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Beneficial Insects and Ecosystem Services in Agriculture

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Abstract

Beneficial insects provide essential ecosystem services that support agricultural productivity, environmental sustainability, and ecological stability. Pollinators such as bees, butterflies, moths, and hoverflies contribute to fruit and seed production, while predators and parasitoids naturally suppress important crop pests. Decomposer insects participate in organic matter breakdown and nutrient cycling, whereas soil-associated insects can influence soil structure and biological processes. These services can reduce dependence on chemical inputs and strengthen integrated pest management. However, habitat loss, monocropping, excessive pesticide use, and climate change threaten beneficial insect populations and the services they provide. Conservation strategies including flowering strips, field margins, crop diversification, reduced pesticide exposure, natural vegetation, and biological control can enhance beneficial insect communities. Recognizing insects as providers of valuable ecosystem services is essential for developing productive, resilient, and sustainable agricultural systems.

Keywords: *Beneficial insects; Ecosystem services; Pollination; Biological control; Biodiversity; Natural enemies; Sustainable agriculture.*

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Introduction

Beneficial insects are essential components of agricultural ecosystems and provide a wide range of services that support crop production, biodiversity, and environmental sustainability. Although insects are often associated with crop damage, only a relatively small proportion of insect species are agricultural pests. A much larger diversity of insects contributes positively through pollination, biological pest control, decomposition, nutrient cycling, soil improvement, and maintenance of food-web interactions. Agricultural ecosystems depend on these natural processes for productivity and resilience. Bees, butterflies, moths, and hoverflies contribute to pollination, while ladybird beetles, lacewings, predatory bugs, and parasitoid wasps regulate populations of harmful insects. Beetles, ants, termites, and other decomposer organisms contribute to the breakdown of organic matter and nutrient recycling.

The ecosystem services provided by beneficial insects can reduce farmers' dependence on external inputs and improve the efficiency of agricultural production. For example, natural enemies can suppress pest populations without direct human intervention, while pollinators can improve fruit and seed production. These services become particularly important in diversified and sustainable farming systems. Intensive agriculture, habitat destruction, excessive pesticide use, monocropping, and climate change can threaten beneficial insect populations. Conserving these organisms requires a shift toward ecological approaches that recognize agricultural fields as complex living ecosystems. Understanding and protecting beneficial insects is therefore essential for maintaining productive, resilient, and environmentally responsible agricultural systems.

Ecosystem Services

Ecosystem services are the benefits that humans obtain from ecosystems. In agriculture, these services include pollination, pest regulation, nutrient cycling, soil formation, water regulation, and biodiversity maintenance. Beneficial insects contribute to several of these services simultaneously. A single insect group may perform different functions during different life stages. For example, adult hoverflies may visit flowers and contribute to pollination, while their larvae prey on aphids. Similarly, some beetles contribute to pest suppression while also participating in decomposition.

The major ecosystem services associated with beneficial insects can be broadly classified as:

1. **Pollination services**
2. **Biological pest control**
3. **Decomposition and nutrient cycling**
4. **Soil-related ecological functions**
5. **Food-web and biodiversity support**

These services interact with one another and collectively influence agricultural productivity.

Pollination: A Fundamental Agricultural Service

Pollination is one of the most visible and economically important services provided by insects. Many flowering crops require or benefit from insect-mediated pollen transfer.

Bees

Bees are among the most important agricultural pollinators. Honey bees, bumblebees, solitary bees, and other bee groups visit flowers to collect nectar and pollen. During these visits, pollen grains are transferred between flowers, promoting fertilization.

Effective pollination can improve fruit set, seed formation, fruit size, shape, and quality. Crops such as fruits, vegetables, oilseeds, and seed-producing plants can benefit significantly from insect pollination.

Butterflies and Moths

Butterflies and moths also contribute to pollination while feeding on floral nectar. Their movements between flowers facilitate pollen transfer and support plant reproduction. Although their pollination contribution varies among crops, maintaining diverse insect communities provides greater ecological stability than relying on a single pollinator group.

Hoverflies

Hoverflies are particularly interesting because they provide multiple services. Adult hoverflies frequently visit flowers and contribute to pollination, while larvae of many species feed on aphids and other soft-bodied pests. This combination of pollination and biological control demonstrates the multifunctional nature of beneficial insects.

Biological Pest Control

Natural pest control is another major ecosystem service. Predators and parasitoids can regulate agricultural pest populations and reduce crop damage.

Predatory Insects

Ladybird beetles, lacewings, predatory bugs, mantids, and other predators consume large numbers of pest insects. Their prey may include aphids, whiteflies, thrips, caterpillars, mites, and insect eggs. Ladybird beetles are particularly well known for consuming aphids. Lacewing larvae also attack several soft-bodied pests and can be important natural enemies in vegetable and fruit crops.

Parasitoids

Parasitoids are insects whose immature stages develop on or inside another insect and eventually kill the host. Many parasitoid wasps are highly specialized and can provide effective biological control.

Trichogramma species, for example, parasitize the eggs of several moth and butterfly pests. Other parasitoids attack caterpillars, aphids, whiteflies, and other agricultural pests. Natural enemies can suppress pest populations without repeated human intervention. Their contribution is especially valuable when farming systems provide suitable habitat and reduce unnecessary pesticide exposure.

Decomposition and Nutrient Cycling

Agricultural ecosystems continuously receive organic material through crop residues, fallen leaves, dead roots, animal waste, and other sources. Decomposer organisms help break down these materials and return nutrients to the soil. Several insect groups participate in this process. Beetles, ants, termites, fly larvae, and other organisms contribute to the fragmentation and decomposition of organic matter. Dung beetles are particularly important in livestock-based agricultural systems. They bury and break down animal dung, helping return nutrients to the soil while reducing the accumulation of waste on pasture surfaces. Decomposition supports soil fertility and reduces the buildup of organic residues. It is therefore an important ecosystem process that contributes indirectly to crop productivity.

Beneficial Insects and Soil Health

Although soil organisms are often emphasized in discussions of soil health, insects can also contribute to soil-related processes.

Ants and termites can modify soil structure by creating tunnels and galleries. Their activities can influence aeration, water movement, organic matter distribution, and nutrient dynamics.

Some insects transport organic material into the soil, where it becomes available for microbial decomposition. Burrowing organisms may also improve soil porosity and create pathways for water infiltration. These effects demonstrate that beneficial insects can influence agricultural productivity even when they are not directly associated with crops.

Food-Web Support and Biodiversity

Beneficial insects are themselves important components of agricultural food webs. They serve as food for birds, reptiles, amphibians, spiders, predatory insects, and other organisms. A diverse insect community therefore supports a broader range of organisms. Loss of beneficial insects can have cascading effects throughout the food web. Biodiversity also provides greater ecological resilience. Diverse communities are often better able to respond to environmental disturbances, pest outbreaks, and climatic variation than simplified ecosystems.

Beneficial Insects and Integrated Pest Management

Beneficial insects form a major component of **Integrated Pest Management (IPM)**. IPM aims to manage pests while reducing unnecessary chemical inputs and environmental risks. Farmers can monitor both pests and natural enemies before deciding whether intervention is necessary. When predators and parasitoids are abundant, they may naturally suppress pest populations below economically damaging levels.

Important IPM practices include:

- Regular field scouting.
- Identification of pests and natural enemies.
- Use of economic thresholds.
- Conservation of natural enemies.
- Crop diversification.
- Biological-control releases.
- Selective pesticide use.
- Proper pesticide timing.

This approach changes the role of beneficial insects from being passive organisms in the field to active components of crop protection.

Habitat Management for Beneficial Insects

Beneficial insects require food, shelter, water, and breeding sites. Agricultural landscapes can be designed to provide these resources.

Flowering Strips

Flowering plants provide nectar and pollen for adult bees, parasitoids, hoverflies, butterflies, and other insects. Flower strips can therefore increase the availability of food resources within agricultural landscapes.

Field Margins

Vegetated field margins can provide shelter and alternative food resources. They may also serve as refuge areas during pesticide applications or periods when crops provide limited resources.

Hedgerows and Natural Vegetation

Hedgerows, shrubs, trees, and patches of natural vegetation increase landscape complexity and provide habitats for beneficial insects.

Crop Diversification

Intercropping, crop rotation, cover crops, and mixed farming systems can provide resources across different seasons and reduce the ecological simplicity associated with continuous monocropping.

Effects of Pesticides on Ecosystem Services

One of the major threats to beneficial insects is inappropriate pesticide use. Broad-spectrum insecticides may kill natural enemies and pollinators together with target pests.

Loss of predators and parasitoids can weaken natural pest regulation. Loss of pollinators can reduce reproductive success in flowering crops. Repeated pesticide exposure can therefore affect multiple ecosystem services simultaneously.

Farmers can reduce these effects through:

- Pest monitoring before spraying.
- Use of economic thresholds.
- Selection of selective pesticides.
- Correct application rates.
- Appropriate spray timing.
- Avoidance of unnecessary repeated treatments.
- Protection of flowering habitats.

Responsible pesticide use is therefore important not only for pest management but also for conserving agricultural ecosystem services.

Economic Value of Beneficial Insects

The services provided by beneficial insects have substantial economic importance, even though farmers may not directly pay for them. Pollination can increase crop yield and quality. Natural pest control can reduce expenditure on insecticides. Decomposition and nutrient cycling can contribute to soil fertility. These services collectively reduce the amount of external input required to maintain agricultural production. The economic value of these services becomes especially apparent when they are lost. Declining pollinator populations may require alternative pollination methods, while loss of natural enemies may increase pesticide dependence. Recognizing the economic value of beneficial insects can encourage greater investment in biodiversity conservation and ecological farming practices.

Beneficial Insects in Different Cropping Systems

Vegetable Crops

Vegetable fields can benefit from ladybird beetles, lacewings, hoverflies, predatory bugs, and parasitoid wasps. These natural enemies can suppress aphids, whiteflies, thrips, and caterpillars.

Fruit Orchards

Orchards can provide habitats for pollinators and natural enemies. Flowering ground vegetation and suitable field margins can support insect diversity.

Pulse Crops

Natural enemies can contribute to the suppression of aphids, pod borers, and other insect pests in pulse crops. Diverse vegetation can provide additional resources for parasitoids and predators.

Oilseed Crops

Flowering oilseed crops can attract pollinators, while predators and parasitoids may suppress pest populations. Maintaining insect diversity can therefore provide multiple services simultaneously.

Cereal Crops

Predatory beetles, bugs, spiders, dragonflies, and parasitoid wasps can contribute to pest regulation in cereal-based agricultural landscapes.

Beneficial Insects and Climate Change

Climate change can influence insect abundance, distribution, reproduction, and seasonal activity. Temperature changes may alter the timing of pest outbreaks and natural-enemy activity.

Extreme weather events, drought, floods, and changes in flowering periods may also affect pollinator resources. In some situations, climatic changes may create mismatches between crop flowering and pollinator activity.

Maintaining diverse habitats can increase resilience by providing alternative food and shelter resources. Agricultural landscapes with greater ecological diversity may therefore be better prepared to cope with environmental changes.

Technology for Monitoring Ecosystem Services

Modern technology can help farmers monitor beneficial insects and ecosystem functions.

Smartphone-based insect identification can help distinguish pests from predators and parasitoids. Automated insect traps and digital cameras can record insect abundance and activity. Artificial intelligence and image-recognition technologies may provide rapid identification of insects in field conditions. Geographic information systems can also help identify habitats that support beneficial insect populations. Combining digital monitoring with weather information and crop data could help farmers determine when beneficial insects are providing sufficient pest control and when additional intervention is required.

Table: Practical Strategies for Farmers

Practice	Ecosystem service supported
Maintain flowering plants	Pollination and natural-enemy support
Protect field margins	Habitat conservation
Reduce unnecessary pesticide use	Natural pest control and pollination
Use crop diversification	Biodiversity enhancement

Conserve parasitoids and predators	Biological pest control
Maintain organic residues appropriately	Decomposition and nutrient cycling
Protect natural vegetation	Habitat and food-web support
Monitor insect populations	Better ecosystem management

Role of Extension Workers and Researchers

Farmers need practical knowledge to recognize beneficial insects and understand their ecological importance. Extension workers can provide training through demonstrations, field schools, farmer meetings, and digital platforms. Researchers can evaluate ecosystem services under different cropping systems and identify management practices that increase beneficial insect populations. Long-term monitoring can also help determine how agricultural intensification, pesticide use, and climate change influence insect communities. Collaboration among farmers, researchers, extension professionals, policymakers, and conservation organizations is important for developing effective insect-conservation strategies.

Conclusion

Beneficial insects provide essential ecosystem services that contribute directly and indirectly to agricultural productivity. Pollinators support fruit and seed production, predators and parasitoids regulate crop pests, while decomposer and soil-associated insects contribute to nutrient cycling and soil processes. These organisms also support food webs and strengthen biodiversity within agricultural landscapes.

References

1. Landis, D. A., Wratten, S. D., & Gurr, G. M. (2000). Habitat management to conserve natural enemies of arthropod pests in agriculture. *Annual Review of Entomology, 45*, 175–201. https://doi.org/10.1146/annurev.ento.45.1.175
2. Tscharntke, T., Klein, A. M., Kruess, A., Steffan-Dewenter, I., & Thies, C. (2005). Landscape perspectives on agricultural intensification and biodiversity–ecosystem service management. *Ecology Letters, 8*, 857–874. https://doi.org/10.1111/j.1461-0248.2005.00782.x
3. Bianchi, F. J. J. A., Booij, C. J. H., & Tscharntke, T. (2006). Sustainable pest regulation in agricultural landscapes: A review on landscape composition, biodiversity and natural pest control. *Proceedings of the Royal Society B, 273*, 1715–1727. https://doi.org/10.1098/rspb.2006.3530
4. Klein, A. M., Vaissière, B. E., Cane, J. H., Steffan-Dewenter, I., Cunningham, S. A., Kremen, C., & Tscharntke, T. (2007). Importance of pollinators in changing landscapes for world crops. *Proceedings of the Royal Society B, 274*, 303–313. https://doi.org/10.1098/rspb.2006.3721
5. Kremen, C., Williams, N. M., & Thorp, R. W. (2002). Crop pollination from native bees at risk from agricultural intensification. *Proceedings of the National Academy of Sciences, 99*, 16812–16816. https://doi.org/10.1073/pnas.262413599
6. Kremen, C., Williams, N. M., Bugg, R. L., Fay, J. P., & Thorp, R. W. (2004). The area requirements of an ecosystem service: Crop pollination by native bee communities in California. *Ecology Letters, 7*, 1109–1119. https://doi.org/10.1111/j.1461-0248.2004.00662.x
7. Ricketts, T. H., Regetz, J., Steffan-Dewenter, I., et al. (2008). Landscape effects on crop pollination services: Are there general patterns? *Ecology Letters, 11*, 499–515. https://doi.org/10.1111/j.1461-0248.2008.01157.x

8. Shackelford, G., Steward, P. R., Benton, T. G., Kunin, W. E., Potts, S. G., Biesmeijer, J. C., & Sait, S. M. (2013). Comparison of pollinators and natural enemies: A meta-analysis of landscape and local effects on abundance and richness in crops. *Biological Reviews, 88*, 1002–1021. https://doi.org/10.1111/brv.12040

9. Martin, E. A., Reineking, B., Seo, B., & Steffan-Dewenter, I. (2013). Natural enemy interactions constrain pest control in complex agricultural landscapes. *Proceedings of the National Academy of Sciences, 110*, 5534–5539. https://doi.org/10.1073/pnas.1215725110

10. Dainese, M., Schneider, G., Krauss, J., & Steffan-Dewenter, I. (2017). Complementarity among natural enemies enhances pest suppression. *Scientific Reports, 7*, 8172. https://doi.org/10.1038/s41598-017-08316-z

11. Albrecht, M., Kleijn, D., Williams, N. M., et al. (2020). The effectiveness of flower strips and hedgerows on pest control, pollination services and crop yield: A quantitative synthesis. *Ecology Letters, 23*, 1488–1498. https://doi.org/10.1111/ele.13576

12. Garibaldi, L. A., Steffan-Dewenter, I., Winfree, R., et al. (2013). Wild pollinators enhance fruit set of crops regardless of honey bee abundance. *Science, 339*, 1608–1611. https://doi.org/10.1126/science.1230200

13. Pufal, G., Steffan-Dewenter, I., & Klein, A.-M. (2017). Crop pollination services at the landscape scale. *Current Opinion in Insect Science, 21*, 91–97. https://doi.org/10.1016/j.cois.2017.05.021

14. Nichols, E., Spector, S., Louzada, J., Larsen, T., Amezquita, S., & Favila, M. E. (2008). Ecological functions and ecosystem services provided by Scarabaeinae dung beetles. *Biological Conservation, 141*, 1461–1474. https://doi.org/10.1016/j.biocon.2008.04.011

15. Payne, C. L. R., & Van Itterbeeck, J. (2017). Ecosystem services from edible insects in agricultural systems: A review. *Insects, 8*, 24. https://doi.org/10.3390/insects8010024

16. Ojija, F. (2026). Contributions of Dipterans to pollination services and biological control. *Entomologia Experimentalis et Applicata*. https://doi.org/10.1111/eea.70114

17. Torabian, S., Leffler, A. J., & Perkins, L. (2024). Importance of restoration of dung beetles in the maintenance of ecosystem services. *Ecological Solutions and Evidence*. https://doi.org/10.1002/2688-8319.12297