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Tree Growers' Profitability in Veneer-Based Engineered Wood Products in Mufindi District, Tanzania

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Abstract: Engineered wood products have increased in demand worldwide. This also applies to Tanzania, leading to a developed interest in the increased production and demand of veneer, plywood and marine boards in the Mufindi District. This in turn influenced the aim of this study to examine the potential of Veneer Based Engineered Wood Products (VBEWPs) through the value chain. A cross-sectional study design coupled with purposive, stratified and snowball sampling techniques were adopted. A total of 152 actors involved in VBEWPs were sampled from the population of about 681 tree growers, brokers, traders, transporters and manufacturers. Techniques such as interviews, focus group discussions and key informant interviews were used to collect data. Data was analyzed by computing Gross Profit Margin, Value Added and Value distribution. The study concluded that although chains involving both small and large scale growers played a significant role in production of the veneer based engineered products, small scale chain experienced inefficiency compared to chain that involved large scale growers. Recommendations include increasing efficiency for small-scale tree growers' chains and strong cooperative alliances to enhance collective negotiation for better pricing and access to loans. Furthermore, the government should improve investment policies and reduce various taxes that the value chain actors incur to lower production costs and maximize profits.

Keyword: Value-added; value-added distribution; engineered wood products; cross profit margins; wood based industries.

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Introduction

Globally, there has been an increased focus on production of Engineered Wood Products (EWPs), particularly those based on veneer for the sake of supporting the development of the construction industry (Leggate et al., 2017). These materials have been the subject of extensive research and have been recognized as vital for sustainable construction

(Kohl et al., 2017) and Gong and Vladimirova (2022). Engineered wood products are man-made composites derived from a combination of hardwoods and softwoods, as outlined by Ekundayo et al., (2021). These products undergo regular treatments to enhance their strength and quality. They encompass a variety of types, each with different manufacturing techniques and applications. Examples of EWPs include particleboard, plywood, fibreboard, oriented strand board (OSB), laminated veneer lumber (LVL), glue laminated timber (GLT), and cross-laminated timber (CLT) (Leggate et al., 2017).

In Africa, according to the Mohajer, (2021) the availability of valuable forest resources, such as softwood and hardwood accounts for the increase of production in primary, secondary and tertiary industries, which process engineering wood products for local and international consumption. The production and distribution of veneer-based engineered wood products involve a complex value chain with multiple key players, including producers, intermediaries and processors, as explained by Arnold et al. (2013). The success of this sector relies on the quality of the products, market demand and production costs, all of which can influence the profitability of those involved. Tree producers play a crucial roles in this chain by supplying high-quality trees to processors and traders, as highlighted by Shabani et al. (2013). Additionally, veneer-based engineered wood products offer diverse potentials like serving various purposes, such as construction, due to their robust load-bearing capabilities compared to other wood-based alternatives, as pointed out by Pandey (2022).

The profitability of veneer in ancient years was low due to the methods used. For example, Leggate et al (2017) revealed that sawing of veneer logs and peeling by using knives resulted in great loss, underutilization of plantation materials and depletion of forest resources. In recent years, modern innovation in production technology has resulted in high profitability in veneer-based engineered wood products investment. The ability to extract young tree stands and small log diameter has been pinpointed to effect the situation (Arnold et al., 2013).

In Tanzania, there has been a gradual increase in engineered wood products (EWPs). The scenario has induced attention toward the engineered wood products, especially those based on veneer. Different approaches have been done in exploring engineered wood products in the country. For example, the Tanzanian government, under the Ministry of Natural Resources (MNRT), has initiated a ten-year plan spanning from 2021 to 2031, which outlines the current situation and anticipates the improved outcomes in the EWPs sector. Following its implementation calls upon more scientific research on engineered wood products. As a result, different researches have been conducted to examine the value chain of different forest products. Mostly done in Southern highlands (Moore et al., 2016; Lusambo et al., 2021; Martin and Mwaseba 2021). These studies explored value chains of varieties of wood products but little in engineered wood products, its value added and distribution which is the interest of this study. Therefore, the findings from this study will help in establishing the potential of veneer-based engineered wood to the local economy. The findings will help policymakers in policy improvement on minimizing chain inefficiencies.

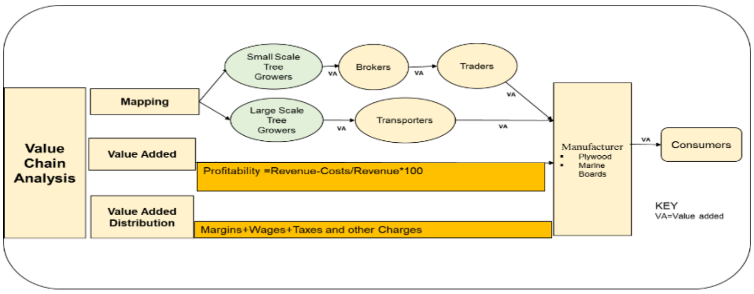

Figure 1: Analytical Framework of Value Chain Analysis of VBEWP

This study sported the potentials of veneer-based engineered products (VBEWPs) through value chain analysis. This is anticipated to be computed through mapping of the actors, value-added and distributions and profitability analysis. The process results are expected to be a map flow of actors and products, gross profit margin of all the actors, value-added, and distribution (Figure 1).

Methodology

Description of the Study Area

This study was conducted in Mufindi District, which is located in Iringa Region, Tanzania. The district is divided into two municipal councils i.e. Mufindi Municipal and Mafinga Township. The district is bordered to the North by the Kilolo and Iringa Urban Districts and to the South by the Njombe Region. On the Eastern side, it is bordered by Morogoro Region and on the Western border there is Mbeya Region. Mufindi District lies between the latitudes of 8°.0’ and 9°.0’ South of the Equator and longitudes of 30°.0’ and 36°.0’ East of Greenwich (Figure 2). The district is one of the areas in Iringa Region that has commercial small- and large-scale industries converting wood to different products for both local and international markets. The engineered wood products industries have excelled in Mufindi District due to availability of raw materials from a range of sources, including small-scale tree growers and large plantations.

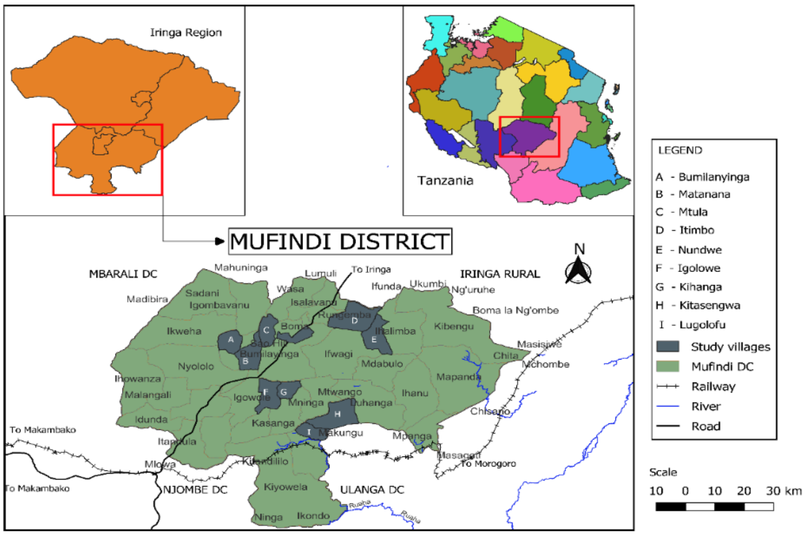

Figure 2: A Map Showing the Study Area

Design

The study used the cross-sectional design, which is the type of research designs where data is collected once from the selected sample of respondents. The cross-sectional design was adopted because it is cost-effective, less time-consuming. In such a design, a lot of information is obtained in a relatively short time and it allows data to be collected at one point in time, from different individuals or groups of respondents (Hemed, 2015; Mohajan, 2020).

Population and Sampling

This study targeted all the groups of actors involved in the veneer-based engineered wood products in Mufindi district. These actors are tree growers, brokers, traders, transporters and manufacturers. An updated list, which contained about 681 actors from the selected study area served as the sampling frame. The study, therefore, included 152 actors as the sample size. The sample size calculation followed the formula proposed by Krejcie and Morgan (1970) as indicated below:

$$n = \frac{X^2 NP(1-P)}{d^2(N-1) + X^2 P(1-P)} \quad \ldots\ldots\ldots (1)$$

Where:

N = Households (681)

n = Sample size

X^2 = The chi-square value for one degree of freedom at the specified confidence level (1.96 representing a 95% confidence level) is listed in the table

P = The population proportion (assumed to be 0.5 for the largest possible sample size)

d = The degree of precision represented as a ratio (0.05)

A stratified sampling technique was used to make three strata, according to different actors that are tree growers, middlemen (brokers, traders and transporters) and manufacturers. Simple random sampling was used in selecting tree growers and manufacturers' foremen. The last group of brokers, traders and transporters were selected using snowball sampling technique.

Data Collection

Both primary and secondary data were collected using various techniques. Primary data was collected through interviews with both open and closed-ended questions. Focus group discussion was used to get a broader understanding of veneer logs businesses. In addition, Key Informant Interviews (KIIs) were conducted to collect data from the Village Executive Officer, District Forest Managers, Saohill Plantation Manager, District Trade Officer and Managers of the selected factories. Secondary data was obtained from different office documents i.e., annual tax collection through forest businesses in the district.

Validity and Reliability

This study demonstrated a dedication to establishing the validity of the results through the application of suitable research techniques, such as purposive, stratified and snowball sampling. To guarantee the accuracy of the data and outcomes obtained from the field, most used tool questions were tested before field data collection. All variables of the study were captured including the cost and benefits of the veneer traders.

Data Analysis

Data were coded and analyzed using the Microsoft Excel software. This included quantification of costs, revenues, prices, taxes and other charges by all actors along the value chain. Furthermore, value-added and distribution along the chain also calculated. Value chain actors' interaction through their activities and linkages were drawn in map features, which showed their horizontal and vertical flow. Gross profit margins were calculated to estimate the profitability using Equation 1:

$$GM = TR - TC \text{ ....(i)}$$

Where:

GM = Average Gross Margin
TR = Average total revenue
TC = Average total variable cost
Ratio= Average total revenue (TR)−Average total cost (TC) /Average total revenue (TR)

The log volume was computed using Hubers Formula whereby mid diameter was used as shown in equation 2. The average volume of log sections for each truck was calculated as $V = \pi \frac{d_{mid}^2}{4} \times L$

Where:

d_{mid} = mid diameter in cm
L = length in m

The total value added in both products were calculated by the use of the following formula

$$VA = Y - I \text{ .... (i)}$$

Whereby:

VA = Value added
Y = Selling price of the goods
I = Intermediate cost (production cost)

$$VA_c = \sum(V_1 + V_2 + V_3 + \cdots V_n) \text{ .... (ii)}$$

Whereby:

VA_c= Total value of the chain
V_1 = Output of the node

Value added distribution which represents margins in terms of the net profit gained by actor in the chain

$$VA = Margin + Wages + Taxes\ and\ other\ charges \text{...(iii)}$$

Results and Discussion

This subsection consists of findings, which were obtained after analyzing the data. These findings were accompanied by discussions.

Research question 1: What are the Veneer-Based Engineered Wood Products (VBEWPs) Value Chains present?

Findings obtained from the collected data show two main chains involving small and large-scale tree growers in the Veneer Based Engineered Wood Products (VBEWPs). The two chains intersect at the manufacturer's node. Plywood and marine boards are the two main finished products in the value chain (Fig. 3). These findings indicate that case 1 flow starts from small-scale tree growers, brokers, traders, manufacturers and consumers while case 2 starts with large-scale tree growers, transporters, manufacturers and consumers.

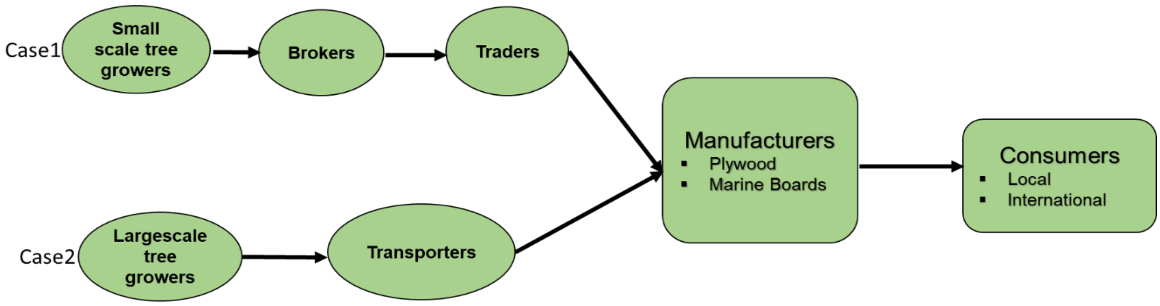

Figure 3: Veneer-Based Engineered Wood Products (VBEWPs) Value Chains Map

The actors in the veneer value chain are engaged in various activities that contribute to the income of each actor. A number of actors involved in veneer production are found in the small-scale tree grower's pathway (Refer figure 3 Case 1 of the results). This may be a result of the existence of intermediate actors that play a significant role in linking tree growers and manufacturers, thereby enhancing the distribution of value-added income across the actors. The findings are in line with the study by Held et al. (2017) and Abdelrazig et al. (2018), who similarly observed that activities performed by actors, and the extent of the chain influence their profits as well as value-added by actors in the chain. Furthermore, a study conducted by Mwinyimkuu et al. (2022) similarly observed that small-scale sawn wood production involved intermediate actors similar to veneer production. These intermediate actors include brokers and traders. The large-scale tree grower's pathway does not involve intermediate actors but rather focuses on maximizing marginal profit without significant value addition in wages paid to other chain actors by performing the added activities.

There was no clear market segmentation by both local and foreign processors due to lack of market information on the exportation of veneer and related products. Local processors sold veneer sheets to foreign factories and the remaining finished products were consumed locally. Large cities in Tanzania, such as Dar es Salaam, Arusha and Dodoma make a significant base of many local consumers. The global markets for these products are mainly Kenya, Zambia, Democratic Republic of Congo (DRC), Congo Brazzaville, China, India and other Asian nations. The work of Leggate et al. (2017) supports the argument by reporting that many developing countries have included veneer production in their local wood production sectors.

Research question 2: What is the Gross Profit Margin under Plywood and Marine Boards Value Chains involving Small Scale Chain?

In Table 1, for small-scale tree growers, the costs of veneer-based engineered wood products value chain activities in TZS/m^3 were TZS 5,031/m^3 generating a high profit of TZS 19,368/m^3 as well as the high gross profit margin of 79.4%.

Table 1: Gross Profit Margin (GPM) for smallholders in the plywood Value Chains (Authors, 2023)

Actors	Revenue (TZS/m^3)	Cost (TZS/m^3)	GPM	
			TZS/m^3	%
Tree growers	24,400	5,031	19,368	79.4
Brokers	28,223	26,811	1,412	5.0
Traders	77,451	71,330	6,121	7.9
Manufacturers	531,176	239,604	291,572	54.9

Table 2: Gross Profit Margin (GPM) for smallholders in the marine boards Value Chains (Authors, 2023)

Actors	Revenue (TZS/m^3)	Cost (TZS/m^3)	GPM	
			TZS/m^3	%
Tree growers	24,400	5,031	19,368	79.4
Brokers	28,223	26,811	1,412	5.0
Traders	77,451	71,330	6,121	7.9
Manufacturers	569,117	239,604	329,513	57.9

Table 3: Gross Profit Margin (GPM) for Large-scale growers in the plywood Value Chains (Authors, 2023)

Actors	Revenue (TZS/m^3)	Cost (TZS/m^3)	GPM	
			TZS/m^3	%
Tree growers	25,000	2,718	22,282	89.1
Transporters	33,008	12,726	20,282	61.4
Manufacturers	531,176	193,074	338,102	63.7

Table 4: Gross Profit Margin (GPM) for Large-scale growers in the marine board Value Chains (Authors, 2023)

Actors	Revenue (TZS/m^3)	Cost (TZS/m^3)	GPM	
			TZS/m^3	%
Tree growers	25,000	2,718	22,282	89.1
Transporters	33,008	12,726	20,282	61.4
Manufacturers	569,117	193,074	376,043	66.1

Brokers attained a least gross margin of 5%. Traders used a cost 71,330/m^3 generating a revenue of 77,451/m^3 which equals to 7.9%. Manufactures used the cost of 239,604/m^3 and reaped the revenue of 531,176/ m^3 equals to 54.9%.

However, marine boards in the same chain of small-scale results show an increase in gross margin from that of plywood by 3% in the manufacturer node. Manufacturers in TZS/m^3 used the total cost of 239,604/ m^3 and generated the revenue of 569,117/ m^3 equals to 57.9% (Table 2).

For large-scale tree growers, results for costs and revenues are indicated in Table 3 and Table 4. Largescale tree growers had a high profit margin of 89.1% in producing plywood, used very low costs of 2,718/ m^3 in the tree-growing process and generated a revenue of 25,000/m.^{3} These were followed by manufacturers with a cost of 193,074/ m^3 and revenue of 531,176/ m.^{3} Finally, transporters used the cost of 12,726 /m^3 with 33,008/m^3 as revenue (Table 3).
On the other hand, similar trends are observed in the production of marine board in Table 4, where GPM is higher for tree growers followed by manufacturers and then transporters. They all had the following costs 2,718/ m^3, 193,074/ m^3, 12,726/ m^3 respectively and reaped a revenue of 25,000/ m^3, 569,117/ m^3 and 33,008/ m.^{3} These variations may be attributed to differences in the selling prices.

Small-scale and large-scale tree growers in Mufindi district are experiencing high profitability for pines and eucalyptus tree species refer to Table 1;2;3;4. These species are used in the production of veneer-based engineered wood products, mainly marine boards and plywood. This high value of gross profit margin was associated with various economic motivations that the tree growers were given during the production process. "Small-scale tree growers are highly motivated in planting and managing trees by different stakeholders and service providers, such as Tanzania Forest Agency Services (TFS), Forestry Development Trust (FDT) and the Small-growers Tree Association (TGA)". The profit earned from the forest product, especially in pine and eucalyptus depend on the size and the health of the tree, which determines the amount of output after logs are processed. The findings are supported by a study by Ngaga (2011), who reported that quality pines and eucalyptus' seeds and seedlings are available in the study area, which facilitates this efficient tree-growing behaviour, hence the profitability of tree-growing activities. The small-scale tree grower's high profits were associated with using small costs in the establishment and management of the stands. Veneer uses most of the eucalyptus species, which small-scale tree growers plant and leave them with little or no management practices at all. Little used cost in growing activities maximizes the profits of small-scale growers.

Large-scale tree growers gain higher profits compared to small-scale tree growers. The situation is influenced by the rise of veneer-based business as realized in small scale tree growers. Veneer production has become a solution to abandoned compartments or forest plantations that lack tending operations. Not only Eucalyptus compartment plantations with mixed products from coppicing are benefited but also the use of leftovers (Vcurfs), remaining after poles and sawn logs harvesting have maximized tree growing business margins as they are resold as firewood. Furthermore, economies of scale in tree-growing activities and advantages of stable prices ought to be reasons for the high profit in large scale to that of small scale. The study is in line with the findings by Moore et al. (2016) who reported that the rise of veneer business will increase the consumption of eucalyptus tree species and maximization of tree growing profits.

Moreover, the large-scale grower's high profits were a result of increased demand for plantation wood by veneer-based engineered wood products (VBEWPs), especially eucalyptus trees. In previous years, eucalyptus trees in Mufindi District had no stable market. "Selling tree stumpage, where customers were selecting their preferred products, led to the destruction of the remaining wood in stumpage, hence the loss" Saohill Harvesting Officer argued.

Another cause of high profit in large scale tree growers was to sell matured trees with good quality compared to small-scale. "Large-scale tree growers often practiced silvicultural management on the plantation, hence the high yield" (From Saohill Forest Plantation). Findings are related to those of studies by Indufor (2012) and Malkamäki et al. (2017), which associated the increment in the demand for wood from large-scale plantations in different wood materials production increasing the profitability of plantations in African countries. This study concurs with other studies by Lusambo et al. (2021 and Mhando et al. (2022), who similarly pinpointed fairly profitability seen in tree-growing activities in Southern highlands.

Manufacturers of veneer-based engineered wood products seem to be efficient in the production process, earning a significant gross profit margin for plywood and marine boards for both small and large scale tree growers. The processors/factories dealing with veneer-based engineered wood products are considered highly efficient businesses because of the price-setting power, efficient use of production technology, especially by foreign investors and rich in market information. Such a gross profit margin appeared to attract more veneer-based engineered wood product processors to enter the industry. The expansion of these veneer-based industries has been achieved because even local investors started investing using new technology. This was clearly seen during data collection whereby among the 12 industries, 3 belonged to local people.

Brokers and traders are other actors in VBEWPs value chains. These reaped a low profit margin compared to other actors in VBEWPs (refers table 1, 2, 3 and 4). Brokers and traders work in coordination to purchase raw materials from growers. The role of brokers in transactions is rich in information on where trees are allocated. Traders experienced low margins in their investments due to several reasons. First, the need to purchase raw materials incurring associated costs and the need to pay for the wages of workers involved in cutting, loading, unloading and transporting logs to the industrial area. This process involved various expenses that eat into their profits. Another reason for low margins was associated with low selling prices. The logs purchased might not fetch a high price in the market, reducing their profit potential. In addition, traders faced quality control issues in that some logs may be rejected due to being too large or too small in diameter, leading to other losses. Lastly, the low profit may be attributed to distance of searching for raw materials species with good grades, which increases transport costs.

Research Question 3: What is the value added and distributed under veneer based engineered wood products (VBEWPs)?

Value added in VBEWPs in the total chain was 454,361 TZS/m^3 in activities that involve production of plywood. Marine board production value added in total was 533,302 TZS/m^3.

Table 5: Value Added and Distribution (TZS/ m^3) for plywood value chain involving smallholders

Item	Tree growers	Brokers	Traders	Manufacturers	Total	%
Margins	19,369	1,412	6,120	248,632	275,533	60.64
Wages	3,314	2,411	9,172	13,268	28,165	6.2
Tax and other charges	0	0	1,798	148,865	150,663	33.16
Total value in the chain	**22,683**	**3,823**	**17,090**	**410,765**	**454,361**	**100**
% Contribution	4.99	0.84	3.76	90.4	100	

Value distribution contribution along the chain margins was high in both plywood and marine boards compared to wages and taxes. Margins scored 275,533 out of 454,361 of the total chain, followed by tax and other charges 150,663 and wages scored 28,165 out of 454,361 (Table 5 and Table 6). However, actors like tree growers and brokers were not involved in tax payments, hence less contribution to the total chain in Table 5 and Table 6. Value added in this chain from tree-growing activities and transporting to the manufacturing unit was 553,928 TZS/ m^3 for plywood (Table 7). It was observed that no tax was paid by tree growers as well as transporters (Table 6).

Table 6: Value Added and Distribution (TZS/ m^3) for marine boards value chain involving small holders

Item	Tree growers	Brokers	Traders	Manufacturers	Total	%
Margins	19,369	1,412	6,120	327,573	354,474	66.47
Wages	3,314	2,411	9,172	13,268	28,165	5.28
Tax and other charges	0	0	1,798	148,865	150,663	28.25
Total value in the Chain	**22,683**	**3,823**	**17,090**	**489,706**	**533,302**	**100**
% Contribution	4.25	0.72	3.2	91.83	100	

Table 7: Value added and distribution TZS/ m^3 for plywood value chain involving largescale tree growers

Item	Tree growers	Transporters	Manufacturers	Total	%
Margins	22,282	20,282	338,102	380,666	68.72
Wages	2,718	2,470	19,209	24,397	4.40
Tax and other charges	0	0	148,865	148,865	26.87
Total Value in the Chain	**25,000**	**22,752**	**506,176**	**553,928**	**100**
% Contribution	4.51	4.11	91.38	100	

Table 8: Value added and distribution TZS/ m^3 for marine board value chain involving large scale tree growers

Item	Tree growers	Transporters	Manufacturers	Total	%
Margin	22,282	20,282	376,043	418,607	70.73
Wages	2,718	2,470	19,209	24,397	4.12
Tax and other charges	0	0	148,865	148,865	25.15
Total Value in the Chain	**25,000**	**22,752**	**544,117**	**591,869**	**100**
% contribution	4.22	3.84	91.93	100	

In large scale tree growers' chain, value-added distribution in plywood was 68.72%, 4.40% and 26.87% for margin, wages and tax, respectively as in Table 7. Wages seem to be less approximated by more than 1% from 5.28 to 4.40 (Refer Table 6 and Table 7).

This study revealed that value added and distribution of profits play a significant role in benefiting actors in the veneer based engineered wood products value chains. However, the distribution is not equal across the various nodes or stages of the chains. Manufacturers contributed significantly to the value-added distribution, especially in the production of plywood and marine boards (Refer Table 7 and Table 8). Their involvement spans activities like raw material procurement, processing and marketing. High efficient technology and access to market information are similarly associated with the findings where they produce high quality veneer and related products, which capture high price market too. The uncertainties in value added are contributed by several situations like selling juvenile trees by small scale growers and lack of tending practices, which results to poor yields. These findings are supported by the study by Alemayehu (2019), which found that tree growers face challenges, one being harvesting trees prematurely due to immediate cash needs, which prevents them from reaching the peak of value added. The findings align with Mhando et al. (2022), who reported that incomplete rotation of trees hampers their profitability, hence little value added. Indufor (2011) supports this observation, stating that woodlot growers often harvest before trees reach the optimal rotation age and are forced to negotiate prices, resulting in lower value in the supply chain.

In contrast, large-scale tree growers, like Saohill Forest Plantation, made a more substantial contribution to the supply chain (refer to Table 5, 6, 7 and 8) due to their large scale and capacity. This was influenced by the constant pricing of trees, which is not subject to market conditions. Findings are in line with the report of Indufor (2011) that large-scale tree owners have non-negotiable prices, hence market stability. Moreover, harvesting mature trees enhances the profit potential for large-scale growers compared to their small-scale counterparts. Conclusively this information underscores the importance of understanding the dynamics and challenges within the veneer-based engineered products (VBEWPs), particularly in terms of small-scale and large-scale tree growers.

Conclusions and Recommendations

Conclusions

In conclusion, although chains involving both small and large scale growers played a significant role in production of the veneer based engineered products, small scale chain experienced chain inefficiency compared to chain that involved large scale growers' unstable price market for their products. All the actors found along the value chains earned a proportion of the profits although some actors' profits (i.e., traders and brokers) were not substantial. Little used cost in all tree growing activities maximized the profit of tree growing activities. There is a significant amount that is added to the revenue generated in the value chain. The distribution in the state, investors and households signifies the contribution of veneer based engineered wood products to the local economy.

Recommendations

To increase efficiency for small-scale tree growers' chains, the formation of strong cooperative alliances or associations is crucial in order to enhance collective negotiation for better pricing and access to loans. These cooperative alliances should be formed and encouraged. Woodlot owners are encouraged to use existing extension education services provided by different stakeholders to improve their entrepreneurial skills. For example, using short rotation and improved seeds and seedlings to increase profitability per acre is essential. Finally, the government should improve investment policies and reduce various taxes that the value chain actors incur to lower the production costs and maximize the profits of other players in the veneer business.

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