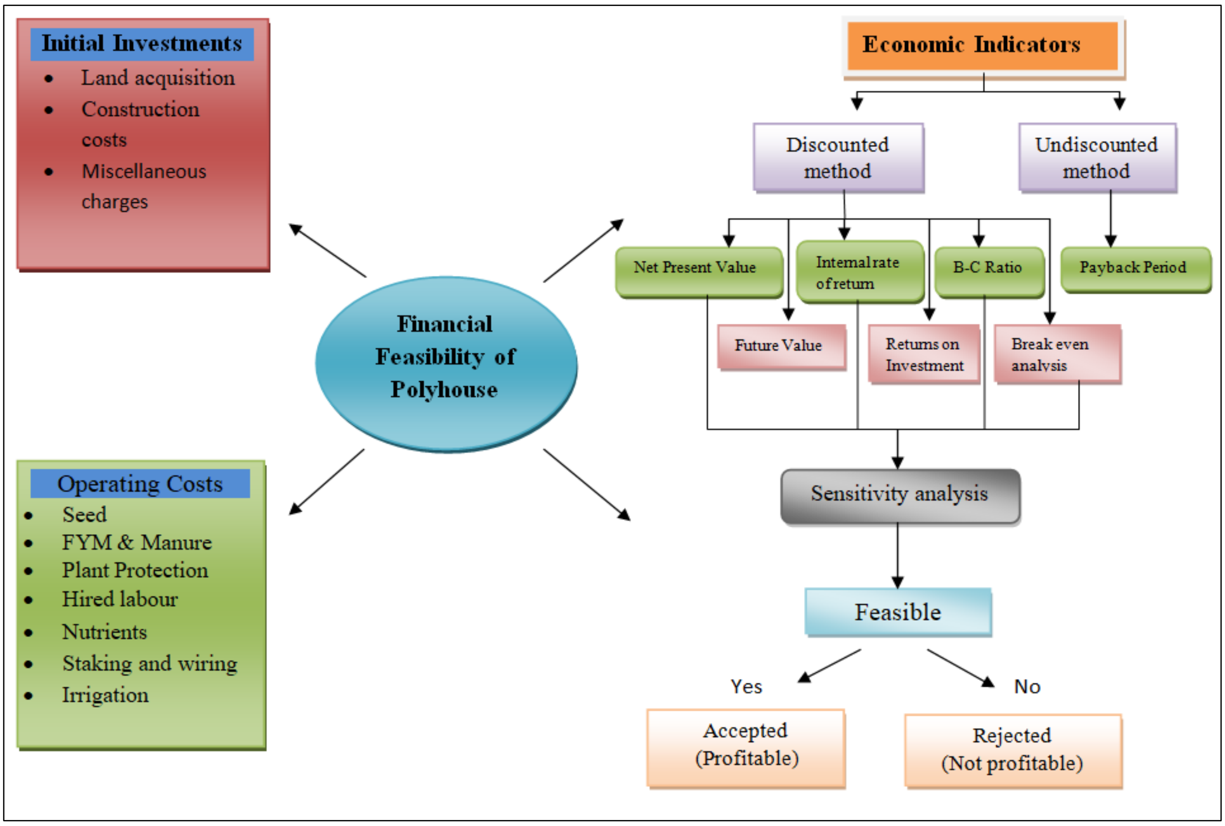

Fig 1: Conceptual framework for financial feasibility study

c. Internal rate of return: The rate at which the net present value is equal to zero is internal rate of return (IRR) to the project and it represent the average earning power of money used in the project life.

$$IRR = \frac{LDR + \text{Difference between 2 discount rates} \times \text{NPV of cash flow at LDR}}{\text{Absolute difference between NPV of cash flow at two dicount rates}}$$

Where,
IRR = Internal Rate of Return
LDR = Lower Discount rate

d. Payback period: PBP is an undiscounted measure of the worth of an endeavor, which measure the efficiency of cultivation by indicating the period within which the returns offset the investment.

$$PBP = \frac{\text{Investment}}{\text{Net annual cash flow}}$$

iv. Paired t test: Paired t test was used to evaluate the impact of adopting polyhouses on crop yield. Stata was used for paired t test.

$$t = \frac{d}{sd/\sqrt{n}}$$

Where,
d= mean of the differences between the paired observations
s_d = standard deviation of the differences
n = number of pairs (sample size)
t = t-statistic

3. Results and Discussion

3.1 Costs and returns structure of capsicum under polyhouse

3.1.1 Initial capital investment for Polyhouse

Initial capital investment is the base of the project i.e., initial capital is the funding needed to start a new business. A polyhouse farmer must have appropriate knowledge of both; protective production technology as well as an awareness of crop cultivation economics. The initial capital investment required to construct various components of polyhouses is presented in Table 2. Total initial capital investment incurred for different categories were ranged between ₹ 306932.42 to ₹ 961277.90. Investments on polyhouses were found ₹ 271326.04 to ₹ 923897.70 for Catergory I (250 sq. m) and Category II (> 250 sq. m). Investment on implements were resulted ₹ 35,606.38 to ₹ 37,380.25 for different sample farms (Category I and II). Proportion of initial capital investment required for construction of polyhouses varied between 88.39 to 96.11 percent of total initial capital investment for different sizes of polyhouses.

Table 2: Initial capital investment for different sizes of polyhouses (₹)

Particulars	Category I (250 m^2)	Category II (>250 m^2)
1. Investment on polyhouse		
1. Cost of site development	2130	6066.66
2. Additional infrastructure	10870.50	40240.33
3. GI pipes	152405.10	523590
4. Steel work welded	1686.36	5868.66
5. Polyhouse sheets	31738.77	115890.30
6. Insect net	8456.34	26746.01
7. Aluminium profiles	15347	48661
8. Moulding, processing, fabrication, and erection expenses	19750	60028.67
9. Fitting and accessories	8000	26200
10. Shading Net	12670	40817
11. Drip irrigation	7083	25715.67
12. Miscellaneous charges	1189	4073.333
Sub total	271326 (88.39)	923897.70 (96.11)
2. Investment on implements		
Major implements (Plough, yoke, manual sprayer, power sprayers, power tiller, tractor)	34762.50	36520
Minor implements (Spade, pickaxe, sickle, plastic crate, axe, kudali)	843.87	860.25
Total investment	306932.40	961277.90

Note: Figures in parentheses are percentages to the total

3.1.2 Costs and returns structure of capsicum under polyhouse

The results pertaining to cost analysis of capsicum crop under polyhouses is presented in Table 3. The results indicated that the total cost for Category I (Cost C3) was ₹ 50009.46, out of which cost A_1, A_2, B_1, B_2, C_1, C_2, and C_3 were ₹ 40307.05, ₹ 40307.05, ₹ 41562.89, ₹ 41985.14, ₹ 45040.89, ₹ 45463.14 and ₹ 50009.46.

Table 3: Cost structure of capsicum under different sizes of polyhouse (₹)

	Particulars	Category I (250 m^2)	Category II (>250 m^2)
Cost A_1			
	Depreciation on frame work (10 years)	9839.03	33183.06
	Depreciation on shading net (5 years)	1140.30	3673.53
	Depreciation on drip irrigation (5 years)	637.47	2314.41
	Depreciation on implements	2337.00	2412.00
	Seed	1821.00	6746.15
	FYM and manure	1392.00	5250.00
	Plant protection	1535.00	6492.00
	Hired labour	1843.00	7254.00
	Nutrients	1507.00	6308.00
	Staking and wiring	1400.00	7023.24
	Irrigation	300.00	1356.00
	Interest on working capital	685.86	2830.05
	Polythene sheet	15869.39	57945.17
	Total	40307.05	142787.60
Cost A_2			
	Rent paid to leased in land	0.00	0.00
	Cost A1	40307.05	142787.60
	Total	40307.05	142787.60
Cost B_1			
	Interest on fixed capital	1255.843	3742.47
	Cost A1	40307.05	142787.60
	Total	41562.89	146530.10
Cost B_2			
	Rental value of owned land	422.25	2685.09
	Cost B_1	41562.89	146530.10
	Total	41985.14	149215.20
Cost C_1			
	Imputed value of family labour	3478.00	6423.00
	Cost B_1	41562.89	146530.10
	Total	45040.89	152953.10
Cost C_2			
	Imputed value of family labour	3478.00	6423.00
	Cost B_2	41985.14	149215.20
	Total	45463.14	155638.20
Cost C_3			
	Management cost (10% of cost C_2)	4546.314	15563.82
	Cost C_2	45463.14	155638.20
	Total	50009.46	171202.00

The cost of cultivation of capsicum was ₹ 171202.00 for Category II polyhouses and cost A_1, A_2, B_1, B_2, C_1, C_2, and C_3 were ₹ 142787.60, ₹ 142787.60, ₹ 146530.10, ₹ 149215.20, ₹ 152953.10, ₹ 155638.20 and ₹ 171202.00, respectively. The cost of cultivation was high primarily due to high labour cost and was resulted ₹ 1843 for Category I and ₹ 7254 for Category II followed by seed, plant protection and nutrients. Labour cost was high primarily due to high labour wages required for different operations like staking and wiring, hoeing and weeding practices etc. Cost of polythene sheet added because the sheet normally lasts for 2-3 years to be replaced depending on wear and tear.

Table 4: Farm profitability in capsicum cultivation under polyhouse (₹)

Particulars	Category I (250 m^2)	Category II (>250 m^2)
Farm Business Income	75692.95	289212.40
Family Labour Income	74014.86	282784.80
Net Farm Income	65990.54	260798
Farm Investment Income	72214.95	282789.40
Yield (Quintal)	20	72
Price (₹)	5800	6000
Output input ratio	2.31	2.52
Break even yield (Quintal)	8.62	28.53

Table 4 revealed that net farm income earned was ₹ 65990.54 to ₹ 260798 for Category I and Category II. Farm business income i.e., ₹ 75692.95 and family labour income ₹ 74014.86 were earned under Category I polyhouse. Under large polyhouse farm business income and family labour income were found ₹289212.40 and ₹ 282784.80, respectively. Farm investment income varied between ₹ 72214.95 to ₹ 282789.4 for different sizes of polyhouses. Output-input ratio was 2.31 and 2.52, respectively, which leads to the results that growing capsicum in polyhouse has not only increased productivity but also yielded higher returns. Similar findings were also reported by Bala (2013) [1], Chaudhary (2016) [7], Kumar *et al*., 2016, Mehta *et al*., 2020 [65].

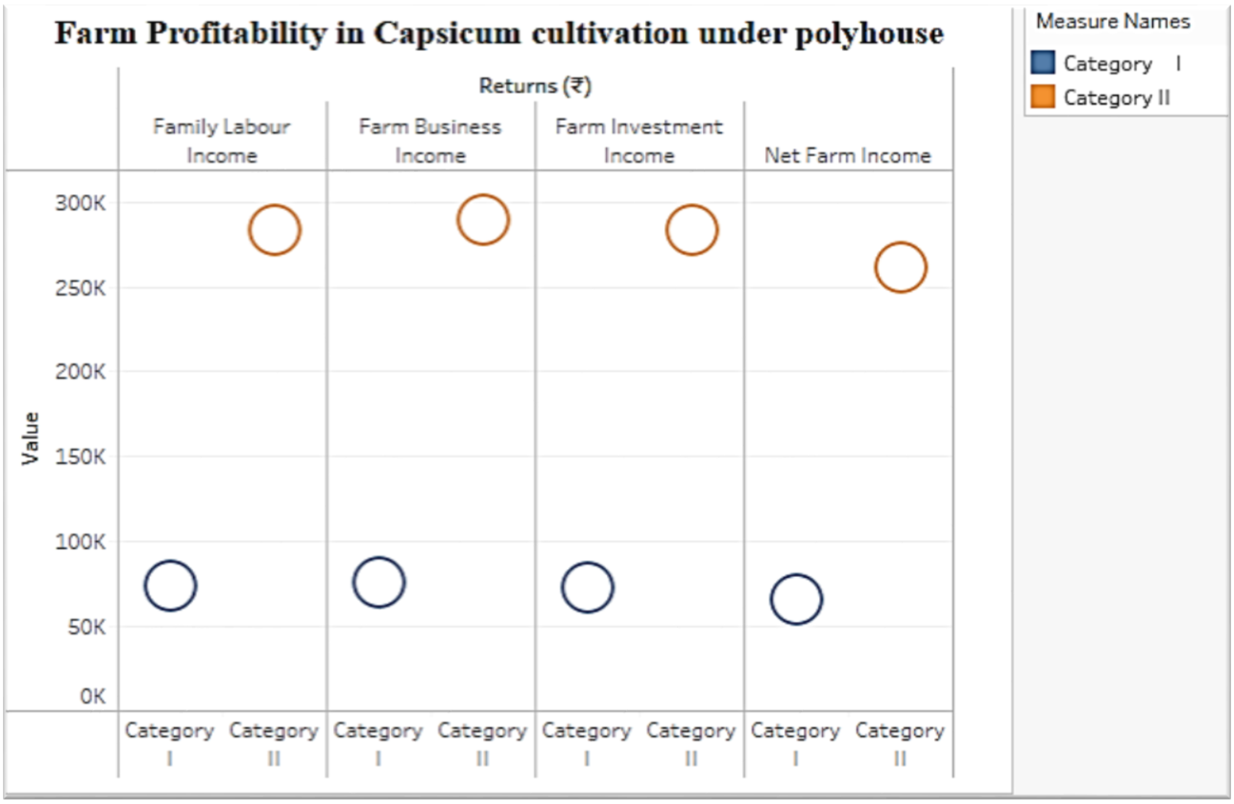

Fig 2: Farm incomes of capsicum cultivation under polyhouse

3.2 Economic feasibility of capsicum cultivation under different polyhouses:

Economic feasibility of capsicum cultivation under subsidized and non-subsidized polyhouses is presented in Table 5 in which Net present value, IRR, payback period and B-C ratio were calculated. The results showed that capsicum cultivation under subsidized and non-subsidized polyhouses for both the Category was feasible as the economic indicators were found in the acceptable limits. Under subsidized polyhouses net present value was found to vary between ₹234271.8 to ₹ 943993.40 for 5 years life span. Benefit-cost ratio of polyhouse units was 2.14 and 2.36, with Payback period of 0.57 to 0.66 years i.e. recoup of initial investment with good profits in first year. In case of non-subsidized polyhouses net present value varied between ₹ 17210.94 to ₹ 204875.30 with B-C ratio greater than one. Patidar *et al*., 2020 observed the B: C ratio on an average of 2.19 under capsicum production. Payback period was found 3.08 year to 3.35 years for non-subsidized polyhouses. Under both categories internal rate of return for subsidized and non-subsidized polyhouses was sufficiently high. Therefore, all the economic indicators indicated that cultivation of capsicum was highly feasible for all the categories of polyhouses and profitable to farme₹ Murthy *et al*., 2009, Prakash *et al*., 2023 [67, 47] also resulted that without government subsidy support, bell pepper cultivation in a polyhouse is sustainable and viable, but with government support farmers reduced their payback period substantially. Vijayalakshmi and Shrinivasarao (2024) [68] revealed that financial feasibility tests i.e., NPV, BCR and IRR were positive and proved that investing on polyhouse was profitable.

Table 5: Economic feasibility of capsicum cultivation under different sizes of polyhouses

	Category I (250 m^2)		Category II (>250 m^2)	
Economic indicators	**Non-subsidized**	**Subsidized**	**Non-subsidized**	**Subsidized**
Net present value (₹)	17210.94	234271.80	204875.30	943993.40
Internal rate of return (%)	13	146	19	168
B-C Ratio	1.04	2.14	1.14	2.36
Payback period (years)	3.35	0.66	3.08	0.57

3.3 Paired t test

A paired t-test was used to assess the impact of adopting polyhouses on crop yield by comparing yields in open condition and under polyhouse**.**

Table 6: Impact of adoption of polyhouses on crop yield by comparing yields before and after use

	Category I (250 m^2)			Category II (>250 m^2)		
Variables	**Yield Before**	**Yield After**	**Difference**	**Yield Before**	**Yield After**	**Difference**
Mean	13.02	20.10	-7.08	48.16	72.04	-23.88
Standard Error	0.12	0.20	0.23	3.06	3.98	1.08
Standard Deviation	0.89	1.44	1.67	21.69	28.15	7.66
95% Conf. Interval	(12.76,13.27)	(19.68, 20.51)	(-7.55,-6.60)	(41.99, 54.32)	(64.03, 80.04)	(-26.05,-21.70)
Paired t test	t=-29.87	P < 0.0001		t=-22.02	P < 0.0001	

The analysis compared crop yields before (open conditions) and after using the polyhouse for both the Categories (Table 6). The mean yield of capsicum in open condition was found 13.02 Quintal, while under polyhouse, the yield increased to 20.10 Quintal. In Category I, the mean difference of-7.08 units indicated a significant increase in yield, with a 95 percent confidence interval [-7.55,-6.60]. t value (t =-29.87, p<0.001) shows that this difference is highly significant. In Category II, the mean yield rose from 48.16 to 72.04, resulting in a difference of-23.88 (t =-22.02, p<0.0001), also showed significant improvement, confirmed the effectiveness of polyhouses in improving production. Spehia (2015) [55] studied the important cash crops suitable for protected cultivation, viz. capsicum, tomato, cucumber, beans, peas, coriander and spinach and the results revealed an increase in crop productivity by a minimum of 59 percent (coriander) to a maximum of 414 percent (cucumber) inside polyhouses as compared to open cultivation. Mehta *et al*., 2020, Kumar *et al*., 2016 [65, 6] also concluded the study on growth and yield parameters of different vegetables and found significant enhancement in yields under protected over open-field.

Conclusion and Policy implication

Protected agriculture is defined as the inspection and supervision of agricultural microclimate with the goal of protecting crops and maintaining the environment surrounding the plant. In recent decades, cropping patterns in Himachal Pradesh of India have diversified in favour of vegetable crops, resulting in the state earning a reputation for off-season vegetable production. Results showed that polyhouse cultivation is viable and profitable and farmers are getting higher rewards. Total cost of cultivation (Cost C3) for capsicum was found ₹ 50009.46 and ₹ 171202.00 for Category I and Category II. The net returns varied between ₹ 169375.61 to ₹ 260798.00 among different farm categories. The break-even yield under polyhouse cultivation was 8.62 quintal for Category I and 28.53 quintal for Category II. Capsicum cultivation under subsidized and non-subsidized polyhouses proved to be economically viable, as the key financial indicators fell within acceptable limits for both categories. Net present value under subsidized and non-subsidized polyhouses for both the category was found to vary between ₹17210.94 to ₹ 943993.4 for 5 years life span. Benefit-cost ratio for subsidized polyhouse ranged from 2.14 to 2.36, with Payback period of 0.57 to 0.66 years indicated that the initial investment was recovered within a year. BC ratio for non-subsidized polyhouse was 1.04 to 1.14 with payback period of 3.08 to 3.35 yea₹ Under both categories internal rate of return for subsidized and non-subsidized polyhouses was sufficiently high. Paired t test analysis was used to compare crop yields before (open cultivation) and after using the polyhouse for both the Categories and resulted that the mean yield of capsicum in polyhouse was higher than open cultivation. Therefore, the results showed polyhouse offers a bounty of opportunity and benefits and an excellent source of income generating method for marginal and small scale farme₹ It is also important for the farmers to evaluate the market's complexities in terms of prices at various times of the year, as well as the optimal timing to enter the market, since these factors have a direct contact with labour productivity, investment, and overall profitability. Farmers should go for cooperative farming to cop up with higher initial investment. Due to perishable nature of vegetables, storage and refrigerated transport facilities should be devised. Also, there is a need to develop procurement facilities and post-harvest infrastructure for vegetables in the state. There is also a need to formulate a method for the selection of genuine farme₹ This will guide the farmers and policymakers on where to focus their efforts to maximize capsicum production under polyhouse cultivation.

Declaration

Conflict of interest

The authors declare no conflicts of interest. The authors declared that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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