JUST AGRICULTURE
multidisciplinary e-Newsletter

Protection Cultivation: Need, Status and Challenges

Supyar Bhanwaria[1] and Lalita Vatta[2]
[1]Ph.D. Scholar, University of Rajasthan, Jaipur
[2]Professor, MMV, BHU, Varanasi
Corresponding Author Email- lalitavatta@bhu.ac.in

ARTICLE ID: 110

Abstract

The use of new protected technology for agriculture in terms to enhance production, eminence and production of vegetable crops has to turn out to be much argued in the present scenario. The modern protected technology contains the use of external covered cultivation and development of the effective package of practices for better utilization of sheltered area, water storage pond lining or rainwater harvesting, efficient utilization techniques for stowed water including gravity fed micro-irrigation, pressurized irrigation, farm machinery mechanisms using plastics as a material for dipping weight and improving effectiveness, and intensive fish culture strategies and devices. The present review reveals that maximum farmers use open field cultivation techniques but this technique does not provide appropriate temperature, humidity, and other requirements due to which ultimately land value, water availability, and farmers' income have been decreased. So, protected structures based cultivation (protected cultivation) technology to enhance the crop yield, land fertility, profitability, and sustainability, etc. is the best technology for cultivation as compared to open field cultivation/conditions. The analysis of review showed that gross and net return was significantly higher in protected structure (protective cultivation) as compared to open conditions, as well as the production of vegetables, which was profitable along with its adoption status under the poly house as compared to open field.

Keywords - Adoption, Problems / Constraints of protected structures, Protected cultivation, Technology, Vegetable

Introduction –

Indian farmers are mostly growing cereals, pulses, vegetables, fruits, etc. while using the old tradition of crop cultivation. India is an independent country to meet the food requirement but continuous crop rotation of these cereal crops on the same land has some

JUST AGRICULTURE
multidisciplinary e-Newsletter

drastic effect on soil, environment as well as on the farmers' income. Ultimately land value, soil fertility, water level, and farmer's income has been decreasing. There is an essential need for diversification to improve these problems in agriculture. Diversification through vegetable cultivation is a method to provide a healthy nutritious diet to the population at a cheaper price (Weinberger and Lumpkin 2007). We need to enhance the production and productivity of vegetable crops through modern technology to meet the appropriate quantity of vegetables in the diet. A mature/ adult person should be consuming daily 400 grams of vegetables to live a healthy life (According to WHO, 2020). Need of adopted modern technology like protected cultivation technology because of the increasing population, climate change, decreasing landholdings, increasing pressure on natural resources i.e. land & water, and high demand for quality horticultural fresh produce (vegetables and fruits). This technology is very best mostly preferred in urban and semi-urban areas and major cities it is a fast-growing market for fresh vegetables produce of the in and out of India and help in opportunities of self-employment for unemployed educated youths. Because the unemployed educated youths were not interested or attracted to traditional agriculture(cultivation) technologies was also showing more interest and can be advance motivated for this type of modern agricultural technology (Singh, 2014). Farmer faces several problems in the adoption of new technologies like lack of training facilities at farmer field, difficult to understand and remember all the functions of new technology, non-availability of inputs, old tradition, lack of skill, and high initial cost. To improve productivity by improving the yield potential of crops and to improve the soil fertility status there is a need to change the cropping pattern or adopt new technologies. The protected cultivation technology of vegetable is one of them. Increased vegetable productivity demands intensive extension support and technical know-how on vegetable crops has been decreased under open field conditions but can be improved with the cultivation under protected structures. The only way to improve the production potential of vegetables is that the available technology should be effectively transferred to farmers. There is a strong need to make a package of practices for protected cultivation so that farmers do not face any difficulty. Even the government is subsidizing it through National Horticulture Board in form of various schemes like providing Credit linked back-ended subsidy @ 50 percent of the total project cost limited to Rs 56 lakh per project for

JUST AGRICULTURE
multidisciplinary e-Newsletter

protected cultivation projects (for projects more than 2500 sq.mt. and it is limited to an area of 1000 sqm. and above in the North East States). (According to govt. MAFW, 2020)

1. Scenario of protected cultivation -

Major protected technologies developed recently include protected cultivation using poly houses, low tunnels, and plastic mulching, rainwater harvesting and its conservation for irrigation and other uses, pressurized or gravity irrigation systems to enhance the packaging, water productivity, and transportation of vegetables and fruits, reduce in drudgery/cost/energy required in farm operations and increasing transportability in adverse topographical conditions, improve livestock shelters and feeding system, intensive fish culture devices and animal husbandry.

It is been observed that the area under protected cultivation in India is increasing day by day as the area under protected cultivation in 2012-13 was around 25 thousand hectares while the greenhouse vegetable cultivation area is about 2000 ha. (Sabir and Singh, 2013). Only in Himachal Pradesh (HP) the area under protected cultivation/structures promoted by National Horticulture Mission has been found nearly 1.5 lakh ha. in 2014-15 (Punera et al. 2017) whereas in Haryana total no. of the poly house increases 1,356 to 1,589 (out of which the maximum no. of poly houses was adopted in Sonepat followed by Karnal, Rohtak, and Bhiwani while the minimum number of poly houses found in district Mahendergarh) (Kumar et al. 2018).

At present, only ~50,000 ha are under protected cultivation in India, followed China was 2 million hectares. There is a need to increase 4 times the area (~2,00,000 ha) under protected cultivation in the next 4-5 years. Production under protected cultivation not only providing high water and nutrient use efficiency but it can easily increase productivity and production by 3-5 folds over open/outdoor field cultivation (Government of India Ministry of Agriculture and Farmers Welfare Department of Agriculture, 2020). The total production of vegetables under protected cultivation is 138 million tons at present and to be increased to 250 million tons by the year 2024-2025 which may be achieved through bringing additional area under vegetable crops, using hybrid seeds, use of improved agro-techniques like protected structures (Sindhu and Chatterjee, 2020).

2. Adoption of protective cultivation

JUST AGRICULTURE
multidisciplinary e-Newsletter

Protected cultivation is a very good technology to increase the production, quality, and productivity of vegetable crops. Off-season cultivation of tomato enhances the crop yield, land fertility, profitability, and net income by 48% as compared to outdoor/open field conditions (Schreinemachers, 2016). Gross and net return of production (Kumar, 2018) and adoption (Kaur, 2017) were found significantly higher in protected cultivation as compared to outdoor field conditions. Crop wise production and the income-expenditure ratio is varied in different crops given below-

2.1 Cucumber and tomato production was compared and the result shows that Cucumber gives higher production (38.07 q/400 m2) as compared to tomato (31.17 q/400 m2) and capsicum (21.92q/100 m2). Protected cultivation is having a significant impact in increasing the crop productivity by a minimum of 41.20 percent (beans) and a maximum of 415.16 percent (Cucumber) as compared to the outdoor/open-field conditions (Mehta, 2020). In other research also it was found that cucumber yield is at the higher side as compared to open field conditions (cost of establishment i. e. one lakh and eighty-five thousand Rs per acre and B:C ratio was two folds) (Kumar, 2015)

2.2 Summer vegetables in the winter season were successfully cultivated in the poly house as the temperature inside poly houses remains higher compared to the outside environment. Covered cultivation was having higher market price and increase the fruit yield up to the extent of 25% in many cucurbits namely summer squash, cucumbers, melons, etc respond over open field conditions during the adverse climatic condition. Winter vegetables in summer months found that the percentage of yield increase was maximum for pea (286%) followed by capsicum (70%) and tomato (58.66%). (Sindhu and Chatterjee,2020)

2.3 Capsicum crop gave benefits under protected structures which were significantly higher from open field cultivation (B:C ratio- 1.3:1) due to high yield and the high price of good quality produce (Sreedhara, 2013).

2.4 Offseason nursery production of vegetables was found profitable under the low-cost poly house and there was a net profit of Rs 59,500 from gherkin through nursery production which was significantly higher from open conditions (Yadav, 2014).

JUST AGRICULTURE
multidisciplinary e-Newsletter

2.5 Tomato cultivation under the poly house was found higher with the B:C ratio was 3.73 (B:C ratio – 1.85) (Shende and Meshram, 2015).

2.6 In poly house cultivation, labor, seed, and input cost was higher as compared to open farm but the threefold yield of tomato was obtained from it, and the market price of good quality produce vegetable from the poly house was also high as compared to open field produce (Duhan, 2016).

2.7 In protected structures, the extent of adoption level in chili growers was higher in all vegetable growing practices especially in land preparation, manures and fertilizer, seed treatment, and sowing time (Ramesh and Singh, 2007).

2.8 Capsicum and tomato were economically feasible vegetable crops under the poly house with a B:C ratio of 1.80 in capsicum 1.75 in the case of tomato (Murthey, 2009).

2.9 Study found that the net returns and total returns from capsicum production under protected conditions were Rs1, 15,279 per unit, and Rs 1, 54,734 per unit respectively. Capsicum production under protected conditions was the B:C ratio of 3.92 (Sreedhara, 2013).

3. Economic benefits of protected cultivation -

Greenhouse technology like protected cultivation is economically viable, technologically feasible, and suitable for the Indian geographical conditions and agro-climatic are needed at the earliest to be adopted by Indian farmers (Mishra, 2014). Protected cultivation proved to be an economically viable deal for the farmers whether marginal or small. The result of a study shows that the overall average annual income of protected growers was 2, 51,005, and both category, large and small protected growers annual income was 30% (3, 00,572) and 19% (`2, 10,732) respectively. Overall adoption average income was increased (25%) of the poly house growers. The total annual household income was higher protected growers (5,88,819), as compared to the open-field (4,38,167) (Mehta, 2020). Protected cultivation technology was to the enhancement of production efficiency (3.71 kg/100m2/day) and good return. The total initial investment of 28 greenhouses was INR 360,400 and the annual cost of cultivation and annual returns was INR 56,000 and INR 477,500 respectively (Kumar *et al* 2019).

JUST AGRICULTURE
multidisciplinary e-Newsletter

To get higher profit and disease-free seedlings in offseason and to raise early crop under protected structure for marginal and small farmers (cannot afford the huge cost of the high-tech poly house) the most viable technology was low-cost Poly houses. In low cost protected structure, 2-year total income was earned to the selected area (50 m2) from offseason nursery (various crop) was Rs. 9500/- (1st year) and Rs. 24,000/- (2nd year) (Yadav, 2014).

In Protected cultivation, technology was not only bringing freeways at a high level but also the growers with the small landholdings as the high productivity levels keep hold of economic relevancy to agriculture (Sabir and Singh, 2013).

Protected cultivation technology in terms of productivity (of yield mainly vegetables), employment generation, increase in income, and improving the socioeconomic status of the farmer belongs to both categories (small and marginal) has been implementing and being adopted successfully. Under protected structures (cultivation) total of 223.18 hectare of area cultivated which contributed a significant enhancement in productivity. It was also created 4.95 lac man-days of employment and giving additional income to the farmers and their families (Spehia, 2015).

4. Models and structure of protected cultivation –

The greenhouse (poly house) industry is developing continually new technologies and strategies to reduce related environmental impact, solve specific cultivation limitations, and to adjust with new market requirements. The main reasons for developing technologies were that this industry needs to update the scientific knowledge and climate control cultivation techniques, water and nutrient management, and environmental issues including life cycle assessment and integrated pest management. A great effort of innovation and research has been carried out by industry and researchers to reduce production costs and environmental impact of the most advanced greenhouse technologies while satisfying the requirements of consumers (Fernández, 2018). In protected cultivation use of different protected structures in a various crop like the use of plastic mulch (25 percent more yield than no mulched), crop cover or low tunnels (for early crop and protection from low temperature), walk-in-tunnels (for temperate region off-season Vegetables), naturally ventilated poly houses (tomato, cucumber, flowers), net houses (for a large number of Vegetables and ornamental plant nurseries), environment controlled greenhouses (healthy nursery and foliage plants, vertical farming of lettuce, strawberry, etc.), soil-less farming (hydroponics and aeroponics, e.g.

JUST AGRICULTURE
multidisciplinary e-Newsletter

lettuce and potato seed production, aquaponics for Vegetables), and vegetable grafts are some important technological interventions that need to be scaled-up and adopted more widely.

4.1 Hi-Tech Poly House

Hi-Tech Poly House is the costly structure among all the protected structures because it is based on the latest technology and all operations i.e. fertigation, irrigation, up and downs of plastic walls, temperature control, etc operated through computers. It is also known as a fan & pad poly house. High valued crops are grown in these structures. Due to higher costs, the adoption of these structures is very less but the production under these structures is higher as compared to other protected structures (Nimbrayan *et al*, 2018). The automated production process should be carefully analyzed. Generic technology principles should be developed to make a feasible R and D business case and also for the smaller market size of crops (Henten, 2013).

4.2 Low Tech poly house

Low Tech (cost) Poly house was economical for marginal and small farmers, who cannot afford the huge cost of the high-tech poly house. It was used for raising nursery; the same types of structures are being used to raise crops during winters **(**Yadev *et al*, 2014). An effort was made to develop low-tech (cost) protected cultivation techniques (PCT) affordable to smallholder farmers and to adapt them to climatic conditions. (Nordey, 2017).

4.3 Natural Ventilated Poly House

Tabular, Wooden, and Bamboo are the basic material used for the natural ventilated poly house. Tabular poly house is a mid-range cost structure, it's the cost is less than hi-tech but higher than others. In a tubular poly house, the structure is made up of stainless steel with a plastic wall and roof. Polythene sheet (150 nm thick) used in its construction which prevents the entry of ultraviolet light, conserves CO2, and enhances plant growth and development (Nimbrayan et al, 2018). Temperature and moisture under the poly house are higher than the /outdoor/outside condition, which improves photosynthesis and uniform plant growth (Rawat and Palni , 2000). Bamboo or wooden poly house is similar to a tubular structure but it is made up of bamboo or wooden and life of this structure is small as compared to the tubular structure. In this no specific control device used for regulating the internal environment in the poly house. Natural ventilation poly house is the most essential

JUST AGRICULTURE
multidisciplinary e-Newsletter

tool that growers can use to maintain the greenhouse/poly house microclimate (temperature, humidity, and CO2) within the best range for the crop (Fernández, 2018).

4.4 Shade Net

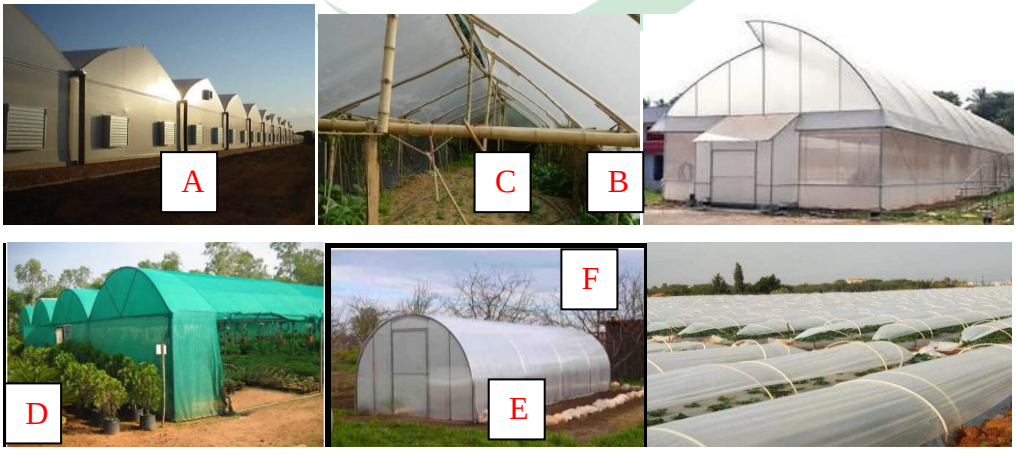
Shade net house is providing development of healthy seedlings for different horticultural crops irrespective of climatic conditions. It is less costly than the above structures and protected crops from harmful Ultra-Violet and some infrared radiation. Along these, it was protected plants from soil moisture; helps maintain air and extreme summer temperatures (Maikhuri *et al.*, 2007). Investment on shade net for capsicum (benefit-cost ratio (BCR) = 1.69: 1) cultivation was found more profitable than tomato (BCR = 1.48: 1) as observed that capsicum crop is more economical than tomato crop under shade net and creates a pathway for continues profitability (Harisha, 2019).

4.5 Walk-in Tunnel

Walk-in tunnel structure covered with Ultra-Violet film, it is suitable for all types of crops, vegetables & flowers, and its lower initial cost structure motivates small farmers to adopt it. This structure temperature (high) is not controlled but the internal climate has differed from the outside. In temperate areas, vegetable growers can increase their income by raising early crops in protected structures mainly in low-cost greenhouses (Sanwal, 2004).

4.6 Plastic Tunnel

A plastic tunnel is a small/miniature structure form of the greenhouse to protect crops from rains, frost, winds, low temperature, hail snow, and other vagaries of weather. The low tunnel are very simple structures easy to constructs and are requiring very limited skills to maintain also offer multiple advantages (Singh, 2008).



JUST AGRICULTURE
multidisciplinary e-Newsletter

Dig. (A) Hi-tech Poly house (B) Low Tech (cost) poly house (C) Natural Ventilated poly house (D) Shade Net (E) Walk in tunnel (F) Plastic tunnel

5. Needs of protected cultivation –

Due to the increasing population, unemployment, climate change, decreasing landholdings, increasing pressure on natural resources (like land and water), and the high demand for fresh vegetables, there is a strong need for modern technology like protected cultivation. This technology is very best especially in semi-urban and urban areas and major cities which are the fast-growing market for fresh vegetable produce of the country and helps in providing opportunities for huge self-employment for unemployed educated youths. The need and importance of protected cultivation is explained below -

1. Production of vegetable crops under protected structure not only provides nutrient efficiency and high water but it can easily increase production & productivity by 3-5 folds over outside/open field conditions for the crops under varied agro-climatic cultivation of the country (Singh, 2014).
2. Increasing population, decreasing natural resources (land, water, etc), and increasing industrialization & urbanization will require high production which is not possible from available resources. Greenhouse cultivation is playing important role in providing high-value crops, ensuring high productivity, improved quality, lucrative return, and continue supply (Parmar, 2020).
3. India is having less productivity of vegetables compared to other leading countries (all) of the world. Open field cultivation of vegetables cause low yield due to various types of biotic and abiotic stresses so necessitate the adoption of new technology which can increase productivity per unit area along with high input use efficiency, one of the helpful technologies is protected cultivation technology as it has the potential of round the year production of vegetables with quality produce. The maximum return on investment can be achieved through protected cultivation of vegetables because it not only produce high-quality yield but also gives higher market price to the growers (Singh, 2019).
4. We have plenty of unemployed educated youths were not interested or attracted in traditional agriculture (cultivation) technology were also showing more interest in

JUST AGRICULTURE
multidisciplinary e-Newsletter

agriculture and who can be advance motivated for these kinds of modern agricultural technologies (Singh, 2014).

5. Protected cultivation is very good and sustainable to meet the demand for fresh vegetables like need fresh vegetables in their diets for better health and nutrition around the towns and cities and the much-needed vegetables are being grown throughout the year in these hostile climates under protected cultivation. Studies proved that the summer vegetables can be successfully cultivated in the winter months (poly house) as the temperature inside poly house remains higher compared to the outside environment (Sindhu and Chatterjee, 2020). In a place like Ladakh, production of tomato, capsicum, brinjal, and other cucurbits are taken in the summer season/months on a large scale, followed the green leafy vegetables (crops) are being grown in the long-frozen winter season/months when reaches the average temperature up to -40oC. Underground greenhouses and soil trenches are also being used on a large scale in these remote areas. (Mishra, 2014). Protected Cultivation Structures (PCS) provides the most suitable growing environment, so growers are benefited by being able to produce higher and offseason tomato which fetched premium prices in the market (Santost, 2017).
6. Various crops which are not possible to grow in a natural setting at various specific regions is now seems possible. It is a very good technique for off-seasonal and seasonal vegetable cultivation in different altitudes in the central Himalayan region but particularly in the high-altitude and can be successful employed for recess/niche areas of agriculture. Not only the yield of selected vegetables crops were found that the to be highly significant ($P < 0.05$) under protected structures/cultivation but the productivity of the vegetables has been observing to increase from 15.85 percent to 932.20 percent as compared to that in outside/open field condition at both the altitudes (Negi, 2013).
7. Protected cultivation technologies are playing an important role in minimizing the impact of temperature fluctuation. Under precipitation, an infestation of disease & pest and controlled environment can be utilized for growing early season/off-season vegetables and high-value vegetables. Most people are demanding early season /off-season vegetable and high-value vegetables at a higher price which are not possible to

JUST AGRICULTURE
multidisciplinary e-Newsletter

grow under open-field situations. The production vegetable is much less than the requirement if a balanced diet is to be provided to every individual (Singh, 2019).

8. Off-season and optimum planting time results in higher economic return & the production system made it remunerative and economically viable. When it is rightly combined with vermicompost (5t ha-1) for better plant growth and maximum return (planting and 75% recommended inorganic fertilizers along with seed inoculation of bio-fertilizer) chances of adoption are higher (Chatterjee, 2015).
9. Greenhouse cultivation of off-season vegetables can not only bring prosperity to the farmers but also address the concern of nutritional and food security to the people living in hill and mountain regions (Kumar, 2019).
10. There is an urgent need to adopt the protected structures for water-saving, organic and integrated pest management, improving technology, maintain high temperature, etc. (Owen, 2020).

6. Problems and Challenges of protected cultivation –

Protected cultivation technology is the best technology for raised offseason vegetables, flowers, and other high valued crops but some problems are also faced by the farmers.

6.1 It was observed that short life of poly sheets and infestation of insect-pest along with problems of marketing (lack of information of the market and minimum support price and high price variations) were the major challenges (Kumar *et al.*, 2016).

6.2 Farmers also faced constraints of root-knot nematode fluctuates with the age of establishment of Poly-houses structure. Root-knot nematodes population increased with the increase and exposure of time of poly-houses and nematodes population found in the newly established poly-houses (Bhati and Baheti, 2020).

6.3 Few of the farmers faced problems like economic, technical, labor, environmental, and marketing in mobilizing sustainability and profitability of protected cultivation technology. The major constraint of rapid adoption was low availability of quality protected structure, material & inputs for post-harvest infrastructure are poor, high initial investment, and lack of viable price policy dimensions/measures (Prabhakar, 2017).

6.4 Cultivation of vegetable crops inside protected cultivation was also felt challenging like a high initial cost for the establishment of structures discourage its wider adaptation, non-availability of various construction materials like GI pipes, polyethylene sheet, etc are not

JUST AGRICULTURE
multidisciplinary e-Newsletter

generally available in the local market which needs to be imported at high costs including freight and customs duty. Sometimes farmers are required monitoring and supervision, skilled workers, for installation and not easily available in the village areas (Sindhu and Chatterjee, 2020).

6.5 Farmers were facing the problems/constraints population explosion of minute insects viz. mites & whiteflies, especially the whitefly menace, frequent occurrence of windstorms, hailstorms, absence of cold storage facilities in villages, high cost of the refrigerated vehicle, and the major serious problem faced of nematode infestation by the poly house growers. Farmers also face field constraints like technical guidance and low availability of quality material, care-intensive with special care for control of whitefly and nematode infestations, proper marketing, valuable knowledge, and skill to farmers for the sustainability of poly house cultivation (Ghanghas et al., 2018).

6.6 Lack of technical guidance, market information, and minimum support price, higher initial investment cost, high cost of fertilizer and pesticide, etc. were some production-related problems faced by farmers. (Malik 2017)

Conclusion –

An in-depth study of various reviews regarding protected cultivation technology used to enhance production, quality, and productivity of vegetables can be concluded that low-cost poly house, rainy shelter, and shade net are mostly preferred protected structures by farmers. To meet out their needs regarding knowledge and skill updating, regular awareness camps and skill training should be organized for farmers to ensure successful vegetable crop cultivation under protected structures and adoption of these technologies on a large scale. Greenhouse farming of off-season vegetables will definitely bring prosperity to the farmers along with catering nutritional and food security to the people. It can be suggested that the new model, easily available of protected structures material and giving subsidy to the farmers for the establishment of protected cultivation will definitely bring prosperity and nutritional security.

References

D.T. Santosh, K.N. Tiwari and Vikas Kumar Singh (2017) Influence of different protected cultivation structures on water requirements of winter vegetable. International Journal of Agriculture, *Environment and Biotechnology (IJAEB)*: 10**(1)**: 93-103.

Dr. N.V. Shende and R.R. Meshram (2015). Cost Benefit Analysis and Marketing of Tomato. American International Journal of Research in Formal, *Applied & Natural Sciences*, 11**(1)**, pp. 46-54

Ghanghas BS, Malik JS, Yadav VPS. (2018) Sustainable vegetables and flowers production technology (Poly House): Problems & Prospects in Haryana. *Indian Research Journal of Extension Education*; 18**(2)**:12-16.

Harisha N., Tulsiram J., Joshi Amritha T., (2019) Techno-Economic Analysis of Vegetable Production under Protected Cultivation in Kolar district of Karnataka: *Agricultural Science Digest - A Research Journal*, Volume : 39*(3)*:224 – 227.

Itigi Prabhakar, K Vijayaragavan, Premlata Singh, Balraj Singh, Janakiram, B L Manjunatha, SeemaJaggi And I Sekar (2017). Constraints in adoption and strategies to promote polyhouse technology among farmers: A multi-stakeholder and multi-dimensional study. *Indian Journal of Agricultural Sciences* 87 *(4)*: 485–90.

J.A. Fernández, F. Orsini, E. Baeza, G.B. Oztekin, P. Muñoz, J. Contreras and J.I. Montero (2018) Current trends in protected cultivation in Mediterranean climates. *European Journal of Horticultural Science*: 83*(5)*, 294–305.

Kanika Mehta, Rajesh Kumar Thakur and J.S. Guleria (2020) Socio-Economic Impact of Protected Cultivation on Tomato Growers of Himachal Pradesh. *Journal of Economic Affairs*, 65**(1)**:01-07.

Katinka Weinberger and Thomas A. Lumpkin, (2007), Diversification into Horticulture and Poverty Reduction: A Research Agenda, *World Development*, 35, *(8)*, 1464-1480.

Kumar P, Chauhan RS, Tanwar N, Grover RK. (2018), Status and constraints in vegetable cultivation under poly house in Haryana. *Advances in Bioresearch*, 9**(2)**:10-15.

Kumar Suman, Singh Amar, and Banyal D. K. (2015) First record of occurrence and distribution of bacterial canker of capsicum under protected cultivation in Himachal Pradesh.*Plant Disease Research*:30**(1)**:61-66.

Malik K. (2017) Economic viability of cucumber cultivation in greenhouses. International *Journal for Innovative Research in Multidisciplinary Field;* 3**(6)**:366-368.

Manoranjan Kumar, Narendra Kumar and K. Srinivas (2019). Greenhouse Farming in High Altitude Areas of North-West Himalayan Region of India: A Success Story. *International Journal of Agriculture Sciences*, 11**(5)**:7944-7949.

Owen, William G. and Behe, Bridget (2020) "A National Survey to Characterize Industrial Hemp (Cannabis sativa L.) Production Challenges Under Protected Cultivation," *Journal of Agricultural Hemp Research*:1**(2):**230-236

Parmar MN (2020) Special horticultureal practices for vegetable under protected cultivation. *The Pharma Innovation Journal*; 9 **(3)**: 425 – 430.

PepijnSchreinemachers; Mei-huey Wu; Md. NasirUddin; Shahabuddin Ahmad and Peter Hanson, (2016) Farmer training in off-season vegetables: Effects on income and pesticide use in Bangladesh, *Food Policy*, 61, (C), 132-140

Punera B, Pal S, Jha GK, Kumar P. (2017), Economics and Institutional Aspects of Protected Cultivation of Carnation in Himachal Pradesh. *Agricultural Economics Research Review*; 30**(1)**:73-80.

R.K.Yadav, P.Kalia, H. Choudhary, ZakirHusainandBrihamaDev (2014). Low-Cost Polyhouse Technologies for Higher Income and Nutritional Security. International *Journal of Agriculture and Food Science Technology*. 5**(3)**: 191-196.

RanjitChatterjee, Ravi KiranThirumdasu and Dipika Mal (2015). Off-Season French Bean (Phaseolus vulgaris L.) Cultivation Inside Agro Shade Net: Influence of Planting Dates and Nutrient Sources, *Journal of Agriculture and Technology*: 2**(1&2)** 87-91.

Sabir N, Singh B. (2013) Protected cultivation of vegetables in global arena: A review. Indian *Journal of Agricultural Sciences*; 83**(2)**:123-135.

Sindhu V and RanjitChatterjee (2020) Off-Season Vegetable Cultivation under Protected Structures: A Promising Technology for Doubling Farmers Income. *Int. Arch. App. Sci. Tech.* (IAAST).11**(3)**:208-214.

Singh Balraj (2014) 3rd International Conference on Agriculture & Horticulture, Hyderabad International Convention Centre, India .2**(4)**: 51

Spehia R. S. (2015) Status and impact of protected cultivation in Himachal Pradesh, India. *Current Science*. 108**(12):**2254-2257

Sreedhara, D. S. ; Kerutagi, M. G. ; Basavaraja, H. ; Kunnal, L. B. ; Dodamani, M. T. (2013) Economics of capsicum production under protected conditions in Northern Karnataka: *Journal of Agricultural Sciences*.26*(2):*217-219

SS Bhati and Dr. BL Baheti (2020) Occurrence and population status of root-knot nematode, Meloidogyne incognita on cucumber under protected cultivation in Rajasthan: *Journal of Entomology and Zoology Studies* (JEZS); 8*(4)*:1441-1444

Vikram S. Negi, R. K. Maikhuri, L. S. Rawat& D. Parshwan (2013) Protected cultivation as an option of livelihood in mountain region of central Himalaya, India, *International Journal of Sustainable Development & World Ecology*, 20***(5)***:416-425.