Final Report

For

Consultancy service of:

Research on Impact of Resin Tapping on Forest Ecosystems and Socio-Economic Conditions of Local Communities (Program Reference Number: 03/2080/081)

Sumitted by

Motherland Nepal (Matribhumi Nepal), Makwanpur

Karnali Province Government

Ministry of Industry, Tourism, Forests and Environment

Forest Research and Training Center

Birendranagar, Surkhet

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Executive Summary

Resin tapping is a longstanding practice in community forests, crucial for local economies and livelihoods, yet its impacts on forest health, regeneration, and socio-economic development require detailed assessment. Resin tapping in Salyan district, Nepal, serves as a cornerstone of local economies, providing essential employment opportunities and bolstering household incomes, especially within marginalized communities reliant on forest resources. This study's comprehensive assessment through forest inventory, focus group discussions, and key informant surveys highlights the dual nature of resin tapping: while it fosters socio-economic development, significant challenges persist. Most of the resin tappers express dissatisfaction with current earnings, citing the mismatch between compensation and the demanding nature of their work alongside inherent risks. Moreover, environmental concerns, particularly the heightened forest fire risks posed by resin-infused trees, underscore the urgency for enhanced regulatory oversight and improved management practices. Further, in our study we found that upto 15% of the tapped trees are immature (below the thresold of 30cm dbh) indicating the neglegance of the guideline for tapping. Recommendations emphasize the imperative to revise payment structures to ensure fair compensation, enforce strict adherence to fire prevention protocols and sustainable forest management guidelines, implement comprehensive training programs to enhance safety and sustainable practices, and foster inclusive community engagement in decision-making processes. These measures are essential for balancing economic benefits with environmental stewardship, thereby safeguarding the long-term sustainability of resin tapping in community forests of Salyan district.

Introduction

Resin tapping, a practice dating back centuries, involves the extraction of resinous substances from trees, primarily conifers such as pines for industrial purposes. This traditional method plays a crucial role in the economic livelihoods of many forest-dependent communities worldwide (López-Álvarez et., al 2023). However, its implications extend beyond mere economic benefits, profoundly influencing both forest ecosystems and the socio-economic conditions of local communities.

The practice of resin tapping typically involves making incisions or wounds on the bark of selected trees to collect resin, which is then processed into valuable products such as varnishes, adhesives, and perfumes (*Sharma et al., 2018*). Historically, resin tapping has been integral to local economies, providing sustainable income opportunities for communities living in or near forested areas (López-Álvarez et., al 2023). The economic significance of resin tapping cannot be overstated, as it often represents a primary or supplementary source of income for rural populations.

Beyond its economic importance, resin tapping exerts significant ecological impacts on forest ecosystems. The process of tapping alters the physiology and health of trees, affecting their growth patterns and making them more susceptible to diseases and pests. The wounds inflicted during tapping can compromise the structural integrity of the tree bark, potentially leading to reduced tree vigor and increased mortality rates in severe cases. Moreover, the removal of resin alters the tree's biochemical processes and can disrupt nutrient cycling within the ecosystem.

Forest biodiversity, another critical component of ecosystem health, can also be affected by resin tapping. The altered microhabitat conditions around tapped trees may favor certain species while disadvantaging others, potentially leading to shifts in species composition and ecological interactions within the forest community. For instance, changes in the availability of tree resin can influence the foraging behavior of insects and birds that rely on resin as a food source or nesting material.

Furthermore, the socio-economic impacts of resin tapping on local communities are multifaceted. While it provides a direct source of income for individuals engaged in tapping activities, the reliance on resin tapping as a primary livelihood option can create economic vulnerability during periods of fluctuating market demand or environmental stresses. Moreover, the traditional knowledge and cultural practices associated with resin tapping are integral parts of many indigenous and local communities' cultural heritage, further intertwining the practice with social identity and community cohesion.

Resin tapping in Nepal centers on the extraction from Chir pine (Pinus roxburghii) and Blue pine (Pinus wallichiana), with Chir pine being economically advantageous due to its widespread distribution across mid-hill regions, typically found between 900 to 2700 meters in altitude (Jackson, 1994; DFRS, 1999). The annual yield from a single Chir pine tree ranges from 3 to 6 kilograms of resin, proving pivotal as a significant income source for local communities and a revenue generator for Community Forest User Groups (CFUGs) (Jackson, 1994; Acharya, 2005). Since its inception in 1986, resin tapping activities have expanded to encompass 34 districts, predominantly managed by CFUGs under the forestry sector's Master Plan (Karki & Tiwari, 1998; Acharya, 2005). Approximately 10,000 individuals engage in resin tapping annually across Nepal, with potential earnings reaching up to 30,000 Nepalese Rupees per person during the eight-month tapping season (Upadhyay, 2064; Subedi, 2010). This employment opportunity significantly bolsters the socio-economic status of forest-dependent communities, particularly in hilly terrains where CFUGs play a crucial role in forest resource restoration and poverty alleviation efforts (Kanel, 2004; Poudel, 2017).

However, the sustainable management of resin tapping hinges on rigorous regulation of tapping intensity and adherence to Resin Tapping Guidelines, 2064, crucial for maintaining a balance between economic benefits and forest conservation (Chaudhary, 2000; Karki & Tiwari, 1998). The resin industry, encompassing rosin and turpentine production, not only fosters employment but also serves as a primary income source for CFUGs (Coppen & Hone, 1995; Acharya, 2005). This study aims to investigate the alignment of resin collection practices with these guidelines, assessing their broader impact on forest health and local livelihoods. By delving into these dynamics, we seek to understand the dual role of resin tapping in Nepal's socio-economic landscape and its implications for sustainable development in forest-dependent communities (Acharya, 2005; Poudel, 2017)

Given these complex interrelationships between resin tapping, forest ecosystems, and local communities, there is a pressing need for comprehensive research to understand and mitigate the potential negative impacts while harnessing the benefits sustainably. This research program, referenced as 03/2080/081, aims to address these gaps by systematically investigating the ecological, economic, and socio-cultural dimensions of resin tapping.

By examining the ecological consequences of resin extraction on tree health, biodiversity, and ecosystem services, this research seeks to quantify the environmental footprint of resin tapping activities. Concurrently, it endeavors to assess the socio-economic dynamics at play, including income generation, livelihood diversification opportunities, and community resilience to external shocks.

The findings from this research program are expected to contribute significantly to policy formulation and management strategies aimed at promoting sustainable resin tapping practices. By identifying best practices for resin extraction, enhancing community involvement in decision-making processes, and integrating traditional knowledge with modern scientific approaches, this research aims to foster a balanced approach to resin tapping that ensures both ecological integrity and socio-economic well-being.

Resin tapping represents a crucial intersection of economic livelihoods, ecological sustainability, and cultural heritage for forest-dependent communities. This research also seeks to illuminate the complexities of resin tapping, providing insights into its impacts on forest ecosystems and local communities while offering pathways towards sustainable development and conservation practices.

2. Objectives

a. Assessing Ecological Impact:

i. Investigate the effects of resin tapping on forest biodiversity and ecosystem health.

ii. Analyze the regeneration capacity of tapped trees and the long-term impact on forest structure.

b. Identifying Sustainable Practices:

i. Evaluate existing resin tapping methods and their sustainability.

ii. Propose environmentally sound and socially responsible tapping practices.

c. Socio-Economic Evaluation:

i. Examine the economic contributions of resin tapping to local communities.

ii. Assess the socio-economic well-being of individuals and communities engaged in resin tapping.

3. Methodology

3.1 Study area

rnali Province, Nepal's largest province spanning 30,211 km^2, encompasses a rich tapestry of landscapes and ecosystems. This study focuses specifically on Salyan district, renowned for its strategic location and ecological diversity. Within Salyan district, the study zooms in on two key areas: Sharadha Municipality, serving as the district's administrative hub, and Chhatreshwori Rural Municipality, which borders Rolpa district (Figure 1). Both areas share a subtropical highland climate, characterized by mean annual temperatures of 25.5°C (maximum) and 13.4°C (minimum), and receive an annual precipitation of 1162.9 mm, nurturing extensive Pinus roxburghii forests.

The selection of Sharadha Municipality and Chhatreshwori Rural Municipality allows for a detailed exploration of resin tapping activities influenced by factors such as accessibility and administrative oversight. Sharadha Municipality, centrally located and hosting the District Forest Office (DFO), likely undergoes stricter monitoring, potentially influencing the regulation and prevalence of resin tapping compared to the more remote Chhatreshwori Rural Municipality. Additionally, national forests within Bangadh Kupinde Municipality were selected due to their untapped status, enriching the study with varied forest conditions.

This dual-site approach facilitates a comprehensive study that not only examines variations in resin tapping practices but also illuminates their ecological impacts and socio-economic ramifications for local communities within Salyan district. The findings aim to inform forest management strategies and policy recommendations across Karnali Province. Furthermore, the social survey included data collection from Community Forest User Groups (CFUGs) located in various local units within Salyan district, ensuring a broad and representative assessment of resin tapping's societal dimensions.

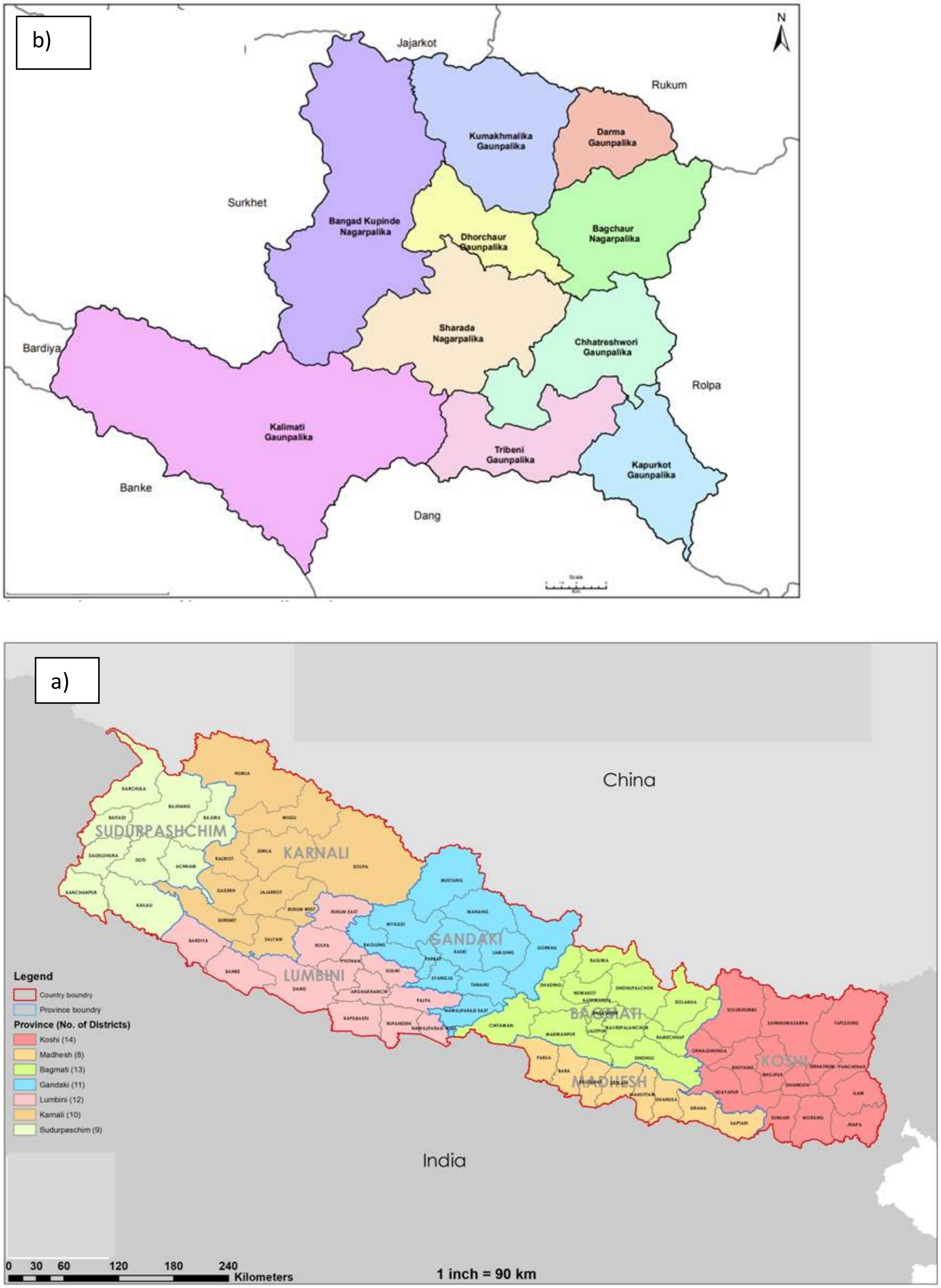


Figure 1: Map of study area with in Nepal (a), map of Salyan District (b)

3.2 Sampling Design and Forest Measurement

The selection of appropriate forests and the design of the sampling strategy were crucial steps in conducting the research on the impact of resin tapping on forest ecosystems and socio-economic conditions of local communities. This section outlines the methodology employed, including the criteria for forest selection, sampling design, and the specific measurements taken during fieldwork.

Forest Selection and Criteria

Initial forest selection was carried out in collaboration with the District Forest Office (DFO) staff in Salyan. The objective was to identify forests where resin tapping activities were actively conducted, as well as forests where no resin tapping occurred, for comparative purposes. Four community forests engaged in resin tapping were selected, along with two forests where resin tapping did not take place. This selection aimed to capture variations in regeneration dynamics and plant species diversity influenced by resin extraction activities.

Sampling Design

A purposive sampling method was employed to select study sites, focusing on forests that could best fulfill the research objectives. The size of the forests was not a primary consideration; rather, the emphasis was on ensuring representation of both tapped and untapped forests within the study area.

Field Procedures and Data Collection

Upon selecting the study forests, field visits were conducted to implement the sampling design and collect relevant data. The following field procedures were undertaken:

Layout of Circular Plots:

Ten concentric circular plots were established in each forest to ensure comprehensive sampling across the study area. The placement of these plots was purposively arranged to cover a representative sample of the forest's spatial variability. The size of plot for seedlings, Sapling and Trees/Poles are presented in Figure 2.

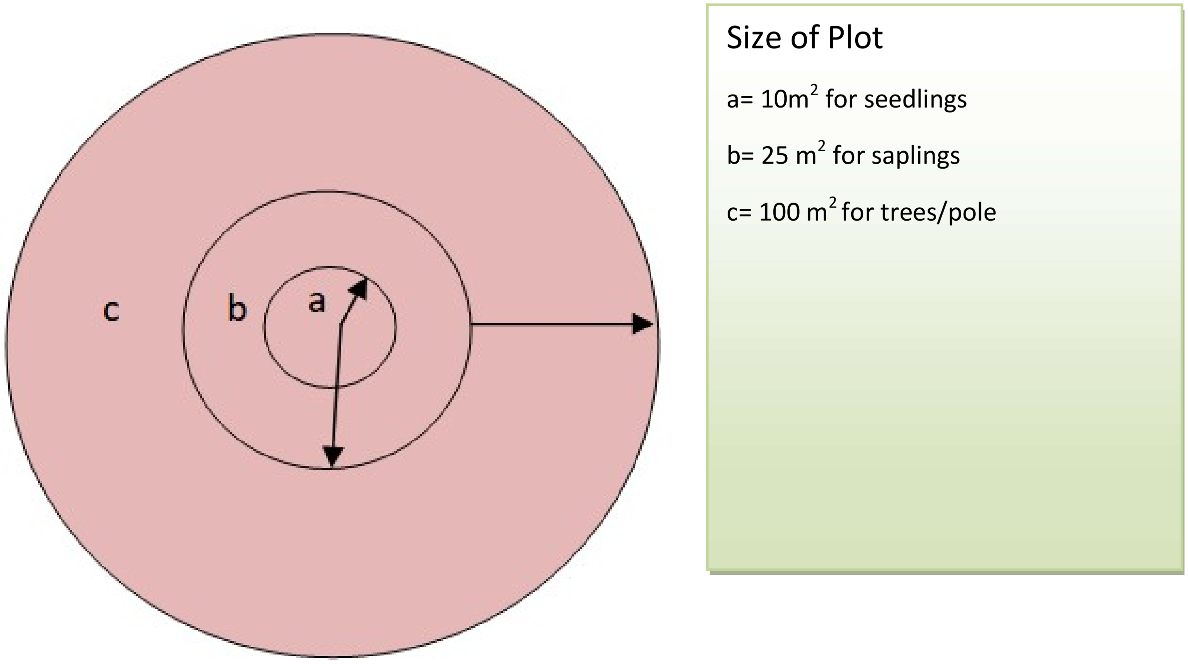


Figure 2 Size of Sample Plot used for forest inventory

Measurement Parameters:

Tree Height: The height of trees with a diameter greater than 10 cm was measured using a vertex or clinometer, ensuring accuracy in vertical measurements.

Tree Diameter: Diameter at breast height (dbh) of selected trees was measured using a diameter tape, typically at 1.3 meters above the ground level. This measurement provides insights into the size and age structure of the tree population.

Sampling of Herbaceous Plants: Sampling of herbaceous vegetation was conducted within 25 square meter quadrats placed within each plot. This method allows for the assessment of ground cover, species diversity, and composition.

Seedling Counts: Within 10 meter square subplots, seedling counts were performed to evaluate regeneration dynamics and recruitment of new tree individuals within the forest ecosystem.

Documentation of Dead and Tapped Trees: Dead trees within each plot were documented to assess mortality rates and potential causes, including impacts from resin tapping activities.

Additionally, any trees with a diameter less than 30 cm that had been tapped were noted to understand the prevalence and spatial distribution of resin extraction within the study area.

3.3 Key Informant Survey and Focus Group Discussion

In addition to assessing the ecological impacts of resin tapping, understanding its socio-economic implications on local communities was a critical component of the research. This section details the methodology employed to gather socio-economic data through key informant surveys and focus group discussions with Community Forest User Groups (CFUGs).

Key Informant Survey

A key informant survey was designed to gather detailed socio-economic information from individuals directly involved in resin tapping activities. The survey questionnaire was developed to capture data on various aspects, including income generation, expenditure patterns related to resin tapping, household demographics, and perceptions regarding the benefits and challenges associated with resin extraction.

Sampling and Data Collection

A total of 45 resin tapping employees were systematically selected to participate in a comprehensive survey aimed at capturing detailed socio-economic insights. These individuals were chosen for their direct involvement in resin extraction, reflecting their integral role in the local economy of the study area. The survey, conducted through face-to-face interviews in the field, ensured meticulous data collection. Participants were extensively queried regarding their income from resin tapping activities, elucidating both the earnings magnitude and variability seasonally or annually. Additionally, the survey delved into expenditure patterns, elucidating how earnings were allocated across household necessities, education, healthcare, and other essential expenses crucial for livelihood sustenance. Socio-demographic characteristics were also documented, encompassing household compositions, educational attainment levels, and various socio-economic indicators to paint a comprehensive profile of the respondents. Furthermore, the survey explored participants' perspectives on resin tapping, encompassing views on its perceived benefits, encountered challenges, and anticipated prospects as a sustainable livelihood option in the future, thus providing a nuanced understanding of the socio-economic dynamics within the resin tapping community

Focus Group Discussions with CFUGs

In addition to individual surveys, focus group discussions (FGDs) were conducted with representatives from Community Forest User Groups (CFUGs) associated with the selected community forests where resin tapping activities took place. CFUG members were selected to provide insights into broader community perspectives, challenges faced, and potential opportunities related to resin tapping.

Secondary Data collection

Secondary data collection from the records of Community Forest User Groups (CFUGs) involved accessing and analyzing historical data pertaining to income generated from resin tapping activities and expenditures across various sectors over a span of five years. CFUGs, which manage community forests and oversee resin tapping operations, maintain detailed records that provide insights into the economic aspects of forest management and utilization.

The process of data collection from CFUG records entailed retrieving financial statements, annual reports, and other documentation that document the revenues derived from resin tapping. This included information on the quantity of resin harvested, market prices, and total income generated annually. By examining trends over five years, the study aimed to identify patterns in resin production, market fluctuations, and income variability, which are crucial for understanding the economic sustainability of resin tapping as a livelihood option.

Furthermore, the secondary data collection also encompassed expenditures associated with resin tapping activities. This involved categorizing expenditures into various sectors such as administrative costs, maintenance of infrastructure (e.g., trails, storage facilities), salaries and wages for workers involved in resin collection, and investments in community development projects funded through resin revenues. Analyzing expenditure patterns provided insights into how income generated from resin tapping was allocated to support community needs, enhance infrastructure, and promote socio-economic development within the CFUGs.

3.4 Data Analysis

The data analysis process for studying the impact of resin tapping on forest ecosystems and local communities involved comprehensive methods to derive meaningful insights. Initially, data were cleaned and prepared to ensure accuracy and completeness, addressing any errors or inconsistencies in the dataset. Descriptive statistics provided an overview of resin production, income from tapping activities, and expenditure patterns across the studied period. Inferential statistics, such as correlation analysis and regression, explored relationships between variables like resin tapping intensity and biodiversity indices. Qualitative data from interviews and focus groups underwent thematic analysis to uncover recurring themes and community perspectives on resin tapping. Spatial analysis using GIS helped visualize the distribution of resin tapping sites and their environmental implications. Longitudinal analysis assessed trends over time in resin production and socio-economic impacts, offering insights into the sustainability of tapping practices. Synthesizing these findings provided a comprehensive understanding of resin tapping's effects on forests and communities, informing policies for sustainable forest management and community development.

4. Result and Discussion.

a. Assessing Ecological Impact:

i. Investigate the effects of resin tapping on forest biodiversity and ecosystem health.

Across the sampled plots in both types of forests, a consistent range of 2-3 woody species per plot was found (Figure 4), suggesting that this aspect of the forest ecosystem remains relatively stable despite human intervention. Similarly, the total number of plant species per plot showed consistent patterns, indicating that overall plant diversity is not significantly disrupted by resin extraction activities. The study provides a comprehensive analysis of how resin tapping, while a prevalent practice in both tapped and untapped forests, does not appear to be a primary driver of plant diversity variations.

However, when examining the diversity within specific forest locations, notable variations emerged. In tapped forests, certain areas like Chandrapala CF, Janaki CF, and Janaki Mahila CF exhibited higher species richness, each harboring 6 distinct plant species. In contrast, Sworgadwari CF displayed slightly lower species richness with 4 species. Among untapped forests, Kupinde National Forest stood out with the highest recorded species richness of 6, followed by Gairigau CF with 4 species, and Sharadha NF with the lowest richness of 2 species (Figure 5). These findings underscore the role of local environmental factors and geographical conditions in shaping plant diversity more significantly than resin tapping practices themselves.

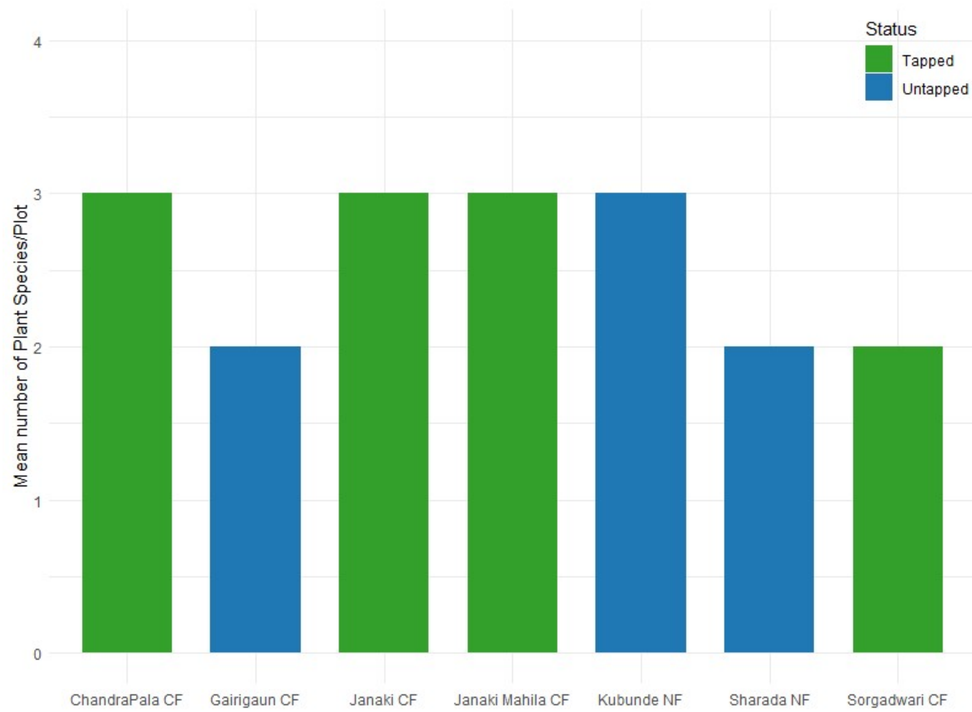


Figure 4 Average number of plant species per plot in seven different forests (4 tapped and 3 untapped forest)

In essence, the study challenges conventional assumptions about the impact of resin tapping on forest biodiversity, highlighting instead the importance of considering broader ecological contexts. Factors such as soil composition, elevation, microclimatic conditions, and historical land use patterns are crucial determinants influencing the distribution and abundance of plant species within these forests. By recognizing and safeguarding the unique ecological characteristics of each forest location, conservation efforts can effectively support the resilience and sustainability of these natural ecosystems, ensuring the continued health and diversity of plant communities for future generations.

Further analysis revealed that across our surveyed plots in both tapped and untapped forests, we did not encounter any instances of dead trees during our comprehensive inventory. This finding challenges the notion that resin tapping significantly contributes to tree mortality within these forest ecosystems. The absence of dead trees suggests that resin extraction activities, including the process of making incisions in tree bark, do not impose a lethal impact on the tapped trees observed in our study areas.

This absence of tree mortality attributable to resin tapping underscores the resilience of trees to this specific human intervention. It implies that while tapping may temporarily affect tree physiology and resin production, trees appear capable of compartmentalizing and healing from these wounds effectively enough to avoid mortality. Moreover, the health and vitality of trees in both tapped and untapped forests suggest that other factors, such as natural senescence, disease, or environmental stressors, may play more significant roles in tree mortality than resin tapping practices alone.

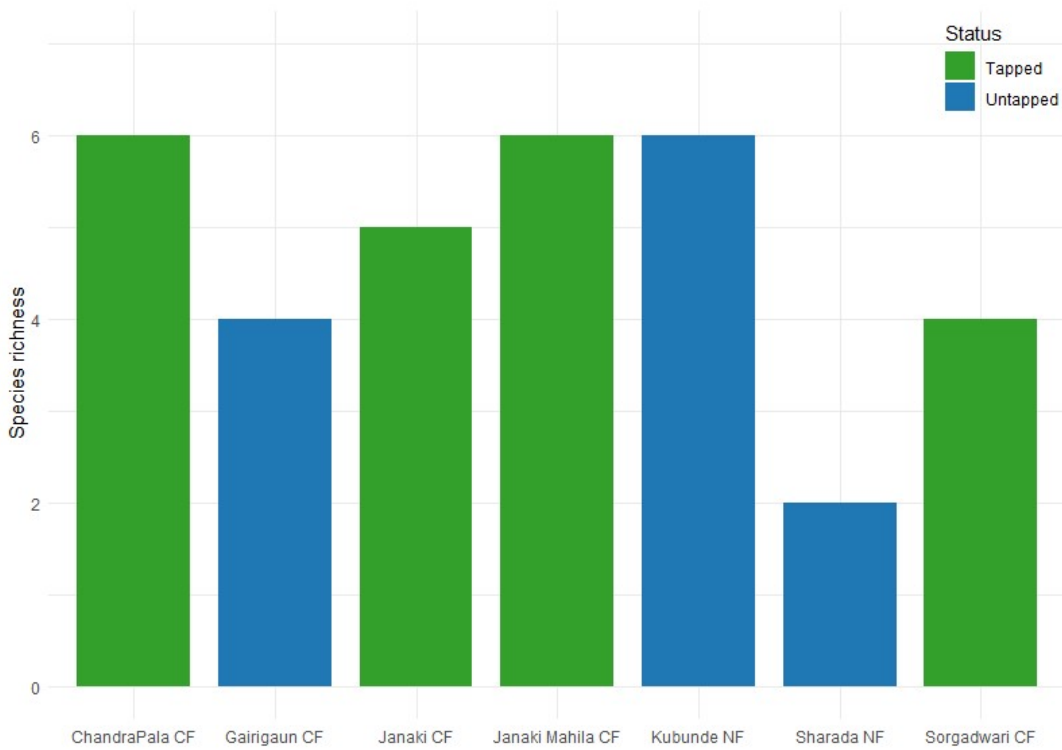


Figure 5: Species richness in tapped and untapped forest

ii) Analyze the regeneration capacity of tapped trees and the long-term impact on forest structure

In our study, regeneration was defined based on the presence of seedlings and saplings, reflecting the future potential growth of forest vegetation. Interestingly, we observed a comparable pattern of regeneration in both tapped and untapped forests across our surveyed areas. Specifically, we found notable differences in regeneration rates among different forest locations. Among the tapped forests, Janaki CF exhibited the highest regeneration density with approximately 6200 seedlings and saplings per hectare, showcasing robust natural regeneration despite resin tapping activities. In contrast, Sorgadwari Forest displayed a lower regeneration density of 3800 per hectare, indicating potential variations in ecological conditions or management practices affecting seedling establishment (Figure 6).

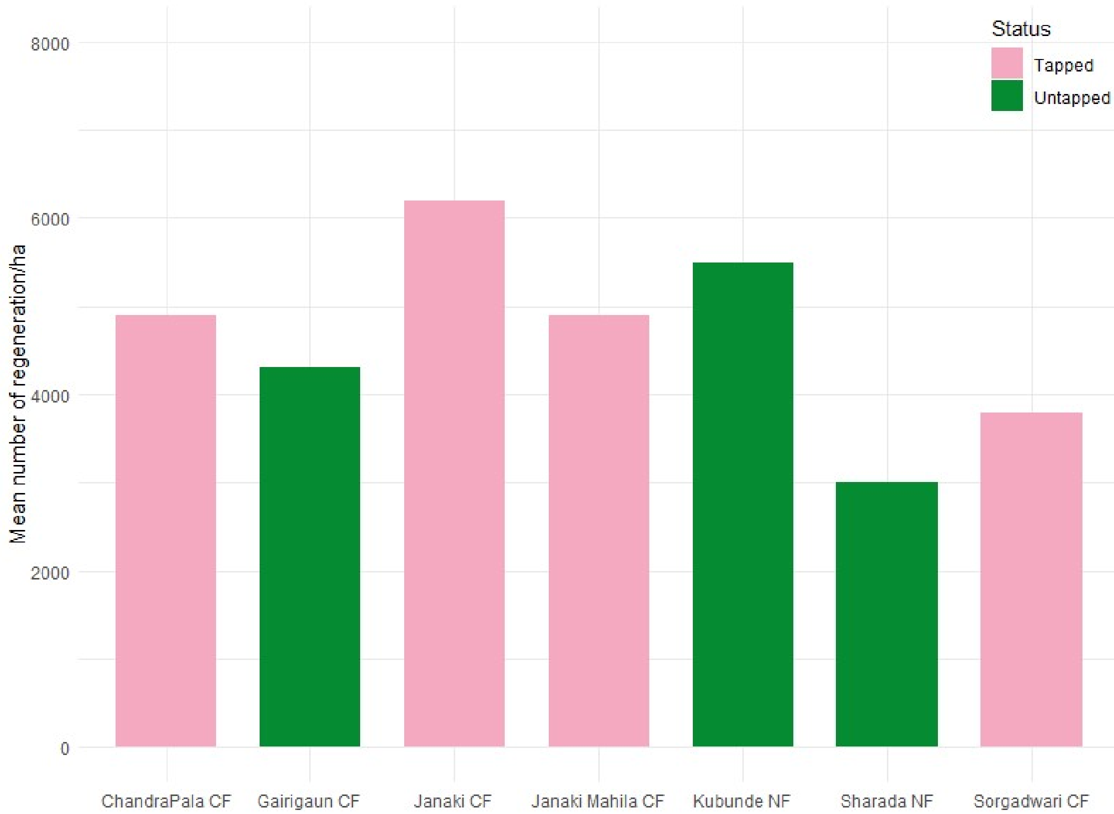


Figure 6: mean number of regeneration per ha in tapped and untapped forest

Similarly, within the untapped forests, regeneration densities varied significantly across different locations. Sharada NF showed a moderate regeneration density of 3000 per hectare, while Kupinde NF demonstrated a higher density of 5500 per hectare. Gairigau CF recorded 4300 seedlings and saplings per hectare, highlighting varying levels of natural regeneration potential across different untapped forest areas. These findings underscore the influence of local environmental factors, such as soil fertility, moisture levels, and light availability, in shaping regeneration dynamics.

In our scientific study focused on resin-tapped and adjacent untapped forest ecosystems, we observed that while both types of forests exhibit similar patterns of regeneration, specific forest locations can significantly influence the density of seedlings and saplings. This finding underscores the complexity of regeneration dynamics and highlights the importance of local environmental factors in shaping forest recovery post-disturbance.

Our research indicates that forest fires are a notable factor affecting regeneration in the study area. Despite initial assumptions that resin-tapped forests might be more susceptible to fires due to human activity and potential disturbances associated with resin extraction, our findings revealed evidence of forest fires occurring in both tapped and untapped forests. This suggests that while resin tapping practices may influence localized disturbances, such as canopy openings or changes in microclimatic conditions, broader environmental factors like fire can impact regeneration irrespective of tapping activities.

Understanding these dynamics is crucial for informing sustainable forest management practices. By identifying the specific factors influencing regeneration rates and patterns in resin-tapped and untapped forests, managers can develop targeted strategies to enhance resilience and support biodiversity conservation efforts. This includes implementing measures to mitigate fire risks, promoting forest health through appropriate silvicultural practices, and ensuring the continuity of ecosystem services essential for both natural ecosystems and the communities that depend on them.

In terms of forest structure, our study revealed consistent tree sizes across both tapped and untapped forests. Specifically, mixed stands exhibited a well-distributed pattern of trees across various size classes, indicating robust forest structure. In contrast, pure stands showed a limited range of tree sizes. This finding underscores that pine forests with mixed stands generally possess more diverse and balanced forest structures compared to those with pure stands. Importantly, our analysis indicates that the presence or absence of resin tapping did not significantly influence these structural characteristics. Instead, the diversity in tree size classes primarily depended on whether the forest was managed as a mixed or pure stand. This insight highlights the importance of forest management strategies that promote mixed-species stands to enhance overall forest structure and resilience, irrespective of resin tapping practices. Such approaches are crucial for maintaining biodiversity, ecosystem stability, and sustainable resource management in pine forest ecosystems.

b. Identifying Sustainable Practices:

i. Evaluate existing resin tapping methods and their sustainability.

Existing resin tapping methods vary globally, each with distinct impacts on tree health, resin yield, and overall forest sustainability. In Nepal, the rill method is employed in all forest where resin tapping activities conducted. Therefore in our study area, we found rill method in tapping resin.one of the traditional methods employed is the rill method, which involves making diagonal or horizontal incisions into the bark of resinous trees, primarily species like pines.

The rill method, practiced in Nepalese forests, entails carefully cutting into the bark to expose resin ducts, allowing the resin to flow naturally down the tree trunk and collect in a small channel or "rill" carved into the wood. This method is known for its minimalistic approach, causing less damage to trees compared to more invasive methods like cup-and-gutter systems. By avoiding extensive bark removal, the rill method helps preserve the tree's cambium layer, crucial for continued tree growth and vitality. This preservation is beneficial for the long-term sustainability of resin production in tapped forests.

Furthermore, the rill method supports sustainable forest management by promoting tree health and reducing the risk of tree mortality associated with more aggressive tapping techniques. The technique allows trees to heal more effectively between tapping seasons, minimizing stress and potential for fungal infections or insect damage. This aspect is particularly vital in maintaining the overall health and productivity of resinous tree populations over extended periods.

However, challenges remain with the rill method, including potential resin flow variability due to weather conditions and the need for skilled labor to ensure precise incisions and proper channel maintenance. Moreover, its sustainability hinges on responsible management practices, including rotational tapping to give trees adequate recovery periods and monitoring to prevent over-exploitation of resin resources.

While the rill method presents promising advantages for sustainable resin extraction in Nepalese forests, its effectiveness depends on careful implementation and adherence to best practices. Continued research and adaptation of tapping techniques are essential for enhancing sustainability, preserving forest ecosystems, and supporting the livelihoods of communities reliant on resin as a valuable natural resource.

In this study, conducted across five community forests, namely ChandraPala, Janki, S tot st) to a nce

Figure 7 : Diameter measurement of tapped trees (<30cm Dbh)

forests, the total number of tapped trees varied, with ChandraPala having 45 trees tapped, Janki 47, Sworgadwari 48, Janaki Mahila 52, and Indra 53 (Table 1). Notably, Sworgadwari , Indra and Janaki Mahila forests exhibited trees that were tapped below the prescribed threshold, with 7, 4 and 3 trees respectively falling into this category (Figure 7 and Figure 8).

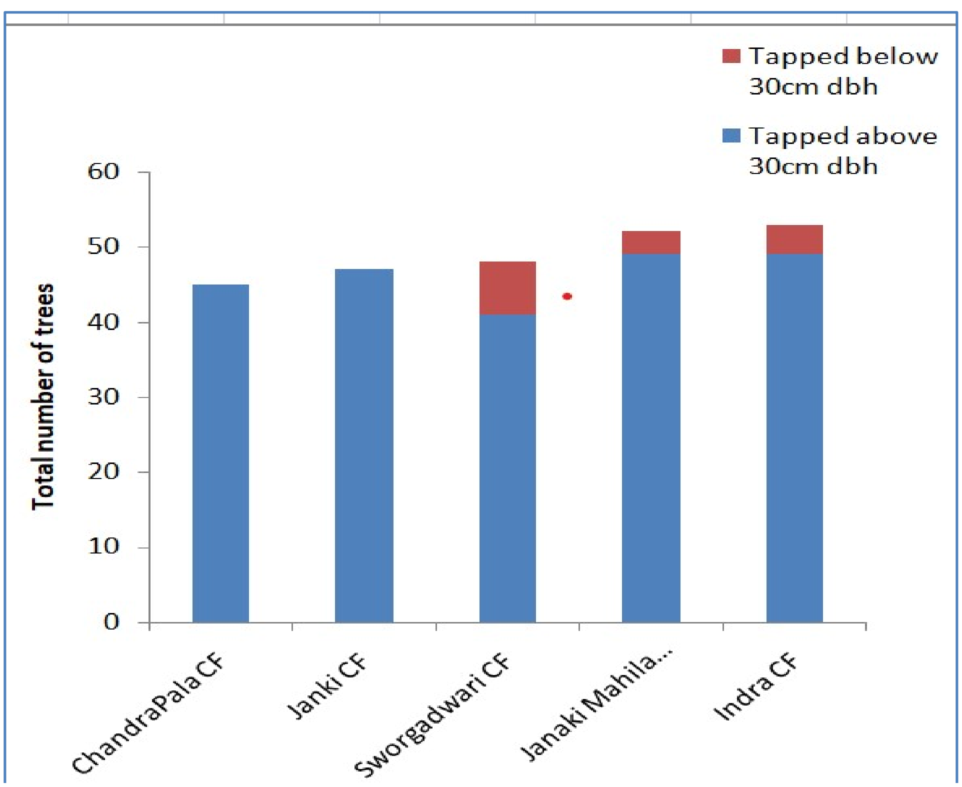
Our study identified a significant deviation from Nepal's resin tapping guidelines, which stipulate that tapping should only occur on trees with a diameter at breast height (dbh) greater than 30 cm. Contrary to these regulations, we observed that approximately 0-15% of trees below this threshold had been tapped across the studied community forests. Notably, many of these tapped trees had a minimum dbh of 20 cm, indicating a widespread practice of tapping younger and smaller trees than recommended.

This discrepancy raises serious concerns about the sustainability of resin extraction practices in these ecosystems. Tapping trees below the specified diameter not only reduces the resin yield per tree but also undermines the trees' ability to recover and sustainably produce resin in the future. Moreover, younger trees are less resilient to the physical stresses of tapping, potentially leading to long-term damage and reduced forest health.

The variability in tapping practices observed underscores the urgent need for targeted management strategies. Effective governance and enforcement of existing guidelines are crucial to ensuring the ecological and economic sustainability of forest resources. It is imperative for stakeholders, including Community Forest User Groups (CFUGs), resin companies, and regulatory authorities, to collaborate closely in implementing robust monitoring systems and enforcement mechanisms. These efforts should aim to promote responsible tapping practices that respect ecological thresholds and support the long-term health and productivity of Nepal's forest ecosystems. By addressing these challenges proactively, we can safeguard biodiversity, enhance forest resilience, and sustainably manage resin resources for current and future generations.

Table 1: Number of trees tapped below 30cm dbh

SN	Name of Forest	Total number of Sample plot	Total tapped trees	Tapped below 30cm Dbh	Remarks
1	ChandraPala CF	10	45	0	
2	Janki CF	10	47	0	
3	Sworgadwari CF	10	48	7	
4	Janaki Mahila CF	10	52	3	
5	Indra CF	10	53	4	



In our study, alongside the identification of trees tapped below sustainable thresholds, we also observed a troubling pattern: some trees were minimally tapped from multiple sides, as evident from the visual evidence provided in Figure 9. This practice indicates a lack of proper supervision and control over resin tapping activities within the community forests. Such practices not only compromise the health and productivity of individual trees but also raise broader concerns about the overall sustainability of resin extraction in these ecosystems.

Figure 9 Resin Tapped from two sides in a Pinus Tree

The responsibility for overseeing these activities primarily lies with the Community Forest User Groups (CFUGs) and the resin companies involved. However, our findings suggest a significant gap in their commitment to ensuring responsible resource management. Both parties seem to deflect accountability by attributing these practices to the laborers conducting the tapping, rather than taking proactive measures to enforce sustainable practices. This lack of effective oversight and accountability undermines efforts to maintain biodiversity, soil health, and overall ecosystem resilience.

Addressing these issues requires concerted efforts to strengthen monitoring mechanisms and enhance regulatory frameworks. It is essential for CFUGs and resin companies to collaborate closely with regulatory authorities to develop and enforce clear guidelines for resin tapping, ensuring that practices are environmentally sustainable and socially responsible. By fostering a culture of accountability and transparency, we can strive towards preserving these valuable forest resources for future generations while supporting the livelihoods of local communities dependent on forest resources.

In our research and field observations concerning resin tapping practices in Nepal, we have noted instances where resin extraction has been conducted on mother trees, despite clear guidelines stipulating their protection. Mother trees are fundamental to the ecological balance of forests as they serve as seed sources for natural regeneration, ensuring genetic diversity and long-term sustainability. Our findings underscore the importance of adhering to established guidelines that prohibit resin tapping on healthy mother trees to safeguard their reproductive capacity and ecological functions.

Resin tapping on mother trees poses significant ecological risks by potentially compromising their ability to produce viable seeds and support forest regeneration. This practice not only threatens the genetic diversity of tree populations but also disrupts critical ecological processes such as nutrient cycling and habitat provision. Our observations highlight the need for enhanced monitoring and enforcement of regulations to prevent unauthorized resin extraction on mother trees. Effective management practices should prioritize education and awareness among stakeholders, including local communities and resin collectors, about the ecological significance of mother trees and the importance of their conservation in sustainable forest management.

ii) Environmentally sound and socially responsible tapping practices.

Environmentally sound and socially responsible practices for resin extraction involves a comprehensive approach that integrates sustainability principles across all operational facets. Strict adherence to established guidelines and regulations forms the cornerstone of responsible extraction. This includes tapping only trees above a minimum diameter, typically 30 cm in Nepal, to protect younger trees and ensure they mature fully. Implementing selective and rotational tapping practices further minimizes ecological impact, allowing for natural regeneration and maintaining forest health over time. By adhering to these practices, resin extraction can sustainably meet economic needs without compromising the integrity of forest ecosystems.

Community engagement is equally vital. Involving local stakeholders, especially Community Forest User Groups (CFUGs), in decision-making processes ensures activities align with local priorities and cultural practices. Transparent benefit-sharing mechanisms, such as revenue sharing and employment opportunities, are essential for equitable distribution of economic benefits derived from resin extraction. Capacity building through training programs enhances local knowledge in sustainable tapping techniques and forest conservation, empowering communities to participate actively in resource management and fostering a sense of ownership over forest resources. This engagement not only strengthens community resilience but also promotes sustainable development that respects local traditions and values.

Continuous monitoring and assessment are fundamental to track and mitigate the ecological impacts of resin extraction. Regular assessments should cover aspects such as tree health, resin yield, biodiversity impacts, and soil quality. This data informs adaptive management strategies, ensuring that operations remain sustainable and adaptive to changing environmental conditions. Investing in research and innovation for improved extraction technologies and practices enhances efficiency while minimizing environmental footprints. Promoting transparency and accountability through certification schemes for responsibly sourced resins ensures adherence to ethical standards and prevents illegal harvesting, thereby safeguarding forest integrity.

The integration of these practices supports a balanced approach that harmonizes economic interests with environmental stewardship. By safeguarding ecosystem health and biodiversity, stakeholders contribute to the long-term sustainability of resin-producing forests. Sustainable resin extraction not only preserves natural resources but also supports the livelihoods of local communities dependent on resin resources, fostering economic stability and resilience. This integrated approach underscores the importance of collaborative efforts among governments, businesses, local communities, and conservation organizations to ensure that resin extraction practices are both environmentally sustainable and socially responsible, paving the way for sustainable development and conservation of forest ecosystems.

c. Socio-Economic Evaluation:

i. Examine the economic contributions of resin tapping to local communities.

Our study conducted a thorough analysis of the financial performance of six distinct Community Forests (CFs) over the five-year period from fiscal year 2074/ 2075 to 2079/2080, aiming to uncover nuanced dynamics in income and expenditure trends within these community-managed forest ecosystems (Figure 10). Through meticulous data collection and visualization, our findings revealed a diverse landscape of financial behaviors among the CFs, each responding uniquely to environmental, economic, and social influences.

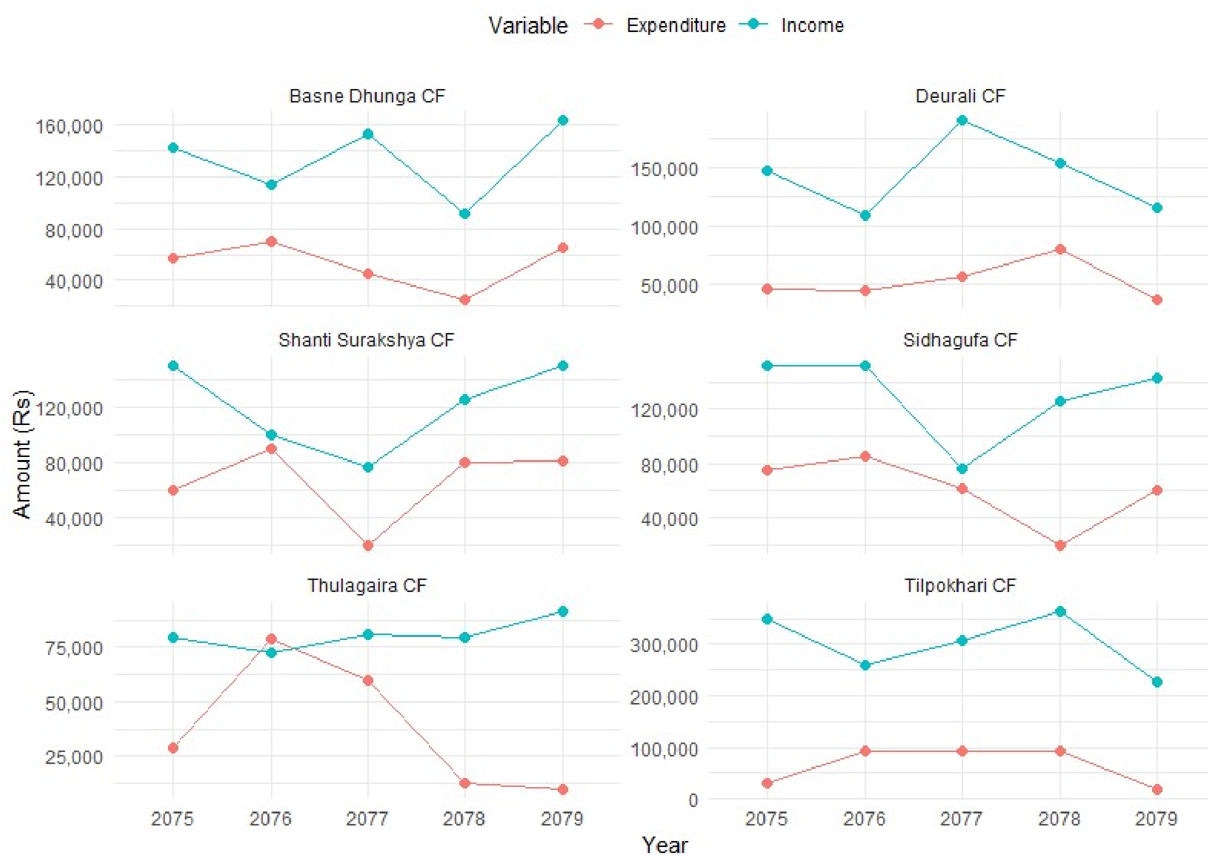


Figure 10 Income and Expenditure of CFUGs from resin tapping activities

A striking observation from our study was the differential growth patterns in income among the CFs. For instance, Deurali CF demonstrated a consistent upward trajectory in income throughout the study period. This steady growth suggests effective management practices and successful implementation of income-generating activities such as resin tapping and sustainable timber harvesting. The sustained increase in income not only indicates robust economic management but also highlights the CF's ability to leverage its natural resources for long-term financial stability.

Conversely, Basne Dhunga CF exhibited more erratic income patterns, fluctuating in response to market conditions or variations in natural resource availability. These fluctuations underscore the challenges faced by CFs in maintaining stable revenue streams, emphasizing the need for adaptive strategies to mitigate economic volatility. Such insights are crucial for CF managers and policymakers, as they navigate the complexities of managing community forests amidst external uncertainties.

Our analysis also shed light on the expenditure patterns across the CFs, revealing diverse approaches to financial management. While some CFs maintained steady expenditure levels focused on essential activities such as forest regeneration and community welfare programs, others experienced fluctuations in spending aligned with variations in income. For example, Thulagaira CF strategically invested in infrastructure and community development projects during periods of heightened revenue, reflecting a proactive approach to capitalizing on financial opportunities for long-term sustainability.

A pivotal finding from our study was the sustainability of income generation through resin tapping across many CFs. The charted data clearly illustrated instances where income from resin tapping surpassed expenditure, highlighting its role as a dependable economic driver for local communities involved in Community Forest User Groups (CFUGs). This surplus not only supported livelihoods but also enabled reinvestment in critical forest management practices, including fire prevention, biodiversity conservation, and sustainable harvesting techniques. These investments are essential for safeguarding the ecological integrity of community forests while enhancing their capacity to deliver economic benefits over time.

The implications of our findings extend to policymakers and stakeholders engaged in community forest management. Our study underscores the importance of tailored financial strategies that capitalize on sustainable income sources while ensuring prudent expenditure on essential forest management and community welfare initiatives. This dual approach not only fosters economic resilience but also promotes ecological sustainability, aligning with global conservation goals and benefiting both local communities and the broader environment.

Our in-depth exploration of income and expenditure trends in six CFs provides valuable insights into the intricate dynamics of community forest management. By elucidating these dynamics, our study contributes to a deeper understanding of how CFs can navigate economic uncertainties and environmental challenges while advancing sustainable development objectives. These insights are instrumental in informing evidence-based policy decisions and guiding future initiatives aimed at enhancing the resilience and well-being of communities dependent on forest resources.

ii. Assess the socio-economic well-being of individuals and communities engaged in resin tapping.

Training for resin tapping

In our study, a significant finding revealed that 90% of the respondents engaged in resin tapping reported that they acquired their skills through informal training methods. This informal training could involve learning from experienced community members, traditional knowledge passed down through generations, or practical hands-on experience gained within the community forest setting. The remaining 10% of respondents indicated that they received formal training or orientation on resin tapping provided by external entities such as companies, NGOs, or government agencies (Figure 11) .

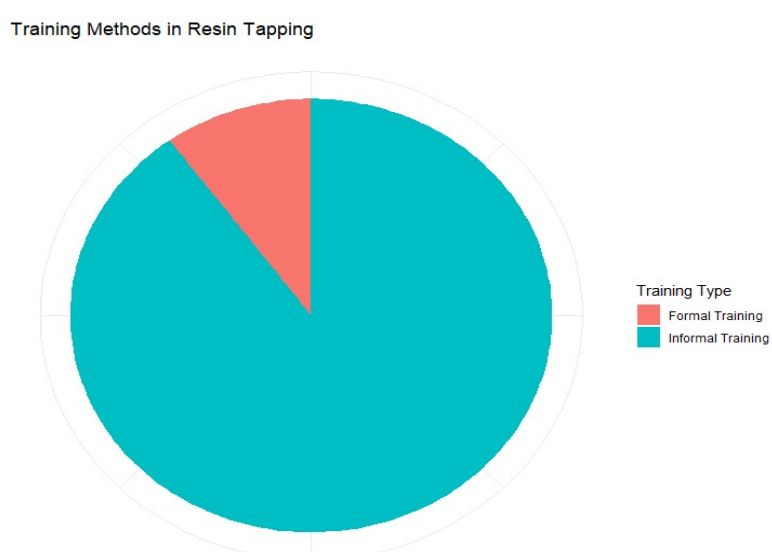


Figure 11: Number of Employee having Training on resin tapping

This distribution highlights the predominant reliance on informal knowledge transmission within community-based resin tapping activities. Informal training methods are often deeply rooted in local knowledge systems and cultural practices, allowing community members to acquire skills and expertise that are adapted to local conditions and practices. This grassroots approach not only enhances community engagement and ownership but also supports the sustainability of traditional practices and ecological knowledge associated with resin tapping.

Income from Resin Tapping

In our study, we explored the earnings distribution among employees engaged in resin tapping during the peak season, revealing distinct income groups. Among resin tappers, 80% earn between 1 to 2 lakhs, indicating a predominant group likely comprising experienced and regular workers. These individuals typically perform essential tasks such as resin extraction and forest maintenance, contributing steadily to the community forest's economic activities.

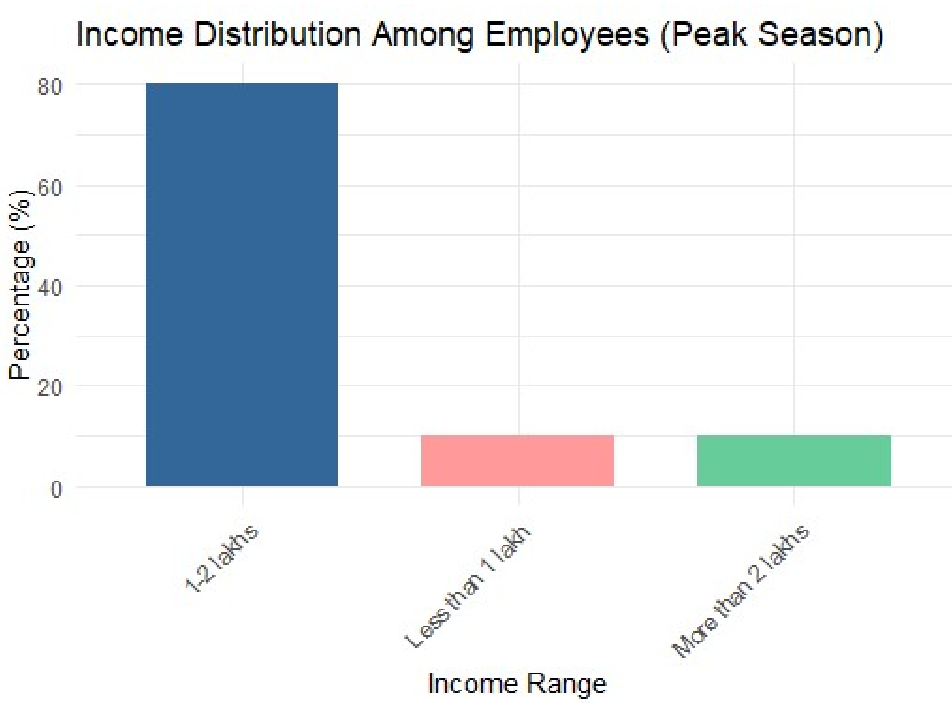


Figure 12: Income generation from resin tapping

Additionally, 10% of resin tappers earn more than 2 lakhs, suggesting specialized roles or higher responsibilities within the resin tapping operations. These individuals may oversee larger-scale resin extraction processes, manage teams, or implement advanced techniques that optimize resin yield and quality. Their higher earnings reflect both skill specialization and the critical nature of their contributions to resin production.

Conversely, the remaining 10% of resin tappers earn less than 1 lakh during the peak season. This group may include seasonal or part-time workers, newer entrants to resin tapping, or those engaged in less intensive roles within the operations. Their lower earnings could stem from fewer hours worked, lower productivity due to limited experience, or intermittent employment within the resin tapping workforce.

This distribution underscores the varied roles and responsibilities within resin tapping activities, highlighting how income levels correlate with experience, skill specialization, and the nature of employment arrangements within community forest enterprises. Such insights are crucial for understanding the socio-economic dynamics and livelihood opportunities provided by resin tapping activities in community forest settings

Job satisfaction

In our study on job satisfaction among employees, we found that a significant majority, 75% of the respondents, expressed full satisfaction with their current roles and stated that they have no intention of leaving their current employment (Figure 13). This high level of satisfaction is indicative of positive workplace conditions, effective management practices, and alignment between individual expectations and organizational culture. It suggests that the majority of employees feel valued, supported, and engaged in their work, which can contribute to higher productivity, lower turnover rates, and a positive organizational climate overall.

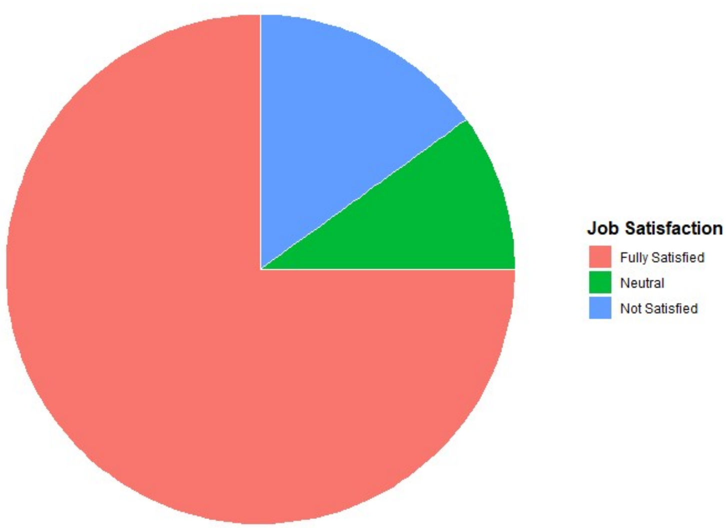


Figure 13: Job satisfaction of the employee

On the other hand, 15% of the respondents reported that they are not satisfied with their current work situation. This group may experience challenges such as mismatched job roles, lack of growth opportunities, or issues with workplace environment or culture. Addressing the concerns of this segment is crucial for improving overall employee satisfaction and retention rates, as dissatisfied employees are more likely to seek opportunities elsewhere, potentially leading to increased turnover and associated costs for the organization.

The revelation that all employees have no savings in banks from their earnings due to living hand-to-mouth warrants a deeper exploration into the financial realities and implications for employee well-being. This situation highlights a critical aspect of the employment conditions within the organization, shedding light on the challenges faced by employees despite their reported job satisfaction levels.

Credit in bank/Savings

For many employees, particularly those earning within the 1-2 lakhs range annually, the absence of savings in banks points to immediate financial needs that absorb the entirety of their earnings. This scenario reflects broader socioeconomic challenges such as high living costs, limited income growth opportunities, and potentially inadequate financial planning or education. Without savings, employees may face heightened financial vulnerability, making it difficult to weather unexpected expenses, invest in personal development, or plan for long-term goals such as education or retirement.

Moreover, the absence of bank savings among employees underscores a need for supportive measures within the organization to address financial stability and well-being. While job satisfaction and engagement are crucial indicators of positive workplace environments, sustainable livelihoods require more than just job contentment. Employers could consider implementing financial literacy programs, facilitating access to affordable financial services, or offering benefits that promote savings and financial resilience among employees.

From a policy and organizational standpoint, understanding the reasons behind the lack of savings can inform targeted interventions. For instance, if employees are spending their earnings primarily on essential living expenses due to inadequate wages or cost-of-living pressures, there may be a case for reviewing compensation structures or exploring ways to reduce living costs through benefits like subsidized housing or healthcare.

In conclusion, the absence of savings in banks despite reported job satisfaction among employees highlights the complex interplay between income levels, living expenses, and financial stability. Addressing this issue requires a multifaceted approach that encompasses not only competitive wages and job satisfaction but also initiatives to enhance financial literacy, reduce living costs, and promote long-term financial planning and stability among employees. By prioritizing these aspects, organizations can foster a more supportive and sustainable work environment that enhances both employee well-being and organizational performance.

iii) Major problems associated with resin tapping

Low Rate for Per Kg Resin Tapping:

Our study uncovered a pervasive issue of low compensation rates per kilogram of resin collected, which significantly impacts the livelihoods of resin tappers. Despite the labor-intensive nature of resin tapping, wherein tappers must ascend trees and carefully collect resin, the financial returns are often meager. This situation is exacerbated by market fluctuations and middlemen who may exploit the tappers' lack of bargaining power.

The low rates contribute to a cycle of poverty among resin tappers, limiting their ability to invest in education, healthcare, and other essentials. This economic vulnerability not only affects current tappers but also deters younger generations from continuing this traditional occupation. Addressing this issue requires interventions such as fair pricing mechanisms, transparent market practices, and capacity-building programs to empower tappers in negotiating fair wages for their labor.

Health Hazards:

Resin tapping exposes workers to a range of health hazards due to prolonged exposure to resin, chemicals, and physically demanding work conditions. Our research highlighted frequent complaints among tappers regarding musculoskeletal strains, respiratory ailments, and skin irritations. These health issues are compounded by inadequate access to healthcare facilities in remote forest areas where resin tapping predominantly occurs.

Efforts to mitigate health hazards should prioritize preventive measures, including the provision of proper protective equipment (PPE) such as gloves, masks, and safety harnesses. Training programs on ergonomic tapping techniques and hygiene practices are also essential to minimize health risks. Collaboration between local health authorities, forestry departments, and community organizations can ensure that resin tappers receive necessary healthcare support and occupational safety training.

Fire Risks and Lack of Compensation:

Forest fires pose a significant threat to resin tapping operations, yet resin tappers often bear the brunt of these risks without adequate compensation or insurance coverage. Unlike formal employees who may have insurance benefits, resin tappers typically operate as independent contractors or informal workers, lacking safety nets in case of emergencies.

The absence of compensation schemes exacerbates the financial insecurity of resin tappers, who rely on consistent resin yields for their income. Policy interventions should include the establishment of insurance schemes tailored to the specific risks faced by resin tappers, including fire damage to resin-producing trees and equipment. Additionally, promoting fire prevention strategies, such as controlled burning and early detection systems, can help mitigate risks and safeguard livelihoods in resin tapping communities.

Lack of Pension Scheme:

Our study identified a critical gap in social security for resin tappers, particularly the absence of pension schemes or retirement benefits. Many tappers work well into old age without access to formal savings or retirement plans, relying solely on their earnings from resin tapping for survival. This lack of financial planning exposes elderly tappers to poverty and economic vulnerability during their later years.

Addressing this issue requires policy initiatives aimed at extending social security frameworks to cover informal workers in the forestry sector. Advocacy efforts for pension schemes and financial literacy programs can empower resin tappers to plan for retirement and build long-term financial resilience. Collaborative efforts involving government agencies, non-governmental organizations (NGOs), and community associations are crucial for implementing sustainable social protection measures that prioritize the well-being of resin tappers.

These findings underscore the multifaceted challenges faced by resin tappers and highlight the urgent need for holistic interventions to improve their livelihoods, ensure occupational safety, and promote sustainable forest management practices. By addressing these issues comprehensively, stakeholders can support resin tappers in achieving economic security and fostering resilient communities dependent on forest resources.

Lack of Formal Training:

One of the primary findings of our research is the absence of structured formal training programs for resin tappers. Many individuals engaged in resin tapping learn through informal means or on-the-job training, often without proper guidance on sustainable tapping practices. This lack of formal training not only hampers the efficiency and productivity of resin collection but also poses risks to the health of resin-producing trees and overall forest sustainability. There is a clear need for targeted training initiatives that educate tappers on optimal tapping techniques, tree health management, and safety protocols. Collaborative efforts involving governmental agencies, NGOs, and community organizations are crucial to developing and implementing these training programs effectively.

Lack of Motivation:

Our study has also highlighted the pervasive issue of low motivation among resin tappers. Factors contributing to this include inadequate economic incentives, challenging working conditions, and a lack of recognition for their skills and contributions. The absence of fair pricing mechanisms and timely payments further diminishes tappers' motivation, potentially leading to reduced engagement in resin tapping activities. Addressing these motivational barriers is essential to sustain the interest and commitment of resin tappers. Strategies such as fair pricing structures, transparent payment practices, and initiatives that promote community recognition and support can significantly enhance motivation levels. By prioritizing these aspects, stakeholders can improve the overall well-being of resin tappers and promote the long-term sustainability of resin tapping as a vital component of forest-based economies.our findings underscore the urgent need for investments in formal training programs and motivational strategies tailored to resin tappers. These efforts are pivotal not only for enhancing the productivity and sustainability of resin tapping practices but also for supporting the livelihoods of forest-dependent communities. By addressing these challenges comprehensively, policymakers, forest managers, and community leaders can foster a more resilient and prosperous future for resin tappers and the forests they rely upon

Conclusion

Our study concludes with several critical observations regarding resin tapping, highlighting both its benefits and the pressing need for improvements in regulatory compliance and worker compensation.

Resin tapping emerges as a beneficial practice for community forest users, contributing significantly to social development and local economies. It provides essential employment opportunities, particularly for marginalized communities dependent on forest resources. The income generated from resin tapping supports livelihoods, enhances household incomes, and fosters economic resilience within these communities.

However, despite its benefits, resin tapping operations face challenges that require urgent attention. Our findings reveal that many resin tappers perceive their earnings as insufficient relative to the labor-intensive nature of their work and the associated risks. There is a widespread consensus among workers that higher payment per kilogram of resin collected is necessary to adequately compensate for their efforts and ensure a sustainable livelihood.

Moreover, our study underscores the potential environmental impacts associated with resin tapping, particularly concerning forest fire risks. While resin tapping itself does not harm forest regeneration or the overall health of the forest ecosystem, the increased flammability of resin-infused trees poses a significant fire hazard. Inadequate fire prevention measures and training further exacerbate this risk, highlighting a critical area where improved regulation and proactive management practices are essential.

In conclusion, while resin tapping plays a vital role in community livelihoods and social development, there is a clear imperative to enhance worker compensation, strengthen regulatory compliance, and improve overall working conditions. Addressing these challenges will not only safeguard the welfare of resin tappers but also ensure the sustainable management of forest resources. By prioritizing safety, fair compensation, and environmental stewardship, stakeholders can foster a balanced approach that supports both economic prosperity and ecological integrity in community forests.

Recommendations for Enhancing Resin Tapping Sustainability

Enhance Worker Compensation:

Resin tapping is essential for community livelihoods but is often perceived as inadequately compensated relative to its labor-intensive nature and associated risks. To address this, it is recommended that stakeholders conduct a comprehensive review of current payment structures. Consideration should be given to increasing the remuneration per kilogram of resin collected. This adjustment would better align earnings with the physical demands and risks involved in resin tapping, thereby ensuring fair compensation for workers and promoting long-term sustainability in community forest management.

Improve Regulatory Compliance:

Strengthening regulatory frameworks is critical to mitigating environmental risks and ensuring worker safety in resin tapping operations. It is recommended that regulatory bodies enhance existing guidelines to include stringent provisions for fire prevention, sustainable forest management practices, and safety protocols during resin extraction. These regulations should be rigorously enforced through regular inspections and compliance checks. By improving regulatory compliance, stakeholders can uphold environmental standards and safeguard both forest ecosystems and the well-being of resin tappers.

Invest in Training and Safety Measures:

Develop and implement comprehensive training programs tailored for resin tappers to enhance their skills in fire prevention, safety protocols, and sustainable tapping techniques. These programs should be mandatory and periodically updated to incorporate emerging best practices and technological advancements. By investing in training and safety measures, stakeholders can empower resin tappers to mitigate environmental risks, enhance workplace safety, and improve overall operational efficiency in resin tapping activities.

Promote Community Engagement:

Foster inclusive dialogue and collaboration among resin tappers, local communities, and regulatory authorities to address concerns and jointly develop solutions. It is recommended to establish platforms for ongoing engagement, such as community meetings or advisory committees, to facilitate meaningful participation in decision-making processes. Through proactive community engagement, stakeholders can build trust, gather valuable insights, and co-design interventions that support sustainable resin tapping practices and enhance socio-economic development in local communities.

Support Research and Innovation:

Allocate resources and support research initiatives aimed at developing innovative resin extraction methods that minimize environmental impact and maximize productivity. It is recommended to promote collaboration between researchers, industry experts, and resin tappers to identify and pilot-test sustainable technologies and practices. Additionally, invest in research on forest ecology and ecosystem resilience to better understand the long-term impacts of resin tapping and inform evidence-based management strategies.

Monitor and Evaluate Impact:

Establish robust monitoring and evaluation mechanisms to assess the social, economic, and environmental impacts of resin tapping activities over time. Regularly evaluate key performance indicators, such as resin yield trends, forest health indicators, worker well-being, and community economic resilience. It is recommended to integrate findings from monitoring efforts into adaptive management strategies, ensuring continuous improvement and responsiveness to emerging challenges. By systematically monitoring and evaluating impacts, stakeholders can enhance decision-making processes and achieve sustainable outcomes in resin tapping operations.Top of Form

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