

# Protected Cultivation Techniques for Enhancing Income



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## INTRODUCTION

Over 70% of Indian agriculture is rainfed and dominated by small and marginal farmers, who are highly vulnerable to the vagaries of climate. Climate change affects the agricultural ecosystem by eroding topsoil, altering the hydrological cycle, disrupting flora and fauna, and modifying cropping cycles and yields. Given these constraints, traditional openfield agriculture is increasingly unable to meet the dual mandates of national foodnutritional security and farmer economic prosperity. To achieve the required production targets, technologies such as precision agriculture, regenerative agriculture, vertical farming, soilless cultivation,

and intensified and diversified cropping systems are essential.

As of 2023, only about 50,000–60,000 hectares out of 28 million hectares under horticulture are under protected cultivation, representing roughly 0.2% of horticultural production. This indicates substantial scope to expand protected cultivation to enhance sustainable food and nutritional security with improved inputuse efficiency. Climate resilient and technologydriven agricultural practices must be adopted to maximize yield and economic returns per unit of input cost. In this context, protected cultivation has emerged as a transformative and highly viable

strategic intervention.

Protected cultivation encompasses a range of protective structures such as low tunnels, walkin tunnels, shade nets, climatecontrolled greenhouses, and modern vertical farming systems that provide full or partial control over the growing environment. By creating a physical barrier between the plant canopy and the external climate, these structures buffer crops against adverse weather fluctuations, including temperature extremes, strong winds, intense ultraviolet radiation, and unseasonal rainfall. The closed nature of these systems also reduces pest infestations and vectorborne viral diseases, thereby lowering dependence

on agro-chemicals and supporting safer, high quality food production. Protective covers such as shade nets and polyfilms filter light intensity and diffusion inside the structures, significantly enhancing photosynthetic activity and maintaining optimal light levels (30,000–50,000 lux) on plant leaves.

These structures can be integrated with precision agriculture technologies, enabling site and plantspecific input management. The controlled environment is particularly suited to advanced microirrigation and automated fertigation systems. Through drip irrigation networks, water and watersoluble fertilizers including calculated NPK combinations are delivered directly to the active root zone at optimal concentrations and frequencies. This minimizes nutrient leaching, reduces ground water extraction, and improves nutrient use efficiency. Studies indicate fertilizer and water savings of 20–40% in openfield cultivation and 25–50% under protected cultivation.

The economic potential of adopting protected cultivation in India is substantial. Agronomically, it overcomes the traditional constraints of seasonality, enabling yearround production of high value, short duration crops, exotic greens, and floricultural products. By aligning crop harvests with periods of low market supply and higher prices, farmers can realize significantly higher incomes. The controlled environment also reduces physical blemishes and size variability caused by weather and pests, resulting in produce with superior quality, uniformity, and extended shelf life. This improved quality helps farmers meet the standards of organized retail chains, supermarkets,



*Coloured capsicum cultivation inside a forced ventilated polyhouse*

and export markets, thereby enhancing gross income. Although agronomic and gross returns are markedly higher, protected cultivation is capitalintensive, with significant upfront costs for structures and recurring operational expenses for climate control, fertilizers, and system maintenance. This requires rigorous financial appraisal before scaling. Moreover, successful operation depends on specialized farmer skills, necessitating targeted training in intensive crop scheduling, microclimate management, and advanced postharvest handling. A few examples of economics of different types of protected cultivation techniques are given below.

### **FORCE VENTILATED POLYHOUSE CULTIVATION**

A force ventilated polyhouse is a GI structure covered with polyfilm and has provision of exhaust fans and cellulose pads for regulating temperature and foggers for humidity. These are climate smart structures which can be integrated with sensors and automation for micro-climate control enabling year round cultivation of high value crops.

The procurement and installation cost of a forcedventilated polyhouse

over a 500 m<sup>2</sup> area for a farmer is approximately Rs.9,00,000 (Rs.1,800/M<sup>2</sup>). With a structure lifespan of 10 years, the annual depreciation cost amounts to Rs.90,000. For a tomato-colored capsicum cropping system, recurring annual costs for labour, seedlings, fertilizers, electricity, and other inputs are estimated at about Rs.2,10,000. Assuming yields of 10 tonnes of tomato and 6 tonnes of colored capsicum per 500 m<sup>2</sup>, and market prices of Rs.20 per kg for tomato and Rs.60 per kg for colored capsicum, the total annual revenue is Rs.6,00,000. Under state and central government schemes, farmers can avail subsidies of up to 50% for polyhouse construction and microirrigation systems. After accounting for depreciation and recurring costs, the farmer can earn approximately Rs.3,00,000 per year from roundtheyear cultivation in a small 500 m<sup>2</sup> poly-house, with a benefitcost (B:C) ratio in the range of 1.5–2.0.

### **CABLE AND POST SHADE NET CULTIVATION**

A cable and post shade net consist of GI columns connected by high tensile wire grid covered by insect proof net/shade net and is primarily used for extreme summer climate. It is a cheaper



*Cucumber cultivation inside a cable and post shade net*

alternative to polyhouses which provides protection from sun and wind and partially from rainfall. It is easy to install and maintain as compared to force ventilated poly-houses.

A farmer opts for a cable and post shade net structure over a 500 m<sup>2</sup> area, with a material and construction cost of Rs.2,50,000 (Rs.500 per square meter). Assuming a lifespan of 5 years, the annual depreciation cost is Rs.50,000. With a cropping pattern of growing cucumber twice and leafy vegetables during the summer season, the annual operational cost is approximately Rs.1,30,000. Assuming yields of 9 kg per square meter for cucumber and 3 kg per square meter for leafy greens, and market prices of Rs.20 per kg for cucumber and Rs.40 per kg for leafy greens, the total annual revenue is approximately Rs.2,40,000.

Under state and central government schemes, farmers can avail subsidies of up to 50% for shadenet structures, microirrigation systems, and related components. After accounting for depreciation, operational costs, and the applicable subsidy, the farmer can earn approximately Rs.90,000 per year from round the year cultivation under the shadenet structure.

### HYDROPONICS CULTIVATION

Hydroponics is a soilless cultivation technique in which nutrient solution is directly supplied to roots of plants which are often supported by media like coco-peat, saw dust, clay balls etc. This technique can reduce water consumption upto 90% as compared to traditional farming and provides control over root environment (EC and pH), multiple vertical stacking and accelerated growth.

A farmer adopts a soilless cultivation technique i.e. hydroponics in a small polyhouse or structure of 100 m<sup>2</sup>. A total of 15 setups, each with a three layer configuration of 1 m × 2.5 m and accommodating 150 plants, can be installed and operated satisfactorily for crops such as leafy vegetables and strawberry. A cropping pattern of strawberry (October–February) and leafy vegetables for the rest of the year requires an approximate capital investment of Rs.1,00,000 in setups and an annual operational cost of Rs. 50,000. With a setup lifespan of 5 years, the annual depreciation cost is Rs.20,000. A well monitored and maintained system can yield 10–15 straw berries per plant, with an average fruit weight of 10 g. Leafy vegetables can be harvested at about 100–150 g per plant. At a market price of Rs.50 per

200 g for strawberries and Rs.50 per kg for leafy vegetables during the summer season, the system can generate a total revenue of approximately Rs.55,000–60,000 from strawberry and Rs.10,000–15,000 from leafy vegetable production.

### GOVERNMENT OF INDIA INITIATIVES AND WAY FORWARD

To enhance the adoption of protected cultivation techniques, the Government of India has put in place a robust policy framework. Financial interventions led by the National Horticulture Board (NHB) and the Mission for Integrated Development of Horticulture (MIDH) provide substantial capital subsidies to offset the high initial infrastructure costs associated with protected cultivation. In addition, subsidies for microirrigation systems can be availed under the Per Drop More Crop (PDMC) scheme, implemented through the Rashtriya Krishi Vikas Yojana (RKVY). Despite these targeted measures, widespread adoption among Indian farmers remains limited due to complex cost-benefit dynamics and perceived investment risks.

To maximize the area under protected cultivation by 2050, the agricultural framework must shift towards smart agronomic ecosystems powered by advanced sensor and AI-enabled technologies. Future engineering efforts should prioritize the development of AI and IoT-integrated fertigation controllers that use sensor-based canopy data and real-time soil moisture mapping to enable dynamic microdosing and thereby maximize nutrient-use efficiency. Moreover, the revisions to MIDH cost norms in future may subsidize these technology-driven ecosystems by updating precision farming guidelines



*Strawberry cultivation under hydroponics cultivation*

to support financially the inclusion of automated fertigation units, closed-loop IoT climate controllers, and automated polyhouse operations as standard components of high-tech protected cultivation systems.

