Climate-Resilient Agriculture

Mains: *GS III – Agriculture*

Why in News?

Climate change is real, and for India to continue meeting domestic food demands, agriculture needs to cope with the increasing unpredictability of the weather, declining soil health, and growing air pollution.

What is climate-resilient agriculture?

- **CRA** – Climate-resilient agriculture (CRA) uses a range of biotechnology and complementary technologies to guide farming practices and reduce dependence on chemical inputs, while maintaining or improving productivity.
- **Tools** – These tools include biofertilizers and biopesticides, and soil-microbiome analyses.
- **Techniques** – Genome-edited crops can be developed to withstand drought, heat, salinity, or pest pressures.
- **Recent developments** – In parallel, AI-driven analytics can integrate multiple environmental and agronomic variables to generate locally tailored farming strategies.

Why does India need CRA?

- **Increasing population** – India is an agricultural nation with a rapidly growing population, which places increasing pressure on the need for higher and more reliable farm productivity.
- **Rain dependent farming** – Around 51% of India's net sown area is rainfed, and this land produces nearly 40% of the country's food, making it especially vulnerable to climate variability.
- **Limitations of conventional farming** – Conventional farming methods alone may not withstand the rising stresses of climate change.
- For instance, recent modelling suggests that by the end of the century, yields of staple crops like rice could fall by 3-22%, and in worst-case scenarios by more than 30%.
- **Potential of CRA** – Climate-resilient agriculture offers a suite of technologies that can enhance productivity while protecting environmental health.
- It can also reduce India's reliance on food imports and strengthen the country's strategic autonomy in the food sector.

Where does India stand today?

- **ICRA's project** – In 2011, the Indian Council of Agricultural Research (ICAR)

launched a flagship network project 'National Innovations in Climate Resilient Agriculture'.

- **Climate resilient farming practices** – For enhancing the resilience and adaptive capacity of farmers to climate variability, location-specific climate resilient technologies such as:
  - System of rice intensification,
  - Aerobic rice,
  - Direct seeding of rice,
  - Zero till wheat sowing,
  - Cultivation of climate resilient varieties tolerant to extreme weather conditions,
  - In-situ incorporation of rice residues, etc., have been demonstrated under the project in 448 climate-resilient villages.
- **The National Mission for Sustainable Agriculture** – It has been formulated to enhance agricultural productivity, especially in rainfed areas, focusing on integrated farming, water use efficiency, soil health management, and synergising resource conservation.
- **Recent policy –** The BioE3 policy also positioned CRA as a key thematic area for the development of biotechnology-led solutions.
- India has a strong scientific capacity for CRA, supported by ICAR, DBT, IARI, and a growing private-sector biotechnology ecosystem.
- Several technologies relevant to CRA are already commercialised, especially biofertilizers, biopesticides, and microbial soil enhancers.
- **Participation of companies** – Leading companies such as Biostadt, IFFCO, GSFC, NFL, and IPL Biologicals supply bio-inputs that improve soil health and reduce chemical dependence.
- **Agritech startups** – India also has an expanding digital agriculture sector, with agritech startups offering AI-enabled advisories, precision irrigation, crop-health monitoring, and yield prediction tools.

What are other countries doing?

- **U.S –** It integrates CRA into federal policy through the USDA Climate-Smart Agriculture and Forestry (CSAF) initiative, investing billions in climate-smart practices.
- **EU –** CRA is embedded in the EU Green Deal and Farm to Fork Strategy, both aiming to reduce chemical inputs and enhance sustainability.
- **China –** The CRA strategy of China centres on climate-tolerant crop breeding, large-scale water-saving irrigation, and agricultural digitalisation.
- **Brazil** – It leads in tropical climate-resilient crop development, driven by EMBRAPA's biotechnology research.

What are the challenges faced by India?

- **Low adoption** – India faces several risks in scaling CRA, including low adoption among small and marginal farmers due to:
  - Limited access,
  - Awareness, and affordability,

    - Quality inconsistencies in biofertilizers and biopesticides that undermine trust in biological alternatives.
- **Slow reach of techniques** – The rollout of climate-resilient seeds remains slow, with the adoption of new tools such as gene editing still emerging and uneven distribution across States.
- **Digital divide** – Further, the digital divide limits the reach of precision agriculture and AI-based decision tools.
- **Ecological changes** – These challenges are compounded by ongoing soil degradation, water scarcity, and accelerating climate volatility, which may outpace current adaptation efforts.
- Fragmented policy coordination further risks slowing progress.

What lies ahead?

- The way forward requires accelerating the development and deployment of climate-tolerant and genome-edited crops, strengthening quality standards and supply chains for biofertilizers and biopesticides, and provision of digital tools and climate advisories to support adoption by small landholders.
- Financial incentives, climate insurance, and credit access are essential to support farmers during the transition.
- Above all, India needs a coherent national CRA roadmap under the BioE3 framework, aligning biotechnology, climate adaptation, and policies to deliver resilience at scale.

Reference

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