PANDA MITI KIBIASHARA
PRIVATE FORESTRY PROGRAMME

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VALUE CHAIN ANALYSIS OF PLANTATION WOOD FROM SOUTHERN HIGHLANDS

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MINISTRY OF NATURAL RESOURCES AND TOURISM
Forestry and Beekeeping

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Value Chain Analysis of Plantation Wood from the Southern Highlands

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ABBREVIATIONS

CCA	Chromated Copper Arsenate
DBH	Diameter at Breast Height
FDT	Forest Development Trust
GoT	Government of Tanzania
GRL	Green Resources Limited
KVTC	Kilombero Valley Teak Company
LMDA	Logging Miscellaneous Deposit Account
MFA	Ministry of Foreign Affairs of Finland
MNRT	Ministry of Natural Resources and Tourism
NGO	Non-governmental Organization
NIPF	Non-Industrial Plantation Forests
PFP	Private Forestry Programme
REA	Rural Electrification Agency
SHFP	Sao Hill Forest Project
SME	Small and Medium Enterprise
SOFIA	Southern Highlands Forest Industry Association
TANESCO	Tanzania Electric Supply Company Limited
TANWAT	Tanganyika Wattle Company Limited
TBS	Tanzania Bureau of Standards
TFS	Tanzania Forest Service
TGA	Tree Growers Association

EXECUTIVE SUMMARY

The Value Chain Analysis studied the current wood processing of plantation wood arising from southern highlands in Tanzania as well as potential and ways for developing the industry in future.

Analysis identified present processing facilities and carried out a baseline study on the size, number and locations of local processors. It was found that majority of sawmills are small and use portable low-quality dingdong saws. In towns near the main government forest plantation some sawmills have invested in stationary sawmills and improved technology small sawmills which are capable to produce higher quality timber with better material usage.

Demand for forest products is growing in Tanzania and, whilst it was once met by government-managed resources, the last three years has seen a reduction in the pine allocations from government resources. This reduction is critical and actions are needed to ensure a future supply of mature pine roundwood logs. Although some steps have already been taken to reduce this shortage, the potential shortfall in volumes of softwood products is still a threat. The analysis of roundwood supplies to wood processing industries showed that sawmills are already starting to rely more on alternative species, namely eucalyptus.

There is a difference between sawmillers operating near government plantation areas and elsewhere. In Mufindi, near the Sao Hill Forest Project, sawmillers can with certain confidence and in some degree rely on receiving an annual allocation from the government. This may have twofold effects: firstly, this increases confidence in investing in better machinery. Secondly, this also increases the number of applicants for the annual allocations. A number of discrepancies were found between the number of sawmills identified and the number of permits issued. 2015/16 harvesting season had reduced harvesting volume for pine (-30 % from 2014/15, total 540,300 m^3) but at the same time had increased number of beneficiaries for allocations (832 to 964). Under TFS regulations, all beneficiaries must qualify technically to be able to receive an allocation but this regulation is not enforced consistently. Most permits issued had an annual volume of 200 m^3 which is not regarded as a sustainable volume for even a small sawmill to be able to operate effectively. Moreover, existing volumes from government resources do not sustain investments in meeting regulation and improving recovery and sawing quality.

Reports and data on new plantation planting are deficient although there is clear evidence that planting by small growers, farmers and tree growers' associations (TGAs) is extensive. Most of this plantation development is relatively new and the volume and age of these recently planted trees is currently not enough to compensate for the reduction in volume from government forests resources.

In Njombe region sawmills are relying purely on small and scattered private plantation resources. All machinery used are portable, cheap dingdong sawmills. This spatially scattered and mobile industry structure makes development of industry and collection of sawmill residues difficult to organise. Near government plantations it would be possible to create "clusters" with improved roading and collection of a considerable amount of wood residues for energy production whilst creating additional income for the enterprises.

Market analysis of sawn timber revealed that there is growing shortage of pine as raw material and also pine processed to the form of good quality timber. Better quality pine lumber produced by more advanced technology sawmills receive a price premium on the market. To reduce the impact of decreasing pine volumes, technology needs to be upgraded to improve the recovery and quality of sawn timber products.

The current sawmill technologies and timber markets do not extract and build potential value of wood and forest products even at satisfactory level. Small dingdong saws have a low recovery rate resulting in poor quality timber with a large volume of low or no value residues. Lack of working market for pulp logs means that the different

grades of logs cut from standing trees are not directed to the highest value adding users.

Development programs to increase the use of waste and low-grade material need to be expanded, and production processes for using alternative tree species, primarily eucalyptus, need to be developed.

The government log sales system is expected to change to consider newly emerging factors, but a framework that suits a centrally managed forestry organisation may not suit an open private-supplier log supply chain and a market information system to serve private forest owners and industries is needed. Factors affecting both the supply and demand sides of the log chain must be taken into account in developing the system: a forest industry enterprise must feel confident that it will have a reliable supply of quality and conditioned raw material; an open and transparent log supply will allow the grower to maximize his earnings potential from the forest stands and encourages investment in future planting.

To overcome the main challenges in the value chains development of viable sawlog supply chains and trading systems is essential, a system similar to those successfully operated by the privately supplied utility poles industry. To cover the whole supply chain, both private and government plantations need to be integrated in the trading system. Transition to alternative log trading systems needs to be trialled and evaluated alongside broad stakeholder consultation conducted to allow for the industries wide acceptance for the new systems.

Regulatory and tax positions are by nature evolutionary but also require analysis and consultation before effective change or development can be achieved. The introduction of grade standards not only increases the quality of end products and projects using the end products, but enables comprehensive development of trading systems with in the raw material sector, creates a level playing field for both large and small stakeholders and results in an open and transparent market.

Introduction of vocational training and practical education in the forestry and forest industry will contribute to achieving the much-needed technical advancements. Development of such a program will be effective in reaching all levels of the industry. It will provide strong support to sustain increases the results from production and product development investments. A wider access to modern saw mill machinery producers and the development of production will be effective and enables greater results to both large and small industrial investment programmes.

Barriers to business and industrial advancement in the Tanzanian forest industry requires the development of a successful wood-based industry that depends on having supplier and market information systems as well as education and technical support. Market demand for higher quality products exists as well interest in investing in improved technology and manufacture of new products. Future investors and current stakeholders must feel motivated, eager and confident that further spending will result in commercial growth and business stability.

1. INTRODUCTION

1.1 PFP Programme

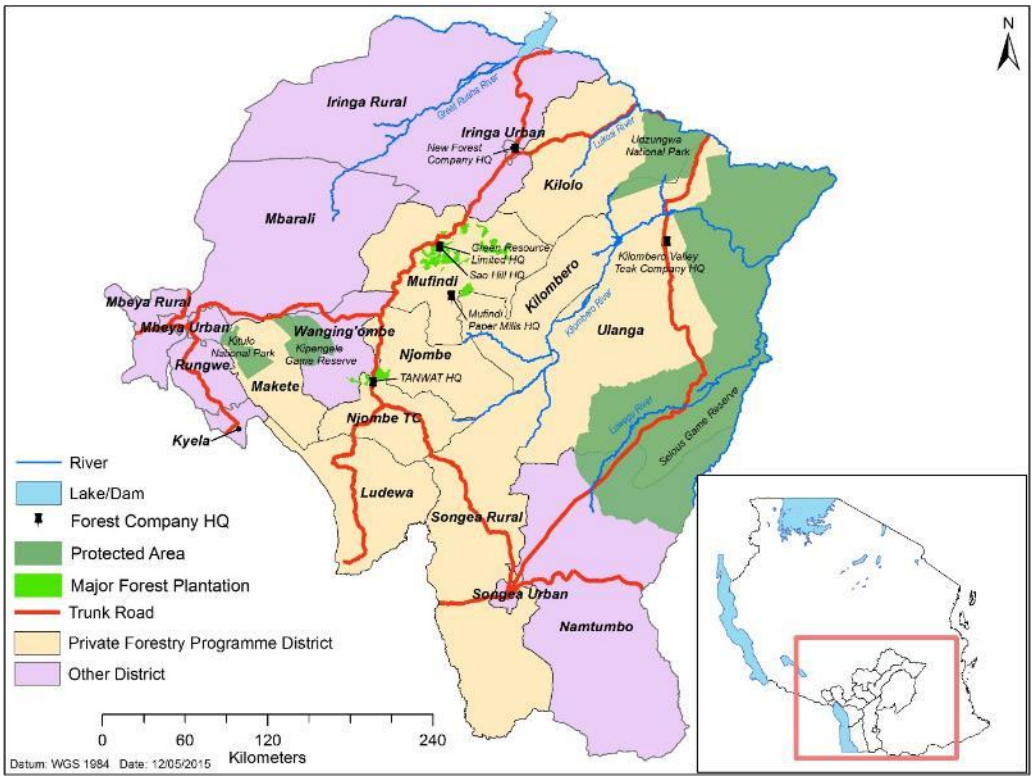
Tanzania's Private Forestry Programme (PFP) aims to increase rural income in its target area, which consists of nine districts in the southern highlands and Kilombero Valley (Figure 1.1). It will reduce poverty and inequality by developing sustainable plantation forestry, add value to the entire forest product value chain, from good quality seeds to high quality products, and create employment. To meet this aim, the programme will support participatory and sustainable land use planning; facilitate the organising of tree growers into Tree Growers Associations (TGAs); develop the capacities of tree growers; support plantation establishment and strengthen plantation management; strengthen extension and business services; and improve industrial production, especially that of small and medium enterprises (SMEs), within the value chain at the same time as it accelerates tree cultivation and improves the quality of trees and wood-processing. The programme's innovative approaches will be evaluated and its best practices disseminated widely within the sector. The programme will also facilitate the broad development of the sector by facilitating dialogue among key stakeholders and by processing proposals for policy, legislative, and business development.

The key beneficiaries of the programme are private tree growers and wood-processing SMEs in the programme area, especially those who already belong to or will one day belong to TGAs. Inclusive and equal participation in TGAs will be promoted, and the rights of vulnerable groups will be strengthened by ensuring that they are genuinely involved in land-use planning processes and employed in the value chain as well as by promoting income-generating activities. To ensure environmental sustainability, the programme will integrate biodiversity conservation into land-use planning and improve biodiversity management in plantation development.

The rationale for supporting private plantation forestry in Tanzania is as follows:

- Tanzania is one of the few countries in the world that still has land with the right climate and soils for successful tree plantations.
- Small-, medium-, and large-scale tree growers in the southern highlands are keen to expand tree plantation; in fact, a strong movement of tree growers has emerged.
- Both plantation forestry and plantation wood-based processing are potentially profitable as well as environmentally and socially sustainable.
- Private plantations and value-added production can have positive economic, social and environmental impacts at the local and national levels.
- Private plantation forestry can generate economic growth and employment in rural areas and thereby considerably reduce poverty.

Figure 1.1 Private Forestry Programme area in the Southern Highlands



1.2 Value Chain analysis

Steady and strong economic growth combined with population growth in Tanzania during last 10-15 years has created high and growing demand for forest products and tree planting boom in the southern highlands area. Despite this the development of the wood products industry is limited and only medium and large companies have made any significant investments in the past few years. Small sawmills operate in much the same way as they have done for the last 20 years. While many have replaced their old machinery, they have replaced it with locally manufactured saws based on the same old technology.

Tree growers, road hauliers, and wood industries are important contributors to Tanzania's economy but many problems have prevented them from reaching their potential. Tree growers lack necessary incentive schemes, materials, skills and organization to allow them to grow quality timber; road hauliers struggle with poor road conditions and delays at checkpoints; government log sale practices are cumbersome and do not reflect recent developments in the Tanzanian wood industries; and wood industries are wasteful and regularly do not achieve the quality and standardization needed to produce high-value products. To address these problems PFP conducted an in-depth study to find out more about the forestry and wood industry value chains and make recommendations for improving their economic performance.

Although there are important non timber forest products in the southern highlands the focus of this assignment has been on wood products only. Detailed Terms of Reference of this assignment are in Annex 12.

2. METHODOLOGY

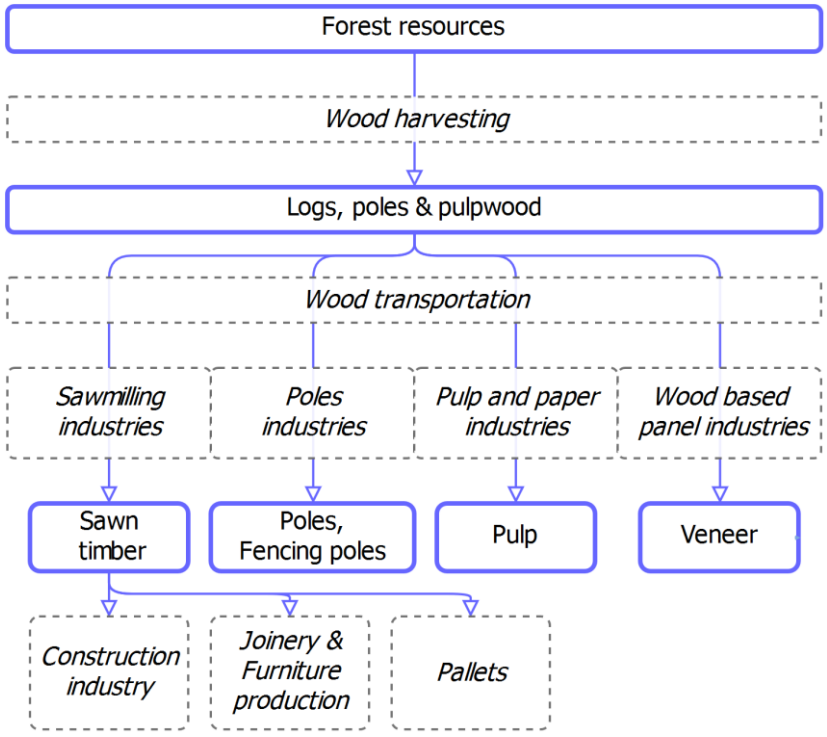
2.1 Wood products and steps in value addition

Market demand for plantation wood in Tanzania has focused on pine sawn timber and poles of eucalyptus. Main source of pine raw material in the southern highlands is Government plantations managed by Tanzania Forest Service (TFS).

Pine sawn timber and poles of eucalyptus are still the main products from plantations in the southern highlands. In addition, veneer production from eucalyptus is coming into the scene. The study focuses on value chains around these three products. About two thirds of the plantation supply goes to sawn timber production and one third for pulp (Mufindi Paper Mills). Recent investments in sawmilling and veneer production are diversifying demand for eucalyptus wood in the region. Almost half of the eucalyptus volume allocated from Government of Tanzania (GoT) plantations in 2015/16 is expected to be utilized for veneer production.

The figure below shows steps in value addition from forest to end-market as well as actors involved outlining the framework for this study. A market based approach is adopted in the study and the report starts with a short overview of wood product markets in Tanzania (chapter 3), then presenting the supply side (chapter 4) before going to the heart of the study, value chain analysis.

Figure 2.1 Production flow in the forest value chain



The study was initiated with identification of different level actors for main forest products along the forest value chain in the southern highlands. Data collection formats and questionnaires were developed to support interviews and data collection and to address characteristics and role of different actors.

The actors are presented in more detail in chapter 5 and are as follows:

- Wood raw material producers: Government plantations, private forest companies and small-holder forest owners
- Actors in logistics: harvesters, transporters, raw eucalyptus pole suppliers

- Actors in processing: sawmillers (SMEs and bigger sawmills),
- Actors in the trade: timber traders and timber merchants
- End-users: buyers of sawn timber, treated poles and veneer.

2.2 Data collection and analysis

2.2.1 Previous studies and research

An overall analysis of Tanzanian forest sector markets and value chains has been carried out in Private Forestry and Carbon Trading Project in 2011 (Indufor 2011). Most of the other relevant previous studies on value chain and related topics were conducted on public plantations, especially the Sao Hill Forest Project (SFHP) plantation. Very few studies have been conducted on private plantations since their establishment is recent. Another gap is that most studies were of *Pinus patula* and very few were of teak or eucalyptus. In addition, the recording and management of data on production levels and the consumption and trade of forest products is poor. Information is scattered among different users and is irregular and uncoordinated. A fourth gap is that there are few studies of community and farm forestry though Singunda's paper from 2009 shows there were already plenty of woodlots in the PFP area then and that farmers need forest-related information to support their decisions and manage their forests commercially. As a part of the desk top study phase also forestry and wood industry reports were reviewed.

2.2.2 Field work, interviews and analysis

Field work and interviews of value chain actors were carried out for wood-processing industrial operations at all levels (SME and industrial scale) in the southern highlands. Data on markets was collected in Dar es Salaam, Arusha, Morogoro, and Dodoma.

Data and information collection covered:

- Wood-processing data, including volumes, species, and end-users of plantation resources
- Review of existing government forest allocation processes and interviews with stakeholders
- Harvest and processing results of government plantations (SHFP) to analyse status of the pine stands and log yields
- Survey and analysis of related industry and wood-product users
- Market data survey
- Logistics and transport survey and analysis
- Analysis of barriers to development both reported and perceived
- Interviews with potential investors in the bio-waste power generation sector
- Interviews with crossover industrial stakeholders

Questionnaire forms for data collection are in Annex 13. In total 208 interviews among different actors in the value chain were carried out. List of interviewees in in Annex 14.

Measurements for sawn timber sections and lengths for saw tolerance and size variation were done in Mufindi area in SMEs and in Dar es Salaam markets. Standing trees were measured at Itona, Mufindi area to assess diameter at breast height (DBH) for young stand and prices paid to private growers. Measurement were also done at Sao Hill Forest Project division 2 for log analysis of government stands.

After the field work data was compiled, systematized and organized to create a detailed picture of processes and role of actors along the value chain for different products. Cost and margin estimates were calculated to have an estimate of the actual value addition and profitability for different levels and actors.

3. WOOD PRODUCTS MARKETS

3.1 Demand by sectors including demand forecast scenario

A market study conducted by Indufor in 2011 identified four major sub-sectors in round wood industry; construction, pulp and paper, furniture and joinery, and utility poles sector. Additionally, there is an arising veneer production industry, which is included in this study. In overall, the demand for pine products is fairly uniform across the country though there are variances in quality, tolerance, and size. Some regions have moderate demand specifics which affect the prevalence of certain sizes and treatments. The range of eucalyptus products is developing rapidly for two key reasons: 1) pine is in short supply, and 2) producers are more willing to try alternatives, though lack of knowledge how to process and use eucalyptus is hampering the efforts.

3.1.1 Construction sector

The largest wood user in Tanzania is presumably the construction sector but there are no statistics or research findings estimating the volumes used by this sector. Trend for wood use can be estimated from the level of construction activity. According to BMI Research (2016), the growth in real terms in Tanzanian construction is forecasted to reach 10% in 2016 and averaging 9% in the next 10-year period.

The construction sector includes residential and commercial buildings and infrastructure development projects. The sawn timber most in demand are two-inch boards of widths from two to six inches. They are used for roof trusses and framing. The market does not use a lot of thinner one-inch thick boards in narrow widths. Nevertheless, there is market for widths in excess of eight inches (200 mm). Such boards are used as barge boards and soffit boards for roofs and buildings. The reduction in pine resources and the imminent threat of sawmills harvesting immature pine stands will however result in a shortage of one-inch thick (25+ mm) boards in wide sections for 8” and greater (200mm). This was also demonstrated by the survey where markets showed concern considering the availability of wide pine boards, but expressed reluctance to use eucalyptus as an alternative. The eucalyptus boards are often perceived as improperly dried and thus, become split and twisted after a while.

The most popular size of sawn timber is two-by-fours (inches), but two-by-twos and two-by-threes are used as cross members on roofing construction and as battens for supporting tiles and metal sheeting. Large sizes are purchased for use in large spans, or, more commonly, bought to convert on-site to two-by-twos and two-by-fours as needed. Until four or five years ago, 12 ft (3.6 m) was the standard length, but now, because of new sawmill technology, the maximum length can go up to 20 ft (6 m). The difference has resulted in a two-tier pricing system differentiated by different units of sale. Traditional 12-ft planks are sold by piece and, as most comes from dingdong saws, the quality and size tolerances and consequently the prices are less than those for long planks, which are sold per meter or foot.

Narrower one-inch boards are used in a number of end markets, particularly in the pallet industry, which has been increasingly installing mechanical handling lines that require a high degree of size tolerance. Since the sawn timber produced by low tech sawmills does not meet the demands of this industry, they are effectively excluded from being suppliers. Companies in Arusha region double up one-by-four boards for use as roof trusses. They do so to save money as one-by-fours cost so much less than two-by-fours, that they can afford the extra cost of a carpenter’s work. Companies in other areas of Tanzania have not adopted this practice.

The market for sawn timber is gradually starting to acknowledge quality differences in sawn timber and pay a higher price for better quality. Sawn timber produced by newer technology sawmills is of better quality than the timber produced from dingdong saws, and consequently paid a higher price. The majority of sawn timber from dingdong

saws is 12” or 3.6 m long and is sold based on the price per piece. Higher quality sawn timber is now becoming available in lengths from 4 – 6 m long and is sold based on a price calculation per running meter or running foot. This sector of the market is also used to offering on a price basis of cubic meters. The large industry sellers with high quality sawn timber and tight size tolerances sell with published price lists showing prices per running foot, running meter and cubic meters. The average price premium of high quality timber is 27% per cubic meter to lower quality timber from small sawmills.

The demand of the construction industry for treated timber varies in different regions not because timber is used without treatment but because companies wish to use domestic products or believe that it is cheaper to treat wood themselves. In general, pine must be subjected to an anti-termite and rot treatment process (chromated copper arsenate (CCA) with 100% penetration of chemicals) such that if a piece of timber is cut and trimmed after treatment, the integrity of the treatment process is not affected. This process can be effectively carried out only in a vacuum-pressure chamber with correct and controlled dosing. Only a few of the main companies treat their timber correctly, and they supply just 25% to 30% of the material that enters the market. Many buyers are aware of the difference between properly and improperly treated timber and, as a result, try to source properly treated material when they have an important project.

80% of sawmills in Mufindi reported that they sold timber locally. Timber is collected from sawmills and stacked in the traders’ yards for air drying. This is done mostly by traders who have their distribution yards in the Mufindi District and then sell onwards to the construction market. Only 13% of sawmills selling locally sold to end customers as well.

Sawmills sell also flitches and slabs produced as side-product in sawing process to local markets, though small volumes may travel to other markets. Flitches are used in low-grade buildings such as those used for agricultural purposes or located in a rural setting, as well as for fencing and partitioning. Good-quality slabs are used by the manufacturers of baskets and boxes to transport agricultural produce. Pine slabs are rarely used for firewood or charcoal because their calorific value is low and they give off little heat, they burn too quickly, and they give off much smoke. Eucalyptus slabs are used in the Iringa region by tobacco processors in their boilers.

3.1.2 Pulp and paper sector

Mufindi Paper Mills (MPM) is the sole paper producer in the southern highlands. Its production capacity—over one million cubic meters—far exceeds the current supply of raw material (pine logs) from government plantations, just 200,000 m^3. Therefore the company will continue to plant to provide raw material for the future. The factory generates power from a biomass boiler that enables it to use waste from harvesting and industrial processes. In order to expand the range of sizes of raw materials, the mill needs to invest capital in changing the technical capacity of its debarking line. The mill produces sack kraft paper, which requires long-fiber wood material. The strength of the paper produced is negatively affected by the use of eucalyptus as raw material although eucalyptus can be used in the biomass boilers.

3.1.3 Furniture and joinery sector

Furniture glue board is currently manufactured by only one producer but its potential for the furniture industry is considerable. Tanzanians believe that furniture and joinery should be made from hardwood, so the demand for pine furniture and cabinets is low. However, as the cost of indigenous hardwood increases furniture producers will have little option but to use commercially produced glue board in order to reduce waste and increase the amount of low-grade sawn timber that can be used in high-grade

applications. The volumes used by furniture sector were not surveyed as collecting data from a huge number of small producers across the country would not have fitted with the timeline and geographic area of the study.

3.1.4 Utility poles sector

Tanzanian market for utility poles is dominated by two main customers, TANECO and REA 1, both of which are helping to increase electrification among the urban and rural populations of Tanzania.

Tanzania´s electrification program is one of the biggest in Africa. Only 2% of the rural population had electricity connections in 2012, and even in areas with transmission network, the rate of connection was low. Since then, connection fees have been reduced and now demand for connections is high. Since 2013, between 200,000 and 250,000 new connections have been established annually.

Under the high demand pole treatment plants have difficulties sourcing enough good-quality raw poles to fill their orders. TANESCO reported that serious defects in the quality of some of the treated poles delivered to their projects had shortened their life spans. These defects included treating wet instead of dry poles, insufficient chemical concentration, and improper treatment processes. According to TANESCO, quality of poles is a critical challenge to their plans for the growth and development of rural and urban electrification.

Persistent shortages have lead utility companies to consider alternatives like concrete poles, especially as poor-quality wooden poles have a short service life. Besides, wooden poles are also easily damaged in grassland fires. Also increasing costs of wood and transportation are pushing utility companies toward using concrete poles. Presently local electricity company TANESCO (Tanzania Electric Supply Company Limited) sources 30% to 50% of the poles from abroad (South Africa, Uganda, Zimbabwe and Zambia).

The annual domestic market for poles is estimated to exceed 350,000 in 2016 and will grow to 400,000 by 2020 provided donor and government funding is available to continue the nation's electrification campaign. The government has, however, struggled to make funding available in time. According to TANESCO's own data demand of wooden utility poles increased from 62,875 poles in 2010 to 136,460 in 2014 and the demand for 2016 is projected to be 240,100 poles (Figure 3.1). The increase in demand is due to the increase in the customer connection target from 100,000 annually to 250,000 annually in order to meet the government's targets of 30% connection in 2015, 50% in 2025, and at least 75% by 2033.

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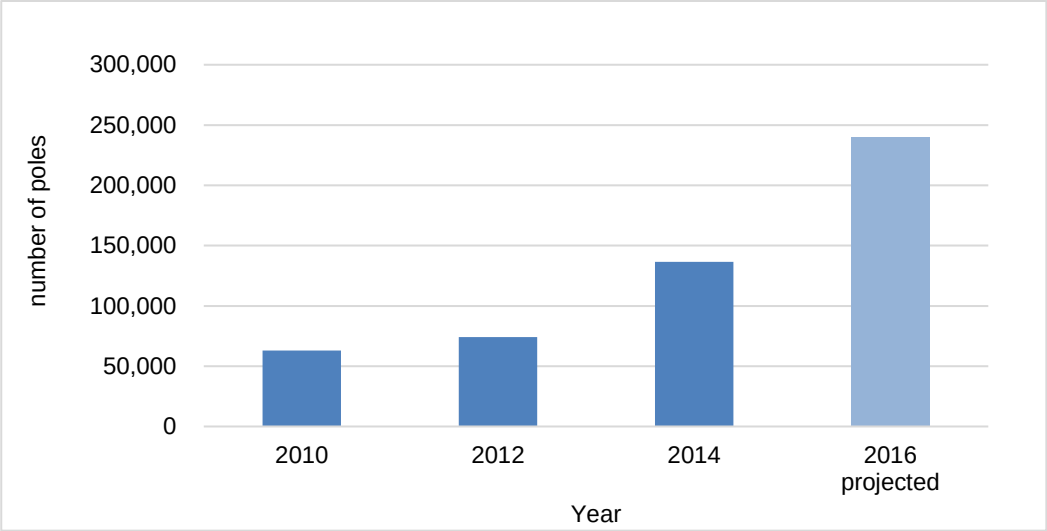
[1] TANESCO, a parastatal under Ministry of Energy and Minerals, owns the interconnection power grid and handles consumer connections.

REA is the government body in charge of extending the transmission network into rural areas through projects financed by the Rural Electrification Fund. Under the REA´s turnkey scheme, contractors build medium-voltage extensions and low voltage distribution grids and connect the first wave of customers. Then, when all construction work is complete, they transfer all assets to TANESCO payment-free and TANESCO is expected to continue connecting customers.

Figure 3.1 TANESCO pole demand 2010-2016



Though no concrete poles have been used in power and telephone networks in recent years, in 2010 TANESCO floated a tender for concrete poles and in 2014 the Minister of Energy informed that from 2015 onwards concrete poles would begin to be produced in order to be able to supply power to the markets. This decision was a direct result of sourcing difficulties and perceived and actual defects in the quality of wooden poles supplied in the past, which shortened their life spans.

One for profit social enterprise has started producing plastic wood poles and planks for construction sector to replace traditional wooden products (planks for Kenya market) in Tanzania. Volumes produced and sold are not yet high but especially if quality problems cannot be addressed in eucalyptus pole production, plastic poles may become a preferred option for some consumers.

Most utility poles are made from *Eucalyptus grandis*, *E. Saligna*, or *E. maidenii*, although technical treatment requirements specify that only *E. grandis* is suitable. Poles are treated with the Tanalith brand of chromated copper arsenate (CCA) or, to a lesser extent, creosote. There is currently no creosote plant in Tanzania although a new plant is planned for installation in 2016.

In addition to utility poles, eucalyptus is also used for smaller fencing poles, poles for buildings, as withies, and as scaffolding and building support poles during construction. Poles for fencing have been in demand only for the last five or six years, but as rates of land ownership have risen, landowners wishing to protect their property against land or stock encroachment have started to fence off their plots. Poles needed for buildings, particularly for the straw and grass roofs of banders and domestic buildings, can be taken from thinnings and forest waste. Their average diameter does not exceed four inches (100 mm) and their length ranges from 12 ft to 20 ft (3.6 m to 6 m). Withies, poles whose diameter does not exceed two inches (50 mm), are used as cross-members in the construction of bander roofs, usually in conjunction with poles for building. When constructing multiple-floor buildings, small poles are used to shutter concrete and for scaffolding. No standards cover this use of eucalyptus though poor-quality poles can endanger employees and risk the safety of a building if concrete dries poorly.

Against the background of high raw material demand and a forest data deficit, the domestic market for utility poles is strong. The range of utility pole sizes has increased in the recent period with the entry of a number of companies demanding light poles for the communications industry. This has increased the forest potential by allowing smaller and younger trees to be harvested either from thinnings or clear cutting.

3.1.5 Veneer production industry

Until recently all the plywood sold in Tanzania was imported mainly from China, India and Kenya and other overseas suppliers, but one Tanzanian producer, TANWAT (Tanganyika Wattle Company Limited) producing plywood in Njombe, has started to supply the domestic market. Nevertheless, the market for plywood is still sustained by imports from overseas producers who have now started to set up veneer production units to manufacture veneer for shipment back to their home country production units. Prices appear strong although the range of sizes and qualities in the market are limited. Not all sizes are reported to be available at all times and popular grades sell quickly before the next overseas arrival. In recent times (6 – 12 months) the currency fluctuation has had a strong influence on sales prices as most material has been imported at US Dollar value.

In addition to the plywood factory operated by TANWAT in Njombe, there are three new producers starting to operate in Mafinga area to produce veneers from eucalyptus. At the time of the report, two of these were functioning and one was in the process of installing machinery. All of these projects are part of overseas based plywood manufacturers and the production of veneers are for exports to supply their own production units. Although the companies interviewed had considered the availability of pine for veneer production, none had made any contracts for the supply of pine material.

Although the largest producer has received an allocation of 70,000 m^3 of eucalyptus from government stands in Mufindi District, it buys almost exclusively from private growers and farmers. The raw material is eucalyptus logs with a maximum length of 1.3 m. Diameters can be from 100 mm up to 300 mm in two cases and up to 400 mm in one case.

The veneer making machinery used is imported Chinese spindle-less peeler machine that allows use of logs with diameters as small as 10 cm. Large volumes of eucalyptus logs are expected to be harvested. The first allocations from government plantations for the new veneer producers were in the listing for the 2015/2016. By adding veneer producers, the government will be able to allocate eucalyptus stands that are too mature and oversized for utility poles, stands that have been in the harvesting plan for some years but which, due to the poor uptake of eucalyptus allocations, have been left to grow. The inclusion of veneer producers will allow the harvesting plan to catch up with the forest management plan.

Veneer production is not expected to significantly affect the demand for eucalyptus **stands** as in a typical stand only a small portion of total volume is used for utility poles and the rest is poor quality, low diameter logs either for low quality sawn products (narrow width and short length) or firewood. Veneer production can compete for some of this material and possibly the revenue for the forest owner could increase.

3.1.6 Miscellaneous sawn wood products

Most handles of implements are made from hardwoods such as eucalyptus, but some are made from pine. The prices of implements with pine handles are very low and sellers report that very few are sold. Eucalyptus handles, though not found in great quantity, are now more common because eucalyptus wood is cheap and available. The sales price of such implements are quite high, however. Eucalyptus handles are produced both by hand and by machine and their quality varies greatly. Some are very low grade as there are no grading standard for these items despite the fact that low-grade materials are a safety hazard. An axe handle that breaks in use, for example, can do tremendous harm.

The main market demand for doors is for hardwood doors with indigenous hardwoods to the fore. Cheaper low quality doors are being made from eucalyptus but as with other joinery products from the same raw material, they become split and twisted after fitting. There is a limited market for pine doors and those that have been made are characterised by stability and good finishing. Since pine is easy to handle and dry, the quality of products made from it is good. However, the resistance of pine to termite attacks is low and treatment is needed. The treatments available in Tanzania are water-based CCA and Tanalith E, neither of which is compatible with the manufacture of joinery products. Spirit-based treatments are available from abroad but are not currently being used. The traditional building practices can restrict the possibility of production line door manufacturing. Walls are erected first in a large number of building projects, following which the openings are measured and the doors ordered. The resulting list of various sizes makes standardisation difficult. National Housing Corporation does buy large volumes of standard sized doors for their projects. They told of serious problems in being able to buy locally made doors of suitable quality and economic prices. Other larger building companies have their own joinery workshops to produce doors and windows for their own projects. Other door production is from small joinery workshops with capacity averaging 10 doors per week. Indigenous hardwoods and eucalyptus were observed as the main material for production of solid wood doors. Pine was not seen being used.

3.1.7 Conclusions

The demand of roundwood by sectors cannot be accurately estimated as there are no statistics available on the main user sectors such as construction and furniture and these sectors are fragmented with multiple companies. For construction it can however be said that the industry is growing and the use of wood will increase as a result. Wooden housing is uncommon in Tanzania but construction uses wood in many forms: window frames, doors, plywood forms in concrete molds, etc. Utility poles sector has been growing for a long time and this trend will continue. There are no foreseeable major market developments occurring in pulp and paper production and levels are expected to remain stable in this sector. All in all, the overall demand for wood will continue growing.

3.2 Imports and exports of wood products

The volume of exports and imports is not well documented and the figures obtained from the Tanzania Revenue Authority may not include the entire volume of imports. Data for Tanzania was extracted from UN Comtrade global trade statistic service to assess the trends in international timber trade.

Since there has been a shortage of raw material available inside Tanzania, TANESCO has been importing 30% to 50% of its demand for utility poles, largely from companies in South Africa. It also gets poles from Zimbabwe and Zambia and increasingly from Uganda. A small proportion of poles from Uganda are transported by ferry across Lake Victoria. The shortest land route to Tanzania from Uganda, and also the one in the best condition, is through Kenya.

The value of lumber exports from Tanzania to neighboring countries is insignificant; only Kenya stands out as a historic export partner. Nevertheless, as Kenya lifted its ban for harvesting of saw logs in 2012, majority of imports from Tanzania have stopped. The value of sawn timber exports has dropped from almost USD 2 million in 2010 to only USD 80,000 in 2014. In addition to sawn wood few thousand poles are also exported annually to Kenya, despite the high demand in domestic markets.

Though still rather small volumes, the export of teak to India and China has increased considerably during past years. In 2015 these exports accounted for around 15,665 m^3.

4. PLANTATION FOREST RESOURCES IN THE SOUTHERN HIGHLANDS

4.1 Government Plantations

4.1.1 Sao Hill Plantations

Tanzania's forest resources and the way in which those resources are managed and marketed have a wide-ranging impact on the development of the wood-product industry and market and on the volume of material which reaches the Tanzanian market. Traditionally, majority of pine sawn wood has been supplied to the construction industry, while small amount has gone to the joinery and furniture industries.

Government forest resources in the southern highlands account for 85% of the total softwood resources used in Tanzania (Indufor, 2011). Southern highland government forests contain pine, cypress, and eucalyptus. The pine reserves are centralized to government plantation Sao Hill, managed by the TFS. Harvesting permits are issued annually with allocation levels determined by analysing mature and sustainable stands. The recent harvesting season, 2015/2016, saw also growth in the demand for governmental eucalyptus resources, mostly due increased veneer log demand.

4.1.2 Requirements for allocation

Only registered enterprises are qualified for government plantation resources allocation. An enterprise that operates a sawmill must register as a sawmill and/or forestry enterprise with the Ministry of Natural Resources and Tourism (MNRT) through the offices of the TFS. Registration is annual per calendar year and fee the same regardless of the date of registration.

The fee structure is all-encompassing: it comprises categories for business sizes (micro, small, medium and large) as well as for business activities. The lowest fee, for sawmills which produce less than 5,000 m^3 of logs per annum, is TZS 512,000 per year. Those businesses which process between 5,001 and 10,000 m^3 of logs per annum pay TZS 1 million. Huge majority of operators fall into the smaller category (954 out of 964 in 2015/2016), while there are only few large-scale operators (5 operators in 2015/2016). Additionally, five registered operators did not pay any registration fees in season 2015/2016). Operators with multiple activities need to pay registration fee for all individual activities, unless stated otherwise. The table for annual fees can be seen in Annex 15.

The current regulations and qualifications for applying for an allocation do not accommodate recent changes and developments in the wood-processing industry nor do they accommodate other wood-processing companies that should be included in the allocation process, namely paper, veneer, and poles. Revision of the provisions is needed to bring all industry stakeholders within the regulations. Currently all enterprises that register in a given year can apply for allocations in that year. They must be registered as wood-processing enterprises and meet the set criteria further defined in Annex 16.

Under current regulations, a wood enterprise must qualify technically in terms of the types and performances of the machinery it uses and the technical experts it employs. The last survey of the technical machinery used in the Sao Hill Forest Project (SHFP) was reportedly carried out in the 2012/13 season.

Many stakeholders claimed that these criteria are overlooked. Our analysis of field data and the 2015/16 allocations confirm this concern. Based on our observations, **only 14% to 23% of operators allocated with forest resources fulfilled the required criteria**. Furthermore, a **majority (72%) of the operators did not appear to have any machinery**.

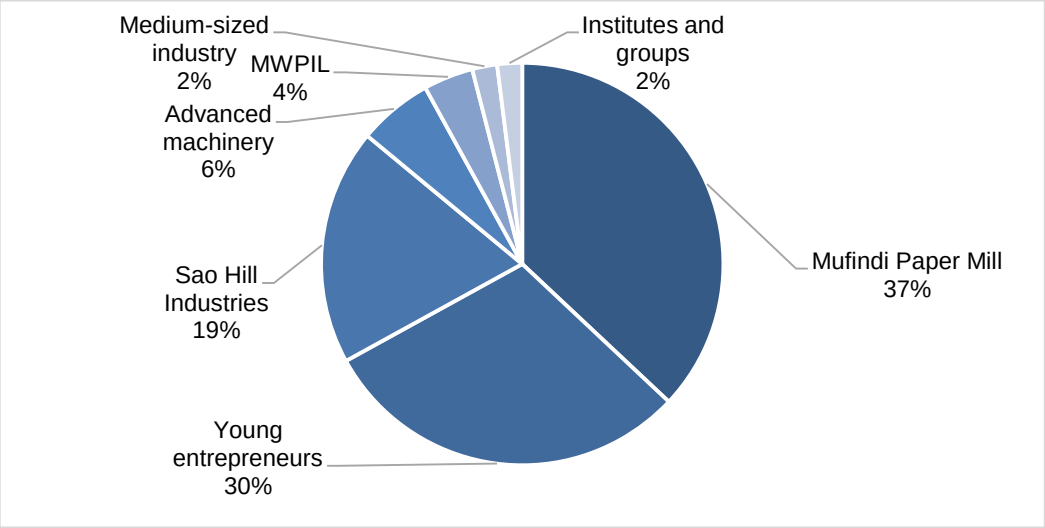
The TFS decides on the volumes to be harvested based on proper forest management practices and its assessment of the resources available. Allocations are issued to stakeholders who apply for forest resources as well as in fulfilment of existing long-term supply agreements.

SMEs reported that they feel that they have too little support from the government and that allocations are too small. Large enterprises reported that they feel they should get priority because they risk investing in better technology and improved systems that meet the demands of the government for improved recovery, efficiency, and quality.

4.1.3 Assessment of the 2015/2016 resource allocation in Sao Hill

Altogether 964 permits were issued for a total of 700,300 m^3, from which 540,300 m^3 were pine and 160,000 m^3 eucalyptus. While around **60% of the total pine volumes were allocated for long-term industrial contracts** (Mufindi Paper Mill, Sao Hill Industries, and Mufindi Wood Poles & Timber Industry Limited (MWPIL), a total of **800 young entrepreneurs received 200 m^3 allocations each**, covering 30% of the total pine allocations.

Figure 4.1 Breakdown of pine allocations for the 2015/2016 harvesting season in Sao Hill Forest Project



According to TFS, of the total pine resources allocated in 2015/2016, 200,000 m^3 will be used in the manufacture of sack kraft paper and 340,300 m^3 will be used for the production of sawn timber for the construction industry in Tanzania.

The allocated pine was processed with varying recovery rate from 30 to 45%. Thus, of the total pine allocation of 540,300 m^3, an estimated 112,000 m^3 to 114,000 m^3 sawn timber was produced and entered the Tanzanian markets.

Previously allocated but with little or low uptake by stakeholders, eucalyptus resources have grown to and in some cases overgrown the planned point of harvest and therefore exceeded in size the limits of their traditional market. In the last 12 months three new businesses (two of which were working at the time of the report), started producing plywood veneer from eucalyptus logs, a totally new use for the eucalyptus in Tanzania.

In the past, the main product sourced from eucalyptus stands was utility poles, but because the **government's forestry system does not allow for selective**

harvesting other than thinning, it requires the purchaser of a compartment to clear-fell all standing trees. On average, stakeholders report that **between 30 to 40% of standing eucalyptus trees are suitable for utility poles, the rest are sold as saw logs or firewood**. This restriction and the low yield of material for utility poles has served as a disincentive for stakeholders to apply for a eucalyptus allocation. As of the start of the 2015/16 harvesting season, some consideration by TFS is being given to offering some compartments in which selective harvesting will be allowed.

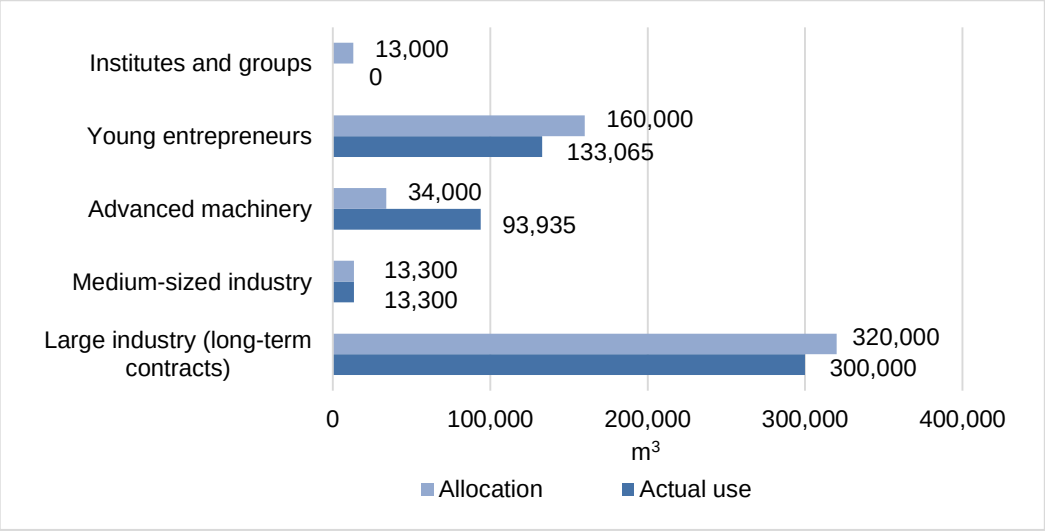
The use of eucalyptus saw logs is growing, especially in the private sector. Larger and older eucalyptus logs are cut with great difficulty because they are hard to handle and suitable machinery is lacking. However, eucalyptus sawn boards are being sold into the market, mostly for the furniture industry. The decrease in the volume of pine and indigenous hardwoods is causing some producers to look at eucalyptus as an alternative for both the construction and the furniture markets. It is reported that **confidence in the long-term availability of eucalyptus as a raw material is high**.

4.1.4 Assessment of actual use of government allocations

Not all entrepreneurs having an allocation had machinery for the production of sawn timber. The survey noted that almost 50% of the allocation assigned to 'Young entrepreneurs' (dingdong saws) was actually used by the category of 'advanced machinery'.

None of the 'Institutes and groups' category appeared to use any of the allocation for their own production. However, this is not contrary to the intention of TFS and the government who use this allocation as assistance to under-privileged groups and it is not obligated to manufacture the allocation.

Figure 4.2 Actual use of government pine allocations



4.1.5 Resource projections in Sao Hill government plantation

The data collection of this study included inventory measurements of two pine compartments in SHFP. The inventory measurements were analysed to estimate saw and pulp log shares. Summary of the inventory results are presented in Annex 17. By extrapolating the results of the collected inventory data to the entire 2015/16 SHFP allocations, **pine log harvest would have yielded 78% saw-quality logs (419,000 m³) and 22% pulp-quality logs**. Thinning and forestry waste was not taken into

account though the annual thinning plan will affect the volume of pulp logs, while some logs from thinning may even be graded as small-diameter saw logs.

More detailed analysis of the Sao Hill resources will be made available in a forthcoming “Southern Highlands Forest Industries Raw Material Resources study” due for publication May 2016 under the PFP.

4.1.6 Costs for Sao Hill plantation resources

Prices for the SHFP’s softwood resources for the 2015/16 season were issued on 14 August 2015. The total cost considers the following factors:

1) Royalty fee for MNRT

2) Tanzania Forest Fund (3% of the royalty)

3) VAT 18% charged from the royalty

4) TFF logging miscellaneous deposit account (LMDA) and road maintenance

5) Transport permit of TZS 7,500 per truckload less than seven tons and TZS 15,000 for heavier

6) TZS 11,000 for documents (per invoice)

The royalties are paid according to a published list (Annex 15), with different prices for different size categories, with the exception of pulp logs, which have one fixed price. According to the field survey, the majority of trees in a mature pine stand exceed 30 cm diameter at breast height, so the average royalty paid per m^3 for standing trees in the SHFP is by estimate between TZS 28,300 and TZS 54,200 per m^3, thus the **average total cost per m^3 for a mature stand, including all costs listed above is TZS 65 000 per m^3 of standing trees, as per the scaled volume**.

Royalty fees for eucalyptus are considerably lower than those for softwood although the additional charges, with the exception of the LMDA, are based on the same calculations. The **LMDA for eucalyptus is twice that for pine** but there seems to be no justification for the difference. Eucalyptus is coppiced and is not replanted, so its operational cost is lower than that of pine. As 50% of the eucalyptus LMDA is destined for silvicultural expenditure, eucalyptus buyers seem to be subsidising the cost of growing pine.

Cess is imposed differently on large and small buyers: large buyers pay for volume of logs harvested and small buyers pay per piece of sawn timber delivered. Cess is assessed when a buyer applies for a transport permit and is paid to the district.

The pricing mechanism for the setting of royalty price and associated fees (LMDA for silviculture and roads) from government plantations is a combination based partly on diameter (TZS/m^3 by diameter classes) and partly on flat fee of shilling per cubic meter (LMDAs). A suitable comparison in East African context is the pricing mechanism and levels applied in Kenya. Kenya Forest Service applies an allocation system similar to Tanzania where portions (sub-compartments) are allocated to local sawmillers. Unlike in Tanzania, the royalty price is set on diameter and species only with no LMDAs (The Forests Fees and Charges Rules, 2012). In addition to stumpage fees based on cubic meters there are transport fees based on tonnage and/or number of trucks and license fees which are excluded from the analysis as they are not directly convertible to amount harvested.

Comparing the total fees for an allocation reveals that the pricing of different diameter trees is significantly different in Tanzania and Kenya (Table 4.1).

Table 4.1 Stumpage fees of TFS and KFS (TSH per m3)

DBH (cm)	TFS royalty	TFS silviculture fee	TFS road fee	TFS TOTAL	KFS royalty pine, clearfelling (Difference to TFS)	KFS royalty pine, thinning (Difference to TFS)
Pulpwood	14,300	8,750	**8,750**	**31,800**	41,158 (+29%)	N/A
11-20	5,700	8,750	**8,750**	**23,200**	N/A	N/A
21-25	11,300	8,750	**8,750**	**28,800**	47,565 (+65%)	39,488 (+37%)
26-30	28,300	8,750	**8,750**	**45,800**	49,339 (+8%)	40,949 (-11%)
31-35	48,900	8,750	**8,750**	**66,400**	50,821 (-23%)	42,180 (-36%)
>35	54,200	8,750	**8,750**	**71,700**	51,572 (-28%)	42,806 (-40%

In Kenya the royalty prices only start from DBH of 20 cm for pines. Royalty prices are also different for clearfelling and thinning. Clearfelling royalty prices is the best benchmark to Tanzania as thinning or selective logging is not carried out in Tanzania.

Tanzanian stumpage fees are much lower in the small diameter classes. 21-25 cm DBH trees are 65% more expensive in Kenya. Pulpwood is also substantially cheaper in Tanzania. However, there is no pulp mill in Kenya anymore and compartments grown and sold as pulpwood may not exist in practice. Large diameter trees on other hand are sold substantially cheaper in Kenya.

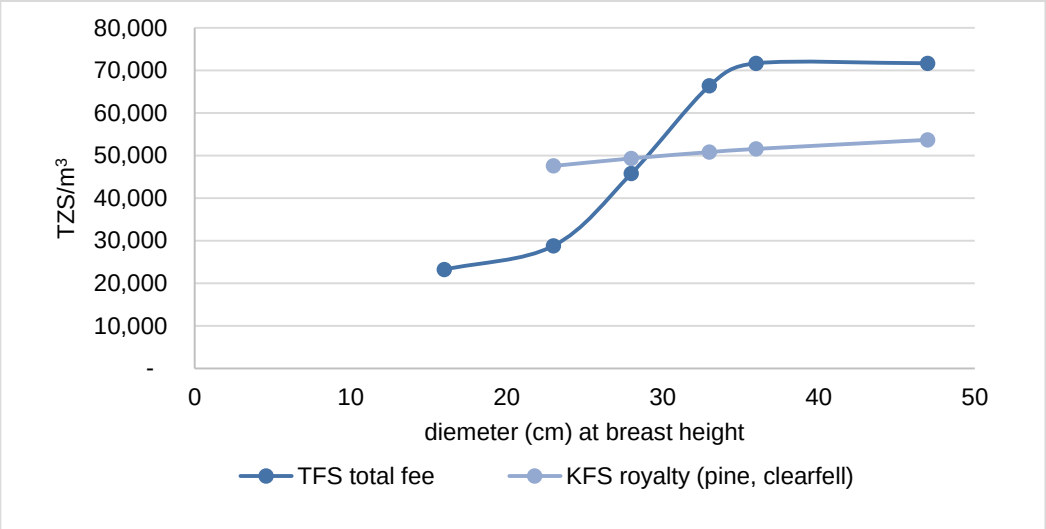
There is a shortage of pine in Kenya and most of the timber available from KFS plantations is cypress. The royalty price for cypress is 11% more than for pine so in effect the Kenyan sawmillers also have to pay the price premium for the species as well since access to pine allocations is limited.

In 2015 KFS tested auctioning some compartments by bidding. Indufor (2015) carried out an analysis of the prices offered versus the royalty prices set by Government of Kenya tariffs. In bidding, prices offered were 2.5 to 3 times higher. Average diameter of trees in the portions available for bidding was 46 cm for pine.

Diameters on KFS plantations are a consequence of a logging ban in the past which has made many compartments over mature. Typically, mature compartments available for allocations in Kenya are estimated to have an average DBH of 30+ cm. In Tanzania average tree diameter of government allocations falls below this. This means that TFS is selling most of its assets at lower price than KFS, and KFS on other hand is selling their large logs at a discount compared to TFS charges (

Figure 4.3). Recovery rate and productivity of sawmills are highly dependent on tree size and in certain size range the economic result increases exponentially corresponding to diameter (depending on sawmill technology used). In Tanzania price per cubic meter rises fairly quickly from mid-sized to big logs. Price is flat after DBH of 35 cm. This may be justifiable as logs bigger than this are actually oversized for the current wood processing technology and sawmills may have to split large ones by chainsaw when processing.

Figure 4.3 TFS and KFS stumpage fees by diameter for pine



4.2 Private industrial plantation resources

Private industrial pine resources in the southern highlands include New Forests Company Ltd., Green Resources Ltd. (GRL), Unilever Tea Tanzania Ltd., Jilango Ltd., TANWAT and Mufindi Tea Company Ltd. In general, they process large majority of their resources by themselves, but they have released small volumes of immature pine onto the market. There are also eucalyptus resources in private industrial plantations, which traditionally have been harvested mainly for utility poles production. Latest harvesting season saw increased demand for eucalyptus logs also in private industrial plantations. Furthermore, Kilombero Valley Teak Company Ltd. (KVTC), grows teak on their plantations, processing approximately 50% of its resources while selling the other half to local sawmill businesses.

Private industrial plantation resources are mainly used for industry's own operations. These private industries include companies such as Green Resources Limited, New Forests Company (NFC), and TANWAT. The major tea producers in the southern highlands have also planted eucalyptus to serve as a source of firewood for their boilers. They have planted additionally small volumes of pine, which they sell to SMEs before it reaches maturity. Two tea companies in Mufindi District planted 1,700 ha with an assessed stocking of 350 m³ to 550 m³ and 380 ha with an assessed stocking of 450 m³ per ha. Additional planting is planned to offset the costs of the firewood production.

Companies do not share information on the age structure of their plantations nor growth rates thus the extent the companies will be able to meet their own wood demand in coming years cannot be estimated accurately. For example, Mufindi Paper Mill has activated in tree planting to prepare for the decreasing supply from Sao Hill in near future. Estimated plantation areas of the biggest companies are shown in Table 4.2.

Table 4.2 Industrial private plantations

Company	Planted area (ha)
Green Resources	16,889
KVTC	8,150
Mufindi Paper Mills	4,000
New Forest Company	4,713
TANWAT (pine)	6,000
Unilever Tea (Tanzania) Ltd	1,450

Many companies are still interested in acquiring an allocation from the government forest resources, regardless of sales of logs from their own stands. Industries original plans were to use government allocation to bridge the gap between planting and maturity. However, presently immature pine from industrial plantations is entering the markets. Limited sales from immature stands are not creating significant influence on the market and it is not expected that any great volumes will become available in the next 3 – 5 years.

4.3 Private smallholder plantation resources

There is continuously increasing amount of small-scale smallholder-managed plantations, or woodlots, in the southern highlands area. However, estimates for total area and volumes vary and no accurate information exists. Most of these plantations are planted with pine. The plantation establishment is mainly driven by high demand for all grades of timber. Compared to governmental and private industrial plantations majority of small holder plantations are of poor quality and often harvested prematurely due farmers acute need for cash. These plantations are also characterized by difficult accessibility and lack of systematic and planned forest management.

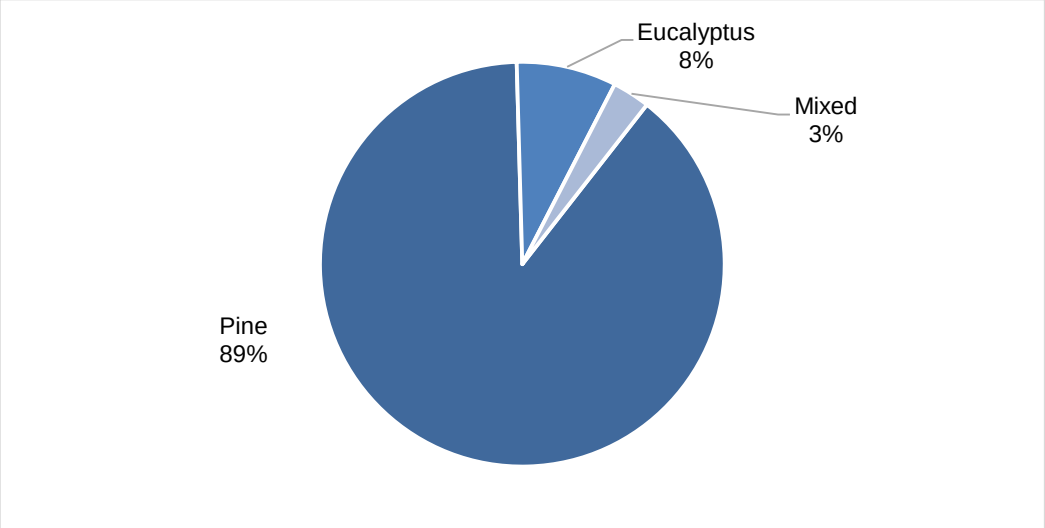
The average reported age of the pine stands harvested (including thinnings) was 9.1 years and a large number were less than seven years old, in the survey only three stands were older than 20 years. Additionally, the results of this survey indicated that there is a common lack of understanding and a large knowledge gap with respect to the proper management and assessment of pine plantations in the smallholder plantations.

Because government forests are producing less pine wood, there is a lot of pressure on existing private forest resources. The demand for pine is growing and sawmills without access to government resources are trying to convince private growers to sell immature stands for cash, though there is a **prevailing gap in terms of quantity and quality of trees grown in smallholder plantations and requirements of the SME sawmilling businesses**. Some smallholders sell an entire compartment for the maximum offer received while others sell trees per m^3 harvested. According to some interviewed smallholders the selling prices ranged from TZS 3,000 to TZS 80,000 per tree, but since details on the average size of the trees in question are not available, this cannot provide an accurate assessment of the sales price per m^3. Of the wood used by SMEs from private sources, pine dominates by 89% (Figure 4.4).

Some smallholders reported that while they had sold their stands, they had not yet been harvested by the buyer. The reasons given for the delay included that the buyer was investing in the future growth of the stand, had cash flow difficulties, or was waiting for the price to increase in the sales market. There is evidence that some sawmills cut their government allocations first and secure additional raw material from private sources to be use later in the season.

The share of wood coming from private smallholder plots of the total wood consumed by the sawmilling industry cannot be estimated with the existing data. In areas south from Sao Hill, such as Njombe, all wood is from private plantations. In Sao Hill and other areas with government forest the roundwood supply is a mix of both.

Figure 4.4 Species sold by private sellers to the SMEs



Also a great number of mixed age plantations exist with eucalyptus as main species. These eucalyptus plantations have been selectively cut for sourcing of poles and large diameter logs and gaps have coppiced or regenerated from seeds of various species. As a result, eucalyptus is main species in these plantations but a number of other species such as pine, wattle and natural species exist and the resulting plantations are multi-layered and aged.

Most of the eucalyptus material coming from TGAs and farmers' plantations were planted and grown without specific referral to end needs. Thus, the **yield from eucalyptus stands is not high: on average only 25% to 35% of trees in a compartment are good for utility poles**. Unlike in the government plantations in Sao Hill, where clear cut is the only permitted method for harvesting, in private smallholder plantations selective harvesting is normally adopted for eucalyptus poles. By default, **raw pole suppliers, using contract fellers, remove the selected trees and load them for transport to buyers**. On receipt of these deliveries, industrial poles producers inspect the trees for size and quality and pay for the delivery if the poles meet specifications. The purchase process has proved stable and reliable, and many buyers have formed long-term relations with the suppliers.

Prices for the sale of raw poles vary depending on demand. Some industrial users use price reductions to discourage suppliers of delivering, rather than stopping supply contracts altogether. Prices for eucalyptus are dominated by the utility pole market, which pays a higher rate per tree than the sawmill industry, which only utilizes part of the tree for end-product. The prices vary between TZS 20,000 and TZS 25,000 for 9 m raw poles, and TZS 35,000 to TZS 45,000 for 12 m raw poles (for a standing tree). The new veneer producers pay the lowest prices for eucalyptus mainly because they can use young trees and small-diameter logs. Prices of TZS 5,000 to TZS 6,000 per tree for private stands are quoted and stands as young as five years have been harvested.

5. PLANTATION WOOD VALUE CHAINS AND ACTORS

5.1 Introduction

As described earlier in this report, pine sawn timber and poles of eucalyptus are still the main products from plantations in the southern highlands. In addition, veneer production from eucalyptus is coming into the scene. Therefore, the analysis will focus on value chains around these products supplied from Government plantations and Non-Industrial Plantation Forests (NIPF). For simplicity of analysis, private company plantations (e.g. GRL, TANWAT) are not included in the analysis. Their value chain basically excludes traders in both wood supply and in sales to markets.

Mufindi Paper Mills is at the moment producing below capacity due to inadequate raw material supply. Therefore, a separate analysis on opportunities for supply from NIPF is recommended to be carried out at a later stage.

The chapters below are shortly describing the value chains to be analysed**.** Chapter **Error! Reference source not found.** provides a brief overview of actors along the alue chains.

5.2 Pine sawn timber

Pine sawn timber value chain includes various actors described below. Figure 5.1 shows the dominant market chain for pine wood from the southern highlands (timber sold on stumpage).

Pine plantation owners - forest producers

Pine forest plantations are owned by government (managed by TFS), private forest companies as well as individual tree growers (NIPF). TFS sells its raw material on stumpage according to pre-set prices (royalties), while private forest companies and individual tree growers may sell either on stumpage or as processed (sawn timber) or semi-processed (poles). The forest producers are described in more detail in chapter 4.

Harvester groups

Harvesters are small, informal groups of chainsaw contractors which provide harvesting services on a performance-rate basis. They are used by SMEs and large sawmills such as Sao Hill Industries.

Logging and sawmilling SMEs

SMEs harvest and process logs into sawn timber both from pine and eucalyptus. Most SMEs use small mobile dingdong saws located in forest near the area being harvested or, in the case of private stands, located in the very compartment being harvested itself. SMEs' business model relies on fast turnaround of raw material in order to keep cash flow sustainable. Their small size restricts their ability to have a salesperson or sales team to market and sell the sawn timber, therefore SMEs rely on the regular arrival of timber traders. Sawn material that is ready for collection is sold immediately to traders. SMEs cannot produce enough volume to fill a truck, so they have a reduced potential to sell to end use buyers other than traders. Regular arrival of timber traders paying in cash allows very small enterprises to exist.

SMEs wish to purchase pine and turn to eucalyptus only as a supplementary species for processing. The few SMEs' which process only eucalyptus do so not due to market or technology differentiation but due to the lack of pine in their sourcing areas.

Tree growers associations (TGAs) and villagers

TGAs and villagers practice very small-scale sawmilling using low-grade technology. They are situated far from the main points of distribution in Mafinga, Makambako and Njombe, and produce small volumes of sawn timber from their own resources. For sales they rely on the arrival of timber traders.

Large sawn timber producers

Currently the largest sawntimber producer Sao Hill Industries has its own network of timber merchants in Dar es Salaam, Morogoro, and Dodoma. The producer also sells directly to major end-users, constructors, and factories. New large producers are also planning to use this same route to market, and some medium-sized enterprises use city-based timber merchants as agents or distributors.

Timber traders (1st level traders)

Timber traders located in Mafinga, Makambako, and Njombe visit private and government forests to buy sawn timber from SMEs. A trader collects and pays for material immediately. Once his lorry is full, a trader returns to his yard to unload and stack the wood so that air drying can start. Air drying reduces the weight of the timber and maximises the amount that can be loaded on a lorry for transport to market.

Most traders have their own lorries for collecting sawn timber. They are not in good enough condition to travel long distances, but they are able to travel on local forest roads. Very few traders have their own lorries for delivering timber to the market and most traders say that it is simply cheaper and more flexible to hire transporter companies or single owner-drivers. The volume of timber sold and bought varies across the year. The major factor affecting volume is the revision period for SHFP and TFS allocations when harvesting in government forests stops. In general, harvesting is not allowed for at least two months each year, from the end of June to the end of August. Only MPM and Sao Hill Industries are exempted from this hiatus. The volume of timber sold decreases during heavy rains too, as it is difficult to access compartments. During both periods, timber volumes fall so much that many sawmills and traders have almost no turnover in their businesses.

Timber merchants (2nd level traders)

Timber merchants are found in major market areas and in nearly all towns and cities around Tanzania. They buy from traders or act as trading agents on behalf of traders in order to sell sawn timber to builders, carpenters, private buyers, and end-users. Some timber yards are owned and operated by sawmills, especially those of large producers. Big traders have some yards but most are operated by independent merchants who sell between one to four trucks per month. The volumes sold vary considerably from month to month depending on market demand, supply, cash flow demands, and external forces such as the latest political elections, which impacted all businesses. Weather patterns (rains) have most impact during the early part of the year and as timber is generally sold for roofing, the volume demand falls dramatically at the peak of the rainy season.

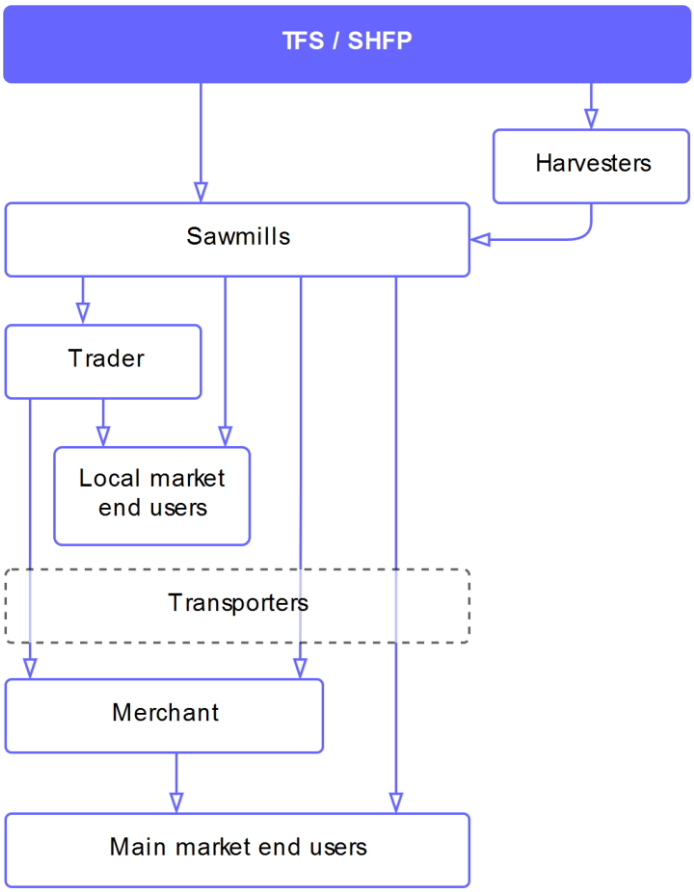
End-users

The buyers of sawn timber and timber products include both large and small construction companies, craftsmen, carpenters, furniture manufacturers, domestic home-builders, and government departments. The scale of a customer's operations determines the type of seller he deals with. Many major buyers have credit terms with suppliers, but small and cash flow-challenged companies rarely do. Instead, they buy from all types of sellers and pay as they collect.

Intermediate participants

Stakeholders involved en route to markets include transport companies and loading and unloading teams. All but the transport companies are informal groups of labourers who provide loading services to traders.

Figure 5.1 Main value chain for sawn timber



Although dingdong sawmilling is the dominant technology used in the southern highlands, there are also other sawmilling technologies in use such as mobile horizontal band saws, stationary circular saws, CVT saws and band saws. Use of stationary sawmills implies adding transport in between forest and sawmill into the value chain.

The SME sawmills differ in the ways of accessing the markets. Approximately half of dingdong sawmillers are also engaged in timber trading buying timber from other dingdong sawmillers and transporting timber to the local market place.

Stationary sawmills either sell to timber merchants who transport timber to major cities or organise the transport themselves. The ones operating several machines typically organise a truckload leaving once in a week or two. In a few cases dingdong sawmillers were found to have a fairly large scale operations owning several saws, operating as a trader (buying at forest sites) plus even transporting directly to Dar es Salaam.

The different sawmill technologies in use are presented in more detail in Annex 7. Value chain analysis in Chapter 6 includes considerations on the impact of different sawmill technologies.

Raw material from government plantations is sold on stumpage through allocations. Full enumeration is carried out prior to sales and the buyer pays for the whole biomass including branches. Not all of the biomass can be used as saw logs and the yield of saw logs from a compartment depends highly on the professionalism and accuracy of

the measurement, quality of the stand and the quality of the harvesting carried out. Sawmillers report that they recover about 70% of the volume invoiced as saw logs.

Information from allocations 2015/16 indicates that majority of the processing is by using dingdong sawmills operated by SMEs, located adjacent to the plantations. Sawn timber produced by SMEs is sold at location either to traders transporting to the local market or traders transporting to the main markets (e.g. Dar es Salaam). Bulk of the sawn timber (~ 80 %) is transported to the local market where it is sold to local end users or taken to main markets.

Small scale tree growers either sell their wood on stumpage or process and sell sawn timber. In case of tree growers selling sawn timber, they typically engage SMEs with dingdong sawmills for the processing. Therefore, the market chain is basically the same for majority of pine processed into sawn timber regardless origin of the wood (government or private small holder), main difference is that Government wood is sold on stumpage and wood from NIPFs sold both as stumpage and processed and sold as sawn timber. When selling on stumpage, measurement of trees prior to selling is not common. Private growers report that they invite offers for compartments or receive unsolicited offers from saw millers. Saw millers indicated that they subjectively assess the volume of saw logs in a compartment and make an offer accordingly.

5.3 Eucalyptus poles

Raw material from GoT plantations is sold on stumpage through allocations. Buyers are the raw pole suppliers who cut and in most cases also deliver at factory gate to utility pole producers. Most utility pole producers are large TBS (Tanzania Bureau of Standards)-certified companies. The pole producers process the poles and deliver them to end users such as Tanzania Electric Supply Company (TANESCO) and REA.

Small scale tree growers typically harvest the trees themselves and sell the poles. Otherwise the value chain and actors is the same as for eucalyptus poles coming from GoT plantations (Figure 5.2).

The actors and their roles in the chain are as follows.

Eucalyptus plantation owners – forest producers

The government provides raw material on stumpage at pre-set selling rates (royalties). Since government forest regulations require clear-felling, it has not been profitable for utility poles producers to buy eucalyptus stands. This is because only 25-40% of eucalyptus trees meet the grade standard of utility poles and the rest, low-grade trees, have to be harvested though they have no commercial market value. Last season, new products and uses appeared which will encourage the better utilisation of eucalyptus stands. Veneer producers, integrated utility poles producers, eucalyptus sawmills, and sawmills with the technical ability to saw eucalyptus are all likely to seek eucalyptus allocations from government resources in the future.

Private plantation owners can selectively harvest only those trees suitable for utility poles, the main eucalyptus product sourced from private growers. This business is regarded as economically profitable.

Harvester groups

Harvesters are small, informal groups of chainsaw contractors who provide harvesting services on a performance-rate basis. Private growers, pole-trading companies, and intermediate sellers use these contractors throughout the industry.

Raw pole suppliers

Raw pole suppliers who range from small ones working from load to load to large organisations with comprehensive business systems including distribution yards and trading structures, sell to major utility pole production companies. They either

purchase poles sourced from private or government plantations or harvest by themselves raw material that meets their customers' demands.

Cash flow in these enterprises is reported to be better than it is among small and medium sawmills. Most of these companies bear the costs of sourcing poles and delivering them to their customers. Raw poles are inspected and paid for almost within 24 hours of delivery, thereby enabling suppliers to increase and decrease their production capacity fairly easily. Suppliers actively search suitable private stands, some of which are in areas difficult to access.

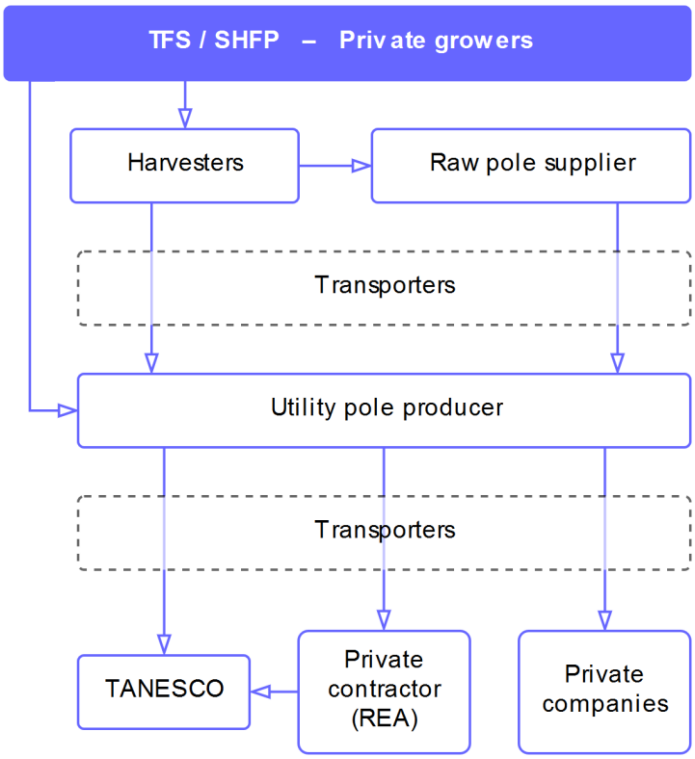
Utility pole producers

Most utility pole producers are large companies that are required to be TBS-certified if they wish to supply to major end-users TANESCO and REA. Cash flow limitations prevent small companies competing in standard utility poles processing. Poles need to be dried for between eight and ten weeks before they can be treated and payment can take 30 days or longer after delivery, therefore a business must have considerable cash to buy and store raw materials which SMEs are lacking.

Utility pole customers

Most utility poles are bought by TANESCO and REA project stakeholders but some small volumes are sold to overseas for aid-funded projects and to a small number of private projects (agriculture, sugar producers and other industrial development projects). Telecommunication companies have also started installing optic fibers between towns on above-ground treated poles.

Figure 5.2 Eucalyptus pole value chain - GoT plantations

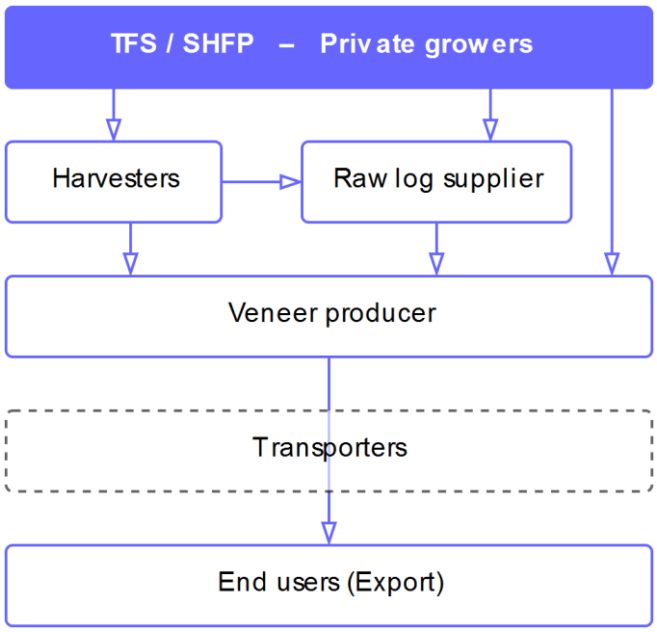


5.4 Eucalyptus veneer

Emerging eucalyptus veneer industry is a new development in the southern highlands. Of the three companies investing in veneer production, two have commenced production. The raw material is sourced both from GoT and private plantations.

Veneer manufacturers are involved with a small chain of log suppliers and transporters only (Figure 5.3). They require a favourable specification that attracts many local private growers who are utilising their eucalyptus stands (in some cases) at a very early stage. This provides them with an acceptable income and allows the producer to source material at low rates. Logs and trees left over after harvesting utility poles are also commonly used as the only other option to the private grower is firewood.

Figure 5.3 Eucalyptus veneer value chain



6. TECHNOLOGY ANALYSIS

6.1 Harvesting

Cutting and de-branching is done by chainsaw contractors who provide harvesting services on a performance-rate basis. They are used both by SMEs and large sawmills such as Sao Hill Industries.

Harvesting differs slightly depending on the technology to be applied in the next step in the value chain, i.e. sawmilling. If dingdong sawmills are used (located in or close to the forest) harvesting does not include skidding and loading to lorry. Harvesting teams leave saw logs piled 50 – 100 m apart. Saw is moved from pile to pile instead of logs being taken to a sawmill location. If logs are to be transported to sawmills, harvesting includes also skidding and loading. Avoiding costs for skidding and loading implies ability to pay a higher stumpage price, which also to some extent seem to be the case in private forests.

The study analysed cost for manual type harvesting. Contractor rates for a complete harvesting service, including skidding to the roadside range 6,000 – 20,000 TZS per m^3. Although individual rates quoted by chain saw operators and other harvesting operators are lower, the contractor includes other overheads into his calculation including a daily meal and transport for the employees. Chain saw operators quote 1,500 – 2,500 TZS per tree harvested. In the case of large eucalyptus trees, the rate can increase to 7,000 – 10,000 TZS per tree, however as the cubic meter volume is higher pre tree, this can reflect a lower rate per m^3.

Skidding costs are dependent on the condition and type of the tractor used, if it is owned or hired and the skill of the driver. Loading from the roadside or harvesting point to the lorry is done either manually or with (in most cases) bell loggers. Contractors report lower loading costs with manual loading but the speed of loading (and thus time to processing and subsequently to markets) is substantially lower. Bell loggers are also used for skidding (not a design use) and therefore are multitasking. Loading costs surveyed were either quoted per log/pole, per truck or per m^3. Average cost for loading when broken down to cubic meters ranged from 3,000 – 15,000 TZS per cubic meter whereby the lower rate was reported from sawmills which had their own harvesting team.

The total harvesting costs, including skidding and loading to a lorry was assessed to be from 21,000 – 35,000 TZS per m^3 with an average of 28,000 TZS per m^3. For SMEs processing to sawn timber in the field, harvesting cost average 8,000 – 14,000 TZS per m^3. Many SMEs working in government forest areas are also not skidding but loading the lorry in the compartment and transporting just outside the government area. This activity is reduced in rainy season.

The lack of harvesting training and the transient nature of the chain saw operators impacts on the quality of the harvesting operation ultimately reducing the yield from the compartment and creating large number of damaged logs (splits and shakes caused by felling trees on top of logs and un-level ground). Much of the mechanical damage is not seen until the log passes through the sawmill operation.

6.2 Haulage and transport

Logs are transported to sawmill and sawn timber is transported to local and main markets. Poles are transported from forest to landing from landing to treatment plant and finally to end user. Therefore, transport is an essential cost factor along the forest product value chains and constraints related to it are a barrier to growth and development of the sector.

Transport logistics along the forestry value chain fall into two overlapping categories:

- Near distance transport: transporters who transport logs from forests to sawmills and

- Long distance transport: transporters who transport sawn timber and timber products from sawmills to markets.

6.2.1 Transport to sawmills

Transportation to sawmills is mostly on poor-quality and poorly maintained roads with little or no tarmac cover. Only occasionally do routes from forests to sawmills pass over weighbridges and checkpoints. Trucks pass through TFS checkpoints, at which logs are inspected and cess collected, but the condition of these trucks is never assessed.

The study included analysis of haulage rates from most main distribution points as well as of points starting off-road in the forest. Most transporters are using separate trucks for the off-road section, which deliver material to distribution points on main tarmac highways.

Transport costs reported by sawmill operating in government forests mostly indicated rates per load. As the harvesting areas allocated by the SHFP tended to be for 6 – 12 months, transport rates remained stable during the period. However the survey was not able to compare rates per km from other areas as most sawmill interviewed had been at their locations for a period of time estimated to be about 6 months.

Rate per truck was difficult to assess as different trucks carried different volumes. Volume carried by one truck could differ for each trip dependent on weather and road conditions. Other factors affecting volume carried include access difficulties, presence of inspection point along the route and truck condition.

Rate per km for off-road transport varies considerably (5,500 - 8,000 TZS). The main determining cost factors are road conditions, distance to be covered and access. In some areas in Mufindi standard rate for all distances less than 20 km is used. In some cases this rate was over TZS 20,000 per km.

Findings indicate fairly low rates for log transport as most of trucks do not go on main roads and therefore avoid costs of annual inspection, insurance, tax and so forth. Rates per m^3 varied from 8,000 – 12,000 TZS per m^3. Large stationary sawmills have considerably higher transport rates as they could be transporting logs from as far as 100+ km. Rates as high as 25,000 – 40,000 TZS per m^3 were estimated for this long distance transport.

According to the survey data and calculations, 817 people are employed in round wood transport (Table 6.1). Each load is 9 m^3, a volume equivalent to 80 utility poles. A truck carrying poles needs 23 workers, one carrying saw logs, just six. Private sources supply five times the poles that government sources do, 100,000 versus 20,000, but supply no saw logs. Government sources, in contrast, supply 240,300 m^3 of saw logs per annum, still less than a third of the optimal volume. In total, 137 trucks are in operation, on average 226 days a year; 120 of them are government trucks. They make 28,200 journeys annually.

Table 6.1 Summary of round wood logistics

Forestry logistics ***	Optimum (p.a.)	Governmental sources (p.a.)	Private sources (p.a.)
Volume per load (m^3)	30	30	30
Number of utility poles per load	80	80	80
Total volume of saw logs transported (m3)	856,019	240,300	-
Total number of raw utility poles transported	240,100	20,000	100,000
Number of persons per truck of saw logs *	6	6	6
Number of persons per truck of utility poles	23	23	23

**			
Number of truck journeys	99,488	26,950	1,250
Number of working days	226	226	226
Journey cycles per day	1	1	3
Number of trucks	441	120	17
Total employees	2,647	717	100
* One driver and five loaders			
** One driver, 20 manual loaders and two unloaders to operate			
*** Excluding large industries, where employment figures are in the total			

Transport of utility poles requires twice as many workers as does transport of round wood and altogether 1,031 workers are employed. Each load is approximately 45 m^3 and 177,332 m^3 are carried each year in 3,341 journeys. Each journey lasts six days (only three for round wood). Fleet of trucks is also less for saw logs, 86 versus 137.

6.2.2 Transport to markets

Transportation to markets is mainly on tarmac roads and although in some cases such roads are poorly maintained, they are better quality than forest roads. Trucks pass numerous checkpoints and weighbridges on the way to the market.

In transporting raw poles to treatment plants, the current routes to markets have poor road infrastructure. The transportation of poles is more restricted than that of saw logs. The minimum length of a pole is 9 m and therefore semitrailers are the only option. It is also not feasible to use small trucks to harvest poles from areas with difficult topology because poles are simply too long. Transport challenges and constraints are described in more detail in Chapter 9.

Transportation rates from distribution points to the main market in Dar are more uniform, although some large sawmills and traders using their own trucks were reluctant to give information on transport costs. They are also more likely to overload their trucks than transport companies were.

Average rates for transportation to markets vary from TZS 3,979 to TZS 4,963 per km (Table 6.2). Prices do not take into account return load rates. In some cased return load rates below their standard prices are refused, implying no return load.

It is estimated that 177,332 m^3 of sawnwood is transported annually on 3,941 journeys. 1,031 persons are employed in sawnwood transports (Table 6.3).

Table 6.2 Average transport rates to Dar es Salaam

Origin	km	Total (TZS)*	Rate per km (TZS)
Mbeya	822	3,600,000	4,380
Songea	947	4,700,000	4,963
Njombe	710	3,000,000	4,225
Makambako	650	2,700,000	4,154
Sao Hill	578	2,300,000	3,979
Mafinga	563	2,300,000	4,085
Iringa	492	2,000,000	4,065

* excluding VAT

Table 6.3 Summary of sawn timber logistics

Forestry logistics **	Optimum (p.a.)	Governmental sources (p.a.)	Private sources (p.a.)
Volume per load (m^3)	45	45	45
Total volume transported (m^3)	348 000	135 668	41 664
Number of persons per truck*	12	12	12
Number of truck journeys	7,733	3,015	926
Number of working days per journey	6	6	6
Number of working days per year	275	275	275
Number of trucks	169	66	20
Number of trucks per day	28	11	3
Total employees	2,025	789	242
*Two drivers, five loaders, and five unloaders			
** Excluding large industries, where employment figures are in the total			

6.3 Sawmill technologies

6.3.1 Overview

Dingdong sawmills are the most extensively used technology in the southern highlands, but there are also other sawmill technologies in use, namely circular sawmills of Kara/Laimet, horizontal band saws, CVT and mobile horizontal band saws (Woodmizer-type). To some extent pit-sawing is also used. Southern highland sawmills are presented in more detail in Annex 7.

Sawmilling technologies differ in investment costs, need for labour and maintenance, production capacity and recovery rates. Choice of technology will have an impact on resource utilization efficiency, profitability of the operations and consequently on the whole timber value chain. Different technologies are analysed in following paragraphs. In the analysis of pine sawn timber value chain (chapter 7.1) use of two different technologies (dingdong and advanced technical saws*)* are analysed in parallel.

6.3.2 Ding dong sawmills

Most dingdong saws are mobile powered by diesel engines. Tanzanian copies are now the predominant model used as they cost about half of original Chinese version. 51% of the sawmills processing logs from Government forests use dingdong saws whereas over 92% of sawmills processing privately grown logs use this machinery. Over the entire southern highlands region, about 78% of the technology used are dingdong saws.

An average of seven employees work on each dingdong sawmill. Due to the transitory nature of the work force used on dingdong saws, the vast majority of operations do not employ women and overall women represent only 9% of the work force.

Logs are sawn manually. Depending on the weight and size of a log, a number of employees will pick it up and walk it through the vertical circular saw blade. Logs too large to lift manually are halved or quartered using chainsaws and then passed through the dingdong saw. The primary cutting is done by eye until a cant is formed. Most sawmills lack a guide rail to control the sizes being cut, resulting in very poor size tolerance (+/-6 – 8 mm) and poor cutting surfaces. Recovery rate is normally 25 – 35 %. Dingdongs working with government forestry allocations cut 496 m^3 per year on average, however 936 m^3 of logs was processed annually by dingdongs operating in

private growers' areas. Efficiency and output is the main factor making the of sawmilling in private forest areas slightly more profitable although profit per m^3 is higher when using government forest resources. Dingdongs operating in private forests make an estimated profit TZS 44,640 per m^3, profit for dingdongs operating in government forests is estimated to be TZS 59,906 per m^3 (Table 6.4).

Table 6.4 Dingdong sawmill cost and profit calculation

	Private forest areas	Government forest areas
Initial investment costs (including infrastructure)	4,000,000	4,000,000
Daily production, log intake (m^3)	4.17	2.21
.Standing price for logs (TZS/m^3)	100,000	92,857
Conversion rate to sawn timber *	37%	37%
Millgate price for logs (TZS /m^3)	270,270	250,965
Harvesting and log transport (TZS/m^3)	14,000	22,000
Consumption of fuel (TZS/per m^3)	18,000	18,000
Daily labour input (as TZS/m^3)**	12,590	16,629
Maintenance costs (as TZS/m^3)	13,000	13,000
Total production costs (TZS/m^3)	313,860	298,594
Sales price (TZS/m^3	358,500	358,500
Profit (TZS/m^3)	44,640	59,906

* NOTE; This calculation is based on actual measure which in the study was assessed as undersized sawn timber.

** NOTE; The employee number for private forest area operations include some harvesting members who provide multiple functions including harvesting and sawmilling.

Quality of the sawn timber produced

Sawing quality is dependent on the ability of the saw doctor and the cutting characteristics of the saw blade. Blades used are both locally made and imports from China and South Africa. Blade maintenance is poor and results in very rough finish to the sawn boards. Saw blade teeth setting is done manually and this irregular tooth swage can be seen by the evidence of heavy tooth scoring on the sawn surface.

Size tolerance along the length varies from 8 – 16% as a result of the manual sawing techniques as well as poor tooth setting on the saw blade (**Error! Reference source ot found.**). No blade guides are used on the dingdong saw so the blade can wander when hitting dense material or large knots.

Maintenance and durability

Though dingdong saws originated in China, very soon after their arrival local Tanzanian artisans started to manufacture copies. Such copies are now the predominant model used as they cost about half of a Chinese version, which runs about TZS 8 to TZS 10 million. The quality of construction and materials is very poor and the equipment needs to be repaired regularly. In particular, metal breaks often have to be welded. Regular maintenance and repair was observed and dingdong saw owners reported that most was due to the soft steel used and poor construction quality.

Work safety perspectives

Owners and operators accord environmental and OHS considerations a very low priority. Accidents are common. Health risks include Log crush injuries, cuts and abrasions, broken bones, muscle strains, and damage to hearing and respiratory organs. However, 96% of respondents claimed that they and their employees were informed about HIV risks and the methods to avoid infection.

Conclusions

Even though dingdong sawmill operation shows considerable potential for profit (Table 6.4) this is a false presumption as it is based on the fact that the timber produced is undersized. **Whilst the market is happy to take undersized timber, dingdong saws will continue to provide an income for the owners and employees but as soon as the market demand turns to correctly sawn, high quality and full measure boards, the dingdong saws will be unprofitable.**

6.3.3 Laimet and Kara type saws

Introduced to the area in the 1980s and 1990s, many Laimet and Kara saws in use at the moment are refurbished. Majority of the sawmills are permanent and powered by diesel engines or electric motors. An average of 16 people (more than 90 % are men) are employed in these sawmills.

Logs are loaded from homemade log racks or lifted by hand onto a saw. The saw carriage is moved over the circular saw blade by chain feed and sawn boards are removed by hand. The guide plate, which is used to regulate sizes, has been removed from most saws. Quality of sawing is better than with dingdong saws, but the size tolerances are still large (6 - 8 mm) and boards are unevenly sawn. Low quality of sawing and low size tolerance produce thin, very poor-quality one-inch (25 mm) boards that are sold at low prices and cannot penetrate the higher-value pallet market, which is a traditional user of one-inch boards. Recovery rate is 40 – 50 %. Average annual log volume target per mill in the southern highlands is 3,300 m^3 of logs. Sawmilling wood from private forest is slightly more profitable also in Laimet/Kara sawmills, the major factor being the lower harvesting and log transport costs. Profit for sawn timber produced from timber originating from private forests is estimated to be TZS 16,466 per m3, and when using government forest allocations TZS 15,324 per m3 (Table 6.5).

Table 6.5 Laimet/Kara sawmill cost and profit calculation

	Private forest areas	Government forest areas
Initial investment costs (TZS)	118,800,000	118,800,000
Daily production, log intake (m^3)	5.14	5.14
Millgate price for logs (TZS/m^3)	100,000	92,857
Conversion rate to sawn timber	40%	40%
Total cost of log (TZS/m^3)	250,000	232,143
Harvesting & log transport (TZS/m^3)	14,000	33,000
Daily consumption of fuel (TZS/m^3	18,000	18,000
Daily labour input (TZS/m^3) **	40,034	40,034
Maintenance costs (TZS/m^3)	20,000	20,000
Total production costs (TZS/m^3)	342,034	343,176
Sales price (TZS/m^3)	358,500	358,500
Profit (TZS/m^3)	16,466	15,324

* NOTE; This calculation is based on actual measure which in the study was assessed as undersized sawn timber.

** NOTE; The employee number for private forest area operations include some harvesting members who provide multiple functions including harvesting and sawmilling.

Recovery rates

The rate of recovery claimed was between 45% and 50% but many of the operations viewed appeared to have lower rates and spot measurements made at four sawmill units found recovery rates between 38% and 40% for medium sized logs. Recovery rates for small diameter saw logs appeared to be no better than on dingdong saws. Poor sawing techniques and removal of the fence had negative impact on production recovery and small saw logs (16 cm diameter) have been recorded with recovery rates of 15%.

Quality of the sawn timber

As with dingdong saws, poor saw maintenance and low quality saw blades contributed to the rough surface of the sawn boards. Size variation along the length was less compared to dingdong saws but was still excessive. Much of the material observed was undersized although there was a higher frequency of full measure boards than in the dingdong saw operations. Most quality defects can be attributed to poor sawmill operating practises, poor saw doctoring techniques and old deficiently maintained equipment.

Maintenance and durability

Many of these saws have been shipped to Tanzania in the 1980's as both new and second hand (but refurbished). There is lack of spare parts and sawmill producer's representation in Tanzania and as a consequence homemade repairs and nonspecific spare parts are being used. If properly maintained, these saw types are seen to be working for decades e.g. around Scandinavia.

Work safety perspectives

Owners and operators of Laimet and Kara saws place little priority on environmental and OHS considerations. Accidents are less common on Laimet and Kara saws than they are for dingdong saw users, but the types of accidents are similar. They include log crush injuries, cuts and abrasions, broken bones, and muscle strains. In addition, hearing damage and respiratory illnesses are possible long–term conditions. Just 78%

of respondents, the least for any sawmill type, confirmed that they and their employees were HIV aware.

Conclusions

Although good quality sawmill technology, the large range of log sizes and the lack of log sorting will always have an effect on the overall profitability of this technology. **Poor saw maintenance and lack of regard for correct operational procedure reduces profit potential. Thick kerf saws will always reduce recovery potential over the band saw options and the sawing process will not be able to cope with eucalyptus logs.** Despite this technology being used in the southern highlands for the last 30 years and its potential for good quality sawing, there is little evidence that the timber produced so far has achieved higher prices from the market and the timber observed was not greatly exceeding the quality from dingdong saws.

6.3.4 Chinese Vertical Technology saw mills

Chinese-manufactured vertical band saw lines (Chinese Vertical Technology - CVT) have been introduced in the southern highlands in the last two years. All units are permanently installed and most are found in Mafinga town. Average number of employees is 18 (almost all men).

Although originally designed to process large-diameter logs, sawmills in the southern highlands are used to process small-diameter pine and to some extent eucalyptus logs. Due to small log size and operator inexperience, production speed was assessed to be about 50% of design capability. For eucalyptus the sawing quality and size tolerance result in high wastage and both pine and eucalyptus lumber produced is of low-quality. Limited technical assistance is available for operating these new saws. Recovery rate is 45 – 50 %. Average annual log consumption target is 4,300 m³ logs. Profit per cubic meter of sawn wood is TZS 56,177 which is better than for Kara/Laimet sawmills and close to the level of dingdong profitability in the calculation.

Table 6.6 CVT sawmill cost and profit calculation

	Government forest areas
Initial investment costs (TZS)	55,000,000
Daily production, log intake (m3)	10.93
Millgate price for logs (TZS/m³)	92,857
Conversion rate to sawn timber *	47%
Total cost of raw material (TZS/m³)	197,568
Harvesting & log transport (TZS/m³)	53,500
Electricity (TZS/m³)	20,000
Daily labour input (TZS/m³) **	18,254
Maintenance costs (TZS/m³)	13,000
Total production costs (TZS/m3 sawn timber)	302,323
Sales price (TZS/m³)	358,500
Profit (TZS/m³)	56,177

* NOTE; This calculation is based on actual measure which in the study was assessed as undersized sawn timber.

** NOTE; The employee number for private forest area operations include some harvesting members who provide multiple functions including harvesting and sawmilling.

Recovery rates

The assessed recovery rate for CVT saws (based on average diameter pine logs) are normally be in the range of 45-50%. Very few of these newly erected saw lines achieved this and only when applying correct operating practices. Small diameter logs did have a higher recovery rate compared to dingdong and Laimet saw types but speed of processing small diameter logs was very slow.

Lack of log sorting and processing small diameter logs and logs with excessive sweep are all factors that are prevalent in sawmill operations in the southern highlands. All these factors have a detrimental effect on recovery rates with all sawmill types but appeared to affect CVT technology more than others.

Quality of the sawn timber produced

With proper saw blade maintenance, sawn surface was observed to be very good. Saw tooth setting was mostly manual but was done well enough to result in good sawing quality. Size tolerance and variation along the length was low producing high quality compared to other technologies. Poor operational processes and low operator experience were the main reasons for poor quality sawn timber.

The lowest quality of sawn timber was observed with eucalyptus. Lack of training and understanding how to saw eucalyptus logs and use of inappropriate technology resulted in very low quality sawn timber with large size tolerances.

Maintenance and durability

This technology is new to Tanzania and the oldest observed saw line is two years. The machinery is robust and uses universal spare parts with simple maintenance programs. It is expected that this technology should provide owners with long durability.

Work safety perspectives

Newly installed units were observed to include guards and protective fences. No serious injuries were reported to the data collection team although it should be noted that most of these sawmills have been working for only a short period of less than one year. Log handling was manual and had little or no regard to safety procedures with the manual unloading of log lorries. Staff did not wear any safety equipment and most had sandals. The log lorries arrived with logs held on the truck between log uprights. These uprights were cut at the base with axes until the weight of the logs broke the upright and the logs fell off the truck to the ground. No sawmills reported injuries but it was observed that there is a high risk to staff.

Conclusions

CVT is considered as robust and effective sawmill technology, and it has the potential for high quality sawing and good economic performance. Machinery siting and operator skills have a direct impact on the performance and effectiveness of this technology. Small defects in the sharpening reduce recovery and saw quality of timber having a negative impact on the end price for the sawn timber. Improvements on recovery are possible with correct log flow infrastructure and operator training. The infrastructure costs for siting and erecting this equipment exceeds the other newer options. **CVTs are ideally suited for pine and eucalyptus processing of large diameter logs but will be out performed by other technology for the processing of small diameter logs.**

Higher quality sawn timber and cutting of longer logs allows timber from this technology to have potential to gain premium prices in the market allowing profit margins in excess of 20% greater than the market average.

6.3.5 Horizontal band saw mills

Saws imported from India and China are new to the region and mainly assigned for pine processing in Mufindi district. An average band saw operation employs 19 workers (85 % men).

Logs pass through a primary horizontal saw on a log carriage. Raising or lowering the saw is used to alter the thickness of sawn boards. Saw quality and size tolerance is higher than for other types of saws in the southern highlands (tolerances +/- 1 mm). Board quality is very good although boards seem to differ in thickness due to operator mistakes. As with CVT sawmills, neither siting nor mounting of has been done optimally. Owners claim to have problems due to lack of technical expertise. Average annual log target volume is 7,400 m^3. Recovery rates are normally 45 – 50 %, but can reach up to 70%. Profitability of sawmilling with horizontal band saws is slightly better compared to CVT and almost equal to the profit of dindong sawmilling as estimated in the calculation (Table 6.7 and Table 6.4).

Table 6.7 Horizontal band sawmill cost and profit calculation

	Government forest areas
Initial investment costs (TZS)	41,000,000
Daily production, log intake (m^3)	10.56
Mill gate price for logs (TZS/m^3)	92,857
Conversion rate to sawn timber *	47%
Total cost of raw material (TZS/m^3)	197,568
Harvesting & log transport (TZS/m^3)	53,500
Electricity consumption (TZS/m^3)	15,500
Daily labour input (TZS/m^3) **	19,944
Maintenance costs (TZS/m^3)	13,000
Total production costs (TZS/m^3)	299,512
Sales price (TZS/m^3)	358,500
Profit (TZS/m^3)	58,988

* NOTE; This calculation is based on actual measure which in the study was assessed as undersized sawn timber.

** NOTE; The employee number for private forest area operations include some harvesting members who provide multiple functions including harvesting and sawmilling.

Recovery rates

As with CVT technology, high recovery rates were observed and reported. Whilst processing average diameter pine logs, rates of 45-50% were prevalent. Two sawmills processing teak and one sawmill processing large diameter eucalyptus logs were achieving recovery rates from 60 to 70% although the teak processing benefitted of customer demand for small size sawn timber.

Simple processing system and ease of maintenance was reported to be one of the reasons for higher recovery rate although the data collection team noted that unlike the CVT system, horizontal saws simplicity gave operators more confidence and could have been a contributing factor in getting better results.

Quality of the sawn timber produced

As with CVT technology, saw blade maintenance was good and therefore the sawn timber quality was high. Size tolerance was the best observed and +/- 1 mm was seen even with eucalyptus. The saw surface was fine and overall the quality of the sawn timber observed was the best in the market. In theory CVT technology should produce the same result, horizontal band saws simple operation process was one of the main factors influencing this result.

Maintenance and durability

This fairly new technology has not been in operation for long enough to be able to get responses from owners but observations noted that the simple robust construction using standard steel profiles and universal spare parts will give this machinery long durability as well as simple maintenance.

Work safety perspectives

Horizontal band saws were observed to have been installed with safety features therefore reducing employee injury risk. The log handling was as dangerous as in any other sawmill and remains the' high risk' area also in this sawmill option.

Conclusions

This simple and inexpensive technology has potential for improveing sawnwood processing, as operator skills are easy to develop and log flow system is simple. Horizontal band saws are highly suitable for large log processing in pine and eucalyptus but economic performance is negatively affected when cutting small diameter logs. Poor saw doctoring will also result in lower quality sawing and reduce the earnings potential. As with the CVT systems, thin kerf saws will help in increasing recovery and keep this technology ahead of circular saws. Simple operation and maintenance will reduce down time and universal parts will allow for cheap and speedy spare part sourcing.

Higher quality sawn timber and cutting of longer logs allows timber from this technology to have potential to gain premium prices in the market allowing profit margins over 20% higher than the market average.

6.3.6 Mobile horizontal band saws (Wood-Mizer type)

Wood-Mizer is the only Western sawmill machinery manufacturer that has sold mobile horizontal band saws in Tanzania. The saws purchased are either medium production sizes or small hobby saws. Chinese versions are similar in production capacity but considerably cheaper. Although quality of the Wood-Mizer machinery is better, Chinese brands are reported to have better value for money.

These band saw types are highly mobile; they come with power units and can be moved and set up quickly. Sawing quality and size tolerance are very high. The average number of employees per band saw mill was 32. Pine production speed is good but for eucalyptus slow. Logs are loaded manually and have to be lifted up onto the saw. Profitability per m^3 of wood-mizer compared to other modern sawmilling technologies assessed was lower (Table 6.8).

Table 6.8 Wood-Mizer type sawmill (LT40) Cost and Profit Calculation

	Government forest areas
Initial investment costs (TZS)	110,000,000
Daily production, log intake (m3)	8.74
Millgate price for logs (TZS/m³)	92,857
Conversion rate to sawn timber *	47%
Total cost of raw material (TZS/m³)	197,568
Harvesting & log transport (TZS/m³)	33,000
Consumption of fuel (TZS/m³)	11,000
Daily labour input (TZS/m³) **	40,251
Maintenance costs (TZS/m³)	25,000
Total production costs (TZS/m³)	306,819
Sales price (TZS/m³)	358,500
Profit (TZS/m³)	51,681

* NOTE; This calculation is based on actual measure which in the study was assessed as undersized sawn timber.

** NOTE; The employee number for private forest area operations include some harvesting members who provide multiple functions including harvesting and sawmilling.

Recovery rates

Recovery rates are normally likely to be 45 – 50 % for the range of log sizes from mature pine forest stands.

Saw quality and size tolerance

Quality and size tolerance can be very good but are more reliant on proper operation and regular maintenance than other sawmill technologies. Wood-mizer saws require specific spare parts and better operating practices to reduce machinery and operational damage. Overall this technology was observed to be less robust and much more expensive than other sawmill systems in use.

Conclusions

Highly engineered imported technology requires greater operator and maintenance skills with the risk of expensive repairs and spare parts sourcing. Lack of universal spare parts and need to buy spare parts only from the manufacturer puts this technology in the **highest bracket for maintenance costs**. Wood-mizers are much more advanced compared to existing dingdong technology used in mobile applications but the machinery does not have a robust image. **Cheaper and lower quality mobile band saws from China cost 1/8 the price and in the southern highlands forestry environment are producing the same economic results with less investment costs.**

Higher quality sawn timber and cutting of longer logs allows timber from this technology to have the potential to gain premium prices in the market allowing profit margins in excess of 20% greater than the market average.

6.3.7 Comparison of sawmill technologies

The type of technology chosen is dependent on the material sawn and the product to be produced. Tanzanian forest industry environment requires many additional factors to be assessed in order to provide a fully analysed technology recommendation. **Lack of knowledge of the various technologies available and lack of active presence by sawmill machinery manufacturers has limited the development of sawmill technology in the southern highlands to the effect that not all machinery purchased has suited the production factors.** Different technologies are needed to produce different end products and in order to meet the current forest industry requirements, a number of options are needed. These are only partly satisfied by the new technological advances pursued so far. Use of band saws for large logs is proving successful but use of large diameter disk saws has not suited the forest resources. **Gaps remain especially for efficient processing of small diameter pine and eucalyptus logs.**

6.4 Recovery and sawn timber price analysis for dingdong sawmills

6.4.1 Introduction

Recovery rates reported by dingdong saw owners averaged 30-35% in government forest areas and 45% in private forest areas. It became apparent that in many cases sawmill owners reported what they considered to be correct but did not have full understanding of the calculation.

Timber is sold to Tanzanian customers based on a nominal indicated size, e.g. 2" x 4" or 50 x 100 mm. The actual size of each piece of sawn timber is irregular and on average is undersized. In reality the actual size can measure 20 – 36% smaller due to the poor quality cutting. The actual size along the full length of each piece of sawn timber can vary greatly and as a result, the carpenter using the timber has to regularise each piece before use.

Sizes measured were from fresh sawn timber. Sawmills did not cut timber with an overcut to accommodate the shrinkage during drying. Hence the timber being sold in the merchants' yards will shrunk further. This has been taken into account in the data results to formulate the exact loss in measure factor.

6.4.2 Dingdong production size analysis

Comparing the size of sawn timber boards with the nominal size that they are sold showed variations below the nominal size as much as 36% less from reported. Irregular sawing is a factor inherent with the machinery and sawing/operational techniques, and as a result, the market accepts the material produced but does not pay a premium price.

Timber analysis was from material sawn in forest compartments and stacked alongside dingdong saws. Material in trader's yard was also analysed but the data was not used as there was only anecdotal evidence and no certainty of the source of the sawn timber. Sizes measured at the site showed loss in measure. Size variation along the length was also recorded and assessed and the variation width was from 8-16% (**Error! Reference source not found.**).

Table 6.9 Sawn timber section size variation

Nominal size (mm)	Actual size	Size after drying and reworking	Total loss in measure
50 x 50	43 x 41	40 x 40	-36%
50 x 75	43 x 72	40 x 70	-25%
50 x 100	43 x 94	40 x 90	-28%
50 x 150	42 x 139	40 x 135	-28%

Source: Fieldwork 2015

Table 6.10 Sawn timber section variation along the length

Nominal size (mm)	Max size thickness	Min size thickness	Max size width	Min size width	% variation thickness	% variation width
50 x 50	51	44	51	44	14%	-14%
50 x 75	51	44	67	77	14%	-13%
50 x 100	54	42	82	98	24%	-16%
50 x 150	49	40	135	147	18%	-8%

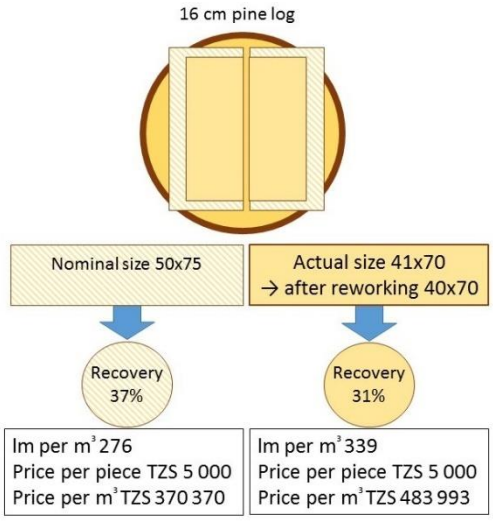
Source: Fieldwork 2015

Recovery calculations are compared between actual and nominal whereby the actual are calculated from the average surveyed section. Nominal recovery for 50x70 sixe was 37% but the actual recovery was only 31%. Similarly for 50x100 the nominal recovery was 39% but in reality only 32% (Table 6.11 and Figure 6.1).

Table 6.11 Recovery variation

Recovery variation example	Nominal recovery	Actual recovery
Nominal - 50 x 75, Actual - 43 x 72 mm	37%	31%
Nominal - 50 x 100, Actual - 43 x 94 mm	39%	32%

Figure 6.1 Nominal vs. actual size and recovery



6.4.3 Market price assessment

The market for sawn timber increasingly differentiates between low quality dingdong sawn timber and the sawn timber from the newer technology sawmill suppliers. The majority of sawn timber from dingdong saws is 12" or 3.6 m long and is sold based on the price per piece. Higher quality sawn timber is now becoming available in lengths from 4 – 6 m long and is sold based on price calculation per running meter or running foot. This sector of the market is also using pricing based on cubic meters. Large industry sellers with high quality sawn timber and tight size tolerances sell with published price lists showing prices per running foot, running meter and cubic meters. **The average price premium of high quality timber is 27% per cubic meter to lower quality timber from small sawmills.**

Data collectors reported that some traders responded to questions about the price per m³ with accuracy and understood the calculation basis. SMEs responded with only price per piece. This observation was clearly identifiable in the range of prices collected and would explain the large variation from SME reported prices and the maximum rates given by traders.

Table 6.5 Reported nominal sales prices converted to cubic meter rates

Nominal size price conversion	(TZS/m³) Ex SMEs in Mufindi District		(TZS/m³) Ex traders yards in the southern highlands	
Product	Min.	Max.	Min.	Max.
PINE				
2" sawn timber	300,000	400,000	329,000	613,000
1" sawn timber	150,000	220,000	463,000	720,000
Average	250,000	310,000	396,000	674,000
Flitches (Slabs)	20,000	40,000	n/a	n/a
EUCALYPTUS				
2" sawn timber	200,000	350,000	350,000	370,000
1" sawn timber	150,000	170,000	150,000	200,000

Using the actual size analysis loss in measure average of 28%, adjustment of the SME sales prices demonstrates the actual TZS rate per m³ and allows for the correct assessment of the value chain profitability (table below).

Table 6.12 Actual SME sales prices converted to m³ rates (TZS/m3)

Product	Min.	Max.	Average
PINE			
2" sawn timber	384,000	512,000	448,000
1" sawn timber	192,000	281,600	236,800
Average	320,000	396,800	358,400
Flitches (Slabs)	20,000	40,000	30,000
EUCALYPTUS			
2" sawn timber	256,000	448,000	352,000
Nominal size price conversion	(TZS/m³) Ex -SMEs in Mufindi District		
1" sawn timber	192,000	217,600	204,800

Average	224,000	332,800	278,400

For analysing the historic price trend, Indufor (2011) report gives indication on the sawn timber prices both in the southern highlands and in Dar es Salaam. In 2011 the price of untreated 2"x4" was approximately TZS 195,000 per m³ and in late 2015 the price is TZS 329,000 - 613,000. In Dar es Salaam price for low quality timber from dingdong saws in late 2015 was TZS 542,000 per m³ whereas in 2011 the price reported was TZS 290,000. **It appears that in five years the prices of pine timber have increased by at least half up to doubling of price. During the same period consumer price index has increased ca. 70% thus price increase slightly surpasses the annual inflation in real terms.**

6.4.4 Conclusions

Claimed recovery by the SMEs corresponds to the assessment made on actual sizes and recovery rates extrapolated from the data collected. If sales are made on the basis of nominal sizes, then the SME recovery rate is higher than the actual rate. As the market accepts undersized timber and purchase as a nominal size, the calculation allows for the correct value chain profit assessment. If the markets become insistent on the supply of full size sawn timber and will not accept the delivery of undersized material sawmills processing and profit will be turn to use the actual recovery rate favouring modern sawmills which are able to deliver sawn wood with full size measures.

7. VALUE CHAIN ANALYSIS

7.1 Pine sawn timber value chain

7.1.1 Analysis

Two different technologies were included in the value addition analysis for pine sawn timber production. Assumption in the analysis was that sawn wood is sold either in the region (Mafinga) or at main market in Dar es Salaam. The analysis includes two different alternatives for processing; dingdong sawmill close to the forest (Table 7.1) and sawmill located in Mafinga using more advanced technology (Table 7.2).

For advanced technology sawmills rough average figures applicable for different technologies are used. Chapter 6.3 presented a detailed cost and profit calculations on different sawmill technologies. Due to price premium for higher quality sold at major markets (Dar es Salaam), the price of sawn timber originating from more advanced technology sawmills is considerably higher.

Table 7.1 Pine sawn timber margins and value addition: Dingdong sawmills (TZS/m³)

	Sawyer/local trader-chain		Sawyer/merchant-chain	
	Mafinga sales	**% of retail price (Mafinga)**	**Dar sales**	**% of retail price (Dar)**
(Stumpage price)	(92,857)	(17.4%)	(92,857)	(17.1%)
(Harvesting costs)	(14,000)	(2.6%)	(14,000)	(2.6%)
(Log transport costs)	(8,000)	(1.5%)	(8,000)	(1.5%)
Processing costs	43,590	8.1%	43,590	8%
Total costs for sawn timber at landing	313,860	58.7%	313,860	57.9%
Selling price for sawn timber at landing	358,500	67%	358,500	66.1%
Profit for dingdong sawmiller at landing	44,640	8.3%	44,640	8.2%
Value added	***265,743***	***49.6%***	***265,743***	***49%***
Transport costs to Mafinga (incl. loading)	12,000	2.2%	12,000	2.2%
Costs at Mafinga – Cess	3,856	0.7%	3,856	0.7%
Cost at Mafinga – Storage / Handling Yard fee	12,500	2.3%		
Total costs for sawn timber at Mafinga	386,856	72.3%	374,356	69%
Selling price at Mafinga	535,000	100%		
Profit for sawmiller or local trader in Mafinga	148,144	27.7%		
Value added	***24,500***	***4.6%***	***12,000***	***2.2%***
Transport costs Mafinga – DSM (incl. loading)			48,500	8.9%
Costs in DSM			0	
Total costs for sawn timber in DSM			422,856	78%
Selling price in Dar es Salaam			542,300	100%
Profit for merchant in DSM			119,444	22%
Value added			***167,944***	*8.9%*

PROFITS TOTAL	**192,784**	**36%**	**164,084**	**30.2%**
VALUE ADDED TOTAL	***290,243***	***54.2%***	***445,687***	***82.2%***

NOTE: The prices per m³ are based on actual measure and reflect the actual value received or paid.

Table 7.2 Pine sawn timber value addition for technical advanced saws (TZS/m³)

	Mafinga sales	% of retail price
Stumpage price	92,857	13.8%
Harvesting costs	33,500	5%
Log transport costs	20,000	3%
Processing costs (tech saws)	48,744	7.2%
Total costs for sawn timber at sawmill gate	349,537	51.9%
Selling price for sawn timber at sawmill gate	500,000	74.2%
Profit for sawmiller at mill gate	150,463	22.3%
Value added	***252,887***	***37.5%***
Costs at Mafinga – Cess	3,856	
Transport costs Mafinga – DSM (incl. loading)	48,500	7.2%
Costs in DSM	5,000	0.7%
Total costs for sawn timber in DSM	553,500	82.1%
Selling price in Dar es Salaam	674,000	100.00%
Profit for sawmiller **or** merchant in DSM	120,500	17.9%
Value added	***169,000***	***25.1%***
PROFITS TOTAL	**271,143**	**40.2%**
VALUE ADDED TOTAL	***421,887***	***62.6%***

Stumpage price

There is a large variation between the highest and lowest price paid per m³ for wood on stumpage. The lowest level observed was for government forest stands and the published rate stood at an average of about 65,000 TZS per m³. Private forest stands have been sold from 80,000 – 120,000 TZS per m³. Although stumpage prices also in the southern highlands tend to be orientated towards government royalty rates, the large variation in stumpage prices in private forest stands is because of variations in diameter, age, accessibility and the level of market knowledge by the seller. Surprisingly little price differences have been noted between large and small diameter saw log prices. Reported prices per m³ for younger stands with small average diameter did not veer far from the perceived average market price levels. This is in contradiction with the fact that smaller diameter logs have lower recovery rates and therefore should cost less.

Most of pine sawn timber in the southern highlands is still originating from government plantations. Therefore government royalties are used in this analysis as stumpage price. Under the government pricing system buyer pays for the whole tree. Sawmillers report that about 70% of the volume invoiced can be used as saw logs. Stumpage price applied in the analysis is based on this sawlog yield rate and government royalties and the actual cost of sawlogs is estimated to be 92,857 TZS per m³.

Results of the compartment quality analysis (see Chapter 4.1.4) showed that average mature pine compartment contains about 78% saw logs and 22% pulp logs. Actual price of saw logs to the saw mill is even higher. Recovery variations between these two grades of logs were not assessed under this study.

When using dingdong the price for the sawn timber is lower, therefore stumpage price has a proportionally bigger share of the end price. This implies that the use of better sawmilling technology would enable higher prices also for the standing timber.

Variation in stumpage prices on private land indicate that there are possibilities for higher stumpage prices, especially on stands closer to tarmac roads, on better terrain and of better quality. Tree growers who are aware of the effect of these on sawmill cost structure and have a strong bargaining position to gain the price premium.

The present system of selling whole compartments is not optimal. Differentiating the product into e.g. sawn timber logs and pulpwood logs and selling to different buyers would improve efficiency of resource use and also wood paying capacity among buyers.

Neither government nor private forest owners do utilise full earnings and growth potential of their stands although TFS has confirmed that the 2016/17 allocation will include a large amount of thinnings from pine stands. Technical limitations to the Tanzanian paper production restrict the use of small diameter logs in the production of pulp and paper products but significant amounts of wood from thinnings could be used as small diameter saw logs.

Harvesting, log transport and processing

Harvesting and transport costs are smaller when processing with dingdong (see 6.3.2). When processing with dingdong, traders buy sawn timber at landing, transporting and selling timber to Mafinga. In contrast, larger sawmils located in Mafinga manage the whole value chain from stumpage to selling sawn timber.

For dingdong saws, the standard and only length of logs cut is 12' or 3.6 m to allow for manual handling of the log through the saw. New sawmill equipment operators are cutting lengths from 4 m to 6 m, which allows for flexibility when optimising tree and resulting in better yields from stands harvested.

Dingdong entrepreneurs (SMEs) buy wood on stumpage and pay for harvesting and logging. Profit margin is rather small (44,640 TSH per m^3), half of the stumpage price. This is one of the reasons why SMEs are sensitive to interruption in cash flows and have little ability to invest in production.

Traders that buy sawn timber from dingdong SMEs and sell in Mafinga are making good profit margins, 1.5 times the stumpage price, more than 3 times higher margins than the dingdong entrepreneurs.

There seems to be no price premium for better quality sawn timber in Mafinga. Sawn timber produced by technically advanced technology needs to be transported and sold in Dar to gain the price premium for good quality.

The actual price for sawn timber produced by dingdong in Mafinga is higher than the timber produced by more advanced technology due to the fact that the timber is under-sized. This issue is in detail explained in chapter 6.4.2.

Sawn timber transport and sales in Dar es Salaam

Timber merchants are buying sawn timber in Mafinga and selling it in Dar es Salaam. Sawmill operators with more processing capacity are also themselves organizing transportation and selling the sawn timber in Dar es Salaam instead of Mafinga.

There is a considerable price premium for better quality sawn timber in Dar es Salaam: Better quality sawn timber prices are ¼ higher than poor quality timber. Producing high quality sawn timber with improved recovery rates will increase profit margins throughout the value chain.

For a sawmiller using advanced technically eliminating the trader from the chain may increase his/her profit margins considerably, up to 40 % of the retail price.

Comparison of profits and value added

Due to the price premium at Dar es Salaam markets, summarized profits of sawmillers, traders and merchants in the dingdong saw value chain are slightly lower than the profits of a sawmiller and a possible merchant in the advanced technology value chain. The profit for sawn timber from advanced saws is roughly TZS 270,000 per m^3. Second highest profits are gained by selling sawn timber from dingdong saws in the local market in Mafinga. The local market cannot however absorb all the volume produced and the majority of the timber has to be transported and sold in Dar es Salaam or other major cities.

Total value added includes financial profits and labour inputs, and describes the economic value creation from a macroeconomic point of view. Also value added is higher in the advanced technology value chain. Harvesting and log transport costs are considerably lower in the beginning of the value chain for dingdong saws. For the advanced saws financial profit in this stage is decreased by the need to transport logs (instead of sawn timber) to Mafinga.

On developed markets in Finland (2016) properly sawn 2" x 4" with no twists and accurate dimensions is sold for TZS 565,000 in retail timber yards. The price is very close to price of poorer quality dingdong sawn timber sold in Dar es Salaam (TZS 542,000). The price of similar quality timber is higher in Tanzania (TZS 674,000). Price for one cubic meter of pine saw log in Finland is TZS 129,000, which is higher than what the processors in Tanzania are paying (TZS 93,000). Looking at only the difference in the cost of material and market prices, one conclusion is that the in theory the earnings potential of the sawn timber processing is higher in Tanzania. The total earnings potential is not realised because of inefficiency in the logistics, and sawmills inability to materialize benefits of economies of scale due to small sizes and lack of raw material.

7.1.2 Conclusion on pine sawn timber value chain

Key to improve on the sawn timber value chain and its margins lies in introduction of improved processing technologies and in building capacity for use of these technologies to improve recovery rates and quality of sawn timber. Education and technical advice to maximise production design capacities will allow new improved sawmills to benefit from efficiency of production, lower costs and improved sales prices. Due to improved recovery in a number of sawmills volume of sawn timber in the market will grow from the same volumes of saw logs. However, expected decreased government log supply indicates that short-term reductions in overall volumes of saw-logs are to be expected, and market volumes of pine are likely to remain stable. In this case only increased demand will have an inflationary effect on the sales prices.

Increased price of sawn timber, recovery rates and better quality sawn timber will improve the potential for higher stumpage prices. At the moment profits for timber traders are higher than the actual stumpage price. Better stumpage prices will only materialize if tree growers are aware of the price structure, giving them a stronger bargaining position.

Better quality sawn wood can only be produced if good quality harvesting produces good quality, damage free logs with proper dimensions to avoid raw material losses and allow processors to fully utilize a larger share of the wood supply for high quality sawn wood.

Through integrated harvesting timber could be allocated for its best potential use and wood resources would be used more efficiently. This could also contribute to alleviating impacts of the decreasing wood supply from Sao Hill plantations.

7.2 Eucalyptus value chains

7.2.1 Potential eucalyptus value chains

Recently emerged new end uses for eucalyptus logs has improved the potential for private and government growers. Until the last two years, the majority of eucalyptus stands have been selectively harvested for utility poles and the remainder of the stands has either been left for later harvesting or clear felled for firewood and limited amounts of saw logs.

The eucalyptus stand will produce various products at different stages of growth. Development of veneer production and substitution of pine with eucalyptus in sawn wood production can provide a steady income throughout the rotation of the stand (Table 7.3.).

Table 7.3 Uses of eucalyptus at different stages of rotation

Stand age	Type of use
Eucalyptus thinnings 5 years	Firewood, fencing poles, veneer logs
Eucalyptus 8 years	Utility poles, small diameter saw logs, veneer logs, fencing poles
Eucalyptus 10 – 12 years	Utility poles, veneer logs, saw logs
Eucalyptus 12 - 16 years	Saw logs, veneer logs

7.2.2 Eucalyptus sawn timber value chain

Eucalyptus is presently not highly valued for sawmilling due to poor quality of sawmilling and drying defects inherent with the material properties. Low quality finished eucalyptus sawn timber is considered as the last resort. However, increasing shortage of pine timber in the market and demand pressures may increase eucalyptus sawn wood prises. Considerable improvements in eucalyptus sawmilling are possible and will be dependent on technical advances in production including understanding of drying techniques specific to eucalyptus timber.

The value chain analysis for eucalyptus sawn timber produced is based on dingdong sawmilling technology (Table 7.4). Sawlogs are sourced from private forests by selective cutting. Pricing is based on number of trees with some regard to the size and has a great variation. Sawmillers enumerate and price the trees subjectively. **Average cost for buying one cubic meter of eucalyptus sawlog grade material is about half of the cost for pine on government plantations.**

Harvesting, log transport and processing cost are very low as the dingdong saw is operated inside the forest stand, and are assumed to be the same as with sawmilling pine. Similarly, transport cost to Dar es Salaam is assumed the same as is the cost with transport of pine sawn timber. Eucalyptus sawn timber sales prices are considerably lower: pine timber fetches circa TZS 542,000 per cubic meter whilst eucalyptus sawn timber only TZS 432,000.

Profit per m^3 for eucalyptus sawnwood is half of the profit for pine sawnwood: TZS 20,000 vs. 44,000 (at landing). Difference in the retail margin in Mafinga is remarkable: TZS 148,000 for pine versus TZS 31,600 for eucalyptus. Transporting eucalyptus timber to Dar es Salaam markets cannot be considered very attractive compared to trade in pine: Trading margin for pine is TZS 119,000 and for eucalyptus only TZS 24,000.

Table 7.4 Eucalyptus sawn timber value addition (TZS/m3)

	Mafinga sales	Dar es Salaam sales	% of retail price (Dar es Salaam)
Stumpage Price (private)	45,000		10.4%
Harvesting costs	14,000		3.2%
Log transport costs	0		0%
Processing costs (Dingdong)	43,590		10.0%
Total costs for sawn timber at landing	279,590		64.7%
Selling price for sawn timber at landing	300,000		69.4%
Profit for sawn timber at landing	20,410		4.7%
Value added	78,000		18%
Transport costs to Mafinga (inl. loading)	12,000		2.8%
Costs at Mafinga – Cess	3,856		0.9%
Cost at Mafinga – Storage / Handling Yard fee	12,500		2.9%
Total costs for sawn timber at Mafinga	328,356		76.0%
Selling price at Mafinga	360,000		83.2%
Profit for sawn timber at Mafinga	31,644		7.3%
Value added	56,144		13%
Transport costs Mafinga – DSM (incl. loading)		48,500	11.2%
Costs in DSM		0	0.0%
Total costs for sawn timber in DSM		408,500	94.5%
Selling price in Dar es Salaam		432,500	100.0%
Profit for sawn timber in DSM		24,000	5.6%
Value added		72,500	17%
PROFITS TOTAL		**55,644**	**12.9%**
VALUE ADDED TOTAL		**150,500**	**35%**

7.2.3 Eucalyptus pole value chain

Integrated poles production and sawmill operations will allow private growers to expand their market by selling both poles and saw logs to the same customers. Rather small volume of trees of utility pole quality trees per stand would indicate supply of saw logs would be higher.

As a regional benchmark the price of locally produced treated poles is approximately the same as for poles in Kenya but higher than in Mozambique and Zimbabwe. Nine-meter poles are sold for TZS 230,000 to TZS 280,000 and 12- meter poles for TZS 380,000 to TZS 410,000.

Value addition for eucalyptus poles produced in the southern highlands is based on 10 m poles that are the most common length produced (Table 7.5).

Private forest growers are the main suppliers to the domestic market, hampered by the quality of their forest stands. Utility pole yields of 30% from growing stands are common and lack of alternative markets for the residue restricts interest to plant eucalyptus. Possibility to sell logs for sawmilling immediately increases tree growers' earning potential. Price paid for raw pole material is substantially lower than the price for sawlog grade eucalyptus: TZS 25,000 versus TZS 5,000.

Lack of information on new eucalyptus growers and growing areas confines domestic poles producers' development plans and the search for raw material is a major cost

factor along the value chain. Pole producers are sourcing raw poles from areas as far as 500 km away from the producers' yard. Although anecdotal evidence indicates that there is at least 150,000 ha in total of new planting in the southern highlands, there is no reliable data to confirm the area nor the share between pine and eucalyptus.

Because TANESCO has considerable cash flow difficulties, issuing and payment of contracts is often delayed and the supply chain is irregular. The government and the donor community finance TANESCO's development projects. Occasionally, the government has failed to submit funds in time, so some poles suppliers have not been paid on time and some small companies have been forced to halt deliveries because of capital limitations. Delayed payments have also resulted in difficulties in production and in sourcing raw materials. Most current and future electrification projects will be run through the REA which has had no major payment problems according to stakeholders.

Profits made by raw pole traders are low, only about TZS 8,000 per pole. However, payments are made directly at delivery which is an advantage for cash deprived entrepreneurs, and the business model is based on fast turnaround of poles from forest to treatment plants.

Profits for the treatment plant appear attractive: TZS 108,000 per pole (a margin of one third of sales price). Attractiveness of the treatment business is somewhat reduced by the uncertainty of call for tenders, winning bids and delay between payments for raw material and receiving the payment for delivery of treated poles.

Table 7.5 Eucalyptus pole value addition (TZS/m^3)

Stumpage Price (9m med)	25,000	7.60%
Harvesting costs	15,000	4.60%
Total costs for poles at landing	40,000	12.20%
Transport costs to processing plant (incl. loading)	7,000	2.10%
Other costs (cess, TP)	5,000	1.50%
Total costs for poles at processing plant	52,000	15.80%
Selling price at processing plant	60,000	18.20%
Profit for delivery of poles at factory gate	8,000	2.10%
Value added	*35,000*	*10.7%*
Costs for pole treatment	110,000	33.50%
Total costs for treated poles	170,000	51.70%
Transport costs to customer	43,800	13.30%
Other costs (unloading)	7,000	2.10%
Total costs for treated poles at customer	220,800	67.20%
Selling price for treated poles at customer	328,000	100.00%
Profit for poles sales at customer	108,000	32.90%
Value added	*268,800*	*82.0%*
PROFITS TOTAL	**116,000**	**35.4%**
VALUE ADDED TOTAL	***303,800***	***92.6%***

7.2.4 Eucalyptus veneer value chain

Plywood veneer is a new product to be produced in Tanzania. Three factories have been set up in Mafinga to produce veneer from eucalyptus. **The product is destined for export and is currently not being planned to be sold domestically in**

Tanzania. Although the companies interviewed had considered the availability of pine for veneer production, none had made any contracts for the supply of pine material.

Production recovery on the new 'spindle less' peelers is considerably higher than on older style peelers. Small logs of 10 cm diameter will give a recovery rate of 40% and logs over 30 cm diameter will result in 80% recovery. An average rate of 70% has been used for this value chain analysis (Table 7.6).

Logs used are short 1.25 m logs and diameters can vary from 10 to 40 cm (max. 30 cm for one producer). This allows tree grower to optimise recovery from each stand and provides for use for logs that do not meet utility pole and saw log quality requirements on sweep and bend. **Income earnings potential from a eucalyptus stand can be optimized by selling to a combination of customers** and as a result only low-grade waste residues are being left from the harvesting operation. Stumpage price for veneer logs is the same as for eucalyptus logs for sawing. Shorter veneer log length leading to higher recovery rate however means the revenue for the tree grower is higher.

Veneer producers are sourcing material from both government and private growers. One producers has concluded a contract of 70,000 m³ of logs with the government. However, at the time of this report, nothing had actually been taken from this contract volume even though the log buyer had been operating the factory at full speed. The producer had found a more flexible and cheaper supply line using private growers and harvesting young trees (as young as five years old). Although the stumpage price was low, growers had very high recovery from each stand and fast cycle earnings potential without the need to sort and grade logs. Due to the large demand volume and requirement for short time delivery period (restricting the distance from which this material can be sourced), there is concern that this supply line may not be sustainable in the medium to long term. It will also encourage growers to have short term outlooks at the eucalyptus forest business model and reduce their motivation to leave stands till maturity when the income earnings potential is at its maximum.

Sourcing of raw material for veneer production has a number of technical limitations that affect the distances from which logs can be sourced as well as the harvesting procedure required. Logs need to be harvested and delivered to the veneer producer within 24 hours in order to reduce the moisture lose, essential for the production process. Alternatively, full length trees can be harvested and delivered to the producer which allows an extended time period before processing.

Veneer production is a new activity thus there is no historic data or trend to analyse. As an export product, demand is dependent on world markets, competing supply from other countries, and demand in the current export market (India). Potential markets are large but competitiveness depends on the costs along the value chain and availability of material.

Profit for the veneer processor is TZS 77,000 per m³ with a margin of 18%. This is much lower than in sawmilling and veneer producers cannot pay prices higher than current market price. In case wood prices would double veneer processing as an investment option would no longer be attractive compared to other options in the wood industry.

Table 7.6 Eucalyptus veneer value addition (TZS/m³)

	Costs	Income	% of retail price
Stumpage cost in the forest	45,000		11%
Harvesting and transport	22,000		5%
Mill gate log cost	67,000		16%
Veneer yield	70%		

Processing costs	36,850		9%
Cost of the veneer	132,564		32%
Transport costs Mafinga – DSM (incl. loading)	48,500		12%
Port costs and shipping - DSM to India	160,000		38%
Total costs for Veneer in destination port	341,064		82%
Selling price in India		418,000	100%
PROFIT		**76,936**	**18%**
Value added		***373,000***	***89.2%***

7.2.5 Conclusions on eucalyptus value chains

Although highly profitable as a business model, utility poles industry suffers from delayed payments and a highly fluctuating demand level affected by political considerations. Should the payment delays be reduced, it would allow for producers to develop their stock holding potential and allow for increased domestic penetration into the Tanzanian market thus reducing the need for imports.

Reliance on one product (poles) increases the business risk and in order to level out the income earning peaks and troughs. Diversification to other production processes would create a more sustainable business model that will attract and motivate the medium sizes businesses and increase competition in the industry as a whole. Diversification would also allow utilization of a ready supply of different log qualities.

Although TANESCO has announced it will start purchasing concrete poles because of the quality issues in the wooden poles. It is to be seen to which extent they can be used. Cost of sourcing and investments in machinery for concrete pole production are higher and there are also technical and economic aspect which favour the use of eucalyptus poles. Expected longer life span of concrete poles is highly dependent on proper materials used in manufacturing and quality inspection procedures of the buying agency are equally important as for wooden poles.

Introduction of eucalyptus sawmilling has not resulted in financial success for the SMEs in the southern highlands. Small sawmills sawing eucalyptus as an alternative for pine are struggling to make a profit. Improved production and drying technology would give confidence to the market of a better quality and better performing material and would eventually increase sales price.

There is very limited market for veneers in Tanzania and sales figures have been difficult to estimate. Current levels of imported plywood sold in Tanzania indicate a strong potential for plywood production development in the southern highlands and Dodoma.

Because of the high port and shipping costs, any domestic sales development in Tanzania will show strong profit margins. The new and cheap technology from China used in all three veneer projects allows for high recovery and provides a possibility to use small diameter logs from younger stands and thinnings. This allows for the sale of additional volumes of previously unsaleable raw material qualities and sizes thus improving the profit margin of the tree growers.

8. EMPLOYMENT AND CONTRIBUTION TO NATIONAL ECONOMY

8.1 Overview of employment by wood processing sub-sectors

The study explored wood-processing sector contribution to employment opportunities in harvesting and processing of round wood as well as in trading and transporting round wood and sawn wood. Lack of baseline data on the area planted annually made it difficult to estimate the number of people engaged in the first stages of the value chain. Number of private tree growers is so significant that any estimate excluding them would be only a small share of the total employment in silvicultural activities. Exact numbers for employment and planting are available only from large corporations.

Since most plantations in Tanzania are in the southern highlands, an estimate of the contribution that plantation wood (pine, teak, eucalyptus) from the southern highlands makes to the national economy should provide a good estimate of the importance of the forestry sector to the national economy.

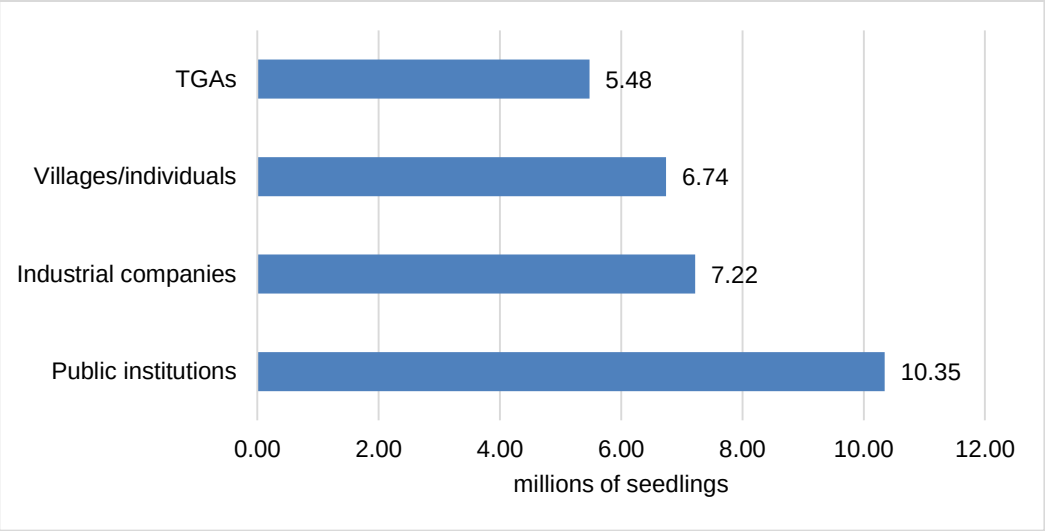
8.2 Nurseries

Estimate for nursery employment and income contribution are based on field visits and interviews in Mufindi district in Iringa, a region where communities are highly motivated to plant trees. District government collects data on seedlings produced annually which was used to estimate contributions to employment and income. In 2015 total of 12.5 million seedlings had been grown by TGAs, individuals, and village councils (Figure 8.1).

Presently a normal price per seedling is TZS 150. If seedlings are sold at an average price of TZS 150, private individuals and TGA may earn about TZS 1.9 billion. Private individuals tend seedlings on a part-time basis. Using the Tanzanian minimum wage in the agricultural sector of TZS 100,000 per month as the unit labour cost, the market value of seedlings can be converted to equal 1,560 full-time man-years. Since seedling production by individuals is self-employment, no corporate profit margins are involved. A farmer may earn more producing seedlings than working on his farm thus private nurseries are an income generating/enhancing activity. If a lower value would be assumed for an alternative cost of labour, this would increase the labour input estimate.

In Njombe and Mbeya regions private planting has taken off in the last few years thus similar figures as in Mufindi district probably apply. However, there are not enough statistics to attempt an analysis for other districts and regions.

Figure 8.1 Number of seedlings produced in Mufindi District



(Source: Mufindi District, 2015)

8.3 Silviculture

There are two types of employment in forest management activities: self-employed farmers and hired labour. Majority of forest management work done is in the first category where no statistics are available, and where the intensity of management depends also on time farmer is able to allocate for plantation management. Agricultural work and food production is normally the priority for an individual small holder farmer and forest management is done if there is extra time and/or sufficient labour available. Some farmers may also hire other villagers to do management if they have money to invest, especially for plantation establishment and early years' management (weeding, pruning and fire lines). At village level this farmer to farmer employment has some impact on local employment opportunities.

Large and small tree planting companies hire workers to plant, tend, and harvest trees. KVTC, for example, engages about 377 people to manage 8,200 ha, and Green Resources 847 people for 26,000 ha (one person for 31 hectares). There is no data on TANWAT and MPM forest management employment. In general, **SME plantations covering area between fifty and six hundred hectares employ three or four people** (Annex 20). After establishment only a few employees are needed to manage and guard a certain area of a recent plantation and extra workers are only needed for the harvest and replanting.

Employment in the project area cannot be accurately estimated as precise information about the area and the number of private, small-scale farms is not available. A very rough estimate on man-years needed for management activities could be established based on the total area of plantations in the southern highlands and work force needed to manage that area. According to NAFORMA (2015) there are 429,539 ha of plantations in the southern highlands. If four employees are needed to manage 300 ha (50-600 ha) on a fulltime basis, this would mean some 5,727 man-years for plantation management and maintenance, excluding establishment and harvesting activities which are more labour intense and especially in SME sector utilize temporary labour. However, small holders normally only own very small areas and only work on their forest plantations a few days per year thus the actual number of people involved is considerably higher.

8.4 Harvesting

Except in large industries, harvesting sector is informal and consists of individual chainsaw operators or groups which provide felling and clearing services and are paid on performance basis. We analysed the number of workers employed (**Error! eference source not found.**) by projecting the volumes of logs harvested by each harvesting technique against the performance figures given in the data collected. With harvesting volumes in 2015 **the minimum level of employment was 3,137 and the maximum, 6,991** (see Annex 19 and Annex 20 for details).

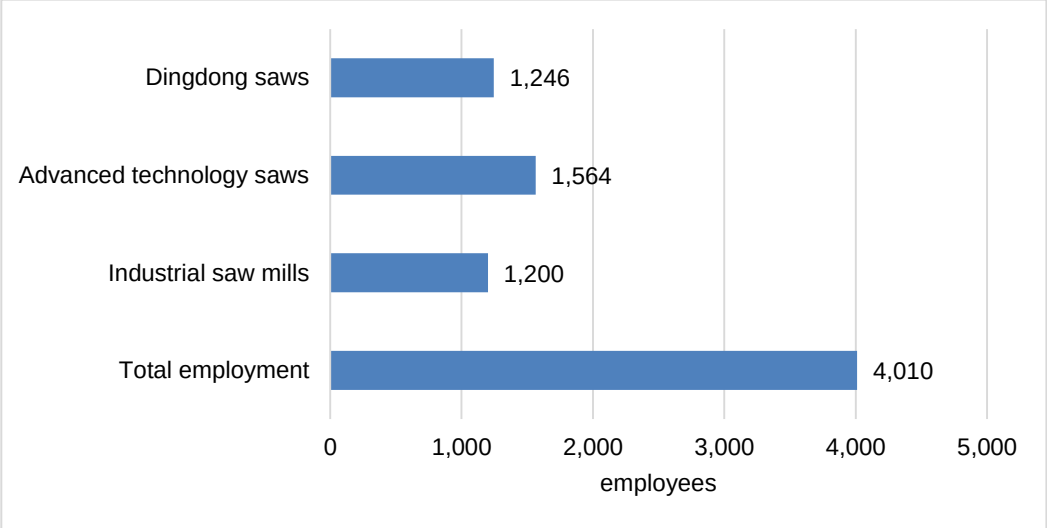
8.5 Sawmilling

Many people are actively employed in the sawmill sector. Sawmills which use SHFP resources employ many itinerant workers from other regions of Tanzania, who are drawn to the Mufindi region because the forest industry centralized around government plantations provides them with many job opportunities. In contrast, sawmills using private forest resources are likely to employ both permanent workers who travel with their mobile saws and locals who travel short distances to find temporary labour in areas where there is sawing activity.

Sawmills in government forest areas employ more workers on average than do sawmills working in private forest areas. Sawmills which work in private forest areas locate their mobile saws within the compartments from which they harvest logs so that they do not need to transport the logs or hire additional handlers to do so. Sawmills cannot set up saws in government forest areas, so they must bear the added expenses of loading, transporting, and unloading the logs they harvest at the sawmill site, a step that requires considerable handling and therefore additional labour.

Based on interviews dingdong sawmills employ seven people on average, and more advanced technology saw mills 17 people. Thus the **total number of employees employed in the sawmill sector is circa 4,058**, approximately 20% of whom are permanently employed. Women employed by small sawmills were mostly recruited locally and tended not to be itinerant. An additional number of women worked at sawmill sites preparing food. Not all small sawmills employed women but overall women comprised 9.2% of all small sawmill employees, and fewer than the 15% of the workforce found in large industries.

Figure 8.2 Labour employed in the sawmilling sector in the southern highlands



8.6 Other major industries

Paper, wood chemicals and recently veneer and plywood industries also employ a considerable number of employees. New plywood and veneer production lines employ already some 3,300 people but this figure will increase as the new production facilities begin to sell their products.

8.7 Carpentry and joinery

Carpentry and joinery are important generators of employment in the country. Furniture and cabinet industries are traditionally labour-intensive, have low start-up costs, and can operate both in rural areas and in towns (Indufor, 2011). Almost 89% of the workers in the furniture businesses surveyed in Dar es Salaam, Iringa, Morogoro and Njombe regions were youths with primary education. Our finding was supported by previous studies from 2011 and 2008 (Embassy of Finland and the National Economic Empowerment Council of Tanzania) which found that 68% and 77% of the operators in carpentry units in Dar es Salaam were primary school leavers.

Carpenters are organised into furniture clusters, which engage between 10 (in Manzese) and close to 1,000 people (in Keko). Some individuals in these clusters produce furniture while others sell it or serve as brokers. Our surveys found 100 carpentry units in Morogoro municipality, 18 in Mafinga, 45 in Njombe and 59 in Iringa towns.

Locally made furniture is not transported long distances. While urban populations buy their furniture from local furniture shop, poor rural households may produce the basic furniture themselves.

By assuming the demand for furniture is consistent across urban populations in Tanzania and by using an average ratio of 0.35 carpentry shops per 1000 urban habitants (Table 12.5), we estimated the number of furniture shops in the country as a whole. Ratio in the four towns ranged from 0.33 to 0.39 and the average number of employees per shop was five. Based on this we estimated that altogether **2,316 persons work in 479 shops in the southern highlands**.

Table 8.1 Ratio of number of furniture shops to urban populations

Municipality / Town	Urban population	No. of furniture shops	Furniture shops per 1,000 habitants
Morogoro	315,866	100	0.33
Mafinga	51,902	18	0.35
Njombe	130,223	45	0.35
Iringa	151,345	59	0.39
Total / Average	649,316	322	0.35

Given a total population of 49.6 million and a rate of urbanisation of 26.7%, a **total of 23,000 people nationwide could be employed in the furniture industry**.

8.8 Transport

Employment in transports differs according to the plantation source used: SMEs which use governmental forest resources must transport all the logs they harvest from the harvesting area to a sawmill cluster, but SMEs using private forest resources set up their sawmill operations in or near the harvested compartment thus saw log transport is not calculated in the assessment of logistics.

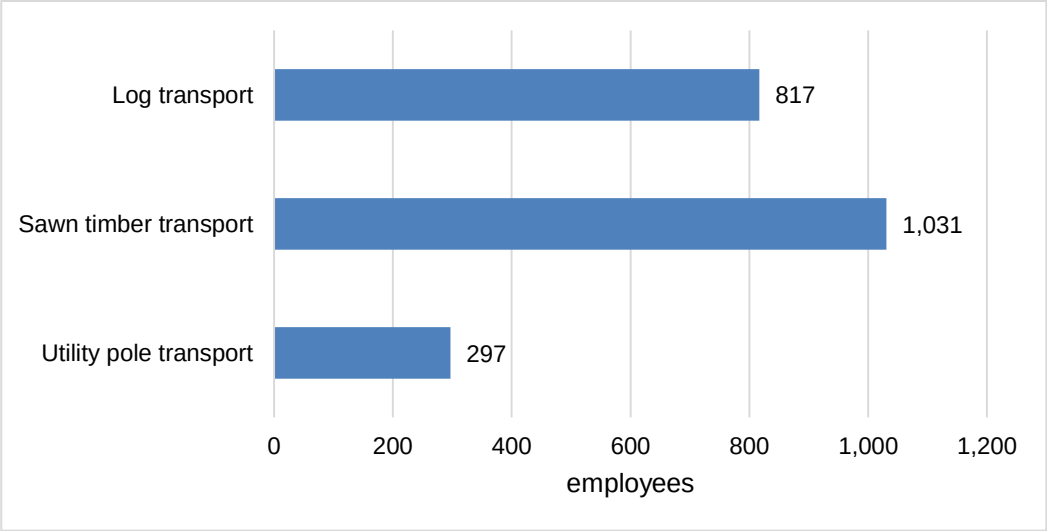
Because they function differently, separate analyses were conducted for the following three transport sectors: i) transport of logs from forests, ii) transport of sawn timber to markets and iii) transport of utility poles (see Annex 19 for details). Activities carried out by the transport logistical sectors of large companies (Sao Hill Industries, MPM and KVTC), and the labour required for these activities are accounted for in the total figures of employment within these companies and not separated into distinct activity categories.

In the SME analysis optimum value is based on the production and output capacity of logistic facilities and indicates full time operation and employment level. Sawn timber is transported from either major sawmill producers or from timber traders to end markets. All producers, with the exception of KVTC, used manual labour to load the timber. Large and small operations had uniform results.

Utility pole transports needs up to 20 persons to manually load trucks with raw poles for delivery to buyers, who in turn used bell loggers and front loaders to unload the trucks. Two of the suppliers surveyed used a distribution yard to prepare full loads of raw logs to deliver to buyers, but the effect of this activity on average employment level was negligible.

According to official statistics a total of 7,840 trucks transported timber from Mufindi district in 2014 and 5,523 trucks did so in the first ten months of 2015 (District Report 2015). The majority (80%) originated in Mafinga and plied regularly between Mafinga and other destinations, making the monthly average of truck movements from Mafinga 602. Only about 20% of trucks crossed the Mufundi weighbridge just once a month. The estimated average transport time for timber to reach the destination from the weighbridge and back was six days, so each truck made roughly four trips a month and the 600+ trips from Mafinga. Based on this it can be estimated that there are some **150 trucks operating on a full-time basis.** This is in line with the actual number of trucks used for calculations. Based on the analysis some 2,145 people are presently employed in SME wood transports.

Figure 8.3 Employment in SME transports



8.9 Total employment creation in wood value chains in the southern highlands

The total number of man-years is estimated to range between 20,000 – 30,000 (Table 8.2). The spread is very large as there is much uncertainty about area planted and the amount of harvesting in private forests. Silviculture and harvesting employ the largest number of workers as all work is carried out manually. Sawmilling is a major contributor to employment, it provides 5000 – 6000 man-years.

Table 8.2 Estimation of employment in forestry/wood industry value chain in the Southern Highlands

	Minimum	Maximum
Total workers employed	20,246	30,967
Seedling and nursery	1,507	2,444
Forestry and forestry management	2,995	4,195
Harvesting	3,137	6,991
Sawmilling	4,864	6,264
Other industries (paper, chemicals, poles, and the like)	3,282	3,282
Furniture	2,316	2,516
Transport logistics	2,145	5,274

8.10 Contribution to the national economy

Forest sector contributes to the national economy not just through employment creation but also through revenue generation as stakeholders pay various taxes and fees. Different sources provide a slightly different picture of the extent of this contribution. Between the fiscal years of 2011/2012 and 2013/14, TFS paid TZS 81.53 billion to the treasurer in income taxes and TZS 17.99 billion in cess and VAT to local governments (Table 8.3). Its contributions varied considerably over the three years.

Table 8.3 The TFS's payments of income tax, cess, and VAT between 2011/2012 and 2013/2014

Year	Income tax	Cess	VAT	Total (billion TZS)
2011/12	31.07	0.66	4.12	39.19
2012/13	20.45	0.87	4.97	29.49
2013/14	30.00	0.70	6.68	40.07
Total	81.53	2.22	15.77	108.74

In terms of the percentage contribution the forest sector to the national gross domestic product (GDP), the recently published FAO report (2015) reports a rising trend, as shown below (Table 8.4). The National Bureau of Standards (NBS) reported lower figures, but its figures also show an increasing trend.

Table 8.4 Contribution of the forest sector to the national GDP

Contribution to GDP (%)	2008	2009	2010	2011	2012	2013	2014
FAO	2.2	2.4	2.7	2.7			
NBS	1.4	1.5	1.4	1.3	1.6	2.1	2.4

Source: FAO (2015) and National Bureau of Standards (2014)

These figures are similar to the estimates given in the Forest Policy document, varying between 2% and 3% (MNRT, 1998). This figure is believed to be an underestimate because the consumption and contributions of wood fuels, bee products, catchment and environmental values, and other forest products, such as poles, are not included in the calculation.

Tanzania Revenue Authority study from 2012 that focused on value chain analysis (Green Advocates International, Inc. 2014) found that forestry had contributed 4% to GDP and that its value was greater than that of the entire export crops sector. FAO report also showed that the value of forest product exports increased from USD 9 to 13 billion between 2008 and 2009 and then was stable for 2010-2011.

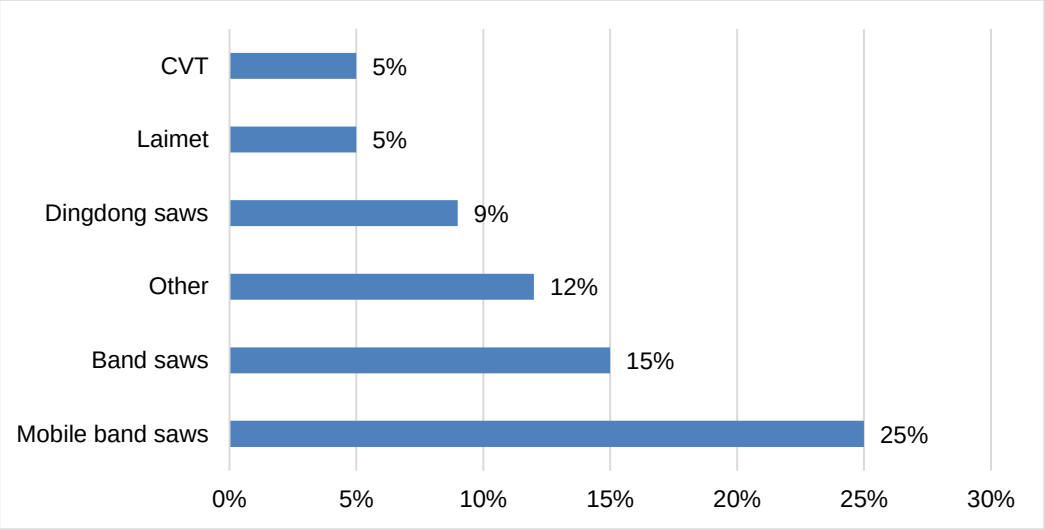
8.11 Female employment

Formally there are no obstacles for women to work in forestry sector but especially harvesting, loading and sawmilling with dingdongs requires physical power which women on average do not have. Women are working mainly in nursery activities, tree planting, weeding, pruning and other forest management activities.

According to PFP information on TGAs, women are well represented among the TGA members: in the TGA 2014 baseline study 36% of the TGA members (in 49 TGAs) were women. Presently some one third of those receiving support for tree planting through PFP are women. For the planting season 2015/16 26% of tree planting support applicants were women. However, conclusion of the division of forest work at household level cannot be made based on these figures, especially in the case of households with two parents or with adult children.

Sawmilling is male dominant work; only 5-25% of employees are women in SME sawmilling (Figure 8.4). Women rarely operate dingdong saws though they do carry sawn timber from operating sites to forest roads. More women work in permanent than in mobile sawmills and they experience better working conditions in the former. No females engage in harvesting.

Figure 8.4 Share (%) of women workers in the small and medium sawmills surveyed



There are also a few females trading lumber and also among sawmill owners. There is no reliable data on women working in carpentry and joinery but traditionally this is considered as men's work.

Salaries paid in forestry and forest processing mainly reflect the hardship of the work, and are in many cases paid as piecework pay. Therefore, it may be assumed that salaries women are paid are lower in general as they are not involved in the heaviest work and may not be able to achieve as high piecework as men do.

9. MAIN BARRIERS ALONG THE FOREST VALUE CHAINS

Identification of barriers is based on the interviews of different actors along the value chain and problems and challenges raised in these interviews.

In general, wood products industry has developed but in a limited fashion and only medium to large companies have made any significant changes in the past few years. Small sawmills continue to operate in much the same way as they have for the last 20 years. Many have replaced their old saws with new ones, but these still use old technology, only now they are manufactured locally.

The level of self-sufficiency of various sawmills affected the type of barriers considered as a de-motivating factor to the technical and economic development of the industry. Unsurprisingly, as government forests have been the main providers of pine to the market, most barriers were related to the structure and system of trading logs from government forest resources.

9.1 Forestry and harvesting

This report does not address and analyse barriers in tree planting because they have been analysed in previous PFP reports and in the programme preparation process.

Training of works in harvesting and processing is inadequate

Some large private tree growers expressed concerns on lack of harvesting expertise in the market. Harvesting companies or harvester groups are poorly trained and lack good-quality equipment. They have little experience in gauging environmental factors and very little regard for safe working practices. They do not achieve maximum forest recovery rates and levels of forest waste are high. Poor harvesting of eucalyptus can cause poor coppicing and reduce yields in future cycles.

Training and education should be provided to improve working practices and safety procedures. Consideration can be given to introducing a code for safe working practises and licencing to allow harvesting activities by qualified personnel.

9.2 Wood processing and business operations

Raw material

High on all sawmills' lists of barriers was the lack of raw material. All interviewees were concerned that the volume of pine from government resources is decreasing and that there is little concrete information about the future of the SHFP's log resources. All of interviewed sawmills in the government forest areas harvest and process more logs than they are allocated. Large producers (between 20,000 m^3 and 40,000 m^3 of logs per year) have invested in better and more effective machinery because they have enough cash to purchase allocations from other stakeholders. In contrast small sawmills which work from truck load to truck load do not have enough cash to purchase large volumes of wood ahead of use. Small sawmills are most worried about the effects of pine reductions in the future.

An open log-trading market could be developed to allow all businesses, large and small, to increase the range of log suppliers they have access to and thereby reduce the risks associated with relying on a single main supplier.

Access to financing

All small sawmills reported that they lack access to loans and that cash-flow difficulties restricted their ability to grow. Interest rates for loans are at least 16-18%, and with the uncertain supply of raw materials, small industries are unwilling to risk loans for capital

expenditure. Short-term loans are used to finance specific production or sales objectives. Sawmill licences are issued for a period of only one year.

If period for which sawmills are licensed could be extended, a stable and open log-trading market could be established and forest supplies could be stabilized. This would give small businesses a strong enough financial planning outlook to encourage lenders to consider longer term loans.

Inflexible public sector regulations

Working hours in the SHFP are from 6 a.m.to 6 p.m. although sawmills report that TFS representatives sometimes do not man checkpoints after 5 p.m. unless by special agreement. The hours were fixed to reduce the theft of logs from the forest. All areas allocated for harvesting have a TFS-manned checkpoint on their access roads in order to record truck movements, control cess payments, and ensure correct stakeholder activity. The result is that forestry activity and truck movements are restricted to daylight hours. Any company considering expansion or development of volume will require capital expenditure on more trucks, harvesting equipment, and personnel. In most forestry projects around the world, expansion begins by engaging existing logistics in second and third shifts. Such an expansion cannot be carried out in Tanzania because of the regulations but furthermore it is too dangerous to carry out manual harvesting in the dark. Mechanical harvesting would be safe at night, but restrictions on working hours are reported to be one reason companies have not considered a move to mechanical harvesting.

The restriction on the SHFP's business hours should be reviewed and possibly revised to accommodate technical advances in harvesting and/or increase safer activities that are possible to undertake at night.

Hammering of logs

Under current regulations, all logs have to be hammered (marked) by a member of the local TFS team. This regulation is not followed with the pine logs harvested in the SHFP but it is followed with the teak logs harvested in Ifakara. Although the plantation in Ifakara is not government-owned or -managed, it still operates under TFS regulations, a fact which is reported to create delays and exacerbate tensions between the plantation management and the local government and furthermore has the potential to generate local-level corruption.

The regulation concerning the hammering of logs should be revised to accommodate plantation working practises.

Poor road network and road maintenance limits access to resources

Poor road conditions and deficient road maintenance make transport costs high. Since access to many harvesting areas is very poor and it is difficult to move logs out of the logging areas, small portable sawmills are used to process logs on or nearby the harvesting site. As a result, a large amount of waste remains on sawmilling sites and environmental damage, particularly destruction of ground integrity, is considerable. Small portable dingdong saws are very ineffective and have a very low recovery rate. Private forest areas tend to be further from the tarmac road structure and in less developed areas so the road conditions are worse than the government forest area. Some areas in the Njombe and Kilolo region are reported to be totally inaccessible during heavy rains.

Taxes collected for the maintenance of forestry roads should be used effectively and to maximal effect. Joint ventures and cooperation between forestry managers and stakeholders for road maintenance should be exploited further.

Availability of power limits larger industries growth

Irregular power supply from TANESCO is reported to be an increasing concern for large industries. The southern highlands saw some of the worst power cuts and load shedding they have ever experienced in 2015. All the major industries report an increase in their demand for power as indicated below:

Tanwat needs more power to produce plywood, an activity which will increase demand by 0.5 MW.

Sao Hill Industries needs 0.6 MW to start its new briquette plant

Unilever Tea Tanzania Ltd. needs over 2 MW to increase its manufacturing capacity and build a new plant in Njombe and Ngwazi.

New Forests Company needs 0.8 MW to start its new sawmill.

Tanganyika Plywood Ltd. needs over 0.4 MW to start its new veneer production line.

Nine new start-up wood processing operations were seen in Mafinga alone. Together they will demand more than 1 MW.

Many manufacturers have a back-up power generation system but running one costs about twice as much as the cost per kW that TANESCO charges. The rapid rate of growth for some manufacturers has outstripped their generator capacity and the cost of upgrading is outside of their current capex budget.

Small sawmills in villages reported that they relied on small engine-driven saws instead of electric motor-driven ones because they had little or no access to a power supply. Because they are mobile, they have no option but to use engines.

TANESCO should review customer demand patterns and power plan for the southern highlands region.

Work safety in SMEs is very poor

Work safety is a major problem. With the exception of large manufacturers which have their own certified and managed operational health and safety (OHS) systems, producers do not have cohesive safety procedures and many workers have never been trained in safety. Southern Highlands Forest Industry Association (SAFIA) reported that each month one or two people engaged in wood industry activities in the Mufindi region died but stressed that such reports were only hearsay: no official statistics or recorded information back up this claim. That said, many small sawmills reported that at one time or another they had seen a death at work. The number of accidents at work has decreased at New Forests Company Ltd, Unilever Tea Tanzania Ltd, Mufindi Tea Company, Tanwat Ltd., and Mufindi Paper Manufacturers Ltd. over the past few years because these companies introduced OHS management.

The Private Forestry Programme could work with OSHA to expand and increase the frequency of its educational services to the small sawmills and consider cooperation with OSHA at the proposed PFP training management unit in Mafinga.

Harvesting and sawmilling waste is not managed

Waste material, whether it be from harvesting, forestry, or industrial activities, is not used effectively. Most sawmills do not have any experience in handling or processing bio-waste; in fact, very few interviewees were well informed about the benefits of using such waste. Small sawmills sell flitches to local customers, who use them for fencing, low-quality village and agricultural buildings, and firewood. The price per m^3 of flitches is between TZS 20,000 and TZS 50,000. Most sawmills reported that they sold a maximum of 30% and 40% of their flitches. Many old sawmilling sites are still covered with large amounts of industrial waste. In respect to forestry waste, this is normally collected by small traders and sold to the Mufindi Paper Mill and/or burnt as an economical way of clearing a harvested compartment prior to replanting it. Only Mufindi Paper Mill and Sao Hill Industries Ltd currently have a use for waste in a process for utilising it effectively.

Education is required in order to instruct sawmills how to handle waste and provide a basis for which large industry can collect therefore enabling small sawmills to earn income from this waste material. If both large and small operations around industrial areas that allow for the collection and processing of waste material can be brought together, more waste can be used.

9.3 Transport

Fuel, spare parts, and tire theft by employees

Since transporters expect to lose a percentage of fuel, they calculate an allowance per trip that is at least 15% - 20% more than the expected consumption. Tires are a major cost to transporters. Poor road conditions contribute greatly to the wear and tear on tires. Furthermore, drivers commonly exchange new good-quality tires for second-hand tires or cheap Chinese tires. As a result, many companies do not invest in high-quality tires but instead buy cheap tires knowing that they will have a short life. Spare parts are also traded by drivers.

The cost of genuine, branded spare parts is high but imitations are cheap

Since imitation parts do not last a long time, they tend to cost more than genuine parts, a fact not considered by many transport companies and truck owners. Furthermore, if a good spare part is purchased, there is a strong possibility that it will be stolen or exchanged by an employee or driver.

Drivers taking back-haulage – lack of "return-load agents"

Drivers tend to take back-haulage to line their own pockets, thereby delaying their return to base and reducing the number of working kilometres for truck owners. Due to corruption at checkpoints and weighbridges transport operators have difficulties in controlling the taking of back-haulage.

The lack of a "return-load agent" infrastructure and the fact that transport agents are very few make it hard for transport companies to find return loads for their trucks. Normally, it is only through transport operators' own activities a return load can be secured.

Lack of trust within the transport industry is a barrier to the development of transport agent companies and systems, it is simply too easy to pay a driver to take a load without reporting that to the owner.

Weighbridges are slow in processing trucks through the system

Most weighbridges are old and use a combination of online and paper processing, thereby slowing the process considerably. Most transporters claim that they have to wait one to four hours at each stop, depending on the time of day and the operational status of the bridge.

Two new weighbridges have opened between the Southern Highlands and Dar es Salaam, one 70 km before Dar es Salaam and one 20 km before Iringa. Because the

system is centralised and connected online, processing is quick—as long as there is an internet signal.

Corruption at weighbridges and police stops
Corruption is extensive, however worse at the old weighbridges. It seems to be difficult to get reliable facts and figures from transporters in order to quantify the extent of corruption. Transporters were understandably reluctant to give details but many reported that the competitiveness of the market was such that they would have been unable to perform without paying bribes.

On matter of special concern is the legislation not allowing heavy goods vehicles on the road between 6 p.m. and 6 a.m. This regulation is not ordinarily enforced, hence allowing for corruption. Many drivers continue to drive up to the next manned checkpoint after the restricted time. Since many drivers pay bribes to pass checkpoints, trucks can be found travelling at any time of day or night. Many trucks in poor, even dangerous condition and often without insurance take to the road at night, especially between checkpoints.

Road conditions are very poor
Poor road conditions cause extensive damage to trucks and shortens their period of service, thereby costing the owner considerable money and time. Although substantial road development is going on in Tanzania, many of the roads built or repaired over the last ten years have become dangerous due to the breakdown of road surface, development of potholes, and subsidence. The main road into Dar es Salaam from Morogoro and the Ruaha Valley are both in poor condition at a number of places.

Roads in the forestry areas of the Southern Highlands are constructed from murrum and poor maintenance is a serious problem. Some of the main routes are repaired only bi-annually. The large volume of heavy trucks which carry materials for the two major industrial users, Sao Hill Industries Ltd. and Mufindi Paper Manufacturers Ltd., damage roads during the rainy season although the latter industry annually maintains the major routes its trucks use.

There are no legal checks or controls on how long a driver can drive
Informants reported that many long-distance truckers had had serious or fatal accidents, sometimes due to dangerous driver activity, including driving overtired, drug consumption and the use of unqualified secondary drivers.

Wide load and overweight transport passes are time-consuming to obtain and the system is rife with corruption
Reports of delays at checkpoints even for drivers with correct documentation are directly related to corruption. Facilitation payments are common at the point of application.

Trucks overload with impunity, shortening the working life of trucks and trailers, damaging roads, and encouraging corruption
Truck owners said that they needed to overload in order to increase their income and compete with inexpensive service providers. Since transport companies factor the write-off value of short-term use into their costs, rates of transport are high.

Introduction of cheap Chinese trucks has allowed a new breed of trucker to grow, the owner-driver. Owner-drivers are more economical and more competitive than big companies but take shortcuts in maintenance and do not always have cargo insurance.

A large part of the traditional transport business is conducted by large, well-established transport companies, but the growth in small companies with between one and five trucks as well as in owner-drivers occurred with the introduction of cheap Chinese trucks to the market. Some large companies have also bought these same trucks, which cost as little as USD 20,000 for a tractor unit.

Informants did not agree on which of the above problems was most serious. Clearly, **a complete study on transport sector with recommendations and analysis is warranted.** Regional differences are small and problems are generic. Increasing volume of road traffic and lack of railways as a viable option has increased the load on roads and thereby severity of the problems. During the field work period of this study, two of the oldest working transport companies in Iringa, S.T. Abri and Nardi Ltd., seeing no profit in the transport industry, stopped operations and started to sell their trucks. In just one year, over 50 trucks were taken off the market.

9.4 Wood markets and sales

Log trading is limited

Large and medium sawmills complain that they are not allowed to sell harvested logs from government forests that are not of sawmilling quality, but small sawmills, which handle each log manually, do not consider that is affecting their overall recovery rates. Most small sawmill owners accept that they have to process whatever they get from the forest and do not see grading logs as a way to improve their recovery rates. The main factor influencing their attitude is that in Tanzania market demand exceeds market supply which forces buyers to accept low-quality sawn timber goods. Therefore, a manufacturer has no incentive to improve his timber quality. Low quality logs or logs with defects both reduce the recovery to the sawmill as well as lower the quality of the sawn timber.

An open log-trading market could be developed in order to maximise forest recovery rates from government resources as well as from private growers, TGAs, and farmers. If a sawmill could sell pulp quality logs to the paper factory and the paper factory sell high quality logs to the sawmill each operation could benefit both in terms of income and quality production.

There are no common grading rules to support establishment of log-trading market for pine

Private growers and TGAs lack comprehensive information about the needs of large sawmill consumers, grade standards and their requirements, and the overall demand framework has restricted the development of an open pine log-trading market. In contrast, eucalyptus sales from private forestry owners rose dramatically because large buyers of utility poles formulated grade requirements based on TANESCO's grade specifications and created purchasing departments that actively inform sellers of their demands and terms. Private sellers and harvesting companies are now active stakeholders in the sale of raw material for utility poles to the major industrial players. No similar interaction has occurred for the sale of pine logs to sawmills or the pulp industry, partly because of the allocation system of government forests. Large companies do not need to be active in the private market as they can fulfil their requirements through existing long-term supply agreements or through the resources they grow themselves. That said, both large and small companies are concerned that the government will not be able to fulfil their requirements in the future and are showing signs of losing confidence that their current capital expenditure and future development plans gives the returns they envisaged.

All stakeholders in the wood processing industry, especially those which have invested both large and small stakes in the development of high-quality processing equipment, must have access to a log supply market that is sustainable, concrete, and reliable. In turn, suppliers and growers of timber should know what the market demands for different products are. As an initial step, a log grading standard is required in order to inform the market about the various industrial demands. A log trading system allowing stakeholders to purchase logs from private and government growers is needed.

Pine allocations do not support efficient use of wood resources in sawmilling and other industries

Most stakeholders in the SHFP complain that the paper industry uses high-quality saw logs and is partly responsible for the current shortage of saw logs.

The practice of supplying high-quality saw logs to paper producers needs to be re-assessed. Since stakeholders' material needs must be met, expansion of suitable material from forest operations must be considered. However, for the paper plant to be able to use an increased range of material, some technical investments may be needed, especially considering the debarker. In other countries, most producers no longer use the knife debarker system but have changed to drum debarkers and as a result can process logs as small as 50 mm diameter.

Excessive bureaucracy and inflexibility in exports and cess

Export rules defined in the Forestry Act of 2002 require that exporters apply for an export permit, which is valid for one lot for three months from the date of issue. The industry regards this procedure as restrictive and recommends that permits last at least a year and not be restricted to one lot.

The export rules restrict the type of products that can be exported. However, the Forestry Act states that inspection of the good is done on the basis of suitable quality and grade standards. This is an ambiguous requirement as there are irrelevant grade standards for export timber goods which have no relevance to the sales contract or the customer demands.

The Forestry Act requires that timber goods are inspected "piece by piece" at "any gazette place or port of exit." This stipulation requires exporter to transport goods to a registered place of export other than his factory or place of work, unload the goods, and spread them out for inspection. Only after inspection they can be packaged for export. This procedure is expensive and restrictive and creates the following problems for exporters:

- Not being able to ensure that their goods are packaged properly at the point of manufacture
- Not being able to ensure that their goods are kept clean and in good condition
- Increased risk of damage from multiple handlings
- Increased cost of export
- Having to place responsibility for the final state of the goods in someone else's hands

If an inspection is carried out in a port, any delays in the process or complications caused by any questions incur expensive demurrage costs. Such difficulties could be avoided if inspections took place in factories, and problems could be more easily resolved, too.

An exporter must have control over his goods and, while inspection is desirable, it should not be restrictive or expensive. Inspections should be allowed at the place of manufacture. A review of the export system and regulation is desirable.

Cess system is not flexible enough to handle the current inventory of sawn products.

The outward cess for sawn timber delivered to the market is charged per piece: the rate is TZS 50 regardless of the size of a piece. This policy hurts small sawmills, which

in order to sell all they produce and maximise their recovery have to cut small as well as large pieces, such as one-by-fours. The buyer, however, will have to pay cess on each of the many pieces, so the price the seller, in this case the small sawmill, receives is less per m^3 than it would receive if it were able to cut large pieces.

Both the export regulations and the cess system should be reviewed and consideration made to standardising the system to accommodate market development and product evolution.

9.5 Technology and project development

Under-developed technical market and the lack of technical information

Under-developed technical market and lack of technical information are regarded as barriers to effective manufacturing development. Many small sawmills are not aware of new and alternative technologies and do not know where to get this information either. Medium sawmills which invested in new equipment reported that they made their purchases based on the recommendations of an importer in Dar es Salaam, who himself brought in machinery on speculation and not as a regular supplier. There is only one foreign machinery supplier Tanzania and it is not related to nor experienced in sawmilling or the wood industry. Technical development should address specifically technical requirements to manufacture eucalyptus, increasing recovery rates, especially for small-diameter pine logs, and improving saw quality.

A wood processing and forestry machinery market which includes education and representation by major manufacturers should be developed. As a practical example, wood technology exhibitions with major machinery manufacturers are regularly held in countries with large forest sector. These functions serve as important meeting points for industry professionals. Currently there are none in East-African context.

Lack of technical skills in eucalyptus value chain

As pine stocks decline, eucalyptus is increasingly seen as the only possible alternative. However the lack of training and experience in the processing and use of eucalyptus has constrained the development of sawn eucalyptus wood products.

Sawmills find it difficult to use the current sawmill technology they have to cut eucalyptus logs and end up with low-quality sawing and many rejects. Drying defects, expensive processing costs, and high logistical costs are among their problems. Because the manufacturing of eucalyptus boards is poor quality and it is difficult to nail and saw, building market pays less for eucalyptus sawn timber than it does for pine sawn timber.

Improper and insufficient drying causes defects which appear after secondary processing further reducing customers' confidence in eucalyptus and furniture made from eucalyptus is regarded as low quality.

Low customer expectations result in low sales prices despite the fact that the logistical and processing costs of eucalyptus are higher than those of pine. Eucalyptus log prices are also lower than those for pine logs.

A lot of eucalyptus timber is not treated with CCA because it is naturally resistant to termite damage. In contrast, all the pine used in the construction market needs to be treated with CCA to reduce its susceptibility to termite damage and wood rot.

Technical gaps in the use of eucalyptus include harvesting, primary and secondary sawn timber processing, drying, and value adding production techniques.

Education, training and technical advice should be provided to speed the development of the harvesting, manufacture, and marketing of eucalyptus.

Lack of reliable information on the forest resources

Development of new projects has been restricted because of the lack of credible information about the raw material resources available in the southern highlands. Symbion Power Ltd. attempts to set up a bio-energy power plant have slowed because of a reported difficulty in sourcing reliable information about the volumes and location of bio-waste and raw material. New Forest Company Ltd. reported that the lack of mapping information providing details about the locations of private eucalyptus stands restricts growth in the purchase of raw material for utility poles. Current supplies are sufficient but they express concern about future growth.

Mapping, information sourcing, and an information network of forest resources will help potential investors and existing companies to formulate development plans.

10. DEVELOPMENT OF ROUNDWOOD MARKET

Timber sales can influence how a forest is grown. Along with other activities, timber sales determine the long-term management of the forest.

The current government log sales system, as shown by the log grade analysis of government stands, does not maximize the earnings potential of government forest or encourage maximum utilization of forest stand and wood, but has nonetheless been adopted by private growers who sell compartments. In comparison private forest owners take offers from buyers, a system which results in higher rates of usage per cubic meter.

10.1 Government forest resources

Option 1 – Auctioning compartments

Free and open auctioning of forest compartments would ensure that the maximum price and thereby maximum economic yield were achieved. Auctions must be fair and must not exclude small sawmills through economic restrictions. The following practices should be considered as a precursor to auctioning:

- The qualifications should be the same as they are now but should be expanded to cover other wood processing industries and sawmills. Strict adherence to the qualifications will provide a level and fair playing field for all stakeholders.
- Auction lots should be sized so that both large and small enterprises can participate.
- All compartments should be scaled before they are auctioned and the results provided to buyers as an indication of the raw material available, but it will still be incumbent on bidders to carry out their own reviews after the auction.
- Auctions conducted every two or three months would allow for market fluctuations and demands. Also forest managers could scale and record the results for compartments up for auction.
- The beneficiaries of auctions should be allowed to trade the log grades that they do not or cannot use. A sawmill, for example, should be able to separate out pulp logs and sell them to a paper factory, and a paper factory should be able to separate out saw logs and sell them to a sawmill.
- Log values should be based on the maximum market value. Sawlogs shall not be sold for pulp log prices.
- Limitations on the maximum number of compartments any one supplier can purchase may be needed.

While prices for a compartment are likely to rise with these practices, for a stakeholder to be able to resell logs of unsuitable grades will help reduce the final price for the raw material.

The system also raises some concerns, including non-compliance with qualifications regulation, exploitation by cash-rich enterprises, second-tier log trading, and the reluctance of sawmill enterprises to sell pulp logs.

Option 2 – Integrated harvesting

Integrated harvesting could maximize the utilisation of forest compartments provided that harvesting was done using mechanical harvesting machines, grade standards were applied, volumes were recorded, and transparency was good.

Machine harvesting allows for the pre-programming of diameters, lengths, and grade standards so that all operators harvest uniformly. A mechanical harvester takes hold of a standing tree, cuts it at the base, and lays it on the ground, from where it is

passed through the harvesting head to remove its branches. As it passes through the head, trunk diameter and length is measured and it is cut as programmed (Figure 10.1, Figure 10.2, Figure 10.3). Computer records specifications of all logs harvested. Since this information can then be sent to the harvester's office by mobile phone, it allows for off-site interrogation.

Figure 10.1 The harvester takes hold of a standing tree, cuts its trunk, strips the branches as it drops it on the ground

Figure 10.3 A forwarder then the logs from the forest floor and stacks them at the side of a road for collection

Integrated harvesting requires a clearly defined log-grading standard that includes at least pulp logs, saw logs and small-diameter saw logs. This commands industry-wide agreement, and is implemented in accordance with TBS regulations.

In order to maintain the integrity and transparency of the process, harvesting will have to be tendered. Stakeholders and individuals involved in the sawmill industry should be exempted from the tender process in order to avoid conflicts of interest, accusations of improper activity, and favouritism. If the tendering process is to be trusted, it should be provided by an independent harvesting organization.

In order to reduce risks, two or more harvesting companies should be appointed. This way, if one company suffers a breakdowns or other problem, the other could take over the task.

Tenders should be invited only from suitably qualified and experienced harvesting companies.

Benefits of integrated harvesting include the following:

- An increase in the yield of commercial material from forest stands
- Maximisation of the economic yield of forest stands
- Management, reduction, and easy collection of forest waste
- Transparent recording of forestry activity
- Clear definition of graded products sold to specific industries (pulp to paper mills, saw logs to sawmills)
- Clear recording of forest materials harvested and reduction of the potential for corruption
- Reduction of OHS risks as only the operators of the harvester and forwarder are present at the harvesting site

Concerns about integrated harvesting include the following:

1. For a harvesting enterprise to be interested in importing and operating a harvester, which is a very expensive machine, it has to be confident that there will be sufficient business for at least three years.
2. Appointing just one harvesting enterprise would increase the risk of instability in the regular supply grading of forest products and in the economics of forestry.

3. If working hours are restricted to between 6 a.m. and 6 p.m., then the harvesting machinery will not be able to maximise production potential and harvesting costs will rise.
4. The total price of log material will be too high for enterprises to make a profit or the increase in the prices of raw materials will drive up market prices.
5. Log theft at forest harvesting sites might increase.
6. Employment in the value chain will shift from basic manual work to the processing phases where specific skills and training are necessary.

Once logs have been harvested, they can be sold in a variety of ways, including set prices, allocations and auctions (for various grades), and tender.

10.2 Private forest resources

Large plantations and industrial companies manage their own forests. The oldest plantations in Tanzania are the teak plantations in the Kilombero valley area and pine and black wattle plantations in the Njombe area. Production levels of both plantations meet the current demand. Other plantations in the study area consist of pine and eucalyptus. The majority of pine stands are at least five to ten years from maturation.

Small plantations, many of which are very new, are spread thinly over a large area. Altogether they comprise at least 150,000 ha according to Forest Development Trust (FDT) forest survey (in progress).

If plantation forest resources are correctly managed, they will produce different raw material outputs at different stages. Much of this output is low-grade material which is not suitable for primary wood production use, but it does have a market and could earn income for the owners.

Forest waste and wood from first thinnings are suitable for use in biomass boilers that generate heat and power. Larger diameter wood from first thinnings can supply the withies and building poles markets. Eucalyptus thinnings can be used to produce charcoal. Second thinnings can be processed into small-diameter saw logs or used in paper production. Presently thinning are not a standard practise on small plantations.

Final felling or clear-cutting is currently done by buyers who buy compartments that best meet their specific demands. Creating an open roundwood log market, sorting logs to grade standards, and selling each grade to appropriate end customers would maximise the economic yields of compartments. An open roundwood log market operates efficiently when sufficient information is available to all stakeholders and information covers a wide range of sector. Some other conditions of such a market are as follows:

- Log sellers should understand the grade requirements of each product required by different industries: pulp, small-diameter saw, standard-sized saw, and veneer logs. Although there could be more products, there is no reason to sort logs for industries that do not exist or for which there is no demand. Grade standards that have industry-wide agreement and acceptance will give sellers confidence to sort and deliver (or prepare for collection) specifications for their customers without worrying about rejections or quality disputes. Such standards will also make end-users confident during product-related discussions.
- There must be communication links among all stakeholders. Each party must know its potential customers and/or suppliers in order to formulate a comprehensive procurement policy. Information technology and spread of Internet coverage available on the mobile phone can facilitate the growth of a market information system which fosters such communication.

- Existing industry stakeholders need information about potential raw material volumes and supply lines in order to formulate development or growth plans, as do investors considering new industrial projects. To provide such information, data should be collected and mapped.

Private growers cannot make up for the decline in government pine reserves as demand is growing faster than Tanzanian pine forest resources can support. For this reason, not only do existing pine reserves need to be utilised more efficiently, but alternatives must be developed and themselves used efficiently.

11. FOREST INDUSTRIES VALUE CHAIN EFFICIENCY DEVELOPMENT

11.1 Background

Although technology of the sawmilling industry in the southern highlands has developed lately, sawing quality, size tolerances, and safety at work are still very poor. Size variations in the lengths of boards require carpenters to spend time regularizing them and reduce board size.

Recovery and yield figures suggest that more sawn timber could be recovered from less raw material if proper technological steps are taken. The volume of pine resources available in government plantations is declining in the short term and private resources, although increasing rapidly, are not yet mature and will not provide enough wood to meet the demand and alternatives must be developed. One alternative for sawmilling is eucalyptus which is available in sufficient volume to meet the demand.

Mobile sawmilling is prevalent and although it allows for forest areas with difficult access to be processed, it results in low recovery, high volumes of un-usable waste, high OHS risks and unregulated activity.

To decide on the most suitable technical advances, the following current and projected raw material determinants must be considered:

- Decline in governmental forest allocations
- Decline in the average diameter of saw logs
- Increase in market demand
- Use of alternative species such as eucalyptus
- Increasing production yields
- Improving sawing quality

11.2 Technical considerations

Observations and results of this study lead to the following conclusions:

Log diameter

- The smaller the diameter of an average log is, the lower the recovery rate is.
- Reduction of available volumes of mature plantations and pressure to sell immature stands is resulting in a small average diameter of saw logs in the market
- Technology currently available in Tanzania is not suited to maximizing recovery from small-diameter logs

Pine - Eucalyptus

- Although decline in pine resources may be only a short to medium-term problem the market demand for that period will remain the same and needs to be met.
- In order to meet the current demand for wood without resorting to the early harvest of immature pine, the only immediate alternative is eucalyptus. Unfortunately, skill and experience in cutting eucalyptus is very limited and the technology currently in use is not well suited to this species.

Saw quality

- Producers do not have the technology or skills to cut thin boards of a quality that meets buyers' expectations.
- Improving the technology producers have will increase their market penetration and their overall recovery rates.

Health and safety

- Old and simple technology has few if any safety features and puts operators at great risk.
- The introduction of new technology will help to reduce this risk.

Issues to consider in wood technology procurement

The issues to consider when planning a procurement in wood technology in Tanzania are:

- Low cost
- Simple operation
- Good recovery rates
- Good sawing quality
- Easy saw doctoring
- Easy maintenance
- Capacity to handle large logs
- Efficient power use
- Ability to saw softwoods and hardwoods, especially eucalyptus
- Availability of education and training

11.3 Summary

Although there are clear economic, safety, and environmental reasons to restrict the use of mobile saws, they are needed in places where topography and poor logistics make it difficult to extract logs from where they are harvested. However, it is essential that the mobile saws used would be more economical, had higher recovery rates, would be safer to operate, and had higher sawing quality. Mobile dingdong saws currently used do not meet any of these criteria.

Economic model for effective sawmilling in the southern highlands involves stationing efficient sawmills where there are reliable and long-term log resources.

Processing of small-diameter eucalyptus and pine logs is a priority, and one that will become more important as pine resources diminish.

Current combination of low grade logs, low sawing quality and poor size tolerance most of the saw mills operating in Tanzania produce affects the end use of wood products and reduces the quality and strength of end product or construction work using this material.

The development a high-quality sawn eucalyptus timber for use within the joinery and furniture manufacturing industry is essential if Tanzania is to reduce the use of illegally harvested indigenous hardwoods and reduce the cost of manufacturing hardwood furniture.

12. DEVELOPMENT OF INCREASED UTILISATION OF FOREST RESOURCES

12.1 Use of waste material for bio-energy

12.1.1 Status

The lack of electricity is by far the largest impediment to development in many parts of the southern highlands. Resolving this problem will transform communities and provide a viable power supply for village use and for the development of small local industries.

Low-grade forestry and wood waste has little income-generating power though medium-sized thinnings and large wood waste is used as firewood and sold in local and village markets. Rates for firewood in villages range between TZS 2,000 and TZS 5,000 per tonne. Small waste material such as chips, sawdust, branches, and loose biomass is not used. Instead, it is burnt in a harvesting compartment to clear it before replanting.

The current status of the use of and markets for woody material for bio-energy in Tanzania can be summarised as follows:

- Large volumes of bio-waste from small and medium sawmill operations are spread over large areas and not concentrated at manageable collection points.
- New plantings of both pine and eucalyptus will require management and their thinning and cleaning will produce bio-waste for large and small growers.
- Using low-value waste and thinning material becomes less economical the further it has to be transported.
- Low-value waste and thinnings have a limited market in Tanzania. Although thin eucalyptus poles can be used for the building poles, only a limited percentage is of suitable quality.
- Two new commercial briquetting projects have started. Both use sawmill waste from large industrial operations.
- Existing briquetting and carbonizing projects have had difficulties in marketing their products and in profitability.
- Major users of biomass for heating use firewood billets from clear-felled eucalyptus.
- Rural areas are poorly supported by electrical supply and power lines to these regions often must be hung long distances over difficult topography.
- Charcoal produced from pine is regarded as inferior and there is little demand for it in the domestic market.

12.1.2 Uses of biomass

The NAFORMA report (2013) claims that 96% of householders in Tanzania use some form of biomass for domestic purposes. Charcoal made from indigenous hardwoods burns slowly and gives off a steady enough heat that a pot of beans cooks slowly over it without maintenance for a couple of hours, during which time a householder can complete other tasks. It will continue to smoulder overnight and can be reignited in the morning. Charcoal made from softwoods like pine, in contrast, burns quickly and does not last overnight. Forest and industrial waste can be used for charcoal production although there is no market for pine charcoal. Eucalyptus charcoal made from waste material makes charcoal suitable for both industrial and domestic users. It has a limited demand in the domestic market as it is inferior to charcoal made from

hardwoods, but where local indigenous hardwoods are short in supply, it is a viable alternative.

Industries use biomass for various processes. In the southern highlands, tea producers use firewood from clear-fell eucalyptus stands to fuel the boilers they use to dry tea. They would like to convert their existing systems to use biowaste in the form of chips or briquettes. Despite the high cost of briquettes and of converting their boiler feed systems, they felt using bio-waste would be economically advantageous. Since they own their own plantations, tea producers can harvest stands commercially and sell high-quality logs going to the sawmill market and feed the bio-waste to their boilers. Most of their stands are eucalyptus as they have already sold their small volumes of pine to sawmills.

Mufindi Paper Mill has a 10 MW combined heat and power plant which runs on bio waste (chips). They also use bio-waste in the form of clean chips (those without bark) to produce paper.

The other main consumer of bio-waste in the southern highlands is the Mbeya cement factory. Its goals to convert up to 50% of the material it burns to manufacture cement into bio-waste. At present, it uses many forms of bio-waste, including rice husks and charcoal. Material has to be small, so dry sawdust is ideal except for the fact that it is expensive to transport long distances. The factory has used products from large industries too, including charcoal from eucalyptus and pine.

The export market has been closed to charcoal producers, but one new project which uses teak waste from industrial sawmills has obtained an export permit because it can demonstrate that all the raw material it uses is waste from the processing of plantation-grown material.

Bio-waste can be used to generate electricity. A major power generation company, Symbion Power Ltd. has explored the possibility of gasification for small- to medium-scale projects but has decided to develop a combined heat and power project. This type of system is demonstrably reliable, efficient and economical. Other stakeholders have explored combined heat and power projects but have not pursued them, mainly due to economic restrictions. TANESCO has reviewed and improved its take-off agreement structure and extended the take-off period to 20 years, thereby increasing the investment potential of power generation.

Some farmers put sawdust on land with heavy soil or poor soil lacking biomass or use it as mulch on root crops. Sawdust aids the retention of water but has to be used carefully so as not to affect soil pH values.

12.1.3 Charcoal

The NAFORMA report (2013) claims that the largest driver of forest and other woody biomass resource degradation is charcoal, which accounts for 32% of all losses, more than livestock grazing, fire, farmland expansion, and many other divers. The major resource for charcoal production are indigenous hardwood forests.

Two other comprehensive studies on the charcoal industry of Tanzania have been carried out. According to the report ‘Impact of Charcoal Extraction to the Forest resources of Tanzania’ (R.E Malimbwi), about 2 million consumers in Dar es Salaam use 471,000 tonnes of charcoal per year. Assuming a value of 100 USD per tonne (market estimation at the time of the report) of charcoal, this amount is worth about USD USD 47 million. CHAPOSA estimated that a total of 125,000 jobs in the region around the capital depend on the production, transport or sale of charcoal. In the CHAPOSA project area, village households obtained between 50% and 70% of their cash income from woodlands and charcoal was the most important commodity. A study performed by the Dutch-funded PREM Project (2003) estimated that the total revenue generated by 1.2 million tonnes of charcoal consumed in 2002 was around USD 200 million and that the charcoal industry directly employed about 70,000

workers. Recent independent calculations estimated the value of charcoal production at USD 350 million and employment at about 1 million workers (CAMCO 2013). The rate of charcoal consumption in the capital was estimated to be around 300,000 tonnes per year, but the authors of the report stress that this is a rough estimate only. The large difference in their estimate and that of CHAPOSA could partly be due to the different dimensions and definitions used, for example, “total revenue” instead of “value of product.” In any case, charcoal production and trade is a major source of income for both rural and urban dwellers in the country.

12.2 Potential new products from eucalyptus and pine

In addition to all-out efforts to increase pine production in government forests, eucalyptus must be developed as an effective supplementary source of timber wood. Plantation-grown timber is now small due to short rotations and has many knots due to wide spacing and much branching, but proper silviculture management can overcome these defects.

The post-harvest problems of eucalyptus wood, including twisting, surface cracks, and split ends due to excessive shrinkage upon drying, are more serious and cause value-added products to be rejected. These problems are caused by collapse, the transverse caving-in of wood cells which occurs during drying below the fibre saturation point. Research conducted around the world on this problem has largely solved many defects associated with improper harvesting, processing, and drying. Tanzania needs to apply the solutions and to extend the uses of eucalyptus.

Worldwide, the major end-uses of eucalyptus include production of railway ties, sports goods, plywood, particle board, furniture, shutters, scaffolding, firewood, and construction material. As a timber, eucalyptus is known for being straight, tall, medium to high density, naturally preserved and general-purpose. It is ideal for pulp and paper (short fibre products such as printing, copy, toilet and tissue papers) and other domestic uses.

Eucalyptus wood has not been commercially used in by Tanzania’s timber industry because stakeholders lack sufficient information about its technological properties and seasoning problems. In addition, its market is just developing. If optimum marketing success is to be achieved end-users must understand the properties of eucalyptus and how to use it. In particular, they must know how to season it properly, a process which necessitates minimising time intervals between felling, pre-drying and sawing, and protecting the sides and tops of air-drying stacks.

New industrial drying techniques and equipment have been developed, and research on solar-heated wood drying has continued across the world. A kiln can be used to dry green eucalyptus timber without over-rapid seasoning if temperatures do not exceed 45 °C and high relative humidity is maintained. Good seasoning limits defects to an acceptable level.

Since reducing seasoning time and improving the quality of seasoned lumber offer potential economic benefits, Tanzanian stakeholders need to be educated about the process, especially as they currently use crude traditional methods, keeping wood in the shade or in the sun to dry for as many months as the seller can finance or until the end-user needs it. Eucalyptus dried this way is often defective: star shake, split ends, compressed wood, cell collapse, twisting, bending and other defects are common. As a result, eucalyptus timber has poor image in the eyes of Tanzanian buyers. Unless their opinion is changed the shortage of pine timber will not be resolved.

However, if eucalyptus is processed correctly, it is a good alternative to indigenous hardwoods. Eucalyptus can be used for furniture production the same way as hardwoods and in the construction industry it is stronger and more resilient than pine.

Eucalyptus product development needs to start at the ground with training and education about proper silviculture management processes, including proper seed selection for the end-use planned.

Education and training must include at least the following issues:

1. Harvest practices — when and how to harvest, handling of logs, and planning timing and logistics.
2. Primary sawing of logs, cutting patterns, handling, stacking, and treating boards.
3. Drying boards using solar kilns or high frequency vacuum kilns, and improved traditional methods.
4. Grading and sorting boards to suit different end-uses.

Nailing and fixing both green and dried eucalyptus is difficult because of the wood's high density and hardness. Many countries use timber stabilization treatments to reduce the wood's resistance to nailing without affecting its ability to hold nails.

Once eucalyptus boards are fixed on a roof, they will be permanent and solid. Work on the most suitable chemical treatment for Tanzanian eucalyptus is being conducted by New Forest Company Ltd. Treatments include pentacryl, wood stabilizer, polyethylene glycol (PEG), diethylene glycol (DEG), paraffin, sucrose, sodium silicate, borax, ferrous ammonium sulfate, zinc sulfate, polyvinyl acetate, diesel oil, alginate, diammonium phosphate, and urea.

Eucalyptus projects

One major industrial stakeholder is now building a new sawmill designed specifically to handle and process both pine and eucalyptus. Initially, it will work exclusively with small and medium-diameter eucalyptus logs as well as continue its utility poles business. Its business model is formed on the fact that a eucalyptus compartment produces material for utility poles, saw logs, veneer production, and waste. Installing the new sawmill will enable it to utilise the majority of whatever stands it harvests.

Small sawmills do cut eucalyptus logs but report that they have severe technical problems with the primary and secondary cutting as the logs bend and split before processing and the boards bend and split as they come off the saw. Other difficulties include size tolerance, size variation, and saw jamming. While blades require special setting and regular sharpening and some mills do this, none are sure that the settings they use are correct. Market prices are affected by these problems and sellers have to undercut prices in order to sell the product.

Small log processing requires special machinery that is currently installed in only one new sawmill in Iringa. The industry lacks information and knowledge about the types of machines it should use, from where to source them, and what costs are involved.

Small log processing for veneer production has started in Mafinga. Three projects plan to utilize about 100,000 m^3 of logs per year and a fourth project will develop a full plywood production unit. Eucalyptus is ideal for this production as long as logs are harvested and utilised within 48 hours or are stored in wet conditions to stop initial drying. Production can take place as long as fibre saturation is present even if full cell moisture is not present.

Furniture manufacturers across Tanzania produce beds, tables and chairs with eucalyptus timber. Many use correct and good-quality production techniques, but since the wood they buy has often been incorrectly or insufficiently dried, finished items shrink and crack after delivery to customers. Customers reluctantly accept this defect as furniture made with indigenous hardwoods is between two and three times more expensive. If furniture makers had good-quality, properly prepared raw material, they would be able to make much better furniture.

12.2.1 MDF Production

Medium-density fibreboard (MDF, Figure 12.1) is an engineered wood product made by breaking down hardwood or softwood residuals into wood fibres, often in a defibrator, combining it with wax and a resin binder, and forming panels by applying high temperature and pressure.

Figure 12.1 MDF boards

Source: http://www.consmos.com/mdf.html

Factors favouring MDF production in Tanzania include:

- MDF requires a regular supply of low quality logs and/or sawmill waste. It can use both eucalyptus and pine.
- MDF is a stable board product with suitable technical qualities to suit the situation that finished products are used including the extreme nature of heavy humidity, high and low temperatures and low technology furniture production processes.
- MDF is easily cut and profiled, painted and lacquered.
- MDF is used in the furniture production in Tanzania.
- Competition comes from only imported product.

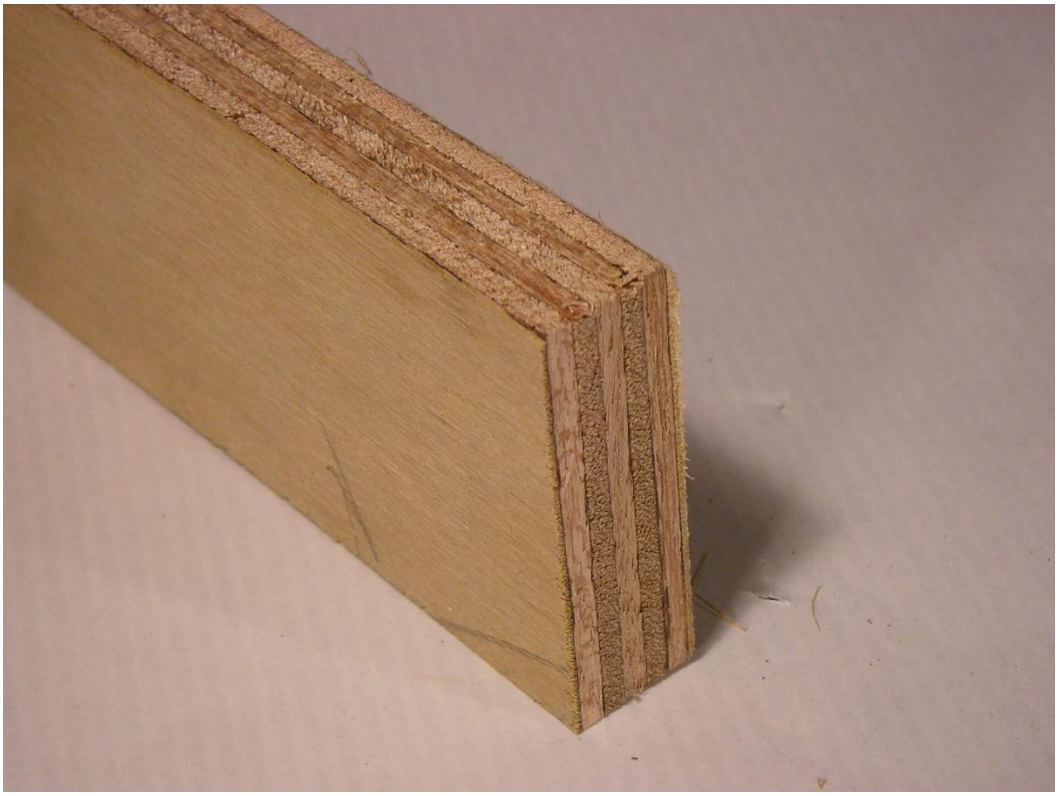
Factors speaking against MDF production in Tanzania are:

- Production process requires a stable and constant electrical power supply.
- Production requires heat for the curing process and platter heating.
- Market for MDF has not grown significantly in the last five years and lags behind the growth of plywood.
- Economic product requires large and expensive production lines and is difficult to scale down to levels below 60 - 80,000m^3 output per year.

12.2.2 Plywood production

Plywood (Figure 12.2) is sheet material manufactured from thin layers or "plies" of wood veneer that are glued together with adjacent layers having their wood grain rotated up to 90 degrees to one another.

Figure 12.2 Plywood



Source: https://en.wikipedia.org/wiki/Plywood

Factors for the production of plywood in Tanzania would be:

- Plywood can be made from eucalyptus.
- New veneer production processes allow for the use of small diameter logs.
- Technology is basically simple and does not require complicated electronic control systems.
- Production can be scaled to suit the raw material supply. Production lines can be designed for small to large capacity and the capital expenditure is at low – medium levels.
- The last five years has seen large growth levels in the volume of plywood supplied into the Tanzanian market.
- Prices are high and as most of the volumes delivered to the Tanzanian market are imports, the price is volatile due to currency changes.
- Currently only one company in Tanzania has developed a new plywood production project.
-

Factors speaking against the feasibility of domestic production and usage are:

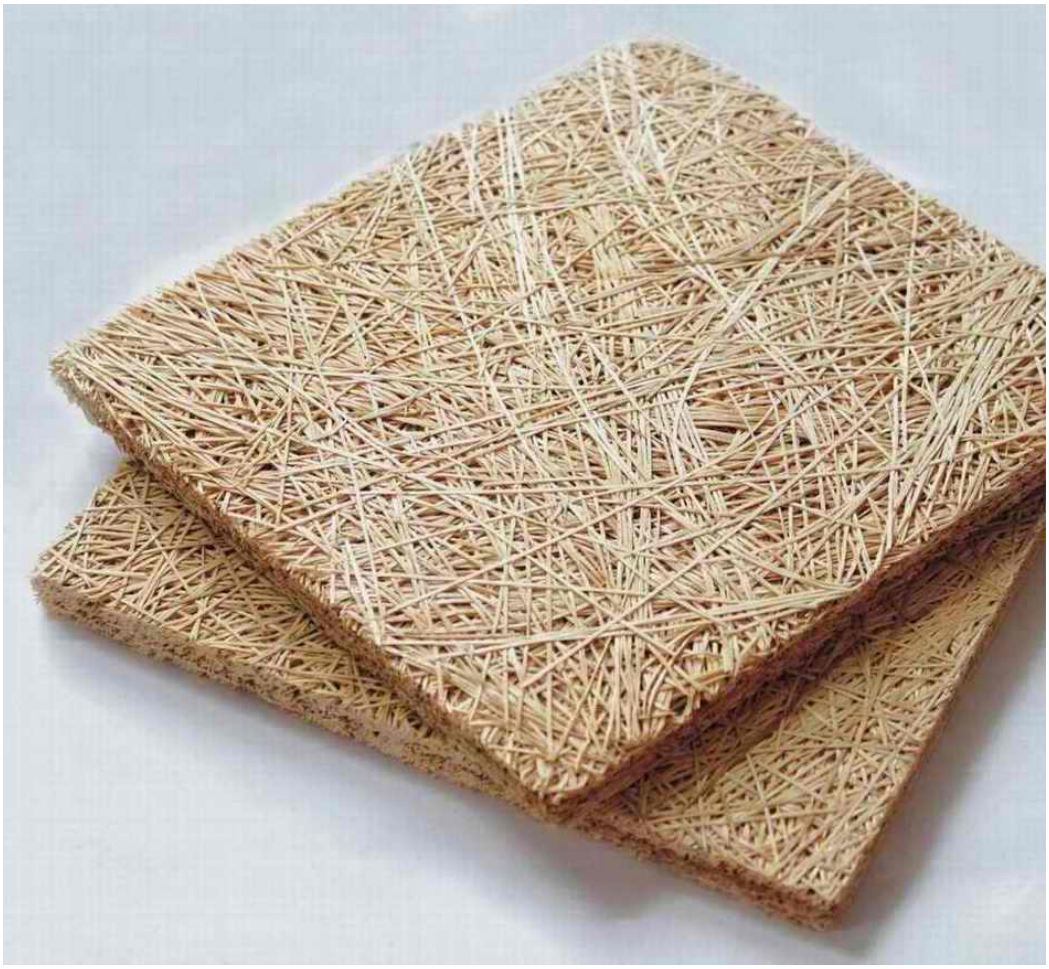
- Due to high humidity in much of Tanzania, the more expensive phenol-formaldehyde glue needs to be used. It is not manufactured in Tanzania and needs to be imported.
- Harvesting logistics need to be controlled tightly in order to avoid splits and defects in raw logs before production.
- Eucalyptus veneers are technically more difficult to dry than pine veneers which can result in high waste factor.

- In order to prevent dust and sand pollution in the production process, a quality building is required.

12.2.3 Wood wool cement board

Wood wool cement board (Figure 12.3) is made from strands of wood bound with liquid cement and formed into sheets for use on flat roofs and sound proof wall partitions. In thick form it can also be used as a fast wall construction material in domestic buildings.

Figure 12.3 Wood wool cement board



Source: www.wordbypicture.com

Factors in favour for wood wool cement board production:

- Utilises low grade raw material.
- Can utilise pine or eucalyptus.
- Cement binding is available in Tanzania.
- Highly resistant to moisture and ideal for high humidity regions.
- Low technology production
- Size of production lines can be from small to large and capital expenditure is low.
- Market potential as roofing material in high rise and commercial buildings.

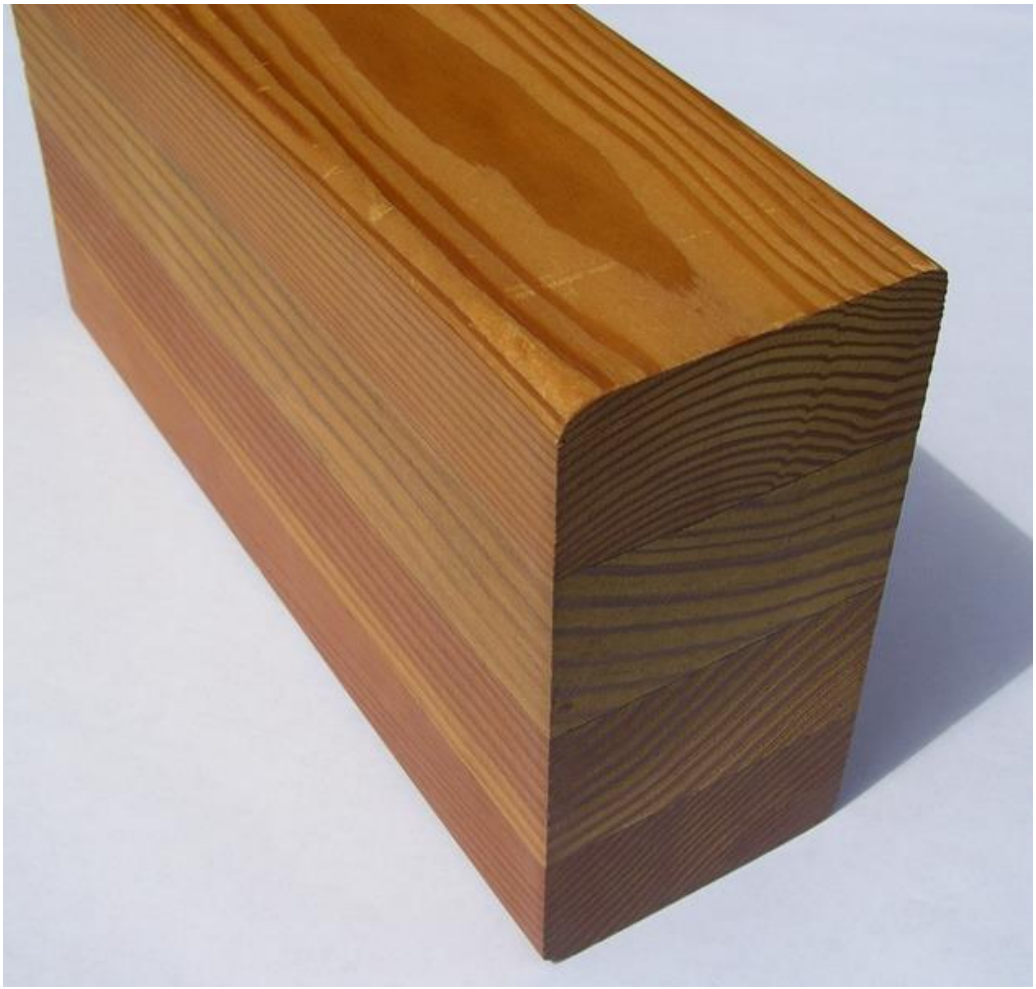
Factors against production:

- New product currently not used in the Tanzanian market.
- Requires active marketing campaign as well as educating architects and designers.
- No technical knowledge in Tanzania.

12.2.4 Glued laminated beams

Glued laminated beams (gluelam) is a type of structural timber product comprising a number of layers of dimensioned timber bonded together with durable, moisture-resistant structural adhesives to allow for large spans to hold heavy loads to be constructed.

Figure 12.4 Gluelam beam



Source: www.panabodehomes.com

Benefits include of using gluelams include:

- Allows for the use of sawn timber to increased load holding and greater spans to be covered. It increases the design limitations for domestic and commercial buildings.
- Can use both pine or eucalyptus sawn timber.
- Medium level technology that can be designed for semi-manual operation.

- Little additional technology required over existing medium and large joinery operations.
- Good market potential.

Factors against the use of gluelams are:

- Although there is knowledge of the product, architects and designs have limited technical education about this product.
- Uses material that can be used in existing construction projects.
- Requires high quality kiln drying process that currently is limited in Tanzania.
- Projects likely to be restricted to larger companies.
- Medium capital expenditure.
- Medium technological knowledge required.

12.2.5 Glue board for furniture industry

Production of pine glue board is not technically difficult but it is essential the raw material used is dry. Narrow strips of pine are planed smooth and glued together to form a wood panel that is both stable and good quality. The use of small sections of timber increases the recovery of timber from the sawmill process. Production can be done on manual presses and does not need high capital expenditure.

The same benefits of furniture glue board made from eucalyptus can be gained, however there is considerably more difficulty in drying the raw material. However, once a supply of dry eucalyptus is available to the joinery workshop, eucalyptus glue board can be used to manufacture high grade hardwood furniture.

A furniture workshop can very easily cut and rework panels to create solid and high quality furniture with less waste than current production processes. Glue board is highly suitable for production line furniture production and standard furniture design opportunities.

Finishing furniture made from glue board is no different than from solid wood furniture with proper painting and lacquering producing and fine finish. Staining and colouring results is good with the exception of eucalyptus. The technical nature of eucalyptus wood restricts the absorption of stains. Other techniques are needed to be able to colour the finished items if a darker color is required.

13. KEY ACTIONS TO SUPPORT PLANTATION FOREST VALUE CHAIN DEVELOPMENT

Development of plantation forest value chains calls for close discussion and joint efforts of various stakeholders to succeed. The government has a key role in developing regulatory environment and also general infrastructure supporting industrial development. Private Forestry Programme is designed to support this work and first steps on this way have already been taken under the programme to support the development of an enabling environment.

Based on the findings of this report, the most urgent focus areas to work with are in developing working wood markets, both for government and private forests. This includes development of common grading standards to allow market systems to develop, and establishment of information systems for informed decision making to link tree growers and wood buyers effectively and to enable longer term investment planning. In addition to a more supportive regulatory environment, wood industries need to be supported in diversifying and modernizing their production to establish economic and sustainable business models which also strengthen SMEs investment capacity.

13.1 Open round wood log market

PFP has the opportunity to provide the motivation and lead in developing a road map to generate the necessary requirements and processes that will allow for the growth of a log market system.

The following factors inherent in open round wood log market are essential in order to create a comprehensive and workable market accessible to all stakeholders, both large and small, on both sides of the business – forest owners and forest industry. Many points need consideration but general consensus is pre-requisite.

a) Definition and understanding of grade standards for each industrial sector.
b) Supplier / buyer lines of communication need defining and developing.
c) Harvesting procedural standards require defining.
d) A forest and market information system requires implementing to provide up to date and reliable data.

13.2 Government forests

In order to advance with new systems for the sale of trees or logs from government compartments, with the objective of maximising the yield and income from them, it is recommended that PFP take the lead in advising and assisting the TFS to run alternative trials of various options including, but not exclusive of, compartment auctioning, integrated harvesting and graded log sales.

13.3 Regulatory

Many stakeholders expressed concerns about the ability to have their voices heard. The development of effective lobbying for interested individual and groups of stakeholders can be improved by PFP with their assistance in the formation of open and interactive process for development of the regulatory environment. PFP should thus facilitate round table industry discussions, help in preparing correct and well thought out preparation of lobbying documents, and advice and support stakeholder groups and organisations in lobbying.

13.4 Grade standards

Grade standards need to pass through the TBS process. In the utility poles industry standards are in place. The standards are very close to standards in neighbouring countries (SA, Kenya, Uganda) and this eases the import-export of products. The buyers are also very conscious of the quality requirements and with only two major buyers in each East African country (the respective national electricity companies and rural electrification agencies) standards have been adopted widely and every market actor is familiar of the quality needed.

In sawmilling there are no standards in place at the moment. However PFP has the opportunity to guide and advise on the development of these grade standards and aid in the promotion and education of such standards.

13.5 Small sawmill permanent motivations

PFP is already working on the establishment of a commercially based sawmill and wood processing training centre. The centre should and will work for the promotion of improved technological sawmill and processing systems, and education and training on the planning, installation, operation and development of sawmill. Among other things, the centre should address the needs related to speeding of the development of the harvesting, manufacture, and marketing of eucalyptus.

Under its component three, and together with the Training Centre development, PFP should develop a showcase forest industry small-scale cluster programme to demonstrate the operation of a permanent saw mill installation and the utilisation of forest and wood processing waste. Additional factors to include;

- Heat and power generation from bio waste.
- Charcoal production
- Market products development (withies, building poles, tool handles)

13.6 Equipment supplier linkage

The lack of active representation of machinery manufacturers requires the promotion of Tanzanian forest industrial sector to potential wood processing machinery manufacturers and retailers. Generating motivation for the growth of domestic production of new, simple and improved sawmill technology will provide machinery producers with potential markets for their goods. The incentive of increased economic returns by improved quality and increased recovery is justification for investment, but investors need to see a wider variation of options in order to assess how their needs can be met. PFP can assist the Tanzanian Government with advice and suggestions as how this promotion can be achieved and along with workshops and conferences, help manufacturers and SME industries widen their knowledge base.

13.7 Information systems

The mapping and identification of forest stands planted and being planted in the Southern Highlands, in association with other forestry development organisations and commercial partners with an interest in Tanzanian forest industry development projects, will create additional motivation for all potential investors to consider new projects. Small sawmills in particular, have limited or no access to comprehensive information on the location of forests for future harvesting. They rely on word of mouth in the areas where they are working.

Forest and market system is under development in PFP. The development of a market system forum for the encouragement and/or the trading of round wood logs in the Southern Highlands will allow all stakeholders the option for longer term planning that in turn will aid in formulating business plans and obtaining financial credit and assistance.

13.8 Crosscutting objectives and safe working environment

Under the PFP crosscutting objectives can be best addressed by promoting and ensuring equal opportunities in forest value chain from gender and social perspective.

Women are less represented at all levels of the forest value chain, as forest owners, workers, and as entrepreneurs. PFP should in first place ensure in its communications that information on the PFP and on the opportunities the Programme can provide reaches women and equally, and highlight that opportunities are open for both men and women, not only in tree planting but also in other supported activities of PFP. PFP should take an active role in promoting training and employment of disadvantaged young people in forestry sector.

Introduction of safer working practices benefits those already working in the industries but often also means the work becomes physically less demanding allowing women also to work at all levels of production. However, in the absence of any safety standards in the country, or certification systems requiring proper work safety, PFP should take a promotional role for work safety. It could be considered if technologies to improve work safety could be subsidized under PFP, but at least awareness on their benefits and supply channels to buy the equipment must be introduced. The PFP supported Training Centre will have a central role in introducing safe work practices but also promotional material is needed to be shared widely among the industries. Safe work practices should cover also aspects of HIV and sexual harassment and abuse to ensure working environment is safe in this sense too.

PFP will address directly climate sustainability aspects. From processing perspective this means improving technologies, efficiency in raw material usage, and in waste utilization which will reduce the carbon foot print of the wood products.

Annex 12 Terms of Reference

Short term consultancy work to elucidate value chains of plantation wood from the Southern Highlands and Kilombero Valley

Background

Private Forestry Programme (PFP) increases rural income in nine districts in the southern highlands and Kilombero Valley of Tanzania. Plantation forestry, which encompasses major government plantations and a rapidly expanding network of poorly managed smallholder woodlots, is a major but inadequately understood contributor to the economy. The programme reduces poverty by developing science-based plantation forestry and adding value to the entire forest product value chain, from quality tree seeds to quality wood products sold to end-users. The programme supports participatory land use planning; organises tree growers into networked tree growers' associations (TGAs); develops the capacities of tree growers and wood processors; supports quality timber plantation establishment; strengthens plantation management; strengthens extension and business services; establishes an accessible forest information system and plantation market information system, and improves the performance of wood processing industries. Recognising the significance of its policy, legal, regulatory, and governance environment, the programme elucidates and analyses these issues, and where strictly necessary, it prepares evidence-based recommendations.

PFP, which is a sixteen-year programme, is currently approaching the halfway mark in the first of its four, four-year phases. The programme is well established in the southern highlands facilitating village land use planning, and supporting quality smallholder plantation establishment; both directly through its tree grower incentive scheme, and indirectly through supporting companies to expand their out-grower schemes. The programme is strengthening tree grower associations, and developing vocational courses in plantation forestry and wood processing.

In compliance with its approved annual work plan, PFP is now seeking specialist short-term consultancies to provide the foundations for its work to make the environment more enabling for plantation forestry, wood processing industries, and other actors along these value chains; and to strengthen related business enterprises. These consultancies will provide policy guidance and strategic guidance to the programme on how best to improve the overall value chains. The consultancy will provide well-researched, costed, actionable, and justified recommendations for consideration by a multi-stakeholder forum (consisting of both policy makers and private sector actors) that PFP will convene for this specific purpose.

Summary of the proposed consultancy work and outputs

PFP seeks to recruit short-term consultants to elucidate value chains; from local production of improved pine, eucalyptus and teak tree seeds; through both government and private tree plantation growers in the Southern Highlands and Kilombero Valley; and through haulage and wood processing industries; to finished wood products for sale to end users in Tanzania, and for export.

The study will survey and map small, medium and large industries using plantation grown wood from the Southern Highlands and Kilombero Valley. It will estimate employment created and the contribution to the national economy of these value chains

The study will identify the roles of all actors along the various value chains; estimate the scale of their operations; their cash flows, profitability and vulnerability to risks. Business barriers will be identified and clearly elucidated with comparisons to practices in other countries; and practical

recommendations will be prepared and justified. Opportunities for vertical integration along the value chains will be explored. Opportunities relating to standardisation of plantation grown timber and poles; and of wood products will be thoroughly explored, and implementable pragmatic recommendations will be prepared and justified. Prospects for superior technology transfer along the value chains, including for the use of small dimension round wood and wood waste will be evaluated. The scale and impact of timber imports and exports will be assessed.

Throughout their studies the consultants will seek opportunities to promote gender equality, reduce inequality, and foster climate sustainability. In addition, the consultants will observe working practices and make recommendations for improving worker safety.

The study will identify and prioritise areas where PFP can best engage; through policy, legislation, and regulatory lobbying; technology transfer; and business incubation to bring about improvements in the value chains.

The consultants will present their comprehensive reports and recommendations for verification by multi-stakeholder forums that will be convened by PFP for this purpose. To ensure political support the high-level participants including policy makers will be invited in the forum.

Specific requirements of the proposed consultant work

The consultants will agree on a final mission work plan with the PFP Team Leader within the first week. PFP will support the consultants to the maximum extent possible. The consultants will conduct some background research which is carefully planned and coordinated with the Private Forestry Financing Scheme Consultancy.

The team will prepare a report, have the report agreed with by the PFP and then present it to validation workshop(s). The consultants will prepare final report based on the recommendations of the validation workshop(s).

Shared background research with the private forestry financing scheme consultancy. (September 2015)

1. Take stock of planned, on-going and completed studies relating to forestry value chains (and forest financing); and other projects; private sector entities, groupings and associations, and Government agencies touching on the same that relate to the programme area.
2. Take stock of the legal, policy, regulatory, governance, and government incentive (and disincentive – including financing) environment of private sector businesses along the value chains.

Forest related value chains research and outputs (September - December 2015)

3. Identify, classify, survey, and map both registered and unregistered enterprises along the value chains. (This will be aided by PFP and FDT preparatory studies)
4. Interview purposefully selected private tree nursery owners, government and private sector tree growers, hauliers, consultants, agents, wood processors, pit sawyers, foreign and local timber exporters, international border trade control agencies, major end users and other key informants.
5. Estimate employment created and the contribution to the national economy of these value chains.
6. Discuss the roles of all actors along the various value chains; estimate the scale of their operations; their cash flows, profitability and vulnerability to risks.
7. Analyse business barriers along the value chains and based on experiences of other countries, prepare and justify recommendations for removing inappropriate barriers.
8. Identify opportunities to increase overall profitability through vertical integration so that growers produce timber and offer it for sale in a manner that reflects the demands of the most profitable markets.
9. Detail the practical arrangements that would be necessary, the costs and the benefits to be derived from introducing quality standards for standing teak pine and eucalyptus timber,

standing eucalyptus poles; and manufactured teak, pine, and eucalyptus products; and treated eucalyptus poles.

10. Accepting that most of the timber that will be coming onto the market in the short and medium term will be of inferior quality for structural load bearing purposes: recommend how engineers and architects may make best use of this timber in Tanzanian building construction.
11. Assess technologies used along the value chain, including for the use of small dimension round wood and wood waste and make justified recommendations for strategic interventions.
12. Quantify the scale and value of wood and timber imports and exports, and discuss the impact of this trade on Tanzanian producers.
13. Recommend how the programme may best promote gender equality, reduce inequality, and foster climate sustainability in its work.
14. Recommend how the programme may best promote safe working environments along the value chains.
15. Prioritise areas where PFP can best engage; through policy, legislation, and regulatory lobbying; technology transfer; and business incubation amongst others to bring about improvements in the value chains.
16. Prepare a consolidated report for approval by PFP and present it for validation at a multi-stakeholder forum, which will be convened by PFP for this purpose.
17. Prepare and submit a final report that takes account of the recommendations of the multi stakeholder forum validation workshop recommendations.

Time frame

The study is to be completed in 16 weeks and before the end of December 2015.

Proposed Consultant team

The study requires high-level international expertise (5 consultant months) and well-recognized senior-level Tanzanian expertise (1.5 consultant months):

The team proposed is as below:

Consultants	Consultant months		
	Shared background research	**Forest value chains**	**Totals**
International consultants			
Lead consultant and senior forest value chain expert	0.5	1.5	2
wood science and wood processing expert	1.0	2.0	3.0
Total international consultant	**1.5**	**3.5**	**5**
Forestry and forest industries expert	1.0	1.5	1.5

Annex 13 Questionnaire for data collection

PFP **VALUE CHAIN ASSESSMENT QUESTIONAIRE**

Date:								
Region:	Mufindi		Njombe north		Njombe south		Makambako	
Type of business	Sawmill		Trader		Poles		Veneer	
Name of organisation:								
Location (village name or other):								
Name of person:								
Contact details:								
Interviewer:								

Industry details:

Type of machinery	Ding Dong		Mobile bandsaw		Stationary		Other	x
Detail								
Recovery	% of log total			Est if not known				
Product purchased	Teak logs		Euc saw logs		Euc poles		Euc poles (build)	
Annual volumes processed		m3		m3		m3		m3
Source of purchase	Mufundi		Njombe north		Njombe south		Makambako	
Type of supplier	Government		Private		TGA		Other	
Detail other								
Transport cost (Forest to sawmill)		TZS per m3			TZS per km			
Logs price at the forest gate		TZS per m3						
NOTES								

Trader details

Product purchased	Pine timber		Euc timber		Euc poles		Building poles	
Type of supplier	Bush sawmill		Village		TGA		Other	
Detail other								
Annual volumes purchased		m3		m3		m3		m3
Price purchased at source (TZS per m3)		TZS		TZS		TZS		TZS
Price purchased delivered (TZS per m3)		TZS		TZS		TZS		TZS

Sales destination			% of volume	
	Arusha			
	Dar			
	Dodoma			
	Mbeya			
	Mwanza			
	Sangida			
	Tanga			
	Zanzibar			
	Local			
	Other			

Annex 14 List of interviewees

Interviews among the value chain actors

Value Chain Actor	Number of interviews
Dingdong saws	86
Tech saws	47
Industry visits	5
Sawmill/traders	35
Traders	16
Merchants	44
Poles producers	3
TGAs and private growers	71
External industry visits (Tea factories and power generators)	4

Organisation	Location	Interviewee
A.Abdallah	Nyololo	Abdallah Maganga
Abel Mbilinyi	Igosi	Abel Mbilinyi
Adrian Mlowe	Matola	Adrian Mlowe
Afread Mtokoma	Itulike	Afread Mtokoma
Alberto Mtega	Uwemba	Alberto Mtega
Ali Mayemba	Njombe	Ali Mayemba
Ally Mziray Workshop	Kingo, Morogoro Municipality	S. Jeremia
Aloyce J. Gadau	Moronga	Aloyce J. Gadau
Altin Sanga	Tandala	Altin Sanga
Ambrose Mwakatobe	Ighbichi, Lupoto	Ambrose Mwakatobe
Angola	Madobole	Angola
Anna Mwaipopo	Kitasegwa	Anna Mwaipopo
Anton Misanga	Mnakavuta	Anton Misanga
Apolo Mahenge	Mwitikilwa	Apolo mAHENGE
Ashery Ngomano	Kinyanambo mafinga	Ashery Ngomano
Association of Citizen Contractors/ Aquifer Construction Co	Dar es salaam	Eng. M. Nyerere
Atanasi Furniture	Morogoro	A. Aidine
August Ngoni	Ihangana, Lupembe	August Ngoni
Baraka Nyambo	Matamba, (Mpangala)	Baraka Nyambo
Barnaba Mwenuka	Uwemba	Barnaba Mwenuka
Ben Mgoko	Ifwagi	Ben Mgolo
bertha R.Mkongwa Company Ltd	Kitasegwa Mgololo	Bertha R.Mkongwa
Blastus Mgimwa Workshop	Mafinga	J. Kisake
Bon chumo	Mafinga Mjini	Bon Chumo
Bonaventura Mlelwa	Luponde	Bonaventura Mlelwa
Bristo Meiata	Matola	Bristo Meiata
British Tanzania Ltd	Kinyanambo mafinga	British Tanzania Ltd
Brown Twewe	Makambako	Brown Twewe
Cannius Mwalongo	Mfarasi	Cannius Mwalongo

Catherine Msovela	Kibao Mfindi	Catherjine Msovela
CF Ng'umbi Investment	Mafinga	C. Ng'umbi
Chakwe General ltd	Mafinga	Chakwe
Chakwe General ltd	mafinaga	Chakwe
Charles Mligo	Mapogoro	Charles Mligo
Christson Tinabo Ltd	Kinyanambo C Mafinga	Christson Tinabo
Construction Company	Dar es salaam	Eng. E. Ibrahim
Construction Company	Dar es salaam	Eng. A. Baraka
Costa Mahanga	Ifwagi	Costa Mahanga
Damas Ngumba	Mapanda	Damas Ngumba
Dan Mlingiliche	Katasegwa-Mgololo	Dan Mligiliche
David Mwada	KK-Village, Mbeya	David Mwada
Denis Mwanri	Lugoda Mlima Unilever	Denis Mwanri
Dickson Mpogole	Matembwe	Dickson Mpogole
Dora Mahenge	Mafinga Mjini	Dora Mahenge
Eda Nyalifa	Mtili Mafinga	Eda Nyalifa
Edith J Mbua	Mafinga	Edith J Mbua
Elia Mbwilo	Kipengere	Elia Mbwilo
Elias Heri Mahelane	Kitasegwa	Elias Heri Mahilane
Elion Swalo	Mangoto	Elion Swalo
Emmanuel Investment Ltd	Kinyanambo C Mafinga	Emmanuel
Emmanuel Mgimba	Makambako	Emmanuel Mgimba
Enock Ngoko	Ifwagi	Enock Ngoko
Erasto Goppa Bias	Nyololo	Erasto Goppa Bias
Erasto Msigwa	Uwemba	Erasto Msigwa
Erasto Pondamali	Moronga	Erasto Pondamali
Erick Deo	Mafinga Mjini	Erick Deo
Ester Sanga Company Ltd	Kitasegwa Mgololo	Ester Kisanga
Evaristo Robart Nyambo	Mpangala	Evaristo Robart Nyambo
Ezekieli Sanita	Mago, Lupalilo	Ezekieli Sanita
Farida M.Haule Company Ltd	Sawala Mufindi	Farida Mhaule
Faustin Martin Paulo	Vikula	Faustin Martin Paulo
Filemon Mwalongto	Matola	Filemon Mwalongto
Frank Mhapa		Frank Mhapa
fred Njau	Lugoda Mlima Unilever	Fred Njau
Fredrick Mabena	Matembwe	Fredrick Mabena
Fredy Mbata		Fredy Mbata
Furniture vendor	Kinondoni-Ndugumbi, DSM	B. Mtupa
Furniture vendor	Kinondoni-Ndugumbi, DSM	M. Mtale
Furniture vendor	Kinondoni-Ndugumbi, DSM	M. Toboa
Furniture vendor	Kinondoni-Mkwajuni, DSM	M. Abdallah
Furniture vendor	Manzese-DSM	J. Hassan
Furniture vendor	Manzese-DSM	L. Renatus
Furniture vendor	Manzese-DSM	T. Said
Furniture vendor	Kinondoni- Morocco, DSM	S. Ally
Furniture vendor	Kinondoni- Morocco, DSM	M. Francis
Furniture vendor	Kinondoni- Morocco, DSM	A. Mwakipesile

Furniture vendor	Kinondoni- Morocco, DSM	B. Anthony
Furniture vendor	Kinondoni Biafra, DSM	F. Ukwate
G.W Sigara	Changalawa Mafinga	Sigala
GENCOM Tanzania Ltd	Dar es salaam	Eng M. Suru
God Ngwale	Mafinga Mjini	God Nkwale
Godlove workshop	Sabasaba, Morogoro Municipality	A. Lukas
Godson Msisi	Mafinga Mjini	Godson Msisi
Haji Makombe	Mwitikilwa	Haji Makombe
Halid enterprises	Kinyanambo C	Halid Imam Sheketo
HEDASCO workshop	Morogoro	P. Mmehwa
Henry Kikwete	Lugoda Mlimani Unilever	Henry kikwete
Heri Ruvanda sawmill	Mafinga	S. Sanga
Ibrahim Nziku	Igima	Ibrahim Nziku
Igoma Women Group	mafinga	Igoma Women Group
Igowole	Mafinga	Robert N.Swallo
Ihembe Timber Products and Poles Ltd	Kinanyambo A	Henry Lukambinga
Imani Mgaya	Kipengere	Imani Mgaya
Ipolito Chapile	Yakobi	Ipolito Chapile
Isaack Kamuzola	Vikula	Isaack Kamuzola
Jailo Elenesto Mbilinyi	Mangoto	Jailo Elenesto Mbilinyi
Jano Mwangota	Mtonga	Jano Mwangota
Johern Trading Ltd	Kinyanambo mafinga	John Nkwambo
John Jackson	Mlevela	John Jackson
Jonas Mawenge	Igawilo, Mbeya town	Jonas Mawenge
Josephy L.Kihweze	Mwitikuwa	Josephy Kihwele
Joyce Mtida	Mafinga	Joyce M Tida
JR Workshop	Morogoro	M. Alli
Juma S Sanga	Vikula	Juma S.Sanga
Justice Julius	Katasegwa-Mgololo	Justice Julius
Kagashani Incorporation	Kinyanambo C	Kagashan
Kanisuus Mwageni	Iwungilo	Kanisuus Mwageni
Kanywani workshop	Mafinga	C. Nzuyu
Kasca	Mafinga Kinyanambo	
Kassim Kashenge	Changarawe	Kassim Kasenge
Kelvin Mtwewe	Lugarawa	Kelvin Mtwewe
Kihansi secondary school	Mwitikilwa	Apolo Mahenge
Kiluwa Ltd	Kinyanambo C	Shaaban Twalib Kiluwa
Komas sawmill Ltd	Sao hill	Audax Mshumbuzi
KVTC	Ifakara	Hans Lemm
Kwa Ale	Fire, Morogoro Municipality	C. Jummanne
Leo Msanga	Mkiu	Leo Msanga
Lesheya investment Ltd	Nyololo	Emily L.Woiso
Linus Sanga	Bulongwa, Kipagalo	Linus Sanga
Lukas Ilomo	Matamba	Lukas Ilomo
Mafinga investmemt	Mafinga	Josephy kIhweze

Mahenge Tunyile Company Ltd	Kitasegwa Mgololo	Mahenge Tunyile
Maka Workshop	Mafinga	M. Luwumba
Makambako Timber Traders Cooperative Society	Makambako, Njombe	J. Kilagwa
Malaki Kilaga	Yakobi	Malaki Kilaga
Malaki Kilaga	Yakobi	Malaki Kilaga
Malicelina Mosha	Katasegwa-Mgololo	Malicena Mosha
Mama Agnes Msigwa	Makambako	Mama Agnes Msigwa
Manhatan investment Ltd	Kinyanambo C	William mgowole
Mara Ngulo company ltd	Kitasegwa	Mara Nguro
Mariam Mbaruku	Katasegwa-Mgololo	Mariam Mbaruku
Marko Ignas Mwalongo	Luponde	Marko Ignas Mwalongo
Marko Malekela	Iwafi	Marko Malekela
Maseta Katumba	Lupoto, Tukuy, Mbeya	Maseta Katumba
Matekeleza Company Ltd	Kinyanambo C	Matekelezo M.Chang'a
Mbaruku	Mwitikilwa	Mbaruku
Mbasa Sanga	Kinyanambo mafinga	Mbasa Sanga
Mbwilo Workshop	Mafinga	A. Mnyavanu
Mduma Furniture	Kingo, Morogoro Municipality	B. Mduma
Mena Wood Company Ltd	Changalame	Anyekwisye Nason Mahenge
Method Mahenge	illasa	Method Mahenge
Method Mgata	Mbalache	Method Mgata
Mgaya Furniture	Mafinga	R. Mtega
Michael George Mngongu	Yakobi	Michael George Mngongu
Micheal Kiliwa	Mafinga Mjini	Micheal Kiliwa
Migodela workshop	Mafinga	P. Sanga
Ministry of Trade and Industries	Dar es salaam	O. Majengo
Mkongo sawmill	Mafinga	D. Mkongo
Mngazija Sawmill	Mafinga	Mngazija
Mninga Group	Manzese-DSM	M. Haji
Mufindi District Council	Mafinga	S. Adha
Mufindi District Council	Mafinga	T.Ubisimbali
Mufindi Investment	Katasegwa-Mgololo	Benadetha Mwapinga
Mufindi Paper Mills Ltd	Mufindi, Iringa	B. Kigodi
Mufinga wood poles & timber ltd	Mafinga	Mufinga wood poles & timber ltd
Mussa Kaduma	Yakobi	Mussa Kaduma
Mwanaidi Mussa Mbulla	Mtili Mafinga	Mwanaidi Mussa Mbulla
Myinga Workshop	Mafinga	G. Madati
Mzee Emmanuel Akyoo Co	Mafinga	P. Lyimo
Mzee Said Swamill	Vikula	Donald Ndaro
N & M Business	Kinyanambo mafinga	N & M Business
Nasibu Wood Furniture	Mafinga	O. Lubugo
Necto M.Chang'a	Kinyanambo C Ifingo	Necto M.Chang'a
Nelly & Eda Sawmill Ltd	Kinyanambo mafinga	Nelly & Eda

Nemes Workshop	Sabasaba, Morogoro	N. Lasway
New Forests Company Ltd	Iringa	Chis Pinaer
Ngosipe Mgona	Nundwe	Ngosipe Mgona
Nguvu Zetu Furniture	Mafinga	P. Mkini
Nisa Mlowe	Kinyanambo C Mafinga	Nisa Mlowe
Njombe Township Council	Njombe	G.Mwamakunge
Njoro Nike Mremi	Kinyanambo C Mafinga	Njoro Nike Mremi
Nobert Mwanginyi	Mlanetali	Nobert Mwanginyi
Nulasco Mtaga	Lufumbu	Nulasco Mtaga
Nyetha Timber & Construction Ltd	Mafinga	J. Kihwele
Omary Kitokesha	Mafinga Mjini	omary kitokesha
Oscar Kaduma	Katasegwa-Mgololo	Oscar Kaduma
Osmund Mnyili	Kidegembye	Osmund Mnyili
Panoe Timber Ltd	Vikula	Mama Natasha
Parker Sawmill	Mafinga	Kasenge
Paul Yona Investment	Mafinga	Y. Mwakanjuki
Peter Zambwe	Kawetire forest, Mbeya	Peter Zambwe
Pilly Abdallah Mashombo	Mafinga	P. Mashombo
Plasto Mwalongo	Uwemba	Plasto Mwalongo
Prime Minister's Office	Dodoma	B. Luanda
Prime Minister's Office	Dodoma	C. Nkemwa
Rashid Sawmill	Mafinga	R. Mnyentelwa
Rehema Kiswaga	Katasegwa-Mgololo	Rehema Kiswaga
Renatus R. Ndelwa	Matola	Renatus R. Ndelwa
Romanus Mgaya	Moronga	Romanus Mgaya
Rural Electrification Authority	Dar es salaam	Eng B. Msofe
Sadick Mbilinyi	Igosi	Sadick Mbilinyi
SAFIA/Manhtannan Investment Co	Mafinga, Iringa	W. Mgowole
Said Kipako	Vikula	Saad Kipako
Said saw Mill	Kinyanambo C Mafinga	Said
Salome Kalinga	Kinyanambo C Mafinga	Salome Kalinga
Samuel Mwinuka	Mlangali	Samuel Mwinuka
Sao Hill Industries Ltd	Sao Hill	Published data
Sheda Genaral supplies Ltd	Mafinga, Iringa	G. Chalamila
Siri Nyambo	Mpangala (Matamba)	Siri Nyambo
Sisto Mpogole	Lupembe	Sisto Mpogole
SJM Furniture	Mafinga	S. Luoga
Tabora Msitu Product Company Ltd	Vikula	Rashid
Tanganyika Wattle Co	Njombe	A. Kiwale
Tankanyika Plywood Ltd	Mafinga	Amar Shanghavi
Tanscan Timber	Kinyanambo C Mafinga	Tanscan
TANWAT	Njombe	H. Kamungu
Tanzania Bureau of Standards	Dar es salaam	Eng. J. Maganga
Tanzania Bureau of Standards	Dar es salaam	A. Mneney
Tanzania Electric Supply Co	Dar es salaam	Eng. M. Mabulla
Tanzania Forest Industries Federation	Dar es salaam	Ben Sulus

Tanzania Forest Service Agency	Dar es salaam	J. Mgoo
Tanzania Forest Service Agency	Dar es salaam	M. Kihongo
Tanzania Forest Service Agency	Dar es salaam	M. Mrutu
Tanzania Forest Service Agency	Dar es salaam	E. Mlowe
Tanzania Forestry Research Institute	Mafinga	S.Mpili
Tanzania Revenue Authority	Dar es salaam	J. Mbunda
Tanzania Wood working Federation	Dar es salaam	S. Kushaba
Thecla Pilla	Jeshin Luganga	Thecla Pilla
Thobias Mgaya	Mlevela (Mdandu)	Thobias Mgaya
Tosiaha Msigwa	Kinenulo	Tosiaha Msigwa
Tree Growers Association	Mafinga	Y. Kikukwe
Tupa Furniture	Morogoro	R. Tupa
Umoja wa Mafundi Seremala- Fire	Morogoro	J. Kibaya
Umoja wa Mafundi Seremala,	Njombe	W. Kaduma
Umoja wa Wafanyabiashara ya Mkaa	Njombe	A. Mbwilo
Unilever Tea Tanzania	Lugoda	Nicholaos Yiannakis
Uwamba Group	Mwitikilwa	Josephat Kingiliwe
Uyole Investment	Kinyanambo C Mafinga	
Vajihee Hardware	Kiwanja cha Ndege, Morogoro	M. Kadaya
Valentin Mbuna	Matembwe	Valentin Mbuna
Wambi timber and tree plantation company Ltd	Kinyambo C	George Ngunyaki
White Rose Investment	Mafinga	J. Mutiganzi
William G.Nyalusi	mafinga	William G Nyalusi
Yona Mwakanjuki	Kinyanambo mafinga	Yona Mwakanjuni
Zabuki Kimiliki	Imalinyi	Zabuki Kimiliki
Zahara Budi Msigara	Mninga Mufindi Kusini (Southern Mufindi)	Zahara Budi Msigara
Zakayo Myale	Katasegwa-Mgololo	Zakayo Myale
Zakayo Sanga	Kitasegwa	Zakayo Sanga
Zawadi Kilingo	Mafinga	Zawadi Kilingo
Zawan Mlowe	Madilu	Zawan Mlowe
Zebedaya Mabena	Matembwe	Zebedaya Mabena
Zededk Mhema	Matola	Zededk Mhema
Zulu Ngingo	Kifanya	Zulu Ngingo

Annex 15 MNRT/TFS Registration fees and royalties

The annex includes relevant parts of the Regulation Part II (pages 12-20)

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THE FOREST ACT,

(CAP 323)

REGULATIONS

(Made under section 106)

THE FOREST (AMENDMENT) REGULATIONS, 2015

Citation G.N. No 153 of 2004

1. These regulations may be cited as Forest (amendment) Regulations, 2015 and shall be read as one with the Forest Regulation, 2004 hereinafter referred to as the "principal Regulations".

Amendment of the Schedules

2.-(1) The Eighth and Fourteenth Schedules to the principal Regulations are hereby revoked and substituted for them Schedules specified in these Regulations.

GN. No. 324 (contd.)

ITEM I : All softwood plantation species except *Juniperus procera*	
Diameter Class at DBH in cm.	Fees/m3 (Softwood plantation)
<5 cm	To be sold as firewood
6-10 cm	To be sold as poles per piece
11-20 cm	5,700
21-25 cm	11,300
26-30 cm	28,300
31-35 cm	48,900
>35 cm	54,200
ITEM 2: Pulp wood	
Fees for pulpwood trees shall be charged per cubic metre and shall not be used for any other purpose thereof. When used for other purpose other than pulp production shall be charged as in part B Item I above	14,300
ITEM 3: Poles from Softwood Plantation Forest Species	
6 cm but not more than 10 cm diameter at butt end (each)	300
ITEM 4. ***Juniperus procera***	
Juniperus procera (all sizes) per cubic metre	73,600
ITEM 5. All Hardwood plantation species except *Teak, Eucalyptus and Olea spp.* (Fees/m3)	
Diameter Class at Breast Height in cm.(*Cederella, Grevillea, Acacia, Acrocarpus and Maesopsis, Terminalia, Cassuarina and Gmmelina*).	
< 5 cm	To be sold as firewood
6 - 10 cm	To be sold as poles per piece
11 - 20 cm	5,900
21-30 cm	11,800
31-35 cm	22,100
>35 cm	29,500
Fees/m^3 for Teak	
< 5 cm	To be sold as firewood

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GN. No. 324 (contd.)

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First thinning (To be sold as poles per piece)		1,200
Second thinning (To be sold as poles per piece)		1,500
"All other sizes shall be sold according to prevailing market prices per cubic meter of teak.		
ITEM 6: Olea plantation species (Fees/m3)		
<10 cm		To be sold as firewood
10 - 20 cm		25,000
21-30 cm		35,000
31-35 cm		55,000
>35 cm		60,000
ITEM 7.Eucalyptus species (for E. saligina & E. grandis)		
Diam. Class at DBH in cm		Fees/m^3
<10 cm		To be sold as firewood
11-20 cm		5,520
21-30 cm		13,800
>30 cm		24,400
Fees/M3 for Eucalyptus all other species		
<10 cm		To be sold as firewood
11-20 cm		To be sold as poles per piece
21-30 cm		5,520
>30 cm		13,800
Fees for Eucalyptus pulpwood shall be charged per cubic meter and shall not be used for any other purpose thereof. When used for other purpose other than pulp production shall be charged as in part B Item 7 above.		12,000
ITEM 8. Poles from hardwood plantations		
	(i) For poles less than 10 cm DBH over-bark fees shall be per running metre.	1,100
	(ii) All Eucalyptus species classified as poles, fee shall be per running metre.	740

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ITEM 9.Firewood from plantations		
	(i) Quantity license for hardwood plantation species per stacked cubic meter	2,950
	(ii) Quantity license for softwood plantation species per stacked cubic metre	1,500

C. Other fees payable on services related to forest products

ITEM 1.Licence to establish and operate other businesses in forest reserves and plantations per year		
	(i) Installation of telecommunication facilities, mineral water extraction facilities, per 15M x 15M	4,416,000
	(ii) Forest reserve management fee (i) above shall be per year.	4,025,000
	(iii) Where the telecommunication facility is shared by more than one service provider, 50% of the fees in part (ii) above shall be charged for each additional service provider.	50%
	(iv) Pre-fabricated houses, hydropower and large scale irrigation scheme (establishment fee per Ha.)	4,416,000
	(v)Forest reserve management fee part (iv) above shall be per year per Ha.	588,800
	(vi) Piers and landings in forest reserves shall be per year per Ha or part of.	736,000
	(vii) To make solar salt pans and prawn farming in the mangrove forest reserves per year.	320,000

GN. No. 324 (contd.)

	(viii)To operate solar salt pan of 2.5ha or less and fish farming in the mangrove forest reserve per year.	130,000
	(ix) To install billboards in forest reserve (establishment fee)	588,800
	(x) Forest reserve management fee for part (ix) above per year per billboard.	147,200
	(xi) Air strips in forest reserve (establishment fee per Ha or part of.)	4,416,000
	(xii) Forest reserve management fee for part (xi) above per year per Ha or part of.	1,472,000
	(xiii) Prospecting/ Exploration fees in a forest reserve per year per 100ha or part of.	736,000
	(xiv) Installation fee for water tank in a forest reserve per ha or part of	500,000
	(xv) Forest reserve management fee for part (xiv) above shall be per year	250,000
	(xvi) Mining fees (forest management fees) in a forest reserve (per year per Ha or part of).	1,472,000
	(xviii)Establishment fee of mineral extraction plant per ha or part thereof	11,500,000
	(xvii) Forest reserve management fee (xviii) above shall be per year	5,750,000
	(xix) Consulting fee (per person per day).	44,200
	(xx) Rest house fees (per head per night for non-residents – in USD).	30
	(xxi) Rest house fees (per head per night for residents – in Tshs.)	25,000
	(xxii) Conference facilities (per day per meeting)	80,000

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GN. No. 324 (contd.)

	(xxiii) Seed collection fees in forest reserves (per kilogram)	30,000
	(xxiv) Fees for Reserved trees on private farms should be 25% of respective forest royalty	20%
	(xxv) Office accommodation fees (per square metre per month or its equivalent in shillings).	59,500
	(xxviii)Fish processing in the forest reserve per ha or part of	425,000
	(xxix)To operate mobile sawmill in difficult terrain in the Forest reserve (with special permit from Chief Executive)	500,000
	(xxx) To undertake any other Commercial business in a forest reserve (not stated in schedule 8) per year per square metre.	73,600
	Application Form for Harvesting trees in plantations and Natural forest:	
	(xxxi) Companies with or without contracts with the Government	200,000
	(xxxii)Medium harvesters (with sawmills having breakdown, edger and resaw or with efficient technology	150,000
	(xxxiii) Small scale harvesters	57,500
ITEM 2: Transit pass application fees:		
	i) For a 7 ton vehicle or below	7,500
	ii) Above 7 ton	15,000

GN. No. 324 (contd.)

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ITEM 3: Grading and export certificates fees		
I. Grading / Inspection fees		
	(a) For commercial consignments	
	Consignment whose value exceeds USD 300.00 will be considered as commercial consignment.	
	(i) Grading fee for commercial consignments such as timber and other forest products for export shall be for a consignment not exceeding 20 m^3.	150,000
	(ii) Fees for inspection of carvings/handcrafts, tanning, gum, Jatropha oil, sandal wood products and other forest products for export shall be for a consignment not exceeding 20 tons.	150,000
	(b) For Non commercial consignments	
	Consignment whose value is less or equal to USD 300.00 will be considered as non commercial consignment.	
	(i) Grading fees for timber and other forest products for export as gift, personal effects and sample (per consignment).	44,200
	(ii) Fee for Inspection of carvings/handcrafts, tannin, gum, Jatropha oil, sandal wood products and other forest product for export (per consignment).	34,500
II. Export Certificate Fees		

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GN. No. 324 (contd.)

	(i) Export certificate fee for commercial consignment	147,200
	(ii) Export certificate fee for non-commercial consignments (per consignment)	44,200
III. Importation charges		
	(i) For Commercial Consignment	
	Inspection/ handling Fee for commercial consignment of $20m^3$	115,000
	(ii) For Noncommercial consignments	
	Inspection/ handling Fee for non-commercial consignments whose value is less than USD 300 (per consignment)	44,200
ITEM 4: Fees for registration of forest produce dealers and Traders for each site per year		
(a)	Trees	270,000
(b)	Timber (For Pit sawyers in productive natural forest)	256,000
(c)	Timber yard	256,000
(d)	Logs	256,000
(e)	Poles	256,000
(f)	Withies	64,000
(g)	Sawmill (capacity of up to 5,000 m3 per year)	512,000
(h)	Sawmill (capacity of up to 5,001 -10,000)m3 per year)	1,000,000
(i)	Chipboard mill	1,000,000
(j)	Hardboard mill	1,000,000
(k)	Plywood mill	1,000,000
(l)	Pulp and paper – mill	2,000,000
(m)	Match Box Factory	1,000,000
(n)	Impregnation Plant	512,000
(o)	Small Curio shops (forestry products)	256,000
(p)	Micro Curio shops (forestry products)	100,000

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GN. No. 324 (contd.)

(q)	Exporters of Forest Products	512,000
(r)	Importers of forest products	512,000
(s)	Charcoal	256,000
(t)	Firewood	256,000
(u)	Furniture mart (Small)	256,000
(v)	Furniture mart (micro)	100,000
(w)	Wood works factory (Small)	384,000
(x)	Woodworks factory (micro)	150,000
(y)	Carpentry per bench	50,000
(z)	Other Forest Products / Produce Dealers	130,000
Micro enterprise is the business with less than 5 employees and operates with a turnover of less than TZS 5,000,000. Small enterprise is the business with staff between 5 to 49 and operating with a turnover between TZS 5,000,000 to TZS 200,000,000		
ITEM 5: Forest road services fees (Vehicles not covered under item 6)		
	Capacity of Vehicle	**Fee Rate Per Entry**
(a)	Less than 1 ton	1,450
(b)	1 - 3 tons	2,200
(c)	3 - 5 tons	3,000
(d)	5 - 10 tons	5,900
	>10 tons	7,400
ITEM 6: LMDA (Logging Miscellaneous Deposit Account) charges in plantation forests. The fees are charged to cater silvicultural activities and road maintenance in Forest Plantations.		
(a)	Silviculture fee per m^3 of Teak logs	5% of the sale value
(b)	Road fee per m^3 of Teak logs	5% of the sale value
(c)	Silviculture fee per m^3 of softwood logs	8,750
(d)	Road fee per m^3 of softwood logs	8,750

GN. No. 324 (contd.)

(e)	Silviculture fee per m^3 of Eucalyptus logs	17,500
(f)	Road fee per m3 of Eucalyptus and other hardwood	17,500

Dar es Salaam ,
....., 2015

LAZARO S. NYALANDU
Minister for Natural Resources and Tourism

Annex 16 Criteria for wood processing enterprises registration

Provisions for processing harvesting forest products from plantations (TFS publication)

5.1 Only those factories and equipment that provide good-quality processing with a minimum of forty percent (40%) design recovery will be allowed. Sawmill factories must have the following features:

i) Three production areas: breakdown, re-saw, and edger

ii) Three kinds of experts: a craftsman sawer (a "saw doctor"), a trained mechanical processing operator for the production of timber, and a mechanical maintenance technician or manager

c) All the industries are to conduct their saw milling operations outside of the forest reserve area.

Original text:

Utaratibu wa kuvuna mazao ya misitu katika mashamba ya miti na masharti ya kufanya…

5.1 mashine / viwanda vitakavyo ruhusiwa ni vile vyenye ubora katika uzalishaji wa mbao kuanzia asilimia arobaini (40%). Mashine viwanda hivyo viwe na sifa zifuatazo.

a) Sehemu tatu ambazo ni "breakdown, resaw na edger"

b) Wataalam wa aina tatu ambao ni fundi misumeno (Saw doctor), fundi mwendesha masgine ya kupasa mbao (Trained operator) na fundi wa matengenezo ya mitambo (Maintenance Technician/manager)

c) Viwanda vyote vitasimikwa nje ya msitu hifadhi

Annex 17 Summary of SHFP inventory

Grade survey of logs from pine stands in compartment numbers 1/7 and 5/20 in Division 2 of the SHFP

Diameter (cm) and description	% of total	Pieces (no.)	m^3	Category
<9	0.08%	275	10	Pulp
9.0 - 10.5	0.32%	900	40.1	Pulp
10.5 - 12.5	1.15%	3,179	146	Pulp
12.5 - 14.5	3.05%	4,736	386	Pulp
14.5 - 15.5	2.9%	2,667	264	Small-diameter saw log
15.5 - 17.0	3.77%	4,093	477	Small-diameter saw log
17.0 - 18.0	2.84%	2,656	360	Small-diameter saw log
18.0 - 19.0	3.12%	2,639	395	Small-diameter saw log
19.0 - 20.0	3.20%	2,435	405	Small-diameter saw log
20.0 - 21.5	5.26%	3,524	666	Saw log
21.5 - 22.5	3.67%	2,195	465	Saw log
22.5 - 23.5	3.85%	2,091	487	Saw log
23.5 - 24.5	3.05%	1,545	386	Saw log
24.5 - 26.0	3.77%	1,768	477	Saw log
26.1 - 29.0	12.71%	4,884	1,608	Saw log
29.1 - 32.0	10.70%	3,446	1,354	Saw log
32.0 - 35.0	7.25%	1,974	918	Saw log
35.0 - 60.0	9.34%	1,896	1,182	Saw log
Reject, 9 - 26	0.32%	178	41	Pulp
Reject, 9 - 26, branch	0.84%	523	106	Pulp
Reject, 23.5 - 26.0	1.38%	678	175	Pulp
Reject, 23.5 - 26 & OD > 33	0.65%	288	82	Pulp
Reject, > 26	0.76%	280	96	Pulp
Reject, 9-23, too much sweep	16.71%	15,537	2,115	Pulp
Reject, 15 - 26 shorts	0.12%	154	15	Pulp
Total		64 541	12 656.1	

Annex 18 Sawmilling technologies in use

Sawmill technology types

1. Pit and chain sawing

Pit and chain sawing are practiced by fewer than 3% of the sawmill operations which operate in private plantation forestry areas and by none of the sawmill operations in government forest areas. This technology is not efficient and it has a poor production capacity. Sawing is poor-quality and size variations are large.

Figure 13.1 Pit and chain sawing

2. Finnish-sponsored Scandinavian technology, Kara and Laimet saws

The Kara saw is a semi-portable machine with a circular saw. Logs are loaded onto a log carriage, which is passed over the saw either manually or with a hydraulic chain drive. The large-diameter circular saw blades are thick, so the width of a saw cut, the kerf, is as much as 6 mm, a fact which decreases recovery efficiency. Capital expenditure for new units is high. Although reconditioned units are sold in Scandinavia at considerably lower prices, no machinery dealers in Tanzania sell such reconditioned saws.

Figure 13.2 Kara saw

Photo: Courtesy of Janne Löytömäki, Indufor

Twenty percent of sawmills operating in government forest areas use Kara type saws but only one sawmill in private forest areas did. The design recovery potential of Kara saws is over 40%, but poor maintenance and operating techniques have reduced this potential in Tanzania. Sawing quality is average if a saw is operated correctly. Size variations are large due to deficiencies in operating techniques and machinery.

3. Dingdong saws

Dingdong saws imported from China were first introduced as a cheap, mobile option. The dingdong is a simple table-frame circular saw onto which logs are manually lifted and pushed through. There are few or no guide rails to regulate size but operations and maintenance are very simple. A dingdong saw can be relocated quickly and can be run by a petrol or diesel engine if it is being moved about to off-grid locations or by an electric motor if it is installed permanently.

Figure 13.3 Operating a dingdong saw

About two-thirds of sawmill operations in government forest areas and 95% of sawmill operations in private forest areas dingdong saws are carried out by these. Sawing quality is not good and size tolerance and precision are very poor.

Tanzanian-made dingdong saws are cheap copies of the Chinese versions. They operate in the same way, but since they are badly constructed from low-grade materials, the quality of the timber they produce is poor. The large-diameter circular saw blades are thick and kerfs are as much as 6 mm, a fact making them at least 20% less inefficient than blades with a small kerf.

The cost of purchasing a new unit has fallen steadily, to as little as TZS 3 million to TZS 4 million per unit, as more companies and craftsmen offer locally manufactured units. No figures comparing imported and locally made machinery are available.

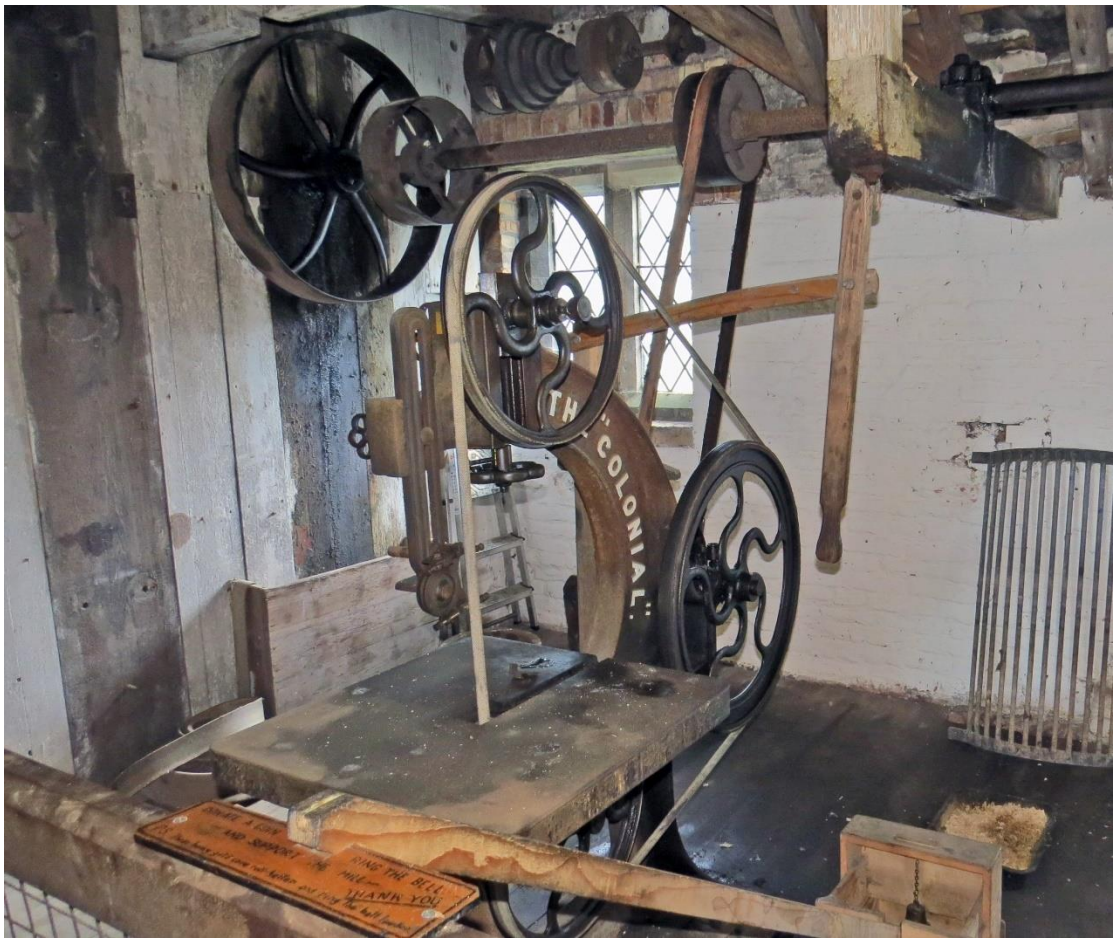
Figure 13.4 Layout of a dingdong saw: table, blade, engine, and drive belt

Figure 13.5 Poor-quality eucalyptus lumber with twists and cracks

4. Chinese vertical band saws

Chinese vertical band saws are permanently fixed saws only recently introduced to the southern highlands. They work by passing a log, mounted and held on a travelling carriage, through a vertically mounted band saw. Installing one correctly requires substantial concrete foundations and a high level of technical knowledge. Their operation is not easy and speed of production is highly dependent on operator skill. Since their kerfs are small, between 1.2 mm and 1.3 mm, recovery is very efficient recovery and little sawdust is produced.

Figure 13.6 Vertical band saw



Capital expenditure on a vertical band saw is medium although infrastructure and installation costs are above average. The saw has to be mounted on a large secure concrete foundation set at least 120 cm below the floor level to accommodate the low-circulating blade wheel. Correct installation is essential as incorrectly mounted machines do not cut effectively and result in poor rates of recovery, sawing quality, and size tolerance.

About 5% of the sawmills which use wood from government forest areas are vertical band saws but such saws are not found in areas where there is no government wood supply. They produce high-quality cutting if they are set up correctly, as well as good size tolerance and size stability. They can handle large logs effectively but not small-diameter logs or eucalyptus.

5. Horizontal band saws

Horizontal band saws, both the Chinese- and the Indian-made models, are fixed saws. To use them, logs are placed on a log carriage and passed through horizontally mounted band saws. The technology is simple and robust and easy to operate. Installing horizontal band saws is much simpler than installing vertically mounted band saws and the saws themselves are cheaper. In addition, they use universal spare parts. Their kerfs are small, just 1.2 mm to 1.3 mm, making for a very efficient recovery and very little sawdust.

Figure 13.7 A horizontal band saw

Capital expenditure on a horizontal band saw is one of the lowest of all saws, as is the cost of infrastructure and installation. The saw is mounted on a secure concrete foundation that is set at floor level. The rails for the trolley need to be level as if they are not size variation will be adversely affected. Correct installation is essential as incorrectly mounted machines do not cut effectively and recovery, sawing quality, and size tolerance will be poor.

About 5% of producers who use wood from government forests use horizontal band saws but none were found in private forest areas. Three horizontal band saw lines are being used in Ifakara to produce teak. The quality of cutting is high if a horizontal band saw is set up correctly and size tolerance and size stability are both good. These saws can handle large logs and eucalyptus logs effectively, but not small-diameter logs.

6. Mobile band saws

Mobile band saws were first introduced two years ago, and only 1% of sawmills use them. About half of the saws are from America and half from China. Mobile band saws are trailers with a moving saw that passes over stationary logs. Their kerfs are small, just 1.2 mm to 1.3 mm, if they are set and sharpened correctly, a fact which has many benefits for end products, makes for very efficient recovery, and yields little sawdust.

Figure 13.8 Mobile band saw

Purchase cost for the Chinese type models is low, but such machines are made of lightweight materials. The prices of American models vary greatly but are five to ten times as much as Chinese models on average. In addition, there are concerns that some American models are hobby machines being marketed for industrial use. Bands saws have a high sawing quality and a tight size tolerance as well as high rates of recovery. These rates depend on the average diameter of the logs processed but average 45%. While band saws can process all logs, including eucalyptus logs, effectively they cannot process small logs of any species economically.

7. Industrial lines

Some complete industrial lines have been set up in Tanzania over the years. A line is a process that includes more than just a sawing unit; it may also include an edger or canter, a sorting line, or a feeding line. The types of lines set in Tanzania are described below.

- The three 1970s Lindsaw lines brought to Tanzania in the 1970s itself are outdated and regularly require expensive maintenance. Their cutting quality and size tolerance are better than average but are not high quality. One line still operates regularly but the other two do not.
- A South African multi-saw line was introduced in 2009 to process teak logs (Figure 13.9).

Figure 13.9 SA multi-saw line

This line works effectively, with recovery rates in excess of 43%, depending on the average diameter of the logs sawn. It is a flexible line with both band saws and circular re-saws. It can work even if logs are not sorted but not very effectively.

- A Hewsaw line was installed in 2012 to process small-diameter saw logs (up to 24 cm). It is one of the most advanced sawing technologies in the wood industry and is highly effective as it was designed precisely for small-log processing with maximum recovery and conversion of waste to technical chip material. It has a high sawing quality and a very tight size tolerance but requires much skill and training to use and cannot be used with anything but small-diameter, high-quality saw logs sorted ahead of time. In addition, in Tanzania, it is difficult to find spare parts and technical support for the Hewsaw line.
- One Wood-Mizer SLP and WM3500 line was installed in November and December 2015. This saw line was developed to saw large- and small-diameter logs of both pine and eucalyptus. It includes both vertical and horizontal band saws with small kerfs of between 1.2 mm and 1.3 mm. As a result, recovery rates exceed 45% and little sawdust is produced. The saw finish is high-quality and the size tolerance very tight. It is flexible enough to process a range of raw material including pine and eucalyptus as well as large and small diameter saw logs.

8. Other sawmill technology considerations

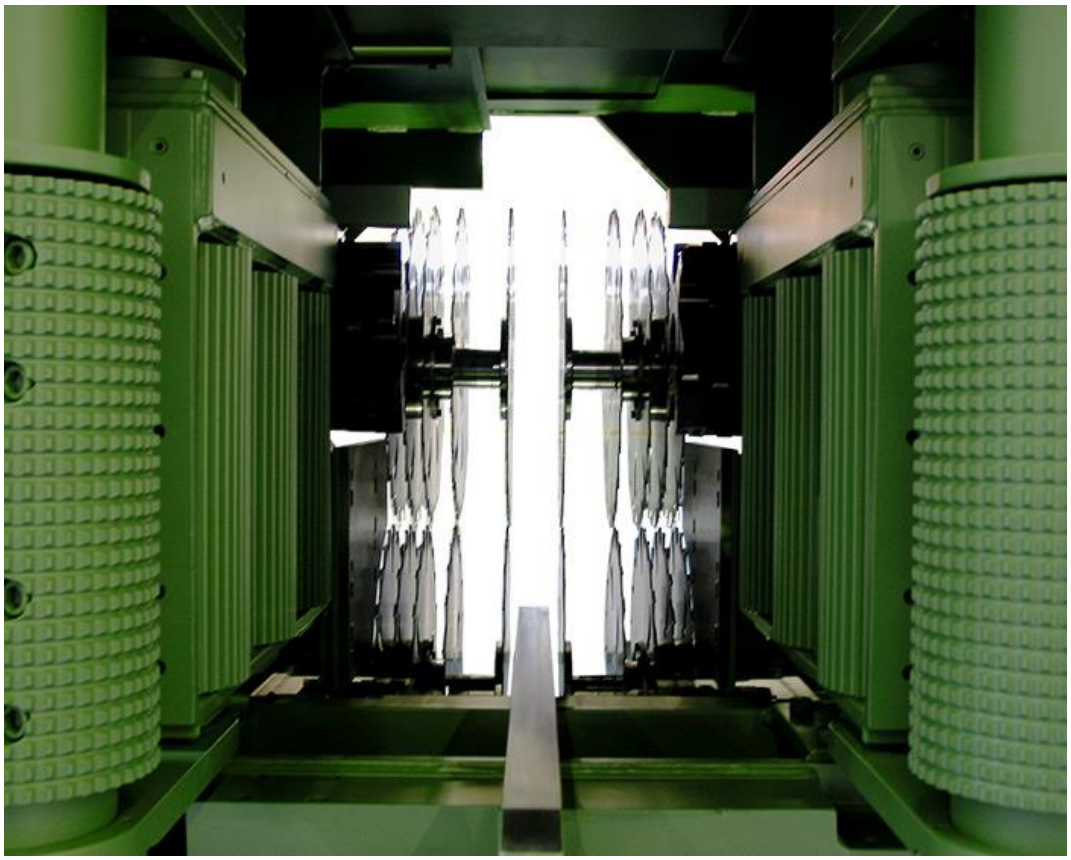
- A frame or gang saw (Figure 13.10) has a frame which holds a number of saw blades that move up and down in a regular motion, sawing a log into multiple boards at one time. This type of saw is economical to operate and uses simple technology but its infrastructure and installation are both expensive and extensive. Blade maintenance is simple and the blades have a medium kerf of about 3 mm to 4 mm, less than the 6 mm kerf of the standard circular saw blades but considerably more than the small 1.2 mm kerfs of band saws.

Figure 13.10 A frame saw

A frame saw cannot be operated or fed manually: it requires extensive feed- in equipment. For this reason, while it is effective for all log diameters and all tree species, capital expenditure on a frame saw is high. Recovery in excess of 45% is expected from medium logs but rates of recovery for small-diameter logs are poor. Saw finish is high-quality and size tolerance is good. Frame saws are easy to maintain and their saws are easy to doctor although parts and blades are not currently available in Tanzania.

- Double arbour round log saws (DARLS, Figure 13.11) are not currently found in Tanzania but are specifically designed to process small-diameter round logs. Though not intentionally designed with eucalyptus logs in mind, DARLS favour their production because sawing is balanced.

Figure 13.11 A double arbour log saw blades set up



DARLS have two spindles, one on the top and one on the bottom, and circular saw blades on each spindle. Logs are cut by both the top and the bottom blades at the same time, not more than between 150 mm and 175 mm deep, thereby reducing the stress on each blade, allowing it to be thinner and reducing its kerf to between 2.2 mm and 2.3 mm. As a result, the rates of recovery of DARLS are better than those of all other technologies than band saws. DARL saw maintenance is simple and less technically challenging than maintaining a thick large-diameter saw blade.

DARLS are manufactured to process different volumes, from 150,000 m^3 logs per year down to 4,000 m^3 of logs per year. The project has identified small units that require little power supply and can process both pine and eucalyptus. Their recovery rate for medium logs is about 45%, and that for small logs however is lower, it is more efficient than other sawmill types. Saw finish is high-quality and size tolerance is very tight. In addition, DARLS are flexible enough to process a wide range of raw material, and both maintenance and saw doctoring are easy. Parts and blades are available in Tanzania.

Annex 19 Mechanical round wood log harvesting

Felling, de-limbing and cutting to length are the first steps to preparing a tree for market. Proper harvesting can maximise the marketable products into which the tree are cut, lower harvesting costs and yield greater usable volume. Maximisation of the economics of each forest stands is most effectively done by mechanical log harvesting with specifically designed harvesting machines. A “harvester” or “whole tree processor/de-limber” uses a harvesting head mounted on a hydraulic crane to cut the tree and pull the trunk through a de-limber. Then the operator can measure or a computer program can automatically cut it into logs of various lengths using a slasher chain saw. The operator and computer will also be able to optimize each log allowing for pre-select grades to be chosen from each log. Once cut the logs are stacked in various piles of each grade harvested. Furthermore the machines control system will record each tree cut and each log produced and send this data to a control point offsite.

Step 1.

The operator takes hold of a standing tree at the base using the harvesting head.

Step 2.

The base of the tree is cut and the tree is laid down to the ground.

Step 3.

The trunk passes through the head and the de-limbing arms remove the branches.

Step 4.

As the trunk passes through the head, the size, diameter and long are recorded on the on-board computer.

Step 5.

The pre-programmed on board computer determines the optimum grade of each log (using physical characteristics including sweep, diameter, branch and others) and proceeds to cut the logs to length where they drop on to piles determined by the operator.

Step 6.

The logs are collected from the forest floor by a log forwarder that then takes them to the roadside where they are stacked in preparation for loading to the customers trucks.

This process is both fast and accurate and allows for the maximum yield of high value logs from a forest stand. It also allows for a real-time record to show exactly the volume of the product passing through.

Benefits:

- Fast processing and efficient operation.
- Combination of operator and computer optimization of each tree.
- Sorted logs into end market qualities.
- Safe working environment as only the harvester and operator are present at the harvesting site. Keeping employees inside the driving cab of the machine provides a safer and more comfortable working environment for industrial scale logging.
- Highly accurate real-time product recording.
- Forest waste, branches etc., can be dropped into collectable stacks or spread over the site.
- Less soil compaction or soil disturbance resulting in less erosion.

Annex 20 Forest sector employment data

Table 13.1 Employment by small-scale tree farm owners in Mufindi District

Name of owner	Hectares owned	Number of permanent employees
Manhatann Investment	6	3
Pilly Mashombo	100	4
Ihembe Timber Products and Poles, Ltd.	300	4
White Rose Investment	50	2
Heri Luvanda	50	4
Halidi Enterprises	9	4
Dama Mkonge	45	6
Sheda General Enterprises	500	3

Table 13.2 Harvesting analysis

	Minimum actual harvests				**Maximum capacity for harvesting**			
	Volumes harvested ($m^{3)}$		**Mechanical**	**Manual**	**Volumes harvested ($m^{3)}$**		**Mechanical**	**Manual**
Dingdong saws (government resources)	88,347			88,347	314,719			314,719
Laimet saws	62,347		31,174	31,174	222,100		111,050	111,050
CVT saws	39,301		19,650	19,650	140,000		70,000	70,000
Band saws	29,082			29,082	103,600			103,600
Wood-Mizer / mobile saws	7,860			7,860	28,000			28,000
Other	13,362			13,362	47,600			47,600
Large industries	320,000		320,000		320,000		320,000	
Total m^3			**370,824**	**189,476**			**501,050**	**674,969**
Working team days			46,353	42,106			62,631	149,993
Working days per year			226	226			226	225.50
Teams total (government resources)			206	187			278	665
Dingdong saws (private resources)		99,200	-	99,200		99,200	-	99,200
Working team days				22,044				22,044
Working days per year				226				225.5
Team total (private resources)				98				98
Employment total			**1,439**	**1,698**			**1,944**	**5,047**

Table 13.3 Summary of employment in forestry log transport activities logistics

Excluding large industries for which employment figures are in the total

	Optimum values	Actual governmental sources	Private sources
Volume per load (m^3)	9	9	9
Number of logs per load	80	80	80
Total volume of saw logs transported (m^3)	856,019	240,300	-
Total number of raw utility poles transported	240,100	20,000	100,000
Number of persons per truck saw logs *	6	6	6
Number of persons per truck utility poles **	23	23	23
Number of truck journeys	98,114	26,950	1,250
Number of working days	226	226	226
Truck day cycles	1	1	3
Number of trucks	435	120	17
Total employees	**2,611**	**717**	**100**
* One driver and a five-member loading team			
** One driver, twenty manual loaders, and two unloaders to run machinery			

Table 13.4 Summary of sawn timber transport logistics

Excluding large industries, for which employment figures are in the total

	Optimum values	Actual government sources	Private sources
Volume per load (m^3)	45	45	45
Total volume transported (m^3)	348,000	135,668	41,664
Number of persons per truck (loading/unloading/Driver) *	12	12	12
Number of truck journeys	7,733	3,015	926
Number of working days per journey	6	6	6
Number of working days per year	275	275	275
Number of trucks	169	66	20
Number of trucks per day	28	11	3
Total number of employees	**2,025**	**789**	**242**
*Two drivers, five loaders, and five unloaders			

Table 13.5 Summary of employment in utility poles transport logistics

Excluding large industries, for which employment figures are in the total

	Large industry	**Small industry**
Poles per load	90	90
Total number transported out of the southern highlands in 2014	80 000	56 000
Number of persons per truck *	9	9
Number of truck journeys	889	622
Number of working days per journey	6	6
Number of working days per year	275	275
Number of trucks	19	14
Number of trucks per day	3	2
Total employees	**175**	**122**
* Two drivers, five loaders, and two unloaders to run machinery		
** Excluding large industries, for which employment figures are in the total		

Table 13.6 Monthly movement of timber from Mufindi District

Month/Year	**Number of trucks in year** (by the number of trucks recorded at the weighbridge)	
	2014	**2015**
January	518	801
February	656	774
March	608	804
April	307	695
May	552	535
June	666	552
July	798	451
August	743	409
September	646	285
October	708	217
November	781	
December	857	
Total	7,840	5,523
Average per month	653	**552**

Table 13.7 Details of female employees in the various sawmill types

	Number of sawmills surveyed	Number of sawmills employing women	Number of women employees	Total employees recorded	% of women employees
Dingdong saws	47	14	31	337	9%
Laimet	27	8	21	423	5%
CVT	8	1	6	125	5%
Bandsaws	6	2	20	132	15%
Mobile band saws	2	1	8	32	25%
Other	3	1	6	50	12%
Total	93	27	92	1,099	8%

Annex 21 The Southern Highlands sawmills

Figure 13.12 Sawmills identified in Mufindi region

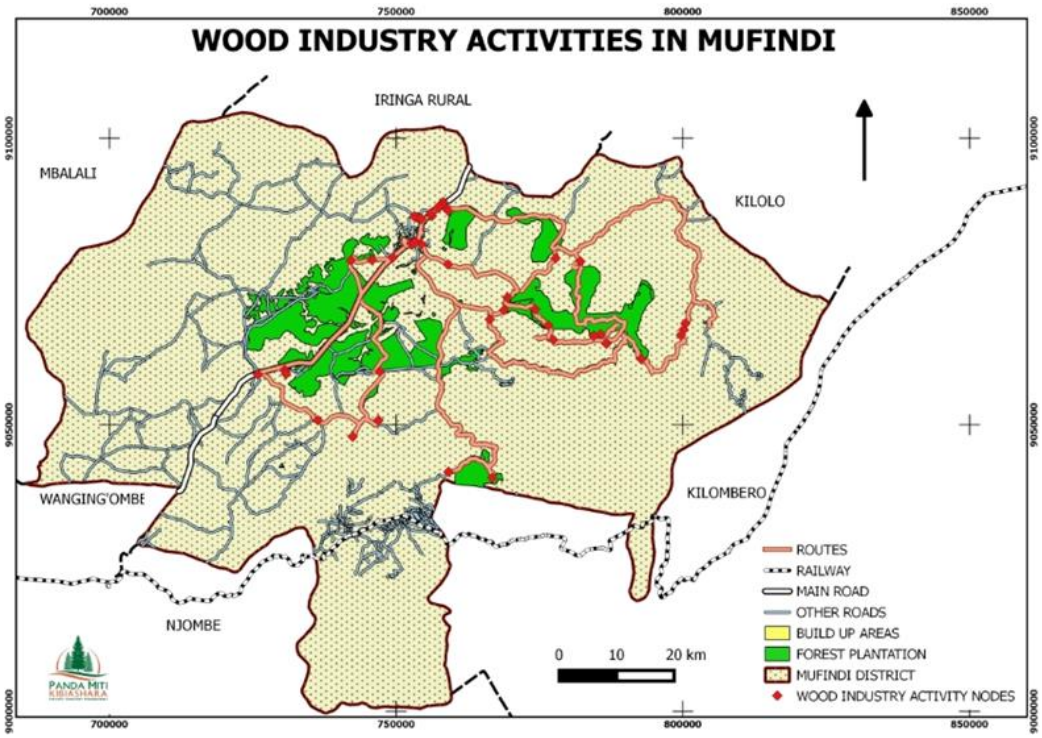


Figure 13.13 Sawmills identified in Njombe region

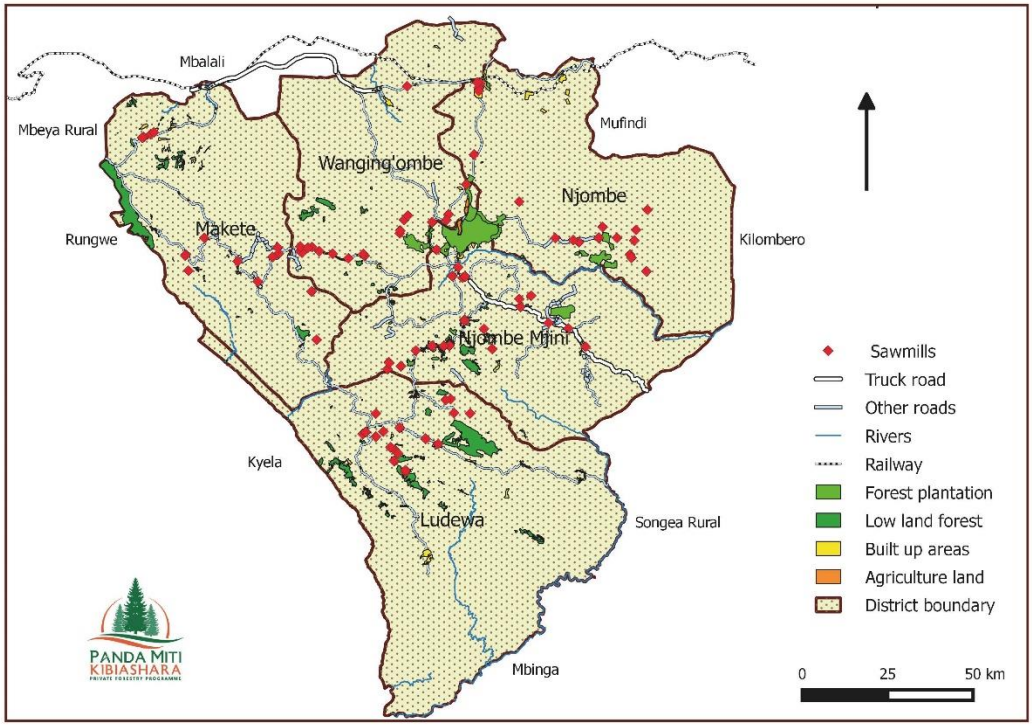
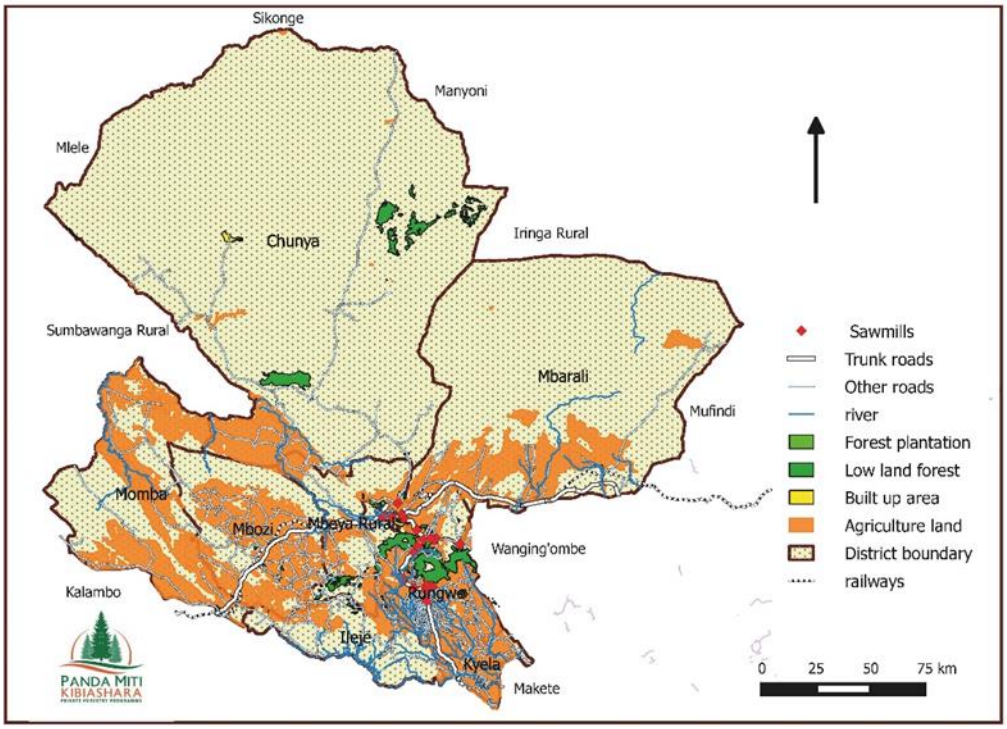


Figure 13.14 Sawmills identified in Mbeya region



Annex 22 Value Chain Workshop 18th December 2015 – Dar es salaam

INTRODUCTION

The workshop brought together some sixty key actors from the high-potential private forestry, road haulage, and wood processing sectors; to discuss and agree on strategic actions that are needed to improve their performance.

Tree growers, road hauliers, and wood industries are important contributors to Tanzania's economy but they face many problems that stop them from reaching their potential. For example; tree growers lack necessary incentive schemes and organization; road haulers face problems with road condition and delays at check-points, government log sale practices are cumbersome and do not reflect recent developments in the Tanzanian wood industries; and wood industries are wasteful and regularly do not achieve the quality and standardization needed for high value products.

The Private Forestry Programme has embarked on in-depth studies involving hundreds of interviews to elucidate these value chains; and prepare recommendations to improve their economic performance. The workshop provided an opportunity for key actors to hear these recommendations, and participate in the thematic groups that will question and corroborate them.

Timetable

The workshop was held on 18 December 2015 in Sea Cliff Hotel in Dar es Salaam. The timetable of the workshop was as presented in Table 13.8. The event facilitator was Mr Kahana Lukumbuzya.

Table 13.8 Planned timetable of the workshop

Time	Topic	
9:00	Registration	-
9:15	Opening remarks, including an executive summary and introductions	Michael Hawkes
9:45	Consultant presentation	Nicholas Moore
10:30	Tea break	-
11:00	Consultant presentation	Nicholas Moore
11:45	Discussion	Facilitator
12:30	Lunch break	-
13:15	Group discussions	Groups/Facilitator
14:45	Group presentations	Groups/Facilitator
16:15	Tea break	-
16:30	Closing remarks	Facilitator
17:00	Closing	Michael Hawkes

CLARIFICATION DISCUSSIONS

After the consultant presentation given by Mr Nicholas Moore the audience was given the chance to present clarification questions from the consultant team. The following issues were raised.

- Why are high quality logs used in the pulp and paper industry?
- Even with the foreseen decline in the raw material base in Tanzania, why are investors still investing in sawmills?
- What are the inputs provided to small-scale farmers by the PFP?
- Is the concrete utility pole project already operational?

- What does integrated harvesting mean?
- The consultant presentation says that there are some 150,000 hectares of plantations in Tanzania while NAFORMA gave a figure three times larger. Why is there such a large gap?
- Why is the report only concentrated on pine and eucalyptus?
- It was acknowledged that forestry is a risky business and that raining is important
- Plantation resource study carried out by FDT was explained.
- Eucalyptus environmental issues were discussed.
- Tanzanian industries are not internationally competitive.

The consultants and other experts gave clarifications to the issues raised and notes were taken for improving the report.

GROUP WORK

The workshop participants were divided into three groups for discussions after lunch. The three groups were: 1) Development of timber products, 2) Forestry regulations and 3) Log markets. The groups were asked to come up with additional challenges that were not identified by the consultants and recommend solutions for top three challenges identified.

Group 1 – Development of timber products

Timber products development group came up with three top challenges, recommendations and responsible parties as presented in the following table.

Table 13.9 Group 1 presentation summary

Challenge	Recommendations	Responsible party
Technology - Machinery - Skilled labour - Cost	- Government incentives - Awareness through exhibitions - Training - Government exemptions - Subsidies	- Government - Training institutions
Lack of general knowledge - Grading - Standardisation - Sampling - Preservation and storage	- Training - Promoting development and development of good industry practises - Relevant policies	- Government - Local authorities - Institutions - Media
Transportation and infrastructure	- Developing and improving of infrastructure - Knowledge of transportation techniques - Elimination of barriers and bureaucracy	- Government - Actors in wood industry - Training institutions - NGOs

After the presentation a brief discussion was held. It was noted that the responsible party is very often the government.

Group 2 – Forestry regulations

The second group listed additional challenges as follows:

1. Procurement regulations
2. Forest industry self-regulation
3. Land rent
4. Taxation/licencing
5. SMEs not complying

6. Stakeholders' inclusion + weak capacity
7. Numerous control check-points

The following table summarises the group's top three challenges, recommendations and responsible actors.

Table 13.10 Group 2 presentation summary

Challenge	Recommendations	Responsible party
Procurement regulations	- Special window for SMEs - Capacity building - Market information	- Government
Taxation/licencing	- Transparent auctions - Review tax rates vs markets	- TFS - LGAs - Stakeholders - Government
Stakeholders' inclusion + weak capacity	- Lobbying - Government capacity improvement - Transparency - Formation of associations	

Overall the group felt that the draft report lacked some interesting cost/benefit analyses relating to markets and economics. Employment generated, costs accrued, incomes to individuals and government were felt missing.

After the group presentation it was discussed that taxation needs to be harmonised and organisations need to be proactive. It was also discussed that an analysis along the value chain investigating profits and losses along the value chain by various actors should be included in the study.

Group 3 – Log markets

Group three had a slightly different approach to the task given than the previous two groups. The group did not identify responsible parties to carry out the recommendations for tackling the challenges. The top three identified challenges and the recommendation are presented in the following table.

Table 13.11 Group 3 presentation summary

Challenge	Recommendations
Decrease in government (forest) resources	- Enabling environment for all actors - Integrated harvesting - Revising MPM contract - MPM to look for alternative raw materials including their own planting - Forest funds to be used to incentivise forest planting - Intensify forest management - Information about good quality seed
Use of high quality logs for paper production	- Special pulpwood schemes - Introducing integrated harvesting - Tree planting by MPM - Outgrowers schemes
Lack of information about available round log options	- Develop FIS/MIS

Additional challenges identified by the group were: political interventions, poor quality logs, short licencing period and harvesting of young trees.

After the presentation the audience gave some more comments that were expected to come up by the group three. These issues related to forest certification, carbon trading and fire management. In addition, TGAs' institutional capacity was discussed and it was mentioned that a new industry using small eucalyptus logs for veneer production is arising.

LIST OF PARTICIPANTS

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Value Chain Consultant	Juha Leppänen

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