

Exploring potential of protected cultivation in India—a review

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ABSTRACT

Protected cultivation has become an integral part of modern agriculture, significantly contributing to global food security and horticultural production. The diverse array of structures and crops grown under protection underscores the adaptability and versatility of these systems. As the world grapples with the challenges of feeding a growing population, protected cultivation is set to play an increasingly vital role in the future of agriculture, offering solutions to the problems of climate change, resource scarcity, and food quality. To realize the full potential of protected cultivation, governments, agricultural institutions, and private sector must work together to support and promote sustainable practices, ensure training and knowledge sharing, and create favourable policies for its continued growth. Looking to the future, the potential of protected cultivation is enormous. As global population growth and climate change continue to exert pressure on traditional agriculture, protected cultivation offers a sustainable solution to increase food production, ensure crop quality, and reduce the dependency on seasonal variations. Additionally, technological advancements in energy-efficient systems, renewable energy adoption, and integrated pest management are expected to make protected cultivation even more sustainable and economically viable.

With time it has been well proved that protected cultivation is a better technology to enhance productivity and quality of the crops by providing a logical and technical solution to manage the major and minor biotic and abiotic stresses encountered under open field cultivation of major horticultural crops. The effectiveness of the technology has also been observed in many parts of the world (Singh, 2013). Presently, the area under different forms of protected cultivation is around 4.5 million ha in the world. During the last two- and-a-half decades, the area under protected cultivation has increased exponentially in various countries and around Mediterranean sea.

In China, various kind of protected cultivation technologies like mulching, use of temporary plastic walls in open fields, plastic low tunnels, plastic covered walk-in-tunnels, high tunnels, temporary and permanent insect-proof net houses, shade net houses, rain shelters and different kinds of greenhouses etc are being adopted. Presently, China is the world leader in cultivating horticultural crops under different protected conditions, total area under protected cultivation being around 3.5 million ha. Out of this area, nearly 96 percent is being used for cultivation of commercial fresh vegetables and their hybrid seed production. Simultaneously, growth in protected cultivation like China has also been observed in developing countries

like Indian and African sub-continent. But the success rate varies significantly because of poor correlation between design of various protected structures and prevailing agroclimatic conditions of a region.

The experience of protected cultivation which emerged in Northern Europe, stimulated its development in other areas including the Mediterranean region, North America, Oceania, Asia and Africa, with various rates and degrees of success. It has been clearly established and proven that mere transportation or adoption of technology as such from Northern Europe to other parts of the world, irrespective of prevailing agroclimatic conditions was not a valid decision and step. Each region and area actually require further research, development, extension, training and new norms, procedures and methods of application of technology to meet the region-specific requirements for protected cultivation of horticultural crops (Singh, 2019).

Protected cultivation In India

India, with its vast and diverse agricultural landscape, has always been a significant contributor to the global agricultural market. The challenges of increasing population and changing dietary preferences have placed immense pressure on our country's food production systems. To meet the growing demands for fresh and nutritious produce, India must innovate and adopt

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modern techniques. Protected cultivation methods, including greenhouses, net-houses, high tunnels, and low tunnels, hold the key to increasing vegetable production and securing India's food future. India being a country with diverse climatic regions has shown an overall growth of around 2.0 lakh ha area under protected cultivation in different states during the last two decades. The success rate of these technologies varied significantly depending upon the climatic conditions of various regions in India. In plains of Northern India, these technologies faced high challenges for making them successful against the harsh climatic conditions, whereas in mild climatic areas like Bengaluru and Pune, the success rate achieved has always been high.

Basically, the dismal growth of protected cultivation technology in the country happened mainly due to Government policies providing handsome subsidies under various schemes launched by the government of India under MIDH (NHM), TM, NHB, RKVY etc., and up to some extent due to the technical beauty of technology. The technical know-how for adoption of protected cultivation technology under Indian conditions was not to the level at the time of inception. With passage of time, research and developmental work carried out by various public sector institutions in collaboration with developed countries gradually reflected that technical designs of different protected structures needs modification suitable to the region-specific needs of prevailing climatic conditions and problems under open field cultivation.

During last few years, varieties & hybrids and production technology suitable for protected cultivation have been developed by various public sector institutions in India. Further there are some most successful examples and models for adoption of this technology even under harsh climatic conditions like Bassi-Jhahra and Basari village, just 15 km away from Jobner (Jaipur), but this seems only in cluster approach. This most successful example in cluster approach clearly shows the potential of the technology expansion up to 15.0-17.0 lakh ha for growing horticultural crops in different states in India by the year 2050. Presently, the area under protected cultivation in India stands at a mere 2.0 lakh ha. In contrast our country produces 207.0 million tonnes of vegetables annually. Looking ahead to 2050, our nation's vegetable requirement is expected to surge to 450.0 million tonnes. To bridge this massive gap, protected cultivation has the potential to play a pivotal role, offering a promising solution (Tuzel and Kacira, 2021).

Expansion of protected cultivation

Promotion and expansion of protected cultivation technology will not only be going to help for creation of huge self-employment for unemployed educated youths, but it will also increase the national economy by sale of quality healthy planting material, fresh horticultural produce for domestic and international markets. Under the era of FDI (Foreign Direct Investment) in retail, these kinds of models possess high potential for enhancing the income of farmers opting for quality and off-season vegetables and cut flowers cultivation through various protected cultivation technologies.

On one hand, production of vegetable and cut flower crops under protected conditions provides high-water and nutrient-use efficiency under varied agroclimatic conditions of the country. On the other, this technology has very good potential especially in peri-urban areas in cluster approach adjoining to major cities, a fast-growing market for fresh quality produce. Thus, it can be profitably used for growing high-value vegetables like, tomato, cherry tomato, coloured peppers, parthenocarpic cucumber and brinjal, cut flowers like roses, gerbera, carnation, chrysanthemum etc. and virus-free healthy seedlings and planting material of horticultural crops in agro-entrepreneurial models.

But protected cultivation technologies require careful planning, attention adequate timing of production and moreover, harvesting time to coincide with high market prices, choice of varieties adopted to off-season environments, and able to produce economical yield of high-quality produce etc. Even though application of chemicals for controlling biotic stresses is also low under protected structures which gives a high-quality safe vegetables for human consumption. By using protected structures, it is also possible to raise off-season and long duration vegetable crops with high yield (3-5 fold as compared to open field cultivation) with quality. Vegetables and cut flowers farming in agro-entrepreneurial models targeting various niche markets of big cities is inviting regular attention of vegetable and flower growers for diversification from traditional ways of crop cultivation to the modern methods like protected cultivation of horticultural crops. (Singh *et al.* 2010).

Tips for protected cultivation

The basis behind the successful implementation of protected cultivation technology largely depends on selection of suitable designs with proper crops, their varieties and adoption of successful cultivation are fundamental variables that may significantly affect success and economic return of the entire. A most successful example of protected cultivation in cluster approach is Bassi-Jhajhra and Basari village 15 km away from Jobner (Singh, 2023). The success of protected cultivation technology entirely depends upon four basic concepts, viz. what to produce, when to produce, how to produce and where to sell and where the export the high-quality produce.

The growers must know two basic options, i.e. choice of crop or variety for its high economic potential/return and to develop most suitable production system in cluster approach. Crop should be selected based on existing structures, wide consumption and good adoption to unsteady climatic conditions and suitable for long cultivation cycles. While adopting the protected cultivation technology, following most important points, viz. market requirement of the produce, distance from the market for the fresh produce, climatic conditions of the area, soil characteristics and quality of water, economic convenience, crop requirement, labour and skilled manpower requirement should be well considered in advance. (Singh, 2005).

Major challenges in India

The major challenges are:

- Non-availability of region-specific designs of green houses and insect-proof net houses for varied agroclimatic conditions and regions.
- Fabrication of protected structure has come up as a big business, taking an opportunity small industry are sacrificing with quality of material to be used to gain more profit and also lack of understanding of designs of the protected structures for different regions and quality of basic steel and cladding material used for fabrication and installation of structures.
- Limited trained skilled and professional manpower for designing, fabrication of protected structures and thereafter, maintenance of the structures and for protected cultivation of various high-value crops.
- Lack practical training institutions and advisory services in the area of protected cultivation of horticultural crops.
- Limited availability of suitable crop varieties and planting material specific to protected cultivation, especially with public sector institutions, its management practices etc. as planting material/seeds, cladding material, water-soluble fertilizers, etc. available with private sector companies are too costly.
- Lack of demand-driven cultivation without proper marketing strategies several times creates problem for proper disposal of quality produce and sometime farmers are even not getting reasonable price of their produce.
- Increasing threat of soil-borne problems like root-knot nematodes and Fusarium for protected cultivation of horticultural crops and more specifically vegetable crops.
- Non-availability of virus-free healthy planting material in vegetables, fruits and ornamental crops.
- Poor power supply for drip irrigation is major challenge in protected cultivation.

Adoption of protected cultivation technologies

Protected cultivation technology for horticultural crops has tremendous potential for adoption under varied agroclimatic conditions of the country. The most potential areas where high scale interventions are required to be promoted are as under (Report of the Working Group, 2013).

- Use of plug tray nursery technology on commercial scale for raising virus free healthy vegetable and flower seedlings as Agri-business models.
- Large scale use of different designs of insect proof net houses with different designs for commercial vegetable cultivation and for hybrid seed production of vegetable crops.
- Use of modified naturally ventilated greenhouses equipped with mini sprinklers on the roof top area and zero energy consuming exhausts on gutters for continuous removal of greenhouse hot air for cultivation of vegetable and flower crops under harsh conditions of arid and semi-arid regions of the country.
- Use of naturally ventilated green house for hybrid seed production in vegetables for increasing the overall profitability of the farmers.
- Large scale use of plastic mulches for commercial vegetable cultivation under open fields and also under

Table 1: Expansion potential of protected cultivation technologies in different indian states by 2050

Protected structure	Suitable crops	States	Pace expected expansion
Low-cost playhouses - es up to 50m ² - 250m ² area	Several vegetable crops for protection against frost and pests and viruses	Uttarakhand, Himachal Pradesh, Tamil Nadu, Jammu and Kashmir and all North East states	8-10% growth every year over the present level of this technology
Rain shelters-cum-insect proof net-houses	Several vegetables for protection against insect pests and viruses and continuous rains	All North East States, Bay Islands, Eastern Coastal Region, Western Coastal Region, Kerala etc	6-8% growth over the present level of use of the technology
Plastic low tunnel technology (but now needs replacement of Synthetic plastic with Non-woven material for covering the tunnels)	Mainly for off season cultivation of cucurbits during winter months	Punjab, Haryana, Rajasthan (parts adjoining to Haryana, Punjab), Uttar Pradesh	15-20% over the level of use in around 20,000-22,000 acres
Walk-in-tunnels	For off-season vegetable cultivation during winter months	Foot Hills Uttarakhand, Himachal Pradesh, Jammu and Kashmir and North Eastern	8-10% over the present use of the technology
Insect-proof net houses	For protection of vegetable and fruit crops like Papaya against viruses and Insect pests and up to some extent from frost	North Indian Plains, central India, western Parts like Rajasthan, Gujarat	15-20% over the present status of use in around 8000- 10000 ha
Naturally ventilated greenhouses	For large scale and year-round cultivation of vegetables viz. tomato, cherry tomato, Capsicum, seedless cucumber, eggplant, etc. and hybrid seed production of vegetable	Punjab, Haryana, Rajasthan, Uttar Pradesh, Madhya Pradesh, Gujarat, Maharashtra, Kerala, Telengana, Orissa, Bihar, Jharkhand, Tamil Nadu, Andhra Pradesh	15-20% over and above the present use in around 1.20-1.30 lakh ha.
Semi-climate-controlled greenhouses	Nursery production and use for commercial vegetable cultivation and seed production of high value vegetable crops.	Rajasthan, Gujarat, Madhya Pradesh, Maharashtra, Arid Region and Semi-arid regions	8-10% over the present status of use in around area of 1500-2000 ha.
Shade net houses	For cultivation of leafy. Vegetables & herbs during peak summer months.	Arid and semi-arid regions of Madhya Pradesh, Rajasthan, Gujarat, Maharashtra, Andhra Pradesh., Tamil Nadu, etc.	10-12% over the present area in use around 12,000-14,000 ha
High tunnels	For off-season cultivation of cucurbits and other vegetables during winter months + large-scale drying of chilli and pan methi	Rajasthan, Andhara Pradesh, Maharashtra, Madhya Pradesh, Gujarat and other arid and semi-arid regions	8-10% over and above the present level of use
Retractable green-houses	For cultivation of black berry and blue berries	Uttar Pradesh, Uttara- khand, Trait Region Madhya Pradesh, etc.	5-8% over the leaf level. 20-30 ha
Climate controlled greenhouse/glass-houses	For quality planting material production of Potato under aeroponics systems and hydroponic system	Haryana, Punjab, Uttar Pradesh and Rajasthan	3-5% over the leaf level
Mulching (replacement of system-atic plastic with biodegradable or compostable plastic is needed or by organic mulch in fruit orchards)	For cultivation of major vegetables, fruit crops, spices ornamental crops.	Across the country clubbed with raised beds and drip irrigation system	15-20% over the plant level of 50,000-60,000 ha

green houses and even under insect proof net houses under varied agro-climatic conditions but now the use of synthetic plastic needs replacement with biodegradable or organic mulch.

- Commercial application of micro-grafting technology for developing resistant plant material against soil borne problems.
- To promote cultivation of fruit crops like papaya, pomegranate under insect proof net houses for protection against biotic and abiotic stresses.
- Large scale application of low-pressure drip irrigation system for managing an area of 1000-2000 sq. mts. area for cultivation of different horticultural crops under protected structures.
- Commercial use of open roof type high tunnels in northern parts of the country and even under temperate conditions can be more rewarding.
- Large scale skill development of youth manpower in two ways following the Chinese model i.e., designing, fabrication and maintenance of protected structures and secondly the production management of crops under protected conditions
- Application of GAP procedures and standards for protected cultivation of high value vegetable crops will help to catch international trade.
- Government support should be extended for self-fabrication mode of temporary low-cost structures like insect proof net houses, shade net houses, walk-in-tunnels and plastic low tunnels for the cultivation of suitable vegetable and flower crops.
- Promotion of protected cultivation technology for its sustainability in cluster approach especially in peri-urban areas of the country by following Bassi-Jhajhra village in Jobner.
- Government should also promote to develop input hubs for protected cultivation in multi-locations in PPP mode.
- Use of solar energy for running drip system and up to some extent for running heating and cooling devices of the protected structures should also be promoted.
- All the protected cultivation clusters must be mandatorily clubbed with rain water harvesting infrastructure facilities.
- Promotion of most suitable crop sequences for different protected structures and seasons based on research data.
- Promotion of large-scale mechanization in vegetable and flower cultivation by using raised bed makers, plastic laying machines, plastic low tunnel making machines, pipe bending machines

for making walk-in-tunnels, drip lateral laying and binding machines

- To establish convergence and synergy among various on-going and planned government programmes in the field of protected cultivation development.
- To ensure adequate, appropriate, time bound and concurrent attention to all links in production under protected conditions, post production on-farm value addition, processing, consumption chains and for export.
- Cluster approach for taking up protected cultivation as a whole is required and may be clubbed with processing industries and export along with national high ways and dedicated freight corridors.

Benefits of protected cultivation

Protected cultivation provides a barrier against pests and diseases. The enclosed environment helps prevent the entry of harmful insects and pathogens, reducing the need for chemical pesticides. This contributes to a more environment-friendly and sustainable crop production systems.

The increased efficiency in resource utilization is another advantage. Controlled environments enable precise application of fertilizers and nutrients, minimizing waste and optimizing plant nutrition. This efficiency not only benefits the environment but also contributes to cost savings for farmers.

Protected cultivation also offers a range of benefits, including extended growing seasons, enhanced control over environmental factors, protection from adverse weather conditions, water conservation and pest and disease management. These advantages collectively contribute to higher agricultural productivity with better food quality, and increased sustainability in the face of evolving challenges in agriculture sector. (Singh, 2005). Its versatility in adapting to diverse agroclimatic conditions. This technology allows year-round cultivation. It is beneficial for having with extreme climates. It supports sustainable crop diversification, enabling the cultivation of high-value crops such as fruits, vegetables, and flowers. Furthermore, it facilitates crop intensification by maximizing yields per unit area (Singh, 2011).

Addressing water scarcity

Water scarcity is a significant concern in many parts of India. Protected cultivation provides a means to optimize

water-use efficiency by controlling the microenvironment within the structure. Reduced water wastage and precise irrigation management are critical benefits, especially in areas struggling with water availability.

Product quality and safety

In an era of increasingly stringent market demands, standards, and regulations, product quality and safety are paramount. Protected cultivation allows for meticulous control of environmental factors such as temperature, humidity, and light, resulting in consistent and high-quality produce. Moreover, protection from external contaminants and pests minimizes the need for chemical interventions, aligning with the growing consumer preference for organic and safe products.

Cluster approach for success

The cluster approach has been instrumental in successful expansion of protected cultivation. Cluster of farmers adopt this technology in proximity benefit from shared knowledge, resources, and market access. This approach fosters collaboration, enhances economies of scale, and minimizes risks associated with technology adoption (Singh, 2023).

Multiple applications of protected cultivation

Protected cultivation technology finds diverse applications in Indian agriculture. Firstly, it plays a pivotal role in raising disease and virus-free healthy planting material. The controlled environment of greenhouses and polyhouses ensures that the initial crop material is of highest quality, contributing to the success of subsequent cultivation.

Secondly, it is instrumental in hybrid seed production, especially for vegetables. This technology enables the isolation and controlled pollination of different varieties, ensuring the purity and quality of hybrid seeds. (Singh and Tomar, 2015).

Thirdly, protected cultivation is central to the production of fresh food for better economic viability. The extended growing seasons and higher yields empower farmers to meet market demands consistently, enhancing their income.

Role of skilled manpower

For the sustained growth of protected cultivation, developing a skilled workforce is paramount. This

involves training rural youth in two key areas: designing, fabricating, installing, and maintaining protected structures, and managing the entire crop production process under protected conditions. Skilled labour not only ensures the efficient operation of these systems but also opens up opportunities for employment and entrepreneurship in agricultural sector.

Expansion of protected cultivation in India

The future of protected cultivation technology in India is promising. It is envisioned that by 2050, the technology could be expanded to cover an estimated 15.0-17.0 lakh ha of agricultural land across the country. This expansion would offer solutions to the multifaceted challenges facing Indian agriculture, making it more resilient and sustainable in the face of changing climate patterns.

Gujarat

Gujarat has been a pioneer in greenhouse farming and is known for its successful adoption of protected cultivation techniques. The state's moderate climate and progressive government policies make it conducive for expansion. Vegetables, flowers, and export-oriented crops like capsicum, tomato, and seedless cucumbers are successfully being grown under protected conditions. The two sea ports for fast export of value-added options are the major ladder for the State of Gujarat for making fast progress in protected cultivation:

Maharashtra

Maharashtra, with its diverse agroclimatic zones, offers ample opportunities for protected cultivation. The state has seen increased adoption, especially in the Nashik region for grapes, Pune for floriculture, and areas around Mumbai for vegetables. The state government has also been encouraging farmers to invest in protected cultivation. Some of the areas have already come up as protected cultivation hubs around Pusa for cultivation of vegetable and ornamental crops. More areas in the State have potential for protected cultivation like Konkan region and areas which are boarding with Karnataka State.

Protected cultivation can be taken up on a large scale-seed production of vegetable crops.

Himachal Pradesh

The hilly terrain and cold climate in Himachal Pradesh make it suitable for high-value crops like strawberries, capsicum, cucumbers, tomatoes and cut flowers under protected cultivation. The state government has been promoting polyhouses for extending growing season and increasing yield. Seed production of vegetable crops can also be taken up in foothills of the State under low cost protected structures.

Karnataka

Karnataka, with its varied agroclimatic zones, is another state with immense potential for protected cultivation. Regions like Bengaluru, Mysore, and parts of North Karnataka have seen growth in greenhouse farming for vegetables, while the Coorg region is known for its floriculture. Seed production of vegetable crops can also be taken up in different regions of the state. Dharwad, Rani Benur etc. are ideal for cut flower crops like gerbera, carnation or even roses. Protected cultivation of flowers can be taken up in large scale in different regions of State like Ooty hills, Coimbatore, Salem area, etc.

Tamil Nadu

Tamil Nadu's favourable climate allows for year-round cultivation of various crops. Protected cultivation is extensively used for vegetables, flowers, and even fruits. The state government has provided subsidies to encourage farmers to adopt these techniques. Protected cultivation of flowers can be taken up in large scale in different regions of State like Ooty Hills, Coimbatore, Salem areas, etc.

Punjab and Haryana

These states in northern India have adopted protected cultivation for vegetables and fruits, especially during the off-season. The region's extreme weather conditions make greenhouses and polyhouses vital for year-round production of high value vegetables, seed production of selected vegetables and large scale healthy nursery production. Protected cultivation can be taken up in cluster approach along with mega highways like NH 152D KMP, NH-1, etc. for cultivation of high value vegetables and nursery hubs can also be developed in these areas for fast transportation of the produce and planting material to far-flung areas of the country.

Rajasthan

Rajasthan's arid climate and extreme temperatures can be challenging, but protected cultivation, particularly shade net houses and polyhouses, have been adopted and can be further expended for growing fruits and vegetables like tomatoes, capsicum, cucumbers, and papaya. In Rajasthan, insect-proof net houses and shade-net houses can be used at large scale and Bassi-Jhajhara village model can be replicated in several other parts of Rajasthan and other states.

Andhra Pradesh and Telangana

These states have seen an increase in protected cultivation for export-oriented crops like flowers, vegetables, and fruits. The government has introduced subsidies to promote these practices. Seed production of vegetable crops can also be taken up to large scale in different regions mainly around Hyderabad.

Kerala

In Kerala, due to its humid tropical climate, protected cultivation is used for growing orchids, vanilla, and spices. Polyhouses and shade net houses have gained popularity and up to some extent vegetables like cucumbers and capsicum are being grown. There is a need to use protected conditions for large-scale healthy planting material production of spices like black pepper, cardamom, ginger, turmeric etc.

Uttarakhand

Uttarakhand's hilly terrain and cold climate provide opportunities for protected cultivation of high-value crops such as organic vegetables, medicinal herbs, and strawberries. Seed production of vegetable crops can also be taken up in foothills of the state.

Bihar and Jharkhand

Greenhouses and other low-cost protected structures in like insect-proof net houses, high tunnels, walking tunnels and shade net houses can be used at large-scale vegetable cultivation and also ten Gerbera, Carnation etc. Protected structures like greenhouses are required to be used at large scale for disease and virus-free planting material of different horticultural crops.

North-Eastern States

Low-cost protected structures like poly houses and rain shelter-cum insect-proof net houses can be used for cultivation of vegetable and ornamental crops. There is a need to use protected conditions for production of healthy planting material of different horticultural crops. In these states protected cultivation can be well linked with low-pressure drip irrigation system.

Orissa and West Bengal

Protected cultivation like greenhouses or net houses can be used for a large number of vegetable cultivation but in cyclone-prone coastal regions only low-cost protected structures are required to be used for cultivation of different horticultural crops.

Uttar Pradesh

In Uttar Pradesh, protected cultivation of vegetable and flower crops have very good potential. Same time, large scale planting material production can also be expanded along with national highways and in NCR region including Peri-urban areas of Lucknow, Prayagraj, Banaras, etc.

The expansion of protected cultivation in India also depends on market demand, access to technology, infrastructure development, and government incentives. Many state governments offer subsidies, technical assistance, and training programmes to encourage farmers to adopt these practices. With climate change affecting traditional agriculture, protected cultivation can play a crucial role in ensuring food security and income generation for farmers.

Diversified uses of protected structures

Post-harvest management: Plastic high tunnel can be used for better post-harvest drying, as it acts as a protected site under plastic and operates like a solar dryer with ventilation. The open sun drying under field reduces the face value of the produce by loss of excess moisture and discolouration besides chances of microbial contaminated if done on Kachcha platforms. Looking to the benefits of high tunnel, following are potential uses in arid/semi-arid regions (Singh, 2019).

Drying of Nagaurimethi: For drying of Nagaurimethi use of high tunnels can be very quick

and clean process wherein the leaves can be dried 2-3 days earlier than sun drying. It is also safe from damage caused due to unusual weather situations like winter rains. This technology is more effective to have a clean and green produce of Nagaurimethi leaves especially for export purposes.

Drying of vegetable crops: Introduction of high tunnels is a cheap and clean process for drying vegetable like chilli, mint, spine gourd, ashwagandha etc. with maintaining quality for better consumer acceptability.

Drying of specific commodities: Some products like Panchkuta, kachri etc. which are unique to arid ecologies are sun dried by farmers. The use of high tunnel can be innovative approach in drying of these commodities for better quality and fast drying.

Drying of plantation crop products: In the region of Sojat and Paliregion cultivation of heena leaves holds special identity as a Geographical Indicator. The drying of henna leaves under high tunnels will be very useful in producing better heena powder for local and international market.

Conclusion

There is a huge potential of expansion of the protected cultivation technology in India, in different states huge but highly dependent upon the technicality and recommendation of the technology implementation. The technology can be expended up to 15.0- 17.0 lakh by the year 2050. The cluster approach in its adoption can play crucial role in its successful expansion. The protected cultivation technology has to play a significant role under varied agroclimatic conditions of our country as a means for sustainable crop diversification, intensification, and for vertical growth of productivity of horticultural crops leading to optimization of water and fertilizer-use efficiency. In the near future, first and most important requirement of it is raising disease and virus-free healthy planting material of horticultural crops. The use of technology for hybrid seed production of vegetables and production of fresh food for better economic-viability are other uses. Further, sustainability of the technology is utmost important to develop a large skilled manpower in form of rural areas. There is a need to replace use of synthetic plastic mainly used for mulching purposes or as a covering plastic low tunnels either with the use of biodegradable or non-woven material.

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