



The Future of Farming: How Smart Agriculture is Changing Indian Farms

*Darshan M. Parmar¹, Satvik S. Panda¹ and K. G. Parmar³

¹ICAR-Directorate of Medicinal and Aromatic Plants Research, Anand, Gujarat

²College of Agriculture, Professor Jayashankar Telangana Agricultural University, Hyderabad, Telanagana, India

³College of Agriculture, Junagadh Agricultural University, Junagadh, Gujarat

*Corresponding Author's email: darshanparmar3133@gmail.com

Agriculture has been the backbone of India since time immemorial, providing ample opportunities for employment, food security, and contributing substantially to its economy. Around 40% of the workforce in India is engaged in agriculture in one way or the other. Nevertheless, agriculture in India faces several hurdles, including climatic changes, small size of land holdings, water scarcity, higher labor costs, soil infertility, and occurrence of pests and diseases in crops (CEEW, 2023; Government of India, 2021). Though traditional agricultural practices have their own significance, they are no longer able to match the requirement of the contemporary times. Thus, the concept of smart agriculture has evolved to address the emerging problems. Smart agriculture, popularly referred to as precision agriculture and digital farming, involves the application of technologies like IoT, AI, drones, sensors, remote sensing via satellites, robotics, and mobile applications in order to enhance productivity and sustainability in agriculture (Balafoutis et al., 2017). With smart agriculture, farmers are provided with a platform for decision-making based on information collected from fields using technology instead of following experience and guesses.

What is Smart Agriculture?

Smart agriculture refers to a new agricultural method involving the use of technology for the monitoring of crops, soil, weather, water, and pests. In this practice, there is no need for fertilizer, pesticide, or irrigation application throughout the farm; rather, these can be administered based on the exact needs at specific locations (Gebbers and Adamchuk, 2010). For instance, soil moisture sensors planted in the field will provide information on when irrigation is necessary. In addition, drones may detect signs of crop stress and disease before the naked eyes can notice them. Using artificial intelligence, weather conditions can be analyzed, and the system will notify the farmer about any upcoming rainfall or pest invasion (Shamshiri et al., 2018).

In essence, smart agriculture is all about “doing more with less.”

Technologies Changing Indian Farms

1. Drones in Agriculture

Drones for agriculture are gaining increasing popularity in India. They are widely used for crop observation, crop mapping, spraying pesticides, and nutrient application. Drone spraying takes less time and labor but ensures proper pesticide application (Pathak et al., 2020).

Using multispectral camera-equipped drones helps determine areas that have nutrient deficiencies, are prone to diseases, or suffer from drought. This way, farmers will only target the necessary areas for treatment without covering the whole plot and reduce the amount of pesticide required.

Subsidies are now available in India for agricultural drones through the Sub-Mission on Agricultural Mechanization and other government schemes (Government of India, 2022).

2. IoT-Based Smart Irrigation

Water scarcity is one of the main issues that challenge Indian agriculture. The use of smart irrigation based on IoT sensors allows for determining soil moisture and adjusting irrigation accordingly (Kamienski et al., 2019).

Crops like cotton, sugarcane, and vegetables can benefit greatly from smart irrigation because they will consume significantly less water with the same or better results compared to traditional irrigation methods.

One of the components of the National Mission for Sustainable Agriculture called "Per Drop More Crop" aims at effective irrigation in India (Government of India, 2021).

3. Artificial Intelligence and Machine Learning

Artificial Intelligence and machine learning have been revolutionizing agriculture through the use of large-scale analysis of data and making accurate predictions. AI could be used for predicting:

- Climate
- Outbreaks of pests and diseases
- Markets prices
- Optimum sowing and harvesting dates

AI-based image recognition algorithms can also diagnose crop diseases using the pictures of leaves taken on their smartphones (Kamilaris and Prenafeta-Boldú, 2018). This allows farmers to take immediate action against the problem. Some regions in India have already adopted hyperlocal weather forecasting system enabled by AI to improve agricultural decision-making.

4. GPS and Precision Farming

GPS technology allows farmers to conduct precision agriculture. Tractor and equipment controlled by GPS enables precision sowing, fertilizer application, and harvest (Zhang et al., 2002).

Precision agriculture is also cost-effective as it prevents unnecessary overlapping and waste of seeds, fertilizers, and chemicals. Yield and soil maps can also be prepared using GPS.

5. Mobile Apps for Farmers

Smartphone applications are bringing agricultural knowledge to the fingertips of farmers. Farmers get:

- Weather forecasts
- Markets prices
- Diagnosis of pest and diseases
- Recommendations for fertilizers
- Details about government schemes

Regional languages based mobile applications make access to agricultural knowledge even easier for rural farmers (Mittal and Mehar, 2016).

Benefits of Smart Agriculture

- Higher Productivity
- Reduced Input Costs
- Efficient Water Management
- Better Pest and Disease Management
- Environmental Sustainability
- Increased Profitability
- Climate Resilience

Challenges in Adoption

- High Initial Investment
- Lack of Awareness

- Poor Internet Connectivity
- Data Privacy and Security

Government Initiatives Supporting Smart Agriculture

The Government of India is actively promoting smart agriculture through various initiatives:

1. **Digital Agriculture Mission** – encourages the use of AI, blockchain, remote sensing, and digital databases.
2. **Agriculture Infrastructure Fund (AIF)** – supports development of precision farming infrastructure.
3. **Mission for Integrated Development of Horticulture (MIDH)** – promotes protected and precision cultivation.
4. **Pradhan Mantri Krishi Sinchayee Yojana (PMKSY)** – supports efficient irrigation.
5. **eNAM (National Agriculture Market)** – connects farmers to digital marketplaces.

These initiatives are expected to accelerate adoption of smart farming technologies across the country.

Future Prospects of Smart Agriculture in India

Technological innovations such as vertical farming, hydroponics, robotics, blockchain-based traceability, advisory system, and satellite-based crop monitoring have the potential to become common practices in the coming years. Young entrepreneurs and agri-tech startups have played a vital role in this transformation. In addition, research institutes such as Indian Institutes of Technology have contributed to the innovation of technologies using AI.

Conclusion

Smart farming is more than a trend; rather, it is essential for the future of Indian agriculture. By combining the use of modern technology and traditional farming knowledge, India can enhance its productivity and sustainability. Although there are several issues related to cost, awareness, and availability of infrastructure, innovations and government support have made the process easier. India, a country where agriculture plays an integral part in sustaining millions of lives, can ensure food security and farmers' profits through smart agriculture. This way, India can also preserve natural resources for future generations. The farmer of tomorrow will not only rely on plough and tractors but may also use drones, sensors, satellites, and AI technologies.

References

1. Balafoutis, A. T., Beck, B., Fountas, S., et al. (2017). Precision agriculture technologies positively contributing to GHG emissions mitigation, farm productivity and economics. *Sustainability*, 9(8), 1339.
2. CEEW. (2023). Precision Farming in India. Council on Energy, Environment and Water.
3. Gebbers, R., & Adamchuk, V. I. (2010). Precision agriculture and food security. *Science*, 327, 828–831.
4. Government of India. (2021). National Mission for Sustainable Agriculture. Ministry of Agriculture & Farmers Welfare.
5. Government of India. (2022). Sub-Mission on Agricultural Mechanization. Ministry of Agriculture & Farmers Welfare.
6. Kamienski, C., Soininen, J. P., Taumberger, M., et al. (2019). Smart water management platform: IoT-based precision irrigation. *Sensors*, 19, 276.
7. Kamilaris, A., & Prenafeta-Boldú, F. X. (2018). Deep learning in agriculture: A survey. *Computers and Electronics in Agriculture*, 147, 70–90.
8. Mittal, S., & Mehar, M. (2016). Socio-economic factors affecting adoption of modern information and communication technology by farmers in India. *Journal of Agricultural Education and Extension*, 22(2), 199–212.
9. Pathak, H., Brown, P., & Best, T. (2020). A systematic literature review of the factors affecting the precision agriculture adoption process. *Precision Agriculture*, 21, 1292–1316.

10. Shamshiri, R. R., Kalantari, F., Ting, K. C., et al. (2018). Advances in greenhouse automation and controlled environment agriculture. *Information Processing in Agriculture*, 5(1), 1–22.
11. Zhang, N., Wang, M., & Wang, N. (2002). Precision agriculture—A worldwide overview. *Computers and Electronics in Agriculture*, 36, 113–132.