



International Journal of Research in Agronomy

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; SP-8(12): 609-611
Received: 05-10-2025
Accepted: 08-11-2025

Avinash Kumar Gautam
Assistant Professor, Farm
Machinery & Power Engineering,
CARS, Gariaband, IGKV,
Chhattisgarh, India

Lekh Ram Verma
Assistant Professor, Agriculture
Extension, CARS, Gariaband,
IGKV, Raipur, Chhattisgarh,
India

Monika Gautam
Former SRF, Department of Plant
Breeding & Genetics, JNKVV,
Jabalpur, Madhya Pradesh, India

A review of AI and precision farming in Indian agriculture: Innovations, applications, and challenges

Avinash Kumar Gautam, Lekh Ram Verma and Monika Gautam

DOI: <https://www.doi.org/10.33545/2618060X.2025.v8.i12Sh.4542>

Abstract

Precision farming and artificial intelligence (AI) are transforming Indian agriculture by enhancing productivity, optimizing resource use, and ensuring sustainability. With over 58% of the Indian population dependent on agriculture for their livelihood, integrating AI is vital for addressing the sector's challenges. This review explores the integration of AI in precision farming within the Indian context, highlighting current applications such as crop monitoring, soil health management, irrigation management, pest control, and market access. It also discusses the benefits of increased productivity and resource optimization, the challenges of high initial costs and lack of infrastructure, and future prospects involving government initiatives and public-private partnerships. This paper provides a comprehensive understanding of how AI technologies can revolutionize Indian agriculture, contributing to the nation's food security and economic growth. The discussion includes relevant data and case studies to illustrate the impact and potential of AI-driven precision farming.

Keywords: Precision farming, artificial intelligence, Indian agriculture, sustainability, crop monitoring, soil health, irrigation management, market access, public-private partnerships

1. Introduction

Indian agriculture, characterized by small landholdings, diverse agro-climatic zones, and resource constraints, is undergoing a technological revolution. Precision farming, combined with AI, promises to address these challenges by providing data-driven solutions. With an estimated 140 million hectares of arable land and over 80% of farmers being smallholders, the potential impact of AI in agriculture is significant. This paper provides a comprehensive overview of how AI is utilized in India's precision farming, including specific examples and data to highlight its impact.

2. Current Applications of AI in Precision Farming

To enhance understanding and adoption, this section includes a visual table 1 illustrating the applications of AI in precision farming and their impacts:

Table 1: Applications of AI in precision farming and their impacts

AI Application	Description	Impact
Crop Monitoring	AI-powered drones and sensors for real-time health and pest monitoring	Yield improvement up to 30%
Soil Health Management	AI models analyzing soil data to optimize fertilizer application	Reduced fertilizer use by 20%, yield boost
Irrigation Management	Smart systems using AI for optimal water utilization	Water use reduced by 25%, yield increase
Pest and Disease Control	Image recognition tools for early pest detection	Crop loss reduction by 40%
Market Access Optimization	AI-driven price forecasting and logistics management	Profits increased by 15%, reduced losses

3. Crop Monitoring and Management

AI-powered technologies are increasingly used to monitor and manage crops more effectively.

Corresponding Author:
Avinash Kumar Gautam
Assistant Professor, Farm
Machinery & Power Engineering,
CARS, Gariaband, IGKV,
Chhattisgarh, India

3.1. Remote Sensing and Drones

AI-powered drones and remote sensing technologies enable real-time monitoring of crop health, soil conditions, and pest infestations. For example, drones equipped with multispectral and hyperspectral sensors have increased crop yields by up to 30% through early detection and intervention (Ministry of Agriculture & Farmers' Welfare, 2023) ^[4].

3.2. Predictive Analytics

Machine learning models predict crop yields and potential disease outbreaks. In Punjab, predictive analytics has reduced losses due to wheat rust by 15%, showcasing practical benefits (Indian Council of Agricultural Research, 2023) ^[2].

4. Soil Health Management

4.1. Soil Sensors and AI Models

AI models analyze data from soil sensors to determine soil moisture, nutrient levels, and pH, enabling precise fertilizer application. For instance, in Maharashtra, soil sensors have reduced fertilizer use by 20% and increased crop yields by 15% (International Food Policy Research Institute, 2023) ^[3].

4.2. Digital Soil Mapping

AI algorithms create detailed soil maps, guiding farmers on suitable crops and optimal farming practices. Digital soil mapping in Karnataka has improved soil management practices, resulting in a 10% increase in agricultural productivity (Food and Agriculture Organization, 2023) ^[1].

5. Irrigation Management

5.1. Smart Irrigation Systems

AI systems optimize water use by analyzing weather forecasts, soil moisture data, and crop water requirements. In Rajasthan, smart irrigation systems have reduced water usage by 25% and increased crop yields by 20% (Ministry of Agriculture & Farmers' Welfare, 2023) ^[4].

5.2. Water Resource Management

AI aids in the efficient allocation and management of water resources. In Tamil Nadu, AI-based water resource management has improved water use efficiency by 30%, benefiting thousands of farmers (Indian Council of Agricultural Research, 2023) ^[2].

6. Pest and Disease Control

6.1. Image Recognition

AI-powered image recognition tools identify pests and diseases early, enabling timely intervention. In Andhra Pradesh, AI-powered pest detection apps have reduced crop losses by 40% due to accurate pest identification (Food and Agriculture Organization, 2023) ^[1].

6.2. Integrated Pest Management

AI supports integrated pest management strategies by predicting pest outbreaks and recommending appropriate measures. In Gujarat, AI-driven pest management programs have reduced pesticide use by 25% while maintaining crop health (International Food Policy Research Institute, 2023) ^[3].

7. Pest and Disease Control

Improving market access and optimizing supply chains are crucial for enhancing farmers' incomes.

7.1. Price Forecasting

AI models predict market prices, helping farmers time their sales for maximum profit. In Madhya Pradesh, price forecasting has

increased profits by 15% by optimizing crop sale timings (Ministry of Agriculture & Farmers' Welfare, 2023) ^[4].

7.2. Supply Chain Management

AI enhances supply chain efficiency by optimizing logistics, reducing post-harvest losses, and improving traceability. In West Bengal, AI-driven supply chain systems have reduced post-harvest losses by 20%, ensuring more produce reaches the market in good condition (Indian Council of Agricultural Research, 2023) ^[2].

8. Benefits of AI in Precision Farming

Table 2 provides a clearer perspective on the advantages of AI in precision farming,

Table 2: Statistical data and trends

Parameter	Impact in AI-Adopted Regions
Average Yield Increase	20-30% rise in productivity (Ministry of Agriculture, 2023)
Input Cost Reduction	15-20% reduction in fertilizer and pesticide usage
Water Efficiency	25-30% improvement in water usage
Farmer Income Growth	10-15% higher profits due to better resource use

Additionally, studies show that AI-integrated farming practices have led to a 40% decrease in crop losses due to pests and a 20% reduction in post-harvest losses (Food and Agriculture Organization, 2023) ^[1]. Adopting AI tools like predictive analytics, smart irrigation, and market forecasting has also improved supply chain efficiency by 25% (Indian Council of Agricultural Research, 2023) ^[2].

8.1. Increased Productivity

AI technologies help precisely apply fertilizers, water, and pesticides, leading to healthier crops and higher yields. Implementations have increased crop yields by an average of 20% in regions where AI-driven precision farming has been adopted (Ministry of Agriculture & Farmers' Welfare, 2023) ^[4].

8.2. Resource Optimization

AI ensures efficient use of water, fertilizers, and pesticides, reducing waste and environmental impact. By providing data-driven recommendations, AI systems optimize resource use, promoting sustainable farming practices (International Food Policy Research Institute, 2023) ^[3].

8.3. Risk Mitigation

Predictive analytics and early warning systems enable farmers to mitigate risks associated with weather, pests, and diseases. By forecasting adverse conditions, AI systems help farmers prepare and take preventive measures, reducing crop losses (Food and Agriculture Organization, 2023) ^[1].

8.4. Economic Benefits

Improved crop yields and better market access result in higher incomes for farmers. AI technologies also enhance supply chain efficiency, ensuring better returns (Indian Council of Agricultural Research, 2023) ^[2].

9. Challenges in Implementing AI in Indian Agriculture

Table 3 provides a concise overview of the challenges in implementing AI in Indian agriculture along with actionable solutions, enhancing clarity and aiding stakeholders in identifying key areas for intervention.

Table 3: Challenges in implementing AI in Indian agriculture along with actionable solutions

Challenge	Description	Proposed Solution
High Initial Costs	AI technologies and precision farming equipment are expensive for small and marginal farmers.	Government subsidies, financial support, and low-interest loans for purchasing AI equipment.
Lack of Infrastructure	Poor digital connectivity and lack of technological infrastructure in rural areas.	Investment in rural internet connectivity and infrastructure development.
Data Availability and Quality	Inadequate data collection and sharing limit the accuracy and effectiveness of AI applications.	Standardization of agricultural data collection and sharing protocols.
Knowledge and Training	Farmers lack the skills to effectively use AI tools and technologies.	Extension services, training programs, and farmer field schools to educate farmers.
Policy and Regulatory Issues	Lack of clear policies on data privacy, intellectual property, and AI usage in agriculture.	Formulating supportive policies and regulatory frameworks to address these issues.

9.1. High Initial Costs

The cost of AI technologies and precision farming equipment remains a significant barrier, especially for small and marginal farmers. Subsidies and financial support can mitigate this challenge (Ministry of Agriculture & Farmers' Welfare, 2023) ^[4].

9.2. Lack of Infrastructure

Inadequate digital infrastructure, such as internet connectivity in rural areas, hampers adoption. Developing rural connectivity is essential for enabling the use of AI tools (International Food Policy Research Institute, 2023) ^[3].

9.3. Data Availability and Quality

High-quality data is crucial for AI accuracy, but gaps in data

collection and sharing limit its effectiveness. Standardizing and sharing agricultural data can improve AI outcomes (Food and Agriculture Organization, 2023) ^[1].

9.4. Knowledge and Training

Farmers require training to use AI technologies effectively. Extension services and training programs can bridge this gap (Indian Council of Agricultural Research, 2023) ^[2].

9.5. Policy and Regulatory Issues

Policies addressing data privacy, intellectual property, and AI use are needed. Supportive policies can accelerate AI adoption (Ministry of Agriculture & Farmers' Welfare, 2023) ^[4].

Table 4: Future Prospects

Aspect	Current Trends	Future Projections
AI Adoption in Farming	15% of farmers currently use AI tools (Ministry of Agriculture, 2023).	Expected to increase to 50% by 2030 with supportive policies and training.
Crop Yield Improvements	Average yield increases by 20-30% in AI-adopted regions.	Anticipated rise to 35-40% with advanced AI technologies.
Cost Savings	Reduction in input costs by 15-20% (Food and Agriculture Organization, 2023) ^[1] .	Likely to improve to 25-30% as AI systems become more efficient.
Farmer Income Growth	10-15% income growth was observed in regions utilizing AI tools.	Projected to reach 20% with enhanced market access and price forecasting.

10. Government Initiatives

Expanding schemes like PMFBY and eNAM to include AI can accelerate adoption. Subsidies for AI equipment and training programs can further boost usage (Ministry of Agriculture & Farmers' Welfare, 2023).

10.1. Public-Private Partnerships

Collaboration among stakeholders can drive innovation and reduce costs. Scaling up pilot projects can ensure wider adoption (International Food Policy Research Institute, 2023) ^[3].

10.2. Education and Training Programs

Comprehensive training programs delivered through farmer field schools and digital platforms can equip farmers with the necessary skills (Indian Council of Agricultural Research, 2023).

11. Conclusion

AI and precision farming have the potential to revolutionize Indian agriculture by increasing productivity, optimizing resource use, and ensuring sustainability. Government support, public-private partnerships, and educational initiatives will be crucial in overcoming challenges. Embracing AI technologies can lead to a resilient and prosperous agricultural sector in India.

References

- Food and Agriculture Organization. Digital technologies in agriculture: enhancing productivity and sustainability. Rome: FAO; 2023.
- Indian Council of Agricultural Research. Advances in precision farming technologies. New Delhi: ICAR; 2023.
- International Food Policy Research Institute. Leveraging AI for sustainable agriculture. IFPRI annual review. Washington (DC): IFPRI; 2023.
- Ministry of Agriculture & Farmers' Welfare. AI in Indian agriculture: a roadmap for the future. New Delhi: Government of India; 2023.