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Role of Protected Technology in Improving Farmers' Income: Empirical Evidences from Net House Vegetable Cultivation

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Abstract

The study has examined the socio-economic characteristics, differentials in costs, returns along with use of chemicals at production stage in vegetables cultivation in net house and open field systems. The state govt. provided subsidy on net house structures thus financial viability of net house investment with and without subsidy was analyzed. Production and marketing constraints faced by the vegetable growers were studied. The study is based on the primary data collected from 120 vegetable growers consisting of 60 net house vegetables cultivator and 60 open field cultivators in Punjab state for the year 2011-12. The net house vegetable cultivation was adopted by the large farmers, who are educated and progressive and were members of one or the other Farmers' Society/Club/Organization and had more extension contacts. There was a substantial difference in yields, prices, costs and returns of all the vegetables grown under net house and open field conditions. Chemical used in terms of fertilizers and pesticides were lower in net house vegetable cultivation in almost all vegetables than that of open field. It was found that net house investment was economically viable with subsidy and even without subsidy. The major constraints identified by sample vegetable growers were low price of vegetables followed by perishable nature of vegetable crops, exploitation by middlemen/commission agents etc. Net house vegetable growers demanded special marketing arrangements for their produce by giving incentive price.

Keywords: Vegetable cultivation, net house cultivation, financial viability, production constraints, Garrett ranking, paddy-wheat rotation

JEL Classification: Q12,Q16

Introduction

Over the years, paddy and wheat cropping system has brought farming in Punjab to a critical juncture, resulting in various ecological, environmental and soil-related problems. It also causes a sharp decline in the diversity in cropping pattern (Sekhon *et al, 2013 and* Toor *et al*, 2007). The declining diversity has severe effect in terms of over-use of water resources and soil nutrients (Dhawan,1995 and Hira *et al*, 2004). On the other hand, over time technology fatigue has manifested in terms of declining/stagnation in the productivity of major crops which has further aggravated the problem of declining income of the farmers. It is due to the mis-match of input-output prices as the cost of cultivation per hectare and per quintal has increased many times, but productivity and MSP have not increased at that pace, resulting in a decline in the farm profitability (Bhoi, 2017).

Diversification towards high-value crops offers a great scope to improve farmers' income. As revealed by Chand (2017), due to differentials in productivity of high-value crops, shifting one hectare area from staple crops to commercial high-value crops has the potential to increase returns up to Rs 1,01,608 per hectare. The high-tech production of vegetables under protected conditions is the recent development in this field. Subsequently vegetable farming seems to be a good replacement for wheat- paddy monoculture because vegetable crops give higher returns per unit

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area as compared to paddy-wheat crops and being more labour-intensive as compared to cereals, provide more employment opportunities for hired as well as family labour (Bhatti and Singh, 1993). But, the farmers are not willing to leave paddy-wheat rotation because vegetable crops are more prone to weather conditions and are risky.

The production of vegetables under protected conditions involves protection of vegetables at the production stage mainly from adverse environmental conditions such as temperature, hails, scorching sun, heavy rains, snow and frost (Singh *et al,* 1999). Net house and poly house technologies are widely used as protection technologies, especially for high- value crops such as vegetables. As a result, higher input-use efficiency is achieved, weather risk is reduced and superior quality of produce is obtained.

Producing vegetables under a net house structure has several benefits including reduced pesticides-use, off-season vegetables production, advancing maturity, increased productivity period and improved quality of produce (Singh *et al,* 1999). Although protected technology is capital- intensive, it has the capacity to increase the productivity of vegetables by many folds and also improve the quality of vegetables (Singh *et al,* 2008). Punjab State Farmers Commission (PSFC) based on its experimental data and field demonstration have broadly placed benefits of two "one Kanal (500sq, meters) net houses at Rs 70 to 80 thousand per year. However these experiments need to be firmed up with broader study of farmers who have started the net house cultivation of the vegetables. Keeping in view, the high productivity of vegetables under protected conditions, health and environmental issue and economic conditions of farmers in the state, the Government of Punjab provides subsidy to encourage the adoption of net-house technology for vegetable cultivation. Besides all these reported benefits the adoption of the technology is very slow. In the light of the facts mentioned above the present study has been planned in Punjab state with the objectives to analyze the socio-economic characteristics of adopter farmers of net house technology; differential in yield, price, returns, chemical use in net house vegetable cultivation over open field cultivation and risk involved in vegetable cultivation. Financial viability was assessed with and without subsidy given by state govt. during the period of survey.

Data Sources and Methodology

Sampling design and data set

The study is confined to the Punjab state and based on primary data. Initially a list of net house vegetable growers was obtained from the Punjab State Farmers' Commission, Mohali. A sample of 60 net house vegetable cultivators was selected from 12 districts of Punjab having comparatively high concentration of net house adopters. An equal number of households either from the same village or nearby village cultivating vegetables in open field was selected for the comparison purpose. Thus, a sample of 120 vegetable growers were selected for the study. Farm size category wise the sample consisted of 15 small (< 5 acres), 20 medium (5-15 acres) and 25 large (> 15 acres) net house vegetable cultivators and 23 small, 18 medium and 19 large open field vegetable cultivators. A comprehensive schedule was prepared separately for net house and open field categories of vegetable growers. The information on socio-economic characteristics of selected households, investment and maintenance expenditure on net house structures, subsidy availed, vegetables grown, costs and returns details were recorded from the selected households. It is important to mention that the net house structure were of 500 sq meters size. Thus costs and returns details of vegetables cultivated under net house were converted on per acre basis to facilitate comparison with the open field vegetable cultivation. Data were collected during September 2012 to January 2013 for the reference year 2011-12.

Analytical techniques

Simple averages and percentages were used to work out input use, costs and returns structure of vegetable cultivation under net house and open field. The coefficient of variation was calculated to analyse the extent of variability in yield, prices and returns from vegetable cultivation. Discounting cash flow techniques such as net present value (NPV) and benefit cost ratio (BCR) were used for assessing the viability of net house investment.

The NPV and BCR can be defined as follow:

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

$$BCR = \frac{\sum_{t=1}^{n}(B_t)/(1+i)^t}{\sum_{t=1}^{n}(C_t)/(1+i)^t} \quad (2)$$

where

B_t = benefit in the year t,

C_t = cost in the year t,

n = project life (in years),

i = Rate of discount (or the assumed opportunity cost of investment), and

$B_t - C_t$ = net cash flow in the t^{th} year.

Garrett Ranking

The problems encountered by farmers in production and marketing of vegetables were analysed using Garrett Ranking Technique. Garrett and Woodworth (1971) and Ray and Mondal (2004) have enunciated a scoring procedure suggested by Garrett in 1969 for converting the ranks into scores when the number of items ranked differed from respondent to respondent. The conversion method used was as follows.

As a first step, the percent position of each rank was found out by the formula (3):

$$\text{Per cent position} = 100\ (R_{ij} - 0.5)/N_j \quad (3)$$

where,

R_{ij} = Rank given for the i^{th} item by the j^{th} individual, and

N_j = Number of items ranked by the j^{th}individual.

The per cent position of each rank, thus obtained was then converted into scores by referring to the Table given by Garrett in 1969. Thus, mean score of each reason was obtained by adding the score of each individual and was divided by the total number of respondents. The mean scores for all reasons were arranged in a descending order and ranks were given. By this method, the accuracy in determining the preference was obtained.

Results and Discussion

Socio-economic characteristics of vegetable growers

Decisions to adopt new technologies/investment and risk bearing ability of the farmer are influenced by his various socio-economic characteristics. It is observed that the education level of net house vegetable growers was better than their counterparts open field cultivators; the operational size of land holding was more (15 acres) in case of former than later category (!2.52 acres) of vegetable growers (Table 1). Percentage of households possessing tractors and electric motors was 90 and 95 respectively in case of net house vegetable cultivators whereas about 83 and 87 per cent of open field vegetable growers possessed tractors and electric motors respectively. Annual family income of net house vegetable cultivators was Rs 9.59 lakh and was around two times higher than open field vegetable growers (Rs 4.85 lakh). The net house vegetable cultivation contributed an amount of Rs 97,888 (10.21%) per annum to total family income. Income from non-farm sources was also higher for net house cultivators than their counterparts open field vegetable cultivators. Net house vegetable growers were members of different societies/clubs (see Appendix-I) and they also (31farmers out of 60) participated in specialized training programmes/demonstrations organized by the consultants of Punjab State Farmers Commission, vocational trainings organized by the KVKs and other training programmes organized/sponsored by NABARD, Agricultural Training Management Agency (ATMA) on net house vegetable cultivation. Jeevandas *et al* (2010) reported that the probability of adoption of net house technology improves 50 per cent with farmers having income from sources other than crop income and five times with improvement of extension contacts and being member of societies each.

The size of net house structure was 500 sq. meters. The average investment in a net house structure was Rs 1.15 lakh and the subsidy given by the government was to the tune of Rs 40,000 per net house structure during the survey period. The area under vegetable cultivation amongst both the categories of farmers accounted for 29 per cent.

Cost and returns differential in net house and open field vegetable cultivation

The vegetables grown in net house by the sample households included capsicum, tomato, cauliflower, cucumber, chilli, spinach, coriander, etc. A very few farmers grew parcelle, celery leek, thymine (a leafy vegetables) covering a little area in the net house. The information relating to number of farmers cultivating different vegetables has been given in Table 2. The majority of sample farmers grew capsicum in net house (86.7%), whereas majority of open field cultivators

Table 1. Socio-economic characteristics of sampled households

Particulars	% of households	
	Net house cultivators	Open field cultivators
Average age (in years)	48	45
Education (average no of years in school)	11	9
(a) +2 and above (%)	43.3	28.3
(b) Graduate and above (%)	31.7	16.6
Size of operation holdings (acres)	15.0	12.52
Farmers with ≤ 5acre op. holding (%)	25.0	38.3
Participation in training programs on net house veg. cultivation (No.)	31	-
Family size (No.)	5.95	6.75
Possession of agriculture machinery(% households)		
(a) Tractors	90.0	83.3
(b) Electric motors	95.0	86.7
Av. investment on net house structure (Rs)	1.15 Lakhs	-
Subsidy on net house structure 500 sq. metre(Rs per net house structure)	40000	-
Total family income (Rs/annum/household)	959097 (100.00)	485426 (100.00)
Farm Business Income		
Crops (%)	62.17	73.17
Income from net house vegetable cultivation (%)	10.21 (Rs 97888)	-
Dairy (%)	3.05	7.32
Non-–farm income (%)	24.57	19.51

Table 2.Number of farmers cultivating different vegetables in net house and open field in Punjab

Vegetable	Net house	Open field
Capsicum	52 (86.7)	8 (13.3)
Tomato	17 (28.3)	16 (26.7)
Cucumber	15 (25.0)	14 (23.3)
Brinjal	2 (3.3)	7 (11.7)
Cauliflower	11 (18.3)	35 (58.3)
Chilli	4 (6.7)	9 (15.0)
Spinach	3 (5.0)	2 (3.3)
Coriander	7 (11.7)	1 (1.7)

Figures within the parentheses are percentages to total number of sample farmers

grew cauliflower (58.3%).The other main vegetables grown in net house were tomato, followed by cucumber, cauliflower, chillies, coriander and spinach.

For the cost structure, only variable costs were considered. The costs items included were seed/ seedlings, chemical fertilizers, plant protection chemicals, growth stimulators, irrigation, hired labour, transportation costs and costs of permanent structure erected to support the vegetables and low tunnels formed to protect the vegetables during winter season from frost. The information on total variable cost, yield, price and returns over cost of vegetable cultivation under net house and open field in Punjab is presented in Table 3. The cost details are given in Appendix-II.

A substantial difference was noted in yields, prices, costs and returns of all the vegetables grown under net house and open field conditions. The average yield of capsicum was higher (197 q/acre) in net house than under open field (98 q/acre) cultivation. Similarly the yield of tomato was 235 q/acre in net house and 178 q/acre under open field cultivation. The yield of cauliflower, chilli and spinach was 126 q/acre, 128q/ acre and 119q/acre under net house and 88q/acre, 47

Table 3. Costs and returns differentials in vegetables cultivated in net house and open field conditions in Punjab

Particulars	Net house	Open field	Difference%
		Capsicum	
Yield (q/acre)	197	98	101.0
Price (Rs/q)	2125	2250	5.5
Variable cost (Rs/acre)	77233	51714	49.3
Gross Returns (Rs/acre)	418625	220500	89.8
Returns over variable cost(Rs/acre)	341392	168687	102.4
		Tomato	
Yield (q/acre)	235	178	32.0
Price (Rs/q)	795	409	94.3
Variable cost (Rs/acre)	84287	28987	190.7
Gross Returns (Rs/acre)	186825	72802	156.6
Returns over variable cost(Rs/acre)	102538	43815	134.0
		Cucumber	
Yield (q/acre)	126	124	1.6
Price (Rs/q)	1356	648	109.2
Variable cost (Rs/acre)	48828	38111	28.1
Gross Returns (Rs/acre)	170856	80352	112.6
Returns over variable cost(Rs/acre)	122028	42241	188.9
		Brinjal	
Yield (q/acre)	184	138	33.3
Price (Rs/q)	609	511	19.1
Variable cost (Rs/acre)	30942	26680	15.9
Gross Returns (Rs/acre)	81114	43838	85.0
Returns over variable cost(Rs/acre)	81114	43838	85.0
		Cauliflower	
Yield (q/acre)	126	88	43.1
Price (Rs/q)	1109	678	63.56
Variable cost (Rs/acre)	35910	21769	64.9
Gross Returns (Rs/acre)	139734	59664	134.2
Returns over variable cost(Rs/acre)	103824	37895	174.0
		Chilli	
Yield (q/acre)	128	47	172.3
Price (Rs/q)	1333	951	40.1
Variable cost (Rs/acre)	52970	19385	173.2
Gross Returns (Rs/acre)	170624	44697	281.7
Returns over variable cost(Rs/acre)	117654	25312	364.8
		Spinach	
Yield (q/acre)	119	110	8.1
Price (Rs/q)	978	1031	-5.1
Variable cost (Rs/acre)	30650	20890	46.7
Gross Returns (Rs/acre)	116382	113300	2.7
Returns over variable cost(Rs/acre)	85732	92410	-7.2
		Coriander	
Yield (q/acre)	37	64	-42.1
Price (Rs/q)	2320	1000	132.0
Variable cost (Rs/acre)	24815	16730	48.3
Gross Returns (Rs/acre)	85840	64000	34.1
Returns over variable cost(Rs/acre)	61025	47270	29.1

q/acre and 110 q/acre, respectively under open field cultivation. The average price received by the net house vegetable growers was higher except for capsicum than the open field vegetable growers. The variable cost was higher for vegetables cultivated under net house than the open field; it was as high as 191 per cent in case of tomato and 173 per cent in chilli.

The returns over variable cost (gross returns-variable cost) hereafter referred as gross margins for the vegetables grown in net house and open field, are presented in Table 3. The estimated returns on per acre basis were the highest in case of capsicum cultivation in the net house at Rs 341392 and were Rs 168687 per acre in the open field. The difference in gross margins in both the situations of capsicum cultivation was of Rs 172705 (102.4 per cent). Sharma *et al* (2000) have also reported higher returns over variable costs per acre in case of capsicum cultivation. The difference in gross margin from different vegetables cultivated in net house and open field conditions ranged from Rs 13775 in coriander cultivation to Rs 172705 in capsicum cultivation. In percentage terms the gap was the lowest in coriander cultivation (29.1 per cent) and the highest in chilli (364.8%) cultivation. Overall, table revealed that vegetable cultivation is more remunerative in net house than in open field situation; mainly due to higher yield and higher market price for the vegetables cultivated under net house.

Risks in vegetable cultivation

The two types of risks involved in crop cultivation in general and perishable commodities such as vegetables in particular are at the production stage,i.e. due to failure of crop or low yield and at the marketing stage i.e. due to low market price. The information regarding the variability in price, yield, and crop failure in vegetable cultivation was compiled and is discussed below.

Variability in yield

The intensive vegetable cultivation under the protected technology could enable farmer to get yields which are ten times higher than cereal crops per unit of land (Kapila *et al*, 1985). The minimum yield, maximum yield and CV of yield of different vegetables grown under net house and open field are presented in Table 4.

The majority of the farmers (87%) cultivated capsicum in net house; and a higher variability in yield in capsicum was observed in net house (49.21 per cent) and in open field (23.71 per cent). The yield of capsicum ranged from 57 q /acre to 400 q /acre in net house; and from 40 q/acre to 120 q/acre in open field. This shows that the yield of capsicum was quite high in net house than open field cultivation on per acre basis. In case of tomato, the CV of yield was higher in open field at 55.85 per cent being 45.45 per cent in net house. Even the minimum yield of tomato achieved by the farmers was higher in net house cultivation than in the open field cultivation. In case of cucumber, though the maximum yield was higher (450 q /acre) in open field cultivation than in the net house vegetable (320 qtl /acre) cultivation, the variability was also higher at (99.4%) in open field than in net house vegetable (75.25 %) cultivation. Similar pattern was observed for other vegetable crops. Overall it could be concluded that a high variability exists in the yield of different vegetables cultivated in net house and open field conditions.

Table 4.Variability in yield of vegetables in net house and open field cultivation in Punjab (Yield q/acre)

Vegetable	Net house			Open field		
	Min.	Max.	CV	Min.	Max.	CV
Capsicum	57	400	49.21	40	120	23.71
Tomato	60	320	45.45	42	333	55.85
Cucumber	16	320	75.25	20	450	99.39
Cauliflower	96	208	33.90	38	210	48.83
Spinach	40	336	71.43	38	38	-
Chilli	64	160	60.61	30	35	28.84
Coriander	13	160	97.60	64	64	-
Brinjal	152	200	19.28	60	200	36.72

Source: Compiled by authors

Table 5. Variability in prices of vegetables cultivated under net house and open field conditions in Punjab

Vegetables	Price (Rs/q)					
	Net house			Open field		
	Min.	Max.	CV	Min.	Max.	CV
Capsicum	700	5000	41.65	800	2200	28.49
Tomato	250	2000	54.45	300	1000	41.77
Cucumber	1000	2500	38.96	400	1400	48.68
Cauliflower	600	2000	39.46	392	1360	39.37
Spinach	1000	3500	77.47	800	800	-
Chilli	1000	3000	70.71	800	1200	14.14
Coriander	1000	10000	86.42	1000	1000	-
Brinjal	368	700	43.89	500	650	11.70

Source: Field Survey

Variability in prices

The variability in market price is quite high in vegetables. The variability in market price of any crop, particularly vegetables being perishable in nature depends upon harvesting season, quality and demand supply forces. The protected cultivation of vegetables offers distinct advantages of quality, productivity and favorable market price to the growers (Singh and Sirohi, 2006).The variability in market prices of vegetables as measured by minimum price, maximum price and CV is reported in Table 5.

In case of net house, the minimum sale price of capsicum was Rs 700/q whereas the maximum price was Rs 5000/q, the estimated CV was 41.65 per cent, which shows a large variation in the price. The CV of price among different vegetables grown in the net house ranged from 38.96 per cent in case of cucumber to 86.42 per cent in case of coriander. Among different crops, the CV of brinjal price was higher in net house cultivation (43.89%) than in open field cultivation (11.70%). The maximum price received by the farmers for all the vegetables grown in the net house was higher than the maximum price received by the open field vegetable growers because of off-season production of vegetables in net house due to extended period of harvesting in net house structure. Thus it is inferred from above findings that though the vegetables cultivated under net house had higher yield and higher price in comparison to open field cultivation but also experienced high variability in yield and prices resulting to substantial variability in returns from vegetable cultivation even under protected technology.

Variability in returns from vegetable cultivation under net house

This section incorporates information on gross margins actually received by sample net house vegetable growers from vegetable cultivation on per net house structure basis (500 sq. meters) and its variability. In the previous section the cost and returns were discussed on per acre basis thus for net house these were converted into per acre basis for the reason of comparison with open field cultivation. For working out the profitability of net house vegetable cultivation per structure the costs and returns from minor crops such as celery, thyme, leek, knoll-khol etc. along with the main crop has also been accounted. The returns from net house vegetable cultivation varied widely from Rs 10310 to Rs 112092 among sample households. The sample farmers were distributed into 10 groups according to the levels of gross margins they received and information is presented in Table 6. More than one fifth (21.7%) of sample households received between Rs 20,000 and 30,000 of gross margins from net house vegetable cultivation, followed by 15 per cent who received returns between Rs 30000 and 40000 and 13.3 per cent received returns between Rs 60000 and 70000. Overall, 71.7 per cent farmers received gross margins up to Rs 60000 per annum per net house from vegetable cultivation. About seven per cent farmers received returns above Rs 80000 per annum per net house. Thus, it is clear that though the net house vegetable cultivation gives high returns as compared to open field cultivation, but the difference in returns remains quite large.

Table 6. Frequency distribution of net house vegetable growers according to size of gross margins per net house (Rs)

Size class of gross margins (in' 000)	No. of net house growers	Percentage of households	Cumulative frequency
Up to 10	4	6.7	6.7
10 – 20	7	11.7	18.4
20- 30	13	21.7	40.1
30- 40	9	15.0	55.1
40- 50	5	8.3	63.4
50- 60	5	8.3	71.7
60- 70	8	13.3	85.0
70 -80	5	8.3	93.3
80-90	2	3.3	96.6
>90	2	3.4	100.0
Min. gross margin		10310	
Max. gross margin		112092	
Av. gross margin		43700	

Impact of training in vegetable cultivation on gross margins from net house

Among the sample net house vegetable cultivators, 31 farmers had participated in different training programmes on vegetable cultivation, 29 farmers had not attended/participated in any training programme. To find the impact of training on returns from vegetable cultivation, the farmers were categorized into two groups one who has acquired training in vegetable cultivation another who has not acquired any training on vegetable cultivation. The mean value of gross margin from net house vegetable cultivation of both the categories of farmers was compared. The average return of farmers who had acquired training was Rs 52881/ net house structure/annum for those who had not participated in any training programme (Rs 34901). The difference in returns was Rs 17980 per net house structure per annum. The difference was statistically significant (t value=2.55) at 5 per cent level. Thus, it was concluded that the training programme has a significant impact on improving farmer's skill in specialized vegetable cultivation in net house.

Less use of chemicals in net house vegetable cultivation

The protected cultivation of vegetables provides for better quality produce as compared to open cultivation where the crop may not survive due to the prevailing temperature, and other biotic and abiotic stress (Singh and Asrey, 2005).The vegetables grown in the net-house face minimum incidence of viruses transmitted through insect vectors like whitefly, aphid, etc. and therefore, application of chemicals is less on the produce thereby keeping the nutritional value intact and increasing the quality of output. The chemical use in vegetable cultivation in comparative situations are discussed in terms of expenditure on plant protection chemicals and fertilizers use.

Expenditure on plant protection chemicals in vegetable cultivation

The excessive and indiscriminate use of pesticides increases the cost of production and also results in many human health problems and environmental pollution. The effect of chemical pesticide-use is more harmful in vegetables. The cultivation of vegetables in the net house is expected to reduce the expenditure on pesticides-use. Table 7 provides information relating to expenditure on plant protection chemicals to control the insect and pest in vegetable cultivation in net house and open field on per acre basis. Table reveals that the expenditure on plant protection chemicals was less in all the vegetables grown in net house than in the open field. The difference in expenditure ranged between Rs 370/acre in brinjal to Rs 2220/acre in chilli in absolute terms and between 4.81 per cent to 88.91 per cent in

Table 7. Difference in expenditure on plant protection chemicals among different vegetables in net house and open field cultivation (Rs/acre)

Vegetable	Net house cultivation	Open field cultivation	Difference in expenditure	Difference (%)
Capsicum	3800	5060	-1260	-24.90
Tomato	2863	3590	-727	-20.25
Cucumber	1604	2318	-714	-30.94
Brinjal	7400	7770	-370	-4.81
Cauliflower	1022	1535	-513	-33.42
Chillies	650	2870	-2220	-77.35
Spinach	377	2440	-2063	-84.55
Coriander	213	1920	-1707	-88.91

proportionate terms. In absolute terms the difference in expenditure on plant protection chemical was the highest in chilli (Rs 2220/acre) followed by spinach (Rs 2063/acre). The highest expenditure on plant protection chemicals was made on brinjal in both net house and open field cultivations.

Expenditure on chemical fertilizer in vegetable cultivation

The expenditure on chemical fertilizers applied on different vegetables in net house and open field cultivations is presented in Table 8. The expenditure on chemical fertilizers was highest on tomato cultivation in the net house (Rs 6362/acre), which was higher by 176.25 per cent than in the open field cultivation. In capsicum, the expenditure on chemical fertilizers was higher in net house by 12.30 per cent than in the open cultivation. But, in other vegetables the expenditure made by farmers was lower in net house than in open field cultivation. Thus, chemical used in terms of fertilizers and pesticides were lower in net house cultivation in almost all vegetables, except higher expenditure on fertilizer in tomato and capsicum cultivation in net house than open field.

Economic viability analysis of net house investment

The life span of a net house structure is one of the most important variables which determine the profitability from the investment. To find out the economic viability of net house investment, following assumptions were made.

Assumptions

1. The life span of net house structure was considered 10 years.
2. The income stream from net house vegetable cultivation was taken uniform and constant over

Table 8. Difference in expenditure on chemical fertilizers among different vegetables in net house and open field cultivations (Rs/acre)

Vegetable	Net house cultivation	Open field cultivation	Difference in expenditure	Difference (%)
Capsicum	2793	2487	306	12.30
Tomato	6362	2303	4059	176.25
Cucumber	1584	1688	-104	-6.16
Brinjal	3877	6651	-2274	-34.19
Cauliflower	1593	2287	-694	-30.35
Chillies	3485	1436	-2049	-142.69
Spinach	2503	3200	-697	-21.78
Coriander	642	3200	-2558	-79.94

the entire life, and

3. Differential rates of discount (10%, 12% and 15%) were considered to undertake the sensitivity of investment to change in capital cost.

To find out the economic viability of net house investment, both net present value and benefit-cost ratio were computed using discounted cash flows. The investment cost was considered for the year 2011 at Rs 115000 (Table 9). The maintenance cost was Rs 30000 every third year for the replacement of net cover of the structure; the expenditure on minor repairs was taken at Rs 500 for the other years during the life of the project. The operational cost considered was the variable cost of Rs 12560 per net house structure and gross returns were Rs 56260 per net house structure.

Table 9. Cash flows of investment in net house structures

Particulars	Value (Rs)
Initial investment	115000
Subsidy	40000
Gross returns	56260
Operational cost of vegetable cultivation	12560
Cost of replacement of net cover (after every third year)	30000
Minor repair cost	500

The present value of future gross returns was estimated as Rs 282356, Rs 317882 and Rs 345693 at a discount rate of 15 per cent, 12 per cent and 10 per cent, respectively; the present value of total cost was estimated at Rs 221081, Rs 235373 and Rs 246575 for different discount rates (Table 10). The net present value was positive for all the discount rates considered for analysis, it was Rs 61275, Rs 82509 and Rs 99118 at 15, 12 and 10 per cent cost of capital. The benefit-cost-ratio was worked out to be 1.40, 1.35 and 1.28 at 10 per cent, 12 per cent and 15 per cent discount rate. The investment in net house technology was found economically viable even without subsidy.

During survey period the subsidy given by the government was Rs 40000 per net house it has now increased to Rs 50000 per structure. The NPV was worked out at Rs 139119, Rs 122509 and Rs 101275 at 10 per cent, 12 per cent and 15 per cent discount rate; the benefit-cost-ratio was 1.67, 1.63, 1.56 for the respective discount rates. Thus, it is concluded that the net house investment is economically viable with subsidy and even without subsidy.

Subsidy provided by state govt. on protected cultivation

The Govt. of Punjab in consultation with Punjab State Farmers Commission has placed a target of about two lakh units of net house for vegetable cultivation of whom the majority targeted, about one lakh, to be small and marginal farmers (Govt. of Punjab, 2007). Under the head of protected cultivation State govt. provides subsidy for different components such as poly house, shade net house, walk- in- tunnels, mulching and low cost tunneling, cost of planting material. The amount of subsidy granted by the Govt. was to the tune of Rs 3256.12 lakh during 2015-16, Rs 1869.93 lakh during 2016-17, Rs 147.09 lakh during 2017-18 and Rs 1054.88 lakh during 2018-19.

Constraints in vegetable cultivation

Both the categories of vegetable growers faced constraints in production and marketing of vegetables. The production and marketing constraints faced by the net house and open field vegetable growers ascertained and are listed in Table 11.

These problems were analyzed using Garret ranking technique. The net house vegetable growers gave the highest rank to vegetable cultivation being labour intensive activity, followed by expensive inputs; the quality of seed/nursery, damage by pests and diseases and labour availability. The open field vegetable growers gave the highest rank to expensive inputs, followed by labour-intensive nature of vegetable cultivation. Overall there is a marginal difference in ranking of these production problems faced by both the categories of vegetable growers.

The various marketing problems identified by sample vegetable growers were low price of vegetables, ranked highest by both the categories, perishable nature of vegetable crops. The exploitation by middlemen/ commission agents was also an important constraint ranked 4th by both types of vegetable growers. Difficult to work in summer season and no incentive price were the addition constraints reported by net house vegetable growers.

Table 10. Economic viability of net house investment with and without subsidy

Discount rate	Without subsidy	With subsidy
Present worth of gross return (Rs/net house)		
15 per cent discount rate	282356	282356
12 per cent discount rate	317882	317882
10 per cent discount rate	345693	345693
Present worth of gross cost (Rs/net house)		
15 per cent discount rate	221081	181081
12 per cent discount rate	235373	195373
10 per cent discount rate	246575	206575
Net present worth (Rs/net house)		
15 per cent discount rate	61275	101275
12 per cent discount rate	82509	122509
10 per cent discount rate	99118	139119
Benefit-cost/ratio		
15 per cent discount rate	1.28	1.56
12 per cent discount rate	1.35	1.63
10 per cent discount rate	1.40	1.67

Table 11. Constraints faced by sample vegetable growers in Punjab

Constraint	Net house vegetable growers		Open field vegetable growers	
	Garret's mean score	Rank	Garret's mean score	Rank
Production Constraints				
Labour intensive	43.67	1	32.88	2
Expensive inputs	39.32	2	52.72	1
Low quality seed/nursery	28.68	3	26.46	4
Damage by pests and diseases	20.45	4	26.62	3
Labour availability	17.76	5	9.43	5
Difficult to work in summer season	8.84	6	-	-
Damage by adverse weather			3.66	6
Marketing Constraints				
Low price of vegetables	70.52	1	70.32	1
Lack of incentive price for net house vegetables	33.57	2	-	-
Perishable nature	27.17	3	40.81	2
Exploitation by middleman	21.94	4	10.82	4
High marketing cost	14.17	5	25.29	3
Lack of public procurement at the MSP	12.38	6	4.86	6
High cost of transportation	-	-	5.17	5

Conclusion and Policy Implications

From the above study it is inferred that the net house vegetable cultivation was adopted by vegetable growers, particularly the large farmers, who are educated and progressive and are members of one or the other Farmers' Society/Club/Organization and have more extension contacts. Thus for high adoption of new technology better extension services should be geared up to reach larger segment of farming population, particularly the less educated and aware. Cultivation of vegetables under protected technology yield substantially higher returns than the open field cultivation but at the same time equally risky as variability in returns is very high. Significant impact of training in vegetable cultivation on returns from net house vegetable cultivation was observed. Therefore, subsidy should be linked to it. The study has concluded that vegetable cultivation in net house yields high returns and better quality produce in term of less chemical used. Thus, generating awareness across the farmers is needed for adoption of net house technology for higher income and consumers about the quality of vegetables cultivated in net house. Special marketing arrangements are required by giving incentive price.

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Annexures

Distribution of vegetable growers according to membership of Societies/Clubs

(No. of farmers) (Multiple Response)

Particulars	Net house cultivators	Open field cultivators
Cooperative Society	18(30.0)	7(11.7)
Punjab Dairy Farmers Association /Milkfed	10(16.7)	-
Agricultural Technology Management Agency	5(8.3)	-
Self- Help Group	2(3.3)	-
Farmers' Club PAU	14(23.3)	1(1.7)
Net House Vegetable Growers Association/Societies	2(3.3)	-
Vegetable/Horticulture Growers Association	6(10.0)	-
Suraksha Agriculture and Rural Development Society	5(8.3)	

Figures within the parentheses are percentages.

Cost structure of major vegetables cultivated under net house and open field in Punjab

(in per cent)

Particulars	Capsicum		Tomato		Cucumber		Brinjal		Cauliflower		Chilli		Spinach		Coriander	
	Net House	Open Field	Net House	Open Field	Net House	Open Field	Net House	Open Field	Net House	Open Field	Net House	Open Field	Net House	Open Field	Net House	Open Field
Seed/seedlings	18.00	20.16	9.45	12.1	34.49	13.73	9.57	20.41	7.85	9.86	15.81	19.44	29.12	13.88	14.65	2.85
Chemical fertilizeRs	3.87	4.81	7.55	7.95	4.44	10.52	6.58	7.41	6.70	15.32	2.59	19.13	3.24	4.42	12.53	24.93
Farm yard manure	4.24	4.36	3.16	2.20	9.58	0.73	0.50	0.46	7.49	3.59	8.46	-	8.04	2.63	-	7.09
Plant stimulants	1.92	0.40	5.12	0.07	1.67	0.08	1.20	0.14	-	4.31	1.88	-	1.72	0.05	2.24	4.11
Plant protection chemicals	5.26	9.78	3.40	12.38	2.85	7.05	1.22	14.80	1.23	11.68	0.86	11.48	3.29	6.08	23.92	29.12
Irrigation	0.69	1.16	0.66	2.41	1.53	3.03	1.29	4.44	1.49	9.10	1.89	3.88	1.17	1.98	2.26	3.37
Machinery	1.35	1.78	1.26	2.71	2.28	3.50	2.42	6.29	4.25	5.26	3.90	6.22	2.04	2.34	3.14	2.68
Hired labour	46.64	39.12	52.78	34.75	33.20	46.66	65.64	33.44	60.38	19.34	42.31	-	32.83	41.45	17.56	21.33
Marketing cost	9.03	4.51	9.15	6.43	9.96	14.70	11.58	12.61	10.61	21.54	22.30	39.85	7.28	10.14	23.70	4.52
Low tunnel cost	9.00	13.92	7.47	18.97	-	-	-	-	-	-	-	-	11.26	17.03	-	-
Total variable cost (Rs/acre)	**77233**	**51714**	**84287**	**28987**	**35910**	**21769**	**52970**	**19385**	**30650**	**20890**	**24815**	**16730**	**48828**	**38111**	**30942**	**26680**