

4. Artificial Intelligence (AI) Transforming Indian Agriculture- S & T

Indian agriculture operates under deep structural constraints that limit productivity, income growth, and resilience. Artificial Intelligence (AI) is emerging as a strategic enabler to overcome these systemic challenges. Indian agriculture is characterised by fragmented and small landholdings, with over 85% of farmers classified as small and marginal farmers. Such fragmentation limits economies of scale, reduces bargaining power, and constrains access to advanced technology. Climate variability and climate change have significantly increased the frequency and intensity of extreme weather events such as droughts, floods, heatwaves, and unseasonal rainfall. These disruptions adversely affect crop yields, increase production risks, and destabilise rural incomes. Therefore, predictive and adaptive technologies are essential for ensuring resilience.

Agricultural markets in India are marked by price volatility due to supply-demand mismatches, inadequate storage infrastructure, and uneven market access. Farmers often suffer from distress sales due to lack of real-time market intelligence. To align with national development goals such as doubling farmer incomes, achieving food security, and promoting climate-resilient agriculture, there is a need for affordable, data-driven advisory systems that can provide customised solutions to farmers. In this context, Artificial Intelligence offers scalable, precision-based, and predictive capabilities that can transform agricultural productivity, risk management, and market integration.

Role of Artificial Intelligence in Agriculture

Soil Health Diagnostics- AI-driven systems use deep learning algorithms and image recognition technologies to monitor soil health in a scientific and real-time manner. AI analyses satellite imagery, drone-based observations, and farm-level photographs to detect soil nutrient deficiencies, moisture levels, and degradation patterns. These systems help farmers adopt precision fertilisation practices, reducing excessive chemical input usage and promoting sustainable soil management.

By integrating data from the Soil Health Card programme, AI can generate farm-specific nutrient advisories. Thus, AI improves both productivity and environmental sustainability.

Enhancing Farm Mechanisation and Efficiency- AI technologies such as machine learning, robotics, drones, and remote sensing are improving farm operations.

Smart irrigation systems powered by AI optimise water usage by assessing soil moisture and weather forecasts. Drones enable crop monitoring, pesticide spraying, and disease detection with higher efficiency and reduced labour dependency. In horticulture, where crops require continuous monitoring across multiple growth stages, AI-based surveillance systems provide real-time alerts regarding pest attacks, nutrient stress, and growth anomalies. These technologies enhance input efficiency, reduce labour costs, and improve yield outcomes.

Improving Price Realisation and Market Intelligence- AI-driven predictive analytics utilise large datasets from platforms such as-

1. e-NAM (National Agriculture Market),
2. AGMARKET,
3. Agricultural Census,
4. Soil Health Card database.

By analysing arrival trends, price fluctuations, demand patterns, and regional consumption behaviour, AI models provide predictive insights regarding optimal selling times and locations.

Such systems reduce information asymmetry and help farmers avoid distress sales, thereby improving farm incomes.

Climate-Smart Agriculture and Risk Management- AI plays a crucial role in strengthening climate resilience. AI-based models can predict weather patterns and issue early warnings for extreme weather events such as heavy rainfall, drought, and cyclones. Integration with platforms like WINDS (Weather Information and Network Data System) enhances risk assessment and decision-making. AI tools support crop diversification strategies based on climate suitability forecasts.

These interventions enable farmers to take preventive measures, thereby reducing crop losses.

Government Initiatives in AI-Driven Agriculture

Kisan e-Mitra– Launched in 2023, Kisan e-Mitra is a voice-enabled, AI-powered chatbot designed to assist farmers. It provides information regarding government schemes such as PM Kisan Samman Nidhi, Kisan Credit Card, and Pradhan Mantri Fasal Bima Yojana. It operates in 11 regional languages. It addresses over 8,000 farmer queries per day. This initiative enhances digital inclusion and improves access to welfare schemes.

National Pest Surveillance System (NPSS)– Launched in 2024, NPSS uses AI and Machine Learning to detect pest infestations and crop diseases at an early stage. It integrates field data, satellite inputs, and image-based diagnostics. Early intervention reduces crop losses and chemical overuse.

Bharat-VISTAAR (Proposed in Union Budget 2026–27)– Bharat-VISTAAR is proposed as a multilingual AI tool to integrate AgriStack portals with ICAR's agricultural advisory packages. It aims to create a unified AI-driven advisory platform. It seeks to strengthen digital public infrastructure in agriculture.

AI-Enabled Crop Insurance

CROPIC (Collection of Real-Time Observations and Photographs of Crops)– Uses geotagged and time-stamped crop images. Enhances transparency in crop damage assessment. Reduces delays and disputes in insurance claim settlement.

YES-TECH (Yield Estimation System based on Technology)– Utilises remote sensing and AI analytics. Provides scientific yield estimation, reducing reliance on manual crop-cutting experiments.

Krishi Decision Support System (KDSS)– Integrates multiple datasets to generate digital crop maps, soil maps, yield estimates, and drought/flood monitoring outputs. Supports evidence-based policymaking.

Challenges in AI Adoption in Indian Agriculture

Rural Connectivity Gaps– Many small farmers lack access to smartphones, IoT devices, and reliable internet connectivity. Frequent power supply disruptions hinder effective use of AI-enabled devices. Digital literacy levels remain uneven. These factors create access asymmetry and widen the digital divide.

Data Privacy and Governance Concerns– AI systems rely heavily on farm-level data, including–

1. Land records,
2. Crop patterns,
3. Financial transactions,
4. Yield records.

However, there is no clearly defined farmer-centric data ownership and consent framework. This raises concerns regarding–

1. Commercial exploitation,
2. Data misuse,
3. Lack of transparency.

A robust agricultural data governance framework is essential.

High Cost of Advanced Technologies– Precision agriculture tools such as drones, robotics, AI sensors, and automated machinery require high initial capital investment. With an average landholding size of approximately 1–1.2 hectares, individual adoption becomes financially unviable. Lack of institutional credit for AI technologies further restricts adoption.

Way Forward– While Artificial Intelligence holds transformative potential for Indian agriculture, its success depends on inclusive and well-governed implementation. Rural digital infrastructure must be strengthened through improved broadband connectivity and reliable power supply.

A farmer-centric agricultural data governance framework should be established to ensure informed consent, data security, and transparency. Shared-service models should be promoted through Farmer Producer Organisations (FPOs), cooperatives, and custom hiring centres to reduce technology costs. Capacity building and digital literacy programmes should be expanded to empower farmers. Public-private partnerships should be encouraged to accelerate innovation while maintaining regulatory oversight.

Conclusion- Artificial Intelligence can act as a force multiplier in Indian agriculture by enhancing productivity, improving price realisation, strengthening climate resilience, and enabling evidence-based policymaking. However, technological transformation must be accompanied by institutional reforms, digital inclusion, and equitable access to ensure that AI-driven agriculture remains farmer-centric, inclusive, and sustainable.

Source- <https://www.pib.gov.in/PressNoteDetails.aspx?NotelId=157351&ModuleId=3®=3&lang=2#~~~text=In%20agriculture%2C%20AI%20helps%20turn,use%2C%20and%20wh>

