Protected Cultivation as a Climate Change Mitigation Strategy for Sustainable Agriculture in Jharkhand, India

Dr Ajai Singh

Professor, Department of Civil Engineering, Central University of Jharkhand, Ranchi, India,
Email: ajai.singh@cuj.ac.in

The technologies associated with protected agriculture focus on designing and implementing controlled environments which ensures regulation of microclimate factors such as temperature, relative humidity, light, and carbon dioxide levels. Examples of controlled environments are greenhouses/polyhouses, shade net houses, and low tunnels, each being suitable for particular crops under specific environmental conditions. For instance, a greenhouse is designed to cover a specific area using UV stabilized polyethylene or polycarbonate sheets which may be naturally ventilated or have climate-controlled conditions through fan and pad systems. It is largely used for high value crops such as offseason vegetables and flowers. The greenhouses can also be provided with CO_2 generators for enriching the atmosphere to stimulate photosynthesis. Efficient soil moisture management is ensured by adoption of drip irrigation and fertigation systems which enable watering the roots efficiently. The construction of such structures includes galvanized iron or aluminum structures coupled

with tough cladding material that can withstand wind force and provide appropriate drainage and orientation. In spite of the high costs involved in the process and subsequent maintenance requirements, protected cultivation results in higher productivity and water efficiency along with the ensuring year round cultivation.

Coverage and adoption of protected cultivation in India is still limited but is growing steadily due to implementation of scheme such as Mission for Integrated Development of Horticulture. The total area under protected cultivation, as of 2026, amounts to around 5.6 million ha. China leads in this field with more than 90% share in the world production of vegetables through protected cultivation. In India, the total acreage covered under protected cultivation including that under polyhouses, greenhouses, shade-net houses, and plastic tunnels is estimated to be about 2.5-2.75 lakh ha, which is highly insignificant in terms of total cultivated area in the country as well as against other nations such as China, which exceeds 2 million ha. Thus, it may be stated that the practice of protected cultivation in India is still at a nascent stage accounting for less than 2% of the total horticultural area despite its rapid growth owing to incentives, modern technologies, and demand for high-value crops. However, the scenario regarding the adoption of protected cultivation in the state of Jharkhand stands out as being at a primitive and limited level. The main objective of using greenhouses in Jharkhand is the promotion of protected agriculture

https://doi.org/10.52151/aet2026502.1932

with an aim to increase productivity from agricultural products such as carnations, gerbera, roses, marigolds, and other exotic vegetables like tomato and capsicum. There are around 1.8 million ha of cultivated land in the state with low irrigation levels and largely rain-fed agricultural practices, there lies great potential in terms of adopting protected cultivation in Jharkhand. Currently, adoption of protected cultivation is largely found in peri-urban areas such as Ranchi, where farmers have started using polyhouses as well as shade net technology for vegetables and floriculture with technical training and subsidies provided by state governments.

The technique of protected cultivation is one of the pragmatic approaches to overcome the difficulties associated with climate change, especially in a state like Jharkhand, where agriculture is predominantly dependent on rainwater, climatic variability is rising, and irrigation facilities are still inadequate. Erratic rains and extended dry periods are some of the most significant threats posed by climate change in Jharkhand. The systems of protected cultivation, such as polyhouses and shade-net houses, make efficient use of water resources via drip irrigation and fertigation techniques, thus minimizing water usage without affecting plant development even in water-deficient situations. Protected cultivation structures help shield plants from temperature fluctuations caused by climate change by creating a stable microclimate environment through ventilation, shading, and evaporative cooling processes.

Protected cultivation provides strong quantitative evidence in addressing climate change challenges, particularly in Jharkhand where agriculture is predominantly rainfed and highly vulnerable to climatic variability. One of the most critical advantages of protected cultivation is water-use efficiency, as drip irrigation and fertigation systems can reduce water consumption by 40–70% and improve nutrient-use efficiency by 25–40%, which is highly relevant for Jharkhand where irrigation coverage is less than 10% of the net sown area. In terms of productivity, protected cultivation can increase yields by 2 to 5 times compared to open-field conditions; for instance, capsicum yields can rise from 20–30 tonnes/ha in open fields to about 80–120 tonnes/ha under polyhouse conditions. These systems reduce crop losses caused by extreme weather events such as heavy rainfall, hailstorms, and strong winds, with damage reduction ranging from 60 to 90%, while also lowering pest incidence by 30–50%. Water productivity also improves by 2–3 times, and cropping intensity increases from a single seasonal crop to 2–3 crops per year, enhancing overall land-use efficiency. Economically, farmers can achieve 3–5 times higher net returns, supported further by government subsidies of 40–60% under schemes such as MIDH. The protected cultivation enhances resource efficiency, stabilizes yields, reduces climate risks, and improves farmer income, making it a highly effective strategy for climate-resilient agriculture in Jharkhand and similar other states.

In the context of uncertain climates, protected cultivation converts threat into sustainability and scarcity into abundance. The future of farming is in controlled systems, where technological advancements enable the farmer to triumph over climatic difficulties and sustain productivity.