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# Economics of cucumber and capsicum cultivation under naturally ventilated polyhouses – imperative study from Haryana

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## ABSTRACT

**The study has assessed the socio economic impact of the Naturally Ventilated Polyhosues (NVPH) in the Haryana state. The relevant data were collected from the 80 NVPH farmers from two districts. The study is comparing three cropping system which are more commonly practiced in the state like cucumber-cucumber, capsicum-cucumber, and three time cucumber for calculation of its economic viability. Impressive Net Present Worth, Benefit Cost ratio and Internal Rate of Return suggested that the establishment of polyhouses to be economically viable under the current scheme of subsidy. Major constraints to the farming includes higher seed cost, high occurrence of biotic stresses, low produce price scarcity in skilled labour, and lengthy technical procedures.**

**Key words:** Protected cultivation, farm business analysis, Garret's ranking.

## INTRODUCTION

The developing country like India faces challenges to feed its growing population under inadequate natural resources. Apart from the overall benefits of the first green revolution, the unbalanced application of fertilizers and other inputs accelerates the degradation of the soil and natural resources hastily (Singh, 14; Bumb *et al*., 1). Contrarily the increasing food demand has to satisfy only through increasing productivity of the crops through innovative technologies (Michael, 6). Polyhouse farming is one of such technology have the potential to increase the productivity of the horticultural crops in a sustainable way (Murthy *et al*., 7; Franco *et al.,* 2; Planning Commission, 12). The field level acceptance and the promotion efforts of the government authorities led polyhouse farming into new heights in the country. Different schemes were implemented by the central and state governments for the endorsement of these looking forward technologies.

Polyhouse cultivation is one of the sustainable approach towards the horticultural production under adverse biotic and abiotic condition like heavy rainfall, excessive solar radiation, thunderstorms, temperatures, humidity, Pest attack and diseases (Max *et al*., 5). Besides that the vegetables under protected cultivation yields high quality in terms of shape, size and colour (Sringarm *et al*., 15). Crops are grown under controlled climatic condition which is more suitable for its growth. It also reduces dependency on the water requirement through water harvesting and makes the optimum use of land and water resources. Different types of polyhouses are available for the crop cultivation with diverse cost level. The investment cost depends upon the level of sophistication and the level of automation required. The Low cost Naturally Ventilated Polyhouse (NVPH), Medium cost Partial climate controlled polyhouse, high-cost fully climate controlled polyhosues, Plastic Low Tunnels (LT) and Net Houses (NH) are some of the categories among them. Out of these structures NVPH and NH was getting good momentum in the country which is more suitable to the climate as well as the budget of the small and marginal farmers.

The northern state Haryana is primarily an agricultural state and also a forerunner of the polyhouse technology. The foremost area of the state is coming under National Capital Region (NCR) and sharing border with states like Delhi, Punjab, Himachal Pradesh, Uttrakhand, Uttar Pradesh and Rajasthan as well as well established Market infrastructures makes the state positive economies of scale in marketing. Apart from that the state government is promoting polyhouse technology at its best by allocating more budget every year. The detailed study on the socio-economic impact of polyhouse technology is the need of the hour to find its pros and cons for its better establishment. Thus, the paper tries to elucidate the polyhouse farming scenario of the state.

## MATERIALS AND METHODS

The study made use of both primary as well as secondary data for the data analysis. The Haryana state was purposefully selected for the study where the polyhouse technology is fetching greater momentum. Secondary data were collected from state agriculture departments and published agriculture journals. The Karnal and Sonipat districts were purposively selected for primary data collection

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where the maximum numbers of structures were existing in the state and survey was carried out during the year 2018-19. From each district 40 NVPH farmers were selected randomly and thus total sample size of the study consists of 80 in number. For the comparative economics analysis the 20 open cultivated farmers growing vegetable crops were selected from the respective districts and thus consist of 40 in number. The descriptive statistics and tabular method was used for the narration of socio-economic status of the farmers in detail. The different cost concepts were calculated as per the Commission for Agricultural Costs and Prices (CACP) notations for the scrutiny of economic impact. Farm business analysis and discounted cost measures were used for the evaluation of economic benefits. The detailed methodologies with the notations are comprehensive below.

Cost $A_1$ = Value of hired human labour + Value of hired bullock labour + Value of owned bullock labour + Value of hired machinery labour + Value of owned machinery labour + irrigation charges + Value of seed + Value of pesticides + Value of manure + vale of fertilizer + Depreciation on implements and farm buildings + Land revenue and other taxes + Interest on working capital + Miscellaneous expenses

Cost $B_1$ = Cost $A_1$ + interest on value of owned fixed capital assets (excluding land)

Cost $B_2$ = Cost $B_1$ + rental value of owned land + rent paid for leased in land

Cost $C_1$ = Cost $B_1$ + imputed value of family labour

Cost $C_2$ = Cost $B_2$ + imputed value of family labour

Cost $C_3$ = Cost $C_2$ + 10 percent of cost $C_2$ accounting for managerial input

Farm business income = Gross revenue – cost $A_1$

Family labour income = Gross revenue – cost $B_2$

Net income over cost $C_1$ = Gross revenue – cost $C_1$

Net income over cost $C_2$ = Gross revenue – cost $C_2$

Net income over cost $C_3$ = Gross revenue – cost $C_3$

Different discounted measures like Benefit Cost ratio (B:C ratio), Net Present Value (NPV) and Internal Rate of Return (IRR) were calculated using the standard formulas. The average life period of NVPH was assumed as 10 years and for fertigation system as 8 years (Palanisami *et. al.,* 9). In order to measure the economic feasibility of the polyhouse structures and fertigation system, 8 per cent interest rate (ODA, 8) was taken as discounted rate.

Benefit cost ratio calculated by using the following formulae.

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

where i = Discount rate (Here taken as 8%), t = Time period, $B_t$= Benefits over the year, $C_t$= Cost over the year

Net present worth is the subtraction of discounted cost from the discounted benefits. Higher the value is considering best for the project.

$$NPW = \sum_{t=1}^{t=n} \frac{B_t}{(1+i)^t} - C$$

where C = Initial investment

The Internal Rate of Return (IRR) is the discount rate that generates a zero net present value for a series of future cash flows. The Microsoft excel software was used to optimize the objective value (NPV) to zero by changing the value of discount rate.

Farmers had been asked to assign the rank for all pre identified problems through literature review. The constraints were ranked using garrets ranking (Garrett and Woodworth, 3) method. The ranks have been converted into score value with the help of the following garrets ranking formula for ranking the constraints.

$$percent\ position = \frac{100\ (R_{ij} - 0.5)}{N_j}$$

Where $R_{ij}$= rank given for the $i^{th}$ variable by the $j^{th}$ respondent, $N_j$= Number of variable ranked by $j^{th}$ respondents

## RESULTS AND DISCUSSION

The Haryana state has been implemented different schemes for the popularization of polyhouse technology in the state from 2005-06 onwards. The compilation of different annual reports (Table 1) shows that the total number of polyhouse beneficiaries in the state was 1589 by the end of the year 2016 and 1272 acres of land brought under protected structures. On an average, an individual polyhouse farmer is cultivating 0.8 acre of land and received an average subsidy of 14.36 lakh rupees for their polyhouse structures. The district like Sonipat and Karnal have the maximum number of polyhouse structures in the state. The proximity to the national highway and the protected cultivation training institutes may be the reason for the quicker adoption of structures in those districts. But the other districts are also alluring the momentum over the period of time.

The area wise growth over the period of time is depicted in the Fig. 1. The diagram shows that the financial year 2011-12 onwards the coverage of the acreage is effectively increasing at a positive trend. The high allocation of fund in the state government budget and promotional activities undertaken by the state may be the reason for the drastic change in the adoption.

The state government is promoting four different types of plasticulture technologies in the state. District wise distributions of different plasticulture structures were shown in the Table 2. Among the different structures Naturally Ventilated Polyhouse (NVPH) having maximum number of adoption which

**Table 1.** Status of polyhouses in the Haryana state.

| Sl. no | District | No of beneficiaries | Area (Acre) | Subsidy given (Rs. in lakh) |
|---|---|---|---|---|
| 1 | Sonipat | 207 | 177.21 | 3290.15 |
| 2 | Karnal | 194 | 174.67 | 3351.02 |
| 3 | Rhothak | 126 | 106.02 | 2198.49 |
| 4 | Bhiwani | 143 | 107.95 | 1764.84 |
| 5 | Hisar | 115 | 82.44 | 1451.75 |
| 6 | Panipat | 114 | 93.60 | 921.12 |
| 7 | Panchakula | 96 | 67.56 | 1221.10 |
| 8 | Kurukshetra | 78 | 64.22 | 1218.49 |
| 9 | Jhajjar | 69 | 55.32 | 1071.61 |
| 10 | Ambala | 71 | 59.19 | 969.83 |
| 11 | Jind | 80 | 65.63 | 1184.99 |
| 12 | Gurugram | 51 | 31.07 | 835.59 |
| 13 | Sirsa | 53 | 28.73 | 604.54 |
| 14 | Yamunanagar | 56 | 42.91 | 705.62 |
| 15 | Faridabad | 5 | 4.59 | 78.83 |
| 16 | Fatehabad | 44 | 42.94 | 584.77 |
| 17 | Palwal | 33 | 27.56 | 566.61 |
| 18 | Nuh | 29 | 25.69 | 460.03 |
| 19 | Mahendragarh | 25 | 14.50 | 332.69 |
| | Total | 1589 | 1271.819 | 22812.08 |
| | Average | | 0.80 | 14.36 |

*Data of districts like Charkhi Dadri, Kaithal and Rewari were not available.
**Compiled from the annual report of Horticulture Department, *Government of Haryana.*

**Table 2.** District-wise number of beneficiaries in different types of plasticulture technologies.

| District | HTPH | NVPH | NH | WIT | Total |
|---|---|---|---|---|---|
| Sonipat | 2 | 148 | 50 | 7 | 207 |
| Karnal | 1 | 125 | 66 | 2 | 194 |
| Bhiwani | | 73 | 67 | 3 | 143 |
| Rhothak | | 110 | 15 | 1 | 126 |
| Hisar | | 53 | 27 | 35 | 115 |
| Panipat | | 79 | 32 | 3 | 114 |
| Panchakula | | 51 | 40 | 5 | 96 |
| Jind | | 43 | 35 | 2 | 80 |
| Kurukshetra | 1 | 55 | 22 | | 78 |
| Ambala | | 32 | 38 | 1 | 71 |
| Jhajjar | | 51 | 15 | 3 | 69 |
| Yamunanagar | | 40 | 14 | 2 | 56 |
| Sirsa | | 42 | 11 | | 53 |
| Gurgaon | | 4 | 47 | | 51 |
| Fatehabad | | 19 | 30 | | 49 |
| Palwal | | 24 | 6 | 1 | 31 |
| Mewat | | 20 | 11 | | 31 |
| Narnaul | | 22 | 2 | 1 | 25 |
| Kaithal | | - | - | - | 0 |
| Rewari | | | | | 0 |
| Faridabad | | - | - | - | 0 |

Source: compilation of different annual report (2005-16), Haryana Horticulture Department.

is followed by the Net Houses (NH) and Walk in Tunnel (WIT). The hi-tech polyhouses in which huge investment is required have less number of adopters. However, some of such structures were established for nursery and research purposes across the state. The Sonipat district have the maximum number of NVPH followed by Karnal district. But in the case of NH, Bhiwani district ranks first followed by Karnal and Sonipat. At the beginning of the plasticulture policies the NVPH is getting more attraction from the farmers view but slowly shifts to net houses where vegetable production is more economical.

The state average crop yield of the polyhouse farming is compared with the traditional (open) cultivation in Table 3. Different vegetable crops like

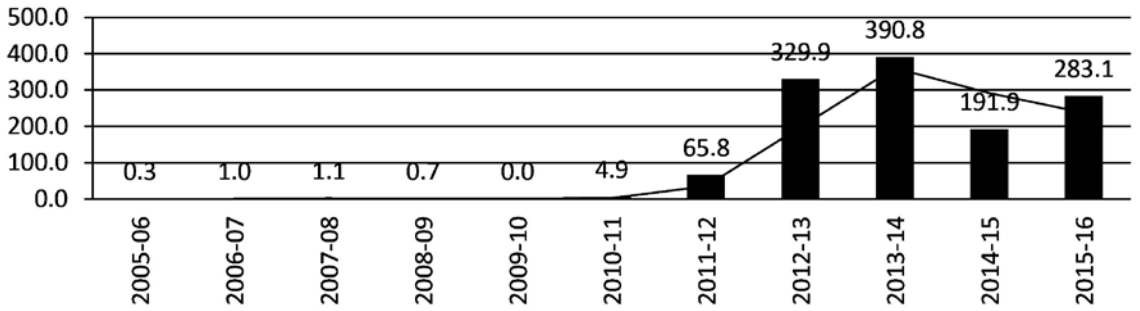


**Fig. 1.** Growth in area (acres).

**Table 3.** State average yield & area under selected crops.

| Crop | Open condition (% in parenthesis) | | Protected condition (% in parenthesis) | |
|---|---|---|---|---|
| | Area (ha) | Production (MT) | Area (ha) | Production (MT) |
| Cucumber | 14471 (97.88) | 161242 (88.61) | 314 (2.12) | 20720 (11.39) |
| Capsicum | 3282 (98.06) | 25885 (90.34) | 65 (1.94) | 2769 (9.66) |
| Tomato | 29027.5 (99.81) | 675384 (99.41) | 56.5 (0.19) | 4035 (0.59) |

Source : Haryana Horticulture Department statistical report 2016-17.

cucumber, capsicum, tomato, cabbage, cauliflower and brinjal is being cultivating under polyhouses in Haryana. Among these vegetables, cucumber and capsicum are more popular combination. From the area of hardly 2% of the total state cucumber production, polyhouse cultivation is contributing more than 11%, lauds the importance of these innovative technology in the state horticulture scenario. Similarly, the polyhouse capsicum is cultivated area is less than 2% contributes more than 9% of the total state production. The tomato cultivation under the polyhouses didn't fetch more attraction because of frequent market glut. Apart from these vegetables, farmers are also starts to grow vegetables like cauliflower, cabbage, mint and brinjal in the polyhosues recently.

Primary field survey shows that businessman by profession are attracting more to the polyhouse farming. Out of the total interviewed polyhouse farmers (Table 4) more than 46% are doing other kind of business than sole farming. This directly implies the economic resilience power of the polyhouse farmers were generally high and supported by the other livelihood options than the lone farming. Most of the polyhouse farmers are either supported by the other occupational income nor enjoying the high economic status in the society. The farmers who are totally depends on farming for livelihood engaged in the polyhouse cultivation is merely 13% of the total. The survey depicts that the average monthly household income of the polyhouse farmers supported by business occupation is Rs. 31583 from the other sources than the farming.

**Table 4.** Livelihood based classification.

| Category | % of farmers | Avg. monthly income |
|---|---|---|
| Only farming | 13.46 | 21428 |
| Farming + Private job | 34.61 | 19000 |
| Farming + Business | 46.15 | 31583 |
| Farming + Public sector job | 5.78 | 21666 |
| Source : Farmers field survey | | |

Based on the acreage (Table 5) under polyhouse farming, the majority of the farmers are having 1-2 acre polyhouses, which accounts 55% of the total. Even though the maximum area allowed for the subsidy is one acre, the famers are managed to get the subsidy in their relatives names may be the reason for higher number of farmers in those category. Interestingly all the farmers availed the subsidy for their structures under the state polyhouse policy.

The initial investment in the NVPH is huge and detailed in the Table 6. The one acre polyhouse structure costing an average of Rs. 3434438. The central and state governments are providing considerable level of financial assistance of 50% and 15% subsidy to the total cost respectively for the promotion of technology and that commensurate an average of Rs.2200695 to the total cost. The details of other investments like water harvesting pond, drip irrigation system and packaging house

**Table 5.** Classification of sampled farmers based on the area under polyhouse farming.

| Sl. No. | Area (acre) | No. of farmers | Percentage |
|---|---|---|---|
| 1 | <1 | 17 | 21.25 |
| 2 | 1-2 | 44 | 55.00 |
| 3 | 2 - 3 | 15 | 18.75 |
| 4 | 3 - 4 | 3 | 3.75 |
| 5 | > 4 | 1 | 1.25 |

**Table 6.** Details of fixed investment for one acre of NVPH.

| | Total cost | Subsidy (State + centre) | Farmers contribution |
|---|---|---|---|
| Polyhouse | 3434438 | 2200695 | 1233743 |
| Water harvesting pond | 250000 | 221000 | 29000 |
| Drip irrigation | 98000 | 49000 | 49000 |
| Packaging house | 200000 | 100000 | 100000 |
| Total | 3982438 | 2570695 | 1411743 |

*Source: Farmers field survey

are also enlisted in the table. Including all the initial investments cost an average of Rs. 3982438 has to be spent by the farmer in totality. Meanwhile total subsidy for one acre of polyhouse and allied structure accounts an average of Rs. 2570695. The remaining cost of Rs. 1411743 has to be paid by each beneficiary from his/her own resources or through loaning facility.

The farmers are depending upon different linkages for their input and output marketing. As the individual is having more than one source for their inputs purchasing, their options are made into percentages in Table 7. The private agencies were the main distributors of inputs like seed, fertilizer, pesticides and machinery. For seeds and fertilizers, farmers have completely depending upon the private shops and company agents. The private companies are providing technical support to the farmers through their service agents throughout the cropping season that is the main attraction of the farmer to purchase their costly seeds. But in the case of fertilizers and pesticides the farmers are lenient to the private fertilizer shops from where they are traditionally purchased the fertilizers.

The Table 8 shows the output linkage for the polyhouse farmers. Same farmer is opting different channels for marketing their harvest according to the price availability. The primary markets like Karnal, Panipat, Sonipat, and Chandigarh were the main selling points for the output. More than 76% of the farmer is depending upon the primary markets for their product sale. Some farmers have keeping (12%) direct link between the nearby supermarkets and local traders. But at the peak harvesting season the whole produce is not able to absorb by those supermarkets again force the farmers to send their product in the primary markets. The large farmers (36%) have the accessibility to the wholesale market like 'Azadhpur mandi' (Delhi) to sold their product frequently because of the bulkiness in the harvest. Besides that farmers are also practicing the cooperation through grouping of marketable surplus for reducing the cost of transportation.

**Table 8.** Output linkages of farmers for product sale (Percentage).

| Source | Percentage |
|---|---|
| Wholesale market | 36 |
| Local traders | 18 |
| Super Markets | 12 |
| Primary markets | 76 |

*Source: Farmer's field survey

The study tries to compare the economics of cucumber cultivation under protected and open condition to find the economic impact of adoption of polyhouse technology (Table 9). One season cucumber crop growing under polyhouse cost the total of Rs.2.12 lakh. Out of which 1.70 lakh accounts the total variable cost and Rs.42365 was contributed by the fixed investment. The open cultivation of cucumber is less risky in terms of cost which accounts a total of Rs. 82231 for one crop. The data shows that the seed is the major cost incurring under protected cultivation which accounts 24.27% of the total. The alternate day profound harvest requires more number of labours at harvesting days makes it a costlier affair. The fertilizer cost is high in the polyhouse farming accounts Rs.15907 compared to Rs.6075 in the open cultivated crop because of high cost of liquid fertilizers. Electricity cost of open field cultivation is little high due to the following flood irrigation practices.

The comparative economics of capsicum is depicted in Table 10. The total cost of cultivation under polyhouse is accounted Rs. 361743 and in open condition it is Rs. 75887 per crop season. In the polyhouse, the capsicum is grown as 9 to 10 month crop which will be harvested as both in coloured and green colour berries. The open cultivated capsicum is grown as 5 to 6 months crop and harvested as green coloured berries. The seed cost and inter cultural operations are costlier components to the total variable cost. The fertilizers contribute 6% and plant protection chemicals accounts 5% of

**Table 7.** Linkages of farmers for different inputs (Percentage).

| Inputs | Seed | Fertilizer | Pesticide | Machinery | Bio-fertilizers |
|---|---|---|---|---|---|
| Govt agencies | - | - | - | 14.64 | 4.88 |
| Private shops | 18.50 | 76.00 | 100.00 | 68.29 | 56.10 |
| Company agents | 82.50 | 24.00 | - | - | - |
| Agri. University | - | - | - | - | 21.95 |
| Farmers association | - | - | - | - | 17.07 |
| Contact Farmers | - | - | - | 17.07 | - |

*Source: Farmer's field survey

**Table 9.** Cucumber cost of cultivation (per acre).

| Sl. No. | Particular | Polyhouse cultivation | | Open cultivation | |
|---|---|---|---|---|---|
| | | Cost (Rs.) | (% Share) | Cost (Rs.) | (% Share) |
| 1 | Land preparation | 9022.5 | 4.24 | 7925 | 9.64 |
| 2 | Seed | 51658.75 | 24.27 | 5712.5 | 6.95 |
| 3 | Nursery preparation | 9362.5 | 4.40 | 700 | 0.85 |
| 4 | Transplanting | 1236.25 | 0.58 | 1562.5 | 1.90 |
| 5 | Weeding | 2885 | 1.36 | 7312.5 | 8.89 |
| 6 | Irrigation | 1100 | 0.52 | 3625 | 4.41 |
| 7 | Fertilizer | 15907.89 | 7.47 | 6075 | 7.39 |
| 8 | Plant protection | 17770.83 | 8.35 | 9625 | 11.70 |
| 9 | Propping | 6250 | 2.94 | - | - |
| 10 | Harvesting | 29437.5 | 13.83 | 20437.5 | 24.85 |
| 11 | Packaging | 1380 | 0.65 | 636.25 | 0.77 |
| 12 | Transporting | 6780 | 3.19 | 5275 | 6.41 |
| 13 | Organic manure | 5180 | 2.43 | 3987.5 | 4.85 |
| 14 | Electricity | 1334.75 | 0.63 | 1562.5 | 1.90 |
| 15 | Interest on the working capital | 11151.42 | 5.24 | 5954.9 | 7.24 |
| 16 | Variable cost | 170457.4 | 80.09 | 80391.15 | 97.76 |
| 17 | Depreciation on fixed capital | 42365.3 | 19.91 | 1840 | 2.24 |
| | Total | 212822.7 | | 82231.15 | |

*Source: Farmers field survey

**Table 10.** Cost of cultivation of capsicum under polyhouse and open condition (per acre).

| | Polyhouse | | Open condition | |
|---|---|---|---|---|
| | Rupees | % | Rupees | % |
| Land preparation | 15272.73 | 4.22 | 7333.33 | 9.66 |
| Seed | 66081.82 | 18.27 | 1291.67 | 1.70 |
| Nursery preparation | 10090.91 | 2.79 | 833.33 | 1.10 |
| Transplanting | 2086.36 | 0.58 | 1285.00 | 1.69 |
| Weeding | 14127.27 | 3.91 | 9916.67 | 13.07 |
| Irrigation | 3030.91 | 0.84 | 1716.67 | 2.26 |
| Fertilizer | 21909.09 | 6.06 | 5475.00 | 7.21 |
| Plant protection | 17818.18 | 4.93 | 9583.33 | 12.63 |
| Propping | 8227.27 | 2.27 | 0.00 | 0.00 |
| Harvesting | 44690.91 | 12.35 | 9416.67 | 12.41 |
| Packaging | 3890.91 | 1.08 | 7833.33 | 10.32 |
| Transporting | 33318.18 | 9.21 | 3716.67 | 4.90 |
| Organic manure | 9361.09 | 2.59 | 7166.67 | 9.44 |
| Pruning and trailing | 6945.45 | 1.92 | 1466.67 | 1.93 |
| Insurance | 16600.00 | 4.59 | | 0.00 |
| Electricity | 5236.36 | 1.45 | 1750.00 | 2.31 |
| Interest on the working capital | 19508.12 | 5.39 | 5502.80 | 7.25 |
| Variable cost | 298195.58 | 82.43 | 74287.80 | 97.89 |
| Depreciation on fixed capital | 63547.95 | 17.57 | 1600.00 | 2.11 |
| Total | 361743.53 | | 75887.80 | |

*Source: Farmers field survey

the total cost in polyhouse capsicum cultivation. Weeding is the costly intercultural operations in the open cultivated capsicum are solved by the plastic mulching technique under the protected cultivation. The pruning and trailing of the crop is done along with the harvesting makes the capsicum crop more labour intensive than the cucumber crop. As 9 to 10 months crop, capsicum consumes more time under polyhouse, so that the depreciation cost of fixed assets is high as compared to cucumber crop.

The average yield of cucumber under polyhouse is 38.18 tonne/acre and the open cultivated is 19.68 tonne/acre. Because of better quality and taste which is combined with off-season production, the average price of polyhouse cucumber stands Rs. 14 around the season against Rs. 7.25 of counterpart. Moreover, the high cost of polyhouse cultivation is justified by the higher yield and better price. The polyhouse farmer is able to fetch an average of Rs. 2.44 lakh after deducting all the cost from his gross revenue (Table 11). Unlikely family labour oriented small and marginal farmer cultivating open crop, the family labour involves in the polyhouse farming is very few and because of that the difference between the cost B1 and cost B2 was considerably less. The permanent hired women labour is employing in majority of the polyhouse farms for the intercultural operations. At the initial stages and end of the crop season the farmers are able to sell their product at higher price. But when the open field cucumber starts to arrive in the market makes competition and faces market glut for the high quality polyhouse cucumber in the peak harvesting season. The findings of the study is corroborate with the Praveen *et al.* (10) where they calculated the net return from the cucumber crop under polyhouse cultivation is nearly Rs. 1.4 lakh per season.

The financial analysis of the capsicum revealed that the capsicum yields an average of 36.32 tonne/acre under the polyhouses and 13 tonne/acre under open condition. At the initial time period the farmers are harvesting the green coloured capsicum and in later changes the preferences to coloured berries harvest under polyhouse cultivation. The coloured capsicum harvest will yield less but earns good remunerative income because of attractive market price. The net income over the cost C3 calculated as Rs.6.92 Lakh and Rs.62312 under polyhouse and open condition, respectively. The polyhouse capsicum is big in size and its colour gives an average price of Rs.32 whereas open cultivated capsicum fetches an average of Rs.12 only.

The economic viability of the polyhouses under different cropping system were analysed under with and without subsidy criteria and shown in Table 12. The BC ratio under capsicum- cucumber cropping system was found as 2:1, indicates better option among the others. Even though the three time cucumber rotation was less practiced exercise in the region that attracts the BC ratio of 1.76:1 for a year and that for two season it has been calculated as 1.53:1 under present subsidy regime. With subsidy

**Table 11.** Financial analysis of capsicum and cucumber under polyhouse and open condition.

| Cost / income | Cucumber | | Capsicum | |
|---|---|---|---|---|
| | Polyhouse (lakh Rs.) | Open (Rs.) | Polyhouse (lakh Rs.) | Open (Rs.) |
| Cost A1 | 2.13 | 82231.15 | 3.62 | 75887.8 |
| Cost B1 | 2.18 | 82451.95 | 3.69 | 76079.8 |
| Cost B2 | 2.48 | 92451.95 | 4.14 | 86079.8 |
| CostC1 | 2.34 | 91666.24 | 3.79 | 87246.47 |
| Cost C2 | 2.64 | 92451.95 | 4.24 | 86079.8 |
| Cost C3 | 2.90 | 101697.1 | 4.67 | 94687.78 |
| Output (Tonne) | 38.18 | 19.68 | 36.32 | 13.08 |
| Avg. Price | 14 | 7.25 | 32 | 12 |
| Gross revenue | 5.34 | 142734.4 | 11.62 | 157000 |
| Farm business income | 3.21 | 60503.23 | 7.97 | 81112.2 |
| Family labour income | 2.87 | 50282.43 | 7.44 | 70920.2 |
| Net income over cost C1 | 3.01 | 51068.14 | 7.79 | 69753.53 |
| Net income over cost C2 | 2.71 | 50282.43 | 7.34 | 70920.2 |
| Net income over cost C3 | 2.44 | 41037.23 | 6.92 | 62312.22 |

*Source: Farmer's field survey

**Table 12.** Economic viability of different cropping system under polyhouses.

| S l . No. | Crop combination | Without subsidy | | | With subsidy (present level) | | |
|---|---|---|---|---|---|---|---|
| | | NPV | BC | IRR | NPV | BC | IRR |
| 1 | Capsicum - Cucumber | 22.24 | 1.33 | 19% | 45.19 | 2.00 | 58% |
| 2 | Cucumber - Cucumber | -32.69 | 0.95 | 8% | 19.68 | 1.53 | 30% |
| 3 | Cucumber - Cucumber- Cucumber | 13.87 | 1.19 | 16% | 36.82 | 1.76 | 47% |

*Source: Farmer's field survey

all the cropping system has been found profitable with good IRR value. The higher NPV value also support the profitability of the polyhouses under subsidy regime. The results are convinced and comparable with the studies from other parts of the country (Prakash *et al*., 18; Franco *et al*., 2). But the case was found unappealing in without subsidy regime. If government is withdrawing the entire subsidy for the polyhouses it may not be sustainable at present level of cost and prices in the region. The BC ratio has been found less than one (0.95) in two crop cucumber shows polyhouse is a nonviable economic option under no-subsidy regime. However, the capsicum - cucumber system has been found profitable under without-subsidy regime but with non attractive IRR, i.e. 19% level. The analysis suggests that in case of non subsidy regime the average market price of the cucumber and capsicum should be more than Rs.21/ kg and Rs.48/kg respectively to maintain the same level of BC ratio as they got in subsidy regime.

Different problems that needs special attention from the policy makers and implementing agencies in polyhouse farming were identified with the consultation with the famers and ranked using Garrets ranking method (Table 13). The high cost of imported seeds and the market glut ranked as main economic constraints faced by the polyhouse farmers in the study area. The biotic stresses like pest and diseases ranks first in the technical constraints category. These result is corroborate with the finding of Patil *et al.* (11) and Kayani *et al*. (4) where they stated that root rot nematode in polyhouses was serious issue that drastically reduces crops vegetative growth and yield. The availability of skilled labour and awareness on good quality materials for polyhouse structures were the other constraints under technical side. The technical competitiveness of the extension agents and lack of demonstration farms for polyhouse farmers were the main constraints under the extension side. The lengthy technical procedures to get the sanction for polyhosues and poor support from the state department officials were found as major constraints on administrative side.

The polyhouse farming under the naturally ventilated polyhouse is a prospering technology which has a high potential to increase the production and productivity of the crop under protected atmospheric condition compare to open field cultivation. The polyhouse farming have the capacity to provide year around employment opportunities in the rural and peri-urban areas of the country. The government needs to give more attention to develop the technical skill by incorporating the polyhouse farming as a part

**Table 13.** Constraints faced by the polyhouse farmers.

| Economic constraints | Garret score | Rank | Extension constraints | Garret score | Rank |
|---|---|---|---|---|---|
| Seed cost | 66.25 | 1 | Technical expertise | 63.38 | 1 |
| Market glut | 53.05 | 2 | Lack of Demonstration farms | 58.66 | 2 |
| Crop insurance | 50.03 | 3 | Lack of Resource person | 43.38 | 3 |
| High Fertilizer cost | 49.89 | 4 | Market information | 35.28 | 4 |
| Price policy | 47.72 | 5 | Administrative constraints | | |
| Technical constraints | | | Lengthy Technical procedures | 72.07 | 1 |
| Abiotic stresses | 66.77 | 1 | Support from agriculture department | 64.31 | 2 |
| Availability of Skilled labour | 62.78 | 2 | Institutional | 50.38 | 3 |
| Quality implements | 61.87 | 3 | Banks loan availability | 40.24 | 4 |
| Polyhouse sheets quality | 53.12 | 4 | | | |

*Source: Farmers field survey

of curriculum in agricultural courses. The subsidy level can be reduced in future and widen its outreach by releasing subsidy for more number of farmers at same quantum of budget. Protected cultivation in India is in its infancy even after the long year's efforts in research and promotion. Care should be given to reduce the cost of cultivation by strengthening the research for polyhouse structure and varieties which will be more suitable under Indian condition.

## DECLARATION

The authors declare no conflict of interest.

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