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Protected Cultivation of High-Value Fruit Crops: A Profitable and Climate-Resilient Technology for Modern Horticulture

*Korani Harini¹, Jingyasha Meher², Vijay Kumar Vimal³ and Tanya Jain⁴

¹Ph.D. Scholar, Department of Fruit Science, Sardar Krushinagar Dantiwada Agricultural University, Jagudan, Gujarat, India

²SMS (Horticulture), Krishi Vigyan Kendra, Deogarh, Odisha-768119, India

³Scientist (Horticulture), Krishi Vigyan Kendra, Kotwa, Azamgarh-I, U.P., India

⁴Assistant Professor, Gyanveer University, Sagar, Madhya Pradesh, India

*Corresponding Author's email: harini.arjunkerani09@gmail.com

Agriculture in the present era is facing multiple challenges due to climate change, shrinking agricultural land, water scarcity, and increasing production costs. These challenges have made traditional open-field cultivation increasingly uncertain, particularly for horticultural crops that are highly sensitive to climatic fluctuations. High-value fruit crops such as strawberry, blueberry, raspberry, kiwi, and dragon fruit require specific environmental conditions for optimum growth and quality fruit production. Even slight variations in temperature, humidity, or rainfall can reduce both yield and quality, leading to economic losses for farmers. In this context, protected cultivation has emerged as an effective and innovative solution. It is a modern production technology in which crops are grown under structures like polyhouses, greenhouses, shade net houses, and tunnels, where the growing environment can be partially or fully controlled. This system protects plants from adverse weather conditions and creates favorable conditions for better growth, higher productivity, and improved fruit quality. Protected cultivation not only enables off-season production but also ensures higher economic returns, making it a promising approach for the cultivation of high-value fruit crops.

Concept of Protected Cultivation

Protected cultivation refers to the cultivation of crops under a protected environment where climatic factors such as temperature, humidity, light intensity, and soil moisture are regulated to meet the specific requirements of the crop. The main objective is to reduce the negative impact of external environmental conditions and create an ideal microclimate for plant growth. Under protected structures, crops are shielded from excessive rainfall, strong winds, frost, and heat stress. This is especially important for high-value fruit crops, which are often delicate and require precise growing conditions. By controlling the microclimate, farmers can ensure uniform growth, better flowering, and improved fruit development.

Need for Protected Cultivation in High-Value Fruit Crops

High-value fruit crops are economically important because they fetch premium prices in the market due to their superior taste, nutritional value, and consumer demand. However, these crops are generally more sensitive to environmental stresses than field crops. For example, strawberry fruits are prone to rotting under high humidity, while blueberry requires acidic soil and moderate temperatures. Similarly, crops like raspberry and kiwi require specific climatic conditions that may not be naturally available in all regions. Protected cultivation helps overcome these limitations by providing an optimum environment for these crops. It also facilitates **year-round cultivation**, enabling farmers to supply fruits during off-season

periods when market prices are high. This leads to greater profitability and market competitiveness.

Types of Protected Structures

Several types of structures are used in protected cultivation depending on the crop requirements, climatic conditions, and investment capacity.

1. Polyhouse

A polyhouse is a framed structure covered with transparent polyethylene sheets. It traps solar radiation inside and creates a warm environment suitable for plant growth. Polyhouses can be naturally ventilated or climate-controlled. These structures are highly suitable for strawberry and other delicate fruit crops.



2. Greenhouse

Greenhouses are more advanced protected structures equipped with automated systems for controlling temperature, humidity, and irrigation. Though costly, they provide ideal conditions for growing premium-quality fruits.



3. Shade Net House

Shade net houses are covered with woven plastic nets that reduce sunlight intensity and protect plants from excessive heat. These are useful for nursery production and for crops that require partial shade.



4. Low Tunnels

Low tunnels are simple and low-cost structures made with hoops covered with plastic film. They are mainly used for early season cultivation and frost protection. Each of these structures offers specific advantages, and their selection depends on the crop and local climatic conditions.



Advantages of Protected Cultivation

Protected cultivation provides several advantages that make it highly suitable for high-value fruit production.

1. Higher Productivity

By maintaining favorable environmental conditions, plants grow more vigorously and produce higher yields compared to open-field cultivation. Yield increases of 2 to 3 times are commonly reported under protected structures.

2. Better Fruit Quality

Fruits grown under protected conditions have better size, shape, color, and taste. They are also cleaner and free from damage caused by rain, wind, or dust.

3. Off-Season Production

Protected cultivation allows farmers to grow fruits during periods when open-field cultivation is not possible. This off-season production enables farmers to obtain premium market prices.

4. Efficient Use of Water and Nutrients

Drip irrigation and fertigation systems used under protected cultivation provide water and nutrients directly to the root zone, reducing wastage and improving resource efficiency.

5. Reduced Pest and Disease Incidence

The protected environment limits the entry of pests and reduces disease occurrence, resulting in lower pesticide use and safer produce.

6. Higher Economic Returns

Although the initial investment is high, the combination of higher yield, superior quality, and premium prices results in significantly greater profits.

Crop Management Practices

Successful protected cultivation of high-value fruit crops requires proper management of several factors.

Microclimate Management: Temperature and humidity inside the protected structure must be carefully regulated using ventilation, foggers, and shade nets. This ensures optimum conditions for plant growth and fruit development.

Irrigation and Fertigation: Drip irrigation is essential for providing precise amounts of water. Fertigation allows soluble fertilizers to be applied through irrigation water, improving nutrient use efficiency.

Mulching: Mulching with plastic sheets conserves soil moisture, suppresses weeds, and improves fruit cleanliness.

Training and Pruning: Crops like kiwi and raspberry require regular pruning and training to maintain plant shape and improve light penetration.

Pollination: In protected environments, natural pollinators may be absent. Therefore, beehives or manual pollination methods are used to ensure proper fruit set.

Economic Viability: Protected cultivation requires investment in structure construction, irrigation systems, and quality planting material. Although the cost is higher than open cultivation, the returns are substantially greater. For example, strawberry grown under polyhouse conditions can yield significantly higher profits due to better quality and off-season availability.

Government support through subsidies under various horticulture schemes has made protected cultivation more affordable for farmers. This financial assistance encourages adoption among small and medium-scale growers.

Challenges in Adoption

Despite its benefits, the adoption of protected cultivation faces certain constraints:

- High initial investment cost
- Lack of technical knowledge among farmers
- Requirement for skilled labor
- Maintenance costs of structures
- Market fluctuations affecting profitability

These challenges can be addressed through training programs, extension services, and better market linkages.

Future Scope

The future of protected cultivation in India is very promising. With increasing demand for high-quality fruits and growing awareness among farmers, this technology is likely to expand rapidly. Integration of modern tools such as automation, sensors, and artificial intelligence can further improve efficiency and reduce labor requirements. Protected cultivation is particularly important in the context of climate change, as it helps mitigate the effects of erratic weather and ensures stable production. As the horticulture sector continues to grow, protected cultivation will play a crucial role in meeting consumer demand for premium fruits.

Conclusion

Protected cultivation of high-value fruit crops is a modern, profitable, and climate-resilient farming technology. It offers numerous benefits, including higher productivity, superior fruit quality, efficient resource use, and better market opportunities. Although the initial cost and technical requirements may pose challenges, the long-term economic benefits make it a highly viable option for progressive farmers. With continued technological advancements and institutional support, protected cultivation has the potential to transform the future of fruit production in India.