



## **Popular Article**

**Domain: Agriculture Science**

**Vol 5 Issue 5, May 2026, 617-622**

# **Advances in Insect Pest Management in Agriculture: From Chemical to Biocontrol Methods**

**Preeti Sharma<sup>1</sup>, Dr. M. Ramasamy<sup>2\*</sup>, Chaman Kumar<sup>3</sup>, and A. Balaji<sup>4</sup>**

<sup>1</sup>Ph.D Scholar, (CCSHAU, Hisar-125004, Haryana), College of Agriculture, Department of Entomology, CCSHAU, Hisar-125004, Haryana, India.

<sup>2</sup>Assistant Professor, Veterinary and Animal Sciences, Krishi Vigyan Kendra, Tamil Nadu Agricultural University, Virinjipuram Post, K.V. Kuppam Taluk, Vellore-632104, Tamil Nadu, India.

<sup>3</sup>Assistant Professor cum Junior Scientist, Department of Entomology, RNTAC Deoghar (BAU Ranchi), India.

<sup>4</sup>Faculty, Department of Science, Tamil Nadu Board of Secondary School Education, Pattanam Post, Rasipuram Taluk, Namakkal, Tamil Nadu, India.

\*Corresponding Address: [samyvet2@rediffmail.com](mailto:samyvet2@rediffmail.com)  
[doi.org/10.5281/TrendsInAgriculture.20152338](https://doi.org/10.5281/TrendsInAgriculture.20152338)

### *Abstract*

Insects have been one of the major limiting factors when it comes to increasing agricultural output all across the globe. Pesticides were thought of as the main way out of the problem of insect infestation in the past. However, despite the success that pesticides brought to agriculture in terms of higher productivity, over-reliance on pesticides led to resistance and various adverse effects including pollution, harm to natural predators, damage to ecosystems, and even danger to human life. In the modern world, there is an understanding that pesticides cannot be the only source of pest management in sustainable agriculture. There are new technologies, such as remote sensing, precision farming, biotechnology, and others, which can be used in addition to pesticides. In this paper, the evolution of pest management in agriculture, drawbacks of using only pesticides, recent innovations in biology-based pest control will be discussed.

**Keywords:** Integrated pest management, Insect pest management, chemical pesticides, biological control, biopesticides.

### **Introduction**

The field of agriculture has often been subjected to numerous threats from insect pests. Insect pests not only affect crops in the fields but even when in storage; hence, they reduce yields. Unmanaged infestation by insect pests results in considerable losses in crop yield for most farmers.

However, in the twentieth century, there was a significant breakthrough in agricultural pest control through the use of synthetic pesticides. Pest control was achieved within a reasonable timeframe, and farmers managed to increase their crop production. Nevertheless,

reliance on chemical pesticides has come at a cost. Overdependence on pesticides has resulted in insect resistance to such pesticides. Also, the application of pesticides results in pollution of soils, water, and even food produce, as well as harming beneficial organisms like bees.

In recent years, efforts have been made towards pest control that do not only consider chemical pesticides. The modern approach to pest control emphasizes reducing the over-reliance on pesticides through integration of biological techniques. This shift from purely chemical methods to biological ones is among the most significant advancements in sustainable agriculture.

### **Traditional Chemical Control Methods**

The use of chemical pesticides has been extensively utilized as a crop protection strategy against insect pests for decades. Chemicals like organophosphates, carbamates, pyrethroids, and neonicotinoids were extensively employed due to their speed and broad spectrum of action. Some of the benefits provided by chemical control include:

- Ease of application
- Rapid population reduction
- Scalability in field application
- Economic gain

Although there are many benefits of using pesticides, it had led to many issues over time.

- **Development of Resistance:** The repetitive application of similar insecticides has helped insect species develop resistance. Resistant insect species survive the effects of pesticides and reproduce further, reducing the effectiveness of chemicals.

Many agricultural pests today exhibit resistance to more than one type of insecticide, posing significant problems for farmers.

- **Environmental Pollution:** Pesticides frequently result in soil contamination, groundwater contamination, river pollution, and environmental damage. In addition, non-target organisms such as birds, fish, helpful insects, and soil microbes may be affected.

The excessive use of pesticides has decreased biodiversity in agricultural environments.

- **Effect on Human Health:** The residual presence of pesticides in agricultural products affects farmers, agricultural laborers, and consumers. Chronic exposure to some chemicals has caused health problems and environmental toxicity.

These factors motivated researchers to find safe solutions.

- **Shift Toward Integrated Pest Management (IPM):** Integrated Pest Management (IPM) is seen as a more rational way of pest management. Rather than relying wholly

on the use of pesticides, IPM utilizes different techniques for managing pests in an economic manner.

Some of the key concepts in IPM are:

- Pest surveillance
- Economic threshold levels
- Preservation of natural predators
- Pesticide application only if required
- Biological, cultural, and mechanical integration

IPM works to keep the population of pests low so that they do not cause any harm. It should be noted that recent studies have demonstrated that modern IPM techniques rely more on biological approaches.

### **Advances in Biological Control Methods**

Biological control involves the use of living organisms or natural products to suppress pest populations. It is one of the fastest-growing areas in sustainable agriculture.

**1. Predators and Parasitoids :** Beneficial insects are very useful for the natural control of agricultural pests.

#### **Predators**

Predators prey upon harmful insects.

Examples are:

- Ladybird beetles on aphids
- Lacewings on whiteflies and mealybugs
- Predator mites on spider mites

#### **Parasitoids**

Parasitoids are insects that lay eggs either in or on other insects, thereby causing their death after emerging from the host insect.

Examples are:

- Trichogramma wasps against caterpillar eggs
- Braconid wasps on larvae pests

Parasitoids are very specific and harmless to the environment.

### **2. Microbial Biocontrol Agents**

Microbial biopesticides are becoming popular in the quest for eco-friendly alternatives in controlling pests.

#### **Bacterial Biopesticides**

The bacterium *Bacillus thuringiensis* (Bt), which produces insecticidal proteins but does not affect mammals, has been one of the most commercially successful microbial biopesticides.

Applications of Bt products are found in various pests such as caterpillars of vegetables, cotton, and cereal crops.

### **Entomopathogenic Fungi**

Some fungi species that are entomopathogenic include:

- *Beauveria bassiana*
- *Metarhizium anisopliae*

They kill insect pests and are being exploited as bio-insecticides.

### **Viral Biopesticides**

Some viruses are insect-specific and do not infect other life forms. They include baculoviruses that target lepidopterans.

### **Entomopathogenic Nematodes**

These are micro-worms that can attack soil-inhabiting insect pests.

## **3. Botanical Pesticides**

The popularity of botanical compounds is growing due to their degradable properties and reduced toxicity.

The use of neem-based materials which include azadirachtin is common in the management of insects.

Other plant extracts such as essential oils are also becoming popular.

## **4. Semiochemicals & Pheromones**

Semiochemicals are chemicals involved in communication by insects.

Pheromone traps have become common in:

- Monitoring of pests
- Disruption of mating
- Mass trapping

These methods minimize insect reproduction without causing harm to other organisms.

## **Role of Biotechnology in Pest Management**

In pest management, biotechnology has emerged as an essential technology due to its environmentally friendly and effective means to control pests in agriculture. The technology assists in developing crops that are resistant to pests and developing bio-pesticides, among other technologies. Biotechnology is used in detecting and managing pests in ways that ensure sustainability in agriculture production.

**Biotechnology has introduced new tools for insect pest management.**

### **Bt Crops**

Genetically modified Bt crops produce insecticidal proteins that protect plants against major pests.

Examples include:

- Bt cotton
- Bt maize

These crops reduced insecticide use significantly in many regions.

### **RNA Interference (RNAi)**

RNAi technology targets specific insect genes responsible for survival or reproduction. This method provides highly precise pest control with minimal impact on non-target organisms. Recent research highlights RNAi as a promising future tool in sustainable pest management.

### **Precision Agriculture and Digital Technologies**

Advancements in technology are revolutionizing the pest control system.

1. Drones and satellite imagery aid in identifying pest problems at an earlier stage and enable targeted application of pesticides.
2. AI-driven technology is useful in identifying insect pests, forecasting pest outbreaks, and aiding farmers in making decisions. There is a growing trend in recent research of using AI technology for automatic pest detection systems.
3. Automated insect traps equipped with sensors facilitate the monitoring of pest activity.

### **Challenges in Adopting Biocontrol Methods**

Although biological methods offer many advantages, several challenges remain.

1. Slow Action
2. Shelf-Life and Storage Issues
3. Variable Field Performance
4. Limited Farmer Awareness
5. Regulatory and Commercial Challenges

### **Future Prospects**

According to experts, the future insect pest management would be geared towards ecological control techniques combined with the use of sophisticated technology for an effective and sustainable solution. Among the new trends are innovations in climate-proof biological control methods and AI-assisted insect pest prediction techniques. The future of insect pest management would also involve the utilization of nano-based technology for the precise application of the pest control method. In addition to this, the use of habitat management technique would help conserve natural enemies using conservation biological control. It should be noted that the use of integrated pest management approach in agricultural production systems would have a key role to play in the future of insect pest management.

## Conclusion

The approach to insect pest management has seen a significant shift from an almost exclusive reliance on chemical pesticides to sustainable and eco-friendly alternatives. Although chemical pesticides continue to play a crucial role in some cases, their shortcomings have led to a growing preference for biological control and IPM techniques. Modern pest control techniques are seeing revolutionary changes through the use of microbes as biopesticides, beneficial insects, the science of pheromones, genetic engineering, and precision agriculture. Sustainable pest management practices emphasize the need for a balance between pest management and biodiversity preservation.

## References

- Acta Tropica. (2025). Entomopathogenic fungi and future prospects in agriculture.
- Agrios, G. N. (2005). *Plant Pathology*. Elsevier Academic Press.
- FAO. (2021). *Sustainable pest and disease management in agriculture*.
- Galli, M., et al. (2024). Can biocontrol be the game-changer in integrated pest management? *Journal of Plant Diseases and Protection*.
- Jha, S. K., et al. (2025). Recent advancements in biological control for sustainable pest management. *Tropical Agriculture*.
- Koller, J., et al. (2023). Entomopathogens and parasitoids allied in biocontrol. *Pathogens*.
- Mawcha, K. T., et al. (2024). Biopesticides for sustainable agriculture. *IntechOpen*.
- Munnysha, S., & Bunker, R. N. (2024). Advances in microbial biopesticides for integrated disease and pest management. *Annals of Plant and Soil Research*.
- Offor, E. (2025). *Microbial Biocontrol Agents in Integrated Pest Management*. SSRN.
- Pobożniak, M., & Olczyk, M. (2025). Biocontrol in Integrated Pest Management in Fruit and Vegetable Field Production. *Horticulturae*.