



AgriTech and Climate Resilient Technologies for Farmer Welfare

AgriTech and Climate Tech are emerging as transformative tools for enhancing farmer welfare, ensuring food security and strengthening climate resilience. These technologies integrate digital innovation, scientific advancements and climate-smart practices to improve productivity, optimise resource use, and promote environmental sustainability. AgriTech and climate-resilient technologies are reshaping Indian agriculture into a more adaptive, inclusive, and sustainable sector by enabling data-driven decision-making, strengthening Agricultural Value chains, and promoting climate-resilient farming systems. As a result, Farmers are better equipped to manage risk, enhance incomes and adopt to the growing challenges posed by climate change.

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Agriculture plays a pivotal role in the Indian economy, contributing significantly to national income, employment generation, foreign exchange earnings, and rural development. In 2024–25, the agriculture and allied sectors accounted for nearly 18 per cent of the country's Gross Value Added (GVA) and provided livelihood support to more than 46 per cent of the population.

The sector has witnessed substantial growth over the years, with its GVA increasing more than threefold, from ₹15.02 lakh crore in 2011–12 to ₹53.9 lakh crore in 2024–25 (Table 1). Although the relative share of agriculture in the economy has declined over time due to the rapid growth of the industrial and services sectors, it remains central to India's socio-economic structure by ensuring food security, sustaining rural livelihoods, and fostering inclusive growth.

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Table 1: Sector Wise Gross Value Added at Current Prices (₹ Lakh Crore)

Year	Agriculture & Allied Sector	Non-Agricultural Sector	Total GVA
2011–12	15.0	66.1	81.1
2012–13	16.8	75.3	92.0
2013–14	19.3	84.4	103.6
2014–15	20.9	94.1	115.1
2015–16	22.3	103.5	125.8
2016–17	25.2	114.5	139.7
2017–18	24.6	126.8	151.4
2018–19	30.3	141.5	171.8
2019–20	33.7	150.1	183.8
2020–21	37.1	145.1	182.1
2021–22	41.0	175.4	216.4
2022–23	44.5	202.0	246.5
2023–24	48.8	225.4	274.1
2024–25	53.9	246.3	300.2

Source: National Statistics Office, MoSPI, Statistical Report on Value of Output from Agriculture and Allied Sectors, June 2025

Need for AgriTech and Climate-Resilient Technologies

Indian agriculture is undergoing a structural transformation driven by climate change and the rising demand for food security. Increasing temperatures, erratic rainfall, frequent droughts, floods, soil degradation, and shrinking landholdings are posing serious challenges to agricultural sustainability and rural livelihoods. These challenges require innovative, technology-enabled solutions to build a more resilient and efficient agricultural system. The convergence of AgriTech and Climate Tech offers a strategic pathway for sustainable farming by enabling efficient resource use, reducing production risks, and supporting data-driven decision-making through digital and climate-responsive innovations.

Major AgriTech and Climate-Resilient Technological Interventions

India's agricultural landscape has been undergoing a rapid technological transformation through a wide range of AgriTech and Climate Tech interventions. These innovations are enhancing agricultural productivity, improving resource-use efficiency, strengthening climate resilience, and empowering farmers with real-time, data-driven solutions for informed decision-making.

Precision Farming and IoT-Based Smart Agriculture

Precision agriculture and Internet of Things (IoT)-based smart farming represent a transformative shift towards data-driven and technology-enabled agricultural practices. These systems integrate advanced technologies such as GPS, drones, sensors, satellite imagery, artificial intelligence, and automated monitoring tools to facilitate real-time tracking of soil health, crop growth, pest incidences, weather variability, and livestock management.

Major applications include smart irrigation systems, drone-based crop monitoring, soil moisture sensors, and AI-enabled forecasting and decision-support platforms. By enabling optimisation of critical agricultural inputs such as water, fertilizers, and pesticides, these technologies help reduce production costs, enhance productivity, strengthen climate resilience, and promote environmentally sustainable farming practices.

Climate-Smart Agriculture Technologies (CSAT)

In the wake of increasing climate variability and extreme weather conditions, Climate-Smart Agriculture Technologies (CSAT) have emerged as a critical approach for ensuring sustainable agricultural development. These technologies focus on enhancing productivity, resilience and reducing green house gas emission. Key practices such as crop diversification, agroforestry, conservation agriculture, organic farming, zero tillage, integrated nutrient management, and efficient water-use practices improve soil health and farm sustainability.

Weather Forecasting and Agro-Advisory Services

Weather forecasting and agro-advisory services, supported by satellite remote sensing and geospatial technologies, have become essential tools for risk-informed farming. High-resolution data on weather patterns, soil conditions, and crop health enable the generation of location-specific and timely advisories for farmers. These services support timely decision-making related to sowing, irrigation, fertilization, pest control, and harvesting, thereby minimising pest outbreaks and climate-related risks.

Disaster Preparedness and Early Warning Systems

Disaster preparedness and early warning systems have become indispensable in rural India due to the increasing frequency and intensity of natural



disasters caused by climate change and environmental degradation. Advanced technologies such as remote sensing and GIS-based platforms and digital monitoring systems enable timely warnings for floods, droughts, cyclones, landslides, and other climate-related hazards. These early warning systems help governments, local authorities, and farming communities receive timely alerts, undertake preventive measures, and respond rapidly during emergencies. As a result, they minimise loss of life, reduce crop and livestock damage, protect rural infrastructure, and ensure faster restoration of agricultural livelihoods and rural economic stability.

- Artificial Intelligence and Digital Advisory Systems in Agriculture**

Artificial Intelligence (AI) is playing a transformative role across the agricultural value chain, from production to marketing. AI-enabled systems support crop planning, yield estimation, and risk management through predictive analytics. In agricultural marketing, AI enhances price discovery, demand forecasting, supply chain efficiency, and quality assessment, thereby improving transparency and ensuring better returns for farmers. AI-driven digital platforms also facilitate direct linkages between farmers and buyers, reduce intermediaries, promote standardised grading systems, and provide real-time market information for informed decision-making and improved market access.

Government Initiatives

The Government of India has launched several initiatives to promote AgriTech and Climate-Smart Agriculture with the objective of enhancing agricultural productivity, ensuring environmental sustainability, strengthening climate resilience, and improving farmers' welfare.

The **National Mission for Sustainable Agriculture (NMSA)**, launched in 2014-15, aims to make Indian agriculture more resilient, eco-friendly, and productive, particularly in rain-fed regions. The Mission adopts a holistic approach to sustainable agricultural development by integrating water-use efficiency, soil health management, and climate-resilient farming practices.

The **National Innovations in Climate Resilient Agriculture (NICRA)**, launched in 2011 by the Indian Council of Agricultural Research (ICAR) as a flagship programme, focuses on promoting climate-resilient technologies through strategic research, technology demonstrations, and capacity-building initiatives in climate-vulnerable districts. It supports adaptation measures such as seed banks, fodder banks, and custom hiring centres to strengthen farmers' adaptive capacity and livelihood security. Since its inception, NICRA has made significant progress, including the development of around 3,000 climate-resilient crop varieties and the establishment of 448 Climate-Resilient Villages (CRVs) across the country between 2014 and 2025.

The **Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)**, launched on 1 July 2015, aims to ensure irrigation access for every farm under the vision of "Har Khet Ko Pani" and improve water-use efficiency through "More Crop Per Drop". The scheme promotes micro-irrigation technologies such as drip and sprinkler systems, along with watershed development and rainwater harvesting initiative. Since 2015-16, approximately 109 lakh hectares of agricultural land have been brought under micro-irrigation with central assistance of ₹26,325 crore, contributing significantly to improve irrigation efficiency and water conservation.

The **Soil Health Card Scheme**, launched on 19 February 2015, seeks to promote balanced and judicious use of fertilizers for improving soil productivity and long-term sustainability. Under this scheme, farmers are provided with detailed information about the nutrient status of their soil along with scientific recommendations for balanced fertilizer application.

In 2023, the scheme was further strengthened through a GIS-integrated digital platform for spatial mapping of

**e-NAM Growth Trends:
Market Expansion and Trade Value**
Across 23 States and 4 UTs



Source: Ministry of Agriculture and Farmers Welfare

(As of March, 2026)

soil health data. Since its launch and up to 31 March 2026, more than 25.79 crore Soil Health Cards had been issued and 11,531 soil testing laboratories established across the country, making it one of the largest soil health monitoring initiatives in the world.

Among the most significant recent interventions, the **Digital Agriculture Mission** launched on September 2, 2024, with an outlay of ₹2,817 crore, marks a transformative step towards building a robust digital ecosystem in Indian agriculture. The Mission promotes the adoption of advanced technologies such as satellite imaging, remote sensing, Geographic Information Systems (GIS), drones, Internet of Things (IoT), and Artificial Intelligence (AI)-based solutions. It emphasises the development of GIS-based digital land records, farmer registries, and digital crop surveys to improve resource efficiency and strengthen climate-resilient agricultural systems. As per the Ministry of Agriculture & Farmers Welfare, more than 9.20 crore Farmer IDs had been generated across the country up to 19 March 2026.

Government Digital Agriculture Platforms

The Government of India has launched several digital platforms and mobile applications to empower farmers through improved access to markets, weather forecasts, and real-time advisory services. The Electronic National Agriculture Market (e-NAM), launched on 14 April 2016, integrates APMCs across the country into a unified digital trading platform, enabling transparent online trading, digital bidding, and direct payments while reducing transaction cost and market inefficiencies.

As of 28 February 2026, e-NAM had integrated 1,656 mandis across 23 States and 4 Union Territories. Around 1.80 crore farmers, 2.72 lakh traders and over 4,724 Farmer Producer Organizations (FPOs) registered on the platform, facilitating trade worth more than ₹4.82 lakh crore since its inception.

Complementing this initiative, the Kisan Suvidha App and mKisan platform provide farmers with real-time information on weather, market prices, crop protection, insurance schemes, pest management, and expert advisories through mobile and SMS-based services. Collectively, these digital initiatives are promoting data-driven, efficient, and climate-resilient agriculture by enabling informed decision-making and improving market access for farmers.

The Challenges and Way Forward

The integration of AgriTech and Climate Tech is transforming Indian agriculture from a subsistence-based system into a more scientific, market-oriented, and climate-resilient sector. However, challenges such as the digital divide, inadequate infrastructure, affordability constraints, data privacy concerns and weak institutional coordination continue to limit their large-scale adoption.

Addressing these issues requires stronger public-private partnerships, supportive policy frameworks, and continuous technological innovation. Improving rural connectivity, digital literacy, and farmer-centric institutions such as Krishi Vigyan Kendras (KVKs) and Farmer Producer Organizations (FPOs) is essential for expanding access to modern technologies.

Greater investment in agricultural research, climate-resilient infrastructure, institutional credit, crop insurance, and climate-risk financing can further strengthen resilience. In addition, strengthening value chains through better storage, processing and market linkages, together with integration of traditional knowledge modern science, will ensure inclusive growth, and sustainable farming, and stable rural livelihoods.

Conclusion

AgriTech and Climate Tech are transforming agriculture into a more resilient, sustainable, and efficient sector. Climate-smart and resource-efficient practices such as precision farming, digital advisory systems, and renewable energy solutions have significant potential to improve farmer welfare and strengthen rural resilience.

However, challenges such as the digital divide, infrastructure gaps, affordability constraints, and uneven technology access must be addressed through stronger rural connectivity, institutional support, farmer-centric policies, and inclusive innovation ecosystems with sustained investment, supportive policies and wider technology adoption, India can build a future ready agricultural system that ensures food security, environmental sustainability, and long-term social and climate resilience. In essence, the convergence of AgriTech and Climate Tech offers an immense potential for farmer welfare and sustainable agricultural transformation in India. □

