



An overview of the Digital Agriculture Mission towards Agriculture Revolution 4.0 in India

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Abstract: This review analyses the India's Digital Agriculture Mission's impact on adoption of smart farming technologies in agriculture sector and how it revolutionized agriculture by integrating digital technologies like precision farming, smart sensor networks, predictive analytics (artificial intelligence and machine learning), automation (drones and robotics) and internet of things (IoT). Article starts by providing the global view of the technology driven agriculture revolution, what are the key technologies and how the mission of government particularly benefits the farmers livelihood. This concludes with addressing some concerns and challenges of the initiative.

Key words

Agriculture revolution, Digital Agriculture mission

Introduction

Agriculture through emerging technology hold immense potential in India since, it plays an important role in feeding the emerging population and also contribute to significant part of GDP. However, the sector currently faces unprecedented challenges, including reduced land availability along with fragmented land patterns, soil degradation, erratic climatic conditions, groundwater depletion, and rapid urbanization. Following a traditional farming system results into a low productive and yield of crop produce. As a result, India must explore innovative and resource-efficient cultivation practices capable of meeting national food demands without further burdening natural ecosystems since the population of India is increasing rapidly. Smart farming, is the future of agriculture, shaped by embracing technologies, recognizing its potential to create abundant food, thriving ecosystems, and to foster sustainable farming practices Indian cabinet approved digital agricultural mission.

Decoding Agriculture 4.0 - The Global Vision

Smart farming also known as Agriculture 4.0 the fourth industrial revolution is a technology driven revolution in agriculture sector with the goal of raising industry production and efficiency and the adoption of data-centric decision-making processes. The use of the Internet of Things (IoT), big data analytics, artificial intelligence (AI), machine learning, robotics, and automation has led to enhanced efficiency, sustainability, and productivity in the field of agriculture. The use of these cutting-edge technologies like IoT, AI, and other sensors transforms traditional production methods and international agricultural policies. While agriculture sector has seen tremendous changes from its traditional farming methods in ancient era to the modern smart farming with new tools. This era of agriculture 4.0 is enabled with advancements in technology and with integration of digital systems. This change possesses the capacity to alter food production, boost sustainability, and tackle the complex array of difficulties that affect our worldwide food system. Coming to the details of

each factor in smart farming artificial intelligence automates tasks and makes decisions based on data, while IoT devices collect and exchange data like nervous system of human body. Also, the drones are used for surveillance and mapping also gene editing allows scientists to modify living organisms genetic code.

The key technologies in Agriculture 4.0

- Precision farming
- Smart sensor networks
- Predictive analytics (AI/ML)
- Automation (drones, robotics)
- Internet of Things (IoT)

Smart farming led the transformation of various traditional farming methods foremost, in case of precision agriculture, by involving use of IoT, sensors and GPS technology to create precise field maps for agricultural practitioners, identifying soil composition, moisture levels, and crop loss disparities. Providing comprehensive maps enables farmers to tailor their agricultural techniques to the unique characteristics of each section within their farms. Farmers are able to collect real time data to accurately do farming measures. Intelligent irrigation system along with technologies like hydroponics caused the optimisation of water usage and reducing water scarcity in crop production especially in urban areas. With recycling water for the production of nutrient rich healthy crops. And another important one in vertical farming which is a sustainable approach to urban food provision, addressing food security, population growth, farmland shortages, and greenhouse gas emissions.

Drones are increasingly used in agribusiness and precision farming, providing aerial photography for vegetation analysis, density, germination, growth, and land productivity prediction. They also help identify oppressed vegetation. Traditional satellite remote sensing is used for NDVI calculations, but affordable unmanned aerial vehicles reduce costs and increase efficiency. IoT technology is transforming agriculture by enabling farmers to monitor and manage various aspects of farming through smart devices and sensors. Drones also facilitate crop health surveillance and timely action against pests or diseases.

Digital Agriculture Mission

Digital agriculture mission is an umbrella scheme approved by cabinet of India on September 2024 with a total outlay of Rs.2817 crores. Scheme approved for the implementation of Digital Public Infrastructure (DPI) in Indian agriculture sector to improve the life of farmers using emerging cutting-edge technology which are the part of smart farming system. Agri stack and Krishi Decision Support System (DSS) are the in-built basic foundational pillars of this program along with soil profile mapping.

Agristack is a farmer-centric DPI to streamline services and scheme delivery to farmers. These are the three key components of agristack.

- Farmer's Registry: Issuance of 'Farmer IDs', created and maintained by the State Governments or Union Territories, which will act as a trusted digital identity for farmers, similar to Aadhaar.
- Geo-referenced village maps: Linking of the Farmer IDs to farmer-related data.
E.g. Land records, demographic and family details etc.
- Crop Sown Registry: Maintaining a record of crops sown in each season by farmers through mobile-based ground survey, that is, Digital Crop Survey.
- Scheme for special assistance to States for capital investment.

Krishi Decision Support System is to integrate remote sensing data on crops, soil, weather, and water resources into a comprehensive geospatial system. Moreover, it supports crop map generation, drought and flood monitoring and assure the transparency in crop insurance claims.

Soil Profile Mapping is for creating detailed soil profile maps on a 1:10,000 scale for approximately 142 million hectares of agricultural land. This mapping provides data for soil health and hence helpful for effective implementation of smart technologies.

Connecting Digital Agricultural Mission initiatives to Agriculture 4.0 goals

By creating digital identities of 11 crore farmers over three years, it will ease the implementation of smart farming technologies and transparency of government services. The digital crop survey launched helps to analysis the region wise crop information and to find suitable technologies into boost the productivity of farming community as well as the industry. Similarly, help the farmers to take important decisions on adopting need-based technologies. DGCEs-based data will help crop diversification and evaluation of irrigation needs which will aid in making agriculture sustainable. Additionally, for the growth of Agri-tech startups through public-private partnerships and for creating new employment opportunities in data management, drone operations and digital advisory services for rural youth this DAM plays a great role.

Initiatives for promoting Digital Agriculture

- India Digital Ecosystem of Agriculture (IDEA) framework: For creating an integrated database of farmers to build innovative agri-focused solutions.
- National e-Governance Plan in Agriculture (NeGP-A): Aimed at providing relevant information related to farming free of cost to the farmers.
- Market based interventions: Like e-NAM, AGMARKNET etc.
- Drones for land mapping: Used in Swamitva Scheme; Sensor-based Smart Agriculture (SENSAGRI) programme etc.
- National Strategy on AI recognizes agriculture as one of the priority sector areas (Niti Aayog)
- Applications to aid farmers: PM-KISAN Mobile App, Kisan Suvidha App, HORTNET project for Horticulture

These initiatives for the mission speed up the process of implementation of smart farming technologies.

Concerns and challenges

Smart farming technologies are connected with a big amount of data and it creates ample amounts of worries about data security and privacy. There are chances of threat to sensitive data about farmers and related farm sectors. The digital infrastructures are not accessible in many regions. So, there should be a collective work from the authorities to protect data resources to overcome the hurdles of connectivity, digital illiteracy, and for capacity building among small and marginal farmers.

Conclusion

The digital agriculture mission is driven by cutting-edge technologies and data-centric solutions, presents a wide range of advantages that possess the capacity to transform farming methodologies and the wider agricultural industry. The schemes like DAM emphasize that successful implementation will lead to a more productive, sustainable, and profitable agricultural sector for millions of Indian farmers. These advantages not only tackle current obstacles but also provide the groundwork for a more sustainable and efficient future and will be a holistic accelerator for integrating India into the global Agriculture 4.0 framework.

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