



# Guardians of the Green: Indigenous Ecological Knowledge and Environmental Conservation Practices among Santhal Tribes of Santhal Pargana

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## Abstract

This comprehensive study examined the Traditional Ecological Knowledge (TEK) systems of the Santhal tribes in the Santhal Pargana region and their critical role in environmental conservation. Through a qualitative synthesis approach, this study documents five key domains of Santhal TEK: sacred grove stewardship, medicinal ethnobotany, agroecology, livestock management, and customary governance. The findings reveal that Santhal-managed landscapes demonstrate significant biodiversity conservation outcomes comparable to the global patterns observed in indigenous-managed territories. This study analyzes the statutory frameworks affecting Santhal forest governance, including the Forest Rights Act (2006) and the Panchayats (Extension to Scheduled Areas) Act (1996), while identifying implementation challenges and opportunities. This study proposes integrated conservation strategies that incorporate Santhal TEK into contemporary environmental management frameworks, emphasizing the dual benefits of ecological resilience and cultural preservation. This study contributes to the growing body of literature advocating for the recognition and integration of indigenous knowledge systems in global conservation efforts, demonstrating how traditional practices can inform sustainable resource management and enhance biodiversity conservation outcomes.

**Keywords:** Traditional Ecological Knowledge, Santhal tribes, biodiversity conservation, sacred groves, indigenous governance, environmental stewardship

## 1. Introduction

### 1.1 Background and Context

Indigenous ecological knowledge and environmental conservation have become important areas of study and practice in sustainability discussions (Berkes, 2012). Indigenous communities around the world have deep understanding of their local environments, built over thousands of years of living closely with nature, creating knowledge systems that combine ecological, cultural, and spiritual aspects (Drew & Henne, 2006). The Santhal tribes of the

Santhal Pargana region in India are a good example of how traditional knowledge connected to environmental care.

The Santhal community is one of India's largest tribal groups with over 6.4 million people living mainly in Santhal Pargana in Jharkhand, and also in West Bengal, Odisha, Bihar, and Assam (Banik, 2008). They have maintained their unique cultural practices and environmental knowledge that has helped both their way of life and the natural diversity of their lands for generations. Their Traditional Ecological Knowledge (TEK) includes a deep understanding of forests, farming, medicinal plants, and how to manage resources in ways that match modern sustainable development ideas.

The Santhal Pargana region has different types of environments like forests, grasslands, and farmlands that support many different species while being home to indigenous communities who depend on natural resources for their living (Nath et al., 2001). The area is important not only for its biological diversity but also for the cultural landscapes created by Santhal management practices, including sacred groves (Jaherthan), traditional farming systems, and community-based ways of governing resources.

## 1.2 Research Problem and Significance

Although indigenous knowledge systems are increasingly valued for conservation, key gaps remain in the understanding of Santhal Traditional Ecological Knowledge (TEK) and its role in modern environmental management.

First, Santhal ecological practices are partly recognized, but their TEK is not fully documented. Important links between culture and ecology—such as sacred groves, traditional farming, and local governance—need deeper study to reveal their conservation value.

Second, many conservation programs neglect indigenous knowledge, causing a disconnect between Santhal practices and modern strategies. This limits opportunities for innovative approaches that support biodiversity while respecting community rights.

Third, the ties between Santhal cultural identity and ecological practices are underexplored. Studying these links is vital to see how cultural preservation influences conservation and community well-being, especially under pressures of modernization.

Addressing these gaps matters not only for research but also for practice. Documenting and applying Santhal TEK can strengthen biodiversity strategies, empower communities, and ensure their role in decision making. At the same time, preserving TEK protects cultural heritage from social, institutional, and developmental threats, while passing this knowledge to future generations.

## 1.3 Research Objectives

This study seeks to fill important gaps in our understanding of Santhal Traditional Ecological Knowledge (TEK) through four key objectives. First, it documents Santhal knowledge systems in areas such as sacred groves, medicinal plants, agroecology, livestock care, and local governance. Second, it evaluates how these practices contribute to biodiversity and community

well-being, while also comparing them with the global experiences of indigenous land management. Third, it examines the role of statutory frameworks such as the Forest Rights Act (2006) and the Panchayats (Extension to Scheduled Areas) Act (1996), focusing on how they shape Santhal forest governance and the challenges they face. Finally, it develops integrated conservation strategies that bring Santhal TEK into modern management approaches, ensuring both ecological sustainability and community empowerment.

The significance of this study lies in its dual contribution. On the academic side, it enriches the scholarship on traditional ecological knowledge and offers methods that can be applied to other indigenous contexts. Practically, it provides evidence-based recommendations to make conservation strategies more inclusive and effective. At the policy level, it sheds light on how laws and institutions can support indigenous conservation efforts. Most importantly, it values and validates Santhal cultural practices, aiming to strengthen their role in shaping both their future and wider environmental management.

## **2. Literature Review and Theoretical Framework**

### **2.1 Conceptualizing Traditional Ecological Knowledge**

Traditional Ecological Knowledge (TEK) is the collective wisdom of indigenous communities built through generations of interactions with their environment. It blends ecological understanding with cultural beliefs and guides sustainable ways of living (Berkes 2012). TEK is not static; it adapts to social and ecological changes while maintaining core cultural values (Drew & Henne, 2006). Recent perspectives describe it as a biocultural system in which knowledge, practices, and spiritual values are deeply connected (Torri and Herrmann 2011).

### **2.2 TEK Components and Characteristics**

TEK has four key elements: knowledge of species and ecosystems, resource management practices, social institutions, and cultural worldviews (Berkes 2012). Its empirical side reflects detailed observations of the local ecology (Drew & Henne, 2006). Management practices demonstrate the adaptive and sustainable use of resources (Folke, 2004). Social institutions regulate access to and knowledge across generations (Ostrom, 2009). Underpinning these are worldviews that stress reciprocity and respect for nature (Kimmerer, 2013).

### **2.3 Sacred Groves in Indigenous Conservation**

Sacred groves are powerful examples of TEK. Protected for cultural and spiritual reasons, they conserve biodiversity and maintain an ecological balance (Sharma & Kumar, 2021). Research shows that groves often sustain richer biodiversity than the surrounding areas under human pressure (Anthwal et al., 2010). Their effectiveness originates from cultural taboos, traditional management, and community governance (Kandari et al., 2014). In India, groves across regions like the Western Ghats and Eastern Himalayas preserve rare species and medicinal plants (Rath & Ormsby, 2020).

### **2.4 Indigenous Land Management and Global Outcomes**

Globally, indigenous-managed lands often perform better for conservation than state-protected areas (Schuster et al., 2019). Studies show these territories maintain higher forest cover and lower deforestation rates (Walker et al., 2020), support more species diversity (Garnett et al.,

2018), and provide ecosystem services like carbon storage and water protection (Fa et al., 2020). These outcomes highlight the ecological value of traditional management systems.

## 2.5 Challenges and Opportunities in TEK Integration

Integrating TEK into mainstream conservation faces obstacles. Differences between scientific and indigenous knowledge systems create epistemological gaps (Agrawal, 1995; Nadasdy, 1999). Legal and institutional barriers often exclude indigenous voices (Nadasdy, 2003). Yet, opportunities are growing with international recognition of indigenous rights, collaborative research, and conservation's increasing respect for TEK (Buschman, 2022). Co-production approaches that bring together scientists and indigenous communities, based on equity and shared learning, hold promise for both conservation and empowerment (Jamsranjav et al., 2019)

## 3. Methodology

This study adopts a qualitative synthesis approach to explore the Traditional Ecological Knowledge (TEK) of the Santhal tribes in Santhal Pargana by analyzing existing literature, ethnographic accounts, and documented practices. Using socio-ecological systems, biocultural conservation, and institutional perspectives, the study identifies recurring themes and patterns in Santhal conservation traditions, integrating cultural, social, and ecological dimensions. While this method captures a broad understanding of TEK, it is limited by reliance on existing sources, which may omit oral, sensitive, or recent community knowledge, and variations within Santhal groups. Findings are therefore presented as preliminary, emphasizing careful source selection and the need for future field-based research.

## 4. Santhal Traditional Ecological Knowledge Systems

### 4.1 Sacred Grove Stewardship: The Jaherthan System

The Jaherthan, or sacred groves, are one of the strongest expressions of Santhal TEK, where spirituality, culture, and ecology meet. These groves, ranging from small patches to large forests, are maintained as sacred sites for ancestral spirits and deities (Jagdale, 2021). Beyond their cultural role, they serve as biodiversity hotspots, often hosting rare and endemic species no longer found elsewhere (Sharma & Kumar, 2021).

Santhal management practices—like taboos, seasonal restrictions, and rituals—act as effective conservation rules. Cutting trees, hunting, or entering without ritual purification is strictly controlled (Sen & Bhakat, 2021). Governance rests with traditional leaders such as the Manjhi and Naik, who enforce rules and pass down sacred grove knowledge (Narayan, 2024). Studies show these groves also support soil health, water regulation, and local agriculture through their microclimatic benefits (Rath & Ormsby, 2020).

### 4.2 Medicinal Ethnobotany and Traditional Healing

Santhal ethnobotany is a vast system of plant-based medicine, covering over 200 species for treating ailments from digestive issues to chronic diseases (Jain & Tarafder, 1970). Knowledge includes plant identification, preparation methods, dosages, and dietary rules. Healing is holistic, combining plant medicine with ritual and counseling by Ojha or Sokha healers (Hembrom, 2022).

This system also shows ecological sensitivity, with sustainable harvesting methods, careful timing of collection, and habitat protection for medicinal plants. Santhals often conserve wetlands, forest edges, and even grow medicinal species in home gardens to ensure availability.

### 4.3 Agroecological Systems and Crop Diversity

Santhal farming blends ecological principles with production needs, maintaining diverse crops and sustainable soil practices (Borthakur & Singh, 2021). Traditional varieties of rice, millet, legumes, and vegetables provide resilience against pests, climate shifts, and food insecurity (Singh & Singh, 2017).

Intercropping and mixed farming mimic natural forest systems, enriching soil and supporting biodiversity. Soil fertility is maintained through organic matter, crop residues, and cover crops. Pest management combines rotation, beneficial insects, and plant-based pesticides, reducing ecological harm while protecting crops.

### 4.4 Livestock Management and Pastoral Practices

Livestock rearing among Santhals is closely tied to ecology and culture. They prefer indigenous breeds of cattle, goats, and poultry that are well adapted to local conditions and resilient to diseases (Singh & Bondya, n.d.). Grazing is managed through rotational systems, seasonal shifts, and controlled burning, which sustain both pastures and wildlife habitats.

Animals are integrated into agriculture, providing draft power, manure, and income, while feeding on crop residues. Traditional veterinary knowledge includes herbal remedies and nutrition management, reducing dependence on external inputs.

### 4.5 Customary Governance and Resource Institutions

Santhal governance is rooted in customary law and community institutions that balance resource use with social harmony (Dayal & Sharma, 2024). Leadership lies with the Manjhi (village head) and Naike (elders), who enforce rules and resolve disputes (Narayan, 2024).

Customary law regulates forests, water, and land use, specifying rights, responsibilities, and restrictions. Enforcement comes through social sanctions and ritual obligations rather than formal systems. Collective decision-making in village assemblies and clan councils ensures wide participation.

These institutions are adaptive, capable of revising rules, absorbing new knowledge, and engaging with state policies, while still protecting Santhal values and ecological ethics.

## 5. Biodiversity Conservation Outcomes and Global Comparisons

### 5.1 Biodiversity in Santhal-Managed Landscapes

Research shows that Santhal-managed areas retain greater species richness and healthier ecosystems compared to degraded forests or monoculture plantations (Nath et al., 2001). Sacred groves (*Jaherthan*) remain particularly significant as biodiversity refuges, supporting

over 300 plant species, including rare orchids, endemic trees, and medicinal plants absent from surrounding landscapes (Sharma & Kumar, 2021). Their forests, with multi-layered canopies and diverse understory, provide habitats that sustain high faunal diversity. Bird surveys confirm higher richness and abundance in groves than in plantation forests, with many forest-dependent species surviving only in these protected spaces (Rath & Ormsby, 2020).

Santhal farming systems also conserve agricultural biodiversity by maintaining landraces of rice, millet, and legumes, which serve as crucial genetic resources for future crop improvement and climate resilience (Singh & Singh, 2017). At the landscape scale, their traditional practices—preserving forest corridors, water sources, and diverse cropping systems—create ecological connectivity and maintain essential ecosystem functions.

## 5.2 Global Comparisons

These findings align with global research showing that indigenously managed lands often achieve better biodiversity outcomes than formal protected areas, particularly where customary governance remains strong (Schuster et al., 2019). Indigenous conservation worldwide demonstrates similar results: tropical forests under traditional care maintain higher tree diversity and lower deforestation rates than state-controlled reserves.

Sacred sites represent another parallel. Across Africa, Latin America, and Asia, sacred groves and culturally protected landscapes serve as biodiversity reservoirs. The Santhal *Jaherthan* system reflects these broader patterns, emphasizing how cultural traditions contribute directly to ecological resilience. Similarly, agricultural biodiversity maintained through indigenous farming systems globally supports both food security and conservation of genetic resources.

## 5.3 Ecosystem Services

Santhal landscapes also generate vital ecosystem services. Forests under traditional stewardship store considerable carbon in vegetation and soils, with their layered structure and low disturbance promoting long-term carbon accumulation. They protect watersheds by regulating stream flow, preventing erosion, and ensuring water quality. Their diverse cropping systems and field margins provide habitats for bees, butterflies, and other pollinators, benefiting both wild and cultivated plants. These practices together enhance climate regulation through microclimate stability and landscape-level resilience.

## 5.4 Socio-Ecological Resilience

Equally striking is the socio-ecological resilience of Santhal communities. Their livelihoods integrate agriculture, forestry, and livestock rearing, reducing exposure to shocks. Flexible management systems, informed by deep ecological knowledge, enable quick adaptation to changing conditions. Social institutions—customary law, collective decision-making, and traditional leadership—sustain cooperation and ensure continuity of practices. This combination of ecological knowledge, livelihood diversity, and strong institutions underpins both biodiversity conservation and cultural survival.

## 6. Statutory Frameworks and Implementation Challenges

### 6.1 Forest Rights Act (2006): Objectives and Implementation

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006 (FRA), is widely considered a landmark legislation that seeks to redress the “historical injustice” faced by forest-dwelling communities by legally recognizing their customary rights over forests (Singh, 2014). The Act not only secures individual and community rights to land and resources but also empowers local institutions to participate directly in forest conservation and governance.

The objectives of the FRA include: recognition of traditional rights of forest dwellers, enhancement of livelihood and food security, strengthening conservation through community stewardship, and democratization of forest governance structures. These objectives underline the recognition that sustainable conservation is inseparable from the well-being of forest communities.

In Jharkhand, where Santhal populations are concentrated, the implementation of FRA has produced mixed outcomes. Some positive impacts include recognition of community forest resource rights, enhanced participation of tribal communities in decision-making, and evidence of forest regeneration in areas where community rights have been granted (Dayal & Sharma, 2024). Yet, implementation has also been slowed by bureaucratic delays, lack of awareness among eligible communities, inadequate training of community institutions, and jurisdictional conflicts between forest and revenue departments.

The Gram Sabha, envisaged as the central institution for FRA implementation, represents both a strength and a challenge. While it provides a democratic forum for decision-making, its effectiveness is often undermined by limited technical knowledge, weak institutional capacity, and insufficient state support. This uneven functioning has directly affected how effectively forest rights are realized on the ground.

### 6.2 Panchayats (Extension to Scheduled Areas) Act (1996): Provisions and Operationalization

The Panchayats (Extension to Scheduled Areas) Act, 1996 (PESA), extended the 73rd Constitutional Amendment to Scheduled Areas, with special provisions to ensure tribal self-governance. PESA explicitly recognizes traditional tribal institutions and seeks to empower Gram Sabhas with authority over natural resources, land management, and local development decisions (Rath, 2006).

Key provisions relevant to forest governance include: mandatory consultation with Gram Sabhas prior to land acquisition, powers to prevent land alienation and restore illegally transferred land, authority to regulate village markets and money lending, and control over social sector institutions in tribal areas. These provisions were designed to institutionalize community control over resources and strengthen grassroots democracy.

In Jharkhand, however, operationalizing PESA has faced persistent obstacles. Challenges include low awareness among tribal communities, inadequate training of Panchayat members and officials, tensions between customary governance systems and formal Panchayati Raj institutions, and resistance from state agencies reluctant to devolve real power (Bara, 2022).

While both FRA and PESA aim to empower tribal communities in resource governance, their implementation often proceeds through separate bureaucratic pathways, limiting coordination. Integrating these frameworks could create stronger foundations for community-led governance, but this requires harmonization of procedures, capacity-building efforts, and cooperation among different levels of government.

### 6.3 Barriers to Community-Led Forest Governance

Despite supportive legislation, multiple barriers hinder effective community governance.

- **Awareness and capacity barriers:** Many communities remain unaware of their rights under FRA and PESA. Low literacy, language constraints, and lack of technical knowledge make legal and administrative processes difficult to navigate.
- **Institutional barriers:** Bureaucratic complexity, poor inter-departmental coordination, and reluctance of forest officials to share authority weaken implementation. Conflicts between customary law and formal legal systems further complicate governance.
- **Resource constraints:** Lack of financial support, infrastructure, and technical expertise prevents effective forest management. Remote villages face greater difficulties in accessing government services.
- **External pressures:** Mining projects, market forces, and political interventions often undermine community control by prioritizing external economic interests. These pressures introduce unequal power dynamics that disadvantage tribal communities.
- **Legal and procedural barriers:** Ambiguities in law, overlapping legal frameworks, and lengthy claim procedures discourage communities from exercising their rights and provide opportunities for external actors to contest community authority.

### 6.4 Opportunities for Strengthening Community Governance

Despite these barriers, there are opportunities to strengthen community-led forest governance.

- **Capacity building:** Training programs for community leaders, technical assistance in preparing forest management plans, and strengthening local institutions can significantly improve governance outcomes.
- **Institutional innovations:** Hybrid governance structures that integrate traditional leadership roles with formal Panchayati Raj institutions can ensure culturally sensitive and effective management.
- **Technology applications:** Use of mobile-based platforms, GIS mapping, and remote sensing can reduce bureaucratic hurdles, improve monitoring, and enhance transparency in resource management.
- **Collaborative partnerships:** NGOs, research institutions, and government agencies can play supportive roles in advocacy, technical training, and resource mobilization, provided they respect community autonomy and indigenous knowledge systems.
- **Policy reforms:** Simplifying claim procedures under FRA, clarifying the interface between FRA and PESA, and streamlining coordination among agencies can reduce administrative bottlenecks and create enabling environments for genuine community empowerment.

## 7. Threats to Traditional Ecological Knowledge and Conservation Implications

### 7.1 Socio-Economic Transformation and Knowledge Erosion

Santhal TEK is facing pressure from big social and economic changes. Urbanization, migration, new education systems, and modern jobs are changing how knowledge is learned and used.

Migration and urban jobs mean young people spend less time with elders, so traditional knowledge is not passed on properly (Gautam, 2019). Schools also focus more on formal subjects and ignore traditional ways of learning, which reduces interest in Santhal ecological knowledge. Modern farming tools, factory work, and markets reduce dependence on forests and natural resources, making traditional skills less useful.

Language loss is also a serious threat. Since Santhali carries unique words and ideas, its decline makes knowledge weaker. Cultural shifts such as conversion, modernization, or political changes reduce the value of old beliefs and weaken the base on which this knowledge survives.

### 7.2 Environmental Degradation and Habitat Loss

Environmental damage directly threatens TEK because it removes the natural base where this knowledge works.

Deforestation destroys forests needed for sacred groves, medicinal plants, and livelihoods. Changing land for commercial farming or towns reduces ecological diversity and limits traditional practices. Water pollution and overuse disturb farming and rituals that depend on clean water.

Climate change shifts rainfall, temperature, and seasons, so traditional calendars and farming cycles no longer match. Invasive species also disturb local ecosystems and reduce the space for traditional practices.

### 7.3 Institutional and Policy Challenges

Policies and institutions often do not recognize or support TEK. Legal systems rarely protect indigenous knowledge rights, leaving it open to exploitation. Forest rules sometimes block traditional practices like controlled burning, making it hard to continue them.

Agricultural policies promote hybrid seeds and chemicals instead of traditional farming, so local knowledge is sidelined. Development projects such as mining or industry disturb the land and weaken traditional practices. Education policies also fail to include indigenous knowledge, which lowers its value in young people's eyes.

## 7.4 Strategies for Knowledge Preservation and Revitalization

Even with these threats, TEK can be preserved and renewed through careful steps.

Documentation projects can record elders' knowledge with respect to cultural rules. Education can mix modern learning with TEK so children learn both systems. Community festivals, ceremonies, and language programs can keep culture strong.

Participatory research with community members can validate their knowledge and support its use. Policy changes that recognize community rights can also help. Finally, applying TEK in conservation and development projects can show its continued value in solving today's environmental problems.

## 8. Integrated Conservation Strategies and Policy Recommendations

Developing conservation strategies with Santhal Traditional Ecological Knowledge (TEK) needs strong frameworks. TEK should be seen as valuable and dynamic knowledge. Indigenous decision-making must be respected. Free, prior, and informed consent, benefit-sharing, and protection of knowledge are essential. Communities should keep control over their knowledge. TEK should be documented with the help of community members as co-researchers. This includes ecological knowledge, management practices, governance, and cultural values. Traditional knowledge should be combined with scientific research to check its effectiveness. TEK holders should take part in decision-making through committees and advisory roles. Community-based conservation supports both biodiversity and livelihoods. Sacred groves protect habitats and should be included in formal planning. Community forest management can mix traditional governance with legal provisions, supported by training and technical help. Agroecological models promote traditional farming, seeds, biodiversity, and income. Integrated landscape management links multiple conservation strategies. Policy reforms should recognize TEK as intellectual property and ensure benefit-sharing. Laws like FRA and PESA should be strengthened with simple procedures and capacity building. TEK should be included in education, research, and community programs. Monitoring should combine traditional and scientific methods to track changes and improve management. Adaptive management should use these results in decisions with flexible and consultative processes. Evaluation should measure ecological, social, and cultural outcomes. Learning systems should document lessons, share knowledge, and spread successful practices.

## 9. Discussion and Synthesis

Santhal Traditional Ecological Knowledge (TEK) is highly relevant for global conservation. It shows patterns similar to other indigenous systems while offering unique insights. TEK covers sacred grove management, governance, and holistic practices that link culture and ecology. Biodiversity in Santhal-managed areas often exceeds that in formal protected areas. Sacred groves act as refuges for species and ecological processes. Santhal TEK shows how culture and conservation are connected, preserving both biodiversity and cultural identity. Communities are adaptive, with flexible knowledge, strong institutions, and diverse livelihoods, offering models for resilience and climate-adapted planning. Challenges include knowledge

loss, habitat degradation, and institutional barriers, highlighting the need to support and revitalize TEK. The Santhal example reinforces biocultural conservation, showing how spiritual beliefs, cultural practices, and institutions protect ecosystems. Their governance demonstrates effective management of common resources. Documenting TEK advances understanding of indigenous knowledge, integrating ecology, culture, and social systems. Conservation social science benefits by learning about barriers and opportunities for TEK integration. This study uses qualitative synthesis of existing research, but future participatory research is needed to validate findings. Practically, conservation strategies should integrate TEK with scientific methods. Protected area management, restoration ecology, and climate adaptation planning can all benefit. Conservation education should value TEK alongside science to support community engagement and intergenerational knowledge transfer.

## 10. Conclusion

This study of Santhal Traditional Ecological Knowledge (TEK) in Santhal Pargana highlights the sophisticated ways in which indigenous knowledge supports both cultural identity and ecological health. Santhal TEK spans sacred grove stewardship, medicinal plants, agroecology, livestock management, and customary governance, all contributing to effective biodiversity conservation. Sacred groves, in particular, act as refuges for species and ecological processes, demonstrating how cultural and spiritual values can support environmental protection. The conservation outcomes of Santhal practices align with global patterns showing indigenous-managed lands often perform as well or better than conventional protected areas, maintaining ecosystem services and supporting livelihoods. Legal frameworks like the Forest Rights Act and PESA offer opportunities for community-led conservation but face implementation challenges due to bureaucracy, limited capacity, and institutional conflicts. Socioeconomic changes, environmental degradation, and institutional barriers threaten Santhal TEK, yet initiatives such as documentation, education, policy reforms, and participatory approaches offer avenues for knowledge preservation and revitalization. The research contributes to conservation science by showing how cultural practices integrate with ecological outcomes, supporting biocultural and socio-ecological systems frameworks, and highlighting effective commons governance. Practically, integrating Santhal TEK into conservation planning, restoration, climate adaptation, and education can improve outcomes while respecting indigenous rights. Future research should involve participatory approaches, longitudinal studies, comparative analyses, and collaborative monitoring to better understand and apply TEK in conservation. Overall, Santhal TEK demonstrates that successful conservation depends on recognizing the link between cultural and biological diversity, empowering communities, and combining traditional and scientific knowledge to achieve sustainable and socially just environmental stewardship.

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