Comprehensive Assessment of Plant Biodiversity and Medicinal Importance in the Indora, Kangra, Himachal Pradesh, India

Jyotsna, Jay Prakash Thakur*, Sharad Kumar Tripathi,
Aarni School of basic science, horticulture & agriculture
Department of life sciences, Aarni University, Kathgarh, Indora, Distt. Kangra, Himachal pradesh

*jyotsnapandey1983@gmail.com / jpthakur32@gmail.com

Abstract

This study investigates plant biodiversity and economic importance in the Indora region of Kangra, Himachal Pradesh, with a focus on forest trees, medicinal plants, fruit-bearing trees, ornamental species, and agricultural crops. Biodiversity indices, including the Shannon-Wiener and Simpson's Index, were used to quantify species richness, evenness, and diversity, revealing a moderately diverse ecosystem with balanced species distribution. Our findings highlight the ecological and economic value of the local flora and emphasize the need for sustainable use and conservation strategies to promote ecosystem stability and benefit local livelihoods.

Keywords

Biodiversity, Plant Species, Economic Importance, Indora, Kangra, Shannon-Wiener Index, Simpson's Index, Medicinal Plants, Aromatic Herbs

1. Introduction

Biodiversity serves as a cornerstone of ecosystem stability, supporting numerous ecosystem services and contributing to both environmental resilience and economic sustainability. This is particularly true for regions like Kangra, Himachal Pradesh, where a diverse range of plant species supports local economies through sectors such as agriculture, forestry, and traditional medicine. In these environments, biodiversity aids in essential services like carbon sequestration, soil stabilization, water regulation, and nutrient cycling, which in turn foster healthier ecosystems capable of withstanding climate and environmental changes. Plant species such as *Ocimum sanctum* (Tulsi), *Acacia catechu* (Khair), and *Mangifera indica* (Mango) illustrate the tangible economic and ecological importance of preserving biodiversity. Tulsi and Khair are valued for their medicinal and industrial applications, while mango trees provide sustenance and economic support to local communities. Recognizing these benefits, previous studies have consistently highlighted the value of biodiversity in fostering both ecological health and economic resilience, emphasizing the need to systematically document and conserve plant diversity in ecologically significant regions (Singh et al., 2017; Balvanera et al., 2006).

As habitats become increasingly vulnerable to human activity, quantifying biodiversity has emerged as a critical research area. By employing indices like the Shannon-Wiener and Simpson's Diversity Indices, researchers have been able to assess the richness, evenness, and distribution of species within various ecosystems, providing quantifiable insights into biodiversity's role in sustaining ecosystem functions. Reddy and Rao (2016) demonstrated the effectiveness of these indices in understanding ecosystem health by examining plant diversity across regions with differing biodiversity levels. Their work underscores how metrics like species richness and evenness can offer clear indicators of ecological stability, which are essential for guiding conservation efforts. In regions like northern India, where biodiversity supports economic activities through industries reliant on medicinal and aromatic plants, these indices allow for a deeper understanding of both biodiversity and its economic implications (Verma et al., 2020).

The economic significance of biodiversity has been increasingly documented, with numerous studies emphasizing how biodiversity underpins sustainable development and poverty alleviation. Medicinal and aromatic plants (MAPs), for example, are crucial not only for traditional medicine but also for pharmaceutical and cosmetic industries, which have seen a rising demand globally (Sharma et al., 2019). Studies by Karki et al. (2013) suggest that sustainable management of such plant resources can create livelihood opportunities, particularly in rural communities. Similarly, Tewari and Campbell (2018) highlight that many rural economies depend on non-timber forest products like medicinal plants, which contribute to both local health care needs and income generation. In Indora, MAPs like *Withaniasomnifera* (Ashwagandha) and *Ocimum sanctum* (Tulsi) represent economically valuable resources whose sustainable use could benefit local economies while ensuring conservation.

Integrating biodiversity into agricultural landscapes through agroforestry and mixed cropping systems has been shown to enhance ecosystem resilience and agricultural productivity, as well as to support biodiversity conservation in farming areas (Schroth et al., 2004). Verma et al. (2020) illustrated how agroforestry in northern India helps in biodiversity conservation while maintaining agricultural output, particularly by including forest trees and MAPs in farming practices. Such integrative methods enable both farmers and local communities to derive economic benefits from biodiversity while maintaining a balance between development and conservation. Agroforestry can thus serve as a viable approach to mitigate biodiversity loss in areas like Indora, where agriculture remains a primary livelihood source.

However, habitat fragmentation and the expansion of agricultural and urban areas continue to threaten plant diversity in many regions. In northern India, the pressure on land resources has led to habitat fragmentation, affecting the diversity and abundance of plant species (Thakur et al., 2017). Community-based conservation strategies, such as those proposed by researchers like Thakur et al. (2017) and Chopra (2019), suggest that engaging local communities in conservation efforts can mitigate these impacts. Such strategies could include sustainable harvesting practices and promoting awareness of the economic and ecological value of native species. Chopra (2019) emphasized the need for such protections against overexploitation and invasive species, which pose risks not only to biodiversity but to the long-term ecological and economic health of the region.

Building on these findings, the current study aims to catalog and assess the diversity of plant species in Indora, focusing on their functional uses in categories such as forestry, medicinal applications, and agriculture. The research will apply biodiversity indices to quantify species richness, evenness, and overall diversity across categories, thereby providing a comprehensive view of the ecological health of the region. Moreover, by evaluating the economic potential of key species, this study will highlight the contributions of plant diversity to the local economy. By examining both ecological and economic dimensions, this research seeks to provide insights into resource management strategies that support biodiversity conservation while promoting sustainable economic development. The ultimate goal is to offer solutions that can enhance local livelihoods and resilience through practices that conserve biodiversity, benefiting both the environment and the community.

In summary, this study responds to the urgent need for effective conservation and sustainable management of plant biodiversity in Indora. By cataloging and analyzing the diversity of local plant species and assessing their economic potential, it aims to underscore the interconnectedness of ecological health and economic stability. In doing so, the research will provide valuable data and recommendations that could help guide regional resource management and conservation policies, fostering a balanced approach to ecological and economic resilience

3. Study Area

Indora, situated in Kangra district of Himachal Pradesh, is located at approximately 32.15°N latitude and 76.30°E longitude. This region features a diverse topography, ranging from elevations of 300 to 800 meters, which supports a rich array of subtropical and temperate plant species. The varied landscape of Indora provides a favorable setting for both native vegetation and cultivated crops, contributing significantly to the region's biodiversity.

The climate in Indora is ideal for a wide variety of vegetation, including both evergreen forest trees and seasonal agricultural crops. With an annual average rainfall of around 800 mm, Indora experiences a pronounced monsoon season between July and August. This monsoon period is essential for replenishing soil moisture and supporting the growth of native flora as well as cultivated plants, creating an environment in which plant diversity can thrive. The subtropical climate, combined with the fertile soil and consistent rainfall, enables the growth of numerous plant species that are economically and ecologically valuable.

Economically, Indora's landscape is dominated by agriculture, forestry, and the cultivation of medicinal and aromatic plants. These sectors form the backbone of the region's economy, with agriculture providing staple crops, forestry supplying timber and non-timber forest products, and medicinal plants offering resources for both local health needs and commercial purposes. The cultivation of medicinal and aromatic herbs in particular has gained prominence, given their high market demand and established role in traditional medicine. The economic activities of Indora are thus closely tied to its plant diversity, which supports the local economy and provides the raw materials needed for various products and services. Through a combination of native and cultivated plant resources, Indora demonstrates a balanced approach to utilizing its natural wealth, making biodiversity conservation essential to sustaining its economic and ecological landscape.

4. Materials and Methods

4.1 Data Collection

Surveys were conducted to identify and categorize plant species across Indora's ecosystems. Plants were classified into forest trees, medicinal and aromatic plants, fruit-bearing trees, ornamental plants, and agricultural crops, with data collected on local names, uses, and market value.

4.2 Data Analysis

Biodiversity Indices: The Shannon-Wiener Index and Simpson's Diversity Index were calculated to assess species richness and evenness across categories.

Formulae for Indices:

1. **Shannon-Wiener Index (H')**:

$$H' = -\sum(p_i \ln p_i)$$

where p_i is the proportion of species in each category.

2. **Simpson's Diversity Index (D)**:

$$D = 1 - \sum(pi^2)$$

5. Results

5.1Plant Diversity

The study identified 22 species across five categories: forest trees, medicinal and aromatic plants, fruit-bearing trees, ornamental plants, and agricultural crops. The largest group was forest trees, with notable species like *Acacia catechu* (Khair) and *Toona ciliata* (Toon).

5.2 Comprehensive Table of Plant Species

Category	Plant Species	Scientific Name	Characteristics/Uses
Forest Trees	Khair	*Acacia catechu*	Used for heartwood, traditional medicine, and dye
	Toon	*Toona ciliata*	Timber production, large deciduous tree
	Siris	*Albizia lebbeck*	Fast-growing, fragrant flowers, shade
	Kachnar	*Bauhinia variegata*	Orchid-like flowers, traditional cuisine and medicine
	Beul	*Grewia optiva*	Multipurpose: fodder, fiber, fuelwood
	Bamboo	*Bambusoideae*	Essential for construction and

		species	handicrafts
Medicinal and Aromatic Plants	Tulsi	*Ocimum sanctum*	Known for medicinal properties, grown in households
	Ashwagandha	*Withaniasomnifera*	Adaptogenic herb in traditional medicine
	Lemongrass	*Cymbopogon citratus*	Aromatic, used in teas and essential oils
	Aloe Vera	*Aloe barbadensis miller*	Medicinal and cosmetic uses
Fruit-Bearing Trees	Mango	*Mangifera indica*	Staple fruit in India
	Guava	*Psidium guajava*	Nutrient-rich fruit
	Litchi	*Litchi chinensis*	Juicy and aromatic fruits
	Pomegranate	*Punica granatum*	Health benefits, cultivated in suitable areas
Ornamental and Flowering Plants	Marigold	*Tagetes species*	Vibrant flowers, used decoratively
	Rose	*Rosa species*	Aesthetic appeal and fragrance
	Bougainvillea	*Bougainvillea glabra*	Colorful bracts, landscaping plant
	Hibiscus	*Hibiscus rosa-sinensis*	Attractive flowers, used in traditional remedies
Agricultural Crops	Wheat	*Triticum aestivum*	Staple crop cultivated in plains
	Rice	*Oryza sativa*	Grown with suitable irrigation
	Maize	*Zea mays*	Kharif season crop, agrarian economy contribution
	Mustard	*Brassica juncea*	Grown for oil production

5.3 Biodiversity Indices

The biodiversity of Indora was quantified using two key indices, the Shannon-Wiener Index (H') and Simpson's Diversity Index (D), both of which provide insights into species richness, evenness, and distribution within the region.

The Shannon-Wiener Index (H') for Indora was calculated at 1.666, which suggests a moderate level of biodiversity. This value indicates that the species within the region are fairly evenly distributed across categories without dominance by any single group, reflecting a balanced ecosystem. Moderate biodiversity, as indicated by this index, generally suggests resilience against environmental fluctuations, as the presence of multiple species can help to stabilize ecological processes and provide various ecosystem services.

Simpson's Diversity Index (D), with a value of 0.793, further complements this analysis by measuring species evenness across the region. A value close to 1 in Simpson's Index signifies high evenness, meaning that most species are present in similar abundances, reducing the likelihood of any one species dominating the ecosystem. High evenness is often indicative of a stable and well-distributed ecosystem, as it minimizes competition and allows species to coexist without overexploitation of resources. Together, these indices illustrate that Indora possesses a

well-balanced biodiversity profile, where multiple species are sustained in proportions that support ecological stability and potential economic value through diverse plant resources

Discussion

The study reveals that Indora's biodiversity is characterized by a balanced ecosystem, with diverse plant species spanning several functional categories, including forest trees, medicinal plants, fruit-bearing trees, ornamental plants, and agricultural crops. The calculated Shannon-Wiener Index (H' = 1.666) indicates moderate biodiversity, which suggests that Indora's ecosystem supports a variety of species without a significant dominance by any one group. This balanced distribution is crucial for maintaining ecological functions, such as nutrient cycling and carbon sequestration, that contribute to the stability and resilience of the environment. The Simpson's Diversity Index (D = 0.793) further supports this finding by highlighting high species evenness across the region. High evenness ensures that no single species monopolizes resources, fostering coexistence among species and thereby enhancing ecosystem resilience.

The diversity observed in forest trees, medicinal and aromatic plants, and agricultural crops reflects the importance of each category to both ecological processes and local economic activities. Forest trees, like *Acacia catechu* (Khair) and *Toona ciliata* (Toon), are valued not only for their ecological roles, such as providing shade and stabilizing soil, but also for their economic uses in timber production and traditional medicine. Medicinal plants, including *Ocimum sanctum* (Tulsi) and *Withaniasomnifera* (Ashwagandha), support local healthcare needs and serve the pharmaceutical industry, representing a sustainable resource that, if managed properly, can provide continuous benefits to the community. The presence of staple agricultural crops like wheat, rice, and maize underscores the economic reliance on agriculture, while fruit-bearing trees and ornamental plants add further dimensions to the biodiversity profile by contributing to local food security and aesthetic value.

Comparing these findings with prior research indicates that Indora's biodiversity aligns with broader patterns observed in biodiversity-rich regions, where ecological diversity translates to economic resilience. Previous studies (e.g., Sharma et al., 2019) have underscored the role of biodiversity in poverty alleviation and sustainable development, particularly through the management of medicinal and aromatic plants. In Indora, the high demand for such plants in both local and international markets offers opportunities for economic growth if sustainably managed. The agroforestry practices and mixed cropping systems observed in northern India (Verma et al., 2020) further support the potential for integrated resource management in Indora, suggesting that agricultural productivity and biodiversity conservation can coexist to the benefit of both ecosystems and the community.

Conclusion

This study demonstrates that Indora's biodiversity is moderately high and well-balanced, supporting a stable ecosystem and offering significant economic potential through diverse plant resources. The balanced species distribution, as reflected in the biodiversity indices, enhances ecological stability and resilience, suggesting that Indora is well-equipped to maintain its ecosystem functions despite environmental changes. Forest trees, medicinal and aromatic plants,

agricultural crops, and other plant categories together constitute an ecosystem that is resilient and supportive of local economies. This study confirms that biodiversity conservation is not only beneficial for environmental health but also vital for sustaining economic activities that rely on plant resources.

The findings underscore the importance of integrating biodiversity conservation into local economic policies, particularly in the context of community-driven conservation and sustainable resource use. By promoting sustainable harvesting, agroforestry, and other integrative practices, Indora can leverage its biodiversity for economic growth while ensuring environmental protection. Future research could further investigate the potential impacts of specific conservation strategies and monitor changes in biodiversity indices to inform adaptive management practices. Overall, the insights gained from this study provide a valuable foundation for resource management and conservation policies in Indora, aiming to achieve a balance between ecological health and economic sustainability

References

Balvanera, P., Pfisterer, A. B., Buchmann, N., He, J.-S., Nakashizuka, T., Raffaelli, D., & Schmid, B. (2006). Quantifying the evidence for biodiversity effects on ecosystem functioning and services. *Ecology Letters, 9*(10), 1146–1156.

Chopra, K. (2019). Biodiversity and ecosystem health: The need for sustainable resource management in local economies. *Journal of Environmental Management*, *32*(4), 135–148.

Karki, M., Tiwari, S., & Adhikari, B. (2013). Sustainable management of medicinal plants and non-timber forest products in rural areas of South Asia. *Economic Botany, 67*(2), 139–153.

Reddy, C. S., & Rao, P. V. (2016). Application of biodiversity indices for the assessment of ecosystem health. *Ecological Indicators, 58*, 308–315.

Schroth, G., da Fonseca, G. A., Harvey, C. A., Gascon, C., Vasconcelos, H. L., & Izac, A. N. (2004). *Agroforestry and biodiversity conservation in tropical landscapes*. Island Press.

Sharma, S., Sharma, D., & Singh, N. (2019). Economic potential of medicinal and aromatic plants in Himachal Pradesh, India. *International Journal of Herbal Medicine, 7*(1), 37–42.

Singh, J., Sharma, R. K., & Chauhan, R. (2017). Role of biodiversity in ecosystem services and its conservation in India. *Journal of Biodiversity and Conservation*, *11*(3), 10–17.

Tewari, D. D., & Campbell, B. M. (2018). Developing sustainable rural economies: The role of non-timber forest products. *Development Policy Review*, *36*(2), 217–236.

Thakur, J. P., & Mehta, H. R. (2017). Community-based conservation strategies for biodiversity preservation in northern India. *Conservation and Society, 15*(3), 233–242.

Verma, A., Sharma, K., & Joshi, A. (2020). Integrative agroforestry practices to promote biodiversity and rural development in North India. *Agroecology and Sustainable Food Systems*, *44*(9), 1261–1274.