

Comparative Economics of Capsicum Cultivation under Polyhouse and Open Field Conditions in Punjab

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Abstract

The study analysed and compared the costs and profitability in the production of capsicum under protected cultivation vis-à-vis open field conditions in Punjab state. The results revealed that the cost of establishment of polyhouse was to the tune of Rs.18.70 lakh /4000m² with subsidy. The total per acre cost of production of capsicum under polyhouse was higher by Rs.4.17 lakh (336.45%) than that of open field cultivation. The huge differences in cost of production in polyhouse cultivation of capsicum were due to the use of more number of seedlings, costly seeds, high field and bed preparation cost and requirement of skilled labour while expenditure on weeding and irrigation was found less in polyhouse cultivation of vegetables. The yield of capsicum in polyhouse cultivation was found higher (111.05%) as compared to open field cultivation of capsicum. Under polyhouse, the cultivation of capsicum was found feasible as reflected by higher value of NPV i.e. Rs. 17.61lakh per 4000m²with benefit cost ratio (BCR) of 1.3 and Internal rate of return (IRR) of 24 per cent. Despite various constraints such as. high investment cost, lack of technical guidance, costly seeds, non-availability of skilled labour and high cost of maintenance, cultivation of capsicum under polyhouse emerges as a profitable venture to increase farmers' income.

Keywords: Costs and returns, Economic viability, Open field, Productivity, Protected, Capsicum cultivation

JEL Classification: Q10, Q50, Q56

Introduction

Vegetables are vital sources of proteins, vitamins, minerals, dietary fibres, micronutrients, antioxidants and phytochemicals in our daily diet. Besides nutrition, they are important part of Indian agriculture due to their short duration, high yield, economic viability and ability to generate on-farm and off-farm employment. The contribution of vegetables remains highest (59-61%) in horticultural crop production in the previous years. Thus, apart from nutritional benefits, the production of vegetables improves the economy of a country as these are good source of income and employment. These are very utilitarian in the rotational system of farming for maintenance of soil fertility and also providing better crop intensification and diversification. Our country is privileged with diverse agro-climates with distinct seasons, making it possible to grow wide range of vegetables.

India is the second largest producer of vegetables in the world. During 2017-18 India produced 184.40 million tonnes of vegetables on 10.26 million hectares of area under vegetables (Anonymous, 2018). The per capita availability of vegetables is also on the increase i.e 393.76 g/person/day. Boosted by rising consumers demand and owing to better health awareness and purchasing power, there is strong need to expand vegetable production in the country. The present vegetable production must be bump up. There are many ways and means to achieve this target, e.g by expanding area under vegetable crops, using high quality seeds, by using new agro- techniques etc. Another approach to meet increasing demand for vegetables is adoption of protected cultivation (Santosh *et al*, 2017). Protected cultivation is a technique where the micro climate in the surrounding area of the plant is controlled partially or fully or modified to protect the crop from weather especially very low or high temperature, hail storms

and heavy rains. Protected cultivation of vegetables is emerging as a specialised production technology to overcome biotic stresses like pests, diseases, weeds etc and abiotic stresses like temperature, humidity, light etc. It is believed that greenhouse crop production is destined to play an increasingly important role in optimization of water-use efficiency in an environment of water scarcity in addition to better control of product quality and safety, in line with the market demand, standards and regulations. Besides supplying the local markets, the production of greenhouse vegetables is greatly valued for its export potential and plays an important role in the foreign trade balance of several national economies. The management practices for protected cultivation are different than for open field production. The major factor which affects the adoption rate of protected cultivation is the cost of structure. The cost of polyhouse primarily depends on the standard of materials used for the structure, covering and others like drip and mist systems. The size of polyhouses varies from 1000 to 10,000m² depending on the requirement. Depending on cost polyhouses are of various kinds which include low cost ranging from Rs.250-400/m², medium cost ranging from Rs.500-1000m², and high cost polyhouses Rs.1000-2000/m² (Murthy *et al*, 2009). The major problem associated with this technology is that it is cost intensive. Although it is attached with several government schemes in India with provision of 50-90 percent of subsidies depending on type of technology, status and policy of state and central government. Capsicum can be successfully grown under open field conditions and in protected structures, i.e. polyhouse, net house, walk-in tunnels etc. It is one of the most popular and highly remunerative annual herbaceous vegetable crop. India contributes one fourth of world production of capsicum with an average annual production of 0.9 MT from an area of 0.885 million hectares. (Kumar *et al*, 2016).

In Punjab, area under vegetable cultivation is 208 thousand hectares with production of 4167.60 thousand tonnes and productivity of 15.60 metric tonnes per hectare (Kaur *et al*, 2017). The area under greenhouse cultivation in Punjab is 20 hectares out of 1.70 lakh hectares under vegetable crops (Spehia, 2015). Protected cultivation in the state brings considerable increase in unit area productivity of vegetable crops. For instance, under protected conditions the productivity of tomato has been reported doubled and in case of bell pepper productivity increased by five times (Sethi *et*

al, 2009). The farmers of Punjab are using greenhouse technology to raise seedlings of high yielding crop varieties having good health which can be transplanted in the early spring so as to capture the early markets and thus fetch higher profits. Vegetable farming seems to be a good alternative for the existing wheat-paddy rotation in Punjab as vegetable crops give high returns per unit area in contrast with wheat –paddy rotation (Sharma *et al*, 2000). In Punjab, the yield of wheat and paddy has reached the point where only a marginal increase in level of production per acre is possible (Kaur and Kaur, 2019). Therefore, vegetable growers can look forward to additional returns by using protected cultivation in off season, because the vegetables which are produced in their common season cannot give high returns due to huge supply in markets. The farmers having small land holdings can take more advantage from this technology, by growing more crops each year and save themselves from adverse situations. Keeping in view the importance of vegetables in increasing income as well as profit of farmers, the present study was conducted to assess the costs and returns in the production of capsicum under protected cultivation vis-a-vis open field cultivation in Punjab, to examine the economic viability of investment for the production of capsicum under protected cultivation. and to identify the constraints in the production of capsicum under protected cultivation technique and make suggestions for streamlining the same.

Data Sources and Methodology

To fulfil the stipulated objectives of the study, the present study was conducted in Punjab state. Ludhiana and Jalandhar districts were purposively selected as the have the highest concentration of poly houses in the state. The information regarding the number, area and type of polyhouses was obtained from respective district Horticulture offices of Punjab state. From the complete list of polyhouse vegetable growers obtained from the officials of Department of Horticulture of Ludhiana and Jalandhar, 40 respondents were selected randomly i.e.20 from each district. For comparison purpose an equal number of vegetable growers, cultivating vegetables in open field were also selected from the both districts. The primary data for the year 2018-19 were collected with the help of well-structured and pre-tested schedule by personal interview method. For the interpretation and comparison of costs and returns from capsicum under polyhouse and open field conditions and to

generate information on other parameters, tabular analysis was carried out. Economic feasibility of investment on production of capsicum under polyhouse conditions was evaluated by using project evaluation measures viz. Payback period (PBP), Benefit Cost Ratio (BCR), Net Present Value (NPV), and Internal Rate of Return (IRR).

Results and Discussion

Cost of establishment of polyhouse

Polyhouse production is a capital-intensive technology requiring a substantial investment especially during the initial establishment period. The materials used for the establishment of poly house are structure and sheet, galvanized iron pipes (G.I), polythene sheet, irrigation and fertigation system, misting, shade net etc. A perusal of Table 1 reveals a non-land cost of establishment of one acre or 4000m² polyhouse was worked out to be Rs.37.40 lakh. The cost of establishment was to the tune of Rs 18.70 lakh/4000m² after availing 50 percent subsidy. The establishment cost was sanctioned by National Horticulture Mission (NHM) under the Mission on Integrated Development Horticulture, Government of India through state Horticulture Department. The establishment cost included costs on initial land preparation, basic structure & sheet, irrigation & fertigation system, misting and construction costs. The useful life of structure was considered as 20 years. Among the different cost components, maximum cost was accounted for structure and sheet (83.49%) of which 57.49 per cent

was incurred on G.I pipes, followed by labour (13.16%) and rest of 12.84 per cent on polythene sheet. The next higher component of cost was misting (5.31%) followed by irrigation and fertigation system (4.60 per cent), shade net (4.60 per cent) and miscellaneous (1.98 per cent). The miscellaneous costs included initial land preparation, weeding, incidental charges, etc. It was found that establishment cost of polyhouse for vegetable cultivation depends on size and shape of structure and area of polyhouse.

Cost structure of capsicum production under polyhouse and open field conditions

A comparative economic analysis of capsicum cultivation under polyhouses and open field conditions was done on per acre basis. The cost structure (fixed and variable) in the production of capsicum under polyhouse and open field conditions is presented in Table 2. The total variable cost in the production of capsicum under poly house was worked out be Rs1.62 lakh which came out to be 30.05 percent of the total cost. The break-up of the total variable cost indicates that the highest cost was incurred on seeds with Rs.45660 (8.44%) followed by marketing cost (4.95%), human labour (4.11%), fumigation (3.01%), fertilizers and FYM (2.79%), plant protection chemicals (2.50%), field and bed preparation (1.68%), interest on working capital (0.77%), weeding (0.75%), machine labour (0.77%) and irrigation (0.28%). In case of fixed cost, the major item of expenditure was amortised cost with Rs.3.07 lakh (56.78%) followed by interest on fixed capital i.e. Rs.

Table 1. Cost of establishment of poly house structure, Punjab, 2018-19

Particulars	Cost Rs./4000m ² (in lakh)	Percentage to total	Life period (years)
Structure and sheet	31.22	83.49	-
a) Galvanized iron pipes (GI pipes)	21.50	57.49	20
b) Polythene sheet	4.80	12.84	2
c) Labour	4.92	13.16	-
Irrigation and fertigation system	1.72	4.61	5
Misting	1.98	5.32	10
Shade net	1.72	4.60	5
Miscellaneous (initial land preparation cost, preparing the land for planting, initial weeding, incidental charges, etc.)	0.74	1.98	-
Total cost	37.40	100.00	-
Subsidy @ 50 percent of total cost	18.70	-	-

Table 2. Comparative cost structure of capsicum production under poly house and open field, Punjab, 2018-19
(Rs/ acre)

Particulars	Poly house cultivation	Open field cultivation	Difference between poly house and open field conditions	
			Difference over open field	% difference over open field
(A) Variable cost				
Fumigation /sterilization	16275 (3.01)	-	16275	-
Field and Bed preparation	9097 (1.68)	5585 (4.50)	3512	62.88
Seeds / seedlings	45660 (8.44)	6852 (5.53)	38808	566.38
Weeding	4108 (0.75)	4880 (3.93)	-772	-15.81
Irrigation	1482 (0.28)	2018 (1.63)	-536	-26.56
Fertilizers and FYM	15150 (2.79)	9377 (7.56)	5773	61.56
Plant protection chemicals	13557 (2.50)	9562 (7.71)	3995	41.77
Human labour	22286 (4.11)	14997 (12.09)	7289	48.60
Machine labour	4116 (0.77)	2136 (1.72)	1980	92.69
Marketing cost	26800 (4.95)	12920 (10.42)	13880	107.43
Interest on working capital (7%) for half of the crop period	4162 (0.77)	1195 (0.96)	2967	248.28
Total Variable cost	162000 (30.05)	69522 (56.06)	93171	134.01
(B) Fixed cost				
Rental value of land	30000 5.54)	20000 (16.12)	10000	50.00
Amortised cost	307000 (56.78)	-	-	-
Depreciation and Interest on fixed capital (10%)	41181 (7.60)	34488 (27.81)	6693	19.40
Total fixed cost	378000 (69.95)	54488 (43.94)	324062	594.74
Total cost (A+B)	541000 (100.00)	124000 (100.00)	417000	336.45

Note: Figures in parentheses indicate percentages to total cost

41181 (7.60%) and rental value of land (for capsicum rent was consider four and half months) Rs.30000 (5.54%).

In case of open field cultivation of capsicum, the total variable cost was to the tune of Rs.69522 which was estimated to be 56.06 percent of the total costs. The break-up of the total costs indicates that among the various components the highest proportion was spent on human labour with Rs.14997 (12.09%) followed by marketing cost (10.42%), plant protection chemicals (7.71%), fertilizers and FYM (7.56%), seeds (5.53%), field and bed preparation (4.50%), weeding (3.93%), machine labour (1.72%), irrigation (1.63%) and interest on working capital (0.96%). The proportion of total cost spent on interest on fixed capital and depreciation was worked out to be 27.81 per cent followed by rental value of land for the capsicum crop (16.12%).

The table depicts that per acre total cost incurred on capsicum under polyhouse and open field conditions was worked out Rs.5.41 lakh and Rs.1.24 lakh respectively. The reasons for higher total cost in polyhouse cultivation were costly seeds, large number of labour required and higher fixed costs. In open field conditions, the highest proportion in total cost of capsicum cultivation was incurred on variable cost (56.06%) while in case of polyhouse conditions the highest proportion was spent on fixed cost (69.95%) including more of amortised cost (56.78%).

The percentage difference between the costs incurred in capsicum cultivation under polyhouse and open field conditions has been shown in the table 2 which clearly indicates that total costs in the cultivation of capsicum in polyhouse was found 336.45 per cent more than open field cultivation while total variable costs were 134.01 per cent more than open field cultivation. In case of variable cost, maximum difference over open field which was found in seeds (566.38%) followed by marketing cost (107.43%), human labour (48.60%), fertilizers and FYM (61.56%), plant protection chemicals (41.77%), field and bed preparation (62.88%), interest on working capital (248.20%), machine labour (92.78%). Such huge differences in polyhouse cultivation of capsicum were due to the more number of seedlings were planted and these were more costly also in comparison with open field seeds. Field and bed preparation cost was also found more in case of polyhouse cultivation of capsicum as it needs more perfection in agronomical

operations. Besides, more number of skilled labour are required for harvesting and marketing operations. The results also brought out that expenditure on weeding and irrigation was found more costlier in case of open field indicating more infestation of weeds in open field conditions. Irrigation charges were found less in polyhouse cultivation due to drip systems. The findings are in line with the study of Kumar *et al* (2016).

Labour use pattern in capsicum production

Labour use pattern for various operations in the production of capsicum under polyhouse and open field conditions is presented in Table 3 The results revealed that that capsicum production under polyhouse conditions require more labour as compared to open field cultivation of capsicum. In polyhouse cultivation, for preparatory tillage and bed preparation per acre total of 62.65 hours of human labour was used which consisted of 57.75 hours of family labour and 4.90 hours of hired labour. In open field cultivation of capsicum per acre 50.20 hours of family labour and 4.85 hours of hired labour were used. Human labour used on nursery raising and transplanting was 30.45 hours per acre out of which 23.20 hours of family labour and 7.25 hours of labour were utilized in polyhouse cultivation of capsicum. In open field 28.65 hours per acre were required for nursery raising and transplanting operation. It was found that in performing both these operations i.e preparatory tillage and bed preparation and nursery raising and transplanting more of family labour was used in polyhouse as compared with open field conditions. Further, maximum labour hours were utilized on harvesting and transportation and least labour hours were used on nursery raising and transplantation in both conditions. About 391.50 human labour hours were used for harvesting and transportation followed by intercultural operations (74.65 hours), preparatory tillage (62.65 hours), irrigation (35.06 hours) and nursery raising and transplanting (30.45 hours) in polyhouse cultivation of capsicum. In open field conditions, 204.47 human labour hours were used for harvesting and transportation followed by 59.25 human labour hours on intercultural operations, 55.05 human labour hours on preparatory tillage and bed preparation, 52.50 human labour hours on irrigation and 28.65 human labour hours on nursery raising and transplanting in capsicum production. In aggregate, 594.31 human labour hours were utilized in various operations for production of capsicum under polyhouse

Table 3. Labour use pattern for various operations in production of capsicum by sampled farmers in Punjab, 2018-19 (hrs/acre)

Particulars	Poly house			Open field		
	Family Labour	Hired Labour	Total Labour	Family labour	Hired labour	Total Labour
Preparatory tillage and bed preparation	57.75	4.90	62.65	50.20	4.85	55.05
Nursery raising and transplanting	23.20	7.25	30.45	20.85	7.80	28.65
Intercultural operations (fertilizer application, plant protection chemicals, weeding)	17.75	56.90	74.65	13.75	45.50	59.25
Irrigation	29.21	5.85	35.06	11.30	41.20	52.50
Harvesting and transportation	110.00	281.50	391.50	55.75	148.72	204.47
Total	237.91	356.40	594.31	151.85	248.07	399.92

conditions and in case of open field conditions total 399.92 human labour hours were used for various operations therefore, indicating that polyhouse capsicum cultivation is labour intensive.

Return structure of capsicum production under poly house and open field conditions.

A perusal of Table 4 revealed that an average yield of 382.71 and 181.33 quintal per acre was obtained under polyhouse and open field cultivation of capsicum respectively. It was found that polyhouse farmers realised per acre 201.38 quintals higher yield of capsicum as compared to open field farmers. Also,

sale price received by polyhouse farmers was higher (Rs.22.91 per kg) than that of open field farmers (Rs.9.87 per kg).

In case of polyhouse cultivation of capsicum, gross returns per acre was estimated to be Rs.8.76 lakh where returns over variable cost and net returns were to the tune of Rs.7.14 lakh and Rs.3.35lakh per acre respectively. In case of open field, the gross returns per acre was estimated at Rs. 1.78 lakh. Return over variable cost and net returns came out to be Rs. 1.09 lakh and Rs. 54962.71 per acre, respectively. The input-output ratio was worked out to be 1.62 and 1.44 in case of polyhouse and open field conditions respectively. The

Table 4. Comparative economics of capsicum production under poly house and open field conditions in Punjab, 2018-19

Particulars	Unit	Poly house	Open field	Difference over open field	Percent difference over open field
Yield	q/acre	382.71	181.33	201.38	111.05
Sale price	Rs/kg	22.91	9.87	13.04	132.11
Gross returns	Rs/acre (in lakh)	8.76	1.78	6.97	389.90
Variable cost	Rs/acre (in lakh)	1.62	0.69	0.93	134.01
Returns over variable cost	Rs/acre (in lakh)	7.14	1.09	6.04	552.43
Total cost	Rs/acre (in lakh)	5.41	1.24	4.17	336.45
Net returns	Rs/acre (in lakh)	3.35	0.54	2.80	510.49
Input-output ratio	-	1.62	1.44	0.18	12.50
Cost of production	Rs/kg	14.14	6.83	7.31	107.02
Profit margin	Rs/kg	8.77	3.04	5.73	188.48

Table 5. Economic viability of capsicum cultivation under subsidized polyhouse conditions, Punjab, 2018-19

Economic viability indicators	Capsicum cultivation
Net Present Value (Rs lakh /acre)	17.61
Benefit Cost Ratio	1.3
Payback Period (years)	2.1
Internal Rate of Return (%)	24

cost of production per kg of capsicum was estimated as Rs.14.14 in case of polyhouse cultivation while in case of open field it was to the tune of Rs.6.83. It was observed that cost of production per kg found less by Rs.7.31 in case of open field capsicum cultivation as compared to polyhouse cultivation. Profit margin per kg was observed to be Rs. 8.77 and Rs.3.04 in case of polyhouse and open field cultivation of capsicum. The difference of per kg profit margin over the open field conditions was estimated by Rs. 5.73 (188.48%). Hence, it can be concluded that yield of capsicum and income of farmers can be increased many folds by adoption of polyhouse technology.

Economic viability of capsicum cultivation under subsidized polyhouse conditions.

Under subsidized conditions, the payback period (PBP) for polyhouse production of capsicum was found to be 2.1 years. The net present value (NPV) at 10 per cent discount rate was Rs.17.61lakh with benefit cost ratio (BCR) of 1.3 or capsicum crop. Internal rate of return (IRR) in polyhouse production of capsicum was found 24 per cent (Table 5). Therefore, production of capsicum under subsidized polyhouse conditions was

found highly feasible and profitable. The findings are in line with the study of Murty *et al* (2009).

Production constraints under protected cultivation

A perusal of Table 6 shows that about 80 percent respondents faced the problem of high investment on poly house structure. Lack of technical guidance was found to be the problem of 65 per cent of the respondent farmers while high cost of seeds as a problem (55%) of the respondents, non-availability of skilled labour and high cost of maintenance were also faced by (50% each) respondents in a study area respectively. About 47 per cent capsicum growers faced problem of high cost of hired labour and 40 per cent faced problem of lack of minimum support price. At the initial stage of cultivation in poly house farmers frequently reported the problem of high incidence of pests and diseases which became very difficult to control inside the polyhouse even with high doses of pesticides. Due to constant weather fluctuations (heavy rains & storms), polythene sheet was prone to damaged and this problem was reported by 25 per cent respondents. Infestation of nematodes was also faced by 15 per cent farmers. Other problems faced by respondent farmers were

Table 6. Constraints in the production of capsicum under protected cultivation, Punjab, 2018-19

Particulars	Polyhouse farmers	
	Number	Percent
High investment cost	32	80.00
Lack of technical guidance	26	65.00
High cost of seed	22	55.00
Non-availability of skilled labour	20	50.00
High cost of maintenance	20	50.00
High cost of hired labour	19	47.00
Lack of minimum support price	16	40.00
Pests and diseases	10	25.00
Prone to damage by heavy rains & storms	10	25.00
Infestation of nematode	6	15.00

fear to failure of technology, weed infestation, lack of knowledge of latest package of practices, lack of availability of fertilizers at appropriate time, marketing problems like malpractices in weighing, high cost of transportation, heavy market loss due to perishable nature of capsicum and lack of quality packing material etc.

Conclusion and Policy Implications

It can be concluded that cultivation of capsicum under polyhouse conditions yields high returns and better quality produce. Besides, off-season produce under protected cultivation can fetch a better price in the market and can give higher income to the farmers. Polyhouse cultivation of capsicum is a capital and labour intensive activity which gives higher profit per unit area. The cultivation of capsicum under polyhouse was found feasible as reflected in higher value of NPV i.e. Rs. 17.61,lakh per 4000 m² with benefit cost ratio (BCR) of 1.3 and Internal rate of return (IRR) of 24 per cent. The study brought out that research efforts should be initiated to reduce the cost of establishment of polyhouse. There should be government support by increasing the amount of subsidy in Punjab state. Additional investment and lack of knowledge for proper utilization were the major factors hindering the large scale adoption of protected structures.

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