

Protected Horticulture in India: Technical Advancements and Nutritional Security Pathways



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Protected cultivation is an advanced agricultural practice that enables crop production under controlled environmental conditions, thereby enhancing quality, productivity, and overall profitability. Various protected cultivation technologies viz., poly-houses, shade-houses, hydroponics, and drip fertigation systems and their role in improving farmers income. Many evidences suggest that the protected cultivation can increase yield by 2-5 times and significantly improve income through off-season as well as superior quality production. Government support and technological advancements further enhance its potential as a sustainable agricultural or horticultural strategy. protected cultivation could bring the prosperity

to horticultural crop growers in India and ensure nutritional security.

INTRODUCTION

The farmers have experienced that conventional farming is unpredictable and high risk due to variable weather, high cost of production and unstable market. It is high time for farmers to think for alternate technology for assured and maximum productivity and profitability. Hence there is an option to change from the conventional farming to advanced farming such as protected cultivation. The protected cultivation refers to the practice of cultivating crops in controlled environments that safeguard them from extreme weather, pests, and diseases. These structures create an optimal microclimate,

regulating temperature, humidity, and light exposure, leading to higher yields and better-quality produce. Farmers in India are increasingly adopting protected farming techniques to overcome challenges like unpredictable monsoons, soil degradation, Pest and disease infestations, and market fluctuations. It is particularly beneficial for small and marginal farmers aiming to maximize returns from limited land resources.

Status of protected cultivation: There are more than 65 countries now in the world where cultivation of crops is undertaken on a commercial scale under cover, and it is continuously growing at a fast rate internationally with an estimated 623,000 ha of greenhouses

spread over all the continents. Israel is one country which has taken big advantage of this technology by producing quality fruits, vegetables, flowers, etc. in water deficit area. In India, protected cultivation technology for commercial production is hardly three decades old. Approximately 1.25 lakh ha area is under 'protected cultivation' in India, which includes greenhouses (permanent structures) and other temporary protected structures. The exportable quality produce of vegetables and flowers are produced under protected condition and their productivity is very high due to real time monitoring of inputs and plant health. Most commonly grown crops under protected conditions are cucumber, capsicum and tomato, in addition blueberry and strawberry are emerging crops under this system.

TYPES OF PROTECTED CULTIVATION STRUCTURES

Polyhouse (Greenhouse)

Polyhouses are structures covered with transparent polyethylene sheets that allow partial or full environmental control. Two types of polyhouses are designed in Indian condition, one is called naturally ventilated polyhouse and the other is called force ventilated (fan-pad) polyhouse. Naturally ventilated polyhouses are used mainly in temperate and moderate climate conditions while force ventilated (fan-pad) polyhouses are suitable for tropical, sub-tropical and arid zone farming systems. Polyhouse is main structure of protected -cum-covered cultivation groups. It is made by GI pipe and covered by ultra-violet (UV) stabilized plastic sheet with a service life of 3-4 years. These sheets are generally available in 7 and 9 meter widths with 200 micron thickness. The polyhouse structures provide 4-5 time higher yields with export quality produce, high water and fertilizer use efficiency and round the year production facility in any part

of the country. Polyhouses enable off-season production, improve crop quality, and increase yield significantly. However, they require high initial investment and technical expertise. They are widely used for cultivating high-valued vegetables and flowers like Tomatoes, Bell peppers, Cucumber, Roses, Chrysanthemums, Carnations, Anthuriums, Gerbera etc.

Shade Net House

Shade net houses are covered with synthetic nets that reduce solar radiation and temperature. These structures are cost-effective and suitable for nursery raising of crops and leafy vegetables. Shade nets generally use two colour nets (green and black) in horticulture-based farming systems. Both colour shade nets are available in 30, 50, 75 and 90% capacity of shading protection.



This structure enhances 25-35% more yield as compared to traditional methods during peak summer season. Suitable crops identified for shade net houses from economic viability include horticulture nurseries, leafy vegetables, summer tomato and capsicum. Because these systems are mainly used to grow off-season cultivation of crops, their produce fetches much higher prices in the market, hence providing good economic returns to growers, thereby improving livelihood and nutritional security to the farming. Although environmental control is limited, they offer protection from excessive heat and reduce water loss.

Low Tunnels and Walk-in Tunnels

Low tunnels are temporary structures made using plastic sheets supported by hoops. They are primarily used for early crop production. Plastic low tunnels are often used to promote the growth of plants during the period of winter season. Low tunnels are supported above the plants by using hoops of GI wire and a clear or transparent plastic of 20-30 micron is covered/stretched over the hoops and the sides are secured by placing in soil. The farmers can grow different varieties of summer squash (round-fruited, long-fruited), which is an emerging crop along with cultivation of netted muskmelon varieties. These structures are economical and help farmers access markets earlier, leading to better prices.

Insect-Proof Net Houses

These structures prevent pest entry while, allowing ventilation, making them suitable for organic farming systems. These structures make use of insect proof screens of different intensities of perforations, ranging from 25 mesh to 60 mesh. IPP nets of 40 or higher mesh are effective means to control entry of most flying insects and save crop from diseases. Crops suitable for these structures include tomato, cherry tomato, cucumber, bitter gourd, musk melon, summer squash, papaya, meadow and high density orcharding of mango, guava and pomegranate and strawberry etc.

KEY TECHNOLOGIES IN PROTECTED CULTIVATION

Drip Irrigation and Fertiligation

Drip irrigation delivers water directly to plant roots, while fertiligation supplies nutrients through irrigation systems. This combination improves water and nutrient use efficiency. This is one of the major tools of precision farming which effectively increase water and nutrient use efficiency thus

contributing significantly in water scarce areas, increasing production and overall livelihood upliftment through horticulture-based crops. Many of the studies also proved that the water savings of up to 50% and yield increases of 20-40%.

Hydroponics

Hydroponics (soil-less cultivation) a method of growing the plants in (a water based, nutrient rich solution), water containing fertilizers. Plants are grown with or without the use of an artificial media (sand, gravel, vermiculite, rock wool, perlite, peat moss coir, sawdust etc.). It offers high productivity and efficient land use. It is particularly suitable for urban agriculture and high-value crops such as lettuce and herbs.

Benefits:

- Saves up to 90% water compared to soil farming
- Increases plant growth rate and yield
- Ideal for urban and rooftop farming

Various crops grown under hydroponic system:

- **Vegetables:** Tomato, Lettuce, Spinach, Celery, Swiss chard, Cucumber, Muskmelon, Brinjal, Beet, Winged bean, Capsicum, Cabbage, Cauliflower, Radish, Coriander etc.
- **Flowers:** Gerbera, Rose, Orchids, Anthurium, Marigold, Carnation, Chrysanthemum, etc.
- **Fruits:** Strawberry, Raspberry etc.

Sky Farming

Sky farming or vertical farming is the practice of growing crops in vertically stacked layers. It often incorporates controlled environment agriculture, which aims to optimize plant growth, growth, and soilless farming techniques such as hydroponics, aquaponics, and

aeroponics.

Climate Control Systems

Climate control systems in protected cultivation are technologies used to maintain optimal environmental conditions for plant growth by regulating temperature, humidity, light, carbon dioxide, and irrigation. These systems include heating and cooling methods such as ventilation, exhaust fans, evaporative cooling, fogging, and shading, along with automated irrigation and fertigation systems controlled through sensors and smart controllers. Proper climate control improves crop yield, quality, water-use efficiency, and year-round production while, reducing pest and disease incidence. Depending on the level of technology, systems may range from simple naturally ventilated structures to fully automated smart greenhouses using IoT and AI-based monitoring. Protected cultivation with climate control is widely used for crops like tomato, capsicum, cucumber, flowers, and other high-value crops, especially in regions with variable climatic conditions.

ECONOMIC IMPACT AND INCOME GROWTH

- **Higher Productivity:** Yields increase by 2-5 times compared to open-field farming
- **Off-Season Production:** Farmers can produce crops when market supply is low.
- **Improved Quality:** Uniform produce fetches premium prices.
- **Resource Efficiency:** Reduced water and fertilizer use lowers costs.

GOVERNMENT SUPPORT AND POLICIES

Presently, various state Govts extend financial support in the form of subsidies to the growers upto 1 acre of structure costing approximately Rs. 35-40 lakhs of which about 50% of the cost is borne by

Central Govt. with sizable and additional subsidies from State Govts which include the cost of structure, drip irrigation and fertigation system and seed/planting material etc. The Smart Precision Horticulture Programme under the Mission for Integrated Development of Horticulture (MIDH) has allocated Rs. 60.0 billion to cover 15,000 acres and benefit 60,000 farmers between 2024 to 2029.

CONCLUSION

Protected cultivation technologies offer a sustainable and profitable approach to modern agriculture. By enabling controlled environment farming, they ensure higher productivity, better quality produce, and year-round cultivation. Although initial investment and technical requirements pose challenges, government support and proper market linkages can make protected cultivation highly viable. Strategic adoption of these technologies can significantly enhance farmers' income and contribute to agricultural sustainability. Protected cultivation is expected to expand with advancements in automation, precision agriculture, and IoT-based monitoring systems. Integration of digital technologies can enhance efficiency, reduce labor dependency, and improve decision-making. Further, there is a need to convert 10% of the greenhouses into hydroponics/aeroponics with a controlled environment, which can save approximately 15-20% fertilizer and water requirements. To attain the sustainable food system by 2047, our target may be to cut nutrient losses by 50% and reduce fertilizer use by at least 20% by using the protected cultivation.

