Sustainable Plantation Forestry and Engineered Wood Products for Economic and Environmental Impact in Laos

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Abstract

This project tackles critical technical and market barriers to expanding wood processing and engineered wood product (EWP) utilisation in Laos, aiming to build a sustainable, inclusive, and profitable forest industry. Building on 15 years of Australian Centre for International Agricultural Research (ACIAR) partnerships, it will integrate market analysis, product development, and policy research to align Lao plantation resources such as rubberwood, eucalypts (e.g., *E. pellita*, *E. camaldulensis*, and clones), and teak with market opportunities suited to Lao business operations. Planned activities include identifying performance criteria for market access, optimising manufacturing protocols, and promoting timber use in Lao construction through building code reforms and demonstration projects. The project will explore hybrid composites from diverse wood and non-wood feedstocks, characterise under-studied resources, and pilot modular housing systems with private sector partners. Long-term evaluation of adhesive-based EWPs in tropical environments will guide durability standards, with a focus on bio-adhesives and environmentally friendly treatments. Barriers to veneer-based manufacturing, particularly spindleless lathe technologies, will be addressed alongside strategies to improve factory efficiency and returns for micro, small, and medium enterprises through technical innovation and policy engagement. Circular economy practices will be advanced via industry performance reviews, development of residue reuse methods such as lignocellulosic composites, and exploration of adhesive and preservative recycling. Sector-wide occupational health and safety assessments will be conducted with Lao labour authorities to implement safer work environments.

Keywords: Engineered Wood Product, circular economy, Advanced Materials and Manufacturing, Forestry, Waste Management, Environmental Impact

Introduction

Plantation forestry and associated wood processing industries are critical for Laos' future economic development, with the potential to significantly contribute to poverty alleviation, increased household incomes, improved livelihoods, environmental sustainability, climate change mitigation, and reforestation goals (Lao PDR, 2018; Smith et al., 2021; ITC 2021). The Government of Laos has set an ambitious target to establish an additional 500,000 hectares of plantations (and associated processing industries) by 2035, building on the approximately 420,000 hectares already established (Lao PDR, 2024). Laos possesses several advantages that make it well-suited for plantation forestry, including supportive government policies, land availability, high plantation productivity, favourable growing costs, steadily improving infrastructure, proximity to major markets, and rapidly rising global demand for

wood products. However, despite these advantages, Laos has not fully capitalised on the opportunities that neighbouring countries such as Vietnam and Thailand have seized (Arnold et al. 2022). Given the declining available fibre from native forests worldwide, high plantation productivity potential in Laos, and the nation's proximity to major markets, Laos is well-positioned to secure and expand its forestry and forest products manufacturing sectors.

Previous projects funded by the Australian Centre for International Agricultural Research (ACIAR) have achieved several successful outcomes in Laos (Ozarska et al., 2012, 2017; Smith et al., 2023). They contributed to enabling forest policies, plantation inventory and mapping, sector advancement, and significant capacity building, including the creation of the Wood Technical Research Centre (WTRC) at the National University of Laos (NUoL). These initiatives also enhanced wood processing and supported the establishment of commercial engineered wood product manufacturing, including plywood and laminated veneer lumber (LVL) operations. Despite this, gaps and further work remain to build supply chain resilience and momentum, reinforce previous outputs and outcomes, further grow the plantation and wood processing sector, and achieve greater capacity and independence of Lao researchers and practitioners to improve the forest industry and realize its full potential.

While previous projects had a focus on plantation eucalyptus and teak, relatively limited work has been done on rubberwood. Rubber plantations are a major component of Lao forestry, covering 58% of the national plantation area, or 300,000 hectares, with one third managed by smallholders. Most trees are expected to reach senescence by 2030 (NAFRI, 2018, unpublished data; Luang Namtha Province Division of Agriculture and Forestry, 2019, personal communication). Planted primarily for latex, senescent trees are often underutilised, typically wasted or used as low-grade fuel. Research has shown that rubberwood can increase Lao competitiveness, expand processing capacity, and improve returns for smallholders (Belleville et al., 2020; Smith et al., 2020a; Smith et al., 2023). Converting rubber trees into EWPs compatible with domestic and international markets represents an opportunity to capture value from this underexploited resource. Rubberwood contributes substantially to roundwood supply in the Lower Mekong Subregion, and its importance is expected to rise with growing demand for renewable materials (Smith et al., 2023). In 2022, Thailand exported 3.9 million cubic metres of sawn rubberwood to China, valued at US$990 million (ITTO, 2023), and Thai particleboard exports derived from rubberwood reached US$55 million in the first half of 2023 (Thailand International Woodworking & Furniture Exhibition, 2023). Scaling up similar processing in Laos across both smallholder and larger plantations could generate broad economic and environmental benefits.

The previous ACIAR projects in Lao PDR have demonstrated effective approaches for forest sector policy engagement by strengthening the relevance, credibility, and legitimacy of research to achieve tangible outcomes (Ozarska et al., 2012, 2017; Smith et al., 2023). However, plantation-based value chains and regulatory structures continue to favour large enterprises over smallholders and micro, small, and medium enterprises (MSMEs). These projects revealed both the importance of and barriers to greater participation of smallholder tree growers, small-scale traders, and MSME processors, noting that achieving policy goals for inclusive rural and women's livelihood development will require streamlined regulations and enabling services such as those provided by the Luang Prabang Teak Program (LPTP). Resource characterisation efforts proved valuable for improving forest sector planning, land use management, and understanding farmer decision-making amid dynamic crop booms and shifting land use. Findings emphasised the need to address regulatory disincentives to tree growing and wood marketing to promote longer-term investment in plantation forestry. A

major project achievement has been the strong demand for NUoL Faculty of Forestry Sciences graduates by wood processing companies and the recognition of project members by government agencies for their policy contributions. The projects also created meaningful opportunities for women, both in skilled mill work and management, especially in enterprises promoting mechanisation, training, and gender equality. Overall, the projects identified critical policy, governance, and administrative constraints to the development of plantation forests and value chains in Lao PDR and developed strategies to address these challenges through more inclusive and enabling policy engagement.

The project aims to expand sustainable, profitable, and inclusive wood processing based on plantations in Laos to enhance household and national incomes while delivering social and environmental benefits. It seeks to address four key research questions: first, to identify the policies, processes, and strategies that can facilitate tree growing, strengthen the wood processing sector, and enhance participation and benefits for smallholders, women, and MSMEs within evolving policy and governance contexts; second, to examine the barriers to achieving and maintaining self-sufficiency and technical capacity at the WTRC, NUoL, and explore solutions to enable it to function as a self-supporting research centre; third, to determine how technical and market barriers to advanced wood processing and the utilisation of EWPs from Lao forest resources can be overcome; and fourth, to establish processes that will strengthen adherence to circular economy principles and occupational health and safety (OH&S) systems across the Lao forest industry. By addressing these questions, the research will tackle critical challenges and harness opportunities in Laos' forestry and wood processing sectors, contributing to the country's economic development, poverty reduction, environmental sustainability, and climate change mitigation goals.

Methodology

This project employs an integrated research, development, and capacity-building approach to strengthen the Lao wood processing industry and promote sustainable, inclusive growth. The methodology combines technical innovation with social, environmental, and policy dimensions to improve processing efficiency, product quality, and the utilisation of under-used fibre resources. Research will focus on developing high-value EWPs, addressing product performance issues, and enhancing profitability for both small and large enterprises. Sustainability will be embedded through circular economy principles, improved occupational health and safety practices, and strategies to expand the participation of women in research, processing, and management roles.

Market research and product benchmarking will be conducted in collaboration with the WTRC at NUoL, which will be strengthened to become a self-sufficient hub for product testing, certification, and training. Policy research will identify constraints and opportunities to support a more enabling regulatory environment for plantation forestry and value-added processing. Through close collaboration with Lao and Australian partners, the project aims to expand plantation forestry, attract new investment, improve industry standards, increase gender equity, and deliver greater returns to smallholders and MSMEs. Collectively, these activities will contribute to Laos' economic development, environmental sustainability, and climate change mitigation while advancing scientific knowledge in sustainable processing and utilisation of plantation-grown timber.

The proposed research strategy has been developed collaboratively with key private sector, industry, government, and academic partners in Laos and Australia to ensure relevance, local

ownership, and long-term impact. The methodological approach is organised around five interconnected research themes that integrate policy analysis, technical development, market research, circular economy practices, and institutional strengthening. Each theme combines applied research, capacity building, and demonstration activities to address both systemic and technical barriers across the Lao forestry and wood processing sectors.

The first theme, Lao forest policy leadership, will build policy and governance capacity among Lao practitioners and researchers, supported by Australian mentors, to facilitate plantation expansion, enhance value chains for rubberwood, eucalyptus, and teak, attract investment, and improve benefits for smallholders, MSMEs, and women.

The second theme, supporting MSMEs in the Lao timber industry, will focus on improving processing efficiency, product quality, and compliance with government directives while promoting representation of MSMEs in industry associations. Research will address machining, drying, gluing, finishing, and waste reduction to increase MSME profitability.

The third theme, forest product technical and market research and development, will advance manufacturing and performance testing of EWPs, support the creation of national building standards, and include the construction of a demonstration building at NUoL. This theme will also explore converting senescent rubber trees into high-value products, addressing quality issues in eucalypt and other species, and integrating agricultural by-products into composite materials.

The fourth theme, circular economy in timber industries, will minimise waste and develop end-of-life solutions for EWPs by improving recycling, re-use, and resource recovery from industrial residues. This theme will also investigate OH&S issues across the supply chain, addressing deficiencies in equipment use, signage, dust management, training, and regulatory compliance.

The fifth theme, future of the NUoL WTRC, will focus on establishing the WTRC as a self-sustaining centre providing education, research, certification, and testing services to support the Lao and regional wood industries. Activities will include expanding staff capacity, developing new partnerships, and designing a financially viable operational model.

Together, these research themes will apply participatory, interdisciplinary, and market-responsive methods that combine laboratory testing, field trials, stakeholder consultations, gender and policy analysis, and pilot-scale demonstrations to generate scientific, economic, and social outcomes that strengthen the sustainability, inclusivity, and competitiveness of the Lao forestry sector.

Results and discussion

The project goal is to increase national and household incomes from trees and renewable materials to improve environmental stewardship. The end-of-strategy outcomes are an expanded plantation estate (registered and certified) and a profitable, trusted and robust wood processing industry. This project will strengthen the industry, through research and development as well as capacity building, demonstration, improved and committed occupational health and safety practices, efficient processing and smart utilisation of fibre resources which in turn will drive expanded planting for long term industry success.

Intermediate outcomes will include processing research that solves product quality problems, utilises new and under-utilised materials, expands production and increases profitability of both small and larger enterprises. Wood product manufacturing enhancement (servicing both domestic and export markets) will drive industry expansion providing greater employment for locals. This will improve their household incomes, career and employment prospects and ultimately their livelihoods. Within this program of research, we will consider the impacts on women, their households, and increased female employment in wood processing research and industry to identify routes to improved gender equity across all levels of the value chain.

The project will include market research to help the Lao forest products industry profitably expand and/or curate relevant product offerings. Research and development in EWPs, processing efficiencies and Laos based certification (mechanical property performance testing by the WTRC) will benchmark the performance of Laos manufactured forest-based products and contribute to high-value marketable products. This will drive in country adoption of wood products, improve export value and trust and potentially decrease imported building materials into Laos. The project is aiming for the WTRC at NUoL to be completely self-sufficient by the close of the project in 2030.

Sustainability in processing will be addressed through consideration of circular economy dimensions, industrial hygiene, and OH&S. Another dimension of sustainability will be ensuring the continuation of the WTRC as an industry anchor, providing an educated workforce, research support, and essential services such as product testing and certification. Research to identify policy constraints on the plantation forest industry and areas for facilitatory policy development and promotion will be another influence strategy. Through collaboration with our Lao and Australian partners, we expect the following outcomes from this project.

Table 1 outlines the expected outcomes of the project along with key indicators that will be used to assess progress and impact. These indicators capture both quantitative and qualitative dimensions of change across the forestry and wood processing sectors in Laos. They reflect improvements in industrial capacity, resource utilisation, institutional sustainability, and social inclusion. Together, these measures will provide a basis for evaluating how effectively the project contributes to expanding sustainable wood processing, strengthening plantation development, enhancing the role of wood in construction, improving gender equity, and building long-term capacity within the WTRC and the broader industry.

Table 1: Expected outcomes from the project and indicators of impact.

Outcome	**Indicator**
Expanded wood processing	Wood volumes processed to finished use
Increased revenue from wood processing	Profit and loss of Lao timber processors
Expanded plantation area	Hectares standing
Timber use in construction	Volume of wood products used in domestic construction
Staffing at WTRC	Number of employees
Self Sufficiency of WTRC	Income of WTRC
Improved gender equity in Laos forest industries	Percentage of female employees

Conclusion

The project will benefit a wide range of stakeholders, including smallholders, MSMEs, large corporations, workers in the forestry and wood processing sectors, communities surrounding plantation forests, and the Lao government and economy. It will also contribute to global efforts in addressing climate change and promoting sustainable forestry practices.

Building on the successful outcomes of previous ACIAR projects, this research will further advance the knowledge and capabilities in Laos by addressing gaps and reinforcing previous outputs, with a particular focus on increasing Lao leadership and capacity in areas such as forest policy, social science aspects, and forest products research and development. Additionally, the project will contribute to the global knowledge fund by generating new insights and processes related to efficient conversion of plantation wood into engineered wood products suitable for construction and other applications.

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