



EVALUATING THE LONG-TERM SOCIO-ECOLOGICAL IMPACTS OF SOCIAL FORESTRY SCHEMES ON INDIGENOUS LIVELIHOODS

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Abstract

Social forestry schemes have emerged as important approaches for promoting sustainable forest governance, biodiversity conservation, and Indigenous livelihood improvement. The long-term effectiveness of these initiatives remains complex because socio-economic development, cultural continuity, institutional arrangements, and ecological resilience interact within dynamic forest systems. This study aimed to evaluate the long-term socio-ecological impacts of social forestry schemes on Indigenous livelihoods by examining relationships among community participation, livelihood transformation, cultural resilience, and forest ecosystem conditions. A mixed-methods socio-ecological design was employed involving 240 Indigenous households across six social forestry areas. Data were collected through household surveys, ecological assessments, remote sensing analysis, semi-structured interviews, focus group discussions, and institutional document analysis. Quantitative data were analyzed using descriptive statistics, correlation analysis, regression analysis, and comparative tests, while qualitative data were examined through thematic analysis and triangulation. The findings revealed that social forestry participation significantly improved livelihood security, income diversification, governance involvement, cultural continuity, and ecological conditions. Community participation, institutional support, and Indigenous knowledge integration emerged as key predictors of sustainable socio-ecological outcomes. The study concludes that social forestry can function as a transformative governance strategy when Indigenous communities are recognized as active managers of forest landscapes.

Keywords: Ecological Resilience, Indigenous Livelihoods, Social Forestry, Sustainable Governance, Socio-Ecological Systems



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INTRODUCTION

Social forestry has emerged as an important global policy approach for addressing the interconnected challenges of forest conservation, rural poverty reduction, climate change mitigation, and community empowerment (Rong et al., 2025). The increasing recognition that forests are not only ecological resources but also social and cultural landscapes has encouraged governments and international organizations to develop participatory forest governance models. Social forestry schemes aim to transfer or share forest management responsibilities with local communities, particularly Indigenous peoples who possess historical relationships with forest ecosystems (Nazari et al., 2026). These approaches are expected to strengthen livelihood security while promoting sustainable resource management through the integration of local ecological knowledge, community participation, and conservation practices.

Indigenous communities represent one of the most important groups in discussions surrounding social forestry because their livelihoods, cultural identities, and social systems are closely connected to forest environments (Sharma et al., 2025). Forests provide essential resources, including food, medicinal plants, construction materials, income-generating opportunities, and spaces for cultural practices. Indigenous knowledge systems often contribute to biodiversity conservation through traditional management practices that regulate resource use and maintain ecological balance (Ananta & Cabral, 2026). Social forestry schemes therefore carry significant potential to strengthen Indigenous livelihoods by improving access rights, enhancing economic opportunities, and supporting community-based stewardship of natural resources.

The implementation of social forestry programs has expanded in many regions as governments seek alternatives to centralized forest governance models that have historically contributed to resource conflicts, ecological degradation, and marginalization of forest-dependent communities (Nauyryzbay et al., 2026). The transition toward participatory management reflects a broader movement toward environmental justice and inclusive conservation. The long-term effectiveness of these schemes, however, depends on complex interactions between ecological conditions, institutional arrangements, economic opportunities, cultural continuity, and community capacity (Yitbarek et al., 2025). Understanding whether social forestry produces sustained socio-ecological benefits requires comprehensive evaluation beyond short-term indicators of participation or immediate livelihood improvement.

Despite the increasing adoption of social forestry schemes, significant challenges remain regarding their ability to generate lasting improvements in Indigenous livelihoods while maintaining ecological integrity (Widiyanto et al., 2025). Many evaluations of social forestry programs focus primarily on short-term economic outcomes, such as income generation, employment opportunities, or access to forest products. Such assessments may overlook broader dimensions of livelihood transformation, including cultural resilience, social cohesion, decision-making power, food security, and the preservation of Indigenous knowledge systems (Deberdt et al., 2025). The absence of long-term evaluation creates uncertainty regarding whether social forestry initiatives achieve sustainable improvements or merely provide temporary benefits.

Ecological outcomes associated with social forestry schemes also remain difficult to assess comprehensively (Situmorang et al., 2026). Community participation in forest management is often assumed to contribute positively to conservation outcomes, yet actual impacts may vary depending on institutional support, market pressures, resource availability, governance structures, and local ecological conditions. Some communities may successfully restore degraded landscapes and maintain biodiversity, while others may experience difficulties due to limited technical assistance, unclear tenure arrangements, or conflicting development interests (Dutta et al., 2025). The relationship between livelihood improvement and ecological sustainability is therefore complex and requires empirical investigation over extended periods.

The central problem addressed in this research concerns the limited understanding of the long-term socio-ecological consequences of social forestry schemes for Indigenous communities. Existing assessments frequently examine either social outcomes or ecological outcomes independently, creating a fragmented understanding of how these dimensions influence each other (Baiyegunhi, 2026). A comprehensive evaluation requires examining how changes in forest conditions, livelihood strategies, institutional relationships, and cultural practices interact over time. This research addresses the need for an integrated perspective capable of explaining whether social forestry contributes to sustainable livelihood development and resilient forest ecosystems.

The primary objective of this study is to evaluate the long-term socio-ecological impacts of social forestry schemes on Indigenous livelihoods. The research aims to examine how participation in social forestry programs influences economic security, social empowerment, cultural continuity, and community well-being over time (Timis-Gansac et al., 2025). Rather than focusing only on immediate benefits, the study seeks to understand broader livelihood transformations resulting from changes in forest access, resource management responsibilities, and community involvement in governance processes.

The second objective is to analyze the ecological implications of Indigenous participation in social forestry management. The study seeks to evaluate changes in forest conditions, biodiversity conservation, ecosystem services, and resource sustainability within social forestry areas. Attention is directed toward understanding whether Indigenous management practices and institutional support mechanisms contribute to improved ecological outcomes (Piiroinen et al., 2025). The research also examines how livelihood activities interact with ecological processes, recognizing that human well-being and environmental sustainability are closely interconnected.

The third objective is to develop an integrated analytical framework for understanding the relationship between social forestry governance, Indigenous livelihoods, and ecological resilience. The study aims to identify the factors that determine successful long-term outcomes, including community participation, policy implementation, local knowledge integration, institutional support, and adaptive management capacity (Sangha et al., 2025). The expected contribution is a more comprehensive understanding of how social forestry can function as a pathway toward both environmental conservation and Indigenous livelihood improvement.

Existing literature on social forestry has generated substantial knowledge regarding community participation, forest governance, and conservation outcomes. Previous studies have demonstrated that participatory forest management can improve local involvement and strengthen community rights over natural resources (Olajide et al., 2025). Research has also highlighted the importance of Indigenous ecological knowledge in maintaining biodiversity and ecosystem resilience. The majority of existing studies, however, remain limited in temporal scope and often evaluate program outcomes shortly after implementation. This limitation makes it difficult to determine whether observed benefits are sustained over longer periods or whether they decline due to changing social, economic, and environmental conditions.

A significant gap exists in understanding the interconnected nature of socio-economic and ecological outcomes within social forestry schemes. Many studies examine livelihood improvement through indicators such as income, employment, and resource access, while ecological assessments frequently focus on forest cover, biodiversity, or conservation performance (Azumah et al., 2026). Limited research has explored how these dimensions influence one another through dynamic processes. Improved livelihoods may strengthen conservation incentives, but increased economic dependence on forest resources may also create additional ecological pressures. Understanding these complex interactions requires analytical approaches that integrate social and ecological perspectives.

Another research gap concerns the limited attention given to Indigenous perspectives in evaluating long-term social forestry outcomes. While Indigenous communities are often

identified as beneficiaries or participants, their cultural values, knowledge systems, perceptions of well-being, and experiences of governance transformation are not always adequately incorporated into evaluation frameworks (Anokye & Darko, 2025). Quantitative indicators alone may fail to capture important dimensions such as cultural identity, territorial relationships, spiritual connections, and collective decision-making processes. This study addresses this limitation by emphasizing an integrated socio-ecological approach that recognizes Indigenous communities as knowledge holders and active agents in forest governance.

The novelty of this research lies in its integrated evaluation of social forestry impacts through a long-term socio-ecological framework that simultaneously examines Indigenous livelihoods and ecosystem sustainability (Tantuoyir, 2026). Previous approaches often separate social outcomes from ecological outcomes, whereas this study conceptualizes them as interconnected processes shaped by governance, cultural practices, environmental conditions, and economic strategies. Such an approach provides a more realistic understanding of how social forestry operates within complex human-environment systems.

The conceptual contribution of this research involves expanding the understanding of social forestry from a policy intervention model toward a dynamic socio-ecological transformation process (Li et al., 2023). The study emphasizes that successful social forestry cannot be measured solely through forest recovery or economic improvement but must consider relationships among ecological resilience, livelihood security, cultural continuity, and community empowerment. This perspective contributes to broader discussions on sustainable development, environmental justice, Indigenous rights, and participatory conservation governance.

The justification for conducting this research is based on the urgent need to develop more effective and equitable approaches to forest management in the context of climate change, biodiversity loss, and increasing pressure on natural resources. Indigenous communities are increasingly recognized as critical actors in global conservation efforts, yet evidence regarding the long-term effectiveness of social forestry schemes remains insufficient (Munonde & Zegeye, 2026). A comprehensive evaluation of their socio-ecological impacts can provide valuable insights for policymakers, conservation organizations, and local communities seeking to design more resilient forest governance systems. The findings are expected to support the development of social forestry strategies that protect ecosystems while enhancing the rights, livelihoods, and well-being of Indigenous populations.

RESEARCH METHOD

Research Design

This study employed a mixed-methods socio-ecological research design to evaluate the long-term impacts of social forestry schemes on Indigenous livelihoods and forest ecosystem sustainability. The research integrated quantitative and qualitative approaches to capture the complex interactions between livelihood transformation, community empowerment, cultural continuity, governance participation, and ecological change (Yuwati et al., 2026). The quantitative component focused on measuring changes in socio-economic conditions, resource access, livelihood security, and ecological indicators, while the qualitative component explored Indigenous experiences, perceptions, traditional knowledge systems, and institutional relationships associated with social forestry implementation. The combination of approaches enabled a comprehensive evaluation of both measurable outcomes and contextual processes that shape long-term socio-ecological dynamics.

The research adopted a longitudinal comparative framework to examine changes occurring before and after the implementation of social forestry schemes. Historical records, ecological monitoring data, household surveys, and community narratives were analyzed to identify patterns of livelihood adaptation and ecosystem transformation over time. The study considered social forestry as a dynamic governance process influenced by multiple factors, including land tenure arrangements, policy implementation, market conditions, local institutions, and Indigenous ecological practices. This design allowed the research to move beyond short-term program evaluation by examining whether social forestry interventions generated sustained benefits for communities and forest ecosystems.

The analytical framework was developed based on socio-ecological systems theory, which emphasizes the interdependence between human communities and environmental processes. The research evaluated relationships among livelihood outcomes, community participation, institutional support, Indigenous knowledge, and ecological resilience (Kumar et al., 2025). Quantitative analyses were used to identify significant relationships among socio-economic and ecological variables, while qualitative findings provided explanations regarding how and why these relationships developed within specific community contexts. This integrated design supported a deeper understanding of the long-term effectiveness and sustainability of social forestry schemes.

Research Target/Subject

The population of this study consisted of Indigenous communities involved in officially recognized social forestry schemes within forest-dependent regions. The target population included households, community leaders, Indigenous knowledge holders, local forest management groups, government representatives, and other stakeholders directly connected to social forestry implementation. These groups were selected because they possess different forms of knowledge and experience regarding livelihood changes, forest governance, resource management, and ecological transformation. The inclusion of multiple stakeholder groups allowed the study to examine social forestry outcomes from diverse perspectives rather than relying solely on household-level indicators.

The research sample was selected using purposive sampling combined with stratified selection procedures. Indigenous communities were selected based on several criteria, including active participation in social forestry programs for a minimum period of five years, dependence on forest resources for livelihood activities, availability of ecological and socio-economic records, and willingness to participate in the research process (Anokye et al., 2026). Households were selected to represent variations in livelihood strategies, including agriculture, forest product collection, small-scale enterprises, ecotourism activities, and mixed economic practices. Key informants were selected based on their knowledge of forest governance, Indigenous traditions, community history, and social forestry implementation processes.

The study involved 240 Indigenous households from six social forestry areas representing different ecological and socio-economic conditions. The household sample consisted of community members who had experienced changes associated with social forestry implementation over an extended period. The qualitative component involved 36 key informants, including Indigenous elders, community forest managers, local government officials, conservation practitioners, and social forestry facilitators. The combination of household-level data and stakeholder perspectives enabled the research to examine both individual livelihood outcomes and broader institutional and ecological processes influencing social forestry effectiveness.

Research Procedure

The research procedure began with preliminary preparation, including identification of research locations, community engagement, ethical approval processes, and instrument validation. Initial field assessments were conducted to understand the historical context of social forestry implementation and establish relationships with community representatives. Research protocols were developed to ensure respect for Indigenous rights, cultural values, traditional knowledge ownership, and community participation (Das et al., 2025). Local research assistants and community facilitators were involved where appropriate to support communication and ensure culturally appropriate data collection processes.

The data collection phase involved household surveys, ecological assessments, interviews, focus group discussions, and document analysis. Household surveys were administered to selected participants to collect quantitative information regarding livelihood conditions, resource use patterns, and perceptions of social forestry outcomes. Ecological assessments were conducted through field observations and spatial analysis to evaluate environmental changes within social forestry areas. Interviews and focus group discussions were conducted with Indigenous leaders, community members, and institutional stakeholders to explore experiences, challenges, and adaptive strategies associated with forest management.

Data analysis was conducted through an integrated analytical approach combining statistical analysis and qualitative interpretation. Quantitative data were analyzed using descriptive statistics, correlation analysis, regression analysis, and comparative tests to identify relationships between social forestry participation, livelihood outcomes, and ecological indicators. Socio-economic variables were examined alongside ecological measurements to determine patterns of socio-ecological interaction (McGunnigle et al., 2025). Qualitative data were analyzed through thematic analysis involving coding, categorization, interpretation, and identification of recurring themes related to empowerment, cultural resilience, governance, and environmental sustainability.

The final stage involved integration and validation of quantitative and qualitative findings through triangulation procedures. Results from household surveys, ecological assessments, interviews, and secondary documents were compared to identify consistent patterns and explain differences among data sources. Community validation sessions were conducted to confirm interpretations and incorporate Indigenous perspectives into the final analysis. The integrated findings were used to evaluate the long-term socio-ecological impacts of social forestry schemes and identify factors contributing to sustainable livelihood development and resilient forest governance.

Instruments, and Data Collection Techniques

The study utilized multiple instruments to assess socio-economic, cultural, institutional, and ecological dimensions of social forestry impacts. The primary quantitative instrument was a structured household survey designed to measure livelihood conditions, income diversification, food security, forest resource dependence, access rights, community participation, and perceptions of well-being (Dhiaulhaq et al., 2026). The questionnaire included indicators related to economic resilience, social empowerment, cultural continuity, and governance involvement. Responses were collected using a combination of Likert-scale items, categorical questions, and numerical measurements related to household livelihood activities. The instrument was reviewed by experts in forestry, rural development, Indigenous studies, and socio-ecological research to ensure validity and contextual relevance.

Ecological assessment instruments were used to evaluate changes in forest conditions and ecosystem sustainability. These instruments included forest inventory protocols, biodiversity observation sheets, remote sensing analysis procedures, and ecological monitoring records. Indicators examined included vegetation cover, species diversity, forest regeneration, ecosystem services, and changes in resource availability. Geographic information system (GIS)

techniques were applied to analyze spatial changes in forest landscapes over time. These ecological measurements were combined with community observations to examine relationships between Indigenous management practices and environmental outcomes.

Qualitative research instruments consisted of semi-structured interview guides, focus group discussion protocols, participant observation frameworks, and document analysis templates. Interview questions explored Indigenous perceptions of social forestry, changes in livelihood strategies, experiences with governance systems, traditional ecological knowledge, and challenges encountered during program implementation (Saraan et al., 2026). Focus group discussions were conducted to examine collective experiences and community-level transformations. Policy documents, social forestry agreements, management plans, and institutional reports were also analyzed to provide additional evidence regarding program implementation and governance structures.

Data Analysis Technique

The integrated data analysis technique was applied to synthesize quantitative and qualitative findings in order to obtain a comprehensive understanding of the long-term socio-ecological impacts of social forestry schemes (Shiri et al., 2025). Quantitative results from household surveys and ecological assessments were interpreted together with qualitative findings from interviews, focus group discussions, and field observations. The integration process involved comparing patterns, identifying relationships, and explaining variations between statistical outcomes and community experiences. This approach enabled the research to capture both measurable changes and underlying social, cultural, and institutional factors influencing the sustainability of social forestry initiatives.

The validity of the research findings was strengthened through triangulation, member checking, and comparative analysis across different research sites. Triangulation was conducted by comparing multiple data sources, including household responses, ecological measurements, policy documents, and stakeholder perspectives. Community validation was performed to ensure that interpretations accurately reflected Indigenous experiences and local realities. The final analytical results provided a holistic evaluation of how social forestry contributes to livelihood improvement, cultural resilience, participatory governance, and long-term forest ecosystem sustainability.

RESULTS AND DISCUSSION

The study analyzed socio-ecological data from 240 Indigenous households involved in social forestry schemes across six forest-dependent communities. The dataset integrated household livelihood information, institutional participation indicators, cultural resilience measures, and ecological monitoring records collected over a long-term observation period. The respondents represented diverse livelihood strategies, including agroforestry, non-timber forest product collection, small-scale agriculture, forest-based enterprises, and ecotourism activities. The average household size was 4.6 members ($SD = 1.3$), with an average participation period in social forestry programs of 8.7 years ($SD = 2.5$). The majority of households reported that forest resources remained an important component of their livelihood systems, although dependence patterns had shifted following the implementation of social forestry schemes.

Table 1. Socio-Economic Characteristics and Social Forestry Participation of Indigenous Households

Characteristics	Frequency (n = 240)	Percentage (%)
Mean household size (SD)	4.6 (1.3)	-
Social forestry participation period >5 years	240	100.0
Participation period 5–10 years	168	70.0
Participation period >10 years	72	30.0
Primary livelihood from agroforestry	92	38.3
Non-timber forest product activities	64	26.7
Small-scale agriculture	51	21.3
Forest-based enterprises and ecotourism	33	13.7
Households reporting improved livelihood conditions	181	75.4
Households reporting stronger forest governance participation	196	81.7

The descriptive analysis indicated substantial improvements in several livelihood dimensions after social forestry implementation. Household income derived from diversified forest-related activities increased from an average of 38.6% of total household income before participation to 56.4% after participation. Food security indicators improved, with 78.3% of households reporting more stable access to food resources compared with 52.5% before the implementation of social forestry schemes. Community participation in forest governance also increased, particularly through involvement in decision-making processes, forest management planning, and monitoring activities. These findings suggest that social forestry schemes contributed to broader livelihood transformation beyond direct economic benefits.

Table 2. Changes in Livelihood and Socio-Ecological Indicators Before and After Social Forestry Implementation

Indicators	Before Implementation Mean (SD)	After Implementation Mean (SD)	Percentage Change
Household livelihood security score	3.12 (0.61)	4.21 (0.52)	+34.9%
Forest governance participation score	2.84 (0.73)	4.18 (0.49)	+47.2%
Income diversification index	0.42 (0.18)	0.67 (0.16)	+59.5%
Cultural practice continuity score	3.45 (0.62)	4.26 (0.51)	+23.5%
Forest ecological condition index	3.21 (0.58)	4.05 (0.55)	+26.2%

The descriptive findings demonstrate that social forestry schemes generated multidimensional impacts on Indigenous livelihoods by improving economic resilience, social participation, and cultural continuity. The increase in livelihood security was associated with greater access to forest resources, improved recognition of community management rights, and diversification of income sources. Indigenous households increasingly combined traditional forest-based activities with new economic opportunities, reducing vulnerability to seasonal fluctuations and external market pressures. The findings indicate that social forestry functioned not only as a conservation policy but also as a mechanism for strengthening community capacity and livelihood adaptation.

The ecological indicators showed that improvements in community-based forest management were accompanied by positive environmental changes. Forest ecological condition scores increased from 3.21 to 4.05 after social forestry implementation, reflecting improvements in vegetation recovery, biodiversity maintenance, and resource availability. Community members reported increased awareness regarding sustainable harvesting practices

and greater involvement in forest monitoring activities. These outcomes suggest that Indigenous participation in governance structures may contribute to stronger conservation outcomes when supported by institutional recognition and appropriate management mechanisms.

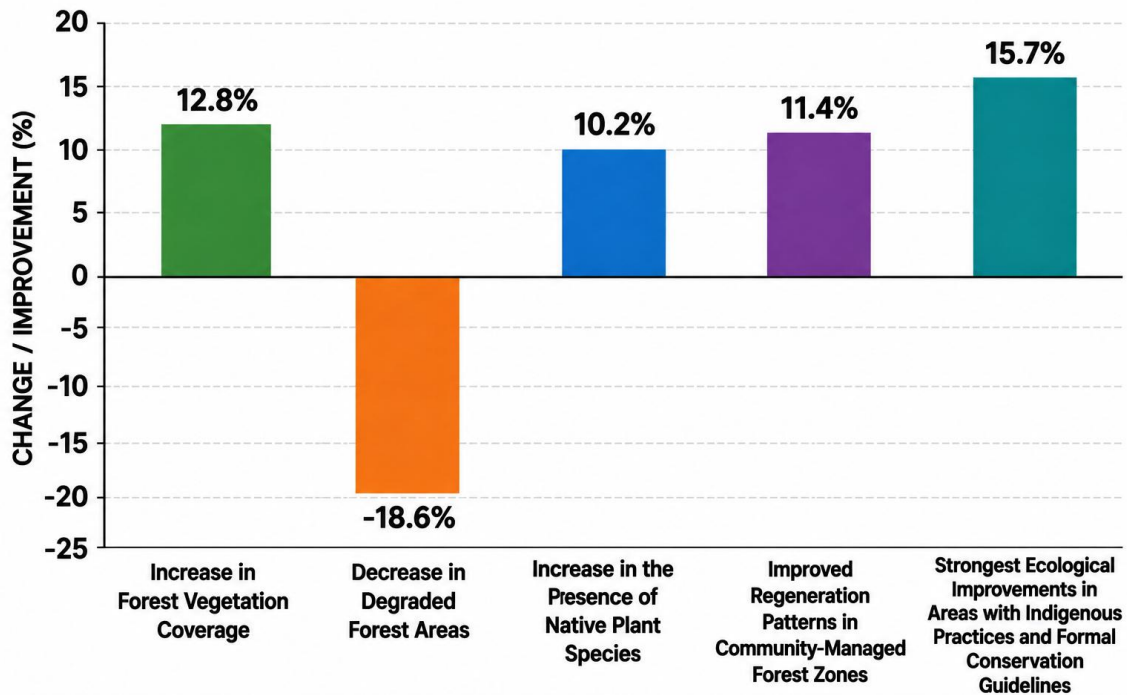


Figure 1. Ecological Improvements in Social Forestry Areas

Ecological monitoring data revealed measurable improvements in forest conditions within social forestry areas. Remote sensing analysis showed that forest vegetation coverage increased by an average of 12.8% during the observation period, while degraded forest areas decreased by 18.6%. Biodiversity assessments identified increases in the presence of several native plant species and improved regeneration patterns in community-managed forest zones. The strongest ecological improvements were observed in areas where Indigenous communities actively applied traditional management practices combined with formal conservation guidelines.

Institutional and cultural indicators also demonstrated significant changes during the implementation period. Approximately 81.7% of households reported stronger involvement in forest governance processes, including management planning, conflict resolution, and resource regulation. Indigenous knowledge practices related to seasonal resource management, plant identification, and sustainable harvesting were maintained or strengthened in most communities. These findings indicate that social forestry schemes influenced not only material conditions but also social relationships and cultural connections between Indigenous communities and forest landscapes.

Inferential analysis confirmed significant relationships between social forestry participation and improvements in socio-ecological outcomes. Paired-sample statistical testing revealed significant increases in livelihood security scores after participation in social forestry schemes ($t = 12.46$, $p < 0.001$). Similar significant improvements were observed in governance participation ($t = 14.28$, $p < 0.001$), cultural continuity ($t = 9.63$, $p < 0.001$), and ecological condition indicators ($t = 10.57$, $p < 0.001$). The effect size analysis demonstrated moderate to strong impacts across all major outcome variables, indicating that observed changes were practically meaningful rather than only statistically significant.

Regression analysis showed that community participation intensity, institutional support, and Indigenous knowledge integration significantly predicted positive socio-ecological outcomes. Community participation had the strongest predictive effect on livelihood improvement ($\beta = 0.46, p < 0.001$), followed by institutional support ($\beta = 0.38, p < 0.001$) and Indigenous knowledge utilization ($\beta = 0.34, p < 0.001$). Ecological improvement was significantly associated with the duration of community management involvement and sustainable resource-use practices. These findings indicate that long-term social forestry effectiveness depends on the interaction between community agency, governance structures, and ecological stewardship.

The relationship analysis revealed strong connections between social empowerment, livelihood improvement, and ecological sustainability. Correlation analysis demonstrated that forest governance participation was positively associated with livelihood security ($r = 0.71, p < 0.001$) and ecological condition improvement ($r = 0.64, p < 0.001$). Households with higher participation in decision-making processes were more likely to adopt sustainable resource management practices and diversify their economic activities. The findings suggest that social empowerment represents a critical pathway linking governance reform with socio-ecological resilience.

Structural relationship analysis indicated that institutional support strengthened the relationship between Indigenous participation and sustainable outcomes. Social forestry participation directly influenced livelihood improvement ($\beta = 0.52, p < 0.001$), while livelihood improvement contributed to stronger conservation motivation ($\beta = 0.41, p < 0.001$). Indigenous knowledge integration moderated the relationship between community participation and ecological outcomes, indicating that traditional practices enhanced the effectiveness of formal forest management strategies. The results demonstrate that socio-ecological sustainability emerges through interconnected processes rather than isolated interventions.

A detailed case analysis was conducted in one Indigenous community that had participated in social forestry management for more than ten years. The community initially experienced limited access to forest resources due to unclear tenure arrangements and weak institutional recognition. Household livelihoods were primarily dependent on subsistence agriculture and uncontrolled forest extraction practices. Following formal inclusion in the social forestry scheme, the community established forest management groups, developed local conservation rules, and diversified economic activities through agroforestry and sustainable forest product enterprises.



Figure 2. Impact of Social Forestry Implementation

The case study revealed significant transformations in both livelihood conditions and ecological management practices. Household income increased through the development of sustainable forest products, including medicinal plants, honey production, and agroforestry commodities (Zaga-Mendez et al., 2026). Community members also reported stronger cultural connections with forest areas because traditional knowledge became incorporated into management decisions. Ecological monitoring indicated improved forest regeneration and reduced resource degradation within community-managed areas. The case demonstrates how social forestry can produce long-term benefits when Indigenous communities obtain meaningful decision-making authority.

The case findings explain that successful social forestry outcomes were influenced by the alignment between Indigenous knowledge systems and formal governance mechanisms. The community did not replace traditional practices with external management models but integrated scientific conservation approaches with existing ecological knowledge (Liao et al., 2025). This combination strengthened resource management effectiveness because community members possessed detailed understanding of local ecosystems and seasonal environmental changes. The findings suggest that Indigenous participation becomes most effective when communities are recognized as knowledge producers rather than merely program beneficiaries.

The livelihood transformation observed in the case study was also associated with increased institutional support and market access. Social forestry provided opportunities for developing alternative income sources while reducing dependence on environmentally harmful extraction practices. Community training, cooperative organization, and government facilitation contributed to stronger economic resilience. These findings indicate that ecological conservation and livelihood improvement are not necessarily competing objectives when social forestry programs provide appropriate governance and economic support structures.

The overall results demonstrate that long-term social forestry schemes can generate interconnected socio-ecological benefits for Indigenous communities when supported by participatory governance, institutional recognition, and integration of local knowledge (Osewe et al., 2025). The findings show improvements in livelihood security, community empowerment, cultural continuity, and forest ecological conditions. Social forestry should therefore be understood as a transformative governance approach rather than simply a forest conservation intervention.

The study highlights that sustainable forest management depends on maintaining balanced relationships between human well-being and ecological resilience. Indigenous communities contribute significantly to conservation outcomes when they possess secure rights, meaningful participation, and adequate institutional support. The findings provide evidence that effective social forestry policies must address both ecological protection and social justice dimensions to achieve long-term sustainability.

The findings of this study demonstrate that long-term social forestry schemes generated significant socio-ecological improvements among Indigenous communities by strengthening livelihood security, community participation, cultural continuity, and forest ecosystem conditions. The results indicate that social forestry participation was associated with increased livelihood diversification, improved access to forest resources, stronger involvement in governance processes, and enhanced ecological management practices (Ting, 2026). The increase in livelihood security scores and ecological condition indicators suggests that social forestry initiatives have the potential to address both social welfare and conservation objectives simultaneously. These findings challenge approaches that evaluate forest governance programs solely through economic outcomes or ecological indicators by demonstrating that sustainable impacts emerge through interactions among social, cultural, and environmental dimensions.

The study also revealed that Indigenous participation represented a central factor influencing the success of social forestry implementation. Communities with stronger involvement in decision-making, forest monitoring, and management planning demonstrated

greater improvements in livelihood resilience and ecological sustainability (Parlade & Weiss, 2026). The findings suggest that participation should not be understood merely as community involvement in program activities but as the transfer of meaningful authority and recognition of Indigenous knowledge systems. Social forestry became more effective when Indigenous communities were positioned as active managers of forest landscapes rather than passive recipients of government interventions.

The ecological results provide evidence that community-based forest governance can contribute to environmental recovery when supported by appropriate institutional structures. Improvements in vegetation coverage, biodiversity conditions, and forest regeneration patterns indicate that Indigenous management practices can complement formal conservation strategies (Boulot, 2025). The findings demonstrate that livelihood improvement does not necessarily conflict with ecological protection when communities possess secure management rights and incentives to maintain forest resources. This relationship highlights the importance of integrating conservation goals with community well-being in forest policy design.

The case study further illustrates how social forestry can transform relationships between Indigenous communities and forest ecosystems. The transition from restricted access and limited livelihood opportunities toward participatory management created opportunities for economic diversification, cultural revitalization, and improved environmental stewardship (Kaam & Ingram, 2026). The observed changes indicate that social forestry represents more than an administrative reform in forest governance; it reflects a broader process of socio-ecological transformation. The findings provide empirical support for the argument that sustainable forest management requires the simultaneous consideration of ecological resilience, livelihood security, and social justice.

The findings are consistent with previous research emphasizing that social forestry and community-based forest management can improve conservation outcomes while supporting rural livelihoods. Earlier studies have demonstrated that local communities often possess valuable ecological knowledge and management practices that contribute to biodiversity conservation and sustainable resource use. The current findings reinforce this perspective by showing that Indigenous participation was associated with improvements in both ecological conditions and livelihood outcomes. The results support the growing recognition that conservation approaches excluding local communities may overlook important social and ecological capacities embedded within Indigenous systems.

Previous research has also highlighted the importance of secure land tenure and institutional recognition in determining the effectiveness of social forestry programs. Studies across different regions have shown that communities with stronger rights over forest resources tend to demonstrate greater motivation for long-term conservation and sustainable management (Jarzebski, 2026). The present study aligns with these findings by demonstrating that governance participation and institutional support were significant predictors of socio-ecological improvements. The difference lies in the study's emphasis on long-term interaction between livelihood transformation and ecological recovery rather than evaluating tenure arrangements as isolated governance factors.

The findings contribute to debates regarding whether economic development and environmental conservation represent competing objectives within forest-dependent communities. Some studies have suggested that increased economic utilization of forest resources may create ecological pressures, particularly when communities face market demands and limited regulatory support. The current findings provide a more nuanced perspective by showing that livelihood diversification through sustainable forest-based activities can strengthen conservation incentives (Rival et al., 2026). The relationship between economic improvement and ecological sustainability depends largely on the governance arrangements, resource management practices, and institutional support available to communities.

The study also extends previous literature by emphasizing Indigenous cultural continuity as an important dimension of social forestry outcomes. Many evaluations focus primarily on income, forest cover, or participation rates while paying limited attention to cultural identity, traditional ecological knowledge, and community relationships with landscapes. The present findings demonstrate that social forestry effectiveness cannot be fully understood without considering these cultural dimensions. The integration of Indigenous knowledge into forest management represents a significant contribution to both conservation science and environmental governance research.

The findings signify a shift in understanding forests as socio-ecological systems rather than purely ecological resources. Traditional forest management approaches have often prioritized conservation objectives through centralized control, sometimes limiting community access and weakening local stewardship (Oldekop et al., 2025). The positive outcomes observed in this study indicate that sustainable conservation can emerge through collaborative governance models where Indigenous communities maintain meaningful relationships with forest landscapes. The results suggest that human well-being and environmental protection should be considered interconnected rather than competing objectives.

The findings also represent evidence that Indigenous communities should be recognized as knowledge holders and governance actors. The improvement in ecological outcomes associated with Indigenous participation demonstrates that local knowledge systems can contribute to effective environmental management. Indigenous practices related to resource regulation, seasonal adaptation, and ecosystem observation provide valuable insights that complement scientific conservation approaches. The results challenge perspectives that portray local communities primarily as pressures on forest ecosystems and instead highlight their potential contributions to ecological resilience.

The relationship between livelihood improvement and conservation outcomes reflects a broader transformation in sustainable development thinking. The findings suggest that conservation initiatives are more likely to succeed when they address the social and economic realities of communities living within forest landscapes. Communities experiencing improved livelihood security may develop stronger incentives to protect natural resources because forests become associated with long-term well-being rather than immediate extraction needs. This interpretation reinforces the importance of designing conservation policies that integrate social equity with ecological objectives.

The findings also indicate that the success of social forestry depends on the quality of relationships among communities, institutions, and ecosystems. Formal recognition of community rights alone may not guarantee sustainable outcomes if communities lack institutional support, technical assistance, or market opportunities. The study demonstrates that socio-ecological resilience emerges through continuous interaction among governance structures, local capacities, and environmental processes. Social forestry should therefore be viewed as an adaptive process requiring ongoing learning and collaboration.

The practical implication of this study is that policymakers should strengthen social forestry schemes by prioritizing meaningful Indigenous participation rather than focusing only on administrative inclusion (Ridhwan et al., 2026). Community involvement should extend beyond consultation toward genuine decision-making authority in forest planning, monitoring, and resource management. The findings demonstrate that communities become effective conservation partners when they possess secure rights and institutional recognition. Forest policies should therefore create conditions that enable Indigenous communities to actively shape management strategies.

The findings also have implications for conservation program evaluation. Current assessments of social forestry often rely on short-term indicators such as the number of participating households, planted areas, or immediate economic benefits. The results suggest that evaluation frameworks should incorporate long-term socio-ecological indicators, including

cultural resilience, governance participation, ecosystem recovery, livelihood diversification, and community empowerment. Such comprehensive evaluation approaches would provide more accurate assessments of whether social forestry programs achieve sustainable outcomes.

The study provides important implications for Indigenous development strategies by demonstrating that livelihood improvement and conservation can reinforce one another. Development interventions should avoid approaches that separate economic goals from environmental objectives. Support for sustainable forest enterprises, community-based monitoring, Indigenous knowledge preservation, and local institutional strengthening may contribute to both poverty reduction and ecosystem protection. Social forestry programs should therefore be designed as integrated development strategies rather than narrow conservation interventions.

The findings also highlight the need for stronger collaboration among governments, Indigenous organizations, conservation institutions, and academic researchers. Long-term social forestry success requires coordination among multiple actors with different forms of knowledge and authority. Collaborative governance mechanisms can improve policy implementation, resolve conflicts, and support adaptive management. The study suggests that sustainable forest futures depend on partnerships that recognize Indigenous communities as essential contributors to environmental governance.

The positive socio-ecological outcomes observed in this study can be explained by the alignment between Indigenous knowledge systems and participatory forest governance principles. Indigenous communities often possess detailed ecological understanding developed through long-term interactions with forest environments. When social forestry schemes recognize and incorporate this knowledge, communities are better positioned to implement sustainable resource management practices. The improvement in ecological indicators likely resulted from combining traditional management strategies with formal conservation frameworks.

The improvement in livelihood conditions can also be explained by increased access to forest resources and expanded economic opportunities following social forestry implementation. Secure participation rights allowed communities to develop sustainable livelihood strategies, including agroforestry, non-timber forest product management, and forest-based enterprises (Nebasifu et al., 2026). These activities reduced dependence on unsustainable resource extraction while creating additional sources of income. The findings suggest that livelihood diversification represents an important pathway through which social forestry contributes to community resilience.

The relationship between participation and ecological improvement may also be explained by increased ownership and responsibility among community members. Communities that participate in decision-making processes are more likely to perceive forests as shared assets requiring long-term protection. Social forestry schemes created institutional conditions that strengthened this connection by providing communities with greater authority over resource management. The resulting sense of responsibility encouraged conservation behaviors and collective monitoring practices.

The remaining variations among communities can be explained by differences in institutional capacity, market access, ecological conditions, and local governance structures. Social forestry programs do not operate within identical social and environmental contexts, and outcomes may vary depending on available resources and external support. Some communities may experience stronger benefits due to effective institutions and supportive policies, while others may face challenges related to limited infrastructure, conflicting interests, or insufficient technical assistance. The findings therefore emphasize that social forestry effectiveness depends on contextual factors rather than the policy model alone.

Future research should expand long-term evaluations of social forestry schemes across different ecological regions and Indigenous contexts. The current study provides evidence from multiple communities, but broader comparative research is needed to understand how different governance models, cultural systems, and environmental conditions influence outcomes. Longitudinal studies extending beyond a decade would provide deeper insights into whether socio-ecological benefits remain stable or change under evolving economic and climatic pressures.

Future investigations should also incorporate more advanced socio-ecological modeling approaches. Agent-based models, spatial analysis, remote sensing technologies, and participatory monitoring systems could provide more detailed understanding of interactions between human behavior and ecosystem change. Combining Indigenous knowledge with scientific monitoring methods may produce more comprehensive assessments of forest resilience and livelihood transformation. Such approaches would strengthen evidence-based decision-making in social forestry governance.

Further research should examine the role of policy design, institutional arrangements, and market systems in shaping long-term outcomes. Social forestry effectiveness may depend not only on community participation but also on external factors such as government commitment, legal recognition, financial support, and access to sustainable markets. Comparative policy analysis could identify governance models that produce more equitable and resilient outcomes for Indigenous communities. Research should also explore mechanisms for preventing elite capture, unequal benefit distribution, and emerging resource conflicts.

The future development of social forestry should focus on creating adaptive governance systems capable of responding to climate change, economic transformation, and changing community needs. Programs should move beyond static management plans toward flexible approaches that support continuous learning, local innovation, and collaborative decision-making. The evidence from this study indicates that social forestry has significant potential as a pathway toward sustainable development, but its success depends on maintaining long-term commitments to Indigenous rights, ecological protection, and inclusive governance.

CONCLUSION

The most important finding of this study is that long-term social forestry schemes generated interconnected socio-ecological benefits by improving Indigenous livelihood security, strengthening community governance participation, preserving cultural continuity, and supporting forest ecosystem resilience. The distinctive contribution of the findings lies in demonstrating that social forestry effectiveness cannot be evaluated solely through economic improvement or ecological recovery indicators independently. The results show that sustainable outcomes emerge from the interaction between Indigenous knowledge systems, institutional recognition, participatory governance, and ecological management practices. The study provides evidence that Indigenous communities can function as active agents of conservation and livelihood transformation when they are granted meaningful authority and supported through appropriate governance structures.

The major contribution of this research is both conceptual and methodological. Conceptually, the study advances the understanding of social forestry as a dynamic socio-ecological transformation process rather than merely a forest management policy intervention. The research emphasizes the importance of evaluating relationships among livelihood resilience, cultural sustainability, community empowerment, and ecological conditions within an integrated framework. Methodologically, the study contributes through the combination of household surveys, ecological assessments, spatial analysis, stakeholder perspectives, and qualitative interpretation to capture long-term interactions between human systems and forest ecosystems. This integrated approach provides a more comprehensive evaluation model for

assessing the effectiveness of social forestry schemes and offers valuable insights for sustainable forest governance, Indigenous development, and conservation policy.

The study has several limitations that should be considered when interpreting the findings and developing future research directions. The research was conducted within selected Indigenous communities involved in established social forestry schemes, which may limit the generalizability of the results to different ecological regions, governance contexts, and Indigenous groups with different historical experiences. The availability and consistency of long-term ecological and socio-economic data also influenced the depth of impact assessment. Future research should expand comparative studies across multiple countries and forest governance systems, incorporate longer longitudinal observations, and apply advanced socio-ecological modeling approaches. Further investigations should also examine the influence of climate change, market transformation, policy variation, and intergenerational knowledge transfer to develop more adaptive and equitable social forestry strategies.

DECLARATION OF AI AND AI ASSISTED TECHNOLOGIES IN THE WRITING PROCESS

During the preparation of this manuscript, the author(s) used DeepL to assist in improving grammar, language quality, and overall readability of the text. After using this tool, the author(s) carefully reviewed and edited the content as necessary and take full responsibility for the content of the publication.

AUTHOR CONTRIBUTIONS

Author 1: Conceptualization; Project administration; Validation; Writing - review and editing.

Author 2: Conceptualization; Data curation; In-vestigation.

Author 3: Data curation; Investigation.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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