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Eco-Economic Valuation of Forest-Based Plant Biodiversity and Its Linkages with Human Health : A Commerce-Based SDG Analysis

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Abstract: Biodiversity provides ecological services that are fundamental for human health and economic sustainability. In India, forest-based plant biodiversity offers critical resources such as medicinal plants, food supplements, and raw materials for industries. However, their economic valuation remains inadequately integrated into commerce and policy frameworks. This study seeks to evaluate the eco-economic contribution of forest-based plant biodiversity to human health within the Sustainable Development Goal (SDG) framework, with a focus on SDG 3 (Health), SDG 8 (Economic Growth), SDG 12 (Sustainable Consumption), and SDG 15 (Life on Land). Using an exploratory approach based on secondary data interpretation, case studies, and indicative valuation methods, the research demonstrates the dual role of biodiversity in ensuring health security and enabling livelihood opportunities. Results highlight that plant-based ecological services not only reduce healthcare costs but also generate sustainable income through eco-commerce. The COVID-19 pandemic further underscores the risks of biodiversity loss for public health, reinforcing the need for conservation and restoration. The findings underline the urgency of mainstreaming biodiversity valuation into commercial decision-making and policy interventions. The study concludes by offering policy recommendations for integrating biodiversity-health linkages into national economic planning, thereby reinforcing India's commitments to global sustainability targets.

Keywords: Forest finance, biodiversity, human health, eco-commerce, sustainable development goals, India.

Introduction - Forests and plant biodiversity form the foundation of ecological and economic systems, supplying food, medicine, energy, and raw materials. Globally, the World Health Organization (WHO, 2018) estimates that more than 70% of modern pharmaceuticals are derived from plants, while traditional systems like Ayurveda, Siddha, and Unani continue to depend heavily on forest biodiversity. In India alone, the herbal and nutraceutical market is valued at billions of dollars, growing annually at double-digit rates, demonstrating the commercial importance of plant resources. Beyond healthcare, plants provide food security, cultural identity, and livelihood opportunities, particularly for forest-dependent communities.

The economic significance of biodiversity has led to evolving legal and institutional frameworks. India's **Biological Diversity Act (2002)** and the **National Biodiversity Authority (NBA)** are landmark efforts to regulate access to biological resources and ensure fair benefit-sharing with local custodians. However, gaps in enforcement and limited integration into national accounts hinder effective valuation. Global frameworks such as the **Convention on Biological Diversity (CBD)** and the **Nagoya Protocol on Access and Benefit Sharing** emphasize linking biodiversity with human welfare and commerce, aligning closely with India's commitments under the Sustainable Development Goals (SDGs).

The COVID-19 pandemic further revealed the consequences of biodiversity loss. Scientists highlight that ecosystem disruption and deforestation increase the risk of zoonotic spillovers. A degraded natural environment intensifies public health risks while weakening resilience. Thus, biodiversity conservation is not only a matter of ecological sustainability but also a determinant of human health security and economic stability. This paper builds on these interconnections, linking biodiversity valuation to health outcomes, commerce, and the SDG framework.

Literature Review

a) Ecology and Economy: Global scholarship highlights the economic significance of ecosystem services. Costanza et al. (1997, updated 2017) estimated the world's ecosystem services at trillions of dollars annually, positioning biodiversity as a critical component of global wealth. The Economics of Ecosystems and Biodiversity (TEEB, 2010; UNEP, 2020 update) further developed methodologies for

valuing ecosystem services, including cost–benefit analysis and willingness-to-pay approaches. However, integration of these valuations into country-level commerce and policy frameworks remains uneven, particularly in developing economies such as India.

b) Biodiversity and Health: The biodiversity–health nexus is increasingly recognized in global reports. WHO & CBD (2020) emphasize that nearly 70% of modern medicines are derived from plants, and biodiversity loss heightens vulnerability to infectious diseases. Empirical studies (Kumar et al., 2019; Pandey et al., 2021) confirm that biodiversity supports preventive healthcare (nutrition, immunity, mental health) as well as curative treatments. Yet, local and indigenous communities—the primary custodians of this biodiversity—often remain excluded from the commercial benefits arising from pharmaceutical and nutraceutical markets.

c) Commerce and SDGs: Linkages between biodiversity and commerce are critical for achieving sustainable development. Research shows that biodiversity-driven industries can contribute to "green GDP" through herbal medicine, nutraceuticals, and eco-tourism (Sharma & Sinha, 2023). However, operational models in India remain underdeveloped, with limited integration of biodiversity valuation into business accounting, trade, and market systems. United Nations (2022) SDG Report highlights that while progress is visible in SDG 3 (Health) and SDG 15 (Life on Land), gaps remain in embedding biodiversity into SDG 8 (Decent Work & Economic Growth) and SDG 12 (Responsible Consumption).

Gap Identified: Despite extensive global research on ecosystem services and biodiversity valuation, very few studies combine eco-economic valuation with measurable human health outcomes, particularly within the Indian context and in direct alignment with SDG frameworks.

Objectives:

1. To analyze the eco-economic contribution of forest-based plant biodiversity to human health.
2. To measure willingness-to-pay (WTP) for plant-based health products and services.
3. To link biodiversity valuation with SDGs (3, 8, 12, 15).
4. To provide commerce-based policy recommendations.

Hypotheses:

1. **H1:** Forest-based plant biodiversity significantly contributes to reducing healthcare costs.
2. **H2:** Commercial valuation of plant biodiversity enhances both livelihoods and health security.

Methodology: This study is based primarily on **secondary data interpretation**, drawing from government reports (MoEFCC, ICMR), WHO biodiversity–health datasets, satellite forest monitoring (FAO, FSI), and published research. A mixed-method lens is applied, combining indicative economic valuation tools (willingness-to-pay surveys, cost–benefit models) with thematic review of case studies from Indian forest regions. The approach remains exploratory and adaptable to available evidence.

Results (Broad Findings):

1. **High Dependency on Plant Biodiversity for Health** – Nearly 70% of modern medicines are plant-derived; traditional systems like Ayurveda and Unani still rely heavily on forest-based plants.
2. **Under-Valuation in Commerce** – Forest plant resources contribute substantially to pharmaceuticals and nutraceuticals, but their value is rarely reflected in GDP or trade statistics.
3. **Benefit–Exclusion Paradox** – Indigenous communities, despite being custodians, receive minimal economic benefits from commercialization.
4. **Health–Economy Nexus Underexplored** – Few studies quantify biodiversity's role in reducing healthcare costs in India.
5. **Alignment with SDGs but Weak Implementation** – Potential to advance SDG 3, 8, 12, 15, but gaps in commerce-policy integration limit progress.

Discussion: The findings of this study reinforce the urgent need to integrate biodiversity into economic and health planning. Secondary evidence confirms that medicinal plants, dietary supplements, and nutraceuticals derived from forests significantly reduce healthcare costs while supporting preventive health systems. However, this contribution remains undervalued in national income accounting, where biodiversity rarely features as an economic asset. Developing a **"green GDP" framework** for India is therefore essential.

A critical aspect of the discussion is the paradox of exclusion. Indigenous and local communities act as custodians of forest knowledge and biodiversity, yet they are often marginalized in commercial benefit-sharing. This is where legal frameworks such as the **Biological Diversity Act (2002)** and the **Access and Benefit Sharing (ABS)** mechanism become vital. Strengthening ABS practices can simultaneously promote equity and incentivize conservation. At the same time, the pandemic highlighted that biodiversity loss is directly linked with human vulnerability to emerging infectious diseases. Evidence suggests that intact ecosystems act as buffers against zoonotic diseases, while deforestation and wildlife trade heighten risks. This strengthens the argument for integrating biodiversity-health linkages into national public health strategies.

Efforts toward conservation and restoration are visible but uneven. Initiatives such as **CAMPA**, eco-restoration projects, and protected area expansion represent important steps. Community-based forestry, joint forest management, and eco-tourism also illustrate pathways for linking livelihoods with conservation. Globally, India has aligned with the **CBD Post-2020 Global Biodiversity Framework**, but stronger implementation mechanisms are required.

Conclusion & Policy Suggestions:

1. Biodiversity must be economically valued to capture its true contribution to health and commerce.

2. Policy should integrate biodiversity-health valuation into national accounts and state health budgets.
3. Public–private partnerships should promote eco-commerce with equitable benefit-sharing.
4. Conservation and restoration strategies must be strengthened with satellite-based monitoring and community participation.
5. Further research should establish standardized valuation frameworks across Indian states.

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