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## The Role of Artificial Intelligent in Agricultural Applications: Trend Methods

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### Abstract

Artificial Intelligence (AI) is increasingly transforming agriculture by introducing advanced methods that enhance productivity and sustainability. Modern AI applications in agriculture encompass several key areas: *Precision Farming*: AI algorithms analyze data from various sources, including satellite imagery and soil sensors, to optimize planting schedules, irrigation, and fertilization, thereby improving crop yields and resource efficiency. *Crop Monitoring and Disease Detection*: Machine learning models and computer vision techniques enable early detection of plant diseases and pest infestations, allowing for timely interventions and reducing crop losses. *Robotics and Automation*: AI-powered robots are employed for tasks such as planting, harvesting, and weeding, increasing operational efficiency and reducing labor costs. *Supply Chain Optimization*: AI assists in forecasting demand, managing inventory, and optimizing logistics, leading to reduced waste and improved market responsiveness. Despite these advancements, challenges persist, including data quality issues, infrastructure limitations, and the need for regulatory frameworks to ensure safe and ethical AI deployment. Addressing these challenges requires collaborative efforts among policymakers, researchers, and industry stakeholders to develop standards and invest in education and infrastructure. This paper explores the current trends and methodologies of AI applications in agriculture, highlighting their potential to transform the sector and contribute to global food security and environmental sustainability.

**Keywords:** Artificial Intelligence, Precision Farming, Machine Learning, Agricultural Robotics, Crop Productivity, Sustainable Agriculture

### Introduction

Agriculture remains a foundational pillar of economic sustainability, contributing significantly to long-term economic growth, employment, and national development. Traditionally focused on food and crop production, the agricultural sector has evolved over the past two decades to encompass processing, marketing, and distribution of both crops and livestock. Today, agriculture not only ensures food security but also supports GDP growth, drives trade, provides raw materials for other industries, and serves as a major source of livelihood across many regions. However, the rapid increase in global population, coupled with challenges such as climate change, land degradation, and labor shortages, demands a fundamental shift in how agriculture is practiced. To meet the growing demand for food in a sustainable and efficient manner, innovative technologies must be integrated into agricultural systems. Among these, Artificial Intelligence (AI) stands out as a transformative tool capable of revolutionizing every stage of the agricultural value chain.

Enabled by advances in big data analytics, robotics, the Internet of Things (IoT), drone technology, and affordable sensors, AI is poised to reshape modern farming. By analyzing data on temperature, soil conditions, weather patterns, moisture levels, and historical crop performance, AI can provide predictive insights—such as optimal planting and harvesting times or the best crop selection for a given region. This not only enhances crop yields but also reduces the reliance on water, fertilizers, and pesticides, thereby supporting environmental sustainability. Furthermore, AI-driven automation improves labor efficiency and worker safety, optimizes supply chains, and ensures food production keeps pace with population growth—ultimately contributing to lower food prices and improved food security.

This paper explores the current trends, methodologies, and challenges in the application of AI in agriculture. It highlights how AI technologies are enhancing productivity, increasing resource efficiency, and paving the way for a more resilient and sustainable agricultural sector [1].

### Precision Agriculture

One of the most prominent applications of AI in agriculture is precision farming. Precision agriculture refers to the use of AI algorithms to analyze data collected from various sources, such as satellite imagery, drones, weather



stations, and soil sensors. These AI systems help farmers make informed decisions about crop rotation, planting schedules, irrigation needs, and fertilizer application. For example, machine learning models can predict soil nutrient deficiencies or moisture levels and suggest targeted interventions, thereby improving crop yield and reducing input costs [2].

Moreover, AI-powered tools can generate customized recommendations for specific plots of land, considering microclimatic conditions and soil properties. This leads to better resource management and helps in reducing water wastage and overuse of agrochemicals. According to Kamilaris et al. (2018), such AI-driven approaches can increase yield by up to 25% while lowering input costs by around 20% [3].

### Crop Monitoring and Disease Detection

Another area where AI has shown remarkable potential is crop health monitoring and early disease detection. With the help of computer vision, deep learning, and image recognition techniques, AI can identify early symptoms of plant diseases, nutrient deficiencies, or pest infestations by analyzing leaf patterns, color changes, and growth anomalies.

These technologies allow for real-time monitoring through drones or smartphones equipped with AI-powered cameras. By detecting problems early, farmers can take swift action to prevent the spread of diseases, ultimately minimizing losses and reducing the need for harmful pesticides. An example of such a system is Plantix, a mobile application that uses AI to diagnose plant health issues from photos taken by users in the field [4].

### Robotics and Automation

AI is also revolutionizing the physical processes of agriculture through robotics and automation. AI-powered robots and autonomous machinery are increasingly used for repetitive tasks such as planting, harvesting, pruning, spraying, and weeding. These machines are capable of working around the clock and in varying weather conditions, significantly reducing the need for manual labor and improving efficiency.

For instance, robots like the “Agrobot” and “Harvest CROO” can identify ripe fruits and pick them without damaging the crops. Weeding robots powered by computer vision and AI can precisely remove weeds without disturbing the surrounding plants. Such innovations not only enhance productivity but also reduce the exposure of human workers to potentially hazardous conditions.

### Forecasting and Supply Chain Optimization

AI also plays a vital role beyond the farm—particularly in agricultural forecasting and supply chain management. Predictive analytics powered by AI can forecast crop yields, monitor market trends, and anticipate consumer demand. This helps in planning storage, transportation, and marketing strategies more efficiently, reducing food waste and ensuring better availability of produce in the market.

Furthermore, AI tools can analyze patterns in supply chains to identify inefficiencies and suggest optimal routing for distribution, thus saving time, fuel, and money. AI systems used in logistics are increasingly capable of dynamic adjustment based on weather patterns, road conditions, or market fluctuations [5].

### Sustainable Farming and Climate Resilience

AI contributes significantly to the goal of sustainable farming by enabling smart decision-making that minimizes environmental harm. AI-based systems can suggest eco-friendly pest control, optimal irrigation methods, and sustainable crop combinations that enrich the soil. By enhancing the accuracy of climate forecasts and risk assessments, AI also supports climate-resilient agriculture, helping farmers adapt to changing conditions and natural disasters.

For example, IBM’s Watson Decision Platform for Agriculture integrates AI and IoT to provide farmers with a full spectrum of insights—from planting to harvesting—while emphasizing sustainability and risk reduction [6].

### Conclusion

AI technologies are not just reshaping how farming is done — they are fundamentally transforming agriculture into a high-tech industry. From precision farming to disease detection, from robotics to supply chain optimization, AI offers comprehensive solutions that improve efficiency, reduce costs, and promote sustainability. As global agricultural demands continue to grow, the adoption of AI will be critical in creating a more productive and resilient food system.

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