

Innovative Insights: Exploring the Role of AI in Agricultural Entomology

D. Prakash^{1*}, Sandeep Shivajat Bangennavar², Dhane Ankur Sudam³, Surendra Ghasal⁴ and Aarti Yadav⁵

¹Assistant Professor, Department of Entomology, School of Agricultural Sciences, Sri Manakula Vinayagar Engineering College, Madagadipet, Puducherry

²M.Sc. Scholar, Department of Entomology, Indira Gandhi Krishi Vishwavidyalaya, Raipur, Chhattisgarh

³Assistant Professor, Department of Entomology, Dr. B. S. Kokan Krishi Vidyapeeth, Dapoli, Maharashtra

⁴M.Sc. Scholar, Department of Entomology, Banaras Hindu University, Varanasi, Uttar Pradesh

⁵M.Sc. Scholar, Department of Agronomy, College of Agriculture, Suwana, MPUAT, Udaipur



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*Corresponding Author

D. Prakash*

Article History

Received: 1. 2.2026

Revised: 5. 2.2026

Accepted: 10. 2.2026

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INTRODUCTION

Insects are among the most significant biological constraints in agriculture, causing substantial yield losses worldwide. From stem borers in rice to fall armyworm in maize and whiteflies in vegetables, insect pests continuously challenge farmers and researchers alike. Conventional pest management relies heavily on field scouting, manual identification and blanket pesticide applications. While these methods have been effective to some extent, they are often inefficient, costly and environmentally unsustainable.

The integration of Artificial Intelligence (AI) into agricultural entomology represents a transformative shift. AI refers to computer systems capable of performing tasks that typically require human intelligence, such as recognizing patterns, learning from data and making predictions. In entomology, AI enables rapid insect identification, real-time monitoring and accurate pest forecasting. Instead of reactive control measures, AI promotes proactive and data-driven decision-making.

Concept and Principles of AI in Agricultural Entomology

The application of AI in entomology is grounded in several core principles:

1. Data-Driven Learning:

AI systems rely on large datasets such as insect images, climatic records and crop health parameters. Machine learning algorithms analyze patterns and improve accuracy over time.

2. Pattern Recognition:

Computer vision models can distinguish pest species based on wing patterns, body shape and colour variations, often with accuracy comparable to expert entomologists.

3. Predictive Modelling:

AI can predict pest outbreaks by integrating historical data, weather variables and crop growth stages.

4. Automation and Real-Time Monitoring:

Smart traps and sensors continuously collect field data, reducing manual labour and human error.

5. Precision Intervention:

AI supports targeted pest control measures, minimizing unnecessary pesticide applications and environmental impact.

These principles collectively shift pest management from generalized control strategies to precise and intelligent systems.

AI-Based Pest Identification and Monitoring

One of the most promising applications of AI is automated pest identification. AI-powered smart traps enable real-time pest detection and automated population monitoring (Figure 1).



Figure 1. AI in action: Smartphone-based pest detection integrated with a solar-powered smart insect trap and drone-assisted field monitoring.

Computer Vision and Image Recognition

Using deep learning models such as Convolutional Neural Networks (CNNs), AI systems can identify insects from field images captured by smartphones, drones or stationary cameras. Farmers can upload insect images to mobile applications, which instantly classify species and suggest management options.

Smart Insect Traps

AI-powered smart traps combine cameras, pheromone lures and sensors. These devices automatically:

- ❖ Capture insect images
- ❖ Count pest populations
- ❖ Transmit real-time data to cloud platforms
- ❖ Alert farmers when pest thresholds are exceeded

Such systems are particularly useful for monitoring migratory pests like fall armyworm and fruit flies.

Drone and Remote Sensing Technologies

Drones equipped with multispectral cameras detect crop stress caused by insect feeding before symptoms become visible to the human eye. AI algorithms analyze spectral signatures and identify patterns associated with pest damage. Satellite-based remote sensing further enhances large-scale monitoring. When integrated with AI models, remote sensing enables:

- ❖ Early detection of infestation hotspots
- ❖ Mapping of pest spread
- ❖ Region-wide surveillance

AI in Pest Forecasting and Climate-Based Models

Insect population dynamics are strongly influenced by temperature, humidity and rainfall. AI models analyze climatic variables and historical outbreak data to predict future infestations.

For example:

AI Application	Function	Benefit
Machine learning forecasting models	Predict pest emergence	Early warning systems
Weather-integrated algorithms	Correlate climate with pest cycles	Timely intervention
Big data analytics	Analyze long-term trends	Strategic planning

By forecasting pest outbreaks, farmers can implement preventive measures rather than emergency pesticide applications. Predictive

models supported by drone surveillance enhance early warning systems for pest outbreaks (Figure 2).



Figure 2. AI-driven pest forecasting system integrating climate data, drone surveillance and precision spraying technologies.

Decision Support Systems (DSS) and Integrated Pest Management (IPM)

AI-driven Decision Support Systems assist farmers in selecting appropriate pest management strategies. These systems integrate:

- ❖ Pest population data
- ❖ Economic threshold levels
- ❖ Weather forecasts
- ❖ Crop growth stages

The system then recommends:

- ❖ Whether control measures are necessary
- ❖ Optimal timing of intervention
- ❖ Suitable biological or chemical options

This enhances Integrated Pest Management (IPM) by promoting rational pesticide use and supporting biological control agents.

Benefits of AI in Agricultural Entomology

1. Improved Accuracy

AI reduces misidentification of insect species and enhances diagnostic precision.

2. Labour Efficiency

Automation decreases dependency on manual field scouting.

3. Environmental Sustainability

Targeted spraying reduces chemical overuse and protects beneficial insects.

4. Cost Reduction

Early detection minimizes crop losses and input costs.

5. Data-Driven Agriculture

Continuous data collection improves long-term pest management strategies.

Challenges and Limitations

Despite its transformative potential, AI adoption in agricultural entomology faces several challenges:

- ❖ High initial investment costs
- ❖ Limited digital literacy among farmers
- ❖ Requirement of large, high-quality datasets
- ❖ Infrastructure limitations in rural areas
- ❖ Data privacy and ownership concerns

Additionally, AI systems must be region-specific since pest dynamics vary across agro-climatic zones.

Future Perspectives

The future of AI in agricultural entomology is promising. Emerging innovations include:

- ❖ AI-integrated robotic sprayers for precision pesticide application
- ❖ Real-time pest surveillance networks linked to national databases
- ❖ Integration of AI with Internet of Things (IoT) devices
- ❖ Development of multilingual AI advisory apps for smallholder farmers

With continued advancements, AI could enable autonomous pest management systems that

operate with minimal human intervention. Collaboration among entomologists, data scientists, agronomists and policymakers will be essential to ensure equitable and sustainable implementation.

CONCLUSION

Artificial Intelligence is reshaping agricultural entomology by introducing intelligent, data-driven and sustainable pest management systems. From automated insect identification to predictive outbreak models, AI enhances precision and efficiency while reducing environmental impact. Although challenges remain in infrastructure, cost and adoption, the long-term benefits outweigh the limitations. By combining ecological knowledge with advanced computational tools, AI offers innovative insights that can strengthen food security and promote sustainable agriculture. As global agriculture faces increasing pressure from climate change and pest evolution, AI-driven entomology stands as a powerful ally in building resilient farming systems.

REFERENCES

- Carneiro, D., et al. (2020). Automatic identification of insects from digital images using deep learning techniques. *Ecological Informatics*, 57, 101089.
- Chen, Y., Zhang, Z., & Tao, F. (2020). Intelligent pest monitoring based on machine vision and deep learning. *Computers and Electronics in Agriculture*, 169, 105202.
- Kamilaris, A., & Prenafeta-Boldú, F. X. (2018). Deep learning in agriculture: A survey. *Computers and Electronics in Agriculture*, 147, 70–90.
- Liakos, K. G., Busato, P., Moshou, D., Pearson, S., & Bochtis, D. (2018). Machine learning in agriculture: A review. *Sensors*, 18(8), 2674.
- Mahlein, A. K. (2016). Plant disease detection by imaging sensors—Parallels and specific demands for precision agriculture and plant phenotyping. *Plant Disease*, 100(2), 241–251.