

Unveiling margin of safety and break-even point of open vis-à-vis protected capsicum cultivation in the northwestern Himalayan state

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In the context of mitigating climate change with investment in advanced production technology, the study was conducted in 2022–23 to ascertain the impacts of open versus protected cultivation of capsicum in the northwestern Himalayan state of Himachal Pradesh. Capsicum is a high-value commercial crop, and it has a lot of scope to augment farm income. Although the initial cost for polyhouses is higher, protected cultivation delivers far better technical and economic results. The yields and net income increased by 200% and 258% respectively, compared to open field conditions. Output–input ratios (3.30 and 2.55) for protected and open are also highly prospective. A higher value of break-even point and a larger margin of safety in protected cultivation implies enhanced feasibility of additional financial involvement and resilience against production risks (yield and profitability), which could help mitigate the climatic risks. Since the return part of the technology is ascertained, the policymakers, researchers and practitioners can leverage these insights to promote these sustainable agricultural strategies among the resource-poor cultivators amidst climate uncertainties. Technical and financial support may encourage the adoption of protected cultivation, which can enhance food security and farmers' income and foster agricultural sustainability in the regions. Future research will explore the scope of diversification of crops to validate the scaling-up of the benefits of protected cultivation at macro level.

Keywords: Break-even analysis, capsicum, margin of safety, profitability, protected vis-à-vis open cultivation.

urgent need to implement resilient agricultural practices, such as protected cultivation, which entails growing crops in controlled environments using structures like polyhouses. These technologies mitigate the adverse effects of climate variability by facilitating better management of critical environmental factors, including temperature, humidity and light⁴.

Beyond climate risk mitigation, protected cultivation enhances resource use efficiency, leading to increased yields and improved economic returns, particularly for marginal and small farmers^{5–7}. Notwithstanding these positive aspects, the adoption of protected cultivation remains limited in South Asia, with India reporting only 0.04 million hectares under such practices, in stark contrast to China's 2.5 million hectares^{8,9}. This discrepancy can largely be attributed to the predominance of small and marginal farmers in the region, whose capacity to invest in advanced technologies is constrained by limited financial resources. As a crucial component of food security and income generation, vegetables are particularly amenable to protected cultivation^{10–12}. Further, in regions like Himachal Pradesh, characterised by marginalised landholdings and rugged terrain, vegetable production has lagged due to insufficient technological advancement¹³. The high costs associated with advanced technologies necessitate that resource-poor cultivators recognising the financial benefits before adopting, ideally with government support. Despite the acknowledged advantages of protected cultivation in enhancing productivity and climate resilience, a significant research gap exists regarding its application to high-value crops such as capsicum in Himachal Pradesh. Due to its high sensitivity to