Available online at
http://currentagriculturetrends.vitalbiotech.org/

ISSN (E): 2583 – 1933

Curr. Agri.Tren.:e- Newsletter, (2025) *4*(7), 35-37

Current Agriculture Trends: e-Newsletter

Article ID: 412

Smart Farming: How IoT and AI are Revolutionizing Crop Management

Murari Lal Meena[1], Rita Fredericks[2], Ravi Patel[3], Manjul Jain[3]*

[1]Ph.D., Research Scholar, Department of Agronomy, College of Agriculture, Ummedganj-Kota, Agriculture University, Kota-324001
[2]CEO, Precision Grow (A Unit of Tech Visit IT Pvt Ltd)
[3]Assistant Professor, School of Agriculture, Eklavya University, Damoh (M.P.)-470661

Article History
Received: 14. 07.2025
Revised: 18. 07.2025
Accepted: 22. 07.2025

INTRODUCTION

What is Smart Farming?

Smart farming is the utilization of smart digital technologies like the Internet of Things (IoT) and Artificial Intelligence (AI) in agriculture. It seeks to enhance the productivity, efficiency, and sustainability of farm operations by facilitating enhanced decision-making through data analysis. IoT devices such as sensors, drones, and GPS units in smart farming are utilized for the acquisition of real-time information regarding soil moisture, temperature, humidity, crop health, and so on. This information is used to analyze through AI algorithms and make informed decisions regarding irrigation, fertilizers, pest management, and harvesting. The most important characteristics of smart farming are real-time monitoring, predictive analytics, and automated control systems. These enable farmers to decrease input costs, maximize yields, reduce waste in terms of resources, and act at a faster rate to adapt to environmental changes. Smart farming is revolutionizing conventional agriculture into a technology-based and precision-centric system, ultimately leading to food security and sustainable development.

Role of IoT in Crop Management

IoT in agriculture is a revolutionary change in the way crops are tracked, managed, and farmed. It entails the amalgamation of intelligent, networked devices like sensors, actuators, GPS equipment, and communication networks that gather real-time data from different agricultural environments. Such data is analyzed to provide informed, timely, and precise decision-making, enhancing the overall efficiency, sustainability, and profitability of agricultural operations.

Important Uses of IoT in Crop Management

Soil Sensors

Soil sensors are sent into the field to measure important parameters like soil water, temperature, pH levels, and nutrient levels (such as nitrogen, phosphorus, potassium). With this constant stream of data, farmers can calculate the precise irrigation and fertilization requirements of the soil, avoiding leaching of nutrients, water loss, or crop stress caused by nutrient deficiency. Precision in soil management also helps to promote sustainable farming by minimizing input usage.

Weather Stations

Smart weather stations with built-in IoT elements gather local, real-time weather information like ambient temperature, relative humidity, precipitation, wind speed, and solar radiation. This information is vital for planning time-dependent tasks like sowing, spraying, harvesting, and frost protection. Additionally, past and forecasted weather analytics may be employed for predicting unfavorable weather conditions, reducing crop damage and post-harvest losses.

Remote Irrigation Systems

IoT-based irrigation systems link soil sensors with automated pumps or drip lines. Depending on real-time soil moisture levels, the system can modify water delivery timetables automatically, giving crops the optimal water at the optimal time. This not just enhances water-use efficiency in arid regions but also minimizes the threat of root diseases from overwatering. Farmers can remotely control irrigation via mobile or web apps, with the added convenience and precision.

GPS-integrated Farming Equipment

New-generation farming equipment, including tractors, seeders, and harvesters, equipped with GPS and IoT devices facilitates precision agriculture. These implements use geospatial information to perform tasks like site-specific sowing, fertilizer application in a variable rate, and automatic reaping. Consequently, the input is delivered only where and when required, saving costs and minimizing environmental footprint while maximizing crop consistency and yield.

Drone-Based Surveillance and Monitoring

IoT-based farming drones are fitted with high-resolution cameras, infrared sensors, and GPS mapping devices to map fields from the skies. They offer a holistic visual inspection of crop health, which detects problems such as pest infestation, nutrient content deficit, disease spots, and water deficit regions. Farmers are able to make prompt and localized corrective measures, thereby avoiding the loss of yield and maintaining healthy plants.

IoT Advantages in Crop Management

Increased Operational Efficiency: Reduces manual efforts and improves task precision in real-time.

Optimized Resource Utilization: Facilitates conservation of water, energy, fertilizers, and pesticides through requirement-based application.

Better Crop Yield and Quality: Timely interventions result in healthier crops and improved yields.

Data-Driven Decision Making: Farmers are informed by dashboards and alerts, allowing them to drive proactive farm management.

Remote Monitoring and Control: IoT allows farmers to control the farms even from remote areas, minimizing reliance on physical presence.

In summary, IoT is transforming conventional farming by bringing digital wisdom into the agrifood supply chain. It enables a move from reactive to predictive agriculture, enabling farmers to foresee issues before they become major problems and respond quickly. With IoT implementation, crop management is not just more accurate and efficient but also climate-change and resource-resilient, leading to long-term food security and sustainability.

Advantages of Smart Farming

Smart farming, which incorporates advanced technology such as IoT, AI, sensors, drones, and data analysis, provides several advantages that transform contemporary agriculture. Not only do these advantages enhance productivity, but they

also enable environmental sustainability and cost-effectiveness.

Real-time Decision-Making:
Smart agriculture allows farmers to gather and process information in real time. It facilitates rapid, well-informed decisions for irrigation, pest management, fertilization, and harvesting, thus enhancing crop management effectiveness.

Improved Crop Yield and Quality:
Farmers can maximize both the yield and quality of their crops through precision methods and timely interventions based on reliable data. Well-maintained, healthy crops translate into increased market value and improved profitability.

Lower Input Expenses (Water, Fertilizers, Pesticides):
By applying inputs site-specifically and keeping track of them, smart farming technologies reduce overuse of expensive inputs. This leads to significant water, fertiliser, and pesticide savings while keeping the crop healthy.

Precise Early Problem Identification (Pests, Diseases, Stress):
Sensors, machine vision-powered image analysis, and drones can identify initial indications of pest infestation, diseases, or crop stress (caused by drought or nutrient deficiencies). Targeted, timely interventions can be made through early diagnosis, saving crops.

Effective Resource Management and Conservation of the Environment:
Optimal resource use is facilitated by smart farming through minimizing wastage and environmental degradation. It aids in water conservation, reducing chemical runoff, and preserving soil fertility, which leads to sustainable agriculture in the long run.

CONCLUSION

Smart farming, powered by the integration of IoT and Artificial Intelligence, is revolutionizing agriculture by making it more data-driven, accurate, and sustainable. These technologies enable farmers to monitor crops in real time, make predictive decisions, and automate labor-intensive tasks, transforming traditional practices into highly efficient systems.

REFERENCES

Alazzai, W. K., Obaid, M. K., Abood, B. S. Z., & Jasim, L. (2024). Smart Agriculture Solutions: Harnessing AI and IoT for Crop Management. In *E3S Web of Conferences* (Vol. 477, p. 00057). EDP Sciences.

Alkhafaji, M. A., Ramadan, G. M., Jaffer, Z., & Jasim, L. (2024). Revolutionizing agriculture: the impact of AI and IoT. In *E3S web of conferences* (Vol. 491, p. 01010). EDP Sciences.

Issa, A. A., Majed, S., Ameer, S. A., & Al-Jawahry, H. M. (2024). Farming in the digital age: Smart agriculture with ai and iot. In *E3S Web of conferences* (Vol. 477, p. 00081). EDP Sciences.

Mohamed, E. S., Belal, A. A., Abd-Elmabod, S. K., El-Shirbeny, M. A., Gad, A., & Zahran, M. B. (2021). Smart farming for improving agricultural management. *The Egyptian Journal of Remote Sensing and Space Science*, *24*(3), 971-981.

Saiz-Rubio, V., & Rovira-Más, F. (2020). From smart farming towards agriculture 5.0: A review on crop data management. *Agronomy*, *10*(2), 207.