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Review Article

Status and future pathways of resin tapping in Nepal: Appeal for special attention

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Abstract

Resin tapping was pioneered five decades ago since the Laxmi Tapping industry started tapping in western Nepal in 1973. Resin tapping is acknowledged as a cost-effective, viable, and adjuvant source of income for rural people with the potentiality for payment for ecosystem services (PES) outside the resin tapping period. This paper explores the SWOT analysis of resin tapping and future pathways to improve this enterprise in Nepal. The systematic and comprehensive literature search was conducted in Google Scholar, ScienceDirect, PubMed, and Scopus; and PRISMA flowchart summarizes the search strategy of the literature survey. SWOT analysis concludes that resin tapping has more strengths and opportunities, but this enterprise is currently under threat due to the shutting down of many resin enterprises with royalty hikes and no incentive. Poor tapping techniques lead to the depletion of pine resources in the long term, so the weakness of the rill method should be counteracted by the modern, cost-effective, more efficient borehole method practiced in many developed countries for resin production. Implementation of the proper policy framework, provision of incentives for enterprise, and sufficient research to create a knowledge base about resin tapping is an urgent need to minimize threats and pedal this enterprise in the right direction. We insist policymakers and stakeholders adopt the integrated forest-based enterprise approach for enabling environment in resin tapping and recommend nine promising value chain upgrading strategies as pragmatic endorsements to execute this enterprise in the long run.

Keywords: Borehole, *Pinus roxburghii* Sarg., Rill method, small scale forest enterprise, value chain upgrading strategy

Introduction

Pinus roxburghii Sarg. (Khote Salla) of the Pinaceae family is a large evergreen only tapped species for resin among the three *Pinus* species found in Nepal (*Pinus roxburghii, Pinus wallichiana, and Pinus patula*) (Satyal et al., 2013). It is native to Afghanistan, Bhutan, China, India, Myanmar, Nepal, and Pakistan. (Kumari et al., 2017). It is widespread in the mid-hills of Nepal at elevations ranging from 900 to 1950 meters, and occasionally up to 2700 meters (Jackson, 1994). Generally, this species is found in all aspects of Western Nepal and typically on well-exposed southern slopes of Central & Eastern Nepal (Aryal et al., 2018). *P. roxburghii* Sarg. has the third-highest stem volume (11.62 m3 /ha or 7.06%) and the fifth-highest forest type (8.45%) in terms of total stem volume and forest cover mapping, respectively (DFRS, 2015).

Numerous studies have recognized the value of forests from where benefits can be increased with the right policy measures (Angelsen & Wunder 2003; Belcher et al., 2005; Sunderlin et al., 2005). About 41,062 forest-based enterprises are officially functional in Nepal, of which 27,342 (> 66%) are engaged in the primary production of ecosystem services and others are involved in processing, manufacturing, and trade (Subedi et al., 2014). Studies have shown that community forest contributes to the goals of variable sectors other than forest management (Kanel & Niraula, 2004; MoFSC, 2013; Nightingale & Sharma, 2014; Pokharel et al., 2007). Studies have revealed that participating in business enterprises by community forests can benefit local communities. These enterprises have been deemed key to fostering household economic growth (Acharya & Acharya, 2007; Bajracharya et al., 2012; Pandit et al., 2009; Rasul et al., 2012; Thapa, 2007) as well as improving social equity, communal development, and resource conservation (Sharma et al., 2004; Timsina, 2005). Resin tapping is acknowledged as a cost-effective, viable, and adjuvant source of income for rural people (Heinze et al., 2021) with the potentiality for payment for ecosystem services (PES) outside the resin tapping period (Justes & Soliño, 2018). A study performed by Upadhyay (2008) shows that there is a high economic potential for resin tapping in Nepal. Resin enterprises of Ethiopia and Sudan generated 23% of total household income contributing to poverty reduction (Abtew et al., 2014).

Traditional and ethnobotanical uses of *P. roxburghii* Sarg. have been documented in diverse cultures (Kunwar et al., 2009). It is also commercially tapped for resin production over 80 types of Pinus trees in the world. China, Brazil, and

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Indonesia produce more than 90% of the world's pine resin (Cunningham, 2012). Resin is secreted due to injury or damage to the plant stem with the removal of the bark. Resin flow is a defensive mechanism controlled by a variety of environmental factors such as rainfall, sunlight, etc., (Rodrigues-Corrêa et al., 2012). Resin is a prime non-timber forest product (NTFP) and the most valuable marketed product of the Khote Salla tree, whose yield rosin and turpentine oil have high market value on national and international markets (Paudyal, 2008). Oleoresin yields a proportion of rosin (75%), turpentine oil (22%), with a loss of 3% in the distillation process (Coppen & Hone, 1995). Oleoresin yield is influenced by diameter, tree crown, growth rate, genetic background, environmental factors, time of tapping, stimulants, the width of the blaze, diameter and can be modulated by resin tapping methods with the combination of chemical stimulation treatment (Cunningham, 2012; Hodges, 1995; Rodrigues-Corrêa et al., 2012; Scherf, 2007; Verma & Pant, 1978). Resin extraction appears to have little effect on pine growth response or vulnerability to climatic stresses (van der Maaten et al., 2017). Without a doubt, the resin collection has a significant impact on tree growth (Cown et al., 2011; Génova et al., 2014; Grissino-Mayer et al., 2001; Papadopoulos, 2013; Tomusiak & Magnuszewski, 2009). According to a study from Poland, resin tapping enhances the radial growth of Scots pine trees (Tomusiak & Magnuszewski, 2009). Several studies from Greece and Spain have shown that pine trees produce more resin and have relatively narrow tree ring widths because of resin collection (Cown et al., 2011; Génova et al., 2014; Papadopoulos, 2013).

Resin tapping was pioneered about five decades ago since the Laxmi Tapping industry started tapping in western Nepal in 1973 (Upadhyay, 2008). A cup-and-lip method was used in Nepal before the introduction of the rill method in 1976 by the Forest Research Institute, Dehradun, India (Paudyal, 2008). The Forest Policy 2015 and Forest Sector Strategy 2016 emphasized the importance of forest-based enterprises in enhancing livelihoods (Paudel et al., 2018) but Nepal lacks documentation regarding the efficiency of existing firms, the quality of their products, export trends, internal and external factors affecting the resin enterprise. Nepal is experiencing a continuous increase in trade deficit due to the low production of export-oriented goods and a declining rate of export (Acharya, 2019). The foremost goal of this review paper was to find all the relevant research articles and several reports related to resin tapping, small scale forest enterprise, and value chain upgrading strategy to conduct a SWOT analysis and to derive relevant insights about the future pathways of resin tapping to upgrade its potentiality and sustain this enterprise in Nepal. Keeping this in mind, this article highlights the SWOT analysis of resin tapping and insights of future pathways in Nepal to improve resin tapping as an enterprise which can help to reduce the trade deficit through the export of rosin and turpentine.

Methodology

Research strategy

The relevant documents restricted to the English language were searched from key scientific databases such as Google Scholar, PubMed, ScienceDirect, and Scopus. A search of the most recent literature dating from 2000 to 2021 was specifically conducted to decipher the most recent literature. We downloaded more than 200 articles related to resin tapping and then, we screened and removed the duplicated articles first. Articles were sorted out, and those considered were selected first by their titles, then by examining their abstracts and full-text reading. The search yielded 256 suitable documents for designing the review and of which 42 were duplicated entries. Moreover, 131 papers were excluded for reasons such as unrelated topics and irrelevant abstracts. The full text of 83 papers was evaluated and 20 papers were removed because of a lack of information on full-text reading. Altogether 63 papers were screened as a final document that is used in our study. Figure 1 shows the PRISMA flowchart summarizing the search strategy.

Resin production, trade, and export trend

Small-scale forest enterprises have received a positive tone in the national discourse, but Nepal's trade deficit is alarming due to negligible exports (Acharya, 2019). Amid such a depressing situation, some industries in Nepal are exporting about 95% of their production to India and bringing millions of rupees into Nepal every year. E.g., the products manufactured from Mount Rosin and Turpentine have helped the Nepalese market to reduce imports from other countries worth 13 million rupees according to the 2075/76 sales report. Nepal mainly exports rosin oil and turpentine to the Indian city of Kolkata. It shows that Nepal lacks diversification in the field of country-wise trade. A comparative analysis of Nepalese Rosin and Turpentine to China, India, and Indonesia in Asian markets is lacking and the present status of resin production and trade lags behind the ideal situation in Nepal (Rai & Chapagain, 2014).

Nepal's contribution to global resin production and trade is not properly documented. However, Rescoll (2013) concludes significant contribution of Nepal's resin (3.18%) in the production of global resins. Rosin and resin acid contribute to 2.3% of total export value in the fiscal year 2016/17 which shares greater than medicinal herbs export value in the same year (TEPC, 2017). Data show that around 40438 MT of resin can be extracted from 13500000 trees in Nepal every year (DoF, 2007). Nepal could potentially tap 60,000 metric tons of resin (Subedi, 2010). Nepal exported about Rs. 1.59 billion and 140 tons of rosin and resin acids in terms of value and volume in F.Y. 2017/18, respectively. About 15 different rosin and turpentine industries are producing rosin in Nepal and the collection of resin is practiced in 35

districts. Kailali, Doti, Dadeldhura, Salyan, and Rolpa are the more resin-producing districts among the total resin collecting districts of Nepal (DoF, 2007). Resin purifying companies can be found in the districts of Banke, Kailali, Kapilvastu, and Jhapa of Nepal (MoICS, 2019). Department of Forest data shows that the annual resin trade varied from about 1,888 to 8,009 tons of resin production with an export value ranging NRs 57 to 360 million in the past twelve years (Subedi et al., 2014). The major export destinations of Nepal's rosin and resin acids are India, the USA, Turkey, Germany, the UK, and China (MoICS, 2019).

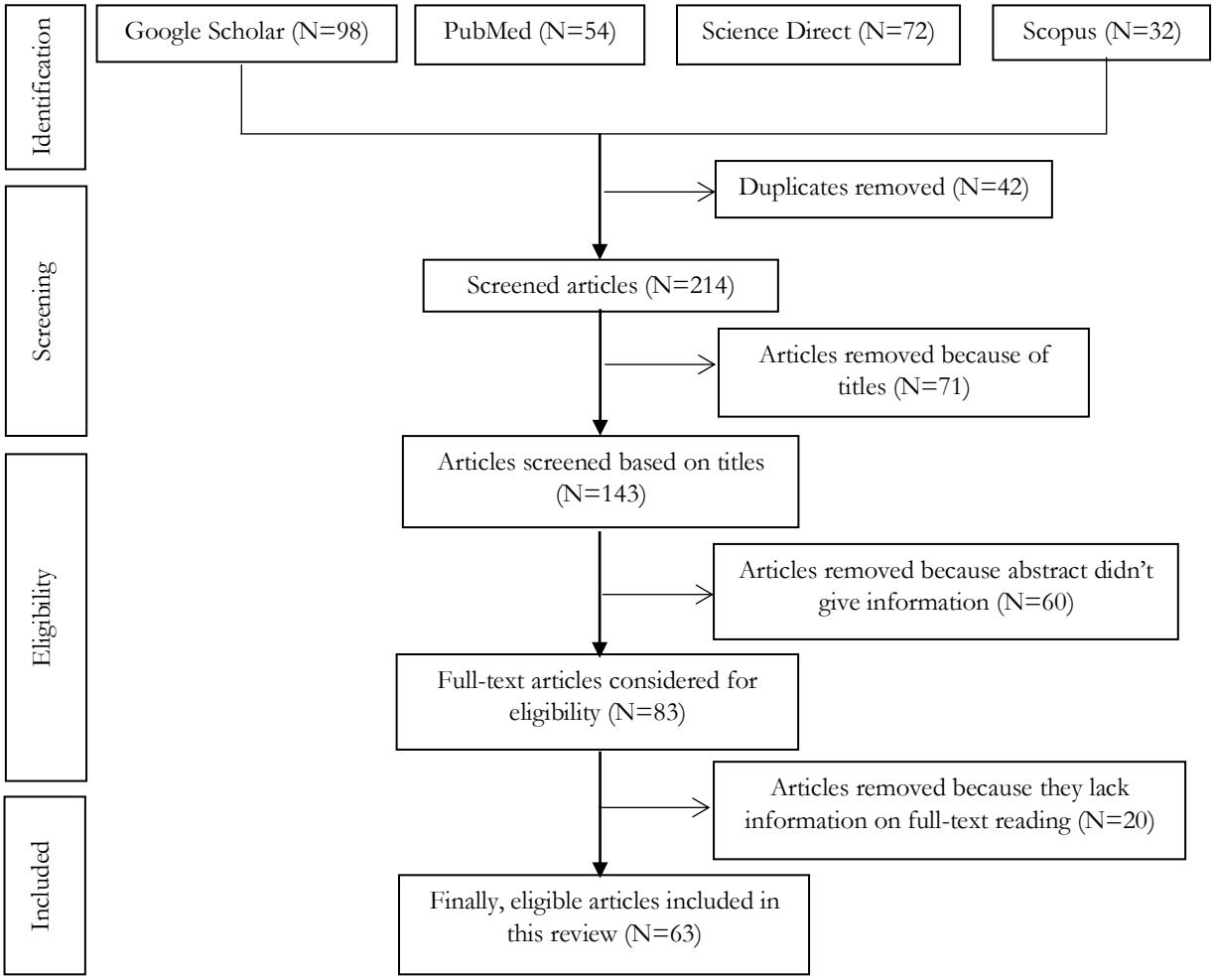

Figure 1 Flow chart of the research strategy adopted

Traders of rosin and turpentine raw materials were facing huge losses in 2016 as they are not getting fair prices for their products (Basyal, 2017). The rosin and turpentine industries are based entirely on indigenous raw materials which has been plagued by high royalty fees, high bank interest rates, and no incentive mechanism. Resin traders are in trouble as the market price is fluctuating and heavily depended on India. The number of rosin and turpentine industries has come down from 18 to half a dozen due to the lack of the government's clear policy to protect and promote export-oriented industries. The Nepalese products have to compete with developed countries including China, Brazil, and Argentina but have not received any assistance from the government. As a result, the export value is declining in recent years (2014-2017), but the export value is significantly higher than the previous decades (Fig. 2).

Revenue sharing

The federal government and district development committee (DDC) receives 90% and 10% of the revenue generated from resin royalty obtained from the government-managed forests, respectively. Community forest user groups (CFUGs) obtain 100% of the total revenue generated from their Community Forests (Paudyal, 2008).

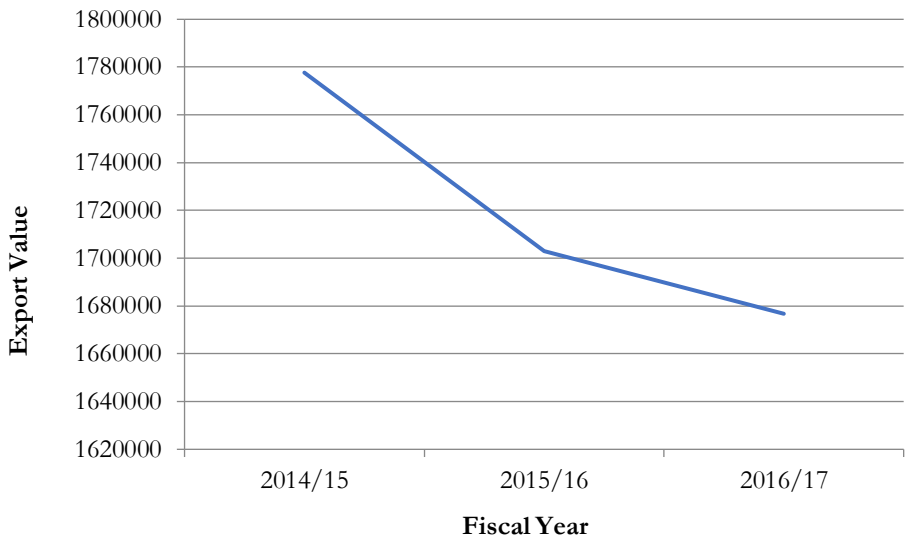

Figure 2 An export trend of Rosin and resin acids in terms of value ('000 Rs.) (Source: TEPC, 2017)

SWOT analysis

SWOT is an acronym standing for 'strengths, weaknesses, opportunities, and threats. It is a simple but powerful tool for assessing the capabilities and weaknesses of a business, as well as its market opportunities and threats (Thompson et al., 2007). The main objective of SWOT analysis is to pinpoint whether the contemporary strategy of an enterprise and its strengths and weaknesses are pertinent to counteract a dynamic circumstance. In Fig. 3, the strengths, weaknesses as well as potential threats, and opportunities external to the current resin collection process are discussed systematically.

Advantages of Borehole method over Rill method for resin collection

The risk of fire hazard is reduced as the resin is tapped after the fire season through the borehole method (Rai & Chapagain, 2014). This procedure saves labor lowering the cost of resin tapping by approximately 25% with higher quality and dust-free resin production. As a result, derivative products of resin will be of greater quality and command a higher price in national and international markets (Sharma & Lekha, 2012). A study conducted by Rawat (2010) in Indian *P. roxburghii* Sarg. reveals that the borehole method of resin tapping is found to be more superior and feasible than other conventional methods (e.g., Rill method) because of less damage to respective trees, and with soft labor work in the minimum time frame (Figs. 4 and 5). A study performed by Utkarsh (2016) stated that Pine resources could be conserved and managed very effectively using this technique.

Future pathways of resin tapping in Nepal

Modality of resin tapping

Although a large study appraises successful factors of forest-based enterprises (Albano et al., 2008; Badini et al., 2018; Lamsal et al., 2017), there is no rigid blueprint approach that can work efficiently for the enterprise. Forest-based enterprises of Nepal are largely restrained to harvesting and modest processing (Lamsal et al., 2017). Kunwar et al. (2009) reported numerous legitimate concerns and operational challenges such as enterprise registration and operation, marketing and trade, taxation, etc., however, Pokharel et al. (2006) pinpointed three major obstructions: uncertain external economics, inefficient enterprise, and multifaceted bureaucratic by-law in Nepal. Developing a durable market arrangement is a prerequisite for crafting a viable forestry enterprise. The forestry enterprise business model is dependent on enabling provisions, such as internal factors and external rules (Molnar et al., 2007). Pokharel et al. (2006) and Acharya and Acharya (2007) presented triumphant case studies of community-based forest enterprises for Nepal, while Ghosh et al. (2009) and Torri (2010) presented successful case studies for India.

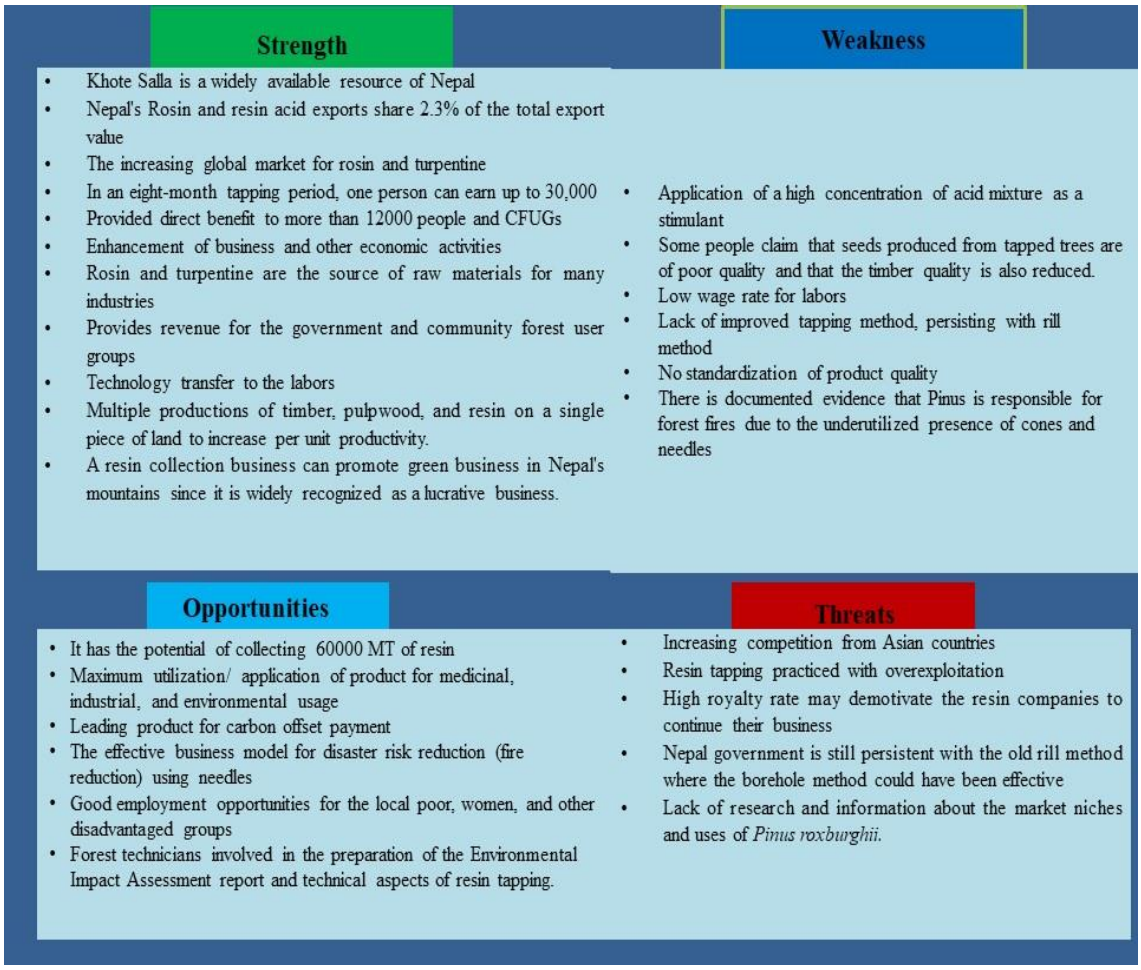

Figure 3 SWOT Analysis within the resin value chain (Sources: Gotame, 2014; Paudyal, 2008; Rai & Chapagain, 2014; Upadhyay, 2008).

Figure 4 Rill method (©Vivek/First Author)

Figure 5 Borehole method [Source: © Bhandari (2017)]

Paudyal (2008) mentioned that environmental, technical, and socio-economic aspects should be taken into consideration to combat the issues and challenges incurred during resin tapping. Gautam et al. (2020) conclude that abnormal temperature change and low precipitation can cause soil moisture deficit provoking detrimental effects on the secondary growth of the trees although the study was carried out in *P. wallichiana*. Hence, there should be a clear discussion on how much resin collection should be done and how can local users be benefitted from sustainable resin tapping in Nepal. Haphazard resin collection without any inventory database can hamper the regeneration status of *P. roxburghii* Sarg. in the forest. So, policymakers must think critically to conserve *P. roxburghii* Sarg. resources from overexploitation on the one hand and attract private sectors with incentive-based policy in resin enterprise to sustain on the other hand. There is no resin collecting nation without a proper policy framework and has given enough priority for resin tapping in resin-tapped countries.

An integrated forestry enterprise development approach as a pillar of successful enterprise development recommends sustainable production of market-oriented goods to run enterprise in a long run (Lamsal et al., 2017). In the Integrated Forest-Based Micro and Small Enterprises (FMSEs) Development method, the social mobilization process identifies target groups using socioeconomic surveys. This will aid in determining the sort of mobilization required, such as income-generating activities (IGA) or enterprise development. This approach explores the market analysis, access to finance, skill development, piloting, market linkage, and regular follow-up for the stabilization of enterprise in the dynamic environment so this strategy is not deterministic but rather needs-based. The Monitoring, structured experiential learning, and evaluation (MeE) strategy assists in the achievement of the dual goals of accountability and learning (Pritchett et al., 2013). This approach may be equally useful in resin tapping enterprises for the stabilization and upbringing culture in Nepalese society. The components of an integrated approach for Forest-Based Micro and Small Enterprises (FMSEs) development may vary depending on the specific regional context (demography, geography, economics, culture, and politics) and the nature of Forest-Based Micro and Small Enterprises (FMSEs) and their products (Fig. 6).

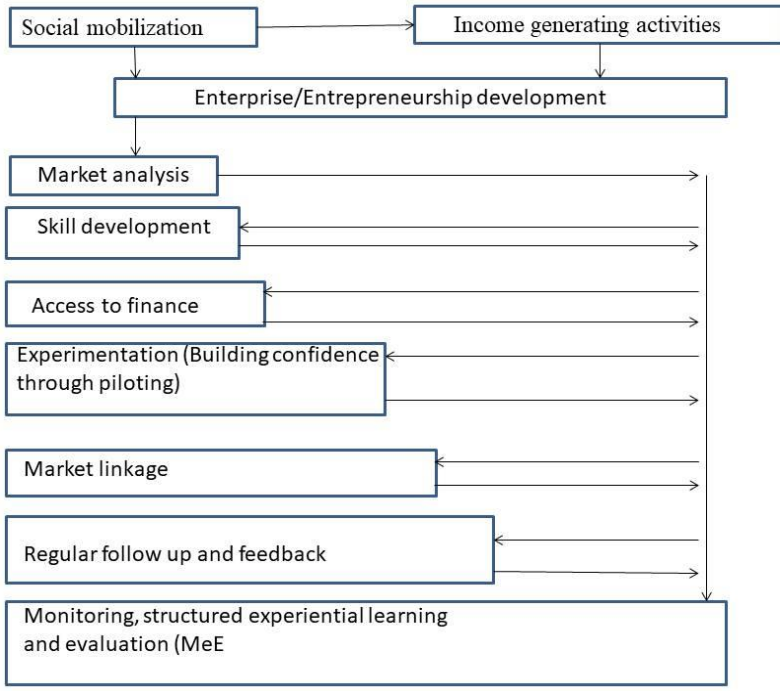

Figure 6 Components of forest-based micro and small enterprises (FMSEs) (Source: Lamsal et al., 2017)

Value chain upgrading strategies

The existing value chain of resin has not benefitted rural people to their potential (Rai & Chapagain, 2014). Resin collection piloting should be done using a bore-hole method in community forest through Community- Private-FECOFUN partnership through maximum utilization of local labor. Revenue generated from the sale of resin collected from community forests should be shared between the central government and community forest user groups which can reduce the misuse of revenue at the local level (Personal communication with Pramod Poddar). Sustained collection of resin has put pine forests at the brink of

extinction in some districts so proper monitoring and evaluation should be done by government officials in the expenditure of revenue collected from the sale of resin by community forests. Encouraging and incentive-based policies for resin tapping should be introduced to allure the private sector to work in underutilized national pine forests. The establishment of permanent plots, facilitating the experimentation of new resin tapping methodologies, and the integrated analysis of all factors affecting resin production, will ensure a clear understanding of the cost-effective and efficient tapping method contributing to the development of new practices, new technologies, and new legislation on resins. Exploration of international markets other than India to export large quantities of raw materials such as rosin and turpentine should be done.

The study done by Rai and Chapagain (2014) recommended nine promising value chain upgrading strategies as pragmatic endorsements to innovate, upscale, and upgrade resin value chain in Nepal although the strategies were developed based on field consultations of resin tapping activities of Dhankuta district, Nepal (Fig. 7).

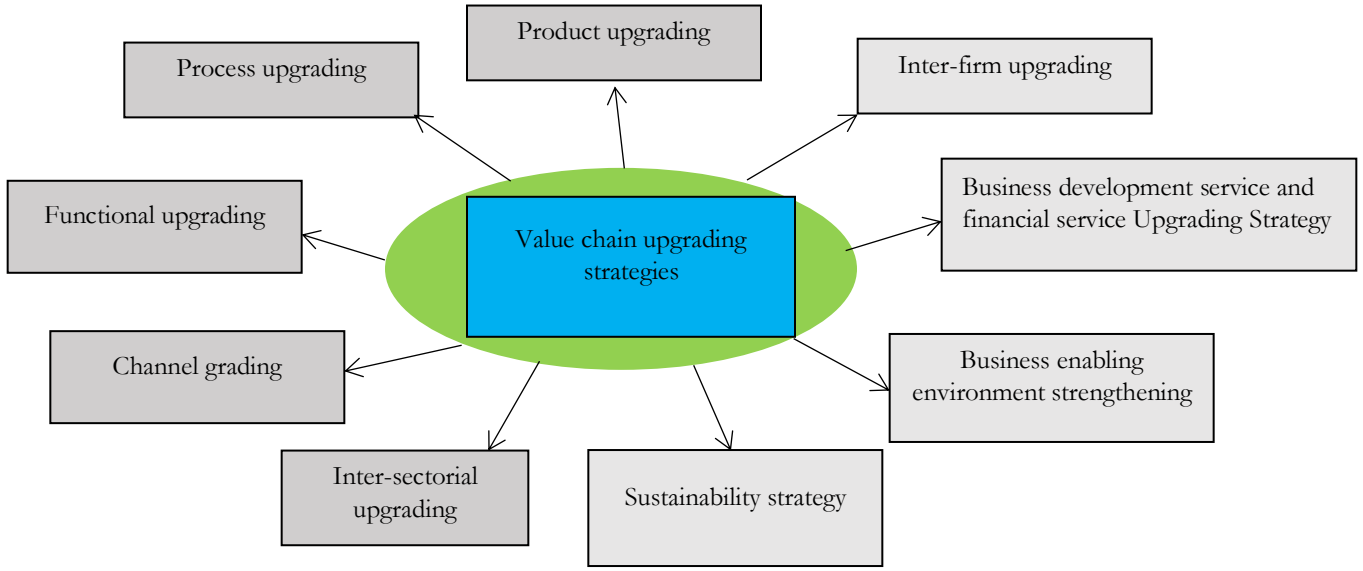

Figure 7 Value chain upgrading strategies **(**Source: Rai & Chapagain, 2014)

Conclusion

Resin production is important not only to resin enterprises but also has a tremendous potential to generate lucrative revenue to the government and income opportunities to the rural people at the grassroots level by using local raw materials. The SWOT analysis of resin tapping concludes with more strengths and opportunities in the case of Nepal but unawareness of government and royalty hike without any incentive has put this enterprise under threat. The weakness of the rill method should be counteracted by the modern, cost-effective, more efficient borehole method practiced in many developed countries for resin production. Despite being interested, the private sectors are finding themselves at a crossroads whether to continue or to shut. The problem of Nepal's rapidly increasing trade deficit is due to low export performance which can be reduced through rosin and turpentine export. Unless Nepal adopts new policies and diversifies its trade structure among different countries to increase its trade competitiveness, resin traders will be facing huge losses in Nepal. We insist policymakers and stakeholders adopt the integrated forest-based enterprise approach for enabling environment, provision of incentives for enterprise, adoption of borehole method, sufficient research to create a knowledge base, and nine promising value chain upgrading strategies as pragmatic endorsements to innovate, upscale, and upgrade resin value chain in Nepal.

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Author Contributions: VTC conceptualized the idea, conducted the literature review, designed the review, and prepared the draft manuscript. ST performed the literature review, prepared graphical representation, and proofreading of the manuscript.

Conflict of Interest: The authors declare no conflict of interest.

Data Availability Statement: The data that support the findings of this study are available from the corresponding author, upon reasonable request.

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