



Protected Cultivation: A New Era in Vegetable Farming

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INTRODUCTION

Vegetables play a vital role in human diet, providing various types of nutrients such as vitamins, minerals, dietary fibers and antioxidants. Population growth, urbanization, along with rising health consciousness in the world has posed a great demand for fresh vegetables round the year. However, traditional open-field cultivation is prone to climatic uncertainties including drought, flood, heat wave, frost and unseasonal rain which are getting more aggravated with the prevailing climate change scenario. Protected cultivation is a climate-smart and resource efficient technique for crop production in which crops are cultivated in a controlled environmental condition. By modifying microclimate condition, it positively influences crop growth, production, quality, resource-use efficiency and off-season production, among others. Also, with the advent of new technologies (automation, sensors, precision farming, etc.), its potential has further increased, making protected cultivation a technology that shows potential for the production of sustainable and profitable vegetables in the next generation.

Concept and Principles of Protected Cultivation

Protected farming provides a suitable microenvironment by controlling temperature, humidity and light, and the growing environment can be maintained from early stage to maturity. Crop production under protective structures protects crops from extreme cold, heat, heavy rain, hail, strong wind, frost, and over exposure to the sun, and it mitigates production risks and potential crop loss. Furthermore, the use of precision technologies (drip irrigation and fertigation) further contributes the water, fertilizer, energy and labor efficiency. Physical methods such as the use of insect-proof nets also contribute to a reduction in pest and disease pressure, and therefore the need for chemical pesticides. Together, these benefits enhance photosynthesis, nutrient absorption, flowering, fruit set, and overall crop performance, resulting in increased yield and superior-quality output.



Types of Protected Cultivation Structures Greenhouses

The greenhouse is a fixed structure of the protected cultivation, which is covered with a transparent material like glass or polyethylene films allowing penetration of sunlight to warm the plants and air inside, thus a good microclimate for plants is created. Based on the degree of environmental control, greenhouses can be divided as follows: naturally ventilated green houses, fan-and-pad green houses and climate-controlled green houses, all of these providing the best conditions for growing crops with the highest yield and quality.

Glasshouses

This allows for the efficient control of environmental parameters, including

temperature, humidity, light and air flow, which can be adjusted to the needs of the plants to maximize their growth, and for high-value vegetable crops with exceptional yield and quality.

Polyhouses

Polyhouses are the most popular type of protected cultivation structure in India, with a frame covered with ultraviolet (UV)-stabilized polyethylene films and either naturally ventilated or climate controlled. This is mainly because they are cheaper to build than glasshouses and they have the potential to increase crop production, improve quality of produce, lengthen the cropping period and protect effectively from unfavourable climatic conditions and environmental variations.



Shade Net Houses

Shade net houses are covered with colored or neutral shade nets that control solar radiation and temperature, suitable for high sunlight intensity and high temperature areas. They reduce heat stress, increase seedling production, enhance vegetative growth, and save water by minimizing evapotranspiration. They therefore improve crop yield and resource-use efficiency in the face of adverse climatic conditions.



Insect-Proof Net Houses

The insect-proof net houses are enclosed with fine mesh nets, which is an effective barrier to insect pests and provides sufficient air flow and ventilation. These constructions drastically decrease the use of pesticides, the rate of insect-transmitted viral diseases, the quality of the produce is enhanced and the production of the vegetable is environmentally sustainable.

Low Tunnels and Walk-In Tunnels

Low tunnels are cost-effective protected environment structures made by placing plastic-covered hoops over crop rows, thereby generating a favorable micro climate. Low

tunnels have been used extensively for season extension, frost protection, early vegetable production, for better seed germination and crop establishment and for early crop growth.



Importance of Protected Cultivation in Vegetable Farming

1. Year-round vegetable production
2. Off-season cultivation
3. Higher crop productivity and yield
4. Improved quality of produce
5. Efficient utilization of water and nutrients
6. Protection from adverse weather, pests, and diseases
7. Higher profitability and income generation for farmers

Improved Quality Produce

Quality of vegetables is improved under protected environment by way of uniform size, good colour, better texture, higher nutrient and less physical injuries. The higher quality of produce from the protected environment results in better market acceptance and farmers are

able to get higher prices in the domestic and export markets.

Efficient Water Management

- 30-70% water saving
- Lower evaporation losses
- More efficient irrigation
- Enhanced water-use productivity



Reduced Pest and Disease Incidence

Protected cultivation acts as a physical barrier to many insects and disease vectors, limiting their ingress and movement throughout the crop. Integrated with pest management strategies (e.g., biocontrol and monitoring), they contribute to an acceptable level of pest and disease incidence. This translates into decreased crop losses, pesticide inputs, enhanced produce quality and environment friendly vegetable production.

Climate Change Adaptation

Climate change has led to more frequent and intense extreme weather events, making it difficult for vegetable producers. Protected cultivation improves the crop resistance by protecting plants from unfavorable environmental factors and providing a beneficial microenvironment. Therefore, it is considered as a climate-smart technology that enables sustainable and resilient vegetable production in the face of changing climate.

Suitable Vegetable Crops for Protected Cultivation

Fruiting Vegetables	Leafy Vegetables	Exotic Vegetables
Tomato	Lettuce	Broccoli
Sweet Pepper (Capsicum)	Spinach	Colored Capsicum
Cucumber	Kale	Zucchini
Brinjal	Celery	Chinese Cabbage
Chilli	Swiss Chard	Iceberg Lettuce
Cherry Tomato	Arugula	Baby Corn

Resource Conservation through Protected Cultivation

Protected cultivation ensures more efficient use of water, nutrients, land and energy with the help of technologies like mulching, fertigation,

drip irrigation, renewable energy systems etc. Such management of resources leads to better resource-use efficiency, higher productivity and lower cost of production eventually resulting in higher profits and sustainability in vegetable production.

The technology enables:

- Higher yields
- Off-season production
- Premium market prices
- Reduced crop losses
- Improved product quality
- Increased profitability

CONCLUSION

Protected cultivation has brought about a new dimension in vegetable farming, leading to its

diversification and intensification in terms of year-round production, enhanced productivity, and quality of produce along with resource use efficiency. It provides a sustainable and climate-resilient production system by protecting crops from climatic vagaries and biotic stresses. To this end, the advances in protected cultivation technology and its expanding application base promise that protected cultivation will become a key factor in ensuring the future production of vegetables, profitability, and food and nutrition security.