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Constraints in adoption of protected cultivation technology in Punjab

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Abstract
The changing demands on agricultural production due to food security, sustainable intensification, climate change and changes in consumer diets call for continuous technological innovation. In pursuit of higher income, farmers are slowly shifting area to fruits and vegetables but horticulture crops are more susceptible to climate changes. Thus protected cultivation deserves serious consideration. The present study was conducted on 80 farmers from Ludhiana and Jalandhar districts having the highest concentration of poly houses in the Punjab state to delineate the constraints in adoption of polyhouse technology. Majority of the farmers (35%) had acquired information regarding the new climate smart technology from PAU followed by HDOs (30%), KVKs (17.50%) and Indo-Israel Centre for Excellence of Vegetables, Kartarpur Sahib (10%). About 60 per cent of the farmers got short term trainings from PAU, while 17.50 per cent got themselves trained from centre of excellence for vegetables, Kartarpur Sahib and 22.50 per cent from others sources. The farmers faced environmental, technical, labour, economic and marketing constraints in harnessing profitability and sustainability of this technology. The major constraints in rapid adoption were high initial investment, poor availability of quality planting material and inputs, poor post-harvest infrastructure and absence of price policy measures. The difference of per kg profit margin for polyhouse technology over the open field conditions in capsicum was estimated by Rs. 5.73 (188.48%) and it was found to be economically feasible under subsidised conditions stressing the need for government support in the form of capital subsidy to enhance rate of adoption of protected cultivation. Also continuous efforts by the Government Officials through regular awareness camps and training courses should be organised to train/upgrade the farmers for successful cultivation of vegetable crops under protected structures and adoption of these technologies at large scale. Farmers' ability to successfully integrate this technology to suit their socio-economic and agro-ecological conditions would further affect its profitability and sustainability.

Keywords: constraints, motivation, protected, returns, subsidy

Introduction

The changing demands on agricultural production due to food security, sustainable intensification, climate change and changes in consumer diets call for continuous technological innovation. Increasingly during the recent decades technology has developed to meet the needs of a sustainable agriculture focused on increasing production at least cost to the environment. Vegetables are important part of Indian agriculture and nutritional security due to their short duration, high yield, nutritional richness, economic viability and ability to generate on-farm and off-farm employment. Apart from nutritional benefits, the production of vegetables improves the economy of a country as these are good source of income and employment. These are very utilitarian in the rotational system of farming for maintenance of soil fertility and also providing better crop intensification and diversification. India is the second largest producer of vegetables in the world next to China; however it's per capita per day availability is well below 92 grams whereas the recommended consumption is 284 grams. During 2018-19 India produced 185.9 million tonnes (MT) of vegetables on 10.10 million hectares of area under vegetables (Anonymous 2019) [1]
. The present production is not sufficient to meet the requirement. This is to be raised to 250 MT by 2024- 2025 (Singh, 1998) [13]. The target can be achieved either by bringing additional area under vegetables, using hybrid seeds, improved agro techniques and another potential approach is perfection or promotion of protected cultivation of vegetables (Singh *et al* 1999) [14]. Olericulturist and extension specialists will also have to do some efforts together to achieve the desired level of production potential (George and Singh, 2006) [3].

Punjab agriculture has undergone many changes since advent of green revolution. Vegetable farming seems to be a good alternative for the existing wheat-paddy rotation in Punjab as vegetable crops give high returns per unit area in contrast with wheat –paddy rotation (Sharma *et al* 2000) [12]. The traditional ways of farming are getting bottlenecked due to issues like shrinking cultivable lands, increasing cost of cultivation and climate change; modern approaches like protected cultivation of high-value crops can tremendously improve the financial condition of farmers in coming days. In pursuit of higher income, farmers are slowly shifting area to fruits and vegetables but horticulture crops are more susceptible to climate changes. Moreover, their short harvesting and retention periods due to perishable nature, results in frequent gluts in the market and crash in prices. This is where the option of protected cultivation deserves serious consideration, especially in the context of enhancing farmers' income. In addition to this, the perpetual demand for vegetables and drastically shrinking land holding, protected cultivation of vegetable crops suitable for domestic as

well as commercial purposes is the best alternative for using land and other resources more efficiently. In the 21st century, for off season production of vegetables, to avoid glut in main season and for superior quality of vegetables with high production, protected cultivation is the best choice for efficient utilization of natural resources (Chandra *et al.*, 2000) [2].

Capsicum is one of the most popular and highly remunerative annual herbaceous vegetable crop. India contributes one fourth of world production of capsicum with an average annual production of 0.9 MT from an area of 0.885 million hectares (Kumar *et al* 2016).'In Punjab, area under vegetable cultivation is 208 thousand hectares with production of 4167.60 thousand tonnes and productivity of 15.60 metric tonnes per hectare (Kaur *et al* 2017). The area under greenhouse cultivation in Punjab is only 20 hectares out of 1.70 lakh hectares under vegetable crops (Spehia, 2015) [15]. Protected cultivation in the state has potential to considerably increase the unit area productivity of vegetable crops. For instance, under protected conditions the productivity of tomato has been reported doubled and in case of bell pepper productivity increased by five times (Sethi *et al* 2009) [11]. In this context, it is important and topical to delineate the constraints and challenges that farmers face in adoption of polyhouse technology. This would help in finding out the determinants of adoption which play a significant role in devising strategies to overcome the challenges. The present study was undertaken to study the awareness of the farmers regarding protected cultivation technology in vegetables along with the problems in its adoption. The study also enlightens different factors affecting the adoption level of the technology. Economic evaluation of the adoption of the technology under subsidised and non-subsidised conditions was also carried out to assess the viability of the technology.

Material and Methods

To fulfil the stipulated objectives of the study, Ludhiana and Jalandhar districts having the highest concentration of poly houses in the state were purposively selected. The information regarding the number, area and type of polyhouses was obtained from respective district Horticulture offices of the state. From the complete list of polyhouse vegetable growers obtained from the officials of Department of Horticulture of Ludhiana and Jalandhar, 40 respondents were selected randomly i.e.20 from each district. For comparison purpose an equal number of vegetable growers, cultivating vegetables in open field (non-adopters) were also selected from the both districts. The primary data for the year 2018-19 were collected with the help of well-structured and pre-tested schedule by personal interview method. The data relating to age, education, operational land holding, area under polyhouse cultivation, sources of information regarding protected cultivation, problems in the adoption of the polyhouse technology and factors inspiring the farmers for adoption of the technology were collected. Comparison in terms of economic feasibility of investment on capsicum production under subsidised and non-subsidised conditions for the adopters was also carried out for by using project evaluation measures like Payback period (PBP), Benefit Cost Ratio (BCR), Net Present Value (NPV), and Internal Rate of Return (IRR). The data were also analyzed with the help of statistical tools such as frequency and percentage methods.

Results and Discussion

Socio-economic profile of the respondents

The Socio-economic profile of the respondent farmers has a great bearing on decisions regarding adoption of new technologies/ techniques of production, risk bearing ability, investment decisions etc. The socio economic profile of respondent vegetable growers (adopters and non-adopters) is presented in Table 1 which revealed that the average age of farmers was 37 years in the case of adopters and 45 years in the case of non-adopter cultivators. A significant association between education and adoption of innovative technology was also found as the percentage of farmers having education up to graduation and post-graduation level were 40 per cent in the case of net house vegetable cultivation and 29 per cent in the case of open field vegetable cultivation. The percentage of respondents educated up to upto +2 and above were more in case of adopters as compared to non-adopters. The average size of operational holding of adopter farmers was marginally higher (19 acres) than the non-adopters (18.75 acres) though the average area under vegetable cultivation was 0.77 acres in case of polyhouse adopter farmers and 1.32 acres in case of non-adopter farmers.

Table 1: Socio-economic characteristics of sampled households (Per cent households)

Sr. No.	Particulars	Adopters	Non- Adopters
1	Average Age (years)	37	45
2	Literary Status		
	+2 and above	32.0	25.0
	Graduate and above	40.0	29..0
3	Size of operational holdings (acres)	19.10	18.75
4	Area under Vegetables	0.77	1.32
5	Size of poly house (sq.m)		
	500 -2000	45.00	-
	2100-4000	55.00	-
	>4000	0	-

Regarding size of poly house 45.00 per cent of the sampled farmers had 500-2000m^2 size of polyhouse. About 55.00 per cent sampled farmers had poly house between 2100-4000m^2. None of the farmers were found having poly house with more than 4000m^2 area.

In agriculture sector women make essential contributions to agriculture and rural economic activities. Table 2 depicts that majority of the farmers were male in both the categories. It was found that 83.75 per cent were male while only 16.25 per cent women were engaged in farming activities. Category-wise analysis showed that the percentage of male non-adopter farmers were found higher for open field conditions (85.00%) as compared to polyhouse adopter farmers (82.50%) while the percentage of females adopters were found to be higher for the technology (17.50%) as compared to open field (15.00%).

Table 2: Gender wise distribution of respondents (Number)

Particulars	Gender		
	Male	Female	Total
Adopters	33 (82.50)	7 (17.50)	40 (100.00)
Non-Adopters	34 (85.00)	6 (15.00)	40 (100.00)
Total	67 (83.75)	13 (16.25)	80 (100.00)

Figures in the parentheses indicate the percentage to total
This reflects an optimistic assumption that removing constraints to access or use the protected cultivation technology can help women to empower themselves.

Experience in vegetable cultivation

The experience of farmers in growing vegetables is presented in Table 3. The results revealed that in case of adopter farmers, the majority of them (52.50%) were having more than 15 years of experience in growing vegetables, 22.50 per cent were having 11 to 15 years and 15 per cent were having 6 to 10 years. Only 10 per cent of them were up to 5 years only. Where as in case of non-adopter farmers, about 83 per cent farmers had more than 15 years of experience in growing vegetables. The percentage of farmers having experience of cultivating vegetables between 6 to 10 years of experience and 11 to 15 years was five and 12.50 per cent respectively. None of the farmers were found to be having experience up to 5 years. The confidence of farmers in their own traditional methods of vegetable cultivation was the major reason for low adoption of protected cultivation technology by the experienced farmers.

Table 3: Distribution of sampled farmers according to experience in vegetable cultivation

Experience in growing vegetables	Adopters		Non-Adopters	
	Number	Percent	Number	Percent
Up to 5 years	4	10.00	0	0.00
6 to 10	6	15.00	2	5.00
11 to 15	9	22.50	5	12.50
>15	21	52.50	33	82.50
Total	40	100.00	40	100.00

Vegetable crops grown

There were few vegetable crops which were preferred for cultivated by sampled farmers in polyhouse. For comparison purpose same crops were taken in open field for non-adopters. Table 4 reveals that cucumber was the most preferred crop of both adopter (57.50 %) and non-adopter farmers (47.50%) as it generates income for longer period. On the other hand, the proportion of adopter farmers growing capsicum was 27.50 per cent where as in case of open field conditions it was one-fourth. Tomato was grown by five per cent of adopter farmers and 17.50 per cent of non-adopters. About five per cent adopter farmers cultivated cucumber and capsicum simultaneously while only 2.50 per cent of open field farmers cultivated both the crops simultaneously. Capsicum and tomato simultaneously were cultivated by 2.50 per cent polyhouse farmers and five per cent of open field farmers. Tomato and cucumber simultaneously were cultivated by 2.5 percent of each adopter and non-adopters.

Table 4: Distribution of sampled farmers according to crops grown

Sr. No	Crops	Adopters		Non-Adopters	
		Number	Percent	Number	Percent
i)	Cucumber	23	57.50	19	47.5
ii)	Capsicum	11	27.50	10	25.00
iii)	Tomato	2	5.00	7	17.50
iv)	Cucumber+capsicum	2	5.00	1	2.50
v)	Capsicum + tomato	1	2.50	2	5.00
vi)	Tomato + cucumber	1	2.50	1	2.50
	Total	40	100.00	40	100.00

Source of information and Motivation about protected cultivation

In the adoption process, access to various information transfer sources and their perceived value by farmers influences adoption of new technology a lot. Sanyang *et al*. (2009) [10] in their study examining technology transfer to farmers in the areas of production and marketing of vegetables found public extension system and farmer groups as sources of technology dissemination to farmers. Farmers with access to sources of technical knowledge and information such as extension officers and industry related media are likely to have more accurate expectations of the distribution of the profitability of the innovation (Ghadim and Pannell, 1999) [4].

The sampled farmers became aware of the new technology of protected technology from different sources (Fig 1). It was found that majority (35%) of the farmers in both the districts had acquired information regarding new polyhouse technology from Punjab Agricultural University (PAU) followed by Horticultural Development Officers (30%), Krishi Vigyan Kendras (KVKs) (17.50%), Centre for excellence of vegetables, Kartarpur Sahib (10%). Only 7.50 per cent of the respondents knew about protected cultivation from peer group.

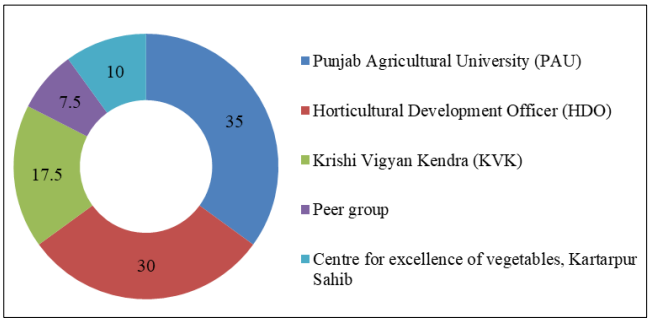

Fig 1: Source of Information about the new technology

It was also observed that trainings carried out by PAU and other Government Departments played an important role in adoption of the technology. All the adopter farmers had attended training programme mostly from government organizations (Table 5). Majority of them i.e. 60 per cent got short term trainings from PAU, while 17.50 per cent got themselves trained for the new technology from Indo-Israel centre of excellence for vegetables, Kartarpur Sahib and 22.50 per cent from others sources. On the other hand, out of 40 open field farmer respondents only 11 got training which accounted for 27.50 per cent out of which 54.54 per cent got training from PAU, 18.18 per cent from Indo-Israel centre of excellence for vegetables, Kartarpur Sahib and 27.27 per cent from others.

Table 5: Information regarding Trainings acquired by the sampled households (Per cent households)

Name of the training agency	Adopters	Non-Adopters
Punjab Agricultural University (PAU)	60.00	54.55
Indo-Israel centre of Excellence for vegetables, Kartarpur Sahib	17.50	18.18
Others	22.50	27.27

The respondent farmers who had accepted the polyhouse technology for vegetable cultivation were also enquired regarding the motivational factors that inspired them to adopt poly house cultivation (Fig.2). Majority of them i.e. about 43 per cent were themselves interested in opting for this method of vegetable cultivation while another one-fourth were lured by the 50% subsidy available. The major scheme is National Horticulture Mission (NHM), which offers 50% subsidy for setting up of protected cultivation structures and also provides 50% subsidy for purchase of planting materials and cultivation of vegetables and flowers under polyhouse/shade net house. In our study, it was observed that a non-land cost of establishment of one acre or 4000 m^2 polyhouse was worked out to be Rs.37.40 lakh. The cost of establishment was to the tune of Rs 1870000/4000^{2}m after availing 50 percent subsidy. The establishment cost was sanctioned by NHM) under the Mission on Integrated Development Horticulture, Government of India through state Horticulture Department. About 18 per cent were following their fellow farmers and rest 15 per cent believed that the technology is more profitable than open cultivation method.

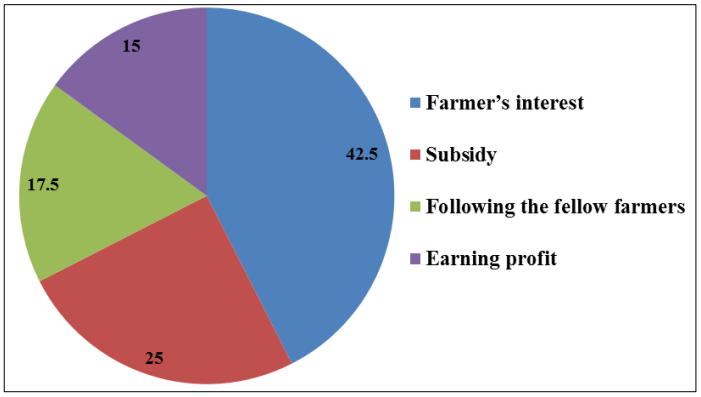

Fig 2: Motivating Factors for adoption of polyhouse cultivation (% adopter farmers)

Impact of adoption of Poly house technology on Return structure of capsicum

Protected cultivation is a capital intensive technique, wherein the microclimate surrounding the plant body is controlled to clinch a higher net return compared to its traditional cultivation. Economic characteristics (profit orientation, agricultural income, technological investment behaviour and farm labour) have the strongest effect on both uptake and intentions to uptake novel technologies. A perusal of return structure for polyhouse cultivation for capsicum (Table 6) reveals in case of adopted polyhouse cultivation of capsicum, gross returns per acre was estimated to be Rs.8.77 lakh where returns over variable cost and net returns were to the tune of Rs.7.14 lakh and Rs.3.36 lakh per acre respectively. On the other hand in case of open field conventional technology, the gross returns per acre was estimated at Rs. 1.79 lakh only. Return over variable cost and net returns came out to be Rs. 1.09 lakh and Rs. 54962.71 per acre, respectively. This was due to higher average yield of 382.71 obtained under polyhouse cultivation than open field cultivation of capsicum (181.33 quintal per acre). Also, sale price received by polyhouse farmers was higher (Rs.22.91 per kg) than that of open field farmers (Rs.9.87 per kg).The input-output ratio worked out to be 1.62 and 1.44 in case of adopter and non-adopters respectively. Though the cost of production per kg of capsicum was estimated to be much higher (Rs.14.14) in case of polyhouse cultivation as compared to open field cultivation method (Rs.6.83). The difference of per kg profit margin over the open field conditions was estimated by Rs. 5.73 (188.48%). Hence, it can be concluded that yield of capsicum and income of farmers can be increased many folds by adoption of polyhouse technology.

Table 6: Impact of adoption of new Polyhouse vegetable cultivation technology on returns obtained by farmers

Particulars	Unit	Adopters (1)	Non-adopters (2)	Difference (1-2)	Percent difference
Yield	q/acre	382.71	181.33	201.38	111.05
Sale price	Rs/kg	22.91	9.87	13.04	132.11
Gross returns	Rs/acre	876788.61	178972.71	697815.90	389.90
Variable cost	Rs/acre	162693.00	69522.00	93171.00	134.01
Returns over variable cost	Rs/acre	714095.61	109450.71	604644.90	552.43
Total cost	Rs/acre	541243.00	124010.00	417233.00	336.45
Net returns	Rs/acre	335545.61	54962.71	280582.90	510.49
Input-output ratio	-	1.62	1.44	0.18	12.50
Cost of production	Rs/kg	14.14	6.83	7.31	107.02
Profit margin	Rs/kg	8.77	3.04	5.73	188.48

Economic viability of new adopted technology under subsidized polyhouse conditions

Economic viability of capsicum cultivation under subsidized polyhouse conditions was also evaluated. A non-land capital investment of Rs. 37, 40, 000 per 4000 m^2 was required for erecting polyhouse. On an average, the sampled Farmers availed 50 per cent subsidy sanctioned by the NHM on the total establishment cost through the State Horticultural Department and it amounted to Rs.18, 70,000 per 4000 m^2.

Under subsidized conditions, the payback period (PBP) for polyhouse production of capsicumwas found to be 2.1 years. The net present value (NPV) at 10 per cent discount rate was Rs.17, 61, 915.66 with benefit cost ratio (BCR) of 1.3 for capsicum crop. Internal rate of return (IRR) in polyhouse production of capsicum was found 24 percent. Therefore, production of capsicum under subsidized polyhouse conditions was found highly feasible and profitable (Fig 3). On the other hand, under non-subsidized conditions, the payback period (PBP) for polyhouse production of capsicum, was found to be 4.2 years. The net present value (NPV) at 10 per cent discount rate was Rs. -36, 76,015.60, with benefit cost ratio (BCR) of 0.98 for capsicum. Internal rate of return (IRR) in polyhouse production of capsicum was found 10 percent which was just equal to cost of capital. Therefore, production of capsicum under non-subsidized polyhouse conditions was not found profitable.

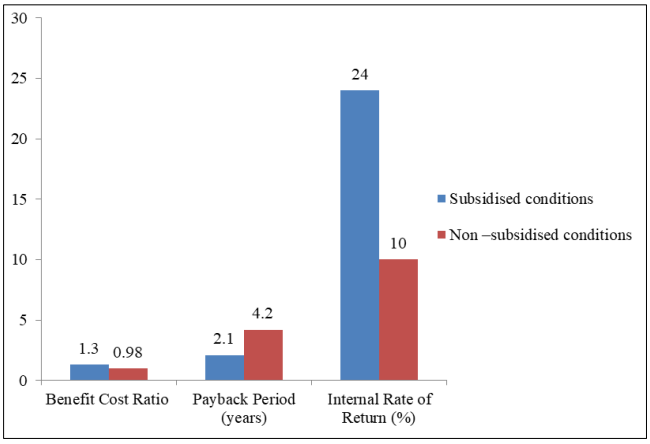

Fig 3: Economic viability of new vegetable cultivation technology under subsidized /Non–subsidized polyhouse conditions

Constraints in the adoption of new technology of protected/polyhouse cultivation

The protected cultivators expressed a number of constraints which needs the attention of the policymakers and implementing agencies. A perusal of Table 7 shows that the adopters of polyhouse technology for vegetables were facing many constraints in its acceptance.

Economic constraints

The major economic problem faced by them was related to the huge investment on the polyhouse structure. About 80 percent respondents faced this problem as the initial cost required to establish a polyhouse is very high and is beyond the reach of small and medium farmers. In our study, the non-land cost of establishment of one acre or 4000^{2}m polyhouse was worked out to be Rs.37.40 lakh. The cost of establishment was to the tune of Rs 1870000/4000^{2}m after availing 50 percent subsidy. Among the different cost components, maximum cost was accounted for structure and sheet (83.49%) of which 57.49 per cent was incurred on G.I pipes, followed by labour (13.16%) and rest of 12.84 per cent on polythene sheet. The next higher component of cost was misting (5.31 per cent) followed by irrigation and fertigation system (4.60 per cent), shade net (4.60 per cent) and miscellaneous (1.98 per cent). About 55 per cent felt the seed cost to be very high. Half of them complained of high maintenance cost while 40 per cent felt the need of minimum support price for the vegetable crop. One-fourth were not much aware about the credit and subsidy facilities and about 23 per cent had poor access to the subsidy available. The poor accessibility to subsidy and absence of pricing policy including crop insurance has further increased the risk of polyhouse cultivation. The farmers expressed that it took minimum of eight months after application, to avail loan facilities from financial institutions and commercial banks.

Technical constraints

Production of crops under polyhouse conditions is highly knowledge and skill intensive. The major technical problem faced by adopters included lack of technical guidance (65 %). Moreover, farmers find it difficult to get the latest information and techniques of crop production under polyhouses, especially in their regional languages (37.5%). Availability of quality planting material at reasonable prices is a challenge. About 40 per cent felt non-availability of quality polyhouse equipments at local market and another 25 per cent even faced non-availability of required quantity and quality planting material at right time. The fact that planting material is supplied only by few private players has resulted into farmers being completely dependent on them. Availability of quality seed and planting material of required cultivar is a severe constraint faced by farmers on account of increased dependence on formal sector especially private seed companies (Manjunatha *et al.* 2015) [7]. Farmers of Punjab are still in the initial phase of polyhouse technology adoption wherein availability of quality planting material and inputs are important issues.

Labour related constraints

Polyhouse cultivation is labour intensive and demands skilled labour throughout the year. Timely availability of skilled labour is a critical issue for Punjab farmers. Migration of rural folk to urban areas in search of better jobs, alternative employment opportunities at the village level (including MNREGA scheme) and indifferent attitude of youth towards agriculture has led to acute shortage of skilled labour especially in the peak seasons of planting/ sowing and harvesting. This has naturally raised the wage rates of skilled labour required for polyhouse cultivation. In our study about 594.31 human labour hours were utilized in various operations for production of capsicum under polyhouse conditions compared to 399.92 human labour hours in case of open field conditions indicating that polyhouse vegetable cultivation is labour intensive. Further, maximum labour hours were utilized on harvesting and transportation and least labour hours were used on nursery raising and transplantation in both the conditions. About half of the adopters faced problem of non-availability of skilled labour followed by 47 per cent facing high labour cost and another abot 18 per cent feeling scarcity of labour during peak season. At the initial stage of cultivation in poly house, occurrence of pest and diseases inside the polyhouse exceed when compared to open cultivation because of favourable climatic conditions (high moisture and humidity) inside the polyhouse. Due to constant weather fluctuations (heavy rains & storms), polythene sheet was prone to damaged and this problem was reported by 25 per cent respondents. Infestation of nematodes was also faced by 15 per cent farmers. About one-fourth of the adopters faced this problem. Farmers of Punjab also reported loss in production because of physiological disorders like heavy rains and storms. Paroda (2013) [8] reported that among the major constraints in production of horticultural crops in India are temperature (hot or cold), sunlight duration and quality, water deficiencies or excesses, atmospheric moisture (relative humidity), weeds, deficiency of nutrients, heavy winds, carbon dioxide and host of diseases and insect pests.

Table 7: Constraints in the adoption of new protected cultivation technology in vegetables

Sr no.	Particulars	Adopter farmers	
		Number	Percent
	Economic constraints		
1.	High investment cost	32	80.00
2.	High cost of seed	22	55.00
3.	High cost of maintenance	20	50.00
4.	Lack of minimum support price	16	40.00
5.	Lack of awareness about credit and subsidy facilities	10	25.00
6.	Poor accessibility to subsidy	9	22.50
	Technological constraints		
1.	Lack of relevant literature in local language	15	37.50
2.	Lack of technical guidance about production techniques	26	65.00
3.	Non-availability of required quantity and quality planting material at right time	10	25.00
4.	Non-availability of quality polyhouse equipments at local market	16	40.00
	Labour constraints		
1.	Non-availability of skilled labour	20	50.00
2.	High cost of hired labour	19	47.00
3.	Scarcity of labour during peak season	7	17.50
	Environmental constraints		
1.	Pests and diseases	10	25.00
2.	Prone to damage by heavy rains & storms	10	25.00
3.	Infestation of nematode	6	15.00
	Marketing		
1.	High fluctuations in market price	15	37.50
2.	Lack of marketing facilities at local place (block/district headquarters)	10	25.00
3.	Heavy marketing losses during transportation	5	12.50

Indian farmer is a price taker and not a price fixer. It is more so in crops where price policy is completely absent as in case of flowers and vegetables. Hence, unfavorable market prices may cause huge financial losses. The deficiencies in the infrastructure such as poor grading and transport facilities and cold chain management combined with market malpractices add to the risk component of farmers in India. The markets for polyhouse products are generally exclusive and far. The farmers felt lack of marketing facilities at their local place (25%) and so they had to incur very high expenditure on transportation costs. about 13 per cent also faced losses during transportation of perishable capsicum crop. About 38 per cent faced the problem of high fluctuations in market price also.

Conclusions and Suggestions

- It can be concluded that cultivation of capsicum under polyhouse conditions yields higher returns and better quality produce than for the non-adopters. Therefore continuous efforts by the Government Officials through regular awareness camps and training courses should be organised to train the farmers for successful cultivation of vegetable crops under protected structures and adoption of these technologies at large scale.
- Economic characteristics (profit orientation, agricultural income, technological investment behaviour and farm labour) have the strongest effect on both uptake and intentions to uptake novel technologies. The results of financial viability of capsicum crops grown under polyhouse showed the technology to be economically feasible under subsidised conditions stressing the need for efforts to reduce the cost of establishment of polyhouse. There should be a government support by increasing the amount of subsidy in Punjab as other states *viz* Haryana and Himachal Pradesh government offer a higher rate of subsidy (about 75%). Thus, it is suggested that the government support in the form of capital subsidy need to be strengthened further to enhance rate of adoption of protected cultivation.
- Cultivation of vegetables under polyhouse cover technique seems to be a remunerative proposition for the resource poor farmers also. Therefore, steps need to be taken to promote off-season vegetable cultivation under polyhouse so that the excess labour force can be optimally utilized in agriculture at large.
- The priorities of marketing agencies revolve around improving the accessibility of technologies and inputs to farmers and need for establishment of marketing infrastructure by Government. Thus, investment in developing infrastructure must be made to spur adoption of polyhouse technology.
- As a profession, agriculture is not attractive for the educated youth, which is partly due to the drudgeries associated with field work. To motivate the educated youth agriculture has to be developed to be a remunerative and drudgery-less industry as competitive as any other industry using agro-technologies like polyhouse.
- The results for adoption of technology by women reflects an optimistic assumption that removing constraints to access or use the protected cultivation technology can help women to empower themselves.
- Formation of Farmer Producers' Organizations should be encouraged so that the hurdles in post-harvest management and marketing are reduced to the minimum for the vegetable producers especially the marginal and small farmers.

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