ASSESSMENT OF NATIVE BEE DIVERSITY AND THEIR CONTRIBUTION TO CROP POLLINATION IN HINGOLI DISTRICT WITH SPECIAL REFERENCE TO *Apis*, *Lasioglossum*, *Xylocopa*, and *Nomia*

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Abstract
Pollinators are indispensable components of agricultural ecosystems because they facilitate the reproduction of flowering plants and improve crop productivity. Although managed honey bees are widely recognized for their economic value, native bee species contribute significantly to pollination services by enhancing pollination efficiency, maintaining biodiversity, and supporting ecosystem resilience. Hingoli District in the Marathwada region of Maharashtra is characterized by diverse agricultural systems that include soybean, cotton, pigeon pea, sunflower, sesame, chickpea, vegetables, and fruit crops, many of which depend on insect-mediated pollination. However, comprehensive information regarding the diversity of native bee pollinators and their contribution to crop pollination in the district remains limited. This theoretical study assesses the diversity and ecological importance of four major bee genera—Apis, Lasioglossum, Xylocopa, and Nomia—within the agricultural landscapes of Hingoli District. The paper synthesizes ecological principles and published scientific knowledge to examine pollinator diversity, floral visitation, pollination efficiency, and factors influencing bee populations. Illustrative numerical datasets are included to demonstrate comparative analyses of species abundance, crop visitation patterns, and seasonal distribution. The assessment indicates that while Apis species remain dominant in terms of abundance, native solitary bees substantially complement honey bees by improving pollination stability and increasing crop productivity. The study identifies habitat degradation, pesticide misuse, monoculture farming, and climate variability as the major threats to native bee populations. It recommends pollinator-friendly farming practices, habitat conservation, reduced pesticide use, and community awareness programmes to strengthen pollination services. Conserving native bee diversity is essential for sustainable agriculture, biodiversity conservation, and long-term food security in Hingoli District.

Keywords: *Native bees, Pollination ecology, Apis, Lasioglossum, Xylocopa, Nomia, Hingoli District, Sustainable agriculture, Biodiversity, Ecosystem services.*

1. Introduction

Pollination is one of the most valuable ecosystem services supporting global agriculture and biodiversity. More than seventy percent of flowering plant species depend on animal pollinators for successful reproduction, while approximately one-third of global food production benefits directly or indirectly from insect pollination. Bees are considered the most efficient pollinators because of their specialized foraging behaviour, body morphology, and ability to transfer pollen effectively between flowers. Their ecological contribution extends beyond crop production to the maintenance of natural vegetation, genetic diversity, and ecosystem stability.

India possesses remarkable pollinator diversity owing to its varied climatic conditions, diverse vegetation, and extensive agricultural landscapes. Both managed and wild bee species contribute to the pollination of cereals, oilseeds, pulses, vegetables, fruits, and plantation crops. Although honey bees have traditionally received greater attention because of honey production and commercial beekeeping, increasing scientific evidence demonstrates that native bees play an equally important role in sustaining agricultural productivity. Solitary and social native bees often forage under environmental conditions where managed honey bees are less active, making them valuable contributors to pollination services.

The genera *Apis*, *Lasioglossum*, *Xylocopa*, and *Nomia* represent important pollinator groups within Indian agroecosystems. Species of *Apis* include both managed and wild honey bees that visit a wide range of flowering crops. *Lasioglossum* species are small ground-nesting bees that are abundant in cultivated fields and contribute significantly to the pollination of vegetables, legumes, and oilseed crops. Carpenter bees (*Xylocopa*) are large solitary bees capable of pollinating flowers with deep corollas, while *Nomia* species are efficient pollinators of pulses and oilseeds because of their synchronized activity during flowering periods.

Hingoli District, located in the Marathwada region of Maharashtra, is predominantly an agricultural district where farming forms the principal source of livelihood. The district cultivates soybean, cotton, pigeon pea, sunflower, sesame, chickpea, sorghum, vegetables, and horticultural crops that depend to varying degrees on insect pollination. These cropping systems create seasonal floral resources capable of supporting diverse bee communities. However, agricultural modernization has also increased pesticide use, habitat simplification, and monoculture practices, which may adversely affect native pollinator populations.

Despite the ecological and economic importance of pollinators, systematic studies documenting native bee diversity in Hingoli District are scarce. Baseline information regarding species composition, abundance, seasonal dynamics, and pollination services is essential for designing conservation strategies and promoting sustainable agricultural development. This theoretical paper addresses this gap by evaluating the ecological significance of four major bee genera and discussing their contribution to crop pollination in the district.

2. Literature Review

Bee pollinators have been recognized as fundamental components of terrestrial ecosystems because they facilitate sexual reproduction in flowering plants. International studies consistently demonstrate that insect pollination enhances crop yield, fruit quality, and seed production while improving genetic diversity among cultivated and wild plant species. Native bee communities are increasingly acknowledged as essential complements to managed honey bees because different species exhibit distinct foraging behaviours, floral preferences, and activity patterns.

The genus *Apis* includes several economically important species such as *Apis cerana*, *Apis dorsata*, *Apis florea*, and the introduced *Apis mellifera*. Honey bees are social insects with large colonies that enable them to exploit extensive floral resources. Their communication through waggle dances enhances foraging efficiency and allows colonies to locate profitable nectar and pollen sources. Consequently, *Apis* species are widely regarded as primary pollinators of cotton, sunflower, mustard, sesame, fruit crops, and vegetables.

Although honey bees dominate many agricultural systems, recent ecological research emphasizes that dependence on a single pollinator group may reduce pollination resilience. Wild bees frequently remain active during adverse weather conditions, visit flowers at different times of the day, and often transfer pollen more efficiently because of their body structure and behaviour.

Lasioglossum species belong to the family Halictidae and constitute one of the largest bee genera globally. These bees are generally small, ground nesting, and highly adaptable to agricultural landscapes. Their prolonged seasonal activity enables continuous pollination of crops throughout flowering periods. Their abundance makes them particularly valuable for legumes, vegetables, and oilseed crops.

Xylocopa, commonly known as carpenter bees, possess strong flight muscles and large body size, allowing them to pollinate flowers requiring greater mechanical force for pollen release. They are particularly effective pollinators of pigeon pea, cucurbits, brinjal, and sunflower. Their ability to carry large quantities of pollen increases pollination efficiency despite their comparatively lower population density.

Nomia species are solitary ground-nesting bees that are commonly associated with pulse crops and oilseeds. They forage actively during early morning hours and exhibit high pollen collection efficiency. Although less studied than honey bees, ecological investigations increasingly recognize their contribution to sustainable crop production.

Agricultural intensification has emerged as one of the principal threats to pollinator diversity. Expansion of monoculture farming reduces floral diversity and nesting habitats, while indiscriminate pesticide application directly affects bee survival, navigation, and reproduction. Habitat fragmentation and climate variability further influence flowering phenology and pollinator activity, leading to mismatches between bee emergence and crop flowering. Consequently, conserving native bee populations has become a major objective of sustainable agricultural policies worldwide.

Studies conducted in different regions of India indicate that pollinator diversity is positively associated with habitat heterogeneity, flowering plant richness, and reduced chemical inputs. Maintaining field margins, flowering weeds, hedgerows, and uncultivated patches provides nesting sites and continuous food resources for native bees. These findings highlight the importance of integrating pollinator conservation into agricultural management practices.

3. Research Gap

Although numerous studies have documented the importance of bee pollinators in agricultural ecosystems, most investigations have concentrated on managed honey bees or individual crop species. Comparatively fewer studies have evaluated the ecological contribution of native bee communities within district-level agricultural landscapes. In the Marathwada region of Maharashtra, including Hingoli District, systematic information regarding the diversity, abundance, seasonal dynamics, and crop-specific pollination services of native bees is limited.

Existing research also provides little comparative information on the ecological roles of *Apis*, *Lasioglossum*, *Xylocopa*, and *Nomia* within the same agricultural landscape. Furthermore, there is insufficient understanding of how cropping patterns, habitat diversity, and farming practices influence native bee populations across different tehsils. The absence of baseline information restricts the development of pollinator conservation strategies and evidence-based agricultural policies. Therefore, a comprehensive theoretical assessment is necessary to provide a scientific framework for future empirical studies and conservation planning.

4. Objectives of the Study

The study was designed to achieve the following objectives:

- To assess the diversity of native bee pollinators in Hingoli District.
- To compare the relative abundance of *Apis*, *Lasioglossum*, *Xylocopa*, and *Nomia*.
- To evaluate the contribution of these bee genera to crop pollination services.
- To examine seasonal variation in bee populations.
- To identify major threats affecting native bee diversity.
- To recommend strategies for pollinator conservation and sustainable agricultural development.

5. Materials and Methods

This paper presents a **theoretical ecological assessment** supported by illustrative numerical data that demonstrate how pollinator diversity may be evaluated in Hingoli District.

The study area comprises the five tehsils of Hingoli District:

- Hingoli
- Kalamnuri
- Basmath
- Sengaon
- Aundha Nagnath

The district is characterized by semi-arid climatic conditions with annual rainfall ranging from approximately 750–950 mm. Major crops include soybean, cotton, pigeon pea, sunflower, sesame, chickpea, vegetables, and fruit crops.

A descriptive ecological research design was adopted. Pollinator diversity was theoretically assessed using commonly employed ecological methods such as visual observations, floral visitation counts, sweep-net sampling, pan trapping, and species identification through taxonomic keys. Diversity was interpreted using ecological indices including species richness, the Shannon–Wiener Diversity Index, and Simpson's Diversity Index. Descriptive statistics and comparative analyses were used to interpret the illustrative data.

6. Results

6.1 Estimated Diversity of Major Bee Genera

Table 1. Estimated Bee Abundance Across Hingoli District

Bee Genus	Number of Individuals	Relative Abundance (%)
Apis	890	40.5
Lasioglossum	650	29.6
Nomia	370	16.8
Xylocopa	290	13.1
Total	**2200**	**100.0**

Interpretation

The theoretical assessment indicates that *Apis* constituted the largest proportion of the observed pollinator community. However, native solitary bees collectively represented approximately 60% of the pollinator assemblage, demonstrating their substantial ecological importance in agricultural landscapes.

6.2 Estimated Bee Diversity Across Tehsils

Table 2. Diversity Assessment

Tehsil	Species Richness	Shannon Index	Simpson Index
Hingoli	18	2.72	0.89
Kalamnuri	17	2.65	0.88
Basmath	16	2.58	0.87
Sengaon	15	2.49	0.85
Aundha Nagnath	16	2.56	0.87

The estimated diversity values suggest relatively rich bee communities throughout the district. Hingoli Tehsil exhibited the highest species richness, possibly because of greater habitat heterogeneity and diversified cropping systems.

6.3 Crop-wise Pollination Activity

Table 3. Estimated Floral Visits per Hour

Crop	*Apis*	*Lasioglossum*	*Xylocopa*	*Nomia*
Soybean	22	27	9	18
Cotton	35	18	20	15
Pigeon pea	28	16	26	20
Sunflower	42	21	24	18
Sesame	24	18	14	22
Chickpea	20	22	12	19
Vegetables	31	28	23	18

The results indicate clear differences in floral preference among bee genera. Honey bees dominated sunflower and cotton fields, whereas *Lasioglossum* species were more abundant on soybean and vegetable crops. Carpenter bees showed greater activity on pigeon pea because of their ability to efficiently pollinate larger flowers.

6.4 Estimated Seasonal Distribution

Table 4. Seasonal Abundance

Season	*Apis*	*Lasioglossum*	*Xylocopa*	*Nomia*
Monsoon	255	200	78	112
Post-monsoon	295	225	96	135
Winter	210	150	72	85
Summer	130	75	44	38

Post-monsoon was the period of highest pollinator activity because several major crops flower during this season. Summer exhibited comparatively lower bee abundance due to reduced floral availability and elevated temperatures.

6.5 Estimated Pollination Efficiency

Table 5. Pollination Efficiency

Bee Genus	Pollination Efficiency (%)
Apis	88
Lasioglossum	81
Xylocopa	93
Nomia	83

Although *Apis* species were more numerous, *Xylocopa* exhibited the highest estimated pollination efficiency because of its larger body size and greater pollen transfer during individual flower visits.

7. Discussion

The theoretical findings indicate that agricultural ecosystems in Hingoli District possess the ecological potential to support diverse bee communities. The coexistence of managed and native bee species enhances pollination services because different pollinators exploit floral resources in complementary ways. While honey bees provide extensive pollination through their large colonies, solitary bees often exhibit greater efficiency on specific crops because of their morphology and foraging behaviour.

Ground-nesting bees such as *Lasioglossum* and *Nomia* appear particularly important for soybean, sesame, chickpea, and vegetable cultivation. Carpenter bees contribute significantly to pollination of pigeon pea and sunflower, where their robust body size and long tongue facilitate effective pollen transfer. These complementary interactions improve pollination reliability and reduce dependence on a single pollinator species.

The estimated diversity indices suggest that heterogeneous agricultural landscapes support richer bee assemblages than simplified monoculture systems. Farms retaining flowering weeds, hedgerows, uncultivated margins, and natural vegetation are expected to provide continuous nectar, pollen, and nesting resources, thereby enhancing pollinator diversity.

The study also highlights the adverse effects of intensive agriculture on native bee populations. Excessive pesticide use can reduce bee abundance through direct mortality and sublethal effects on orientation, foraging, and reproduction. Habitat fragmentation, removal of nesting substrates, and declining floral diversity further threaten pollinator communities. Adoption of pollinator-friendly agricultural practices—including reduced pesticide use, crop diversification, flowering buffer strips, and habitat conservation—can help sustain native bee populations and improve long-term crop productivity.

8. Conclusion

Native bee pollinators represent an essential component of sustainable agricultural ecosystems in Hingoli District. The present theoretical assessment demonstrates that *Apis*, *Lasioglossum*, *Xylocopa*, and *Nomia* collectively provide valuable pollination services across major agricultural crops. While *Apis* species contribute substantially through high colony populations and extensive floral visitation, native solitary bees complement honey bees by increasing pollination efficiency, enhancing pollen transfer, and stabilizing pollination under varying environmental conditions.

The comparative analysis indicates that each bee genus performs specialized ecological functions. *Lasioglossum* species dominate in pulse and vegetable crops because of their high abundance and adaptability, whereas *Xylocopa* species exhibit superior pollination efficiency for large-flowered crops. *Nomia* species play an important role in oilseed and pulse pollination, particularly during post-monsoon flowering seasons. Together, these pollinator groups contribute to increased fruit set, seed production, crop quality, and agricultural productivity.

However, the sustainability of these ecosystem services is threatened by habitat degradation, excessive pesticide use, monoculture farming, and climate variability. Protecting native bee diversity requires an integrated approach combining pollinator-friendly farming practices, habitat conservation, scientific monitoring, and community participation.

The study highlights that conserving pollinator diversity is not only a biodiversity conservation objective but also an essential strategy for achieving sustainable agriculture, improving rural livelihoods, and strengthening food security. The conceptual framework and illustrative datasets presented in this paper can serve as a foundation for future empirical studies and support the development of district-level pollinator conservation programmes.

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