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Protected Cultivation: A Technological Pathway to Livelihood Security in Uttarakhand Hills

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ABSTRACT

Protected cultivation, an advanced agricultural technique, offers significant potential for enhancing livelihood security in the hill regions of Uttarakhand, India. This review examines the adoption of protected cultivation technologies, such as polyhouses, and their impact on agricultural productivity and income generation in Uttarakhand's hilly terrain. Drawing on data from government sources, it highlights key schemes, their implementation status, and the challenges faced by farmers. The findings suggest that while protected cultivation boosts yields and income, its widespread adoption requires sustained subsidies, training, and institutional support.

Keywords: *Protected Cultivation, Livelihood Security, Hill farming, Uttarakhand, Technological Interventions.*

Introduction

Uttarakhand, a predominantly mountainous state in northern India, faces unique agricultural challenges due to its rugged terrain, limited arable land, and susceptibility to climate variability. With only 14% of its 5.35 million hectares of geographical area cultivable (Department of Horticulture, Government of Uttarakhand, 2024), traditional farming struggles to ensure livelihood security for its 78% agriculture-dependent population (Kumar et al., 2021). Protected cultivation—using structures like polyhouses and shade nets—offers a solution by enabling year-round production of high-value crops (HVCs) such as vegetables and flowers. This article reviews the status, data, and government schemes supporting this technology in Uttarakhand's hill regions, emphasizing its role in enhancing livelihood security.

Protected Cultivation: Includes greenhouses, polyhouses, or net houses, which improve yield by controlling temperature, pests, and humidity. Yields depend on factors like crop variety, soil quality, irrigation, and farming practices.

Protected cultivation in Uttarakhand has gained traction due to its ability to mitigate weather risks and

improve productivity. According to the Department of Horticulture (2024), the state's diverse agro-climatic zones, ranging from subtropical plains to temperate hills, are ideal for growing off-season vegetables and flowers under controlled conditions. A study by Kumar et al. (2021) in the Almora and Dehradun districts found that the protected cultivation of crops like tomato and capsicum yielded 200-300% higher returns per unit area compared to open-field farming.

Table 1: Crop Yield & Income Comparison: Open vs. Protected Cultivation (2023–24)

Crop	Yield (Open) Q/ha	Yield (Protected) Q/ha	Income (Open) ₹/ha	Income (Protected) ₹/ha
Tomato	200–300 q	500–700 q	1.8–2.5 lakh	5–7 lakh
Capsicum	150–250 q	400–600 q	1.5–2.2 lakh	4–6 lakh
Cucumber	150–200 q	400–500 q	1.2–1.8 lakh	4–5 lakh
Spinach	80–100 q	150–200 q	1–1.5 lakh	2.5–3.5 lakh
Bell Pepper	120–180 q	350–450 q	2–3 lakh	6–8 lakh
Ashwagandha	4–5 q (roots)	6–8 q (roots)	6–8 lakh	9–12 lakh
Tulsi (Holy Basil)	10–12 q (herbage)	15–20 q (herbage)	2–3 lakh (leaves)	5–6 lakh (oil)
Aloe Vera	100–120 q (leaves)	150–200 q (leaves)	2–3 lakh (gel)	4–5 lakh (gel)
Stevia	8–10 q (dry leaves)	12–15 q (dry leaves)	3–4 lakh	5–7 lakh

Data Source: NHB 2023 Report, ICAR Protected Cultivation Guidelines
NMPB 2022–23 Report
NHB Post-Harvest Guidelines, NMPB & CSIR

Protected cultivation offers significant potential for vegetables and medicinal crops, enhancing yields and quality but requiring careful economic analysis. For vegetables like tomatoes and capsicum, controlled environments double or triple yields, while spinach benefits from shade nets, increasing marketable output by 50–60%. However, high infrastructure costs (₹10–15 lakh/ha) reduce farmer net profits by 30–40%, necessitating subsidies.

Medicinal crops also thrive under protected cultivation—Ashwagandha achieves 30–40% higher root biomass, Tulsi produces 150–200 kg/ha oil (vs. 80–100 kg/ha open-field), and Aloe Vera gains 50% yield improvement by avoiding fungal issues.

The original dataset's omission of medicinal crops and unclear yield metrics highlights data gaps. Research should focus on cost-benefit analysis, such as ₹2–4 lakh/ha net profit for tomatoes or ₹7 lakh/ha for Ashwagandha. Policies should integrate AYUSH Ministry subsidies and region-specific strategies, especially for small and marginal farmers in Uttarakhand's 7.41 lakh hectares of cultivated land.

Government Schemes and Status

The Government of India and the state have introduced schemes to promote protected cultivation. The National Horticulture Mission (NHM), implemented through the State Horticulture Mission (SHM), provides a 50% subsidy for polyhouse construction and planting materials (Department of Horticulture, 2024). In Uttarakhand, the SHM has facilitated the establishment of 1,200 polyhouses by 2023, covering 50 hectares (Agriculture Department, 2025).

Table 2: Status of Protected Cultivation Schemes in Uttarakhand (2020-2023)

Schemes	Units Established	Area Covered (ha)	Subsidy Disbursed (₹ Lakh)	Beneficiaries
NHM (Polyhouses)	8,500+	~4,000	~59,265	20,000+
HMNEH (Shade Nets)	2,300+	~1,200	~20,945	5,500+
State Subsidy Program (e.g., Karnataka)	500	25	1,200	600

Data Source: MIDH Annual Report 2021–22, Agriculture Department (2025); Department of Horticulture (2024)

The National Horticulture Mission (NHM), under the Mission for Integrated Development of Horticulture (MIDH), has significantly expanded protected cultivation infrastructure across India. As per the MIDH Annual Report 2021–22, polyhouses and shade nets cover 4,178 hectares, with subsidies amounting to ₹592.65 crore, far exceeding previous estimates of 1,200 units and ₹600 lakh. State reports from Maharashtra and Gujarat indicate 8,500+ units and 20,000+ beneficiaries, highlighting the program's vast reach.

Similarly, the Horticulture Mission for Northeast & Himalayan States (HMNEH) has developed 1,180 hectares of protected cultivation, backed by ₹209.45 crore in subsidies. The higher per-hectare subsidy (₹17.75 lakh/ha vs. NHM's ₹14.18 lakh/ha) reflects the region's logistical and terrain challenges. State programs, like Karnataka's Polyhouse Scheme, provide 50–60% subsidies, with ₹1.2 crore allocated for 25 hectares in 2023. However, subsidy distribution varies by state, requiring precise, year-wise verification for accurate representation

The Horticulture Mission for North East and Himalayan States (HMNEH) also supports training and infrastructure development. However, only 20% of eligible farmers in Almora have adopted polyhouses, indicating limited outreach (Kumar et al., 2021).

Discussion

Protected cultivation significantly enhances livelihood security by increasing yields and income, as evidenced by Table 1. However, its capital-intensive nature and knowledge requirements pose adoption barriers. Small and marginal farmers, predominant in Uttarakhand, rely heavily on subsidies, yet the schemes' coverage remains inadequate. The success in Almora and Dehradun suggests scalability, but challenges like limited training, poor market linkages, and subsidy accessibility persist. Government data indicate progress, but the gap between potential and actual adoption underscores the need for broader institutional support.

Conclusion

Protected cultivation holds transformative potential for enhancing livelihood security in the hill regions of Uttarakhand by enabling year-round vegetable and floriculture production under controlled conditions. However, as highlighted by Rana et al. (2022), the limited scale of current initiatives and infrastructural gaps hinder its wide-scale adoption. Government schemes such as the Mission for Integrated Development of Horticulture (MIDH) have made strides, but further integration with localized extension

networks is imperative to ensure continuity and scalability.

Strengthening agricultural extension through Krishi Vigyan Kendras (KVKs) has been demonstrated to significantly influence farmer adoption of protected cultivation practices. As Pawar (2023) noted, capacity-building activities, when localized and context-sensitive, result in better adoption of innovations and improved productivity. Continuous engagement through training and demonstrations should thus be expanded in Uttarakhand's hill districts.

Subsidies remain a cornerstone for adoption, yet their procedural complexity limits access, particularly among smallholders. Gulati et al. (2021) emphasized the need to rationalize subsidy delivery using digital platforms and geo-tagged verification for greater transparency and coverage. Simplifying this process will bridge the equity gap in access to resources.

The promotion and formalization of Farmer Producer Organizations (FPOs) further present a scalable solution. As shown in the case studies compiled by Valamannavar et al. (2022), FPOs significantly boost farmers' market leverage, reduce input costs, and enhance post-harvest value addition. This collective framework can mitigate the high transaction costs faced by hill farmers and foster better integration with markets.

Moreover, integrating ICT tools for real-time monitoring of protected cultivation schemes, as proposed by Sati (2024), can enhance governance efficiency, reduce leakages, and improve farmer trust in institutions. In conclusion, a multipronged strategy—enhancing extension services, sustaining subsidies, empowering FPOs, and deploying digital tools—will unlock the full potential of protected cultivation and ensure resilient rural livelihoods in the fragile Himalayan ecosystem.

Recommendations

To strengthen the agricultural sector and enhance the effectiveness of policy interventions, it is essential to focus on expanding training programs through Krishi Vigyan Kendras (KVKs) and Indian Council of Agricultural Research (ICAR) institutes. This would significantly improve farmers' technical skills and enable the adoption of modern practices. Additionally, increasing subsidy coverage and simplifying the process of access—particularly for small and marginal farmers—will ensure equitable distribution of benefits and encourage broader participation in government schemes. The promotion of Farmer Producer Organizations (FPOs) should be prioritized, as they can play a vital role in aggregating demand for inputs and enhancing farmers' bargaining power in markets. Finally, integrating digital tools and platforms for real-time monitoring of scheme implementation can greatly improve transparency, accountability, and timely delivery of services, thereby maximizing the intended impact of agricultural programs

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