The Unsung Pollinators: Why Wild Bees are Critical for Food Security and Biodiversity

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OPEN ACCESS

Keywords

Wild bees, Pollination, Food security, Pesticides, Climate change

How to cite this article:

Sandeep. and Kumar, N. 2026. The Unsung Pollinators: Why Wild Bees are Critical for Food Security and Biodiversity. *Vigyan Varta* 7 (06): 7-11.

ABSTRACT

Bees are widely recognized for honey production, but their greater contribution lies in pollination, a process essential for global food production. While managed honeybees receive most attention, wild bees comprising over 20,000 species, play a critical and often underappreciated role in sustaining agricultural systems. These species exhibit diverse foraging behaviors and plant associations, making them highly efficient pollinators for many crops. However, wild bee populations are declining due to multiple interacting pressures, including pesticide exposure, habitat loss, climate change, and emerging threats such as microplastics and artificial light. This article highlights the ecological and economic importance of wild bees, outlines the major drivers of their decline, and discusses practical conservation strategies. Protecting wild bees is not only a biodiversity concern but also essential for maintaining food security and nutritional quality worldwide.

INTRODUCTION

Many of the foods we consume daily, such as fruits, nuts, and beverages like coffee, depend directly on pollination. A large proportion of this pollination is carried out not by managed honeybees, but by a wide diversity of wild bee species. Despite their importance, these pollinators often remain overlooked in both

public awareness and agricultural planning. In the Indian context, there is a critical need to strengthen pollination research and conservation strategies to address these gaps. (Adit *et al*. 2024).

Globally, more than 75% of food crops and nearly 90% of wild flowering plants depend to some extent on animal-mediated pollination (FAO, 2025). Among these pollinators, wild bees represent a highly diverse and functionally important group. They include bumblebees, solitary bees, and several other native species that have co-evolved with plants, often making them more effective pollinators for specific crops under certain conditions.

In recent years, growing evidence has indicated a decline in wild bee populations across different regions. Multiple factors, including pesticide use, habitat degradation, and climate variability, are contributing to this trend. Such declines raise concerns not only for biodiversity but also for agricultural productivity and nutritional security (Guzman *et al*., 2024; Feuerbacher *et al*., 2025).

This article focuses on the role of wild bees in pollination, their contribution to food systems, the key threats they face, and potential strategies for their conservation. Understanding and protecting these pollinators is essential for sustaining resilient and productive agroecosystems.

1. Wild Bees vs. Honeybees

Honeybees are often considered the primary pollinators because they are widely managed and commercially important. However, focusing only on honeybees overlooks the significant contribution of wild bee species. Wild bees include bumblebees, mason bees, leafcutter bees, sweat bees, and many other native species that differ in behavior, habitat preference, and pollination efficiency.

Studies have shown that wild bees are often more effective pollinators for certain crops. For example, bumblebees are capable of buzz pollination, which is essential for crops like tomatoes and some berries. In addition, research has demonstrated that wild bees can exhibit higher rates of pollen deposition and more frequent flower visits compared to honeybees under specific conditions. Recent global analyses have further confirmed that wild insects and honeybees are equally important to crop yields across various agricultural systems (Reilly *et al*., 2024).

Another important aspect is ecological stability. Pollination provided by a diverse community of wild bee species is generally more reliable than dependence on a single managed species. Species diversity helps maintain pollination services under changing environmental conditions, such as fluctuations in weather or resource availability.

Therefore, wild bees should not be viewed as substitutes for honeybees, but as essential components of a complementary pollination system. Maintaining both managed and wild pollinators is important for ensuring consistent and efficient crop production.

2. The Contribution of Wild Bees to Global Food Security

Pollination is a fundamental ecological process that directly supports global food production. A substantial proportion of crops consumed by humans depends on animal-mediated pollination, particularly by insects such as bees. It is estimated that more than one-third of global food production benefits from pollinators, with wild bees playing a significant role in this process (FAO, 2025; Khalifa *et al*., 2021).

Wild bees are especially important for crops that are rich in essential nutrients, including fruits, vegetables, nuts, and legumes. These crops not only contribute to dietary diversity

but also provide key micronutrients required for human health. Studies indicate that pollinators influence the yield and quality of around 75% of leading global food crops (FAO, 2025). In many cases, wild bees contribute substantially to this pollination, either independently or in combination with managed honeybees (Reilly *et al*., 2024).

From an economic perspective, the global value of pollination services has been estimated at hundreds of billions of dollars annually. A large share of this value is attributed to wild pollinators, which support crop productivity without direct management costs (Khalifa *et al*., 2021). Furthermore, modelling studies suggest that a decline in wild pollinators could lead to measurable reductions in crop yields, increased production costs, and higher market prices for pollinator-dependent crops (Feuerbacher *et al*., 2025).

Beyond yield, pollination also affects the nutritional quality of food. Reduced pollination can lead to lower availability of nutrient-rich foods, potentially contributing to imbalanced diets and micronutrient deficiencies. Therefore, the role of wild bees extends beyond agricultural productivity to broader aspects of food and nutritional security.

Overall, wild bees represent a critical component of sustainable food systems. Their contribution is not only ecological but also economic and nutritional, making their conservation essential for long-term agricultural stability.

3. Threats to Wild Bees

Wild bee populations are increasingly affected by multiple interacting stressors. These pressures do not act in isolation; instead, they often combine to amplify negative impacts on bee survival, reproduction, and foraging efficiency.

3.1 Pesticide Exposure

The use of chemical pesticides, particularly neonicotinoids and other systemic insecticides, has been widely linked to declines in wild bee populations. These compounds can impair navigation, foraging behavior, and reproductive success, even at sublethal doses (Guzman *et al*., 2024; Straub *et al*., 2022). Large-scale studies have also shown that increased pesticide use is associated with reduced occurrence of multiple wild bee species across agricultural landscapes (Guzman *et al*., 2024). In addition, exposure to mixtures of agrochemicals may further intensify these effects, especially under field conditions.

3.2 Habitat Loss and Agricultural Intensification

The expansion of intensive agriculture has led to the loss of natural habitats such as wildflower-rich areas, hedgerows, and nesting sites. This reduction in floral and nesting resources directly affects wild bee diversity and abundance. Evidence from multi-regional studies indicates that both habitat loss and pesticide exposure independently and jointly reduce wild bee populations and functional diversity (Knauer *et al*., 2026). Importantly, habitat restoration alone may not fully compensate for the negative effects of chemical inputs.

3.3 Climate Change

Climate change is altering temperature patterns and seasonal cycles, which can disrupt

the synchrony between bee activity and plant flowering. Such mismatches may reduce pollination efficiency and affect bee population dynamics. Long-term studies on bumblebees have reported significant declines in species distribution and occupancy linked to rising temperatures and drought conditions (Guzman *et al*., 2024). These changes are expected to intensify under future climate scenarios.

3.4 Emerging Environmental Stressors

In addition to established threats, new environmental pressures are gaining attention. Recent findings suggest that microplastic contamination, artificial light at night, and environmental pollutants such as antibiotics may influence bee behavior and health (Howard *et al*., 2025). Although research in this area is still developing, these factors may represent additional risks to pollinator populations in the coming decades.

4. Conservation Strategies and Management Approaches

The decline of wild bees can be mitigated through coordinated actions across policy, agriculture, and community levels. Reducing the use of harmful pesticides, particularly neonicotinoids, is a key step toward improving pollinator health (Guzman *et al*., 2024). Alongside this, policies that support habitat conservation and sustainable farming practices are essential.

At the farm level, maintaining wildflower strips, hedgerows, and field margins can enhance floral resources and nesting habitats for wild bees. Such measures, especially when combined with reduced pesticide use and integrated pest management (IPM), have been shown to improve pollinator diversity and abundance (Knauer *et al*., 2026; Dhandapani *et al*., 2024).

Simple actions at the individual level, such as planting native flowering species and reducing mowing, can also support pollinator populations. Overall, integrating policy support, ecological farming, and local conservation efforts is critical for sustaining wild bees and the pollination services they provide.

CONCLUSION

Wild bees play a vital role in sustaining pollination, agricultural productivity, and nutritional security. Despite their importance, they remain underrepresented in conservation and agricultural planning. Current evidence clearly indicates that wild bee populations are declining due to multiple interacting pressures, including pesticide use, habitat loss, and climate change.

Addressing these challenges requires an integrated approach that combines policy measures, sustainable farming practices, and habitat conservation. Protecting wild bees is not only essential for biodiversity but also for maintaining stable and resilient food systems. Ensuring their conservation will be critical for future agricultural sustainability.

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