



AGRI MAGAZINE

(International E-Magazine for Agricultural Articles)

Volume: 03, Issue: 06 (June, 2026)

Available online at <http://www.agrimagazine.in>

© Agri Magazine, ISSN: 3048-8656

Smart Farming and Precision Agronomy: Transforming Modern Agriculture

*V. Chaithanya¹, Sagarla Sowmyasri¹, Vikram Nalabolu¹ and B. Madhukar²

¹Ph.D. Scholar, Department of Agronomy, PJTAU, Hyderabad, Telangana, India

²Teaching Associate, Department of Agronomy, PJTAU, Hyderabad, Telangana, India

*Corresponding Author's email: chaitanya12389@gmail.com

Agriculture is undergoing a major transformation through the adoption of digital and precision technologies. Farmers today face several challenges including climate change declining soil fertility water scarcity rising labour costs and increasing food demand. To address these problems modern technologies are being integrated into farming systems to improve productivity sustainability and resource-use efficiency. Smart farming and precision agronomy have emerged as innovative approaches that use advanced tools and data-driven techniques for efficient crop management. These technologies help farmers monitor field conditions optimize input use reduce wastage and improve crop productivity. The use of drones sensors Artificial Intelligence (AI) Internet of Things (IoT) GPS and remote sensing technologies has made farming more precise efficient and environmentally sustainable.

Concept of Smart Farming and Precision Agronomy

Smart Farming

Smart farming refers to the use of digital technologies automation and real-time monitoring systems in agriculture for better farm management and decision-making. Technologies such as AI IoT cloud computing and mobile applications are used to monitor crops soil weather and farm operations continuously.

Precision Agronomy

Precision agronomy focuses on site-specific crop management where inputs such as water fertilizers and pesticides are applied according to crop requirement and field variability. This approach improves input-use efficiency reduces wastage and minimizes environmental pollution.

Objectives of Smart Farming

The major objectives of smart farming include:

- efficient utilization of water fertilizers and pesticides
- improvement in crop productivity and quality
- reduction in production costs
- real-time monitoring of crop and soil conditions
- promotion of sustainable and climate-resilient agriculture.

Technologies Used in Smart Farming

Internet of Things (IoT)

IoT involves the use of sensors and connected devices to collect real-time information from agricultural fields. Sensors monitor soil moisture temperature humidity and nutrient levels helping farmers make timely decisions regarding irrigation and nutrient management.

Remote Sensing and GIS

Remote sensing technologies such as satellites and drones provide detailed images of crop fields for monitoring crop health stress conditions and soil variability. Geographic

Information Systems (GIS) help analyze spatial information for precision farming and resource management.

Artificial Intelligence and Machine Learning

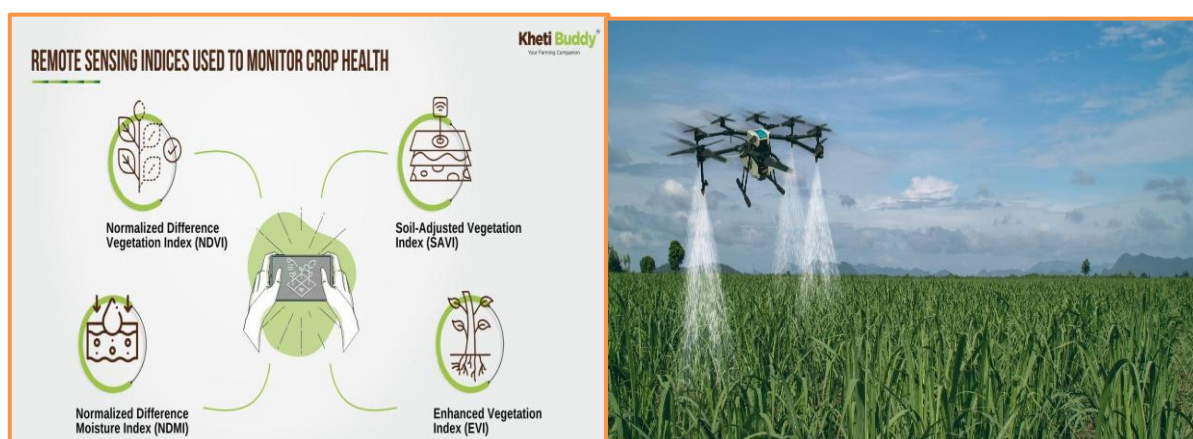
AI and machine learning technologies analyze large volumes of field data to predict pest outbreaks disease incidence irrigation needs and crop yield. These technologies improve decision-making and support automation in agriculture.

Drones in Agriculture

Drones are increasingly used for crop monitoring weed detection spraying of herbicides and pesticides and field surveillance. Drone-based spraying reduces labour requirement saves time and improves precision in chemical application.

Variable Rate Technology

Variable Rate Technology (VRT) enables fertilizers pesticides and irrigation water to be applied at different rates depending on field conditions and crop requirement. This improves input efficiency and reduces unnecessary application.



Applications of Smart Farming in Agriculture

Precision Nutrient Management

Soil sensors and digital maps help determine nutrient variability within fields. Fertilizers can then be applied precisely according to crop requirement improving fertilizer-use efficiency and reducing nutrient losses.

Smart Irrigation

Smart irrigation systems use soil moisture sensors and weather-based information to schedule irrigation efficiently. This helps prevent over-irrigation conserves water and improves irrigation efficiency.

Weed and Pest Management

AI-based systems drones and sensor technologies help identify weeds pests and diseases at an early stage. Precision spraying ensures targeted application of chemicals thereby reducing chemical usage and environmental contamination.

Crop Monitoring and Yield Prediction

Remote sensing and drone imagery help monitor crop growth identify stress conditions and assess crop performance. Machine learning models can also predict crop yields and support better farm planning.

Benefits of Smart Farming and Precision Agronomy

Smart farming technologies improve crop productivity by enabling timely and precise farm operations. Efficient management of water fertilizers and pesticides reduces input wastage and improves resource-use efficiency. Automation and drone technologies reduce dependence on manual labour and improve operational efficiency. Precision technologies also help minimize environmental pollution conserve natural resources and reduce greenhouse gas emissions. Real-time monitoring and predictive analytics support climate-resilient agriculture by helping farmers adapt to weather variability and extreme climatic conditions.

In future smart farming technologies may become increasingly important under labour shortages climate variability and rising input costs. Precision agriculture may help farmers apply inputs only where required thereby reducing unnecessary expenditure and improving farm profitability.

Challenges in Adoption of Smart Farming

Despite several advantages adoption of smart farming technologies still faces multiple challenges. Advanced technologies such as drones sensors and automated machinery require high initial investment which limits adoption among small and marginal farmers. Many farmers are unfamiliar with digital technologies and require technical training for effective utilization. Limited internet connectivity and poor digital infrastructure in rural regions also affect implementation of smart farming systems. In addition large amounts of agricultural data generated through digital technologies raise concerns regarding data security privacy and ownership.

Future Prospects of Smart Farming

The future of agriculture is expected to depend increasingly on digital technologies automation and data-driven decision-making. AI-based advisory systems robotics autonomous machinery and drone technologies may become more common in farming systems. In India technologies such as drone spraying sensor-based nutrient management and smart irrigation are gradually gaining importance especially in commercial crops and high-value agriculture. Integration of climate-smart technologies with precision agriculture can further strengthen sustainable crop production systems. Government support digital literacy programs affordable technologies and policy initiatives will play an important role in expanding smart farming practices among farmers in the coming years.

Conclusion

Smart farming and precision agronomy are transforming modern agriculture by integrating advanced technologies into crop production systems. Technologies such as IoT AI drones remote sensing and precision application tools improve productivity resource-use efficiency and environmental sustainability. These technologies also support climate-resilient agriculture through better monitoring timely decision-making and efficient resource management. Although challenges such as high investment costs and limited technical knowledge still exist continuous technological advancements and policy support are expected to promote wider adoption in the future. Smart farming offers a sustainable pathway for improving farm profitability achieving food security and conserving natural resources for future generations. IoT involves the use of sensors and connected devices to collect real-time information from agricultural fields. Sensors monitor soil moisture, temperature, humidity, and nutrient levels, helping farmers make timely decisions regarding irrigation and nutrient management.

References

1. Gebbers, R. and Adamchuk, V.I. 2010. Precision agriculture and food security. *Science*. 327(5967): 828–831.
2. Kumar, S.N., Suriyan, K., Jacob, A.T., Varghese, A. and Francis, E. 2025. Smart farming for a sustainable future: Implementing IoT-based systems in precision agriculture. *Bulletin of the National Research Centre*. 49: 71.
3. Padhiary, M., Kumar, A. and Sethi, L.N. 2025. Emerging technologies for smart and sustainable precision agriculture. *Discover Robotics*. 1(1): 6.
4. Raj, M. and Prahadeeswaran, M. 2025. Revolutionizing agriculture: A review of smart farming technologies for a sustainable future. *Discover Applied Sciences*. 7: 937.
5. Soussi, A., Zero, E., Sacile, R., Trincherio, D. and Fossa, M. 2024. Smart sensors and smart data for precision agriculture: A review. *Sensors*. 24(8): 2647.
6. Wolfert, S., Ge, L., Verdouw, C. and Bogaardt, M.J. 2017. Big data in smart farming: A review. *Agricultural Systems*. 153: 69–80.