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Financial returns for different actors in a teak timber value chain in Paklay District, Lao PDR

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ABSTRACT

The Government of the Lao PDR has a range of policies, including the promotion of domestic processing and discouraging the export of unprocessed wood, aimed at generating a greater share of benefits to all actors in the value chain. There are however, limited studies of the structures, operations and effects of policies on, value chains. This study aimed to compare financial returns to three different types of actors (growers, traders and a sawmilling and wood products manufacturing company) in a teak value chain in Paklay District of Xayabuly Province. The data were collected from two groups of growers on different site types, two timber traders and an integrated sawmill and wood products manufacturer. These data were triangulated with, and supplemented by, formal and informal interviews with other forest stakeholders in the district and province. Two silvicultural regimes were compared, with a single thinning at 11 years and clearfell at 18 years on good riverside alluvial sites, and 24 years on poorer, hillslopes sites. All sites were profitable for growers, as indicated by internal rates of return. The net returns per cubic meter of final product for the manufacturer is 7.3–20.3 times higher than net returns for the growers. Traders' profits were considerably less than for the two other parts of the chain. Prices for others in the chain are largely controlled by the manufacturer and collaboration and co-innovation between the three actors is unlikely in the current environment. Possible options for increasing growers and traders' incomes and improving value chain links are discussed.

1. Introduction

The Government of Lao PDR wants to increase forest cover, develop timber industries and increase the incomes of those dependent on primary production. Therefore, there is considerable interest in policies to develop timber industries so as to achieve those multiple benefits. Teak has a special status in the Lao PDR, given its historical provenance in the country, relatively high value and the threats to natural teak forests which may be offset by encouraging plantations (Smith et al., 2017). There is however, limited research on industry participants beyond the growers and how policy interventions do or could affect or influence both growers and these others. To make a start on developing such knowledge, this study compared financial returns to three actors (growers, traders and a sawmilling and wood products manufacturing company) of teak furniture value chain in Paklay District of Laos.

We used a value chain framework to visualise actor relationships and to develop the study methods. The traditional view of a firm's competitiveness depends on how effectively and efficiently it can mobilise its internal structures, processes and resources so that it can maximise profit margins (Collins, 2009). This view means that consumer value creation is not the central objective (Stock et al., 2010; Maraseni et al., 2017a). Such firms are "supply push" in nature and believe that "they will sell whatever they produce" and their primary mechanism for increasing surplus is to increase sales or cut costs (Collins et al., 2015). They generally do not give importance to consumers' preference and behaviour and therefore do not get the highest potential value from their products. In a chain of such firms, each actor aims to maximise its profit margins at the expense of other in the chain (Maraseni et al., 2006). As a result, the whole supply chain is not as efficient or generating the maximum overall surplus (Mentzer et al., 2001; Collins, 2009).

An alternative view is the concept of the value chain, where the

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focus is on demand and that producers "will produce what they can sell" (Collins et al., 2015). The term value chain was first coined by Keith Oliver of Booz Allen Hamilton in 1982 but was described by Michael Porter in his book Competitive Advantage: Creating and Sustaining Superior Performance (Porter, 1985). A value chain involves actors along the chain being more market-focused and demand driven, with the actors working collaboratively to deliver a value-added product, resulting in improved collective outcomes for all actors (Adhikari, 2013). This accords with the goals of the Lao PDR; to grow the industry and the incomes of the actors, especially the growers.

Value chain analysis is a diagnostic tool that assists in the identification of opportunities to improve chain performance (Collins et al., 2015). It is not a cure for inefficient production but it can identify inefficiencies in information flows or transaction costs. In general, value chain analysis aims to answer questions related to four dimensions: (1) consumer value (what are the key attributes of the products and services consumers valued most); (2) product flow (what is produced, how is it produced, why it is produced and what are the issues in production system); (3) information flow (how actors shared the information and whether it is timely and efficient or not); and (4) relationships (how interdependent, trustworthy, collaborative and co-innovative are they) (Collins et al., 2015).

Similar to many other countries, the Government of Lao PDR has had policies to promote the planting of trees and the development of a domestic wood processing sector since the late 1980s (Smith et al., 2017). The overarching goals of plantation promotion have been poverty reduction, forest cover maintenance and restoration, and wood production for local industry development. From 1990 to 2015, the global planted forest area increased by about 66% (167.5–277.9 million hectares) (FAO, 2015). During the same period, the planted forests area in Lao PDR reportedly increased from 5000 ha in 1990 to 446,000 ha in 2015, mainly because of foreign direct investment in tree plantations, particularly for rubber and eucalypts for timber, and policies that provided incentives to farmers to plant trees (Phimmavong et al., 2009; Smith et al., 2017). This plantation development contributed to Lao PDR having the 7th highest percentage increase in total forest area (including both planted and natural forests) in the world during 2010–15, with an annual increase of 1.1% (FAO, 2015). Forest cover, including rubber plantations, nation-wide is currently approximately 47% (Earth Systems, 2016; Department of Forestry, 2015). However, unprecedented forest degradation, especially of high conservation value landscapes, is a matter of concern (Phompila et al., 2017).

Through its Forestry Strategy 2020, the Government of Lao PDR has set a target of increasing its forest cover to reach 70% by 2020, mainly by enhancing natural regeneration (6 million ha) and plantation area to 500,000 ha (MAF, 2005; Sovu et al., 2009). It is not possible for the Lao Government to increase forest cover by 23% in two years but the government is trying hard and has implemented several policies such as land allocation to farmers for tree planting by individuals and households with land use rights and land tax exemptions for registered plantations (Smith et al., 2017). It has also provided concessions and leases for companies, including some larger foreign investors. If the plantation target is realised, the mature plantation resource could have an annual farm gate value of $197 million at full production and would offer further value through primary and secondary wood processing (Midgley, 2011).

The establishment of new plantations slowed, largely in response to a moratorium placed on new concessions to foreign investors in 2007 and reissued in 2012 (Earth Systems, 2016). This response was due, in part, to concerns about the availability and allocation of land and the reaction from local populations (McAllister, 2015). As a result, the combined plantation estate (74,000 ha) held by foreign direct investment companies is well below their desired combined target of 133,000 ha (Keenan et al., 2017). Investment in plantations by farmers has also decreased due to land competition for other crops, land sales and development, the regulatory environment and uncertain market prospects (Smith et al., 2017).

Major planted tree species in Lao PDR are rubber, eucalyptus/acacia, teak and agarwood, covering 54%, 13%, 10% and 3% of the total planted forests area, respectively (Earth Systems, 2016). Teak (*Tectona grandis*), the focal species in this study, occurs naturally in north-western Lao PDR. Teak is one of the most popular and valuable tree species in the tropical countries (Tanaka et al., 1998), mainly because of its mellow colour, fine grain, highly durable and water- and pest-resistant attributes (Midgley et al., 2015; Hardiyanto and Prayitno, 2006). It is largely used in boat building, furniture making and carving. Global demand for planted teak rose by 47% by volume and 58% by value during 2010–12, largely due to the decreasing supply from natural forests and rising demand in major consuming countries India and China (Midgley et al., 2015).

Naturally, teak occurs between 9° to 25°30′ North latitude and between 73° and 104° 30′ East longitude, encompassing central and southern part of India, Myanmar, northern part of Thailand and north-western part of Lao PDR (MAF, 2001). In Lao PDR, in 2001 it was estimated there was 16,000 ha of natural forests in which teak was present. This is spread over two provinces, Xayabuly and Bokeo (MAF, 2001), and anecdotally small areas remain in Luang Prabang Province. Teak is also widely planted in countries where it naturally occurs and in Indonesia, Pakistan and Costa Rica (NAFRI and SCC, 2003).

In Lao PDR, the planting of teak was first promoted by the French in the 1940s in recognition of its high value and limited and decreasing supply from natural forests, of which only a small area remains today. Most of the contemporary teak plantations have been established by farmers in northern Laos, and are managed for a range of livelihood purposes including for land tenure security, emergency needs, investment and, to a limited extent, for disposable income generation (Newby et al., 2014; Smith et al., 2017). The exact extent of the planted teak resource is unknown; estimates have been as high as 50,000 ha although these are likely to be exaggerated. A recent ACIAR funded study mapped more than 15,000 ha in Luang Prabang Province (Boer and Seneanachack, 2016) and in Xayabuly province around 8000 ha are thought to have been planted (pers comm PAFO Xayabuly).

These teak plantations supply wood to the domestic processing industry and to international markets (Midgley et al., 2015). Recently the Government of Lao PDR has been promoting domestic wood processing and discouraging the export of unprocessed wood through a combination of policies and regulatory measures aimed at increasing the value generated and retained within the country for growers, industry and more broadly through, for example, employment generation.

A recent Prime Minister's Order (No 15/PMO 2016), amongst many other things, placed a ban on the export of round-logs and unfinished wood products. This research is part of a larger research project "Improving policies for forest plantations to balance smallholder, industry and environmental needs in Lao PDR and Vietnam", funded by the Australian Centre for International Agricultural Research.

2. Methods

This study models the financial aspects of elements of a teak value chain, based on data collected from two groups of teak growers from different sites, two traders and an integrated sawmill and wood products manufacturer (SWPM) in Paklay District of Xayabuly Province. These teak value chain actors were identified with snowball sampling—a chain sampling or chain-referral sampling in which there is recruitment from one part of the value chain to the next, based on participant information about other actors. This method is very powerful in triangulating and validating information provided by different actors.

During the interviews, all the costs and returns for these different enterprises were recorded with the agreement of participants. In this simplified model, the growers plant teak and then sell standing trees to traders who in turn harvest them and sell logs to the SWPM. For growers, teak is only one aspect of their household production systems, which may include other agricultural activities or off-farm employment. The other two types of enterprises only do business in teak products.

2.1. Teak plantations in the study area

The study region (Fig. 1) has a warm and moderately humid climate, with a strongly seasonal rainfall of 1500–2000 mm/yr, and daytime temperatures that can range between 12–40 °C, which contribute to ideal conditions for teak plantations (Kolmert, 2001). There are two major site conditions, based on plantation location in the region: (1) well-drained alluvial sandy loam soil developed by the Mekong River (S1); and (2) poorer, well-drained soils on hillslopes (S2). Hillslope soils are considered better for maize production but are often heavily eroded (Luangduangsitthideth and Limnirunkul, 2016).

Although the planting of teak in Laos commenced in 1940, there

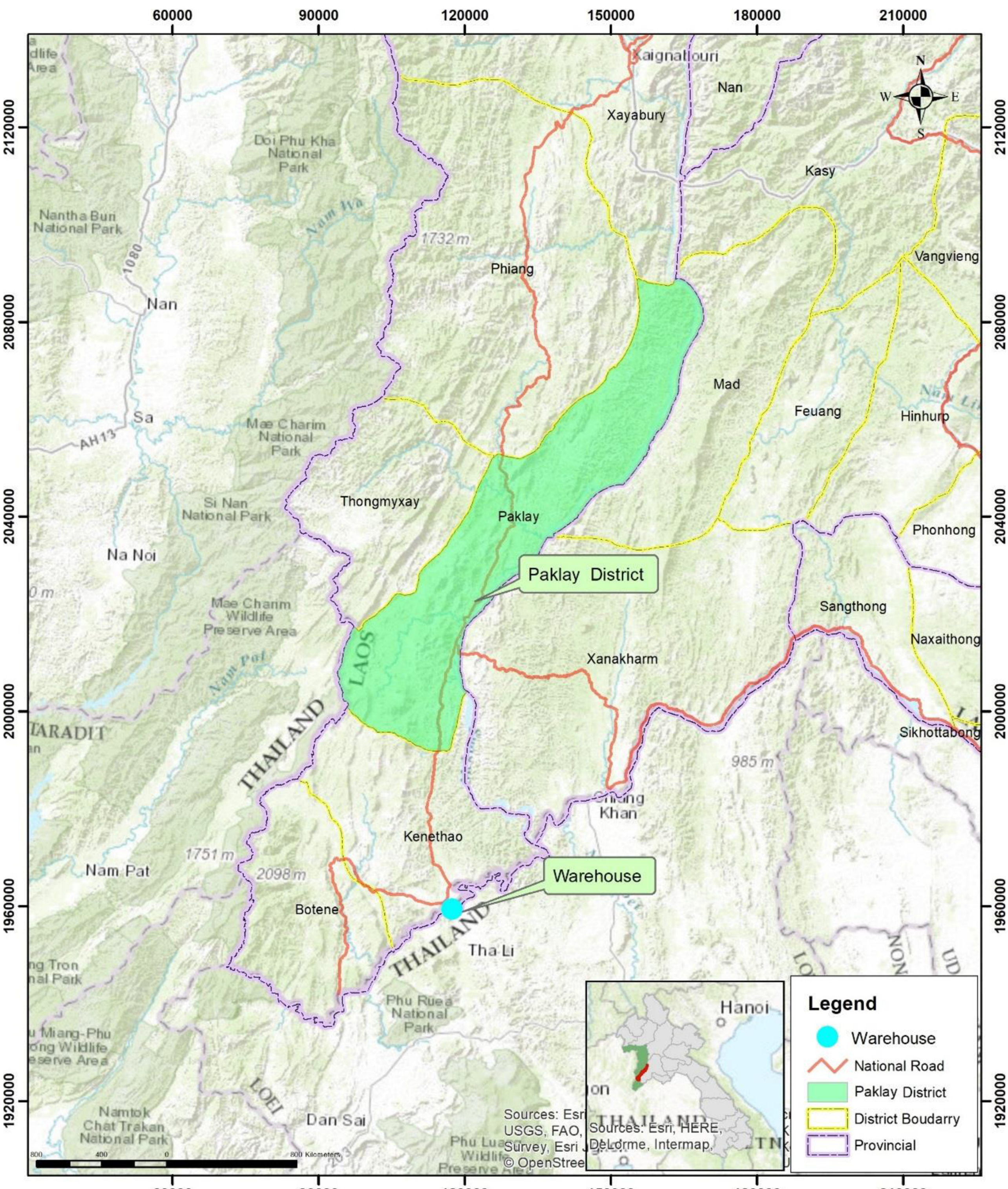

Fig. 1. Map showing Paklay district and Global Warehouse in Xayabuly Province, Lao PDR.

was more rapid uptake in response to the forest land allocation policies in the 1980s (MAF, 2001). According to informants from the Paklay District Agriculture and Forestry Office (DAFO) there are about 4243 ha of teak plantations in the district, equivalent to 84.6% of the total plantation, about 80% of these have been established and managed by farmers. Of these, only 87 ha have been registered with DAFO and our case study farmers have also registered their plantations. Provisions of plantation registration are written in Decree No. 96/PM (2003). According to the Decree, tree plantation with area of more than 1600 m^2 shall be registered by a DAFO while less than 1600 m^2 can be registered in a streamlined village level process. Farmers who registered their plantation will have an authorization to harvest and sell their wood, and if planted in compliance with forest law, can receive compensation if their lands are used for public purposes such as road construction, transmission line and other public purposes.

The Land and Forest Allocation Programs were initiated by the Prime Minister's Decree No. 186 in 1994 and implemented in Xayabuly Province in 1995. The aim of the programs was to legitimate the customary rights of farmers to use and manage the land. Under these programs, individuals within households could be allocated up to 3 ha of land for trees each. In order to secure land title, they were obliged to plant trees in accordance with certain regulations. As with most other farmers, our case study farmers, received rights to land use during that time. As these farmers have now secured the land titles, they are free to change their land uses.

According to the teak growers, the Ministry of Forests and Agriculture also established a pilot Tree Plantation Group with 20 households. Selected groups of these households received some technical and capacity development support from the Government of Lao PDR and Care International, a humanitarian NGO working in the district at the time, while others did not.

2.2. Data collection and financial analysis

Fieldwork was conducted in November 2016 and March 2017. Six growers were interviewed, with three plantations on each of the S1 and S2 sites. Plantations of both groups were close to roads, and ranged in size from 0.5 ha to 2.8 ha. One of the interviewees from the S2 site was the head of the Tree Plantation Group 25 years ago and had been village leader for more than 29 years. Another interviewee from the S1 site was born in the same village and lived there for more than 46 years. Therefore, they had good knowledge of teak plantation practices in the region.

Teak growers in Lao PDR typically do not use a standard silvicultural regime with thinning, growing on to clear-felling followed by replanting. Harvesting is more often 'selective' with farmers selling a few standing teak trees in response to particular needs such as school fees, illness or weddings (Newby et al., 2014).

Estimated returns for the modelled value chain were based on information provided by growers, including costs of establishment, maintenance and harvesting and returns from selling teak trees at the farm gate. For S1, grower information suggests an average production of 221 m^3/ha by the age of 18 whereas for S2 sites there was an average of 224 m^3/ha by the age of 24 years. For the S1 site, the sale of standing trees occurred at two times. From a thinning in year 11, twenty dominant trees over 70 cm in girth at breast height (GBH, 22 cm in diameter) were sold at the price of US$21.75/tree (total price of US $435/ha). At 18 years, there was a clearfell of 730 harvestable trees above 80 cm GBH (25.5 cm DBH) which were sold at US$25.9/tree, for a total return of US$18,900/ha. For the S2 sites, all the practices were the same but there was no thinning. Moreover, due to the poorer site conditions, growers estimated that trees reach marketable size a little later and are expected to sell at the age of 24 with a total return of US $20,473/ha. The yield estimates were the best guesses from growers, rather than recorded measurements, costs and prices.

Administration costs included annual land tax (approximately US$3 per hectare) from year 1 to year 5. The average cost of registrations for farmers in this study is US$56.8/ha. This cost varies based on plantation size and location as farmers must pay *per diem* and travel costs for DAFO. Once registered the plantation is exempt from land tax and other fees. Registration is a legal requirement for farmers who wish to sell their trees, however the cost and procedures associated with registration act as a deterrent. Many growers in Paklay district and Luang Prabang Province do not register their plantations until immediately prior to harvest (Smith et al., 2017), and compliance with registration requirements is known to be low elsewhere. In this analysis, growers reported that they registered their plantations at the ages of three (S1) or five (S2) but for the estimations normalised age (five) is used for both sites. If they do not register they need to pay land tax and therefore this normalisation has an insignificant effect on overall estimates.

There were two traders associated with this supply chain and both were interviewed as part of this study. They buy logs from within a 20 km radius for the furniture company, probably due to the maximum profitable transportation distance. They do not have permanent workers but they have two skilled labourers who do the harvesting for both of them.

There are two sawmills in Paklay but at the time of this study only one was functioning due to wood supply issues arising from PMO15[1]. We interviewed the operators of the functioning mill, which is foreign owned. All the finished products are exported to Thailand, about 74 km from the mill. Working with the Deputy Director of the processing company, data were collected through the processing chain focusing on timber recovery rates, cost of different resources/inputs and returns from different products. This information was further verified with notes from factory registers.

Paperwork related data collected during interviews and observation of the processing were triangulated and supplemented by interviews with the related staff from DAFO. Financial costs and returns were discounted to current day values using a 12% discount rate, the average borrowing rate of the Agriculture Promotion Bank of Paklay district. Sensitivity analyses were conducted for prices, timber harvest yields and discount rates. To make the sawmilller's returns comparable with the trader and farmer's returns, we need a common unit for comparison. It is a common practice to compare profit per unit of final products between the value chain actors (Purnomo et al., 2009), and therefore we have followed that approach.

The paper is based on a number of assumptions: (1) we treat the teak value chain as a stand-alone model; (2) the technical legal requirements are more or less the same as actual practices on the ground in Laos; (3) the impact of PMO15 on planted teak value chain is minimal; (4) the inflation rate of Laos in the future will be the same as for the period of 1989 To et al. (2017); and (5) the current dominance of manufactures over the other actors remains the same. The implications of the first three assumptions may be especially important given that an aim of this paper is to inform policy, they are therefore considered in the discussion section.

3. Results

3.1. Financial analysis of returns to teak growers

Costs to farmers included administration, establishment, maintenance and replanting (Table 1). Plantation establishment costs accounted for 57% of total costs on good sites (US$1149/ha). This included site clearance, constructing firebreaks, clearing burned waste, marking lines for planting, purchase of basic equipment and seedlings, seedling transportation and planting. Maintenance costs for year two onwards were for intensive weeding and maintaining fire breaks. Establishment and management costs on the better and poorer sites were

[1] The sawmill that was not functioning also sourced wood from natural forests, the harvesting of which was suspended through PMO 15

Table 1
Costs and incomes (US$/ha) from teak plantation in Site 1 and Site 2 in Paklay district, Xayabuly Province, Lao PDR (Costs originally provide in Lao KIP, conversion rate is 8100 per USD).

Activities		Site 1		Site 2	
		Costs US$/ha)	Revenue (US$/ha)	Costs US$/ha)	Revenue (US$/ha)
Year 1	Land preparation	61.7		55.6	
	Firebreak	61.7		19.8	
	Cleaning the burned waste	92.6		11.1	
	Lining/marking & basic equipment/tool	44.4		43.2	
	Seedlings and seedlings transportation costs	238.4		260.6	
	Digging & planting	55.6		55.6	
	Weeding	61.7		43.2	
	Other costs	35.2		34.0	
Year 2	Weeding, cleaning & Fire Break	83.0		41.0	
	Basic equipment & tools	19.8		18.5	
	Seedlings and seedlings transportation costs	35.8		52.1	
	Digging & planting	8.3		11.1	
	Other costs	19.1		17.9	
Year 3	Weeding, cleaning & Fire Break	83.0		42.3	
	Basic equipment & tools	19.8		18.5	
	Other costs	15.4		15.4	
Year 4	Weeding, cleaning & Fire Break	42.9		28.7	
	Basic equipment & tools	19.8		18.5	
	Other costs	15.4		15.4	
Year 5	Weeding, cleaning & Fire Break	43.5		29.3	
	Basic equipment & tools	19.8		18.5	
	Plantation registration	56.8		56.8	
	Other costs	15.4		15.4	
Year 11	Income from early harvesting (at the age of 11 in S1)		435.2	NA	
Year	Income from final harvest (at the age of 18 in S1 and 24 in S2)		18,907.9		20,473
IRR			20%		15%
NPV			1659		608
LEV			1907		650

Note: Plantation year is 2007. Inflation Rate in Laos averaged 19.59% from 1989 until 2017. So average inflation rate is 0.7%/year. The current price of trees over 80 cm BHG is $25/tree, it will increase by 4.9% in 7 year (at the age of 18, for S1) and by 9.1% (at the age of 24, for S2) in 13 year. At S1, at the age of 18, there will be about 730 trees above 80 cm GBH which are expected to be sold at a rate of $25.9/tree. At S2, at the age of 24, there will be about 760 trees above 80 cm GBH which are expected to be sold at a rate of $26.94/tree. Some figures could vary due to rounding error. Source: Fieldwork (2017).

generally similar, but the costs of fire breaks, clearing burned waste and weeding were higher on the better sites, and seedling mortality rates were lower on better sites (15%) compared to those of poorer sites (20%). Therefore replanting costs were higher on poorer sites. Replanting was conducted in the second year of the plantation cycle and so the original stem density (1,111/ha) is maintained. Other costs included labour and land tax. On better sites, there were returns from thinning at year 11 and clear felling at year 18 and for poorer sites, only from the clear felling at year 24.

The estimated net present value (NPV) for teak growers on the better sites was US$1,659/ha and on poorer sites $608/ha. The internal rate of return (IRR) on good sites was 20% and 15% on poorer sites. The land expectation value was US$1907/ha on good sites and $650/ha on poor sites. This suggests that teak plantations on both sites can provide good returns (if land and farmers costs are not included) given the information and assumptions on costs and revenues.

Sensitivity analysis indicated that decreasing the discount rate for growers on better sites from 12% to 9% almost doubled the NPV, $US1659/ha to $US 3205/ha (Table 2). For growers on poorer sites, reducing the discount rate almost tripled the NPV because the trees are grown over a longer period. However, most smallholder growers have a high time preference for money and therefore are likely to apply a higher discount rate to their investment. Increasing the discount rate from 12% to 15% more than halved the NPV for growers on better sites and decreased it by almost 100% for growers on poorer sites. The NPV was also highly sensitive to changes in selling price with a 10% decrease in price resulting in a 15% reduction in NPV for growers on better sites and 22% reduction for growers on poorer sites.

Table 2
Sensitivity of financial NPV for growers (on two different sites) and net returns for traders and manufacturers (SWPM) to changes in discount rate and selling price in a supply chain for teak timber in Paklay District, Lao PDR.

Actor	Discount Rate			Selling price of final products		
	9%	12%	15%	−10%	No change	+10%
Growers (S1)	3205.0	1659	739.7	1413.4	1659	1905.2
Growers (S2)	1808.4	608	8.4	472.6	608	742.4
Traders				−1617.4	785.3	3187.9
SWPM				32,584.5	59,918.4	87,252.2

3.2. Financial returns for teak traders

Costs, returns and profit for teak traders were normalised to the grower costs by assessing costs and returns for the purchase, harvest, transport and sale of merchantable trees from one hectare of trees from a poorer site (760, Table 3). The total cost to buy the trees, harvest and deliver to the mill gate was US$23,241/ha. The price paid to the growers for logs of more than 80 cm GBH (about 168 m3 of logs without bark, Mean Annual Increment of 7 m^3/ha/year), close to roads, was reported to be $18,765/ha (81% of the trader's total cost). Harvesting and transportation costs were $2307/ha (12%), and regulatory costs (paperwork for approval) for harvesting and transportation (US$1725/ha) were 7% of the total.

The traders sell logs by size. During the transaction, the sawmiller divides logs into four different grades by size and price (Table 4). According to the teak volume table prepared by Paklay DAFO, a teak tree of more than 80 cm GBH is 0.295 m^3 with bark and 25% of the volume is bark. Therefore, the total volume of 760 teak trees without bark is about 168 m^3/ha. The total income from selling logs at the mill gate is US$24,026/ha. The traders therefore obtain a profit of US$785 per

Table 3
Costs and revenue (US$/ha) for traders for a typical sale of logs from one hectare of teak plantations in Paklay district, Xayabuly Province, Lao PDR. Costs originally provide in Lao KIP, conversion rate is 8100 per USD.

Costs/incomes	US$/ha	Percent
Cost of logs paid to grower	18,765	81
Regulatory costs		
- Application fee to the village leader (per application)	1.2	
- DAFO pre-harvest survey & measuring fee	138.4	
- Application for harvesting permit fee	1.2	
- Harvesting permit fee	830.4	
- Logging certificate fee	276.8	
- Log measuring and grading fee	138.4	
- Log stamp fee	276.8	
- Unofficial cost per ha for securing permit	61.7	
Total regulatory costs	1724	7
Harvesting and transport costs		
- Harvesting and logging cost (using power chain saw)	437.9	
- Making forest trails for trucks	6.2	
-Transportation to second log yard (close to sawmill)	2306.6	
Total harvesting and transportation cost	2750.7	12
Total cost (US$/ha)	23,241	
Income from selling logs at the sawmill (US$/ha); see Table 4 below)	24,026.2	
Profit (US$/ha)	785.3	
Profit (US$/m3) of final product	4.7	

Note: Some figures could vary due to rounding error.

Table 4
Income for a trader by selling teak logs from an illustration one hectare plantation to a sawmill-furniture company in Paklay District, Xayabuly Province, Lao PDR. Selling prices originally in Lao KIP (exchange rate 8100 per USD).

Logs specifications	Price of logs (US $/m3)	% of logs	Price of logs (US $/ha)
< 11 cm diameter without bark	87.0	15	2195.3
11–15 cm diameter without bark	130.6	35	7683.5
16–20 cm diameter without bark	159.6	35	9391.0
> 20 cm diameter without bark	188.6	15	4756.5
Total sale price of logs			24026.2

Note: Quantity of logs without bark168.15m3/ha; 25% is bark (Tewari and Mariswamy, 2013). Some figures could vary due to rounding error.

hectare equivalent of logs or 3.4% of the sale price for growers. The average profit to the trader per cubic meter of debarked sawlog is almost US$5. No data were provided on the amount of time a trader spends on the transactions, the costs of this labour and therefore the return on their labour input.

Because of their low margins, a 10% decrease in the price at the mill resulted in a loss for traders, assuming they continued to pay the same price to growers. By contrast, with a similar assumption of no change to purchase price, increasing log prices by 10% resulted in a quadrupling of their profit.

3.3. Financial returns for the company

All logs in the processing company's operation are plantation teak bought from the two traders. On average, the company buys about 500 m^3 per year in total volume of raw logs without bark at their factory at a price of US$71,443 (Fig. 2). Wood purchase is the highest proportion of the total costs (34%) while labour costs, including management are the second highest cost (31%). Electricity costs are about US$37,000 per year (17%), depreciation costs (assuming a depreciation rate of 12.5%/year on capital equipment)[2] were US$17,728 annually (8%). The total costs for the company are about US$213,420 per year. Due to the proximity of the factory to the border of Paklay District, the company spends only US$4569 annually for transportation of finished product to the retail outlet in Thailand (about 2% of the total cost). Business tax is US$5081/$m^3$.

The recovery rate of final products from raw logs (without bark)[3] is about 70% and therefore total round wood equivalent volume of final product is 350 m^3/year. Therefore, the cost per cubic metre of final products is about US$610. The company produces six products almost in equal proportions by volume ceiling timber, timber for mouldings, window frames, wall fan frame, wood flooring and parquetry (Table 5). After production costs are deducted from the selling price, ceiling timber and timber for mouldings have the highest profit (US$316/$m^3$ each) and flooring and parquetry have the lowest profit (about US$45/$m^3$ each). Average profit from each cubic meter of final products is about US$171. Assuming one hectare of logs yields 168 m3, the total profit on a hectare equivalent of logs is US$21,235, or about 88% of the purchase price of the logs.

A 10% increase in selling prices for SWPM increased profit by 45% while reducing the price of the logs 10% almost halved the company's profit.

4. Discussion

At current prices and costs, and according to this modelling, returns for all three actors in the supply chain are positive. While comparing profit per unit of final products between the value chain actors, manufacturer returns are higher than those of the growers, which are higher than the traders' returns. The profit per cubic metre of final product for farmers was US$23.30 on better sites and US$8.40 on the poorer sites. Whereas for the sawmill-furniture company returns were US$171 and for traders US$4.70 (Table 6). Even if we assumed 20% bark, rather than the currently used 25%, traders profit would be much lower than that of the SWPM.

As noted, based on the Forest Land Allocation Program of the 1980s, each household could be allocated up to 3 ha of land for trees each. From that 3 ha area, each household could produce about 672 m^3 of logs (with bark) over the rotation of 18–24 years. On the other hand, the traders and manufacturer had bought about 500m3 of logs every year. Therefore, over the longer period of time, the manufacturer has much higher profit than traders which, in turn, is higher than the farmers.

The following sections discuss how net returns to farmers and traders can be increased and what are the implications of assumptions.

4.1. Increasing farmer's returns

Both the traders and the SWPM reported that the teak logs from Paklay district are of poor quality, compared to the logs from Luang Prabang Province. Therefore, the price is lower. Poor seedling and soil qualities, site selection, establishment practices, and lack of plantation management are likely contributing factors. The provision of quality seeds and seedlings was a policy mechanism to promote plantations. DAFO was supposed to do this as a technical extension exercise but it has not been supported by further/ongoing funding. DAFO has a teak nursery that is expected to be financially self-sustaining but the quality of seeds and germplasm is not high. They buy seeds from a collector at US$1.20/kg and this low price does not encourage consideration of the

[2] Total capital cost is US$143,600. We assume that the working life of factory life is 8 year.

[3] The recovery rate of 70% looks high but this rate is from logs without bark. As noted, 25% of raw log volume is bark. Therefore, the recovery rate of final products from raw logs with bark is about 52.5%. There is no revenue stream from sawdust and cut-offs.

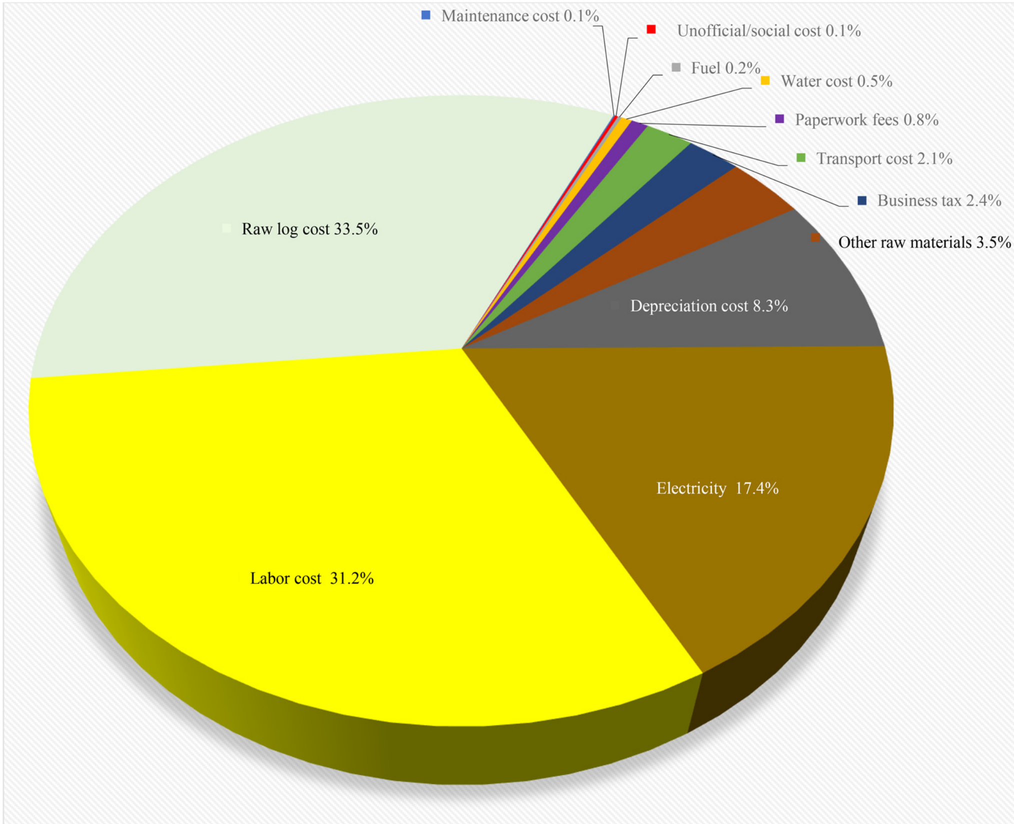

Fig. 2. Yearly cost structure (%) for the sawmill and wood products manufacturer (SWPM) in Paklay District, Xayabuly Province, Lao PDR (total cost US$213,420).

Table 5
Selling price and profit per m3 of final product for sawmill-furniture companies in Paklay District, Xayabury Province, Laos.

Finished products items	Selling price (US$) per m3 of final products in Thailand	Profit (US$) per m3 of final products
Ceilings	925.9	316.2
Timber for mouldings	925.9	316.2
Window frame	803.9	194.1
Wall fan frame	721.4	111.7
Wood floor	654.3	44.5
Parquet	654.3	44.5
Average profit/m3 of final product[a]		171.2

[a] Assuming all products produced in equal proportion.

Table 6
Profit (US$/m3 of final product) for three different actors of teak value chain, in Paklay District, Xayabury Province, Laos.

Actor	Profit (US$/m3 of final product)
Farmer	8.40 (Site 2) and 23.30 (Site 1)
Trader/middlemen	4.70
SWPM (sawmill-wood product manufacturer)	171.00

phenotypic characters of the parent trees. Collection of inferior quality teak seeds has been observed in other parts of Lao PDR (Hansen et al., 1997). Propagation of seedlings from phenotypically and genotypically superior trees or crops could increase both the volume and quality of logs or crops (Hedegart, 1995; Dhakal, 2016). Hedegart (1995) showed that simply the collection of seeds from superior trees without knowing genetic attributes could increase teak logs volume in plantations by 10–15%. Research from Luang Prabang shows that log volume can be increased by using breeding techniques to select and improve teak germplasm such as cuttings or tissue culture and by adopting improved spacing at plantation establishment (Dieters, 2014).

Another way of increasing farmer returns would be through improved management (Maraseni et al., 2017b). For species grown on longer rotations (> 15 years), like teak, thinning can concentrate growth on fewer stems and avoid losses in production due to competition. Thinning can also maintain stand health by reducing leaf water stress during the dry season (Huong et al., 2016). Research on teak in Luang Prabang Province shows relatively small differences in the total productivity of thinned compared to non-thinned plots, but non-thinned stands have fewer, larger diameter trees of higher value (Dieters, 2014). Therefore, financial returns are higher in thinned stands. A better response to thinning is achieved in stands below 10 years of age. To maximise returns, thinning should be done as early as 5–6 years, to a stocking of 600 stems/ha (Dieters, 2014). However, thinning requires skill in selecting and removing trees and avoiding damage to remaining trees (Harwood and Nambiar, 2016; Maraseni, 2007) and thinned stands may be more vulnerable to wind damage (Nambiar et al., 2014; Thu et al., 2014).

In Paklay there are clear differences in the prices for logs of different sizes (Table 4). Prices could be improved by thinning earlier and producing larger logs at an earlier time. In general, farmers in Paklay do not thin their trees, for the following reasons:

(1) there is no market for the products from thinning;
(2) thinning products are not identified or defined as a forest product. Poles are recognised as a forest product if they are from harvesting activities, and need permission from the Government to harvest (Forestry Law Art 43). It is not clear whether or not the same harvesting approvals that apply to final crop logs (which are specified in Art 2.4.1) also apply to thinnings (Smith, 2014).
(3) if thinnings are of a commercial quality or volume they are subject

to tax (Art 2.4.3) (Smith, 2014);

(4) plantation registration requires a minimum stocking number and thinning may reduce stocking below this level; and

(5) farmers view each tree above marketable size of being of potential equal value regardless of size and quality.

Improved growers' awareness about the benefits of thinning, harvesting regulations and definitions of forest products, tax and regulatory exemptions for removal of small volumes and market development to increase demand and price for larger logs can potentially improve financial outcomes for plantation growers and lift the overall contribution of the sector by increasing the supply of quality timber.

Another way of improving value is through grading logs and setting prices based on log quality. Elsewhere in the world, teak logs are sold in the market by size and grade (Midgley et al., 2015). Prices of logs also depend on their origin and the proportion of heartwood compared to sapwood. Teak logs from natural forest attract much higher prices than those from planted forests, and within the planted forest, logs from longer rotation plantation attract higher prices than those from shorter rotation plantation (Kollert, 2013). Studies in Lao PDR indicate that the physical and mechanical properties of teak plantation wood are not significantly different between different age groups of 10, 15, 20, and 25 years and therefore teak wood from younger plantations can be used for furniture production or household construction (Ozarska et al., 2012). The higher price for natural teak logs and longer rotation plantation logs is probably due to higher proportion of heart-wood (Kollert, 2013). In general, the colour of teak wood from forests on wetter sites is darker than that of from drier sites (Kaosa-ard, 1998).

In Paklay, teak logs from the better sites may be of better quality than those from poorer, drier sites but this was not revealed in the study or indicated in the prices received by growers. On the other hand DAFO staff believe that teak grown on the 'better' riverside sites could have a lower strength compared to slower-growing hilly or sloping areas. Currently teak logs are not sold on quality. The development of log grading rules and price differences based on quality, driven by a more competitive processing sector, could potentially improve returns to growers or traders but there was no indication in this study of that potential.

Teak log prices for growers in Paklay are generally lower than those of growers in other parts of the world. For example, average domestic market price of small size teak logs at the log yards for Africa, Latin America and Asia are US\$124/m^3, US\$129/m^3 and US\$149/m^3, respectively (Kollert, 2013; Midgley et al., 2015). Prices for medium and large sized logs are 1.5 or 2 times those of small-sized logs. In Paklay, traders received higher prices than this for large logs but this was only a small proportion of the supply and included harvest and transport costs. Growers generally did not receive more than US\$84/m^3, while the average price in Asia is US\$282/m^3 for medium-sized logs (Midgley et al., 2015). This shows that the growers have limited market information. The practice of buying logs by the number of trees above a threshold size also does not encourage production of higher priced, larger logs. Delivering training and extension activities and providing information on factors affecting log price and supporting market arrangements that results in a high proportion of this increased value going to farmers could assist farmers in better understanding the value of their trees and improve the overall value of output along the chain.

As noted, in this district about 25 years ago, the government distributed land for those households that applied for it on the condition that they plant trees. Farmers suggested to us that they planted trees to secure land use rights, not to grow wood for industry. For the farmers, the teak trees have served this purpose. Now they are attracted to crops with higher, and more regular returns, if labour availability is not an issue. Government policy for establishing plantations was effective but was not necessarily supported by strong policies to support good ongoing management or market development. The government will need to implement new policy measures that motivate farmers to manage their plantations and harvest their trees in ways that meet the needs of the market and wider benefits for society and environment but which does not negatively impact the long-term livelihood strategies of the farmers.

4.2. Increasing traders' returns

There is a general view among many farmers and other forest stakeholders that traders are rent seeking actors who receive large returns from their trading by taking advantage of growers' limited access to markets and market information (Perdana and Roshetko, 2015; Antilla, 2016). However, our study suggests that traders perform valuable roles in the supply chain, undertaking time consuming activities to meet the complex and costly regulations associated with timber harvesting and bearing unofficial costs in getting permission for harvest and transport of logs. Traders have good working relationships with sawmiller/manufacturers, growers and provincial and district government offices. They provide important linkages between processors and many individual growers, reducing transaction costs for both sets of actors. Perdana and Roshetko (2015) suggest that traders scan the market to link the suppliers with timber buyers and facilitate contacts in the market. Our results indicate that traders are deriving less profit from their activities than other actors and that these returns are commensurate with their level of effort, capital costs and the risks of harvesting, logging and transporting wood. Similar conclusions were drawn by Antilla (2016) from a study in Northern Laos and Perdana and Roshetko (2015) from a study in Indonesia.

Given the current low return environment, the two traders we interviewed would like to exit or hand on their businesses but they have informal agreements with the SWPM and are therefore likely to continue for some years. Increasing returns for traders would encourage them, or others, to continue to provide these services. Increasing log value would not automatically generate higher returns to traders and growers are currently getting lower prices for their logs compared to the farmers in other parts of the world (see above). Reducing harvesting and transportation costs would require considerable capital investment. Modifying and simplifying regulation and compliance costs would increase trader returns, as our data indicates that these costs are more than 39% of their total costs outside of the costs of timber purchase. Issues with transaction costs associated with the burdens of regulation of harvesting and distribution of wood and other forest products in Lao PDR are also discussed in Said (2015). On the other hand, if the government does simplify regulatory requirements, the role of traders may be reduced or in extreme case they may be eliminated, because famers could meet these requirements themselves.

4.3. Communication and relationship between the chain actors

There are four ingredients of a value chain that could maximise total and component values: (1) strategic alignment so that all actors in a chain are aiming to meet consumer needs, particularly for the highest value products; (2) efficient and timely flow of information; (3) relationship integrity with high levels of trust and commitment; and (4) insight into consumers so that VC actors can achieve competitive advantage (Fearne, 2009). However, in study value chain, there are many teak growers, only two traders and one processing company. There is no farmer association and farmers receive little support from government to grow and manage trees. Information on final markets is controlled by the manufacturing company. Farmers and traders do not know the key attributes of the teakwood that consumer valued most. All three actors do not know the consumers' preferences and behaviours.

There is no communication, relationships or strategic alignment between the external buyer, the sawmilling and manufacturing company, traders and farmers towards the demand-pull direction. There is neither vertical nor horizontal relationships between the actors. The linkage between them is independent, arm's length, opportunistic and possibly even adversarial. Moreover, there is no government intervention on profit cap. Therefore, there is no current capacity for collaboration and co-innovation in this teak value chain.

Furthermore, the division of responsibility among the government departments at district, province, and national levels is complex (Midgley et al., 2017) and therefore it is hard for actors to work with. Similarly, legal and administrative processes, policies, regulations, and communication system at district, province and national levels concerning the tree plantation are unclear (Smith et al., 2016). These complex issues have not only led to increasing operating costs of plantation value chain, but also undermine the essence of value chain principles.

Building partnership and sharing information between the value chain actors would be mutually beneficial to all actors. Producing ceiling timbers and mouldings results in over six times the profit for the company compared with flooring and parquetry. Gaining an improved understanding of the timber properties for these higher value products (for example, log size, colour or timber strength) and communicating this to growers, and offering higher prices for this wood can encourage greater production of this type of wood. This could increase profits for the company with some of this increase in value paid to others in the supply chain to increase overall value.

4.4. Limitations of the study

As with any financial estimate that projects into the future, assumptions based on current prices and costs need to be treated with caution. Second, this is a limited snapshot of participants in one region.

Third, the modelling does not consider whether or not rules and regulations are followed on the ground. In the whole value chain, traders do all the harvesting and transportation related paper works. They perform an important de facto role in facilitating wood supplies but are largely unregulated and often have no *de jure* status. They may provide a service in navigating the formal bureaucratic requirements for log harvesting and transport or they may circumvent it entirely, thus facilitating participation by growers and processors in the informal timber sector. Although this research interviewed both traders of teak-timber value chain in the district and explored their link with only one teak processor in the district, only limited observations can be made on the ground. Ongoing ACIAR research is exploring in further detail about this issue (Smith et al., 2017).

Fourth, the whole value chain of teak including cost and benefit distributions will be influenced by the VCs of other types of timber. When the price of substitute woods rises, demand for the teak wood also rises and vice versa. On the other hand, teak is a global commodity that is used for specific purposes (Midgley et al., 2015; Hardiyanto and Prayitno, 2006) which limits possible substitutes. Moreover, as noted, its global demand rose by 47% (Midgley et al., 2015) and therefore there is less chance of reducing its price and profitability of value chain actors. If however, illegal natural teak logs increase in the market, this would change the scenarios for all planted teak value chain actors.

Finally, the policy environment is dynamic and the effects of decisions uncertain. PMO15 had been enforced from late November 2016 (Smith et al., 2017), and it had many more elements than the ban on log exports. From the perspective of teak two aspects of the PMO are particularly relevant. Previously, the export of round logs and semi-processed (square logs), particularly but not exclusively, to China was a significant market for growers and small traders (i.e, those who buy round and sell square logs) (Midgley et al., 2015). Anecdotally, this may have maximised value at the grower end of the value chain.

With the advent of PMO, this market disappeared, new actors entered, or existing actors expanded their activities such that increased processing and manufacturing happens in Laos before export. These actors have to increase their inputs and costs, and so to maximise their returns, the return to traders and growers may have decreased.

The other aspect of PMO of relevance to teak is that it emphasised the need to reform the processing sector by assessing existing enterprises, closing down those that are sub-standard, illegal or operating without a licence (To et al., 2017). The focus of this was on the processing of natural timber and those located near natural forests, but again anecdotally, some small teak enterprises, including household enterprises, have been affected. Additionally, and possibly more importantly, in response to PMO15 the Government has introduced strict lists of products that may be exported. At the time of the study, exported teak products were in the eligible list, and therefore, it may not affect the processing industry. However, the list of products — defined by the Ministry of Industry and Commerce (Decision No. 1833, 03 October 2016) — is highly prescriptive, detailing the dimensions of several timber products and these may mean that sawmills that export wood products do not have much flexibility to produce new or innovative wood products that may be of high demand in the domestic and international market. This may affect their bargaining power in the highly competitive teak market.

Moreover, with effective enforcement of PMO may significantly reduce the supply of teak wood from natural forests on the market while plantation teak is allowed to move nationally (Smith et al., 2016). As a result, the price of planted teak may increase. This may improve overall profitability of the plantation teak value chain, but until the dominance of processing company prevails, it is doubtful whether that additional benefits is shared equally by all actors.

5. Conclusions

The Forestry Strategy 2020 in Lao PDR aims to increase the plantation area to 500,000 ha by 2020. In order to achieve this target, the Government has implemented several policies, such as land allocation for tree planting, property rights on planted trees, land tax exemptions for registered plantations and distribution of seedlings at a subsidised price. We compared the financial costs and returns for three actors in a teak furniture value chain in Paklay District, Lao PDR: growers, traders and SWPM. The final products are sold to a furniture wholesaler and retailer in Thailand.

Results from this study suggest that all three actors have positive returns from their investment assuming standard interest rates. However, the returns for the company per cubic metre of final product is much higher than that of the other two actors. The profit for farmers ranged from US$ 8.40 per cubic metre on poor sites to US$23.30 per cubic metre on better sites. For traders the profit was US$4.70 per cubic metre and for the SWPM US$171 per cubic metre. This suggests that the farmers, who bear most of the risk and costs for growing the trees over rotations of 18–24 years are receiving a relatively low share of the final total net surplus. This is a case study of six growers in two sites and therefore more research across a larger number of growers from different sites is required to determine if these findings are indicative of whole growers.

The study also found that there is no strategic alignment between the actors in the chain. All three producers are thinking short-term and are focused on their own production systems. Consequently, the farmers we interviewed are not interested in second rotation plantations and are planning to switch their land and labour activities towards high demand tropical fruit crops that provide a more regular return. Traders have grown tired of paying government fees and dealing with demanding paperwork, that consumes more than 39% of the harvesting and transportation cost. The SWPM is trying to maximise current profit, without thinking about long-term prospects. Therefore, there is little incentive to build the trust, collaboration and co-innovation between the actors required to maintain and grow the size and profitability of this value chain.

The following government interventions could support the achievement of policy objectives to increase production of plantation timber and its value to the Lao economy and society:

(1) improve the quality of teak seedlings and supply them to growers,
(2) train farmers and encourage them to thin at age 5–6 years to produce bigger trees more quickly,
(3) support sale of logs by quality and grade,
(4) eliminate, or at least simplify, current registration, harvesting and transportation rules, regulations and costs,
(5) create a supportive investment environment for traders and timber processors, and
(6) create a conducive environment for a differentiated and competitive processing sector.

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