Indian Research Journal of Extension Education

RESEARCH ARTICLE

Status of Polyhouse Technology and Discontinuance Reasons for Vegetable Cultivation in Punjab: A Comprehensive Analysis

Nisha Rani[1], Devinder Tiwari[2] and Karamjit Sharma[3]

1.MSc Scholar, 2.Ext. Scientist, Dept. of Ext. Edu., 3. Prof., Ext. Edu., KVK Shri Muktsar Sahib, PAU, Ludhiana, Punjab

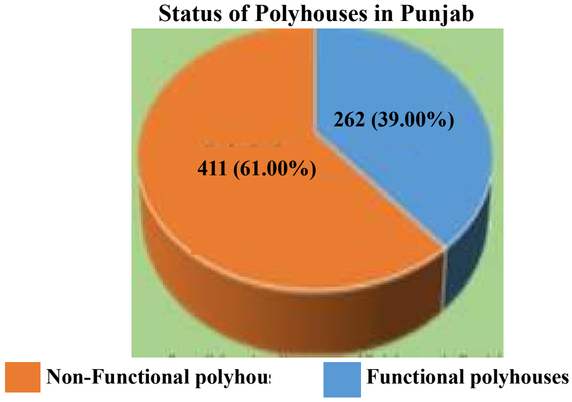
Corresponding author's e-mail: nishamoyal[2]@gmail.com

HIGHLIGHTS

- Need for region-specific interventions and support measures.
- The importance of addressing financial barriers to encourage wider adoption, particularly among small and marginal farmers.
- Provides specific yield data for these crops, emphasizing the potential economic benefits associated with polyhouse cultivation of selected vegetables.

GRAPHICAL ABSTRACT

Status of Polyhouses in Punjab



ARTICLE INFO

Editor:
Dr. V.P.S. Yadav

Key words:
Polyhouse, Vegetable cultivation, Functionality status, Discontinuance.

Received : 03.03.2024
Accepted : 08.05.2024
Online published : 01.07.2024

doi: 10.54986/irjee/2024/jul_sep/104-110

IRJEE METRICS

Google citations	- 8695
h-index	- 43
i10-index	- 291
NAAS rating	- 4.99

ABSTRACT

Introduction: In Punjab, vegetables cover 2.73 lakh hectares, contributing 55.59 lakh metric tonnes. However, cultivable land is diminishing due to industrialization and urbanization, while the population continues to grow.

Context: The study serves as a crucial guide for informed decision-making, offering insights that can shape policies supporting the future of protected cultivation in agriculture and benefiting both farmers and the nation's food security.

Method: A comprehensive analysis" investigated six districts with the highest concentration of polyhouses. A total of 60 adopters were randomly selected from these districts. Out of the 673 polyhouses in the state, Ludhiana, Hoshiarpur, Patiala, Bathinda, Sangrur and Jalandhar districts had the maximum number of polyhouses. Moga and Fazilka reported the highest functional polyhouses, while Mansa and Shri Muktsar Sahib had all polyhouses non-functional., Statewide, 61 per cent of polyhouses were non-functional., Cucumber, capsicum, and tomato were identified as the most suitable crops under polyhouses, providing significantly better yields.

Results and Discussion: A majority discontinued the technology due to structural damage, inferior material quality, and the belief that the technology was unsuitable for Punjab conditions.

Significance: This study on polyhouse technology adoption in Punjab holds paramount significance as it unravels the intricate dynamics influencing its success and discontinuance. In a state pivotal to India's vegetable production, understanding the challenges faced by polyhouse adopters provides crucial insights for policymakers.

India ranks as the world's second-largest vegetable producer, following China, utilizing approximately 10.35 million hectares for vegetable cultivation, yielding an annual production of 191.77 million metric tonnes (Anonymous, 2019) growing a wide range of vegetables round the year even at household level provide self-reliant in round year vegetable production (Noopur *et al*., 2021). These vegetables not only provide food and nutritional security but improve quality of life by providing eco-system services. Year-round production of vegetables provides income and employment also (Noorpur *et al.,* 2023a). In Punjab, vegetables cover 2.73 lakh hectares, contributing 55.59 lakh metric tonnes (Anonymous, 2019). Vegetable crops, valued for their short duration, high yield potential, and nutritional richness, play a pivotal role in Indian agriculture, contributing between 59-61 per cent to horticulture (Kaur, 2020a). Increasing awareness of healthy food and changing dietary habits has raised the per capita requirement for vegetables. However, cultivable land is diminishing due to industrialization and urbanization, while the population continues to grow. The per capita daily availability of vegetables in India is 390 g/person/day which is above than FAO-recommended 300g (Noopur *et al.,* 2023b) indicated that vegetables now can be grown for income and livelihood security. Cultivation under poly-house is an alternative technique which reduces dependency on rainfall, increases the optimum use of land and enhances the efficiency of soil, water and nutrients required for the production of vegetable crops (Ghanghas *et. al.* 2018 and Chikkeri *et al*, 2023). Plasticulture cum protected cultivation is rapidly emerging as a highly promising field, offering vertical expansion, controlled environmental conditions (Chamuah *et al*., 2024), besides other benefits such as enhanced productivity, improved quality, increased income, and opportunities for entrepreneurship. The expansion of area coverage under these protective technologies is particularly impressive, indicating considerable progress in this sector (Singh *et al*., 2017). These structures create microclimates conducive to plant growth, enabling off-season cultivation of crops like tomatoes, cucumbers, and capsicums when open-field conditions are unsuitable. Protected cultivation technology, including polyhouse cultivation, gained attraction in India in the early nineties, with the Indo-Israel initiative on greenhouse cultivation in 1998 marking a significant step (Anonymous, 2015). The government provides subsidies for polyhouse adoption, ranging from 42 to 44 per cent of the total establishment cost (Parkash *et.al.* 2020). The upper ceiling limit of subsidy varies, generally ranging between 20 to 50 per cent of of the cost of erecting the polyhouse (Prabhakar *et. al.,* 2016). Despite these subsidies, the high initial investment remains a significant financial challenge for farmers (Hena, 2018). Despite government subsidies, the adoption of polyhouse technology remains a costly affair, posing challenges, particularly for small and marginal farmers. Factors influencing discontinuance include structural damage, pest problems, short poly-sheet life, high input costs, inadequate farmer training, market fluctuations, maintenance challenges, and dependency on external support schemes (Ghanghas, 2019). While success stories exist, a mixed response to polyhouse cultivation prevails, necessitating a nuanced understanding of its feasibility. In Punjab, a dearth of publicly available data prompted the current investigation, aiming to study its adoption and discontinuance comprehensively.

METHODOLOGY

The study concentrated on six key districts in Punjab—Ludhiana, Jalandhar, Bathinda, Sangrur, Hoshiarpur, and Patiala—recognized for a notable presence of polyhouses. Employing a random selection process, 10 polyhouse technology adopters were chosen from each district, resulting in a total sample size of 60 respondents. Data collection involved both primary and secondary sources. The initial list of polyhouses, comprising farmers name, addresses, and contact numbers, was obtained from the Department

Location of study area Punjab of India

of Horticulture, Punjab. To evaluate the functionality of each polyhouse, farmers were reached through various means, such as telephonic interviews, personal visits, and information was also gathered from Department of Horticulture, Krishi Vigyan Kendras (KVKs), the Centre of Excellence for Vegetables in Kartarpur, Punjab. Ethical considerations were strictly adhered during the data collection process, ensuring participants' informed consent, confidentiality, and the protection of sensitive information. The findings were presented succinctly in tables and figures, facilitating a comprehensive understanding of the status and challenges associated with polyhouse technology adoption in Punjab.

The data was analysed using frequency, percent, mean, standard error. Economic analysis of vegetable cultivation under polyhouse, garret ranking of problems for non-functionality of polyhouses was also conducted.

Economic analysis : For economic analysis average cost of cash inputs (ACC) was estimated as a sum of expenditure incurred for the purchase of cash inputs (Rs. ha-1) like seed, fertilizers, insecticides, fungicides herbicides etc. and labour cost for different field o

$$Av. cost\ of\ cash\ inputs\ (Rs.ha^{-1}) = \sum_{n=1}^{\infty}(C_{n1,2,3,4,5})$$

Where, C1,2,3….., represents cost for different inputs and labour cost.

$$Av. gross\ retunrs\ (Rs.ha^{-1}) = Av. yield \times Av. selling\ pri$$

Average gross returns were estimated as a product of grain yield (kg m^2) under polyhouse for different crops (cucumber, tomato and capsicum) and average selling price (ASP) in Rs. kg^{-1} as reported by farmers and were calculated according to eq. 2.

Average net returns were estimated as a difference in average gross return (AGR) and average cost of cash inputs (ACC), according to eq. 3.

$$Av, net\ retunrs\ (Rs.ha^{-1}) = AGR - ACC$$

Garret ranking : Garret ranking was performed to rank the reasons for non-functionality of polyhouse in Punjab using eq.4.

$$Percent\ posistion = \frac{100\ (Rij - 0.5)}{Nj}$$

Where,

Rij = Rank given for the i^{th} variable by j^{th} respondents

Nj = Number of variable ranked by j^{th} respondents

With the help of Garrett's Table, the percent position estimated is converted into scores. Then for each factor, the scores of each individual are added and then total value of scores and mean values of score is calculated. The factors having highest mean value is considered to be the most important factor.

Statistical analysis: The statistical analysis of vegetable yield, average cost of cash inputs, average gross and average net returns was carried out by analysis of variance. Mean separation for different treatments was performed using *Duncan's Multiple Range Test* (DMRT) test at p <0.5. Statistical analysis was performed with SPSS for Windows 16.0 (SPSS Inc., Chicago, USA).

RESULTS

Statewide functionality status of Polyhouse technology: The data presented in Table 1 depict the district-wise functionality status of polyhouses

Table 1. Distribution of respondents based on district wise status of polyhouse technology in Punjab

District	Polyhouses (No.)	Functionality status			
		Functional		Non-Functional	
		No.	%	No.	%
Mansa	12	0	0.0	12	100.0
Shri Muktsar Sahib	3	0	0.0	3	100.0
Ferozepur	24	3	12.5	21	87.5
Pathankot	15	2	13.3	13	86.7
Barnala	15	2	13.3	13	86.7
SBS Nagar	21	4	19.0	17	81.0
Fatehgarh Sahib	24	5	20.8	19	79.2
Tarn Taran	4	1	25.0	3	75.0
Jalandhar	36	10	27.8	26	72.2
Hoshiarpur	88	27	30.7	61	69.3
Gurdaspur	15	5	33.3	10	66.7
Kapurthala	6	2	33.3	4	66.7
Faridkot	6	2	33.3	4	66.7
Bathinda	57	23	40.4	34	59.6
Patiala	63	26	41.3	37	58.7
Rupnagar	18	8	44.4	10	55.6
Ludhiana	148	66	44.6	82	55.4
Amritsar	24	13	54.2	11	45.8
SAS Nagar, Mohali	19	11	57.9	8	42.1
Sangrur	49	31	63.3	18	36.7
Fazilka	14	11	78.6	3	21.4
Moga	12	10	83.3	2	16.7
Total	673	262	38.9	411	61.1

in terms of both number and area in Punjab. The results highlighted that majority of polyhouses were functional in Moga (83.3%), Fazilka (78.6%) and Sangrur (63.3%) districts which was followed by SAS Nagar and Amritsar district where 57.9 and 54.2 per cent polyhouses were functional. Conversely, in Mansa and Shri Muktsar Sahib districts all the installed polyhouses were non-functional.

In SBS Nagar, Barnala, Pathankot and Ferozepur 81 to ~88 per cent polyhouses were non-functional. In Jalandhar, Tarn Taran and Fatehgarh Sahib 72.2 per cent, 75 per cent and 79.2 per cent, polyhouses were non-functional, respectively. On a statewide scale, out of the total 673 polyhouses installed during last few years, a total of 410 (~61%) of the polyhouses had become non-functional due to various reasons.

Proportion of respondents continuing with the technology, area covered and type of vegetable crops grown under polyhouses in Punjab: Out of the total 60 adopters, only 42 farmers (70%) were continuing with the technology, while the remaining 18 (30%) had dismantled polyhouse structures (Tables 2&4). The distribution of the respondents according to the size of the polyhouse revealed that the majority of the respondents (59.5%) had an area between 0.25-0.4 ha under polyhouse, followed by 35.7 per cent of farmers with an area of less than 0.25 ha, and only about 4.76 per cent of the respondents had an area of more than 0.4 ha.

Table 2. Distribution of respondents according to area and types of vegetables grown under polyhouse in Punjab (N=42)

Area under polyhouse technology (ha)	No.	%
0.25	15	35.71
0.25-0.4	25	59.52
>0.4	2	4.76
Type of vegetable grown under the technology		
Cucumber	24	57.14
Capsicum	10	23.81
Tomato	8	19.05

The vegetable crops like cucumber, capsicum, and tomato were mainly grown under the polyhouse structures. Table 2 illustrates that a majority of polyhouse respondents (59.52%) were involved in cucumber cultivation, followed by 23.81 per cent in capsicum, and 19.05 per cent in tomato cultivation. Thes findings are in line with Rani *et al.*, (2022) who identified that the best crops to produce in polyhouses were tomatoes, capsicums, and cucumbers (Rank 1).

Table 3. Comparative yield and economics of selected vegetables under polyhouse technology in Punjab

Parameter	Cucumber (n=24)	Tomato (n=8)	Capsicum (n=11)
Yield (q ha^{-1})	866.8±171.2	905.8±128.0	621.3±214.5
ASP (Rs. kg^{-1})	22.5±8.03	19.5±9.15	24.5±10.5
ACC (Lakh Rs. ha^{-1})	6.9±0.8^{a}	8.0±1.1^{b}	7.9±0.9^{b}
AGR (Lakh Rs. ha^{-1})	19.5±3.9^{a}	17.7±8.5^{b}	15.2±1.9^{c}
ANR (Lakh Rs. ha^{-1})	12.6±5.9^{a}	9.6±1.5^{b}	7.3±1.3^{c}
B:C Ratio	2.84	2.20	1.93
Profitability (Rank)	I	II	III

ACC-Average cost of cash inputs; ASP-Average selling price; AGR-Average gross return;
# denotes S.E. from mean; Mean values followed by the different letters shown as superscript (i.e. a, b. c) are statistically significant at $p < 0.05$ based on DMRT.

However, a small proportion of farmers were practicing combined cultivation, including cucumber-capsicum, tomato-capsicum, and tomato-cucumber under these polyhouse structures.

Meena *et al.,* (2009) also found that the majority (58.25%) of the farmers covering the highest area (0.6-2.5 ha) during rabi season and under irrigated conditions, brinjal, cauliflower/cabbage, spinach, fenugreek (leaves), coriander (leaves), carrot, radish, pea, green onion, etc were grown under the protected structures.

Comparative yield, economics and suitability of different vegetables grown under polyhouse in Punjab: The data (Table 3) indicate that for tomatoes, respondents achieved a average yield of 0.91±0.13 kg m^2, followed by cucumber (0.87 ± 0.17 kg m^{-2}) and capsicum (0.62 ± 0.21 kg m^{-2}). These trends align with findings reported by Kaur (2020b), Jain *et al*., (2021), and Kaur and Ranguwal (2021). Mishra *et al*., (2009) also reported that front line demonstration findings showed that due to better nutritional interventions and insect pest control under protected cultivation, polyhouse structures could raise the vegetable yields by 13.5 to 19.0 percent.

The average selling price (ASP) was maximum for capsicum i.e. Rs. 24.5±10.5 kg^{-1} followed cucumber (Rs. 22.5±8.03 Rs. kg^{-1}) and least for tomato (Rs. 19.5±9.15 Rs. kg^{-1}). The ACC under polyhouse for cucumber, capsicum and tomato was Lakh Rs. 6.9±0.8, 8.0±1.1 and 7.9±0.9 ha^{-1}, respectively.

The AGR were highest for cucumber i.e Lakh Rs. 19.5±3.9 ha^{-1} followed 17.6±8.5 for tomato and Lakh Rs. 15.2±1.9 ha^{-1} for capsicum, while ANR was highest for cucumber Lakh Rs. 12.6±5.9 ha^{1} followed

Table 4. Distribution of the respondents according to the reasons for discontinuance of polyhouse technology (N=18)

Reasons	No.	%	Rank
Inferior quality structural material	14	77.8	3
Damage to the structure by windstorms, hail storms etc	17	94.4	1
High cost of repair and maintenance	10	55.6	6
Poor post installation service	12	66.7	5
Unsuitability due to high temperature in summer	13	72.2	4
High costs of inputs	8	44.4	7
Lack of subsidy	6	33.3	9
Nematode problem	5	27.8	10
Insect –pest and disease	3	16.6	12
Competition from open vegetable growers	7	38.9	8
Lack of proper knowledge	4	22.2	11
Lack of family support	2	11.1	13
Lack of skilled labour	2	11.1	14
Lack of better market price	16	88.9	2

*Multiple responses

by tomato (Lakh Rs. 9.6±1.5 ha^{-1}) and capsicum (Lakh Rs. 7.3±1.3 ha^{-1}). The B:C for cucumber, tomato and capsicum was 2.84, 2.20 and 1.93, respectively and profitability rank was 1st for cucumber, 2nd for tomato and 3rd for capsicum. Samantaray *et al.,* (2009) revealed that to encourage farmers to produce vegetables, it is necessary to set up training programs and properly demonstrate new technology.

Reasons for non-functionality of polyhouses: The significant amount is spent for installation of polyhouse structures, still large number of farmers discontinued polyhouse cultivation (Table 4). Therefore, it was pertinent to know the reason for non-functionality of large number of polyhouses in Punjab especially when adopter of polyhouse technology was earning significant profits by continuing vegetable cultivation under these protected structures. The secondary as well as primary data collected for studying the reasons for non-functionality of polyhouses revealed that majority of the farmers (94.4%) discontinued polyhouse technology due to the damage of structure by windstorms and hailstorms followed by lack of better prices for the vegetables in the market (88.9%) and inferior quality of structural material (77.8%). Nearly 72 per cent of the respondent reported that this technology was unsuitable for Punjab conditions. More than 66.7 per cent of the respondents reported that post installation services provided by the agencies involved in setting up polyhouses was very poor and they were not keeping their promises regarding the quality of structural material. Non-provision of any subsidy for the repair and maintenance during the post installation was also reason for discontinuance as expressed by nearly 1/3rd of the respondents. The other reasons for the discontinuance of this technology were high input costs (44.4%), less market price due to glut in market from vegetables produced under open field conditions (38.9%), 27.8 percent farmers dismantled their structures due to problems of nematode and other insect-pests attack (16.7%). Nain and Bhagat (2005) also found that the non-availability of quality inputs like plant protection chemicals, seeds, fertilizers and local political taboo are some of the reasons for the low adoption of the technology. Rajasree *et al,* (2019) also showed that the degree of use of eco-friendly technology in vegetable farming was significantly correlated with the use of mass media, exposure to scientific orientation training and for cosmopolitan.

Similarly, lack of technical knowledge (22.2%), lack of family support (11.1%) and lack of skilled manpower (11.1%) were also important reasons for non-functionality of polyhouses. Similarly, Ghanghas (2019) found that lack of better price for vegetable crops and high maintenance cost of cladding material that damage by windstorms and hailstorms were the major reasons of the discontinuance of this technology. Das and Rehman (2018) found that negative and significant association between the caste, land type and discontinuation of innovative agricultural technology. The garret ranking reveals that damage to polyhouses was the most important reason for non-functionality of polyhouses followed by lack of better market prices and inferior quality of structural material.

DISCUSSION

The comprehensive analysis of polyhouse technology adoption and discontinuance in Punjab sheds light on vital aspects. The study identifies key challenges, notably structural damage, material quality concerns, and perceived unsuitability for local conditions, leading to a substantial 61 per cent statewide non-functionality of polyhouses. Moga and Fazilka districts demonstrated robust performance, while Mansa and Shri Muktsar Sahib experienced complete non-functionality. Cucumber, capsicum, and tomato emerged as suitable crops, providing enhanced yields. The study emphasizes the high reliance on loans for adoption, with banks being the primary source. Samantaray *et al,* (2009) revealed that to encourage farmers to produce vegetables, it is necessary to set up training programs, properly demonstrate new technology, and introduce post-harvest technologies through well-structured training programmes with token charges as some of the farmers are willing to pay for the training as well as extension services (Singh *et al*., 2011).

Noteworthy is the nuanced understanding of farmers' perspectives, including dissatisfaction with material quality, unfavorable market prices, and climatic concerns. The findings present a mosaic of factors contributing to discontinuance, encompassing issues with installing agencies, lack of post-installation maintenance subsidies, high input costs, and competition from open-field growers. Nain and Bhagat (2005) also found that the non-availability of quality inputs like plant protection chemicals, seeds, fertilizers and local political taboo are some of the reasons for the low adoption of the technology. Rajasree *et al,* (2019) also showed that the degree of use of eco-friendly technology in vegetable farming was significantly correlated with the use of mass media, exposure to scientific orientation training and for cosmopolitan.

The importance of the study was polyhouse technology in addressing challenges of cultivable land diminishment, offering a solution for off-season cultivation. Policymakers can leverage these insights to refine subsidy structures, provide targeted training programs, and enhance infrastructure support to promote sustainable polyhouse adoption in Punjab's dynamic agricultural landscape. Singh and Singh (2014) also confirmed that the majority of farmers who attended training in commercial vegetable cultivation perceived that knowledge and skills were enhanced as a result of training.

CONCLUSION

The study highlighted the significance of polyhouse technology in Punjab for vegetable cultivation, revealing its potential benefits and challenges. Structural damage from adverse weather conditions, material quality concerns, and perceived unsuitability for local conditions were key reasons for discontinuance. Policymakers can use these insights to enhance support and promote sustainable adoption.

Funding: There was no funding support for conducting this research.

Declaration of competing interest: Authors have no competing interests.

Data availability: Data would be made available on request

Acknowledgment: It’s wonderful to acknowledge the valuable contributions of the farming community, officials and collective organizations in the research areas.

Appendix: Supplementary data : The supplementary data, table, graph in jpeg format for online visibility to the readers are submitted as an appendix.

Author’s contribution: The first author conceptualized operationalized, collected, collated, analyzed the data and interpreted the data and contributing to text and the content of the manuscript. The second and third author participated in conceptualized, operationalized, contributing to text and the content of the manuscript, including revisions and edits.

REFERENCES

Anonymous, (2015). Subsidy Assistance. Retrieved from https://www.pioneeragritech.com/ subsidyassistance.php on 8 October 2021.

Anonymous, (2019). Indian Horticulture Database 2019. National Horticulture Board, Government of India.

Chamuah, S.; Kiran; Divyasharee, N.; Amin, M.A.; Sultana, N.; Hansda, N.N.; Harish, B.M. and Noopur, K. (2004).Protected vegetable crop production for long-term sustainable food security. *Sci. Res and Rep*, **30**(5):660-669.

Chikkeri, S.S.; Kranti, K.V.V.S.; Salalia, R.; Kumar, S.; Samnorta, R.K.; Noopur, K.; and Diksha, L. (2023). Emerging nematode problem in protected cultivation in Jammu. *Ind. J. Hill Farming*, **36** (1):72-74.

Das, G. and Rahman, F. H. (2018). Adoption and discontinuation of innovative agricultural technology by the farmers of NICRA village in Cooch Behar district. *Indian Res. J. Ext. Edu.,* **18**(3): 6-10

Ghanghas, B.S. (2019). Reasons for discontinuation of polyhouse cultivation by farmers in Haryana. *J. Comm. Mobil. Sust. Dev.,* **14**:121-126.

Ghanghas, B. S; Malik, J.S. and Yadav, V.P.S. (2018). Sustainable vegetables and flowers production technology (Poly-house): Problems and prospects in Haryana. *Indian Res. J. Ext. Edu.,* **18**: 12-16

Hena, M. (2018). Factors determining the adoption of polyhouse of poly-house farming in thrissur district. *Int J Soc Sci* **6**: 253-56.

Jain, S; Suwalka, C. and Shekhawat, P. S. (2021). Comparative analysis of economics of crop cultivation under the polyhouse and open field condition in Rajasthan. *Indian J. Eco. Dev.,***17**:479-83.

Kaur, H. (2020a). Contribution of vegetable crops to horticulture in India: A review. *Int. J. Agri., Envir. and Biotech.,* **13**(3):491-500.

Kaur, S. and Ranguwal, R. (2021). Economic viability and constraints in polyhouse cultivation: A case study of Punjab, India. *Int. J. of Agri. Sci.* **13**(3): 16647-16650.

Kaur. (2020b). Protected cultivation of vegetables in Punjab-An economics analysis. M.Sc. Thesis, Punjab Agricultural University, Ludhiana, India.

Meena, S.R.; More, T.A.; Singh, D. and Singh I.S. (2009). Arid vegetable production potential and income generation. *Indian Res. J. Ext. Edu.,* **9** (2): 72-75

Mishra, D.K.; Paliwal, D.K.; Tailor, R.S. and Deshwal, A.K. (2009). Impact of frontline demonstrations on yield enhancement of potato. *Indian Res. J. Ext. Edu.,* **9** (3): 26-28

Nain, M.S. and Bhagat, G.R. (2005). Farmers training on Trench vegetable production technology vis-a-vis knowledge and adoption level in Trans- Himalayan region. *Indian Res. J. Ext. Edu.,* **5** (2&3): 54-56

Nair, M. and Barche, S. (2014). Protected cultivation of vegetables: A review. *Int. J. of Adv. Biol. Res.,* **4** (1): 55-65.

Noopur, K.; Ansari, M.A. and Panwar, A.S. (2021). Self-reliant in year round vegetable production and consumption through Kitchen garden model in Indo Gangetic Plains: *Ind. J. Agri. Sci.*, **91**(12): 1773-7.

Noopur, K.; Chauhan J. K.; Kumar, L.; Chandegara A.K. and Panwar, S.S. (2023a). Vegetables for food and nutritional security: A review. *Indian Res. J. Ext. Edu.,* **23** (4): 21-27

Noopur, K.; Chauhan, J.K.; Walia, S.S.; Verma, M.R.; Dhar, U.; Choudhary, S. and Chikkeri, S.S. (2023b). Constraints in vegetable production in India: A review. *Indian Res. J. Ext. Edu.,* **23**(3): 14-19.

Prabhakar, I.; Vijayaragavan, K.; Singh, P.; Singh, B.; Janakiram; Manjunatha, B.L; Jaggi, S. and Sekar, I. (2017). Constraints in adoption and strategies to promote poly-house technology farmers: A multi-stakeholder and multi-dimensional study. *Indian J. Agri. Sci.* **87**: 485-90.

Prakash, P; Kumar, P.; Kar. A. and Singh, A.K. (2020). Status and impact of protected cultivation of horticultural crops in Maharashtra. *Indian J. Horti.* **77**: 518-26.

Rajasree, R.; Sharma, F.L. and Upadhyay B. (2019). Association between the characteristics of vegetable growers and level of adoption of eco-friendly technologies in vegetable cultivation. *Indian Res. J. Ext. Edu.,* **19** (4): 86-89

Rani, A.J. (2020). Technological gaps in major vegetable crops and suggestions to sustain the vegetable production. *Agri. Update,* **15**: 45-49.

Rani, N; Tiwari, D. and Singh, G. (2022). Potential of Poly-house Technology for Vegetable Cultivation in the Punjab, India. *Indian Res. J. Ext. Edu.,* **22 (2):** 87-91

Samantaray, S.K.; Prusty, S; and Raj R.K. (2009). Constraints in vegetable production-experiences of tribal vegetable growers. *Indian Res. J. Ext. Edu.,* **9** (3): 32-34

Singh, A.K.; Narayan, S. and Chauhan, J. (2011). Capacity of the farmers to pay for extension services. *Indian Res. J. Ext. Edu.,* **11**(3):60-62.

Singh, A.K.; Sabir, N. and Noopur, K. (2017). Horticulture based plasticulture cum covered cultivation for livelihood security. *Ind. Hort*, **62**(5): 68–74.

Singh, D. K. and Singh, P. (2014). Effectiveness of training programmes under agricultural technology management agency in Bihar. *Indian Res. J. Ext. Edu.,* **14** (1): 93-95.

• • • • •