

6. Climate Resilient Agriculture- Environment

India needs climate-resilient agriculture. Climate-Resilient Agriculture (CRA) is a technology-driven approach integrating biotechnology, digital tools, and sustainable practices to maintain productivity amidst climate risks like drought and soil degradation. While crucial for India's food security given its high dependence on rainfed farming, scaling CRA faces hurdles like high costs, quality issues with bio-inputs, and gaps in farmer awareness.

Climate-Resilient Agriculture (CRA)

1. Introduction

Climate-Resilient Agriculture (CRA) is emerging as a critical, technology-driven approach to address the escalating challenges of climate change, such as unpredictable weather patterns, soil degradation, and water stress.

Core Philosophy- It utilizes biotechnology and complementary advanced technologies to guide farming practices.

Objective- To sustain or improve agricultural productivity under climate stress while simultaneously reducing dependence on chemical inputs and limiting environmental damage.

2. Key Technologies in CRA

CRA integrates biological innovations with digital tools to enhance farm resilience.

Biofertilizers

Definition- Natural fertilizers containing living microorganisms.

Function- They increase the availability of essential nutrients like nitrogen, phosphorus, and trace elements.

Benefit- Improves soil health and significantly reduces the reliance on synthetic chemical fertilizers.

Biopesticides

Definition- Biological agents including natural predators, pathogens, or biochemicals.

Function- Used to control pests and diseases in an eco-friendly manner.

Benefit- Reduces environmental harm and human health risks associated with chemical pesticides.

Soil-Microbiome Analysis

Process- Involves studying the microbial community within the soil.

Goal- To understand and optimize the complex interactions between microorganisms, plant roots, and the soil environment.

Genome-Edited Crops

Technology- Uses genetic editing techniques such as CRISPR.

Outcome- Creates crops specifically modified to tolerate climate stressors like drought, heat, salinity, and pests.

Digital Tools & AI-Driven Analytics

Integration- Combines climatic, soil, and crop data.

Outcome- Develops location-specific farming strategies that enable better decision-making and resource efficiency.

3. Key Strategies of Climate-Resilient Agriculture

To implement CRA effectively, several on-ground strategies are employed-

Climate-Adapted Crops- Promoting varieties bred for tolerance to specific stresses (e.g., Scuba Rice for submergence/flooding). Minimizes yield losses caused by extreme weather.

Soil Health Management- Adopting no-till farming and cover crops. Using organic inputs to reduce erosion, improve moisture retention, and enhance soil carbon content.

Agroforestry Systems- Integrating trees with crops and livestock. Provides shade, windbreaks, improved microclimates, and diversified farm outputs.

Crop Diversification- Shifting from monocropping to multiple cropping systems. Spreads climatic risk and stabilizes farm incomes.

Water Management- Expanding drip and precision irrigation, rainwater harvesting, and micro-irrigation. Maximizes water-use efficiency in the face of increasing water stress.

Technology Integration- Leveraging weather forecasts, AI-based advisories, and climate alerts. Enables timely decisions on sowing, harvesting, and risk mitigation.

4. The Need for CRA in India

India's agricultural landscape is highly vulnerable to climate variability, necessitating an urgent shift to CRA.

High Climate Vulnerability- 51% of India's net sown area is rainfed, accounting for nearly 40% of national food output. 75% of annual rainfall occurs during the monsoon months, increasing the frequency of drought-flood cycles.

Threat to Crop Yields- Climate models predict rice yields could decline by 3–22%, and potentially by over 30% by the end of the century under conventional practices.

Strategic and Food Security- CRA is essential to reduce dependence on food imports and strengthen strategic autonomy in the food sector.

Income Stability- Stress-tolerant crops and resilient practices shield farmers from severe income losses caused by extreme weather events.

5. Steps Taken by the Government of India

The Indian government has launched several initiatives to promote CRA

National Innovations in Climate Resilient Agriculture (NICRA)- Launched by ICAR in 2011. Demonstrates location-specific practices (e.g., system of rice intensification, zero-till wheat) in 448 climate-resilient villages. Focuses on in-situ residue management and climate-resilient varieties.

National Mission for Sustainable Agriculture (NMSA)- A core component of the National Action Plan on Climate Change. Emphasizes adaptation through Rainfed Area Development (RAD), agroforestry, and integrated farming systems.

Soil Health and Organic Farming Initiatives- Paramparagat Krishi Vikas Yojana (PKVY) and Soil Health Card Scheme. Aims to restore soil fertility by promoting organic inputs and balanced nutrient use.

Efficient Water Management (PMKSY)- "Per Drop More Crop" component under Pradhan Mantri Krishi Sinchayee Yojana. Promotes micro-irrigation (drip/sprinkler) to reduce vulnerability to droughts.

BioE3 Policy- Identifies CRA as a priority area for biotechnology-led solutions.

Institutional Support- Strong capacity building through ICAR, Department of Biotechnology (DBT), and IARI, alongside a growing private biotech ecosystem.

6. BioE3 Policy

Launch- 2024, by the Department of Biotechnology.

Objective- To set a framework ensuring the adoption of cutting-edge advanced technologies and aligning innovative research to promote Biomanufacturing.

7. Global Practices in CRA

Country	Approach and focus
United States	Integrated into federal policy via the USDA Climate-Smart Agriculture and Forestry initiative with large-scale public investment.
European Union	Embedded within the EU Green Deal and Farm to Fork Strategy, focusing on sustainability and reduced chemical inputs.
China	Emphasizes climate-tolerant crop breeding, water-saving irrigation, and agricultural digitalization.
Brazil	A leader in tropical climate-resilient crop development, supported strongly by EMBRAPA (state-owned biotech research organization).

8. Key Challenges in Scaling CRA

Despite the benefits, several barriers hinder the widespread adoption of CRA in India.

Affordability and Access Constraints- High initial costs of resilient seeds, precision tools, and digital aids limit adoption among small and marginal farmers (the majority of the agrarian base).

Quality Concerns in Bio-inputs- Proliferation of unregulated, sub-standard bio-fertilizers erodes farmer confidence and pushes them back toward chemical farming.

Knowledge and Capacity Gaps- Limited awareness, inadequate extension services, and low digital literacy prevent farmers from effectively using AI advisories and decision-support systems.

Fragmented Landholdings- Small farm sizes reduce economies of scale, making investments in mechanization and micro-irrigation less financially viable.

Institutional and Policy Coordination Issues- Weak convergence among agricultural, water, and climate policies. Inconsistent implementation at state and local levels hampers scaling.

Market and Incentive Limitations- Lack of assured markets, price incentives, or risk-sharing mechanisms for climate-resilient crops discourages the transition from conventional agriculture.

Source- <https://www.thehindu.com/sci-tech/science/why-does-india-need-climate-resilient-agriculture-explained/article70460248.ece>

