Bodhi International Journal of
Research in Humanities, Arts and Science

Vol. 10 Special Issue 3 December 2025
E-ISSN: 2456-5571

Artificial Intelligence and Its Role in India's Agricultural Development

Dr. S. Theenathayalan[1] & Dr. S. Murugan[2]

[1]*Associate Professor & Head, Department of Economics & Centre for Research in Economics*
The Madura College, Madurai, Tamil Nadu
[2]*Assistant Professor, PG & Research Department of Economics*
Thiagarajar College, Madurai, Tamil Nadu

Open Access

Manuscript ID:
BIJ-SPL3-Dec25-ECO-085

Subject: Economics

Received : 20.08.2025
Accepted : 30.08.2025
Published : 31.12.2025

DOI: 10.64938/bijsi.v10si3.25.Dec085

Abstract

Agriculture is one of the oldest and most important occupation in the world, with food demand and work demand increasing as the world population continues to grow. The traditional farming methods cannot satisfy the requirements of billions of people worldwide on food demands and provide jobs, so new automated ways are developed. Smart farming, or the application of intelligent farming processes, including connecting farm machinery, sensors, actuators, and software is being researched and developed for improving quality and production output of agricultural products. Farmers apply pesticides to growing areas in greenhouses or open fields to enhance yield. Machine learning may also be used by farmers. AI also helps with pest management and crop protection, such as treating weeds, pests, and diseases more accurately and timely, using artificial intelligence solutions such as precision spraying methods or self-governing drones for monitoring, reducing the reliance on chemical pesticides and keeping ecological balance. This will lead sustainability growth in the field of Agriculture in the forthcoming years.

Keywords: traditional farming, greenhouses, pesticides, ecological balance and sustainability

Introduction

Agriculture is one of the oldest and most important occupation in the world, with food demand and work demand increasing as the world population continues to grow. The traditional farming methods cannot satisfy the requirements of billions of people worldwide on food demands and provide jobs, so new automated ways are developed. There are several challenges: lack of manpower, stricter regulations, increased global population, and a declining farming population driving farmers to find innovative solutions. The Internet of Things, Big Data & Analytics, Artificial Intelligence, and Machine Learning is impacting almost all sectors. Smart farming, or the application of intelligent farming processes, including connecting farm machinery, sensors, actuators, and software is being researched and developed for improving quality and production output of agricultural products. Farmers apply pesticides to growing areas in greenhouses or open fields to enhance yield. Machine learning may also be used by farmers.

Digital agriculture: Machine learning can be used safely to increase agricultural yield while minimizing environmental impact. Collected agricultural data will help farmers better understand crops, their DNA, and potential diseases. Artificial intelligence is evolving rapidly with increasing

computing power and greater penetration of the cloud, as more parts of the global economy are experiencing the benefits of AI, including agriculture. From weed management to determining optimal times to harvest or monitor soil and crop health, from predicting yield before it happens, AI has already been proven on the farm. First, there is an indisputable increase in data availability and accessibility. In agriculture, AI- and ML-based surveillance systems provide information about crops, insects, and soils, which can help farmers. This article aims to focus on the scope of AI in Agricultural Development of a country

Artificial Intelligence

Artificial intelligence is a multidisciplinary field that aims to mimic human intelligence in machines through emulation of human behavior and thought processes such as problem solving and learning. Artificial intelligence technologies are being used by researchers and extension workers to address production-related concerns in agriculture; AI can support decisions regarding crop varieties, fertilizer and soil management techniques, and pest and disease control, estimate the productivity of crops, and predict prices for commodities. Some of these cutting-edge AI approaches include deep learning, robotics, the Internet of Things, image processing, artificial neural networks, wireless sensor networks, and machine learning to solve agricultural problems. With real-time data collected from their fields (weather conditions, temperature, water usage, etc.), farmers can use these AI technologies to make more informed decisions.

There are many uses for AI today, from driverless cars to facial recognition on our smartphones. While there have been great productivity gains in other industries that can be attributed to the use of AI and machine learning skills, it is impossible to imagine a digital revolution of agriculture. The future of one of humanity's oldest professions has been propelled into the 21st century with artificial intelligence. Artificial intelligence applications for farming are more numerous than you might think. Artificial intelligence enables precision agriculture, such as irrigation, crop rotation, harvesting, crops, planting, and pest control by using ML data. AI is based on the idea that a computer can mimic human intelligence to perform tasks of any complexity in perception, reasoning, and learning. This general influence of artificial intelligence is evident everywhere. Every industry is trying to automate certain functions.

AI's Necessity in Agriculture

Agriculture is a people-intensive industry; as agricultural production increases in response to population growth, technology becomes more essential. Technology has significant advantages for farmers when applied to parts, technology and applications, enhanced farm and crop management systems and predictive analytics ensuring available crops, quality of the crop, businesses calculate acreage using satellite images and meteorological data, monitor crop health in real time, use big data, AI and machine learning to predict pricing, estimate tomato production and output, detect pest and disease infestations, and recommend pricing trends, advising farmers on how much demand there will be for their product, which crop varieties will generate the most money, when they need to apply pesticides, and potential price fluctuations. With its ability to lessen labor and resource deficit, AI will help businesses facing the increasing complexity of modern agriculture. Big firms should.

The use of AI technologies spans nearly all sectors in an effort to increase productivity and efficiency. In virtually every sector people have found ways for AI technologies to overcome traditional problems. Applications exist in finance, transportation, healthcare, agriculture, and more. While the global population is growing, urbanization is also increasing. This growing disposable income will change consumer behavior, and farmers will be

under tremendous pressure to meet this demand by finding a way to become more productive. More food will be needed; farming will have to get creative because there is only so much fertile soil. We must devise strategies for helping farmers mitigate their risks or at least minimize them in some manner. The widespread adoption of AI technologies in agriculture may be the most interesting possibility. However, today many food producers are struggling to control the risks and hazards that pests and other diseases present.

Precision Farming

AI is integrated into precision farming practices that result in increased yields, sustainability, and efficient resource management. Some of the most important applications of AI in precision farming are related to data collection, pest control, fertilization, irrigation, and fertilization.

Precision Irrigation

AI-powered precision irrigation technologies have revolutionized the way water resources are managed in agriculture. Traditional irrigation methods often lead to over or under application of resources, while AI algorithms that work with sensor and satellite data allow for precise monitoring of crop water needs, weather patterns, and soil moisture levels. By combining data from sensors and satellites, artificial intelligence (AI) systems can accurately predict the time and location of watering.

Precision Fertilization

Similarly, AI methods for precision fertilization enhance nutrient management on farms: artificial intelligence (AI) can analyze satellite imagery, drone images, soil sensors, etc., to determine the amount of nutrients present in the soil as well as crop demands with unprecedented accuracy, and then create customized fertilization plans that indicate which type and how much fertilizer to apply where, optimizing nutrition for plants, yields, reducing waste while lowering environmental pollution from excess nutrients flowing into waterways.

Precision Pest Control

Another area where AI is critical for proactive pest management strategies is in identifying and responding to pest infestations. Artificial intelligence (AI) systems may be able to detect patterns of pests or indicators by analyzing data from various sources including satellite imagery, drone images, soil sensors, etc., and then provide farmers with specific plans to address pest problems.

The Integration of Sensors, Drones, and Satellite Images

The effectiveness of AI in precision agriculture relies heavily on combining multiple data sources like sensors, drones, and satellite imagery. Soil sensors deliver real-time information on temperature, moisture, and nutrient levels, allowing for accurate irrigation and fertilization decisions. Drones equipped with cameras and multispectral sensors capture high-resolution images of fields to detect pest infestations, nutrient deficiencies, and crop health issues. Satellite images offer a wider view, facilitating the monitoring of large agricultural areas and assessing crop health, water stress, and vegetation changes over time. By leveraging AI to analyze and interpret data from these diverse sources, farmers gain valuable insights into their fields' conditions, enabling informed decisions that boost productivity, lower input costs, and minimize environmental impact. AI-powered precision farming represents a revolutionary shift in agriculture, delivering unprecedented levels of sustainability, efficiency, and accuracy. Through advanced algorithms and data analytics, farmers can enhance yields, reduce ecological footprints, and optimize resource use. As AI technologies continue to evolve and become more accessible, precision farming is becoming increasingly innovative. Ongoing research and development hold the promise of further transforming agriculture, creating a stronger and more productive food system to address global challenges like population growth and climate change.

Crop Monitoring and Management

Recent advances in data analytics and artificial intelligence have transformed the agricultural industry. One of the most significant innovations is the implementation of AI-driven image recognition, computer vision technologies, and intelligent sensors for the monitoring and management of crops. These tools offer unmatched insights into the health of crops, detection of diseases, prediction of yields, and optimization of cultivation practices. This article examines how artificial intelligence is reshaping crop management and monitoring, leading to more efficient and productive farming techniques.

AI-Powered Computer Vision and Image Recognition Systems

Employing AI-driven computer vision and image recognition technologies is a key factor driving the transformation in crop monitoring. These technologies analyze field data and aerial images to assess the health of crops, identify diseases, and deliver highly accurate predictions of yields. They utilize deep learning algorithms to detect subtle changes in crop conditions that might otherwise be overlooked. For example, they can identify early warning signs of pest outbreaks, nutrient deficiencies, or water stress, allowing farmers to take timely and appropriate action.

Smart Sensors for Real-Time Data Collection

In addition to aerial imaging, intelligent sensors play a crucial role in managing and monitoring crops. When placed directly in the fields, these sensors gather real-time data on various environmental factors, including soil moisture, temperature, and humidity. By continuously tracking these elements, farmers can obtain valuable insights into current growth conditions and make informed choices to improve their agricultural practices. For instance, they can implement climate control strategies in greenhouses to create optimal growing conditions for their crops or adjust irrigation schedules based on moisture levels in the soil.

Predictive Analytics

One effective application of AI in agricultural monitoring is using predictive analytics to optimize yields. Algorithms for predictive analytics can accurately forecast growth trends by analyzing historical data related to crop development, weather conditions, soil characteristics, and other relevant factors. With this insight, farmers can adjust their planting strategies, improve fertilization practices, and accurately time harvests to maximize crop yields. For example, they might time their harvests to align with peak market demand, ensuring maximum profitability, or stagger planting dates to minimize the risk of crop loss due to adverse weather conditions. The combination of AI-driven image recognition, computer vision technologies, intelligent sensors, and predictive analytics has revolutionized the ways in which crops are monitored and managed. By leveraging this technology, farmers can forecast yields, detect crop diseases, and enhance farming practices to mitigate risks and boost profitability. Khandelwal and Chavhan (2019) suggest that as AI continues to evolve and gain accessibility, a new era of smart and sustainable agricultural practices will arise.

Crop Protection and Pest Management

Crop protection and pest control have been a necessary part of farming since the dawn of agricultural practices, and most of those methods are still based on human effort or chemical pesticides, both which have led to environmental degradation and unsustainability. Advances in artificial intelligence (AI) technology are shifting that paradigm as AI algorithms process vast amounts of data to detect pest issues, recommend treatment strategies, and overhaul integrated pest management (IPM) systems; and AI-powered self-driving sensors with actuators are replacing hazardous chemicals and manual labor for weed control.

Challenges and Future Directions

Although Artificial Intelligence has significant potential in pest control and crop protection, some challenges need to be addressed when implementing

these solutions in agriculture. Data privacy issues, algorithmic biases, and accessibility problems must all be considered for AI applications in farming; additionally, farmers in rural communities may need more training and capacity to fully take advantage of AI technologies, so cooperation between researchers, legislators, and industry stakeholders will help overcome challenges and ensure full utilization of AI technology in the future. Future directions for AI involve its integration with other advanced technologies such as block chain, Internet of Things, and precision agriculture.

Future Scope

In the future, AI will give farmers creative answers to most of their problems (pest management, weather forecasting, farm labor support), but in the forthcoming years we will see some exciting innovations that directly affect farming. In future, Artificial Intelligence will enable farmers to be agricultural scientists using data to tailor yields to specific plant rows. Companies are creating robots that can handle a wide range of tasks within an agricultural setting, from harvesting crops faster and more efficiently than a human, to identifying weeds, picking and packing crops while maintaining crop quality, or circumventing the challenges that agricultural labor faces. Artificial intelligence aids in pest management by sending alerts to farmers when pests are detected.

Conclusion

Farmers can use AI-driven solutions to monitor crops in real-time by using machine learning algorithms and data analytics to inform irrigation, fertilization, and harvesting schedules to maximize yields while minimizing resources used and environmental impact. This not only increases output but also encourages sustainable farming for future generations. AI also helps with pest management and crop protection, such as treating weeds, pests, and diseases more accurately and timely, using artificial intelligence solutions such as precision spraying methods or self-governing drones for monitoring, reducing the reliance on chemical pesticides and keeping ecological balance. This will lead sustainability growth in the field of Agriculture in the forthcoming years.

References

1. Ahale, S., Rakhonde, G., Bhateja, S., Kuppuraj, J., & Mishra, S. (2024). Disease and Pest Control through Advance Technology in Artificial Intelligence and Smart Agriculture: *Technology and Applications*, Springer Nature Singapore, Pp. 437-459.
2. Balamurugan, R., Kartheeswari, K. R., & Perumal, S. (2024). *Introduction to Smart Agriculture*. In Advanced Technologies for Smart Agriculture (pp. 1-29) River Publishers.
3. Ali, M.A., Abdellah, I. M. & Eletmany, M. R. (2023). Towards Sustainable Management of Insect Pests: Protecting Food Security through Ecological Intensification. *International Journal of Chemical and Biochemical Sciences*, 24(4), 386-394.
4. Chithambarathanu, M. & Jeyakumar, M. K. (2023). Survey on crop pest detection using deep learning and machine learning approaches. *Multimedia Tools and Applications*, 82(27), 42277-42310.
5. Chougule, M. A. & Mashalkar, A. S. (2022). A comprehensive review of agriculture irrigation using artificial intelligence for crop production. *Computational Intelligence in Manufacturing*, 187-200.
6. Gupta, S., Geetha, A., Sankaran, K. S., Zamani, A. S., Ritonga, M., Raj, R. & Mohammed, H. S. (2022). Machine learning-and feature selection-enabled framework for accurate crop yield prediction. *Journal of Food Quality*, 1-7.
7. Dwivedi, Y. K., Hughes, L., Ismagilova, E., Aarts, G., Coombs, C., Crick, T. & Williams, M. D. (2021). Artificial Intelligence (AI): Multidisciplinary perspectives on emerging challenges, opportunities, and agenda for research, practice and policy. *International Journal of Information Manage ment*, 57, 101994.

8. Ben Ayed, R. & Hanana, M. (2021). Artificial intelligence to improve the food and agriculture sector. *Journal of Food Quality*, 2021, 1-7.
9. Grieve,B.D., Duckett,T., Collison, M., Boyd, L., West, J., Yin, H. & Pearson, S. (2019). The challenges posed by global broad acre crops in delivering smart agri robotic solutions: A fundamental rethink is required. *Global Food Security*, 23, 116-124.