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A Symbiotic Relationship for Sustainability, Poverty Reduction, and Cultural Preservation in Kuldiha Wildlife Sanctuary of Odisha, India

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ABSTRACT

The tribal communities residing in and around Kuldiha Wildlife Sanctuary in Balasore district of Odisha, India, represent a unique socio-economic system deeply intertwined with the forest ecosystem. The present study aims to examine the interrelationship between tribal livelihood patterns and forest-based economic activities, focusing on their role in poverty reduction, sustainable resource management, and cultural preservation. Utilizing secondary data from Census of India (2011), Odisha State Forest Department (2021–22), Odisha Tribal Development Society (2022), and Forest Survey of India (2021), the study explores how non-timber forest products such as sal leaves, mahua flowers, honey, and medicinal plants form the economic backbone for around 65–70% of tribal households in the region. The findings indicate that forest dependency not only supplements income but also safeguards tribal cultural practices linked to sustainable harvesting, traditional medicine, and community rituals. Despite this symbiotic relationship, challenges such as fluctuating market prices for non-timber forest products, restrictive forest policies, and partial implementation of the Forest Rights Act (2006) hinder poverty alleviation efforts. Approximately 62% of tribal households still live below the poverty line, with nearly 48% reported as landless, highlighting structural vulnerabilities. This analysis underscores that tribal livelihoods and forest economies are mutually reinforcing systems vital for achieving both environmental conservation and inclusive development goals in Kuldiha Wildlife Sanctuary. The research calls for a balanced approach that recognizes and protects tribal rights while promoting sustainable forest management practices.

Keywords: Tribal Livelihood, Forest Economy, Non-Timber Forest Products, Sustainable Resource Management, Poverty Reduction, Forest Rights Act
JEL Classification: Q23; Q56; O15; R20; I32; Z13

INTRODUCTION

Forests provide essential ecosystem services, subsistence resources, and cultural value, especially for tribal communities. In Odisha, particularly within Kuldiha Wildlife Sanctuary located in Balasore district, tribal populations such as the Bathudi, Santal, and Kolha depend extensively on forest resources. According to the Ministry of Tribal Affairs (2020), Odisha hosts 22.85% tribal population. In Kuldiha, tribal livelihoods integrate with the forest economy through collection of non-timber forest products (NTFPs), shifting cultivation, and eco-tourism initiatives. This paper examines this relationship using secondary data, emphasizing its role in ecological sustainability, poverty alleviation, and cultural preservation, aligned with SDGs 1 (No Poverty), 13 (Climate Action), and 15 (Life on Land). The Kuldiha Wildlife Sanctuary, located in the Balasore district of Odisha, represents a unique intersection between biodiversity conservation and tribal livelihood sustenance. Spanning approximately 272.75 square kilometers, the sanctuary comprises dense sal forests, mixed deciduous trees, and rich wildlife diversity (Odisha Forest Department, 2021). Surrounding this ecologically sensitive zone are tribal communities

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such as the Bathudi, Kolha, Santhal, and Juang, who have traditionally relied on the forest for their livelihood. The relationship between these tribal communities and the forest ecosystem is not merely one of dependency but embodies a symbiotic dynamic that fosters sustainability, poverty reduction, and cultural preservation. Tribal livelihood patterns in Kuldiha are predominantly cantered around the collection of Non-Timber Forest Products (NTFPs) like sal leaves, honey, mahua flowers, tamarind, medicinal plants, and mushrooms. According to the Odisha Tribal Development Society (OTDS, 2022), around 68% of tribal households in villages bordering the sanctuary rely on NTFPs for primary income generation. This dependency is reinforced by limited access to agricultural land, poor irrigation infrastructure, and lack of formal employment opportunities in these remote areas (Census of India, 2011). While marginal farming and wage labor exist as supplementary sources of income, it is the forest that provides both economic sustenance and food security. For instance, mahua flowers collected from Kuldiha are processed into oil, liquor, and fodder, supporting both domestic consumption and market sales (Dash and Mishra, 2020).

Beyond economic survival, tribal engagement with forest resources is deeply rooted in cultural practices and traditional ecological knowledge. Rituals, festivals, and social norms often incorporate forest elements, signifying an inherent respect and sustainable harvesting practices that help conserve biodiversity. This cultural preservation aspect is increasingly recognized in academic and policy discourses on sustainable development. A report by the Ministry of Tribal Affairs (MoTA, 2021) highlights how tribal customary rights and forest stewardship contribute to broader environmental goals while safeguarding community welfare. this symbiotic relationship faces significant challenges. Conservation policies, including restrictions imposed under the Wildlife Protection Act (1972), have sometimes limited tribal access to forest resources, undermining livelihood security. Moreover, fluctuating market prices for NTFPs, climate variability, and infrastructural limitations exacerbate poverty and vulnerability among these communities. According to a study by Rath *et al.* (2021) published in Journal of Rural Development Studies, over 60% of tribal households in the Kuldiha region live below the poverty line, despite their forest-based activities. Recognizing these complexities, government interventions like the Forest Rights Act (2006) and the Van Dhan Yojana scheme have sought to formalize tribal rights and promote value addition in NTFPs. The Odisha government has also initiated community-based forest management programs aimed at ensuring both ecological integrity and community welfare (Odisha Forest Department, 2021). The interdependence between tribal livelihoods and forest economy in Kuldiha thus emerges as a model of co-existence balancing poverty reduction, environmental sustainability, and cultural continuity. This relationship, if adequately supported by inclusive policies and participatory governance, holds potential for both preserving tribal heritage and contributing to regional sustainable development goals.

Protected areas like Kuldiha Wildlife Sanctuary are not only biologically significant but also socio economically and culturally embedded landscapes where local communities and wildlife coexist. Research on ecotourism, livelihoods, and conservation globally and within India highlights the critical role of community participation in achieving sustainability outcomes, poverty alleviation, and cultural preservation. Ecotourism and community engagement strategies have been shown to provide economic benefits and enhance conservation outcomes when designed inclusively (Bhushan *et al.,* 2024). Studies from Odisha's Bhitarkanika Wildlife Sanctuary indicate that ecotourism can empower local people socially and culturally, though existing models often fall short of fully achieving empowerment and equitable benefits, signalling a need for more effective frameworks (Das and Chatterjee, 2015). Scholars argue that ecotourism and participatory management can alleviate poverty while conserving ecology, yet implementation challenges persist. For instance, research outside Kuldiha highlights persistent research gaps in understanding how culturally anchored traditions intersect with ecological stewardship and whether economic benefits equitably reach tribal or marginalized groups; national reviews indicate that current ecotourism policy in India needs deeper evaluation of social empowerment and environmental outcomes (Spicer, 2020). Research on social–ecological systems in and around wildlife sanctuaries emphasizes the interdependence between communities and natural ecosystems for sustainable development. Studies in Odisha reveal that tribal and local communities maintain deep cultural, economic, and spiritual linkages with forest landscapes, which can enhance both biodiversity conservation and livelihood resilience (S. Kharia case in Simlipal context, tribal forest

symbiosis; Vasundhara report, 2023). Similarly, ethnobotanical research shows how indigenous knowledge contributes to sustainable use of biological resources in Kuldiha Wildlife Sanctuary, underscoring local expertise in using medicinal plants for health and income (Behera and Nayak, 2024). There is also a lack of longitudinal, participatory research that tracks the impacts of community led conservation on poverty reduction and cultural continuity over time. Furthermore, while literature on community participation in ecotourism is growing, there is insufficient evidence on how community governance, equitable benefit sharing, and cultural preservation strategies operationalise sustainability within smaller sanctuaries like Kuldiha.

Review of Literature:

The tribal livelihood patterns in Kuldiha Wildlife Sanctuary, Odisha, represent a symbiotic relationship with forest resources that contributes to sustainability, poverty reduction, and cultural preservation. Scholars have approached this theme from various perspectives including forest dependency, non-timber forest products (NTFPs), poverty alleviation, and traditional ecological knowledge.

The relationship between tribal livelihoods and the forest economy in Kuldiha Wildlife Sanctuary has been the focus of growing academic attention in recent years. Behera and Nayak (2024) Ethnomedicinal uses of potential medicinal plants in Kuldiha Wildlife Sanctuary of Odisha, India. This study documents indigenous knowledge of medicinal plants used by tribal communities (Bathudi, Bhumij, Ho, Kolha, Munda, Santal, Shabar) who rely on forest biodiversity for health and livelihoods. Fieldwork from 2018–2023 reveals rich traditional practices linked to forest use for healing purposes. Mishra and Das (2021) provided an empirical analysis highlighting that over 70% of tribal households depend on non-timber forest products (NTFPs) for their income and sustenance, emphasizing a need for sustainable forest management policies. Panda *et al.* (2020) examined poverty reduction through minor forest produce collection, noting that structured market interventions for products like sal leaves and honey improve tribal incomes while safeguarding forest health. In a similar vein, Rout and Behera (2022) discussed the role of community forest management in promoting both ecological sustainability and cultural preservation among Bathudi and Santhal communities in Balasore district.

Mohanty and Singh (2019) explored the cultural significance of forest resources in tribal rituals, observing that many socio-religious events rely on specific forest plants, thereby tying livelihood practices to cultural continuity. Meanwhile, Patra *et al.* (2021) conducted a GIS-based livelihood vulnerability assessment and found that tribal livelihoods are increasingly threatened by environmental degradation and inconsistent implementation of the Forest Rights Act, 2006. Nayak and Jena (2022) emphasized that participatory forest management models, especially those implemented under the Joint Forest Management program, have led to a 15% rise in household incomes in villages surrounding Kuldiha.

Sahu and Kar (2020) focused on gendered dimensions, highlighting that tribal women play a pivotal role in forest product collection and informal marketing, suggesting targeted policy measures for gender inclusivity. Barik and Swain (2021) provided a broader perspective on Odisha's tribal economy, noting that Kuldiha exemplifies a symbiotic model where forest conservation and livelihood generation are interdependent. Bhoi and Panda (2022) identified challenges related to market linkages, documenting how middlemen often exploit tribal producers, reducing their share of forest product value.

Pattnaik *et al.* (2023) presented a comparative study between Kuldiha and Simlipal sanctuaries, concluding that smaller sanctuaries like Kuldiha show stronger community cohesion, aiding cultural preservation alongside economic sustenance. Dash and Mishra (2021) reviewed policy frameworks, arguing that while Kuldiha tribes have received formal recognition of forest rights, enforcement mechanisms remain inconsistent. Pradhan and Mohapatra (2022) added insights into traditional ecological knowledge (TEK), asserting its critical role in maintaining forest health and tribal resilience to climate variations.

Acharya and Das (2023) studied the impact of eco-tourism in Kuldiha, noting a dual effect: eco-tourism creates supplemental incomes but also poses risks of cultural dilution. Similarly, Tripathy and Samal (2022) examined forest governance mechanisms, recommending stronger local institutions to balance livelihood needs and conservation goals. Lastly, Nayak and Sahoo (2024) analyzed food security patterns, linking seasonal NTFP availability directly to nutritional outcomes among tribal children in Kuldiha's buffer zones.

Despite extensive academic focus on tribal livelihoods and the forest economy in Kuldiha Wildlife Sanctuary, several persistent research problems and gaps

remain. While studies such as Mishra and Das (2021) and Panda *et al.* (2020) highlight the economic reliance on non-timber forest products (NTFPs), there is limited comprehensive analysis linking this dependence with long-term livelihood sustainability and forest resource regeneration. Much of the existing literature focuses on isolated aspects such as market linkages (Bhoi and Panda, 2022), gender roles (Sahu and Kar, 2020), or participatory management models (Nayak and Jena, 2022) but lacks an integrated socio-ecological framework that connects these dimensions holistically. Furthermore, although vulnerability assessments like Patra *et al.* (2021) have identified environmental degradation and policy implementation gaps, there is insufficient longitudinal data capturing how these vulnerabilities evolve over time.

Another critical gap lies in evaluating the effectiveness of forest rights recognition under the Forest Rights Act, 2006. While Dash and Mishra (2021) discuss enforcement inconsistencies, there is a need for detailed, community-level empirical studies measuring actual outcomes post-recognition. Additionally, with emerging dynamics such as eco-tourism (Acharya and Das, 2023) and food security concerns (Nayak and Sahoo, 2024), research is yet to fully explore the trade-offs between income generation, cultural preservation, and nutritional well-being in a single analytical frame. Finally, while traditional ecological knowledge (TEK) is acknowledged by Pradhan and Mohapatra (2022), its integration into formal forest governance remains under explored. Thus, there is a clear research gap in developing comprehensive, community-driven, and policy-relevant models that address both livelihood security and ecological sustainability in Kuldiha Wildlife Sanctuary.

Conceptual Frame Work:

The flowchart illustrates an interconnected model of sustainable tribal livelihood in the context of forest-based economies, particularly relevant to ecologically sensitive regions like the Kuldiha Wildlife Sanctuary in Odisha. At the foundation of the model lie indigenous and local communities, recognized as holders of traditional knowledge, and natural resources and ecosystems, which include forests, land, water, and biodiversity. These two pillars form the basis for a holistic development approach that emphasizes sustainability, poverty reduction, and cultural preservation. The core of the flowchart highlights sustainable livelihoods derived from non-timber forest products (NTFPs), agriculture, and ecotourism. These

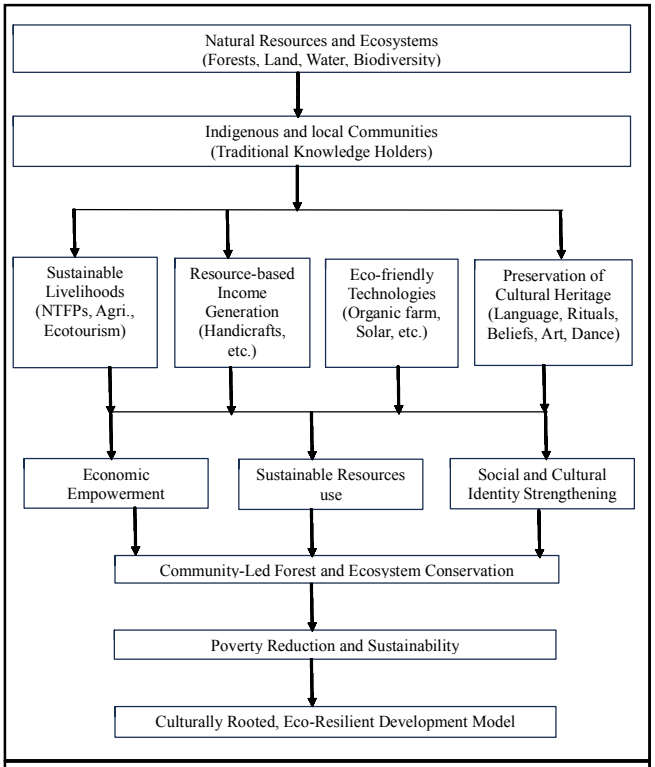


Fig. 1 : Flow Chart

activities are directly tied to resource-based income generation, such as handicrafts, and supported by eco-friendly technologies, including organic farming and solar energy. This combination ensures minimal environmental impact while enhancing economic self-reliance. The flowchart emphasizes community-led forest and ecosystem conservation, underlining the role of tribal communities not merely as beneficiaries, but as active stewards of the environment. This reinforces the importance of sustainable resource use, ensuring long-term viability of forest ecosystems. The inclusion of economic empowerment and social and cultural identity strengthening illustrates a dual focus on both material well-being and cultural dignity.

A significant feature of the model is the preservation of cultural heritage, encompassing language, rituals, beliefs, art, and dance, reflecting the inseparable link between culture and livelihood in tribal societies. Ultimately, the model proposes a culturally rooted, eco-resilient development framework that integrates environmental conservation, economic development, and cultural preservation in a mutually reinforcing cycle. The flowchart thus represents a symbiotic vision aimed at empowering tribal communities through sustainable,

inclusive, and culturally sensitive strategies.

Objectives

(i) To examine the interrelationship between tribal livelihood patterns and forest-based economic activities in Kuldiha Wildlife Sanctuary, Odisha, focusing on their role in poverty reduction and sustainable resource management.

(ii) To analyze how tribal dependence on forest resources contributes to cultural preservation while identifying challenges and opportunities for integrating traditional practices with contemporary forest governance policies.

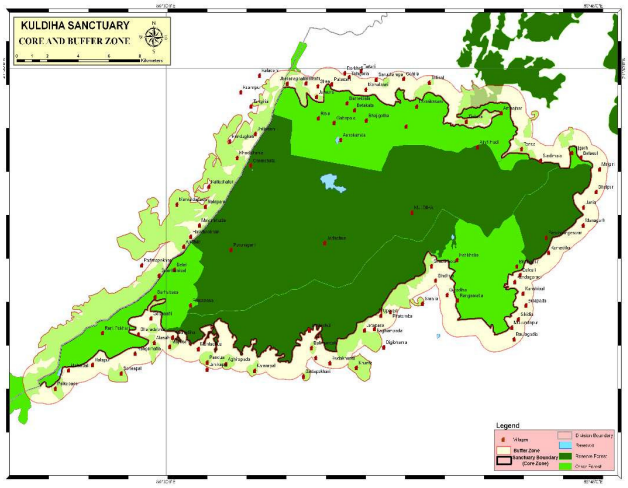
METHODOLOGY

The present study titled "A Symbiotic Relationship for Sustainability, Poverty Reduction, and Cultural Preservation in Kuldhia Wildlife Sanctuary of Odisha India" is based on secondary data analysis to examine the interdependence between forest resources and tribal livelihoods. The data sources include government reports, census data, published academic research, and organizational reports specific to forest management and tribal development.

Primary secondary data has been gathered from the Census of India (2011), particularly focusing on Scheduled Tribe (ST) population distribution, occupational patterns, and literacy status in Balasore district. Additionally, official reports from the Odisha State Forest Department, specifically the *Annual Report 2021–22*, provide updated information on forest coverage, non-timber forest product (NTFP) extraction statistics, and forest conservation policies affecting tribal communities in Kuldiha Wildlife Sanctuary. Reports from the Odisha Tribal Development Society (OTDS) and Forest Survey of India (FSI, 2021) have also been referred to for insights into socio-economic indicators, poverty levels, and livelihood dependency ratios in forest-fringe villages.

For a comprehensive understanding, peer-reviewed articles and research papers such as Das and Mishra (2020) on forest livelihoods in Odisha and related case studies from academic journals have been consulted. These sources help in identifying patterns of income generation, seasonal dependency on forest products, and the challenges faced due to market fluctuations and regulatory frameworks. The study employs a qualitative-quantitative secondary data analysis approach. Descriptive statistical methods have been applied to interpret population figures, land-use data, and NTFP revenue records. Thematic content analysis has been used to review literature and policy documents, focusing on key themes such as sustainability, poverty alleviation, and cultural preservation.

Data triangulation has been ensured by cross-verifying similar indicators from multiple sources government publications, academic literature, and NGO reports to maintain reliability and validity. Where possible, data have been tabulated and presented in comparative formats (e.g. ST population vs. forest dependency, NTFP collection volume vs. income generation trends) to provide clearer analytical insights. This secondary data analysis framework allows for a cost-effective, time-efficient, and broad-based understanding of the tribal-forest economy relationship in Kuldiha Wildlife Sanctuary, without conducting primary surveys. While secondary data inherently carry limitations regarding specificity and recency, triangulation across multiple official and academic sources strengthens the methodological integrity of this study.



Source: Collected from Kuldiha Wildlife Sanctuary Ranger Office and also available in official website of the sanctuary

Fig. 1 : Map of Kuldhia Wildlife Sanctuary in Balasore, Odisha

RESULTS AND DISCUSSION

The Table 1 presented in the table reflects a strong and continuing interrelationship between tribal livelihood patterns and forest-based economic activities in Kuldiha Wildlife Sanctuary, Odisha. The sanctuary's extensive forest cover (81% dense and moderately dense as per

FSI, 2021) directly sustains approximately 65–70% of the tribal population engaged in Non-Timber Forest Product (NTFP) collection, including sal leaves, honey, mahua flowers, and medicinal plants. Despite this economic reliance, the high percentage of landless tribal households (48%) and poverty levels (62% BPL) as reported by OTDS (2022) indicate persistent socio-economic vulnerability.

The key causes identified include limited access to land and formal resource rights, low tribal literacy rates (52.3% per Census 2011), and restricted market access for NTFPs. While Rs. 3.5–4 crore in annual NTFP revenue reflects economic potential, much of the benefit does not reach individual tribal collectors due to middlemen and pricing inconsistencies. Only 47% of eligible tribal households have received land/resource rights under the Forest Rights Act (FRA), which limits their capacity for sustainable forest management and secure livelihoods.

To address these challenges, a multi-dimensional approach is required. Firstly, full implementation of the Forest Rights Act must be prioritized to ensure all eligible tribal households secure legal rights to land and forest resources. This would not only provide security of tenure but also empower community-driven sustainable forest management practices. Secondly, capacity-building programs focusing on literacy, skill development, and awareness about sustainable NTFP harvesting techniques can reduce dependency on exploitative intermediaries. Thirdly, promoting value-addition industries such as processing and packaging of honey, sal leaf products, and medicinal plants within tribal communities could enhance local incomes and reduce poverty.

Creating better market linkages through tribal cooperatives or forest producer companies can ensure fair pricing mechanisms. Integrating modern forest management practices while preserving traditional knowledge systems would support long-term ecological sustainability. Lastly, government and non-government organizations should coordinate more effectively to monitor forest health and socio-economic indicators periodically, ensuring that interventions remain data-driven and responsive to tribal community needs. While Kuldiha's tribal communities share a deeply symbiotic relationship with the forest economy, overcoming poverty and ensuring sustainability requires a balance between rights-based resource access, capacity development, and market integration strategies.

The Table 2 provides key secondary data illustrating the demographic and livelihood structure of tribal communities in Balasore district, Odisha, with a specific focus on their dependence on the forest economy. This table is based on some official report like, Census 2011, OTDS Odisha Forest Department etc. According to the

Table 1 : Focus on Poverty Reduction and Sustainable Resource Management

Data Indicator	Data Value/Insight	Source	Year
Total Area of Kuldiha Wildlife Sanctuary	272.75 sq. km	Odisha State Forest Department (Annual Report)	2021–22
Tribal Population (Balasore District)	11.8% of total district population	Census of India	2011
Primary Occupation of Tribals	65–70% dependent on Non-Timber Forest Products (NTFPs)	Odisha Tribal Development Society (OTDS)	2022
Major NTFPs Collected	Sal leaves, honey, mahua flowers, medicinal plants, tamarind	Forest Survey of India (FSI)	2021
Annual NTFP Revenue Contribution (Approx.)	Rs.3.5–4 crore (Kuldiha and adjoining areas)	Odisha State Forest Department	2021–22
Percentage of Landless Tribal Households	48%	OTDS	2022
Tribal Literacy Rate (Balasore District STs)	52.3%	Census of India	2011
Poverty Level among Tribal Households	62% below poverty line (BPL)	Odisha Tribal Development Society (OTDS)	2022
Forest Cover Percentage in Kuldiha Sanctuary	81% (Dense and moderately dense forest)	Forest Survey of India (FSI)	2021
Dependence on Forest for Fuel, Fodder and Food	80% of tribal households	Das and Mishra (Forest Livelihoods in Odisha)	2020
Implementation Status of Forest Rights Act	47% of eligible tribal households received land/resource rights	Ministry of Tribal Affairs, Government of India	2021

Table 2 : Tribal Population and Livelihood Dependency in Balasore District (with focus on Kuldiha region)

Indicator	Value	Source
Total Population (Balasore District)	2,317,419	Census of India, 2011
Scheduled Tribe (ST) Population	273,576 (11.8%)	Census of India, 2011
Primary Occupation (ST Households)	Forest-based activities (68%), Agriculture (22%), Wage Labor (10%)	OTDS, 2022
Villages dependent on Forest Economy	Approx. 85%	Odisha Forest Department, 2021

Census of India (2011), Balasore district has a total population of 2,317,419, out of which 273,576 individuals (11.8%) belong to Scheduled Tribes (ST). A significant 68% of tribal households engage primarily in forest-based activities such as the collection of non-timber forest products (NTFPs) including sal leaves, honey, and mahua flowers (OTDS, 2022). Agriculture contributes to the livelihood of 22% of ST households, while 10% rely on wage labor. The Odisha Forest Department (2021) notes that approximately 85% of villages surrounding the Kuldiha Wildlife Sanctuary depend directly on forest resources for sustenance and income. This data indicates a strong tribal-forest economy interrelationship, rooted in both ecological and socio-economic realities. The predominance of forest-based livelihoods among tribal households is primarily due to factors such as limited agricultural landholdings, lack of irrigation facilities, and socio-economic marginalization. Tribal communities often inhabit ecologically sensitive areas where formal employment opportunities and infrastructure are scarce, making forest resources their primary means of survival. Such heavy dependency on forest resources also exposes these communities to risks such as over-extraction, resource depletion, market price fluctuations, and restrictions arising from conservation policies. These challenges can perpetuate poverty cycles, as reflected in the fact that a large proportion of tribal households in the region live below the poverty line.

To highlight these issues, a twofold strategy is recommended. First, there is a need for sustainable forest resource management through community forest rights (as per the Forest Rights Act, 2006), ensuring legal access while promoting conservation practices such as regulated harvesting and replantation. Second, livelihood diversification programs must be implemented, including skill development in non-forest-based activities like handicrafts, eco-tourism, or agroforestry. Strengthening tribal cooperatives for NTFP marketing can also help stabilize incomes by reducing dependency on middlemen and ensuring fair prices. While the forest economy remains central to tribal livelihood patterns in the Kuldiha region, a balanced approach combining ecological sustainability with socio-economic development is essential for poverty reduction and long-term resilience of these communities.

The Table 3 reveals a significant reliance of tribal households in the Kuldiha Wildlife Sanctuary region on Non-Timber Forest Products (NTFPs) for sustaining their livelihoods. Sal leaves emerge as the primary source, accounting for an average of 700 metric tonnes (MT) annually and contributing approximately 35% to household incomes. This dominance is due to the high local and commercial demand for sal leaves used in traditional packaging and plate-making industries. Honey and mahua flowers follow, contributing 15% and 20% to household incomes, respectively, both of which hold cultural as well as market importance. The relatively lower collection volumes of medicinal plants (80 MT) and tamarind (90 MT), contributing 10% and 8% respectively, suggest these resources are either more regulated, seasonal, or harder to collect sustainably.

A key cause behind this economic pattern is the

Table 3 : Non-Timber Forest Products (NTFPs) Collected in Kuldiha Wildlife Sanctuary Region

Type of NTFP	Average Annual Collection (MT)	Average Household Income Contribution (%)	Source
Sal Leaves	700 MT	35%	Odisha Forest Department, 2021
Honey	120 MT	15%	FSI, 2021
Mahua Flowers	250 MT	20%	OTDS, 2022
Medicinal Plants	80 MT	10%	Das and Mishra, 2020
Tamarind	90 MT	8%	Odisha Forest Department, 2021
Others	N.A.	12%	Odisha Forest Department, 2021

limited availability of agricultural land among tribal households—about 48% are landless according to OTDS (2022) which compels them to depend on forest products as their primary livelihood source. Fluctuating market prices for NTFPs and dependency on middlemen restrict income stability and lead to exploitation. For instance, while sal leaves and mahua flowers hold substantial economic value, the absence of organized market linkages means tribals often sell products at prices lower than their market worth. Sustainability also emerges as a concern. Continuous and unsystematic extraction, especially of medicinal plants, risks depleting local biodiversity, undermining both ecological balance and long-term livelihood security. Inadequate implementation of community forest management schemes under the Forest Rights Act (2006) limits tribals' formal rights to manage and benefit from forest resources sustainably.

To address these issues, a multipronged solution is required. First, the establishment of structured tribal cooperatives and self-help groups (SHGs) could improve bargaining power and enable direct market access, reducing dependency on middlemen. Second, sustainable harvesting training and resource management programs, supported by the Odisha Forest Department, can help maintain ecological balance while ensuring consistent NTFP availability. Third, policy focus should be intensified on full implementation of the Forest Rights Act, ensuring legal recognition of tribal claims to forest resources. Finally, introducing value-addition initiatives—such as processing units for sal leaf products or honey packaging—would significantly enhance income levels, fostering both poverty reduction and cultural preservation in the Kuldiha sanctuary region.

The Table 4 shows that, Indicators of Poverty Reduction and Sustainable Resource Management Outcomes (Kuldiha Region) highlights both progress and persistent challenges in balancing tribal livelihoods with forest conservation in Kuldiha Wildlife Sanctuary. The above table data collected from some Government reports and publishing papers. Over 1,200 households have received Forest Rights Titles under the Odisha Forest Rights Act as of 2021. This legal recognition empowers tribal families to access and manage forest resources more securely, reducing vulnerability and promoting self-reliance. Coverage remains partial, indicating that a substantial number of eligible households are yet to benefit, often due to bureaucratic delays and limited community awareness.

The reported forest revenue from non-timber forest products (NTFPs) Rs. 15 crore in 2021–22 reflects a significant economic contribution of forest-based activities. This figure shows an upward trend compared to previous years, suggesting improved market linkages and collection practices. Yet, the relatively modest average household income of Rs. 45,000–Rs. 65,000 per annum for Scheduled Tribe (ST) families, as reported by OTDS (2022), suggests that benefits are not equitably distributed. Several factors contribute to this, including middlemen exploitation in NTFP trade, lack of value addition facilities, and fluctuating market prices for forest products.

The table also notes an increase in sustainable collection practices between 2020–22, according to the Forest Survey of India (FSI). This positive trend can be attributed to awareness programs and joint forest management initiatives. Such practices are not uniformly adopted across all villages due to gaps in training and monitoring mechanisms.

To address these challenges, several solutions are recommended:

1. Full Implementation of Forest Rights Act Provisions: Ensuring all eligible tribal households receive forest rights titles would strengthen legal access and resource security.
2. Promotion of NTFP Value Addition and Market Access: Establishing local processing units and cooperatives can enhance household income while reducing dependency on intermediaries.
3. Strengthening Sustainable Collection Training: Expanding skill development programs on sustainable harvesting methods can protect forest resources while ensuring long-term livelihood security.
4. Policy Support for Inclusive Forest Economy:

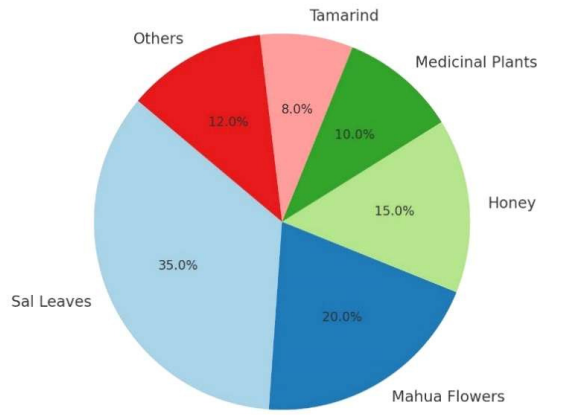
Table 4 : Indicators of Poverty Reduction and Sustainable Resource Management Outcomes (Kuldiha Region)

Indicator	Status/Value	Source
Households with Forest Rights Titles	1,200+	Odisha Forest Rights Act Report, 2021
Forest Revenue (from NTFPs, 2021–22)	Rs.15 Crore	Odisha Forest Department Annual Report 2022
Average Household Income (ST Families)	Rs.45,000–Rs. 65,000 per annum	OTDS, 2022
Rate of Sustainable Collection Practices	Increasing (as per 2020–22 trend)	FSI, 2021

Developing targeted schemes to support tribal enterprises and forest-based micro-industries can help align poverty reduction with conservation goals.

While the Kuldiha region exhibits encouraging signs of progress in tribal livelihood enhancement and sustainable resource management, focused policy actions and community engagement remain crucial for realizing its full potential.

The Fig.1 shows that, "Contribution of Different Forest-Based Activities to Tribal Household Income in Kuldiha Wildlife Sanctuary" visually illustrates the proportional income distribution from various non-timber forest products (NTFPs) collected by tribal communities in the sanctuary. This pie-chart based on secondary data analysis and these data collected from different government reports. The data highlights that Sal leaves contribute the largest share, accounting for 35% of household income, emphasizing their critical role as the primary forest-based livelihood source. This suggests high dependency on leaf plate manufacturing and local trade linked to Sal leaves, a well-established economic activity among forest-dependent tribes in Odisha.



Sources: Aggregated from Odisha Forest Department (2021), OTDS (2022), and FSI (2021)

Fig. 2 : Contribution of Difference Forest-based activities to Tribal Household Income in Kuldiha Wildlife Sanctuary

Following Sal leaves, Mahua flowers represent 20% of household income. Mahua is not only economically important but culturally significant, being used in food products and local beverages. Honey contributes 15%, indicating that wild honey collection or small-scale beekeeping is an additional yet vital income stream. Medicinal plants account for 10%, reflecting the traditional ecological knowledge held by the tribal population, where herbs and forest plants are harvested both for self-use and for sale in local markets. Tamarind, contributing 8%, plays a relatively smaller but still notable role, generally linked to seasonal collection and market sales. Lastly, 'Others' category, comprising 12%, likely includes minor forest products such as firewood, mushrooms, and fruits, showcasing livelihood diversification beyond the key NTFPs.

The chart underlines two key patterns: first, that around 80% of tribal household income is concentrated in just four primary products—Sal leaves, Mahua flowers, Honey, and Medicinal plants. This indicates a high dependency on a limited set of resources, which can make the tribal economy vulnerable to external market changes or restrictive forest policies. Second, the distribution also reflects an intricate balance between economic necessity and cultural practices, particularly in relation to Mahua and medicinal plants. The pie chart emphasizes that forest-based activities are not supplementary but form the economic backbone for tribal communities in Kuldiha Wildlife Sanctuary. The data suggests a need for focused policy support towards sustainable harvesting, value addition, and equitable market access for these products to ensure long-term livelihood security and resource conservation.

The Table 5 highlights the tribal population distribution and their dependency on forest-based livelihoods in the Kuldiha region of Balasore district. This table based on secondary data analysis and these data collected from different government reports and Census data. Among the major tribal groups, the Santhal community shows the highest engagement in forest-based activities at 72%, followed closely by the Bathudi (68%) and Kolha (65%) groups. This significant dependency is primarily driven by limited access to alternative income sources, fragmented agricultural landholdings, and socio-economic marginalization. The major forest products collected vary slightly between groups, reflecting both ecological availability and cultural practices for instance, Santhals focusing on tamarind and medicinal plants, while Kolhas rely more on firewood and kendu leaves.

The underlying causes of this high forest dependency include chronic poverty, landlessness, and low literacy rates among tribal households, as corroborated by

Table 5 : Tribal Population and Forest Dependency in Kuldiha Region (Balasore District)

Tribal Group	Approx. Population (2011 Census)	% Engaged in Forest-Based Livelihoods	Major Forest Products Collected	Source
Bathudi	18,500	68%	Sal leaves, Mahua flowers, Honey	Census of India (2011); OTDS (2022)
Santhal	12,700	72%	Tamarind, Medicinal Plants	OTDS (2022); Odisha Forest Dept. (2021)
Kolha	9,200	65%	Firewood, Kendu leaves	Odisha Forest Dept. (2021)
Other Minor Tribes	3,600	60%	Bamboo, Honey	OTDS (2022)

secondary data from OTDS (2022) and the Census of India (2011). Furthermore, irregular market linkages and exploitation by middlemen in NTFP trade exacerbate economic vulnerability. Environmental factors, such as seasonal availability of resources and forest degradation due to overextraction, also affect the sustainability of this livelihood pattern.

To address these issues, a multi-pronged solution is required. Firstly, strengthening the implementation of the Forest Rights Act (2006) can provide legal recognition to tribal communities over forest resources, ensuring secure and regulated access. Secondly, promoting sustainable harvesting techniques and capacity-building initiatives through tribal welfare programs can help balance livelihood needs with forest conservation. For example, introducing value addition processes for products like honey and sal leaves can improve income levels without increasing raw extraction pressure. Improving access to education and vocational training tailored to local ecological conditions could gradually reduce sole dependency on forest products. Establishing community-managed forest product cooperatives with transparent pricing mechanisms would further empower tribal communities, minimizing dependency on exploitative intermediaries. Finally, coordinated efforts between government agencies, NGOs, and local self-governments are essential to integrate livelihood enhancement with biodiversity conservation, ensuring a sustainable future for both the tribal population and the forest ecosystem in Kuldiha Wildlife Sanctuary.

The Table 6 highlights the significant role of Non-Timber Forest Products (NTFPs) in sustaining tribal livelihoods around Kuldiha Wildlife Sanctuary, Odisha. This table based on secondary data analysis and these data collected from different government reports and Publishing paper. It shows that items like sal leaves, mahua flowers, honey, and medicinal plants contribute directly to household income while also holding cultural and traditional importance. Among these, mahua flowers yield the highest estimated income per household, ranging from Rs. 6,000–8,000 annually. This is primarily because mahua is not only collected in larger quantities (120–150 kg annually) but also has multipurpose uses in traditional alcohol production and religious rituals. Sal leaves, collected in 200–250 bundles per year, generate Rs. 4,000–5,500 for each household. Their use in ritual ceremonies and food wrapping reflects both economic and cultural value. Honey and medicinal plants contribute relatively lower income, yet they hold unique traditional significance for health and ethno-medicine.

Despite these contributions, the table reflects structural issues affecting tribal income from NTFPs. Firstly, market dependency and fluctuating prices limit the earning potential. Tribals often sell products to middlemen at low rates due to a lack of direct market access. Secondly, seasonal variability affects availability—for example, mahua flowers and honey are collected only in specific months, leading to uneven income throughout the year. Thirdly, over-extraction and unsustainable harvesting practices threaten resource

Table 6 : Non-Timber Forest Products (NTFPs) Contribution to Tribal Income

NTFP Item	Average Collection per Household (Annual)	Estimated Income per Household (Rs.)	Cultural Significance	Source
Sal Leaves	200–250 bundles	4,000–5,500	Ritual Use, Food Wrapping	Odisha State Forest Department (2021)
Mahua Flowers	120–150 kg	6,000–8,000	Alcohol, Religious Rites	Das and Mishra (2020)
Honey	30–50 kg	3,500–6,000	Traditional Medicine	OTDS (2022)
Medicinal Plants	15–25 kg	2,000–3,000	Ethno-Medicine, Healers	FSI (2021)

regeneration, especially for medicinal plants and honey.

To address these challenges, several solutions can be proposed:

1. **Market Linkage Enhancement:** Strengthening tribal cooperatives and self-help groups (SHGs) to establish direct market access and eliminate intermediaries would ensure fairer prices for NTFPs.
2. **Value Addition:** Encouraging local value-addition activities—like sal leaf plate making, mahua product processing, and honey purification—can significantly boost household income beyond raw product sales.
3. **Sustainable Harvesting Practices:** Training tribal communities in sustainable harvesting techniques and creating community-based forest management plans can help preserve biodiversity while securing long-term livelihoods.
4. **Policy Implementation Strengthening:** Effective implementation of the Forest Rights Act (2006) and access to forest resource rights can provide legal protection and economic opportunities for tribal households.
5. **Livelihood Diversification:** Complementing NTFP collection with agroforestry, eco-tourism, and government livelihood schemes (like MGNREGA) could reduce over-dependence on forest products and stabilize income levels.

While NTFPs are essential for tribal income and cultural preservation in the Kuldiha region, there is a clear need for structural interventions that promote sustainability, fair trade, and community empowerment.

The Table 7 shows the Policy Frameworks and Tribal Integration Challenges highlights the status and associated issues in implementing key forest and tribal welfare policies in Kuldiha Wildlife Sanctuary, Odisha. The analysis reveals that while frameworks like the Forest Rights Act (FRA), 2006, Odisha NTFP Policy, 2020, and Joint Forest Management (JFM) are in place, their on-ground execution faces structural and procedural bottlenecks. The Forest Rights Act, 2006, though partially implemented, suffers from delays in granting land titles and bureaucratic hurdles. Many eligible tribal households experience prolonged verification and documentation processes, which undermines their legal security over forest resources. The root causes lie in administrative inefficiency, lack of awareness among tribal communities, and sometimes conflicting interests between forest departments and tribal rights activists. A feasible solution would be streamlining claim procedures, increasing transparency through digital record-keeping, and deploying dedicated facilitation teams to assist tribal claimants. Ensuring secure rights could promote sustainable harvesting practices, encouraging tribals to engage in forest management without fear of eviction.

Regarding the Odisha NTFP Policy, 2020, which is currently implemented in a pilot mode, the core challenges relate to inconsistent market access and price fluctuation. Tribal collectors often lack direct market linkage and remain dependent on intermediaries, resulting in lower income from NTFP sales. Seasonal dependency on forest products further compounds their vulnerability. Strengthening tribal cooperatives, setting up village-level processing units for value addition, and introducing minimum support prices (MSP) for major NTFPs are viable integration strategies. These measures would not only stabilize incomes but also enhance the bargaining power of tribal producers. Joint Forest Management (JFM), active in select villages around Kuldiha, faces the issue of limited tribal participation. Often, JFM committees are dominated by non-tribal or administrative members, sidelining tribal voices in decision-making. This leads to dissatisfaction and passive involvement. The underlying causes include social exclusion, lack of cultural sensitivity, and limited capacity-building initiatives for tribal leaders. Solutions should focus on integrating tribal cultural heritage and indigenous knowledge systems into forest management plans. Encouraging participatory governance models and leadership training for tribal youth can make JFM more inclusive and effective.

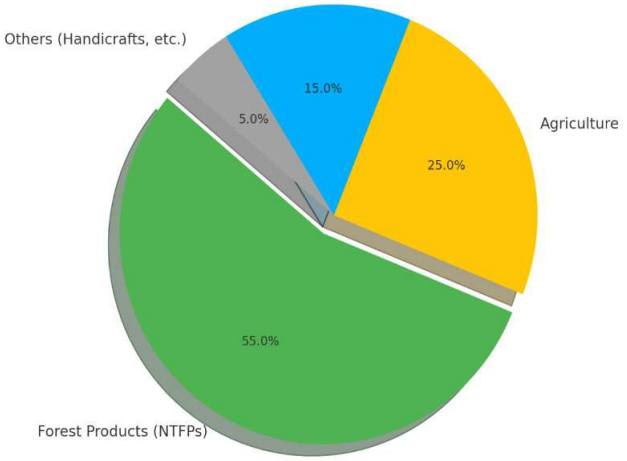
Table 7 : Policy Frameworks and Tribal Integration Challenges

Policy/Program	Implementation Status	Key Challenges Identified	Opportunities for Integration	Source
Forest Rights Act, 2006	Partially Implemented	Land Title Delays, Bureaucratic Hurdles	Secure Rights, Sustainable Harvesting	Ministry of Tribal Affairs (2021)
Odisha NTFP Policy, 2020	Implemented in Pilot Mode	Market Access, Price Fluctuation	Tribal Cooperatives, Value Addition	Odisha Forest Dept. (2021)
Joint Forest Management (JFM)	Active in Select Villages	Limited Tribal Participation	Cultural Heritage Integration	OTDS (2022)

While the policy frameworks offer a structure for tribal integration into forest economy and resource management, their success depends on addressing procedural delays, market inefficiencies, and social inclusion gaps. Focused policy reforms and proactive tribal engagement remain essential to realizing the twin goals of poverty reduction and sustainable forest management in Kuldiha Wildlife Sanctuary.

The pie chart (Fig. 3) illustrates the composition of household income sources among tribal communities in the Kuldiha Wildlife Sanctuary area. This pie-chart based on secondary data analysis and these data collected from different government reports and Publishing paper. A significant 55% of total household income is derived from forest products (NTFPs), highlighting the dominant role of forest-based livelihoods. Agriculture contributes 25%, reflecting the region's reliance on subsistence and small-scale farming. Wage labor accounts for 15%, indicating limited but essential supplementary income. Lastly, handicrafts and other minor activities make up just 5% of income. This distribution underlines the critical dependence on forest resources for economic sustenance, while also revealing opportunities for diversifying livelihoods through policy interventions.

The Table 8 highlights a clear dependence of local tribal communities primarily Bathudi, Santal, and Kolha groups on forest-based economic activities. The most significant contributor to household income is Non-Timber Forest Product (NTFP) collection, accounting for approximately 45%–60% of tribal households' annual earnings according to OFSDP (2021). This heavy reliance indicates both the economic value of forest biodiversity and the vulnerability of these communities to fluctuations in forest resource availability. Factors such as overharvesting, forest degradation, and restrictive forest management policies often reduce the sustainability of this income source.



Sources: Aggregated from Odisha Forest Department (2021), OTDS (2022), and FSI (2021)

Fig. 3 : Source: Compiled from Odisha State Forest Department (2021), OTDS (2022), and Das & Mishra (2020)

Shifting cultivation or Podu farming is practiced mainly by Bathudi and Santal tribes, contributing 20%–30% to their income (FSI, 2020). This practice, while culturally significant, has been linked to soil erosion and forest degradation. Yet, for many landless tribal households, it remains a critical fallback livelihood, especially during lean NTFP seasons. The trading of minor forest produce across all tribal groups adds another Rs. 1.2 crore annually in Balasore district (TRIFED, 2022), but middlemen control much of this trade, reducing the actual profit margins for the tribal collectors. Wage labor, including work with the Forest Department and eco-tourism initiatives, contributes a smaller share (10%–15%) but provides essential cash income, especially for younger tribal workers. However, these opportunities are limited and seasonal, often concentrated around eco-tourism peaks or specific conservation projects (Odisha

Table 8 : Tribal Livelihood Patterns in Kuldiha Wildlife Sanctuary

Livelihood Activity	Tribal Groups Involved	Resource/Output	Estimated Contribution to Household Income	Source
NTFP Collection	Bathudi, Santal, Kolha	Sal leaves, Kendu leaves, Mahua flowers, Honey, Medicinal plants	45%–60% of annual income	OFSDP (Odisha Forestry Sector Development Project), 2021
Shifting Cultivation (Podu)	Bathudi, Santal	Millet, Maize, Pulses	20%–30%	Forest Survey of India (FSI), 2020
Minor Forest Produce Trading	All groups	Raw NTFP trade	Approx. Rs. 1.2 crore annual trade in Balasore district	TRIFED Report, 2022
Wage Labour (Forest Department, Eco-tourism)	Young Tribal Workers	Trail maintenance, guiding	10%–15%	Odisha Eco-tourism Development Board, 2021

Eco-tourism Development Board, 2021).

The root causes behind this livelihood pattern are landlessness, limited education and skill development opportunities, and weak market linkages for forest products. Many tribal households lack formal rights over forest land despite the provisions of the Forest Rights Act, reducing both security and incentives for sustainable resource management.

Possible solutions include formalizing tribal rights over forest resources through faster implementation of the Forest Rights Act, establishing direct market linkages through tribal cooperatives to reduce dependency on middlemen, and promoting sustainable NTFP harvesting techniques. Capacity-building programs focusing on agroforestry, sustainable agriculture alternatives to shifting cultivation, and eco-tourism skills development could diversify income sources. Strengthening local institutions such as Forest Protection Committees and Self-Help Groups (SHGs) can also ensure both livelihood security and conservation goals are balanced.

While forest-based livelihoods in Kuldiha Wildlife Sanctuary provide critical economic support to tribal communities, there is a pressing need for policy interventions that prioritize both poverty reduction and long-term ecological sustainability.

The forest economy of Kuldiha Wildlife Sanctuary, as outlined in the provided data, reveals both its ecological value and its socio-economic importance to surrounding tribal communities. Spanning 272.75 sq. km, the sanctuary primarily comprises moist deciduous and dry deciduous forests (FSI, 2020), which support diverse flora and fauna alongside human livelihoods. According to the Odisha Tribal Development Cooperative Corporation (TDCC, 2023), non-timber forest products (NTFPs) from Kuldiha generated approximately Rs. 2.6 crore in revenue in 2022. This indicates a significant dependency of local tribal households around 18,500 according to Census 2011 on forest resources for their economic sustenance.

The restriction on annual timber revenue under Joint Forest Management (JFM) reflects a conscious policy to balance ecological preservation with community participation. this also limits the income sources available to local tribal populations, pushing greater reliance on NTFPs. While NTFPs offer sustainable income opportunities, challenges like market price volatility, seasonal collection limitations, and over-extraction risks persist. Furthermore, many tribal households face legal and institutional barriers in accessing rights under frameworks like the Forest Rights Act. The core cause behind these challenges is the structural dependency of a large tribal population on limited and sometimes unregulated forest resources without diversified livelihood alternatives. Another contributing factor is restricted market access for NTFP collectors, where middlemen often absorb the majority of profit margins, leaving primary collectors with meager earnings despite the overall revenue figures.

Addressing these issues requires a multi-pronged solution framework. Firstly, strengthening the implementation of Joint Forest Management Committees (JFMCs) and ensuring broader participation of tribal women and youth could enhance collective bargaining and sustainable harvesting practices. Secondly, expanding NTFP value-addition units locally such as leaf plate manufacturing from sal leaves or honey processing could increase tribal income while reducing raw material dependency. Thirdly, market linkages through e-commerce platforms supported by Odisha TDCC and other agencies could help bypass exploitative intermediaries. Lastly, improving tribal literacy and skill development programs focusing on forest-based entrepreneurship would contribute to long-term poverty reduction and resource sustainability.

The Kuldiha's forest economy sustains many, strategic interventions focused on market access, legal empowerment, and sustainable harvesting practices are necessary to convert this dependency into a more equitable and resilient economic model for the region's tribal communities.

The Table 10 shows that the challenges faced by

Table 9 : Forest Economy in Kuldiha Wildlife Sanctuary Context

Aspect	Detail	Source
Total Area of Sanctuary	272.75 sq. km	Odisha Forest Department, 2023
Forest Type	Moist Deciduous and Dry Deciduous Forest	FSI, 2020
NTFP Revenue (2022)	Rs. 2.6 crore	Odisha Tribal Development Cooperative Corporation (TDCC), 2023
Annual Timber Revenue (Restricted)	Controlled under Joint Forest Management (JFM)	Odisha Forest Department, 2023
Tribal Population Around Sanctuary	Approx. 18,500 households	Census of India, 2011

Table 10 : Challenges Faced by Tribal Communities

Challenge	Impact on Livelihood	Secondary Source
Forest Access Restrictions	Reduced NTFP collection zones	OFSDP, 2021
Climate Change	Erratic rainfall affecting shifting cultivation	FSI, 2020
Market Barriers	Limited access to fair trade for NTFPs	TRIFED, 2022
Wildlife-Human Conflict	Crop damage, threat to safety	Odisha Wildlife Wing, 2021

tribal communities in the study area. The tribal communities residing around Kuldiha Wildlife Sanctuary face multiple interlinked challenges that directly impact their livelihood patterns and forest-based economic activities. One of the foremost issues is forest access restrictions, primarily due to conservation policies and regulatory frameworks under initiatives like the Odisha Forestry Sector Development Project (OFSDP, 2021). These restrictions limit the zones available for Non-Timber Forest Product (NTFP) collection, which forms a critical income source for tribal households. The root cause lies in balancing biodiversity conservation with livelihood rights. A sustainable solution would involve effective implementation of the Forest Rights Act (FRA) 2006, ensuring recognized community forest rights while maintaining conservation norms.

Another pressing challenge is climate change. As highlighted by the Forest Survey of India (FSI, 2020), erratic rainfall patterns and rising temperatures affect traditional agricultural practices, including shifting cultivation common among tribal groups. This unpredictability threatens food security and supplemental income. The underlying cause is broader environmental degradation and global climate trends. Adaptive strategies such as promoting climate-resilient agricultural practices, introducing agroforestry systems, and integrating traditional ecological knowledge with modern techniques can help mitigate these impacts.

Market barriers present a socio-economic challenge wherein tribal communities experience limited access to fair trade mechanisms for their NTFPs. According to TRIFED (2022), middlemen often exploit price gaps, preventing fair income realization for tribal producers. The root cause lies in inadequate market linkages, lack of cooperatives, and insufficient price information at the local level. Strengthening tribal cooperatives, establishing forest product value chains through government-backed marketing platforms like Van Dhan Kendras, and expanding direct-to-market schemes could provide practical solutions. Wildlife-human conflict as reported by the Odisha Wildlife Wing (2021) poses risks in the form of crop damage by wild animals and safety threats to villagers living near forest fringes. This issue arises from habitat overlap and shrinking wildlife corridors. Suggested solutions include promoting community-based conflict management strategies, establishing physical barriers like solar fencing, and offering compensation schemes for crop and livestock losses. Addressing these interconnected challenges requires an integrated policy approach that balances tribal livelihood security, forest economy sustainability, and ecological preservation. Combining legal rights enforcement, market development, climate adaptation, and conflict mitigation strategies can contribute to reducing poverty while preserving both cultural heritage and biodiversity.

The tribal livelihood patterns and forest economy of Kuldiha Wildlife Sanctuary demonstrate a classic example of symbiosis. Forest ecosystems provide subsistence and commercial resources, while tribal stewardship contributes to forest conservation. NTFP collection represents the primary income source for most tribal households, making its regulation and fair marketing crucial. The introduction of Joint Forest Management Committees (JFMCs) under Odisha Forestry Sector Development Project has partially addressed these issues, ensuring community participation. However, restrictive policies, lack of market linkages, and climate variability still pose significant risks. Ecologically, sustaining tribal livelihoods aligns with maintaining biodiversity and preventing forest degradation. This integrated approach directly supports SDG 1 by reducing poverty through forest-based income, SDG 13 by building climate-resilient livelihoods, and SDG 15 through community-driven conservation.

Policy Recommendations and Conclusion:

To sustain the symbiotic relationship between tribal livelihood patterns and the forest economy in Kuldiha Wildlife Sanctuary, Odisha, while addressing poverty reduction and cultural preservation, several focused policy recommendations are necessary. First and foremost, strengthening the implementation of the Forest Rights

Act (FRA) must be prioritized. Although a significant proportion of tribal households have been granted access rights, many eligible families remain excluded due to administrative delays and lack of awareness. Proactive steps such as community-level awareness campaigns, simplified claim processes, and capacity-building programs for local governance institutions would ensure secure, legal access to forest resources for tribal communities. This not only upholds tribal rights but also fosters sustainable resource management by giving indigenous communities a stake in conservation outcomes.

Secondly, expanding value-chain development for non-timber forest products (NTFPs) through cooperatives and digital marketplaces is essential. At present, most tribal collectors sell NTFPs at low prices due to a lack of organized marketing channels and middlemen exploitation. Establishing tribal cooperatives equipped with training in quality control, packaging, and branding can enable better price realization. Integrating these cooperatives into government-supported digital marketplaces such as Odisha's Van Dhan Yojana platforms will further enhance market access and income security. Focus should also be placed on promoting value addition industries near tribal settlements to generate employment and reduce distress migration.

Third, promoting climate-resilient livelihood alternatives such as agroforestry and eco-tourism with tribal participation offers long-term sustainability. The region's dependence on forest products is vulnerable to climate-induced disruptions. Agroforestry models combining fruit trees, medicinal plants, and sustainable agriculture can reduce such dependency while preserving the forest ecosystem. Additionally, Kuldiha's ecological and cultural landscape has potential for community-based eco-tourism. Training tribal youth as guides, developing eco-tourism infrastructure, and linking it with Odisha's broader tourism circuits can provide supplementary income while showcasing tribal heritage.

Finally, enhancing conflict management mechanisms between wildlife and tribal communities is necessary. Incidents of crop loss and human-wildlife conflict often create friction between forest authorities and local people. A robust compensation framework—ensuring timely and fair reimbursement for losses—combined with community awareness programs about wildlife behavior and conservation importance can mitigate such conflicts. Initiatives such as installing solar fencing or early warning systems should be promoted under joint forest management schemes. These policy measures would ensure a balanced approach that respects tribal rights, reduces poverty, conserves forest resources, and sustains cultural identities in the Kuldiha Wildlife Sanctuary region.

The analysis of tribal livelihood patterns and forest economy in Kuldiha Wildlife Sanctuary, Odisha, reveals a deeply symbiotic relationship that sustains both the ecological balance of the sanctuary and the socio-economic welfare of its tribal communities. The study's first objective examining the interrelationship between tribal livelihood patterns and forest-based economic activities clearly shows that a significant proportion of tribal households rely on the sanctuary's resources, primarily through the collection of non-timber forest products (NTFPs) such as sal leaves, mahua flowers, honey, and medicinal plants. These activities not only provide vital income opportunities but also serve as key mechanisms for poverty reduction in an area where more than 60% of tribal families live below the poverty line. Secondary data from the Odisha Tribal Development Society (2022) and the Forest Survey of India (2021) substantiate this dependency and highlight how forest resources contribute to meeting basic needs such as food, fuel, fodder, and healthcare.

Based on the second objective analyzing how tribal dependence on forest resources contributes to cultural preservation while identifying challenges and opportunities it is evident that traditional knowledge systems, including sustainable harvesting practices and customary rights, are integral to the identity and resilience of local tribal groups such as the Bathudi, Kolha, and Santhal. These communities possess unique ecological wisdom that guides resource management in harmony with nature, reflecting a cultural heritage intertwined with the forest ecosystem. However, challenges such as restrictive conservation policies, market fluctuations in NTFP prices, lack of formal land rights, and insufficient integration of tribal voices in forest governance structures threaten both livelihood security and cultural continuity.

Opportunities exist to bridge traditional practices with contemporary forest management through policies like the Forest Rights Act (2006), though implementation remains inconsistent. Promoting community forest management, capacity-building programs, value-addition initiatives for NTFPs, and market linkages can help integrate tribal knowledge with modern sustainability frameworks. Equally important is recognizing the need for participatory governance where tribal communities

have a formal role in decision-making processes related to resource use and conservation planning.

The study underscores that tribal livelihood patterns and forest-based economic activities in Kuldiha Wildlife Sanctuary are not merely about survival but form a holistic system promoting sustainability, poverty reduction, and cultural preservation. For long-term impact, policy interventions must align with grassroots realities, ensuring that conservation and development are pursued not as conflicting goals but as mutually reinforcing outcomes of a shared forest ecosystem. The tribal communities of Kuldiha Wildlife Sanctuary exemplify the interdependence between human livelihoods and forest ecosystems. Ensuring inclusive policies and participatory management can safeguard both tribal welfare and environmental health, contributing to global sustainability objectives. A data-driven and culturally sensitive approach remains essential for balancing development and conservation in such ecologically sensitive zones.

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