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Case Study

Economic Feasibility of Capsicum Cultivation Under Greenhouse Condition – A Case Study

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ABSTRACT

Greenhouse cultivation is one of the most promising emerging technologies in vegetable or flower crops, ensuring high quality and quantity. It also ensures year-round production of vegetables with high value in the market, particularly during the off-season. However, cost is the major concern in this technology. The present study focuses on the economic viability of capsicum cultivation under a naturally ventilated medium-cost greenhouse equipped with drip facility. The study was undertaken in the semi-arid region, a village called Saidapur of Sangareddy district near Hyderabad. The primary data were collected directly from the farmer through personal interview. The detailed data required for further evaluation were generated by the cost-accounting method. The feasibility of production under greenhouse was examined with the help of project evaluation methods such as Pay Back Period (PBP), Net Present Worth (NPW), Benefit-Cost Ratio (BCR), and Internal Rate of Returns (IRR). The actual worth of economic inputs with subsidy component (75%) provided by the Government was considered for detailed evaluation purposes. The capsicum cultivation under the greenhouse by availing above said subsidy was found highly feasible as indicated from shorter pay-back period, larger net-present worth, benefit-cost ratio of more than unity and IRR more than usual rate of interest of bank loans. However, the results also indicated that capsicum cultivation under a greenhouse without subsidy is not feasible economically.

HIGHLIGHTS

- Profitability indicators for capsicum cultivation in greenhouse conditions indicated economic worthiness of the proposition.
- The capsicum cultivation in greenhouse without subsidy is not profitable.

Keywords: Capsicum, Economics, Greenhouse, Polyhouse, Production, Price, Subsidy

The current agricultural setup is a mix of unpaid achievements and missed opportunities. If India must develop as an prominent economic power globally, our agricultural productivity should match that of developed countries, which are now appraised as the world's economic power. Existing agricultural practices are both economically and environmentally less sustainable. Human kind has been cognizant that a sensible modification of the environment could improve the productivity of crops (Meena *et al.* 2018). The greenhouse could be one of those technologies wherein there is greater control over the growing environment of plants. Plants growing with polyhouse technology is both an art and a science. Greenhouses may be used to overcome shortcomings in the growing qualities of a piece of land (Jadhav and Rosentrater, 2017; Singh *et al.* 2019). It is relatively used to protect the plants from adverse climatic conditions such as wind, cold, precipitation, excessive radiation,

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extreme temperature, insects, and diseases, and thereby it improves food production in marginal environments. It can give manifold production of quality produce round the year from small landholdings, compared to the open field cultivation (Murthy *et al.* 2009; Rao *et al.* 2013).

India, known as the fruit and vegetable basket of the world, is the second-largest producer of overall fruits and vegetables next to China. Capsicum (*Capsicum annum L.*) is an important vegetable cum spice crop grown in almost all parts of tropical and subtropical regions of the world. It comprises numerous chemicals, including steam-volatile oils, fatty oils, capsaicinoids, carotenoids, vitamins, proteins, fibers, and mineral elements. Capsicum fruits may serve as a source of natural bactericidal agents in food and medicinal systems. The study results would benefit small-scale and medium-scale farmers, extension institutions, polyhouse companies, and the government. Also, to extend the area of greenhouses, especially vegetable crop area. The detailed cost structure gives valuable information in the cultivation of Capsicum, which might be a very profitable vegetable crop under greenhouse. It also provides room for entrepreneurs and youngsters to prefer agriculture as their profession (Jain *et al*. 2021).

The literature review revealed that there had not been any studies on the economic viability of commercial crops based on farmer input, real-world circumstances, and market changes. In light of this, this study was designed to examine the economic viability of polyhouse for the production of the capsicum crop using a variety of discounted and undiscounted measures in the analysis. It also sought to determine whether or not polyhouse cultivation is feasible with or without subsidies based on changes in market prices over time.

Even though capsicum is widely grown in greenhouses, there has only been a limited amount of research on the economic viability of capsicum cultivation under greenhouse conditions, taking into account the subsidy component as well as market price sensitivity analysis, which determines the viability of capsicum at various market prices. Therefore, it is deemed vital to investigate if producing capsicum is economically viable.

MATERIALS AND METHODS

Sangareddy district of Telangana state was chosen for study as most of the farmers in this area are growing vegetable crops where there is a scope for enhancement of productivity and quality of produce with the help of greenhouse. The place is near Hyderabad, where the subsidy (75%) is applicable for farmers to establish polyhouse (It was the condition that the areas within 100 km distance from Hyderabad only be covered under the scheme). A sample of 15 farmers growing vegetable crops under greenhouses in the Sangareddy district were randomly selected for the study. Details regarding the establishment of greenhouse and cost of cultivation of Capsicum were collected with the help of specially designed schedules by personal interview method and presented at current prices (2017-18) to estimate costs and returns. The data related to agriculture years 2015-16, 2016-17, and 2017-18. The project evaluation measures were derived based on certain assumptions. The first and foremost assumption was that the life span of the current project is assumed as 25 years. Typically, 5 to 6 months are required for one crop, and hence, in the present study, two crop seasons were included for every annual cash flow. For estimating cash flows, actual data was used for the first three years, and the remaining years, the cash flows were extrapolated approximately based on the available information. Secondary data of the capsicum crop details and greenhouses established were collected from the district planning office Sangareddy, Department of Agriculture.

Undiscounted and discounted cash flow techniques were used to analyse the capital productivity of polyhouse with capsicum crop. The following undiscounted and discounted measures were used in the analysis: payback period, net present worth, benefit-cost ratio, and internal rate of returns.

Pay Back Period (PBP)

The payback period represents the duration from the start of project to the time where the net value of cumulative incremental production of the project reaches its total capital investment. It is a potential tool to assess any project whether one would be feasible for proceeding further or not (Paul *et al.* 2012).

$$P = \frac{I}{E}$$

Where, '*P*' is the Payback period of the project in years, '*I*' is the investment of the project in rupees, and '*E*' is the annual net cash revenue in rupees.

Net Present Worth (NPW)

NPW of any project is the present value of the incremental net benefits/cash-flow stream. If the NPW of any project is positive i.e., greater than zero, then the project could be considered for further steps and vice-versa (Paul *et al.* 2012).

$$NPW = \sum_{j=1}^{n} \frac{B_j - C_j}{(1+i)^j}$$

Where, B_j represents the benefits in rupees in j^{th} year, C_j represents costs incurred in j^{th} year, I is the discount rate in calculating the NPW, and n is the total no of years.

Benefit-Cost ratio (BCR)

The ratio of present value of the benefits to the present worth of costs at any given point of time gives the BCR. This BCR helps us to assess the profitability of any project. In other words, if BCR is greater than one, the project could be handy and if not, project would be the loss making one (Paul *et al.* 2012).

$$Benefit - Cost\ Ratio = \frac{\sum_{j=1}^{n} \frac{B_j}{(1+i)^j}}{\sum_{j=1}^{n} \frac{C_j}{(1+i)^j}}$$

Where, B_j, C_j, I, and n are same as that in NPW

Internal Rate of Return (IRR)

The IRR indicates an investment's average earning capability during the project's economic life cycle. It is that discount rate that simply makes the net present value of cash flow equal to zero (Paul *et al.* 2012). Mathematically it can be represented as:

$$IRR = \text{Lower Discount Rate} + \text{Difference between higher and lower rates} \times \frac{(\text{NPW at lower discount rates})}{\text{Absolute difference between PW at two discount rates}}$$

RESULTS AND DISCUSSION

Cost of the establishment of polyhouse

Polyhouse production is a capital-intensive technology requiring substantial investment, especially during the initial establishment period (Kumar *et al.* 2016; Prakash *et al.* 2020). The details of cost components in establishing a polyhouse are given in Table 1.

Table 1: Cost of Establishment of a Polyhouse Structure

Sl. No.	Particulars	Lifetime (yrs.)	Per acre (in Lakhs.)	% of total cost
1	Structure, sheet, and construction		33.6	76.36
A	GI structure	25	24.42	55.49
B	Polythene sheet	5	7.06	16.04
C	Labour charges for construction		2.12	4.83
2	Irrigation and fertigation system	8	2.17	4.92
3	Misting system (Foggers)	8	1.25	2.85
4	Shade net	5	1.15	2.61
5	Miscellaneous		1.83	4.16
6	Red soil for cultivation		4	9.09
Total amount*			44	100

**According to the bill copy at Farmer.*

A non-land capital investment of ₹ 44,00,000 was required for the establishment of one acre (4040 m²) polyhouse. The break-up of establishment costs indicates that the major component under this category was incurred on GI frame (₹ 24,41,666), followed by polythene sheet (₹ 7,05,850), and labour (₹ 2,12,485), which comprised of 55.49%, 16.04% and 4.83%, respectively. Irrigation-fertigation system, misting and shade net accounted for 4.92%, 2.85% and 2.61% of the total establishment cost, respectively. The other costs incurred in establishing polyhouse were grouped under miscellaneous costs, which were accounted as ₹ 1,83,041 (4.16%) for one acre. The expenditure incurred on red soil was ₹ 4,00,000 per acre, accounting for 9.09% of the total establishment cost. This is a one-time investment, unlike the structure parts where replacement is needed.

Cost of cultivation of capsicum crop under polyhouse

The details of the cost of cultivation of Capsicum under polyhouse are presented in Table 2. Naturally, two crops are taken in a year as the crop duration for Capsicum is about six months. Two expenses are incurred on cultivating vegetables in a polyhouse viz., variable costs and fixed costs. The total costs expended per acre per season stood at ₹ 2,81,005 of which ₹ 2,74,699 (97.76%) were variable costs and ₹ 6,307 (2.24%) were fixed costs.

Table 2: Cost of cultivation of capsicum under polyhouse (₹/acre/season)

Sl. No	Particulars	Cost (in thousand rupees)	% contribution
1	**Variable cost**		
A	Material cost		
i	Farm yard manure	8.50	3.02
ii	Seeds	60.00	21.35
iii	Seed treatment	6.50	2.31
iv	Plant protection chemicals	7.50	2.67
v	Chemical fertilizers	12.00	4.27
	Subtotal	94.50	33.63
B	Labour cost (4 permanent labour)	144.00	51.24
C	Transportation of produce to market	25.00	8.90
D	Interest on working capital @7% per annum	11.19	3.99
	Total variable cost	274.69	97.76
2	**Fixed Cost**		
A	Rental value of owned land @5000/yr.	2.50	0.89
B	Land revenue paid to Govt. @ 120/yr.	0.06	0.02
C	Bed preparation @ 20000 for 3 yrs. lifetime	3.33	1.19
D	Interest on fixed cost @ 7%/ annum	0.42	0.15
	Total fixed cost	6.31	2.24
3	Total cost (1+2)	281.01	100.00

It can be seen that among total costs, human labour (51.24%) seeds (21.35%), and transportation of yield to market (8.90%) together accounts for 81.49%, whereas chemical fertilizers (4.27%), interest on working capital @ 7% per annum (3.99%), farm yard manure (3.02%), plant protection chemicals (2.67%), seed treatment (2.31%), bed preparation @ ₹ 20,000 for 3 years life (1.19%), rental value of land @ 5,000/ year (0.89%), interest on fixed cost @ 7% per annum (0.15%) and land revenue paid to Govt. @ 120 per year (0.02%) together constitute 18.51%.

The results indicated that two principal variable inputs, i.e., human labour and chemical fertilizers, together consume nearly three fourth of the total cost, and among variable costs, labour costs took the lion's share with an amount of ₹ 1,44,000.00 per acre per season. It is a known fact that Capsicum being an important commercial and labour-intensive vegetable crop and highly liquidating required heavy cash.

Returns from capsicum crop under protected cultivation per season

It is evident from Table 3 that the gross income obtained from the capsicum crop was ₹ 4,60,000 per acre per season. The average yield from one acre of Capsicum under greenhouse per season was 23 tonnes. The selling price of Capsicum was ₹ 20 per kg based on the average yearly price.

Table 3: Returns from capsicum crop per season per acre

Sl. No.	Particulars	Amounts (in thousands)
1	Yield (in kgs)	23.00
2	Price per ton	20.00
3	Gross income	460.00
4	Total cost of cultivation (₹ per acre)	281.01
5	Net income (₹)	178.99
6	Cost of production per ton	12.22

Costs and returns from Capsicum under greenhouse during its economic life period (25 years)

The vegetable cultivation under the greenhouse in the study area is shown in Table 4. It is evident from the result that on an average ₹ 2,16,47,924 without subsidy and ₹ 1,77,32,396 with subsidy incurred as the cost for one-acre greenhouse vegetable cultivation during 25 years of lifespan. Gross income realized by the farmer during its life span amounted to ₹ 2,30,00,000 per acre. The respective net income received by the farmer without and with subsidy stood at ₹ 13,52,076 and ₹ 52,67,604. The study

revealed that without subsidy, capsicum cultivation under the greenhouse is not a profitable proposition.

Table 4: Cash flow of costs and returns of capsicum crop throughout economic life of polyhouse (25 years) (per acre)

Sl. No.	Particulars	With subsidy (in Lakhs)	Without subsidy (in Lakhs)
1	Cash outflows (in ₹)	177.32	216.48
2	Cash inflows (in ₹)	230.00	230.00
3	Net returns (in ₹)	52.68	13.52

Economic Feasibility of the greenhouse with capsicum crop

The costs and returns are not the perfect measures to assess the profitability of the greenhouse investment. The costs and returns from open field conditions are different from that of the protected cultivation of Capsicum. Before choosing any enterprise, it becomes necessary to examine the economic feasibility of the enterprise (Sreedhara *et al.* 2013).

The cash inflows and outflows were worked out for the project period of 25 years. Actual costs and returns during 2015 in capsicum cultivation under polyhouse were documented and used for cash flows. During this period, two crops were taken. For the remaining periods, the costs and returns were assumed based on the actual costs and returns. The polythene sheet and shade net used in polyhouse usually is replaced every six years, and hence for every six years, there is an additional cost, i.e., during the 6^{th}, 12^{th}, 18^{th} years.

In the same manner, irrigation and fertigation systems with foggers are to be replaced every eight years. Also, it has been observed that for every alternate year, the farmer practiced acid reclamation to the soil to increase the yields by rejuvenating the soil fertility; hence additional costs were borne by the farmer for every alternate year. In the present study, the costs and returns had been discounted at 7 and 12% to estimate discounted cash flow.

Payback period

The payback for greenhouse production of Capsicum was found to be 12.16, 9.69, 8.06, 6.90, 6.03, 5.35, and 3.04 years at the original price without subsidy and 10, 20, 30, 40, and 50% hike over the actual price of the Capsicum and original price with subsidy respectively as shown in Fig. 1. The payback period decreases as the price of the produce increases, and even at a 50% hike in price over the original price, the payback period was more compared to (5.65 years) the payback period at the actual price with subsidy (3.04 years). Hence, the time required to get back the Investment was less when the farmer provided a subsidy.

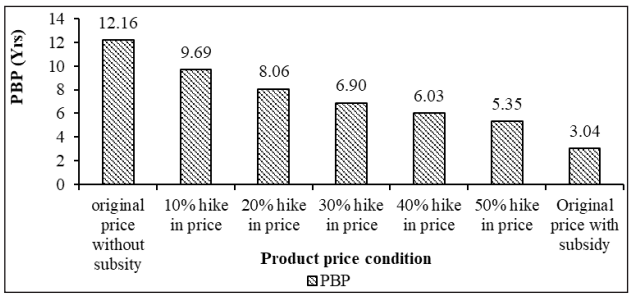

Fig. 1: Pay-back period of greenhouse production of capsicum

Net present worth

The cash flows for 25 years life span of polyhouse with Capsicum were presented in Fig. 2 by considering 7 and 12% discount rates (DR). It is evident from the graph that the net present worth was increased as the price increased both at 7 and 12% interest rates.

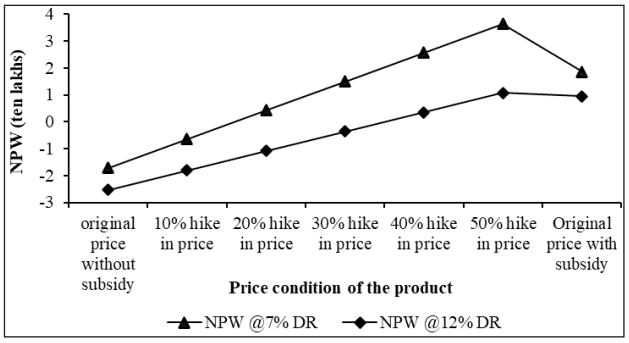

Fig. 2: Net present worth of greenhouse production of capsicum

It was also observed that present net worth with market price without subsidy worked out as unfavourable, i.e., negative at 7 and 12% interest rates which were not feasible. As against NPW with original market price with subsidy, it worked out as positive, viable to the farmers. The net present worth worked out at a 50% hike in price of the produce over the original price was much higher than the net present worth worked out at the actual

market price with subsidy (₹ 18,62,880). The higher positive net present worth worked out at 7 and 12% discount rates with a 50% hike in price over the original market price, i.e., from ₹ 20 to ₹ 30 indicated the soundness of the Investment made.

Benefit-cost ratio

It is evident from Fig. 3. that the benefit-cost ratios were 1.29 and 1.11 at 7 and 12% discount rates with a 50% hike in price over the original market price of Capsicum. The benefit-cost ratio was more than one at market price with subsidy, with a 40 and 50% hike in price over the original market price even at higher discount rates of 12%. So, the Investment in polyhouse with Capsicum was economically feasible even without subsidy with a 50% hike in price.

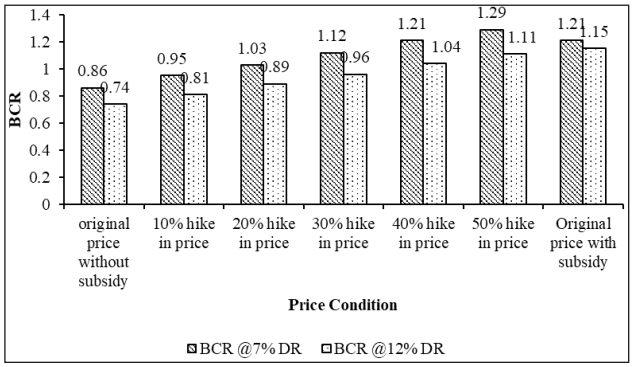

Fig. 3: Benefit-cost ratio of greenhouse production of capsicum

Internal rate of returns

From Fig. 4, the internal rate of returns with original price with subsidy was found to be 29.14%, which was much higher than the bank rate of interest (7%) on long-term loans.

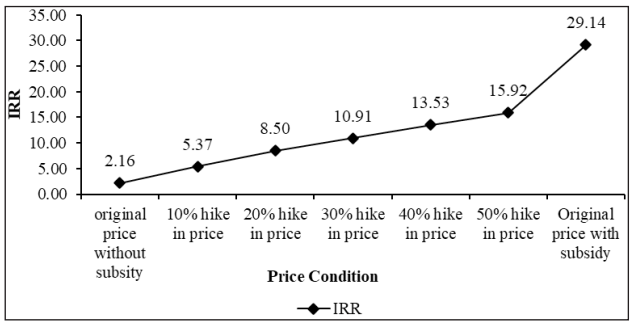

Fig. 4: Internal rate of returns of greenhouse production of capsicum

The internal rate of returns at a 50% hike in price over the original market price, without subsidy, was 15.92%, which was more significant than the bank interest rate. Hence, capsicum cultivation under polyhouse is economically feasible.

It is evident from the above discussion that the investment in capsicum cultivation under polyhouse is a good proposition when the government provides a subsidy. Otherwise, it is profitable with a minimum of 40% hike in the price over the original market price of the product, i.e., from ₹ 20 to ₹ 28.

CONCLUSION

It is observed from the study that despite the higher investment cost of polyhouse, cultivation of crops (primarily commercial crops) is found profitable over more extended periods with the normal cost of the product, as a crop in polyhouse gives more yield. But, without any assistance from the government, it was observed that BCR value falls, simultaneously prolonged payback period was seen. It is also seen that without subsidy, polyhouse was proven beneficial only when there is at least a 40% increase in the price of the product in comparison with current prices. On the contrary, polyhouse cultivation of Capsicum is worthy even at current market prices when the government provides a subsidy. Given the experience of uncertainty in market prices, it is recommended that government should assist farmers in the initial stages so that small farmers can shift towards this kind of high-end farming. Also, there are multiple benefits like a supply to demand factor saturation, even prices in consumers' point of view, and effective land utilization.

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