



Protective Irrigation Planning for Climate-Resilient Agriculture

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India, an agrarian economy, is deeply reliant on its agriculture sector, which employs nearly 42% of the workforce and contributes 17-18% to the GDP. However, agriculture in India is highly vulnerable to climate variability. With the growing impacts of climate change, especially in the form of erratic rainfall, prolonged droughts, and shifting monsoon patterns, the need for climate-resilient agricultural practices has become crucial. Protective irrigation planning emerges as a key strategy in this context, providing farmers with a reliable water source and enhancing their capacity to adapt to changing climate conditions.

Overview of Climate Change Impact on Indian Agriculture

India's agriculture is predominantly rain-fed, with over 52% of the gross cropped area depending solely on monsoons. The uneven distribution of rainfall and increased instances of extreme weather events such as droughts and floods have a profound effect on crop yields. According to the Ministry of Agriculture and Farmers Welfare (2019), droughts alone affected over 50 million hectares of agricultural land between 2014 and 2019. Additionally, the Indian Meteorological Department (IMD) reported a 6% decline in monsoon rainfall over the past 50 years, further exacerbating water stress in agricultural regions.

What is Protective Irrigation?

Protective irrigation is a form of supplementary irrigation designed to stabilize crop production under conditions of limited water availability. Instead of full irrigation, which provides the complete water needs of crops, protective irrigation delivers just enough water during critical growth stages (e.g., flowering or grain formation) to prevent crop failure and ensure minimal yields. This approach optimizes water usage by focusing on maintaining productivity under adverse weather conditions, such as droughts or insufficient monsoon rains.

Importance of Protective Irrigation for Climate-Resilient Agriculture

a) Mitigating Drought and Water Stress: Protective irrigation helps farmers mitigate the effects of erratic rainfall and drought. Given that about 68% of India's cropped area is prone to drought, it is essential to ensure that crops receive water during critical growth phases to prevent total failure. For example, crops like wheat, pulses, and oilseeds are highly sensitive to water stress during flowering and grain-filling stages. A well-designed protective irrigation system can stabilize yields even with minimal water supply.

b) Ensuring Yield Stability: Protective irrigation can ensure yield stability in water-scarce regions by offering timely irrigation during key growth stages. A study by the Indian Council of Agricultural Research (ICAR) found that crops grown with protective irrigation in drought-prone regions exhibited yield stability, with an increase of 15-20% in crop yields compared to rain-fed farming.

c) Efficient Water Use: In water-limited environments, efficient use of water is critical. Protective irrigation maximizes the impact of the limited water available, minimizing wastage while ensuring crops survive during dry spells. According to a report from the International Water Management Institute (IWMI), protective irrigation in India could increase water productivity by 25-30% if effectively implemented, allowing more crops to be grown with the same or even less water.

d) Enhancing Livelihood Security: For smallholder farmers, who make up the majority of India's agricultural sector, protective irrigation can be a lifeline. In regions with uncertain rainfall, even modest irrigation facilities can mean the difference between a viable harvest and crop failure. The World Bank estimates that nearly 60% of Indian farmers operate on less than 1 hectare of land, making them particularly vulnerable to climate impacts. By providing supplementary irrigation, farmers are better able to maintain their livelihoods and reduce the risk of economic collapse due to failed crops.

Challenges in Implementing Protective Irrigation in India

While protective irrigation offers significant potential for enhancing climate resilience, there are several barriers to its widespread adoption:

a) Infrastructure Gaps: India's irrigation infrastructure is inadequate, especially in rain-fed and drought-prone areas. According to the Central Water Commission (CWC), only 49% of India's net sown area is under any form of irrigation. Expanding irrigation facilities, particularly for smallholder farmers, is a major challenge.

b) Inefficient Water Management: India has one of the lowest water-use efficiencies in agriculture. The Food and Agriculture Organization (FAO) estimates that 60-70% of water used for irrigation is wasted due to inefficient systems, leakage, and poor management practices. This reduces the effectiveness of protective irrigation and highlights the need for improved water management practices.

c) High Costs of Drip and Micro Irrigation: Drip and micro-irrigation systems are ideal for protective irrigation but are often expensive for small farmers to adopt. Despite subsidies under schemes like the Pradhan Mantri Krishi Sinchayee Yojana (PMKSY), the upfront costs and maintenance of these systems remain prohibitive for many small and marginal farmers.

d) Lack of Awareness and Capacity Building: Many farmers are unaware of the benefits of protective irrigation or lack the technical knowledge to implement it effectively. Capacity-building programs and training are essential to ensure that farmers can use protective irrigation methods to their full potential.

Strategies for Enhancing Protective Irrigation in India

a) Expanding Micro-Irrigation Coverage: Expanding the use of micro-irrigation systems (drip and sprinkler systems) is crucial for protective irrigation. The government has already taken steps through PMKSY, which aims to increase the area under micro-irrigation by 2 million hectares per year. However, efforts must be intensified, particularly in states like Rajasthan, Maharashtra, and Madhya Pradesh, which are highly drought-prone.

b) Integrated Water Resource Management: Water resource management should be integrated at the watershed level to ensure the sustainable use of water. This involves rainwater harvesting, groundwater recharge, and the development of minor irrigation projects to provide farmers with reliable water sources during dry spells. The MGNREGA scheme (Mahatma Gandhi National Rural Employment Guarantee Act) has been used effectively in several states to develop water storage facilities, which can be used for protective irrigation.

c) Subsidies and Financial Incentives: Enhancing subsidies and financial incentives for smallholder farmers to adopt protective irrigation systems is essential. The government can partner with banks and financial institutions to provide low-interest loans for the purchase of drip irrigation equipment.

d) Promoting Crop Insurance: The Pradhan Mantri Fasal Bima Yojana (PMFBY), India's flagship crop insurance scheme, can play a key role in protecting farmers from climate risks. Linking protective irrigation practices with crop insurance could provide farmers with added security, ensuring that they can recover from climate-induced losses.

Conclusion

Protective irrigation is a vital tool in India's quest for climate-resilient agriculture. By ensuring that crops receive water during critical growth periods, protective irrigation can help stabilize yields, improve water-use efficiency, and safeguard the livelihoods of millions of smallholder farmers. However, its successful implementation requires overcoming significant challenges, including inadequate infrastructure, high costs, and a lack of awareness.

By adopting a comprehensive approach that integrates protective irrigation with micro-irrigation systems, water management, and crop diversification, India can build a more resilient agricultural sector that is better equipped to face the challenges posed by climate change.

References

1. Ministry of Agriculture and Farmers Welfare (2019). *Annual Report*.
2. Central Water Commission (CWC) (2020). *Status of Irrigation in India*.
3. Food and Agriculture Organization (FAO) (2021). *Water Management in Agriculture*.
4. Indian Council of Agricultural Research (ICAR) (2020). *Climate Change and Indian Agriculture*.
5. International Water Management Institute (IWMI) (2019). *Water Use Efficiency in Indian Agriculture*.
6. World Bank (2018). *India: Enhancing Climate Resilience in Agriculture*.