

Integrating Tradition and Ecology: The Role of Indian Knowledge Systems in Biodiversity Conservation

Review Article

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Introduction

One of the most ecologically and culturally diverse nations in the world, India is home to a broad range of ecosystems and traditional communities that have coexisted with nature for thousands of years. Indian Knowledge Systems (IKS) refers to the indigenous, local, cultural, and customary ethnic knowledge that people have created and maintained via intimate connection with their environment for coexistence. This knowledge system enrooted to cultural customs, spiritual beliefs and empirical observation transmitted from one generation to the next through oral traditions, rituals and group learning that help in maintaining biodiversity by protecting habitats and promoting the growth of diverse plant and animal species [1].

In its widest definition, biodiversity encompasses the diversity and adaptability of all living things, including microorganisms, plants, animals, and the ecosystems they create [2]. The resilience of ecosystems and human well-being are supported by biodiversity. But the swift deterioration of ecosystems caused by several anthropogenic factors highlighted the necessity of complementary and alternative conservation strategies.

A subset of IKS is represented by indigenous knowledge in biodiversity conservation, which is defined by environmentally sound techniques tailored to regional conditions [1]. It involves a deep comprehension of biodiversity, soil, climate, and ecological

relationships. Techniques used by indigenous communities that directly support habitat preservation and increase in species variety include several traditional methods such as traditional agricultural practices, agroforestry, ceremonies, taboos, sacred grooves, etc. Additionally, traditional ecological methods and the usage of medicinal herbs show a holistic perspective of nature, where livelihood and conservation are intertwined [3]. Blending such traditional and modern approaches to biodiversity conservation is vital for achieving sustainable outcomes. While modern science provides advanced tools, indigenous knowledge offers ecologically sound and culturally rooted practices, prompting growing support for their integration. The purpose of this review is to examine how Indian Knowledge Systems contribute to biodiversity conservation, with an emphasis on indigenous agroecological models, sacred landscapes, community stewardship, and traditional ecological practices. Case studies from certain parts of India were highlighted. The contribution of these knowledge systems to the preservation of biological diversity will be discussed, and the possibility of integrating IKS with contemporary conservation frameworks will be evaluated.

Biodiversity conservation and forest in ancient Indian texts

Historical manuscripts and ancient literature from ancient India exhibit rich legacy of biodiversity protection, deep appreciation

for ecological balance and a respect for the natural world. Kautilya's *Arthashastra* describes soil types, irrigation techniques, farming techniques, microecological contexts, management of forest, garden, orchard and cattle, penalties and punishment were specified for causing injury to any living being and the king was supposed to protect the forest and forest resources [4]. Similarly *Manusmṛiti* written in post-vedic period is the first ethical compendium on human law, contains ecological ethics and recognizes biodiversity as "Chara" or the animal and "Achara" or plants. It consists of biodiversity rules like prohibitions on killing certain animals (buffalo, snakes, elephants), environmental pollution and its effect etc. In *Rig Veda*, (1700-1100 BCE) there are hymns for mentions tree worship and sacred groves [5]. *Atharva Veda* (c. 800 BCE) consist of hymns invoke protection for forests, rivers, mountains, manifesting early conservation consciousness. Another important treatise *Caraka Samihita* and *Susruta Samihita* includes the management of wild medicinal plants and their cultivation. Post vedic literature, Surapala's *Vrikshayurveda* describes the forest ecosystem and its management practices. Besides, ancient Indian epics like the *Mahabharata*, *Ramayana*, and *Bhagavad Gita* depict divine and sacred forests inhabited by sages, and diverse flora and fauna. These texts highlight sacred groves (Tapovanas) as centers of ecological harmony and spiritual practice. *Abhijnanasakuntalam* by Kalidasa beautifully portrays the vibrant biodiversity of hermitage forests. Such treatises emphasize the sanctity of nature and advocate for its reverent protection [4].

Traditional Practices in Biodiversity Conservation

Traditional practices in biodiversity conservation emphasises the time-tested ecological knowledge of indigenous and ethnic communities in India. These practices have a strong hold on spirituality, cultural traditions, and sustainable use natural resources. Their insights into maintaining ecosystem health and species diversity are invaluable. There are several indigenous technologies used in the conservation of nature such as, rituals and ceremonies, tabbos, sacred groves, prohibitions etc.

1. Rituals and ceremonies: The connection between religious rituals and biodiversity protection is an intriguing story that combines cultural beliefs and environmental responsibility. Ethnic communities worship tree, animals, forest and mountain deities from time immortal. Certain important ethnic rituals related to biodiversity conservation are (Table 1)

2. Traditional agricultural practices: Indigenous Technical Knowledge (ITK) plays a vital role in sustainable agriculture, especially among the 80% of Indian farmers practicing low-input farming [2]. Rooted in local ecosystems, ITK enables effective adaptation to soil, climate, and water conditions. It promotes sustainable resource use through agroforestry, crop rotation, and traditional irrigation. ITK also conserves genetic diversity via traditional seed and breeding practices. It enhances resilience to climate change through drought-resistant crops and soil conservation. Culturally embedded, ITK strengthens community identity and intergenerational knowledge transfer. By fostering food sovereignty and reducing external dependence, ITK supports resilient, ecologically sound, and self-reliant agricultural systems.

3. Traditional farming systems: Indigenous farming technologies in India includes, Jhum cultivation Double cropping of rice, Multiple Cropping, Bun system of cultivation (Meghalaya), Rice-fish system of Apatani plateau, Bamboo drip irrigation system (Meghalaya), Alder based agriculture in Nagaland, ZABO system (Nagaland), Diversified Hill Horticulture (East Himalaya) etc. [15]. Besides, there is particular seed selection, collection and preservation methods are there in different states of India. Indigenous organic manure such as Kunapajala, Adiuram, Makkavaithal, Chapathikalli, Nelmakkuuram and Songukal have been used by several communities from ancient time which maintains the health of soil microflora [16]. Several ecocultural festivals and rituals are associated with harvesting in different communities. Thus, traditional indigenous knowledge in India is deeply rooted with the protection, preservation and conservation of farming indigenous practices, native gene pool of the cultivar varieties as well as the tools and techniques of farming.

4. Sacred Groves and Landscape Ethos: Sacred groves are small forest patches preserved by local ethnic communities due to their religious beliefs, cultural sentiments, and traditional taboos [17]. These groves not only serve as important reservoirs of biodiversity but also regarded as living repositories of biological heritage, housing numerous threatened species. The concept of sacred groves is found worldwide including in India, as well as in regions across Asia, Africa, Europe, Australia, and America [18]. India alone may have over 1.5 lakh sacred groves [19]. Sacred groves may be of different types such as temple groves, traditional sacred groves related to folk deities, religious groves associated with religious beliefs and customs, island groves consist of certain ecological importance such as mangroves, coastal or reverie areas, burial, cremational or memorial groves are the places where deceased are kept and are believed to be inhabited by the spirits of ancestors.

Sacred groves serve an important role in biodiversity conservation, ecosystem protection, and the preservation of traditional ecological knowledge [5]. Managed by local ethnic communities, these forest patches serve as sanctuaries for a variety of plant and animal species. They also hold great cultural and spiritual value, and are frequently regarded as hallowed sites for rites and ceremonies. The protection of these groves empowers communities, strengthens their involvement in natural resource management, and promotes environmental balance by preventing soil erosion and cleaning the air. Furthermore, holy groves represent community-led conservation, which promotes sustainable livelihoods, food security, and the preservation of indigenous history.

5. Ethnobotany in biodiversity conservation: Ethnobotany is the scientific study of the relationship between people and plants, holds significant relevance in addressing several global challenges such as food security, climate change, biodiversity conservation, and public health. Interaction of local communities with their environmental resources contributes to sustainable practices rooted in traditional knowledge [20]. Moreover, it serves as a bridge between indigenous wisdom and contemporary science fostering integrated approaches toward achieving biocultural conservation. Home gardens, herbal markets, traditional food and fodder, folk livelihood, traditional healing practices continuously foster the

Table 1: Traditional rituals/festivals/celebrations related to biodiversity conservation

| SI No | Indigenous technology | Ritual | Region | Conservation relevance | Reference |
|-------|-------------------------------------|---|---|--|---------------|
| 1 | Tree worship | Vruksha Puja, Vat Savitri Puja, Ashvattha Puja | Pan-India | Protection of sacred groves, trees, plants and spread awareness for plantation, prohibit deforestation | [6] |
| 2 | Sacred Grove Rituals | Devrai / Devban Worship, Kavu Worship, Umang Lai Worship | Maharashtra, Himachal Pradesh, Assam, Kerala, Manipur | Protection of forest ecosystem | [7], [8], [9] |
| 3 | River and Water Body Rituals | Ganga Aarti & Ganga Dussehra, Pushkar Mela (Lake Worship), Yamuna Chhath, Kumbh Mela | North India, Rajasthan, | Discourages water pollution and promotes water conservation, water body protection. | [10] |
| 4 | Harvest and Seasonal Festivals | Pongal / Makar Sankranti, Bihu, Onam | Pan-India, South India, Assam | Celebrates agricultural biodiversity, crop cycles, and land fertility, promotes sustainable agriculture. | [11] |
| 5 | Animal Worship Rituals | Nag Panchami, Gau Puja (Cow Worship), Kartik Purnima Rituals (Fish Feeding) | Pan-India | Conservation of local fauna | [12] |
| 6 | Agricultural and Ecological Rituals | Makar Sankranti, Bhoomi Puja, Hal Shashti, Navadhanya Worship, Bihu | Pan-India, Bihar, UP, South India, NE India | Celebrates farming tools, sustainable farming practices | [2], [13] |
| 7 | Totem Worship | Worship Crocodile, Tortoise, Monkey, Tiger, Snake, Elephant, Crow, Plants like Sal tree, Peepal tree etc. | Gond, Baiga, Bhil (Madhya Pradesh, Chhattisgarh) | Conservation of faunal diversity | [13], [14], |
| 8 | Forest and Mountain Worship | Nanda Devi Raj Jat Yatra, Vanadevate, Dongar Dev Worship, Singhasan mountain in Assam, Mawlynong forest in Meghalaya, Pat Festival, | Uttarakhand, Madhya Pradesh, Maharashtra, NE India | Prohibition of activity, conservation of biodiversity, | [13] |

local communities to conserve the locally available medicinal herbs and other plant species. Thus, ethnomedicinal practices directly contribute to the conservation of ethnomedicinal biodiversity.

6. Community-based Forest and Wildlife Management
Community-based Forest and Wildlife Management in India is a participatory approach that empowers local communities to sustainably manage forest and wildlife resources [21]. Rooted in traditional knowledge and practices, this model emphasizes the role of forest dwellers and indigenous communities in conservation efforts. One of the most prominent initiatives in India is Joint Forest Management (JFM), introduced in the 1990s, where village communities collaborate with the Forest Department to protect and regenerate degraded forest lands. Other methods include the establishment of Community Forest Rights under the Forest Rights Act (2006), allowing tribal and forest-dependent communities legal access and management rights over forest resources. Community Reserves and Conservation Reserves, recognized under the Wildlife Protection Act (1972), further involve local populations in protecting biodiversity-rich areas outside formal protected zones. These community-led initiatives often include activities such as patrolling, afforestation, fire prevention, wildlife monitoring, and sustainable harvesting of non-timber forest products. By blending traditional ecological knowledge with modern conservation tools, these approaches not only contribute to biodiversity conservation but also ensure livelihood security and cultural preservation. Despite challenges like inadequate support and legal ambiguities, community-based management remains a vital strategy in India's efforts to achieve inclusive, effective, and sustainable forest and wildlife conservation.

Case studies

i. Mawphlang Sacred Grove, Meghalaya: The Khasi tribe has

preserved this ancient forest for centuries through strict taboos which harbour rare orchids, endemic medicinal plants, and unique fungi species [22]

- ii. Bishnoi Community Saving Wildlife, Rajasthan:** Bishnoi community of Rajasthan is known for their 500 year old wildlife protection tradition [23]. They worship wildlife and trees and in 1730 Khejarli Massacre, 363 Bishnois died protecting trees.
- iii. Apatani Valley Conservation, Arunachal Pradesh:** The Apatani tribe practices traditional wet rice-fish cultivation, maintaining soil, water, and aquatic biodiversity. In 2014, their landscape was nominated for the UNESCO World Heritage list for its unique indigenous resource management system [24].
- iv. Niyamgiri Hills Conservation by Dongria Kondh, Odisha:** In 2013, the Supreme Court of India upheld the rights of the Dongria Kondh tribe to protect the Niyamgiri Hills from bauxite mining. Their spiritual and ecological reverence for the hills helped preserve a biodiversity hotspot rich in medicinal plants and endemic species [25].
- v. Use of Traditional Seed Banks 'Navdanya Movement', Uttarakhand:** Founded by Dr. Vandana Shiva, this movement revived traditional seed-saving practices. Farmers use indigenous knowledge to preserve crop biodiversity, particularly drought and pest resistant varieties, playing a crucial role in food security and agrobiodiversity [26].

Challenges and Limitations

The incorporation of traditional knowledge into biodiversity conservation faces numerous challenges. Modernization and

urbanization have eroded traditional knowledge systems, with younger generations becoming increasingly disconnected from ancestral practices. This is exacerbated by the loss of intergenerational transmission, in which knowledge is not passed down due to changing lifestyles, migration, and decreased interest in indigenous practices. Conflicts frequently arise between state led conservation efforts and customary practices, particularly when legal frameworks limit community access to traditionally managed lands, undermining local stewardship. Furthermore, intellectual property rights and biopiracy are serious concerns, as corporations and researchers occasionally exploit traditional knowledge without fair compensation or acknowledgement, resulting in mistrust and loss of control over indigenous resources.

Future Prospects

To strengthen the role of indigenous Indian Knowledge Systems (IKS) in biodiversity conservation, several visionary strategies could be implemented. Integrating IKS into national biodiversity action plans formalizes and supports community-based conservation practices. Revitalizing traditional institutions like village councils and customary guardians contributes to the restoration of local governance and environmental stewardship. Participatory documentation and capacity building enable communities to record and preserve their knowledge while also improving conservation skills. Eco-cultural tourism provides a long-term source of income by highlighting indigenous practices and raising environmental awareness. Finally, promoting cross-disciplinary and multi disciplinary research and education could connect traditional wisdom to scientific knowledge, benefiting both conservation efforts and academic understanding.

Conclusion

Traditional ecological wisdom is extremely valuable in biodiversity conservation and ecosystem sustainability, as it provides time-tested practices based on a deep understanding of nature. Rather than being viewed in isolation, this knowledge should be seen as a supplement to modern scientific approaches, enriching conservation strategies with cultural, ecological, and ethical dimensions. A truly sustainable future requires the respectful integration of traditional knowledge systems into mainstream environmental policies and practices, ensuring community participation, cultural preservation, and ecological resilience.

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