PANDA MITI KIBIASHARA
PRIVATE FORESTRY PROGRAMME

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INVESTMENT OPPORTUNITIES IN THE TANZANIAN FOREST INDUSTRY AND BIOENERGY SECTORS

CLUSTER ANALYSIS

April 2018

United Republic of Tanzania
MINISTRY OF NATURAL RESOURCES AND TOURISM
Forestry and Beekeeping

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MINISTRY FOR FOREIGN AFFAIRS OF FINLAND

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Investment Opportunities in the Tanzanian Forest Industry and Bioenergy Sectors

Cluster Analysis

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ABBREVIATIONS

EBITDA	Earnings before interest, taxes, depreciation and amortisation
EIA	Environmental impact assessment
FAO	Food and Agriculture Organisation of the United Nations
FDT	Forestry Development Trust
FSC	Forest Stewardship Council
GDP	Gross domestic product
GPS	Global Positioning System
ha	hectare
IRR	Internal rate of return
m^3	cubic meter
MAI	Mean annual increment
MFA	Ministry of Foreign Affairs, Finland
NAFORMA	National Forest Monitoring and Assessment
NEMC	National Environment Management Council of Tanzania
NPV	Net present value
NPZ	Not-preferred zones
PFP	Private Forestry Programme
RWE	Roundwood equivalent
SMCA	Spatial multi-criteria analysis
SRTM	Shuttle radar topography mission
TANESCO	Tanzania Electric Supply Company Limited
TGA	Tree growers' association
TIC	Tanzania Investment Centre
USD	United States dollar

EXECUTIVE SUMMARY

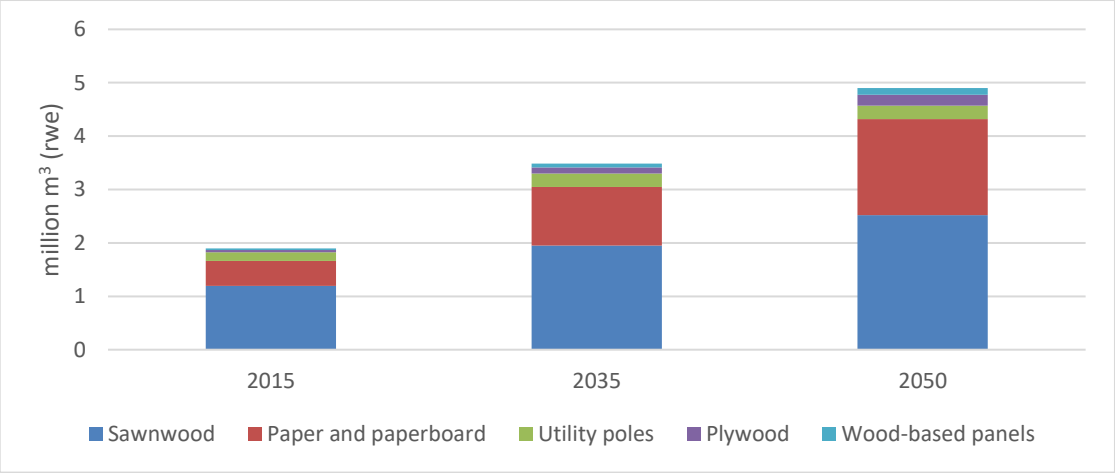
This technical report, a cluster analysis, is part of a study that also includes a diagnostic climate investment assessment of Tanzania. Together, these reports will form the foundation of a roadmap the Tanzanian government can adopt in order to provide an enabling environment for the development of the wood products industry and to draft an information package for potential investors in the Tanzanian forestry sector.

This report identifies investment opportunities in selected clusters in the Southern Highlands of Tanzania. It assesses the future demand for plantation wood products, current and potential new plantation resources and proposes viable investments which would work toward filling future gaps in the market.

Demand for Forest Products

Adopting a demand-driven approach, the study assessed the demand for plantation wood products and identified gaps in the nation's wood-production and wood-processing capacities. Forest products demand was forecasted by using demand elasticities based on long-term observations of the responsive of this demand to GDP growth.

Figure 0.1 Development of Demand for Plantation Wood Products in Tanzania



Then, using this analysis, researchers identified gaps in the production capacities of the products mostly likely to be in demand and able to be produced profitably and sustainably in Tanzania, including utility poles, sawnwood, veneer, and plywood. The demand for pulp and paper products is also projected to grow, but since pulpwood resources are scattered and the resource base is small, investment in pulp and paper production does not seem promising. Because wood-based panels, or fibreboards, are not likely to be in high demand in the future, investment into fibreboard production does not seem promising either.

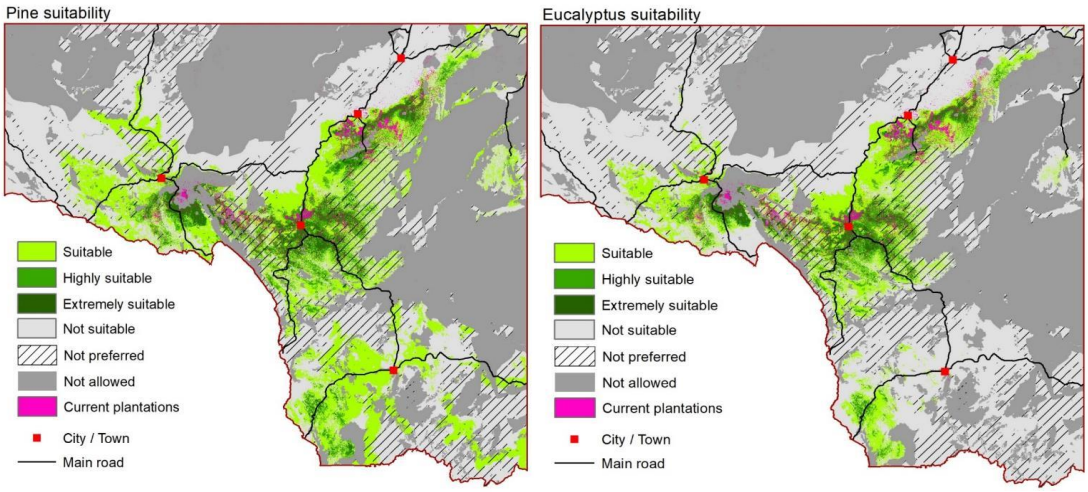
Plantation Forest Resources

According to a 2016 mapping, there are about 196,000 ha of plantations in the Southern Highlands. About 67% (132,000 ha) are pine; 19% (37,000 ha), eucalyptus; and 13%, wattle (26 000 ha). The majority of these plantations are around Mafinga and Njombe, but the districts of Makete, Mbeya and Kilolo also have large areas dedicated to plantations. The areas were used to estimate wood flows currently possible without establishing new large-scale plantation projects.

The potential for establishing new plantation areas to meet gaps in the current wood supply was assessed using spatial multi-criteria analysis that considered variables such as rainfall, temperature, soil, and road accessibility and examined both suitability and preferability. The analysis found that some 2.8 million ha of land is suitable for planting pine and 1.8 million ha for planting eucalyptus, but that areas overlap and are not necessarily available to investors, in part because food security considerations would restrict their size. An analysis of agricultural

pressure in the Southern Highlands found that most of Mbeya and parts of Songea have high agricultural pressure and that, as a result, the area for forestry would have to be decreased.

Figure 0.2 Areas Suitable and Preferable for Pine and Eucalyptus Plantation

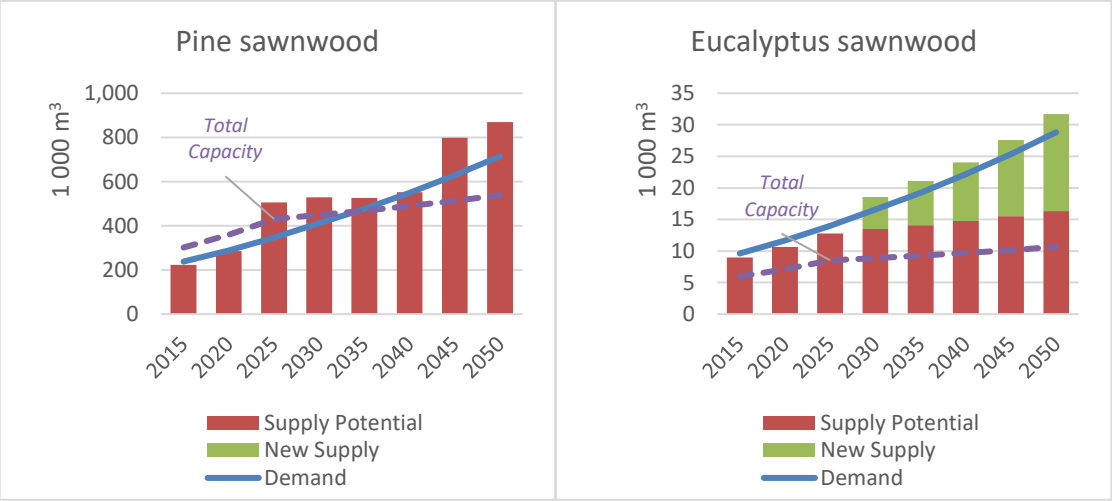


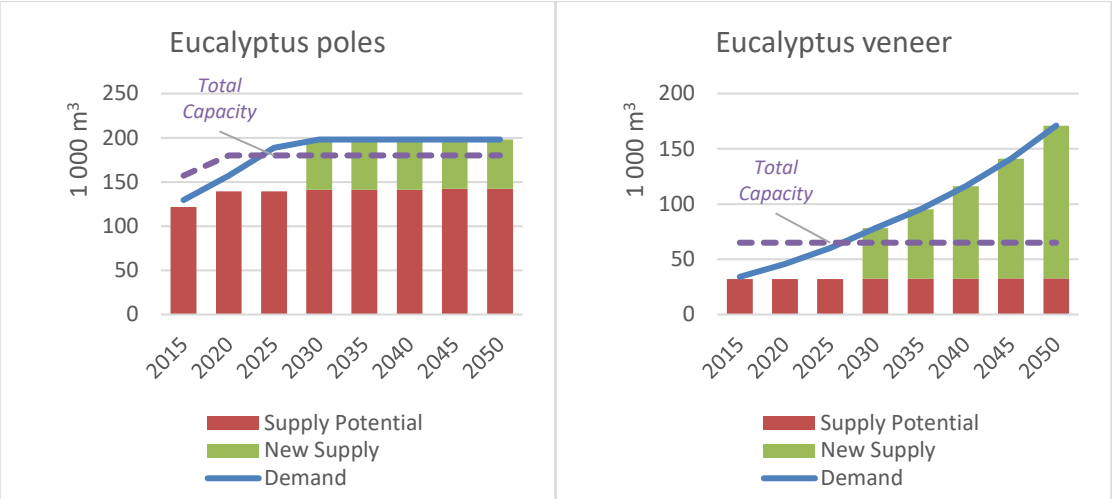
Supply-Demand Balance

Assuming that pine plantations are managed sustainably and utilised efficiently, they should be able to supply enough pine for the pine sawnwood market in the long-term, but sawmills will have to increase recovery rates.

More eucalyptus needs to be planted to satisfy the increasing demand for poles and veneer though there are enough eucalyptus logs to meet the demand for eucalyptus sawnwood. Eucalyptus sawmilling will not take place on a significant scale.

Figure 0.3 Supply-Demand Balance of Key Products in Tanzania





Cluster Analysis

The study assessed six clusters, one each centred in Kilolo, Njombe, Mafinga, Makete, Mbeya, and Songea, for their suitability for large-scale industrial development given their current plantation resources, potential for future plantations (assessed by the area of suitable land less the area needed to ensure food security), and current and future infrastructure. The two most promising clusters, Mafinga and Njombe, were then analysed in detail.

Mafinga Cluster

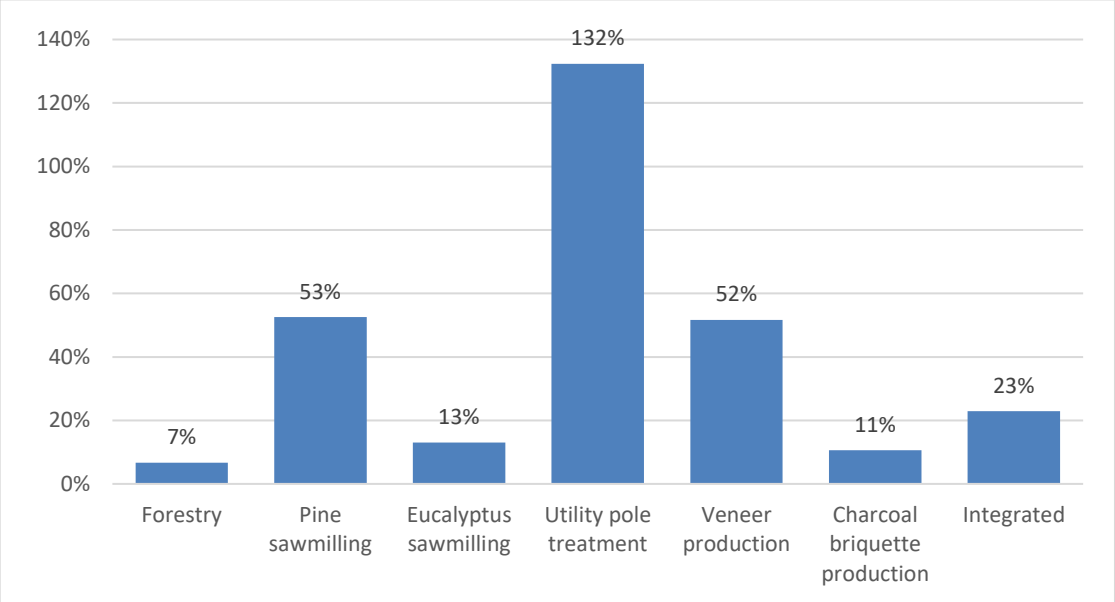
In addition to maintaining its current wood resources and processing capacity, Mafinga Cluster should invest in medium-scale plantation of eucalyptus targeted at harvesting veneer logs, moderately increase its capacity for pine sawmilling, and significantly increase its capacity to produce veneer. In addition, it should make smaller investments in sawmilling eucalyptus, treating utility poles, and charcoal briquette manufacturing out of sawdust.

Table 0.1 Proposed Investments in Mafinga Cluster

Investment item	Scale
Planting eucalyptus to harvest veneer logs	30 200 ha
Extending capacity in pine sawmilling	130 000 m^3 (intake)
Building capacity in eucalyptus sawmilling	33 000 m^3 (intake)
Building capacity to treat utility poles	14 000 m^3 (intake)
Building capacity to produce eucalyptus veneer producing capacity	235 000 m^3 (intake)
Building capacity to produce charcoal briquettes	76 800 m^3 (intake)

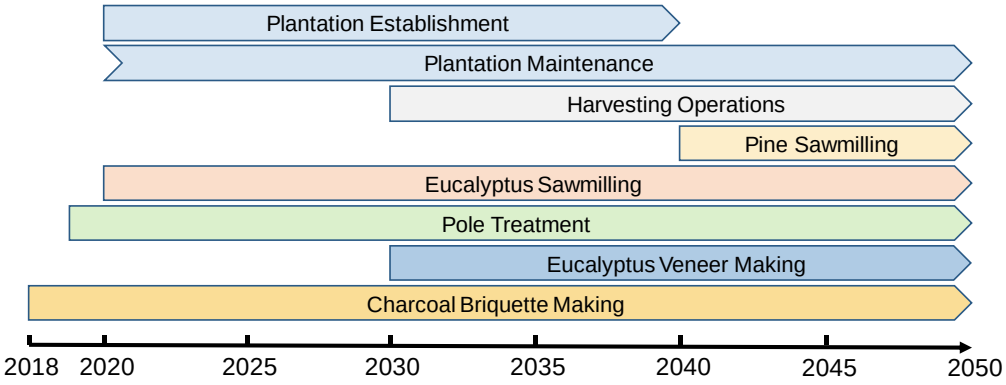
The profitability of the investments as a whole, measured by the average of their internal rates on return (IRR), is 23%, but the IRRs of each investment vary considerably: planting eucalyptus has the lowest IRR (7%) and the treatment of utility poles the highest (132%). Since the scale of the investment in utility pole treatment is low, however, despite its high IRR, profits would be small. In any case, the high IRR can be attributed to the limited supply of raw material, the undervaluing of eucalyptus, low treatment capacity, and the high demand for utility poles.

Figure 0.4 Comparison of Internal Rates of Return in Mafinga Cluster



Investment should be carried out in phases, as indicated in the figure below. Investment should begin with producing sawdust briquettes from sawmilling residues and proceed over time to utility-pole treatment, new plantation establishment, and eucalyptus sawmilling. New investments into pine sawmilling should start only in around 2040.

Figure 0.5 Phasing of Investment – Mafinga Cluster



Njombe Cluster

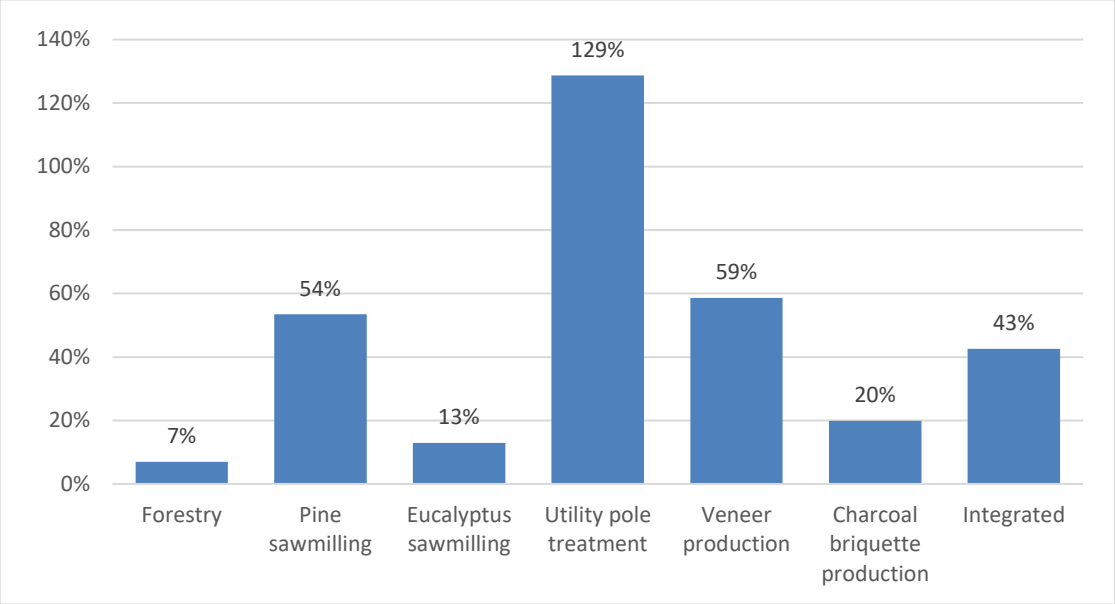
In addition to maintaining its current wood resources and processing capacity, Njombe Cluster should invest in moderate planting of eucalyptus targeted at harvesting veneer logs, significantly increase its capacity for pine sawmilling, and increase its capacity to treat utility poles. In addition, it should make smaller investments in sawmilling eucalyptus, producing veneer, and charcoal briquette manufacturing out of sawdust.

Table 0.2 Proposed Investments in Njombe Cluster

Investment item	Scale
Planting eucalyptus to harvest veneer logs	8 400 ha
Extending capacity in pine sawmilling	263 000 m^3 (intake)
Building capacity in eucalyptus sawmilling	7 200 m^3 (intake)
Building capacity to treat utility poles	36 000 m^3 (intake)
Building capacity to produce eucalyptus veneer producing capacity	2 400 m^3 (intake)
Building capacity to produce charcoal briquettes	36 800 m^3 (intake)

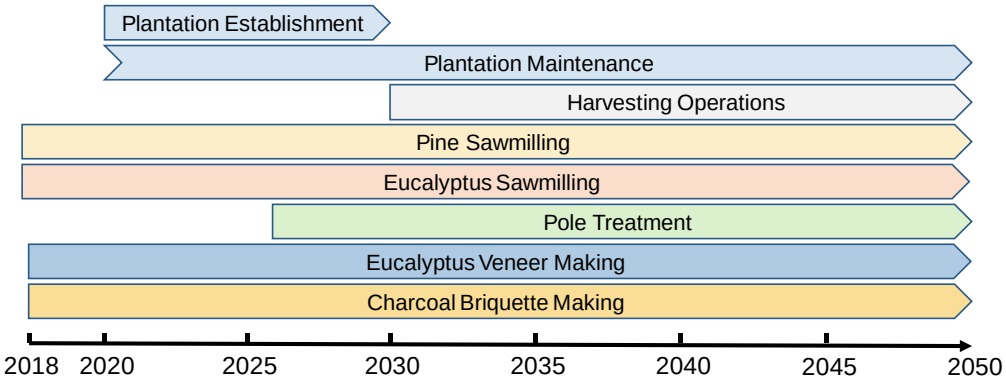
A single actor who invested in all the proposed activities would earn an IRR of 43%. the overall profitability is high as not only is pine sawmilling, with an IRR of 54%, quite profitable, but it is also a large-scale investment. As is the case in Mafinga, the IRRs of the investments vary considerably, with forestry the lowest (7%) and utility-pole treatment the highest (129%).

Figure 0.6 Comparison of Internal Rates of Return in Njombe Cluster



Investments should be carried out in phases, as indicated in the figure below. Immediate investments should be made in sawmilling both pine and eucalyptus and in producing both veneer and sawdust briquettes. Investments in utility-pole treatment should come later, in around 2025.

Figure 0.7 Phasing of Investments in Njombe Cluster



Sustainability

In addition to being financially sustainable (and, with IRRs of 23% and 43% respectively in Mafinga and Njombe clusters, they are), the proposed investments must be socially and environmentally sustainable. This study assumes that best practices in forestry and forest industries will be followed and that, for example, plantations will be established as per local environmental laws and will be at least certifiable (if not certified) under international certification schemes. Achieving this standard means, for example, that plantations are not established in areas converted from natural forest or other valuable ecosystems and are established far from streams.

Properly established tree plantations are likely to result in many positive environmental impacts, both locally and globally. High-yielding plantations sequester carbon efficiently in both above- and below-ground biomass. They do not need to be irrigated and have little impact on groundwater levels when sites and species match, as they do because sites were chosen considering the availability of sufficient rainfall.

Plantations also improve water regulation and reduce pressure on natural forests and woodlands for wood products and firewood. They do not ordinarily require the application of chemical fertilisers and, compared to other land uses, produce little sediment. For these reasons, water quality downstream of plantations is often better than that downstream of farmland.

On the social side, plantations should generate much-needed income in rural Tanzania, reduce the pressure for urbanisation, and, by ensuring a more equal distribution of income, reduce social unrest. Establishing plantation and expanding the forest industry also create more opportunities for women to find decent employment.

Plantations are likely to include both smallholder and large-scale industrial plantations. To overcome a common constraint on developing a nation's forest industry—the lack of sufficient land, Tanzania will have to integrate smallholders into its forestry value chains and thereby achieve sufficient scale. To access land, a foreign investor needs to reach an agreement with local communities or get support from the Tanzania Investment Centre.

Development Impact

The development impact of investment in Tanzania's forestry sector and forest industry is rooted in its ability to increase income and create employment. The investments proposed in this study will directly create some 1,500 decent jobs and, through the multiplier effect, indirectly create many more. Income will increase as employees earn wages and service providers gain business.

Investments in plantation establishment, sawmilling, plywood and veneer production will also reduce the trade deficit as Tanzania will be able to develop self-sufficiency in these areas. However, the trade balance will likely continue to be negative because the increasing demand for paper products cannot be met domestically.

The investment in producing charcoal briquette manufacturing out of sawdust will reduce demand for natural forest-based charcoal and thereby reduce forest degradation. By sequestering significant amounts of carbon plantations help reduce emissions.

1. INTRODUCTION

1.1 Background and Objectives

The Private Forestry Programme (PFP) is a bilateral initiative between the governments of Finland and Tanzania. It aims to increase income in the Southern Highlands by promoting market-driven scientific private plantation forestry and developing the region's forest industry.

The PFP's interventions are designed to maximise the potential that Tanzania's forestry sector has to be an important driver of socio-economic development. As well as increasing carbon sequestration, PFP initiatives will help create wealth and reduce poverty, in part by providing fair employment opportunities. Currently, however, as a value chain analysis and other studies carried out by the PFP found, investments in the forest industry sector are inadequate[1].

The Tanzanian Plantation Forestry Conference held in Dar es Salaam in November 2016 moved the nation a step further toward attracting investment in forestry, especially in the Southern Highlands. Since then, discussions about maintaining momentum, identifying concrete steps to remove various barriers, and creating more enabling conditions for forest investment in an effort to accelerate forestry and forest industry investments in Tanzania have continued.

The rationale for this study, an important follow-up step on that conference and those discussions, lies in the well-established fact that, at least in principle, major investment opportunities exist along the value chains of the forest and bioenergy sectors. Tapping into those opportunities, however, requires finding out more about the constraints on investment faced by different groups of stakeholders as well potential investors' perceptions of the likely opportunities and challenges investment entails. In particular, key stakeholders need to understand the balance between the supply of forestry resources and the demands of the industry both as it is now and as it might change over time under different scenarios.

This study builds on earlier work and reports on i) the policy and regulatory environment in Tanzania commissioned by the PFP in 2014[2], ii) value chain and market studies commissioned by the PFP, the Ministry of Foreign Affairs (MFA) of Finland, and the Forestry Development Trust (FDT)[1,3,4] in 2016, iii) the plantation forest resource assessment conducted by the FAO and the University of Turku in 2016[5], and iv) studies on finance, including a forest sector financing study[6] that focused on financing opportunities for smallholders interested in plantation forestry in Tanzania and a financial and economic study of investment opportunities in the Ruvuma region[7]. The work also takes stock of other relevant studies and strategy and policy documents, including the Biomass Energy Strategy Tanzania and the National Five-Year Development Plan.

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[1] PFP. 2016. Value Chain Analysis of Plantation Wood from the Southern Highlands. Iringa, Tanzania: Private Forestry Programme. http://www.privateforestry.or.tz/en/resources/view/value-chain-analysis-of-wood-plantation-from-the-southern-highlands

[2] PFP. 2014. Desk Study for Developing Mechanisms and Policies That Strengthen the Private Plantation Forestry and Related Value Chains. Njombe, Tanzania: Private Forestry Programme.

[3] FDT. 2013. Distribution of Pine and Eucalyptus Woodlots and Plantations in the Southern Highlands of Tanzania, 2013. Forestry Development Trust, Iringa, Tanzania. http://forestry-trust.org/wp-content/uploads/2016/12/Plantation-map-for-southern-highlands-2013_FDT-resize.jpg

[4] FDT. 2018. Tanzania Wood Market Study. http://forestry-trust.org/wp-content/uploads/2018/01/2017_UNIQUE-Tanzania-Wood-Market-Study-FINAL.pdf

[5] PFP. 2017. Forest Plantation Mapping of the Southern Highlands. Final report. Iringa, Tanzania. http://www.privateforestry.or.tz/en/resources/view/forest-plantation-mapping-southern-highlands-final-report

[6] PFP. 2016. Forest Sector Financing Study. Iringa, Tanzania: Private Forestry Programme. http://www.privateforestry.or.tz/en/resources/view/forest-sector-financing-study

[7] PFP, 2017. Financial and economic analysis of private forestry investment opportunities in Ruvuma Region. Iringa, Tanzania: Private Forestry Programme. http://www.privateforestry.or.tz/en/resources/view/financial-and-economic-analysis-of-private-forestry-investment-opportunitie

The main objectives of this study were as follows:

i. Package information about plantation forest resources and investment opportunities in the Southern Highlands in easily understandable formats and provide it to key decision-makers and potential investors;
ii. Disseminate information to relevant government agencies to increase their capacity to engage with potential forest-sector investors and other stakeholders.
iii. Identify potential investors, both local and foreign, and disseminate information to them.

There were four major deliverables:

A. Two interim technical reports:
    1. Diagnostic Assessment of the Investment Climate in the Tanzanian Forest Sector
    2. Cluster Analysis
B. Two main outputs consolidating the information in the interim reports:
    1. Roadmap for Developing the Tanzanian Forest and Wood-based Bioenergy Sectors in the Southern Highlands
    2. Investment Opportunities Information Package

This report, the cluster analysis, comprises the technical aspects of the study. The PFP will make it and the three other reports available online once its recommendations have been validated.

1.2 Report Structure

Chapter 2 estimates changes in the demand for plantation wood products in Tanzania between now and the year 2050 in order to create a basis for the study's analysis of wood product options. Chapter 3 then assesses the current availability of plantation resources before Chapter 4 analyses the balance between that supply and the predicted demand. After infrastructure and work force issues are addressed in Chapter 5, Chapter 6 presents a detailed financial analysis of priority forestry and forest industry investment clusters. Finally, Chapter 7 highlights the economic, social, and environmental factors that should be considered.

2. ANALYSIS OF WOOD PRODUCTS OPTIONS

2.1 Forecasting Demand

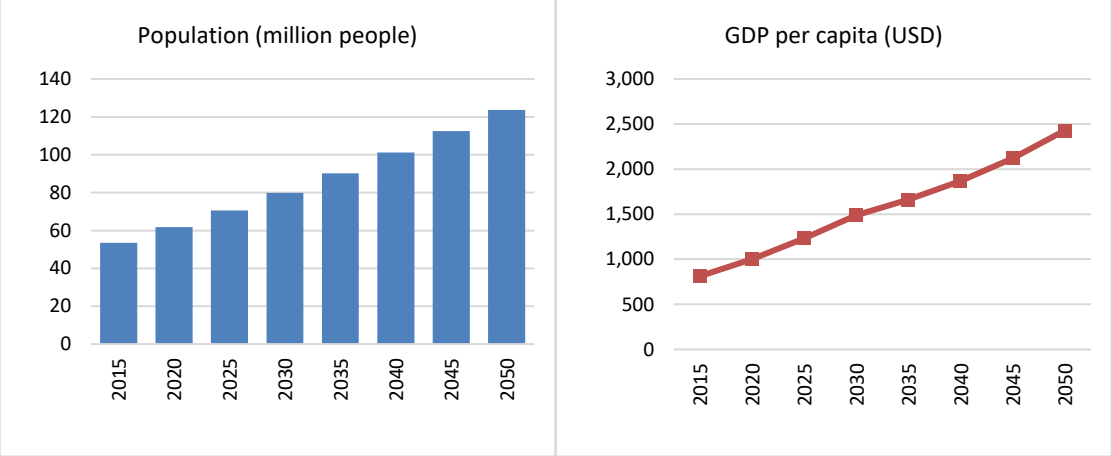
The demand for wood products is forecasted using the projected increase in Tanzania's gross domestic product (GDP) and the GDP demand elasticities of various wood products (Buongiorno, 2015).[8] These elasticities (Table 2.1) are based on long-term observations of the responsiveness of the global demand for wood products to changes in the global GDP globally and are those used in the widely-accepted global forest products model.

Although Tanzania's GDP growth has recently shown signs of slowing down, it is assumed that long-term economic growth will continue to be strong. The World Bank projects that Tanzania's GDP will grow annually by 6.9% in 2030 (Figure 2.1).[9] Beyond 2030, this growth will likely slow to an annual rate of 4.7% at which rate it will continue until 2050. According to the United Nation, Tanzania's population will increase from 53 million people in 2015 to 124 million people by 2050. This growth will, naturally, grow the economy as well.[10]

Table 2.1 The GDP Demand Elasticities Used in the Study

Product	Elasticity
Sawnwood	0.24
Veneer and plywood	0.72
Fibreboard	0.92
Newsprint	0.42
Printing and writing	0.59
Other paper and paperboard	0.40

Figure 2.1 Forecasts of Population and GDP per Capita



2.2 Wood Products

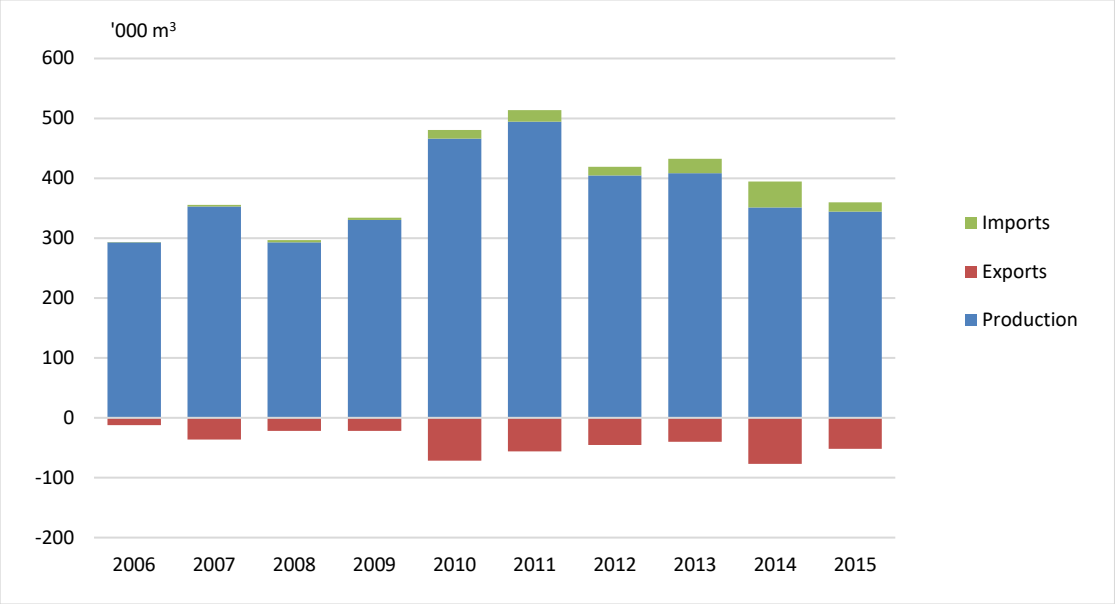
2.2.1 Sawnwood

The current production levels of sawnwood were estimated by examining the latest estimates of sawnwood production and comparing them with the volumes harvested from government forests in the past. On average, annual sawnwood production is less now than it was it was

[8] Buongiorno J. 2015. Income and time dependence of forest product demand elasticities and implications for forecasting. *Silva Fennica*, *49*(5), article id 1395.
[9] World Bank. Data: Tanzania – GDP growth (annual %). https://data.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG?locations=TZ
[10] UN. 2017. UNDATA: United Republic of Tanzania Country Profile. http://data.un.org/en/index.html

before the turn of the century, the reason for the decline is mainly the unfavourable age-class distribution of trees in the Southern Highlands.

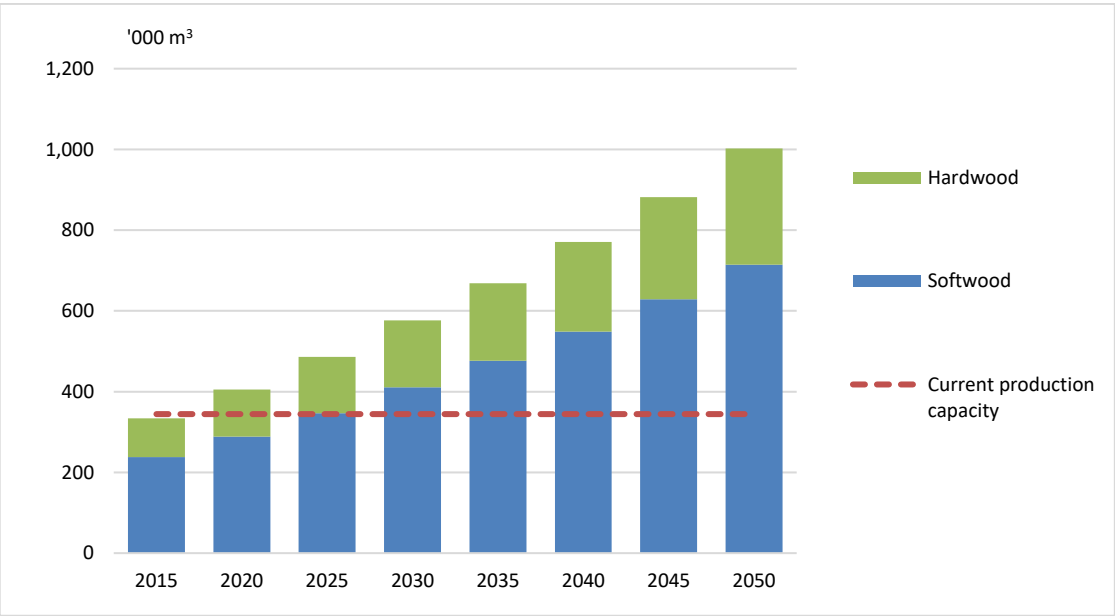
Figure 2.2 Sawnwood Production, Imports, and Exports



The current production of sawnwood exceeds the apparent current consumption in Tanzania primarily because there is a trade surplus: more hardwood sawnwood, specifically teak sawnwood, is exported than imported. Softwood sawnwood is used primarily by the construction industry, whereas hardwood sawnwood is utilised primarily by the furniture manufacturing industry.

Hardwood sawnwood is produced primarily from wood sourced from natural forests. Plantation-grown hardwood sawnwood, the majority of which is eucalyptus, comprises only a minor share of the total hardwood sawnwood consumption in Tanzania. Even so, eucalyptus sawnwood has the potential to replace some of the indigenous wood used in the production of furniture.

Figure 2.3 Forecast Domestic Demand for Sawnwood

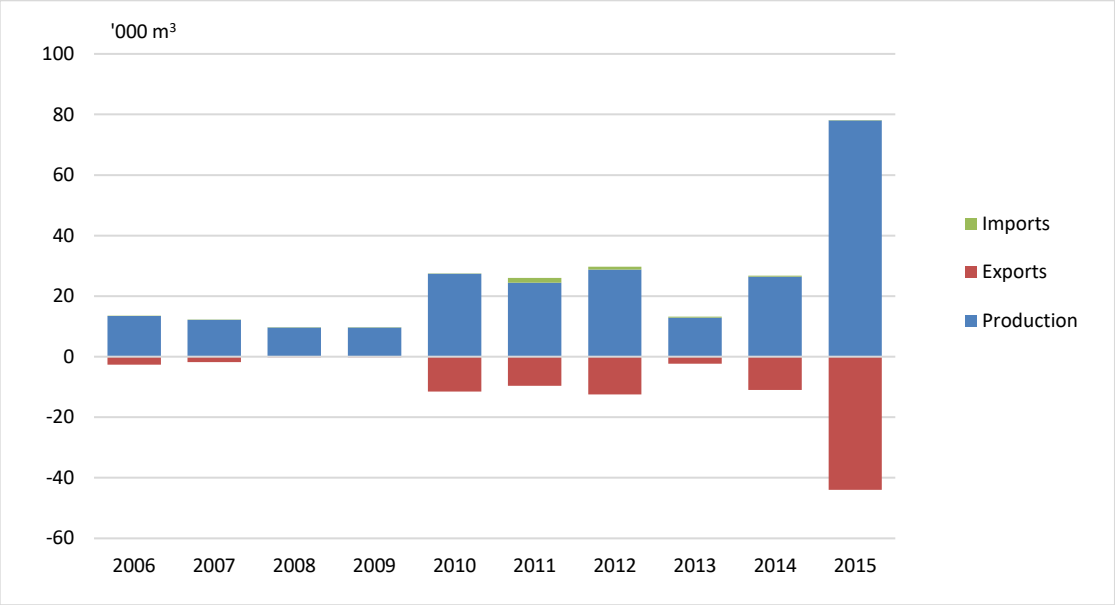


The supply of sawnwood comfortably meets the demand at present, but projected increase in demand means that, by about 2025, the current processing capacity will no longer be sufficient to satisfy the demand. By 2050, the demand for sawnwood will be around one million m^3, about three times the current production capacity of around 0.35 million m^3.

2.2.2 Veneer and Plywood

Tanzania has five main producers of veneer and plywood: Tanganyika Wattle Company, Tanganyika Plywood Limited, and three Chinese exporters of veneer. The spike in the production and export of veneer in 2015 is mostly due to the arrival of the three Chinese producers. Currently, there are very little imports of veneer to Tanzania. The domestic demand for veneer is derived from plywood demand.

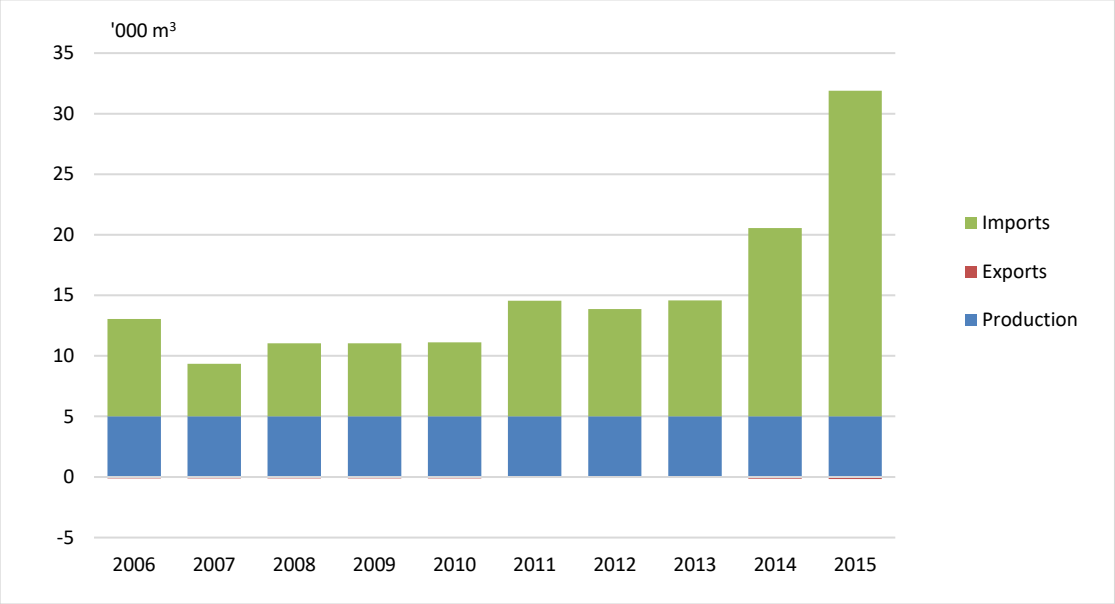
Figure 2.4 Veneer Production, Imports and Exports



Source: Estimated based on interviews and FAOSTAT data.

Currently, most of the plywood used in Tanzania is imported. The volume of imported plywood has increased quite significantly over the last two years. The volume of plywood exports, in contrast, is negligible.

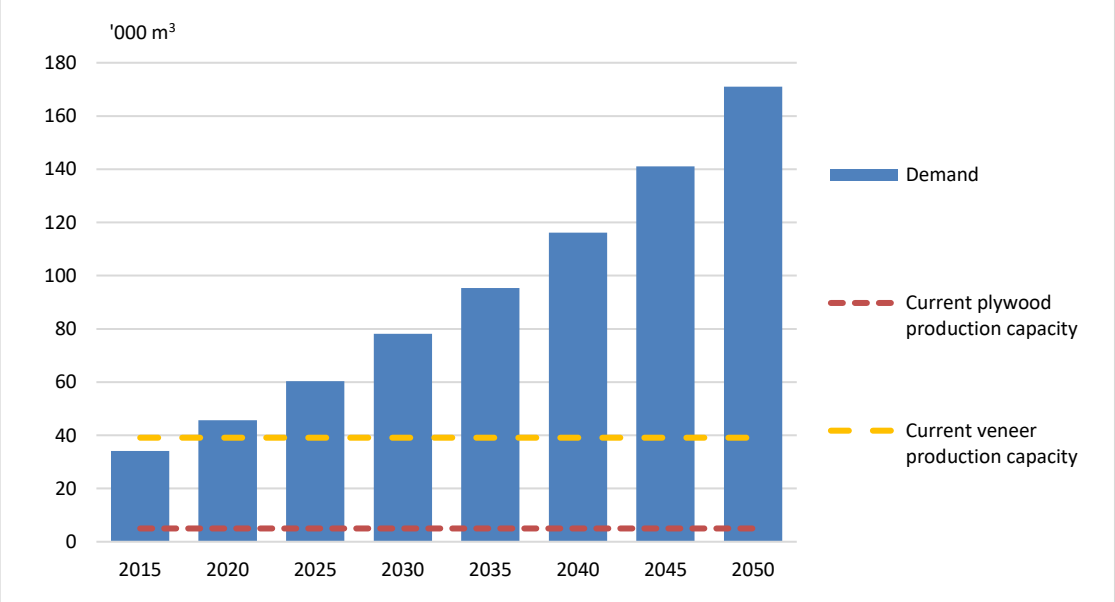
Figure 2.5 Plywood Production, Imports and Exports



Source: FAOSTAT and interviews.

As the demand for veneer is driven by the demand for plywood in the construction and furniture industries, it is estimated to increase to some 170,000 m^3 from the current 34,000 m^3. To increase capacity, investment in both plywood and veneer production is needed.

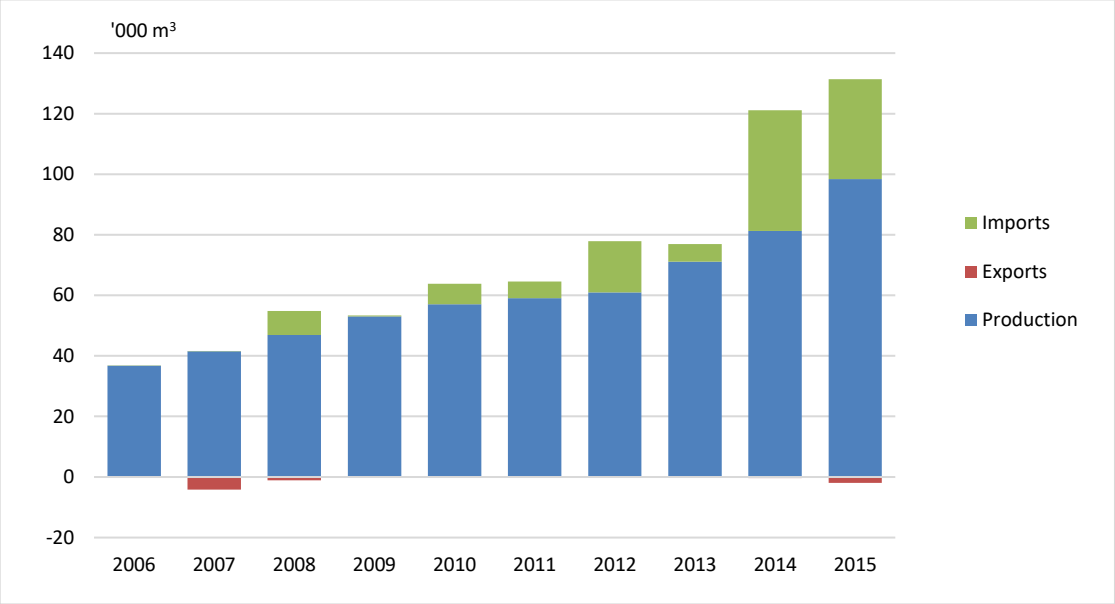
Figure 2.6 Forecast Demand for Plywood



2.2.3 Utility Poles

The largest utility pole producers in the Southern Highlands are Tanganyika Wattle Company, Green Resources, and New Forests Company. These poles are made mostly from eucalyptus.

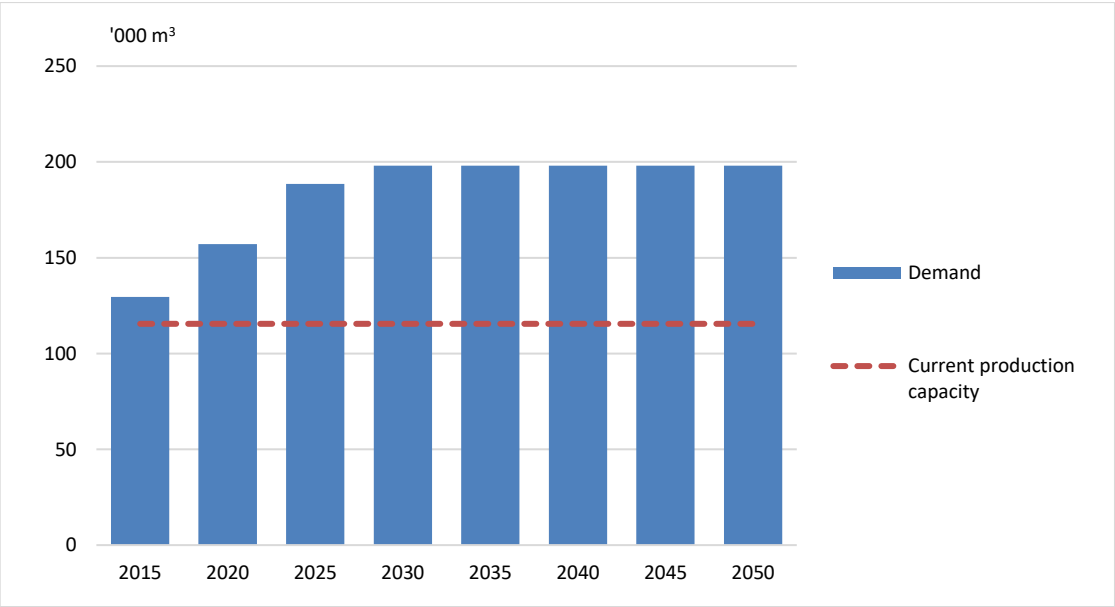
Figure 2.7 Utility Pole Production, Imports, and Exports



Source: FAOSTAT and interviews.

At present, about 350,000 utility poles are made annually and 115,500 m^3 of wood used. According to interviews with staff of the Tanzania Electric Supply Company Limited (TANESCO) and the Rural Electrification Agency, the total annual demand for utility poles will cap at 600,000 poles, or 198,000 m^3, a fact indicating the current capacity needs to be increased to meet it.

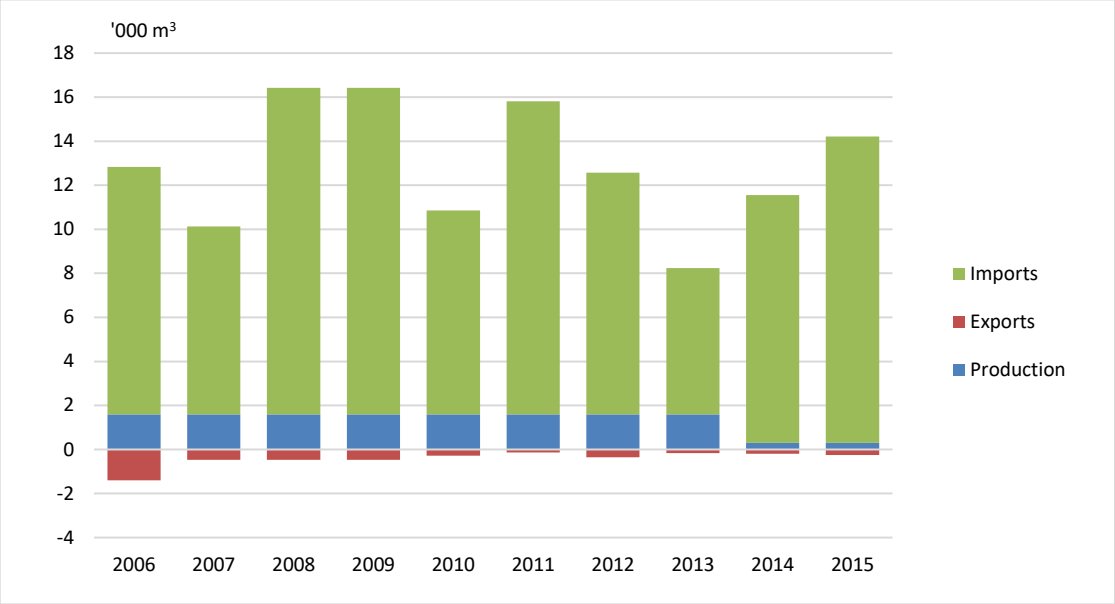
Figure 2.8 Forecasted Demand for Utility Poles



2.2.4 Wood-Based Panels

Wood-based panels, including medium-density fibreboard, particleboard, and oriented strand board are, for the most part, imported to Tanzania though particleboard was produced by Tanzanians until 2013. Now, only one Chinese operator produces what is thought to be small volumes of particleboard.

Figure 2.9 Wood-Based Panel Production, Imports, and Exports

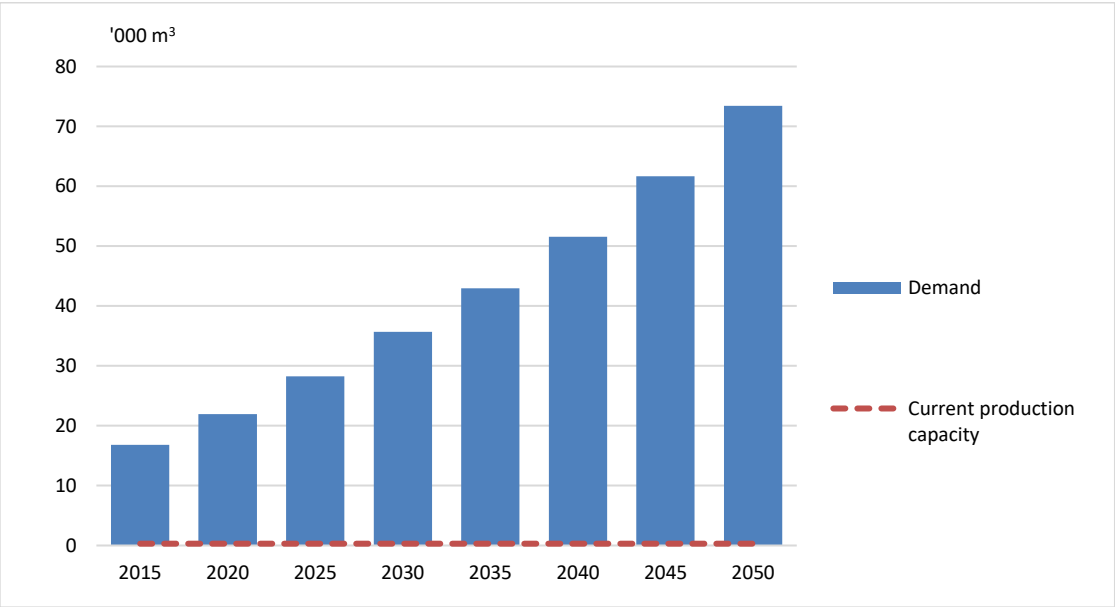


Source: FAOSTAT and interviews.

The demand for wood-based panels will continue to grow, but the quantities demanded will remain relatively small and there is unlikely to be any significant demand for particleboard. To reap the advantages of scale, a viable medium-density fibreboard plant needs a capacity of around 100,000 m³. Such a plant should concentrate only on medium-density fibreboard and oriented strand board, not on particleboard.

The gap between the projected demand for domestic wood-based panels and the supply is significant. At present, such panels are mostly imported. Since demand is very low and the electricity supply, at least in the short and medium term if not the long term, is likely to be too variable, investment in wood-based panels is not warranted.

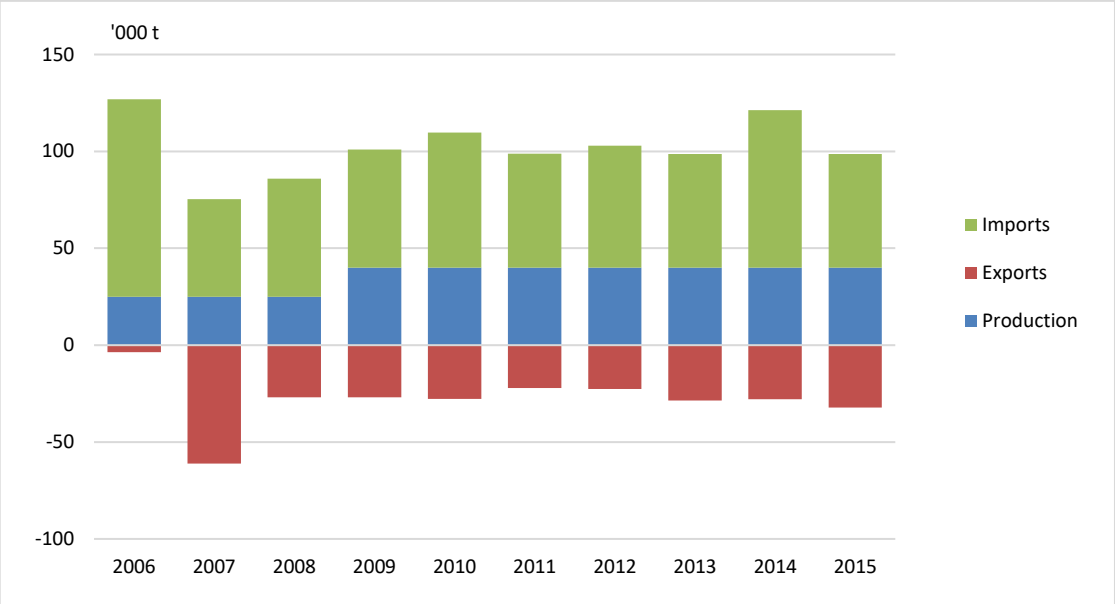
Figure 2.10 Forecasted Demand for Wood-Based Panels



2.2.5 Paper and Paperboard

Uncoated kraft is the only grade of paper produced in Tanzania. About half of it is exported and half consumed domestically. The main end-use of uncoated kraft is packaging products.

Figure 2.11 Paper and Paperboard Imports and Exports

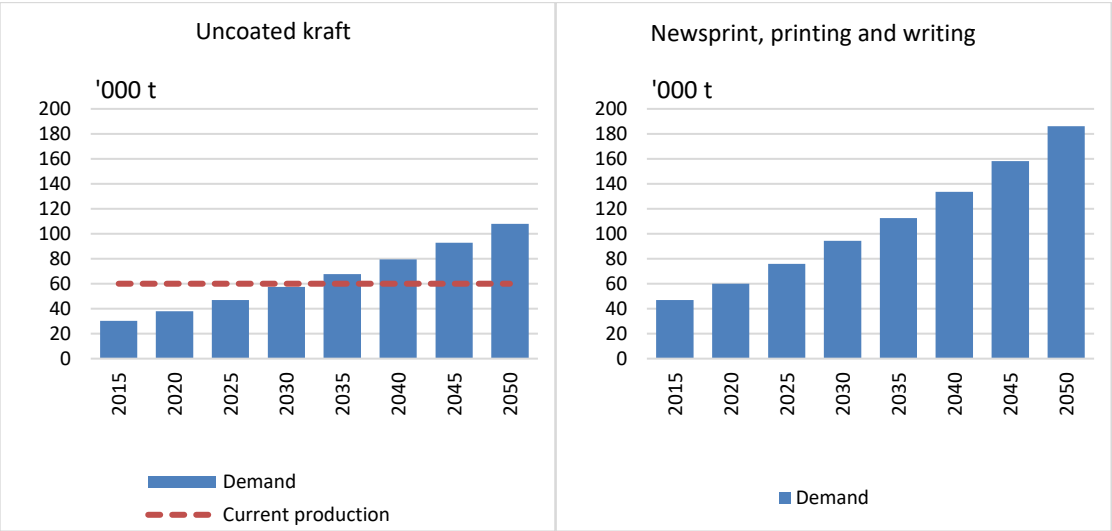


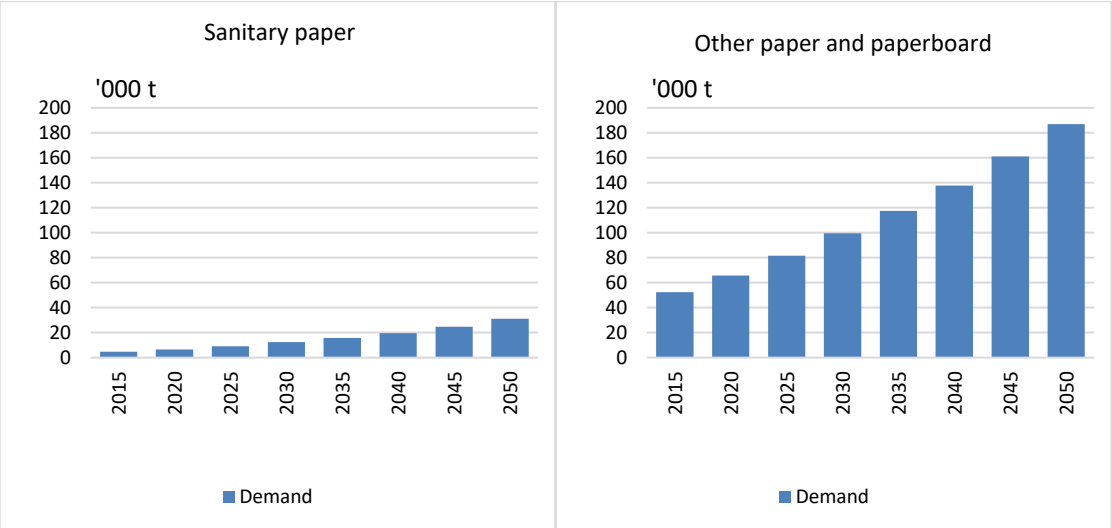
Source: FAOSTAT and interviews.

Domestic demand for uncoated kraft is forecast to surpass the current production of 60,000 tonnes between the years of 2030 and 2035 and reach 100,000 tonnes by 2050.

While the domestic demand for sanitary paper is forecast to increase faster than demand for other paper and paperboard products, the total consumption in 2050 is expected to reach only very modest 31,000 tonnes.

Figure 2.12 Forecast Demand for Paper and Paperboard



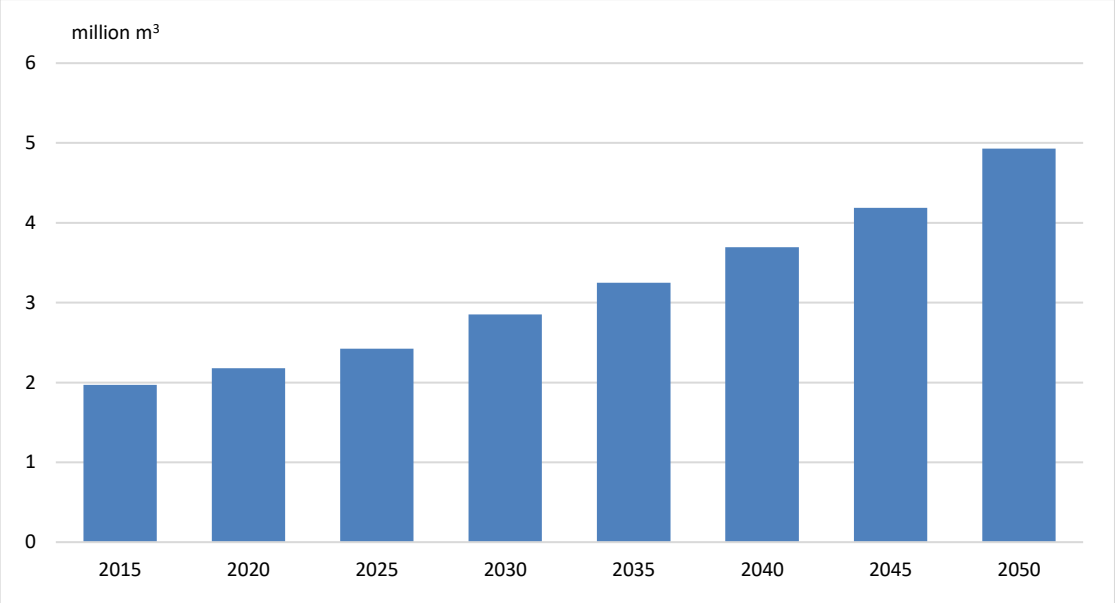


At present, pulp and paper consumption in Tanzania depends heavily on imports and may continue to do so in the future as even in the medium-term it is unlikely that there will be a steady and secure enough supply of raw material to warrant investment in a mill capable of producing pulp and paper products. In addition, the demand for these products will remain moderate.

2.3 Roundwood

Current annual roundwood production in Tanzania is around two million m^3 and will likely increase 2.8% per year until 2050.

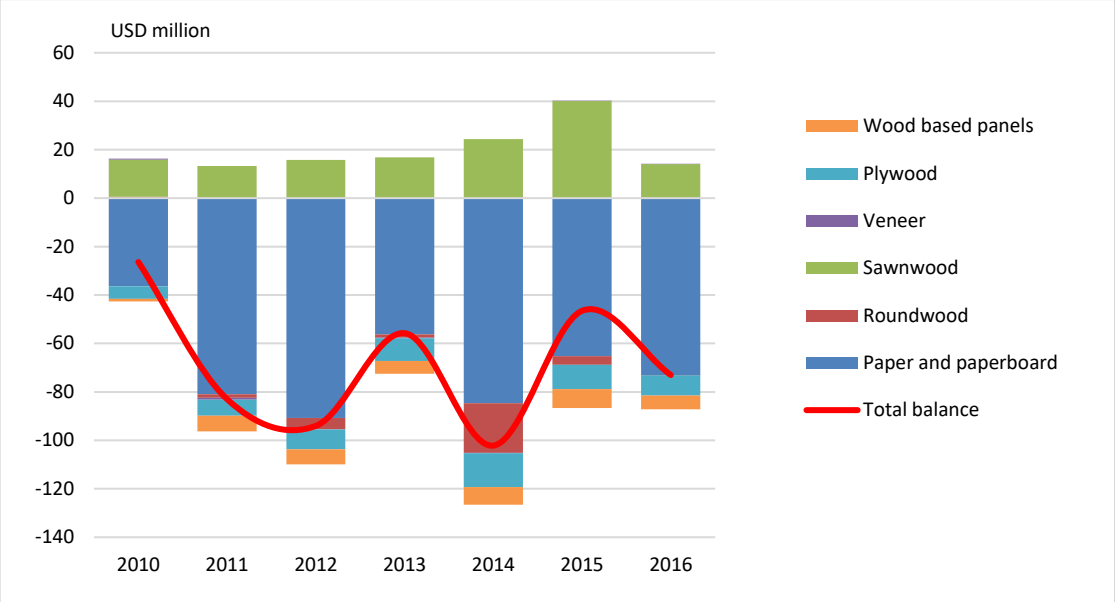
Figure 2.13 Forecast Demand for Roundwood



2.4 Trade Balance

Between 2010 and 2016, there was a trade deficit in total forest products in Tanzania, meaning that the domestic demand for forest products surpasses the domestic supply. This deficit is mostly attributable to the import of paper and paperboard products, but the import of roundwood (including utility poles), plywood, and wood-based panels has also contributed. In contrast, there was a trade surplus of USD 20 million for sawnwood exports, dominantly of teak sawnwood exports during the same period. Since 2015, veneer has also had a trade surplus, but both its value and its volume were small.

Figure 2.14 Trade Balance in Tanzania by Value, 2010-2016

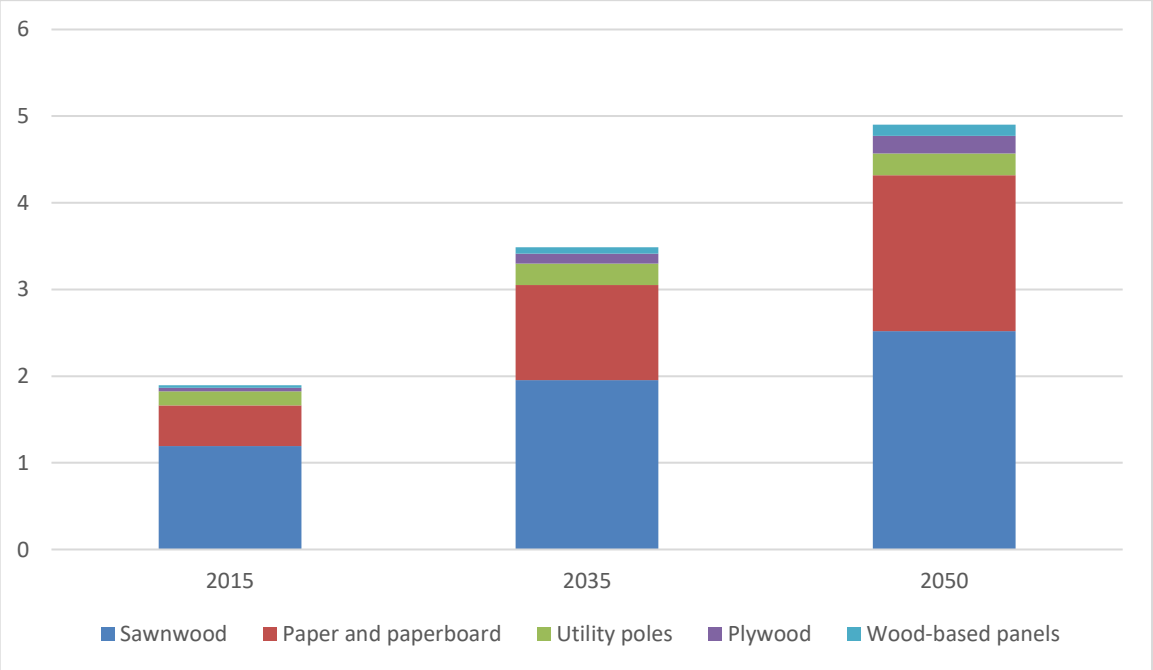


Source: UN COMTRADE, 2017.

2.5 Implications of the Forecast Demand for the Forest Sector

In 2050, the domestic demand for forest products will total about 5 million m^3 roundwood equivalent. Figure 2.15 shows how the aggregate demand for five main wood product categories will change over time. All will rise until 2050 except for the demand for utility poles, which, it is assumed, will reach a cap once electrification reaches national targets and the demand for utility poles no longer includes new poles but just replacement ones.

Figure 2.15 Aggregate Demand for Plantation Wood Products over Time



The key take-aways from the wood products analysis are as follows.

- The domestic demand for utility poles will increase and more capacity should be installed to match it (Figure 2.8).
- Sawnwood production capacity should be increased to match domestic demand (Figure 2.3).
- Veneer and plywood capacity should be increased (Figure 2.6)
- Domestic demand for fibreboard and particleboard will not warrant investment into new production capacity. Instead, relying on the import of products may be the best option.
- The demand for paper products will remain moderate and new investments in its production capacity do not seem justifiable.

3. AVAILABILTIY OF PLANTATION WOOD RESOURCES

3.1 Existing Plantation Resources

About 80% of Tanzania's plantation forest area is located in the Southern Highlands, and it is here that most of the primary wood products for the Tanzanian construction and furniture industries are produced. The Southern Highlands has the land and biophysical characteristics to expand wood resources expansion as well as the infrastructure to support investment in the forest industry.

In 2016, the University of Turku and the Food and Agricultural Organisation of the United Nations (FAO) mapped the existing forest plantations in the Southern Highlands[5] using a multi-sensor approach which included Landsat OLI, Sentinel-1 and Sentinel-2 satellite images, the SRTM Digital Elevation Model, and Hansen Global Forest Change data acquired between 2013 and 2016. A supervised random forest algorithm was used to classify data, which was collected by supervised Tanzanian university students and staff.

The accuracy of the plantation mapping exercise, 91.5%, was good and means that its estimate of existing plantation resources is generally correct. That said, the mappers found it difficult to identify recently established plantations (those identified in the last three years), so the estimate is probably on the low side. Another shortcoming of the mapping was that it was limited in its ability to assess the species, age classes, and densities of various plantations.

This study modified the plantation mapping data by using the most recent Sentinel-2 satellite imagery and very high-resolution satellite images available at Google Earth to remove forest areas that were non-plantation. The removal was conservative: only clearly non-plantation forest areas were removed; unclear areas were left. Approximately 5% (11,000 ha) of the plantation area was removed.

The 2016 plantation mapping found that about 196,000 ha of plantations lie in the Southern Highlands area. About 67% (132,000 ha) of the plantations are pine, 19% (37,000 ha) are eucalyptus and 13% (26,000 ha) are wattle (*Acacia mearnsii*). The majority of plantations are around Mafinga and Njombe, but the districts of Makete, Mbeya and Kilolo also have substantial areas dedicated to plantation (Figure 3.1). Pine plantations are found in all five districts, but eucalyptus plantations are concentrated in Mafinga, Njombe and Mbeya. The majority of wattle plantations are in Njombe. About 139,000 ha of plantations are owned by smallholders, 36,000 ha by the government, and 20,000 ha by companies (Figure 3.2). Almost all government plantation resources are located in and around Mafinga though a small area is also found in Mbeya. Private companies have plantations in Mafinga and Njombe.

Figure 3.1 Plantation Resources in the Southern Highlands by Species

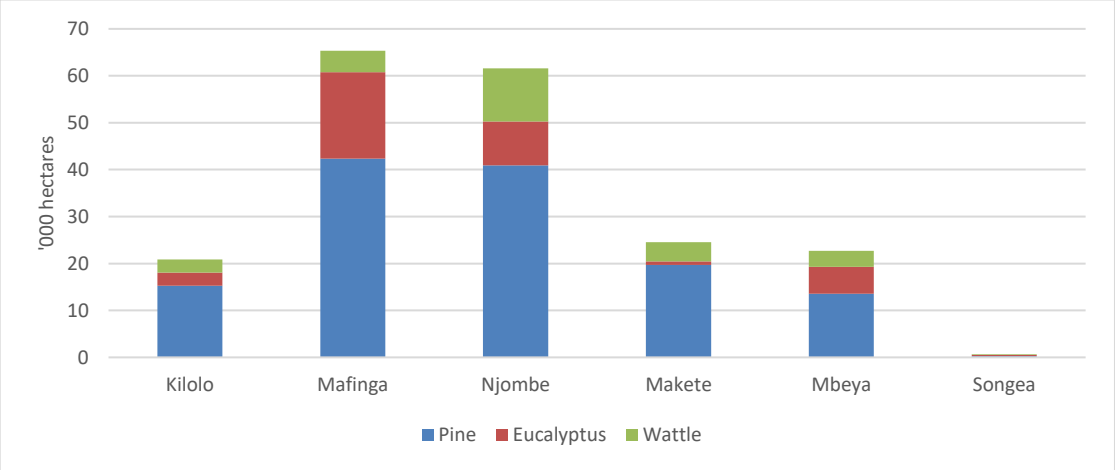
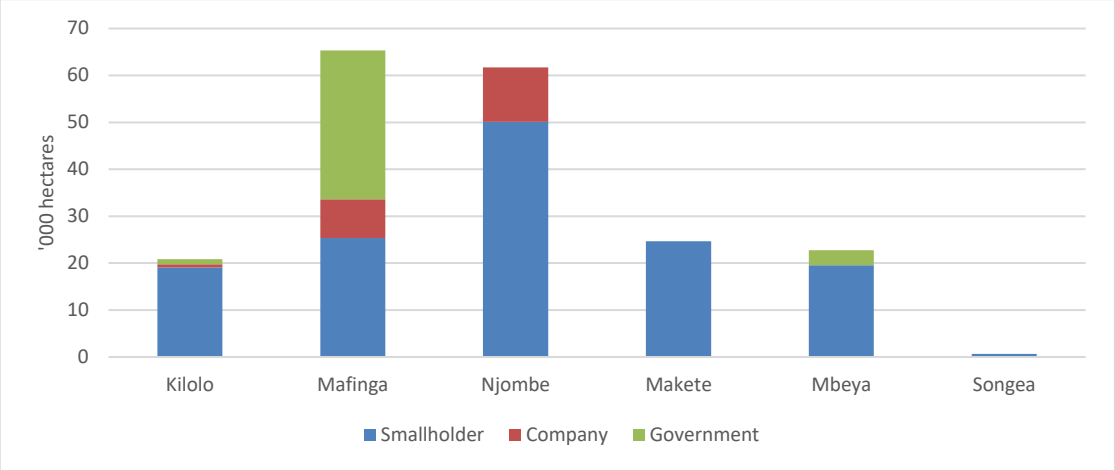


Figure 3.2 Plantation Resources in the Southern Highlands by Ownership



3.2 Potential for Plantation Expansion

3.2.1 Approach

The potential for expanding plantation in the Southern Highlands was evaluated by estimating the area and location of land suitable for tree plantations. Suitability for tree plantation was evaluated with spatial multi-criteria analysis (SMCA), a planning tool used to identify the most suitable locations for various land allocations using those multiple spatial criteria[11] which influence the particular land allocation desired. The spatial variables chosen, like land cover, and their attributes, like montane forest, open woodland, grains and crops, are then standardised and weighted according to how much they influence the land allocation in question. In the end, the values of the weighted and standardised attributes of all the variables are summed for the spatial unit of the analysis chosen, whether pixel or polygon. The value calculated for the unit represents its potential for the land allocation. In comparison with the values of all the other units, this value can be then used to estimate the most and the least suitable locations for the particular land allocation.[11]

In short, an SMCA follows these steps:

1. Setting a target
2. Identifying criteria and spatial variables representing those criteria
3. Standardising the attributes of the variables
4. Weighting the variables
5. Calculating suitability ranking
6. Apportioning suitability rankings to suitability classes
7. Evaluating the outcome

The target of the SMCA of this study was to identify areas in the Southern Highlands and Ruvuma Region suitable for the commercial planting of pine and eucalyptus trees. The site requirements of *Pinus patula* and *Eucalyptus grandis* were used as indicators of the suitability of a particular area of land for pine and eucalyptus plantation. These requirements were based on the EcoCrop (2013)[12] database managed by FAO (Table 3.1). The suitability of land for drought-resistant eucalyptus and pine species was determined by modifying annual rainfall requirements to significantly lower levels.

[11] Malczewski, J. (1999). GIS and multicriteria decision analysis. New York, U.S.A : John Wiley & Sons..
[12] Ecocrop, 2013. Ecocrop database. FAO, Rome, Italy.

Table 3.1 Site Requirements of the Species Used in the SMCA

Pinus patula	Optimal		Absolute	
	Min.	Max.	Min.	Max.
Temperature	16° C	30° C	10° C	34° C
Precipitation	1000 mm	2000 mm	700 mm	3000 mm
Soil depth	> 150 cm		> 20-50 cm	
Soil texture	Medium to light		Heavy, medium, light	
Soil fertility	Moderate		Moderate	
Soil drainage	Good		Poor	

Eucalyptus grandis	Optimal		Absolute	
	Min.	Max.	Min.	Max.
Temperature	17° C	23° C	13° C	28° C
Precipitation	1000 mm	2500 mm	700 mm	4000 mm
Soil depth	> 150 cm		> 50-150 cm	
Soil texture	Medium to light		Heavy, medium, light	
Soil fertility	High		Low	
Soil drainage	Good		Poor	

The site requirements for eucalyptus and pine were used as the criteria for eucalyptus and pine suitability, and spatial datasets corresponding to these requirements were collected and modified as variables for the SMCA. Altitude was not used as a variable because the effects of altitude were instead modelled through temperature and precipitation. A more detailed explanation of the SMCA, including the data it used and how variables were standardised are found in Annex 1.

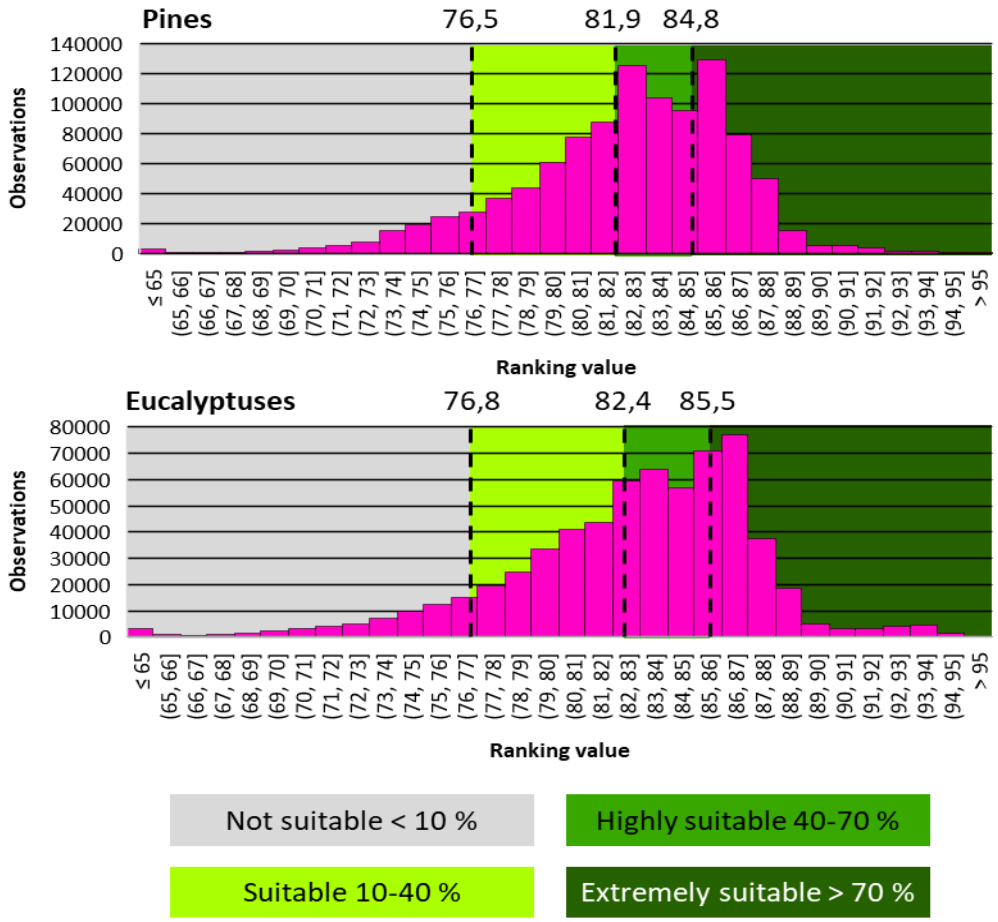
The SMCA included a total of nine variables representing climate, topography, soil, agricultural pressure, and accessibility. Two variables, land cover and protected areas, were used to define 'no-go zones,' areas where plantation activities should not be allowed. The weightages assigned to the variables are presented in Table 3.2.

Table 3.2 Weightages Used in the SMCA

Variable	Weight
Rainfall	24 %
Growing season temperature	10 %
Slope	10 %
Ruggedness	8 %
Soil fertility	10 %
Soil depth	6 %
Soil drainage	10 %
Agriculture areas	6 %
Distance to roads	10 %

Once the weightages were set, continuous suitability results were calculated to provide a suitability ranking from 0 to 100. This ranking was then classified into four suitability classes – not-suitable, suitable, highly suitable, and extremely suitable – based on the suitability rankings of existing forest plantations and woodlots. PFP experts concluded that approximately 10% of current plantations are in areas that are not fully suitable for tree planting. Those areas which had suitability rankings lower than the worst 10% of existing plantations were classified as non-suitable (Figure 3.3). The remaining area was divided into terciles, with the first classified as suitable, the second as highly suitable and the third as extremely suitable. Pines and eucalyptuses were classified separately.

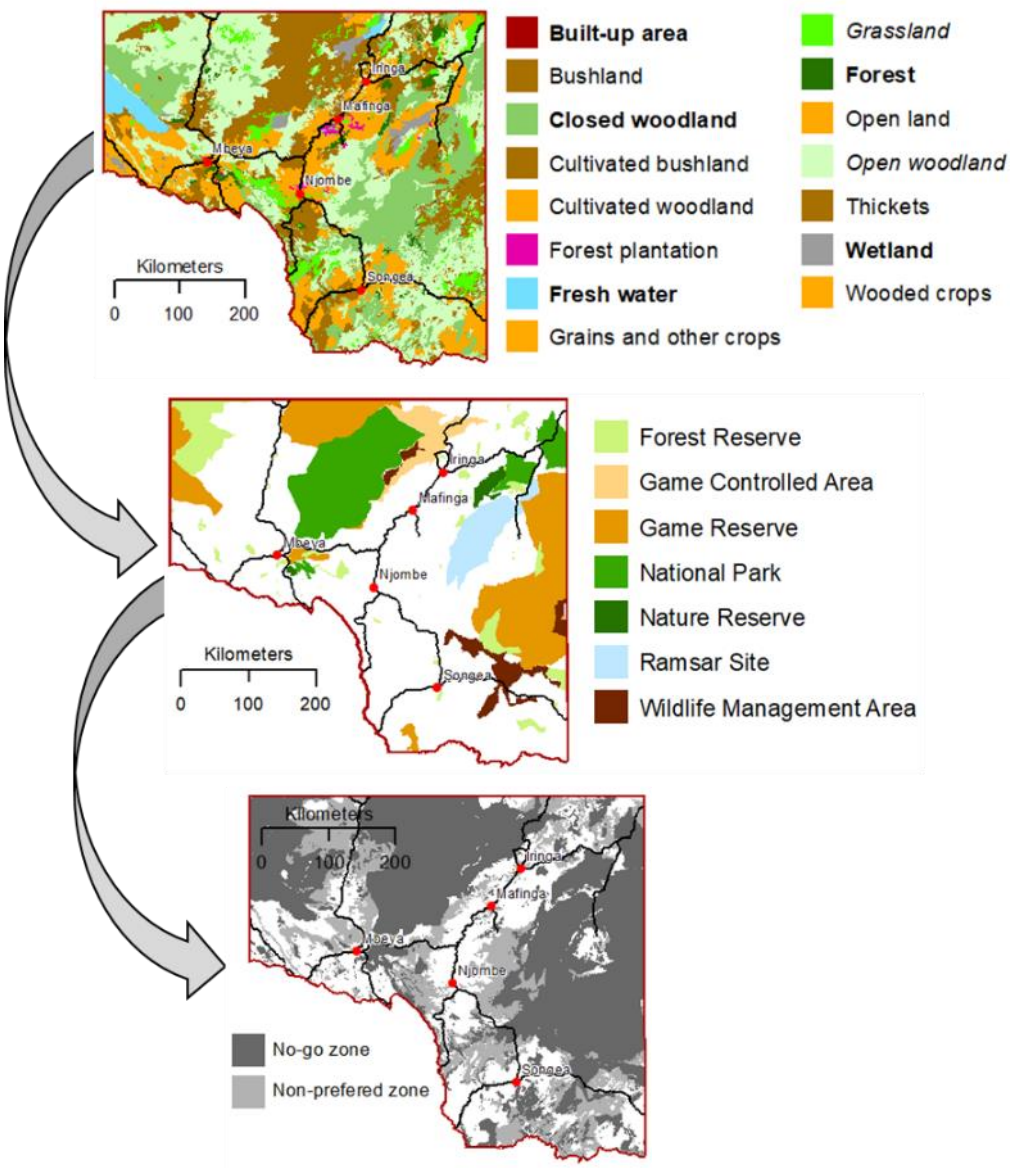
Figure 3.3 Suitability Classification according to the SMCA Results



The accuracy of the suitability results was evaluated using a field survey with questions related to land use, land cover, vegetation, plantation performance, topography, soil texture, soil drainage, and land ownership. The questionnaire was made for Open Data Kit Collect, which allows a surveyor to register GPS locations while answering questions about site conditions. After observing 121 sites, the field surveyor defined the overall suitability of each for plantation.

The results of the field survey were then compared statistically to those of the SMCA. Using their respective classifications of pine, a confusion matrix including the overall, producer, and user accuracies of the SMCA classification was calculated. See Annex 1 for details.

Figure 3.4 Data Used to Define No-Go and Non-Preferred Zones



3.2.2 Results

Approximately 3.8 million ha of land in the Southern Highlands is suitable for pine plantations (Figure 3.5). Of that area, 2.8 million ha lies in allowed areas and 1 million ha in not-preferred zones (NPZs). Approximately 15% (0.57 mil. ha) of the suitable land is highly suitable and 10% (0.39 mil. ha) is extremely suitable. When drought-resistant pine species are considered, the total suitable area increases by almost 20% (0.74 mil. ha) though most of that increase lies in suitable areas and little in either highly nor extremely suitable areas.

Table 3.3 Suitability Results for Pine

	Pine (in 1,000 ha)			Drought-resistant pine (in 1,000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	2 032	796	2 828	2 561	974	3 535
Highly suitable	435	136	570	452	136	588
Extremely suitable	318	67	385	328	67	396
Total	2 784	999	3 783	3 341	1 178	4 519

* NPZ = Not-preferred zone.

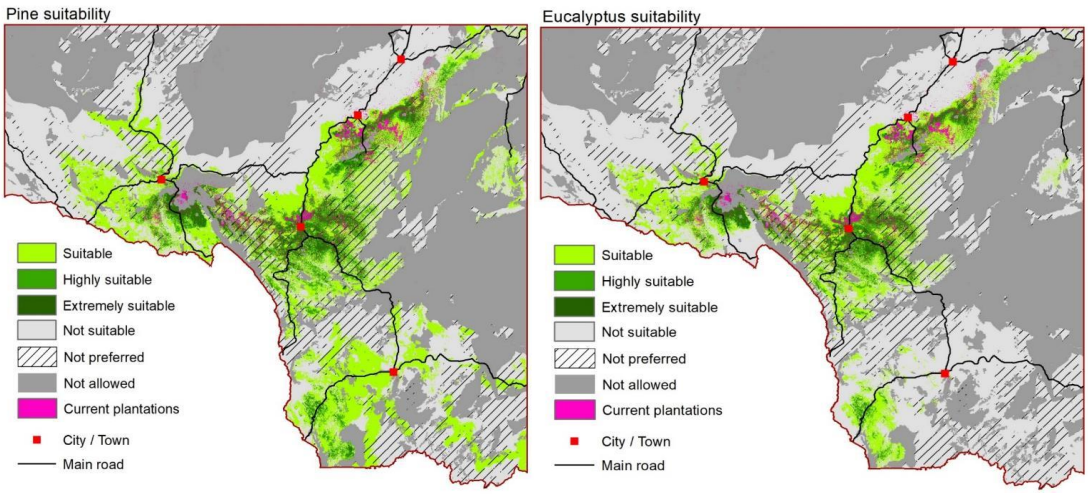
The suitable area for eucalyptus plantation (2.3 mil. ha) is somewhat smaller than that for pine plantation (Table 3.4). Of that area, 0.8 million ha lies in allowed land areas and 0.6 million ha lies in NPZs. Over 20% of the total suitable land is highly suitable and 12% is extremely suitable. Planting drought-resistant eucalyptus would increase the total suitable land area by 17% (0.49 mil. ha), but the area that is either highly or extremely suitable would increase only by 3% (0.03 mil. ha). The areas suitable for pine and eucalyptus plantations overlap.

Table 3.4 Suitability Results for Eucalyptus

	Eucalyptus (in 1,000 ha)			Drought-resistant eucalyptus (in 1,000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	1 170	413	1 583	1 559	494	2 053
Highly suitable	376	104	480	393	105	498
Extremely suitable	231	41	272	239	41	280
Total	1 777	559	2 336	2 191	639	2 830

* NPZ = Not-preferred zone

Figure 3.5 Suitability Maps for Pine and Eucalyptus



4. SUPPLY-DEMAND BALANCE

4.1 Current Situation

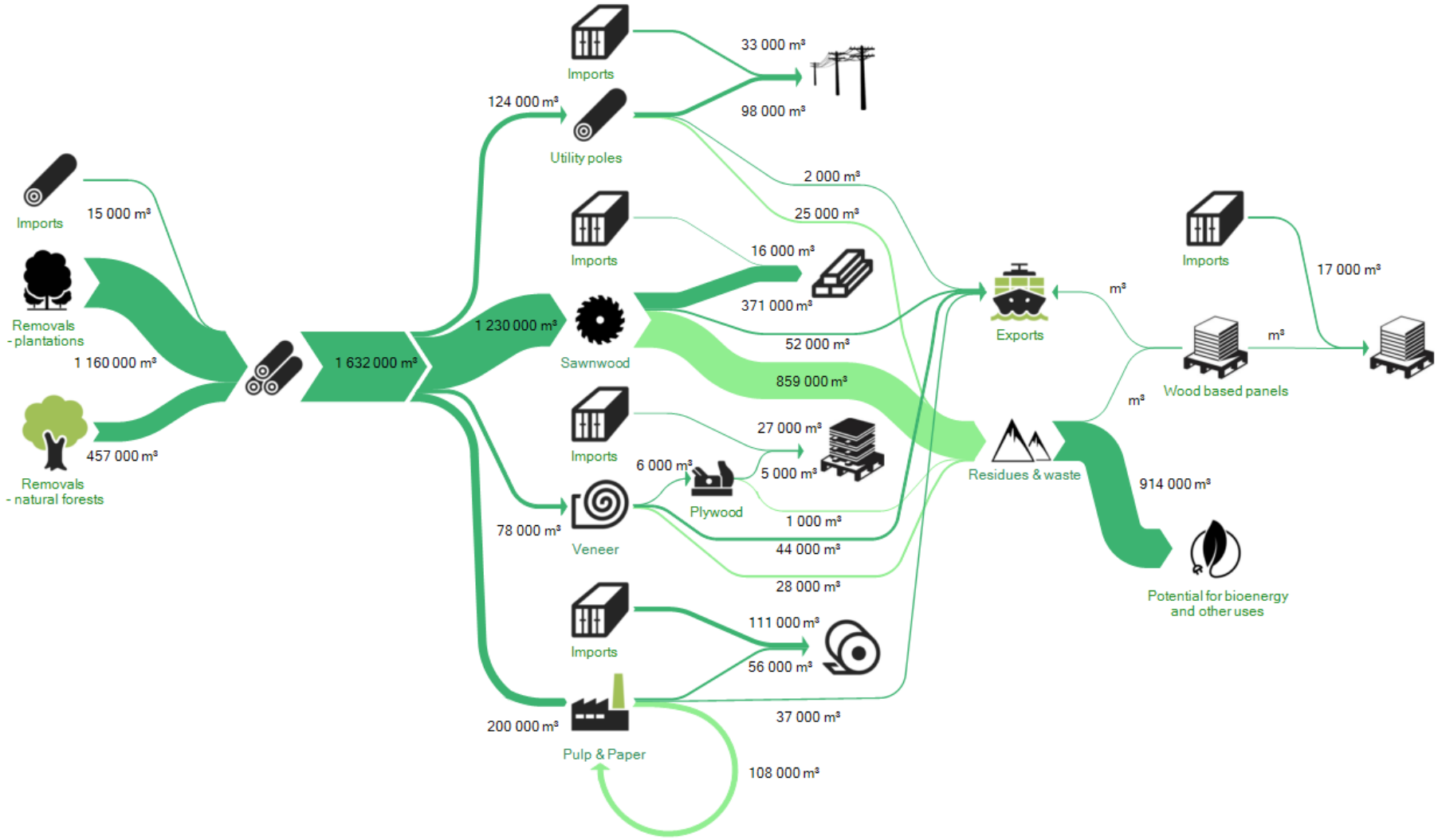
Figure 4.1 shows wood flows in 2015, the only year for which complete data was available. About 1.2 million m^3 of wood was harvested from plantations and the forest industry used almost 1.6 million m^3 of roundwood.

Of the total wood consumed, the sawmilling industry used the majority (over 1.2 million m^3). About 400,000 m^3 of sawnwood was consumed domestically and over 50,000 m^3 was exported. The roundwood consumption volume indicates that the residues from sawnwood production amounted to 860,000 m^3.

The pulp and paper industry, primarily the production of kraft paper by Mufindi Paper Mills, used the second largest amount of roundwood. Mufindi's annual use of pine roundwood was 200 000 m^3. Roughly half of the amount of kraft paper produced was exported, primarily to Kenya, India, and Uganda as well as Middle Eastern and Southeast Asian countries. Two-thirds of the paper consumed in Tanzania was imported.

Producing utility poles requires 170,000 m^3 of roundwood annually. The majority of the transmission poles are used domestically, and most are eucalyptus.

Figure 4.1 Wood Flows in Tanzania in 2015



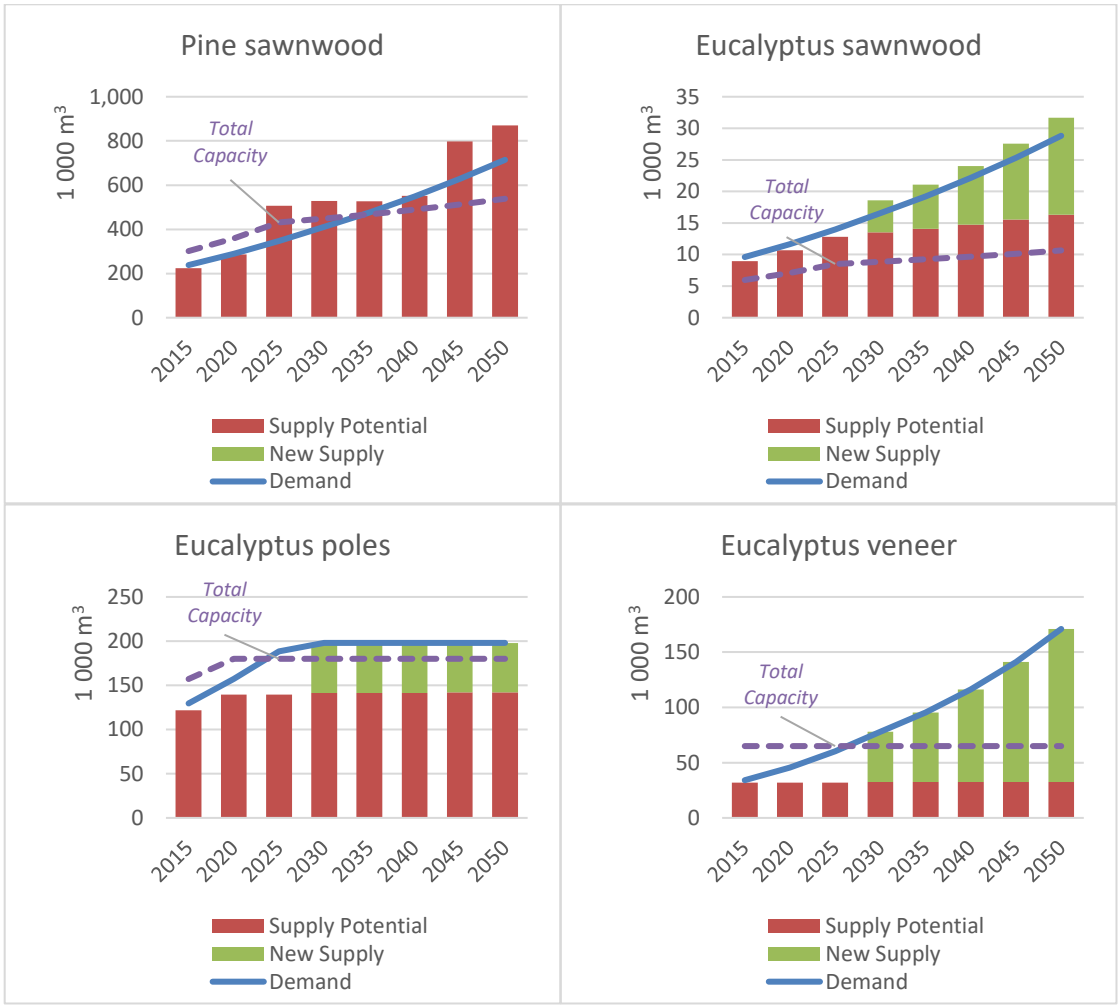
4.2 Supply-Demand Balance over Time

If pine plantations are managed sustainably and utilised efficiently, the supply of pine plantation wood should be enough to meet the demand in the long-term, but the capacity of sawmilling to recover wood needs to be improved.

More eucalyptus plantations need to be established to satisfy the increasing demand for utility poles and veneer. The same plantations that produce veneer log will be able to produce enough sawnwood logs to satisfy the demand for eucalyptus sawnwood. The scale of eucalyptus sawmilling will not be significant.

The demand for logs varies greatly across the Southern Highlands. These imbalances are addressed in this study's recommendations for investing in each of the six key clusters.

Figure 4.2 Supply-Demand Balance of Key Products in Tanzania[13]

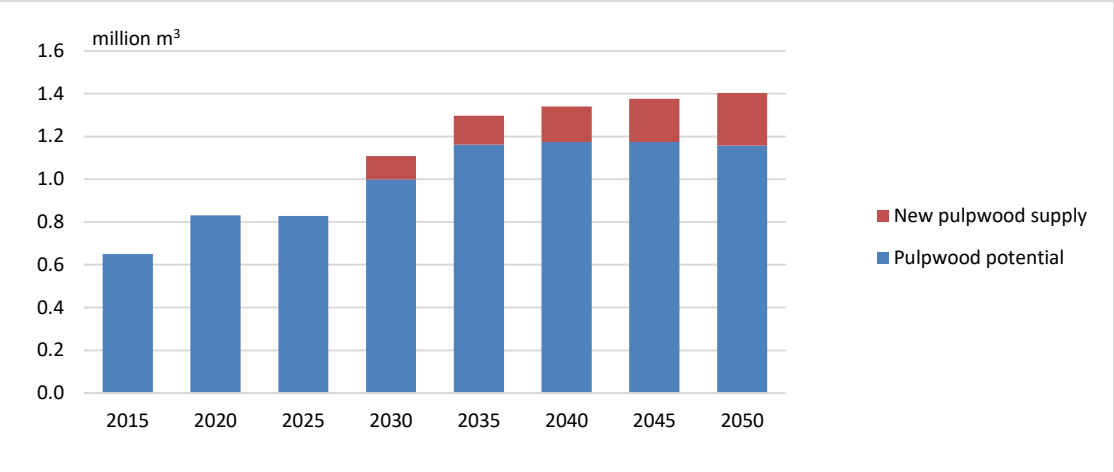


In 2050, some 1.4 million m^3 of pulpwood will be available in Tanzania. This volume is two times what it was in 2015. At the moment, however, pulpwood has few viable uses in Tanzania and pulpwood resources are scattered across the Southern Highlands. For these

[13] Supply potential refers to the amount of roundwood that could be produced on existing plantations, whereas new supply refers to the roundwood supply that could be harvested from proposed plantations.

reasons, investing in a large-scale operation to produce this raw material is unlikely to be profitable. That said, pulpwood use may change in the medium term due to the increase in the amount of discussion about both grading logs and developing in-country pulpwood markets.

Figure 4.3 Pulpwood Supply in Tanzania



Pulpwood could be chipped to increase the cost efficiency of transportation, and if there were a functional rail connection in the Southern Highlands, the export of chipped pulpwood through sea ports could be viable, given that the regulatory framework of the country supports such a development. Minimising the lower diameter limit for sawmills could also decrease the amount of pulpwood left unused though it would, at the same time, lower the recovery rates of sawmills.

4.3 Forest Industry Development

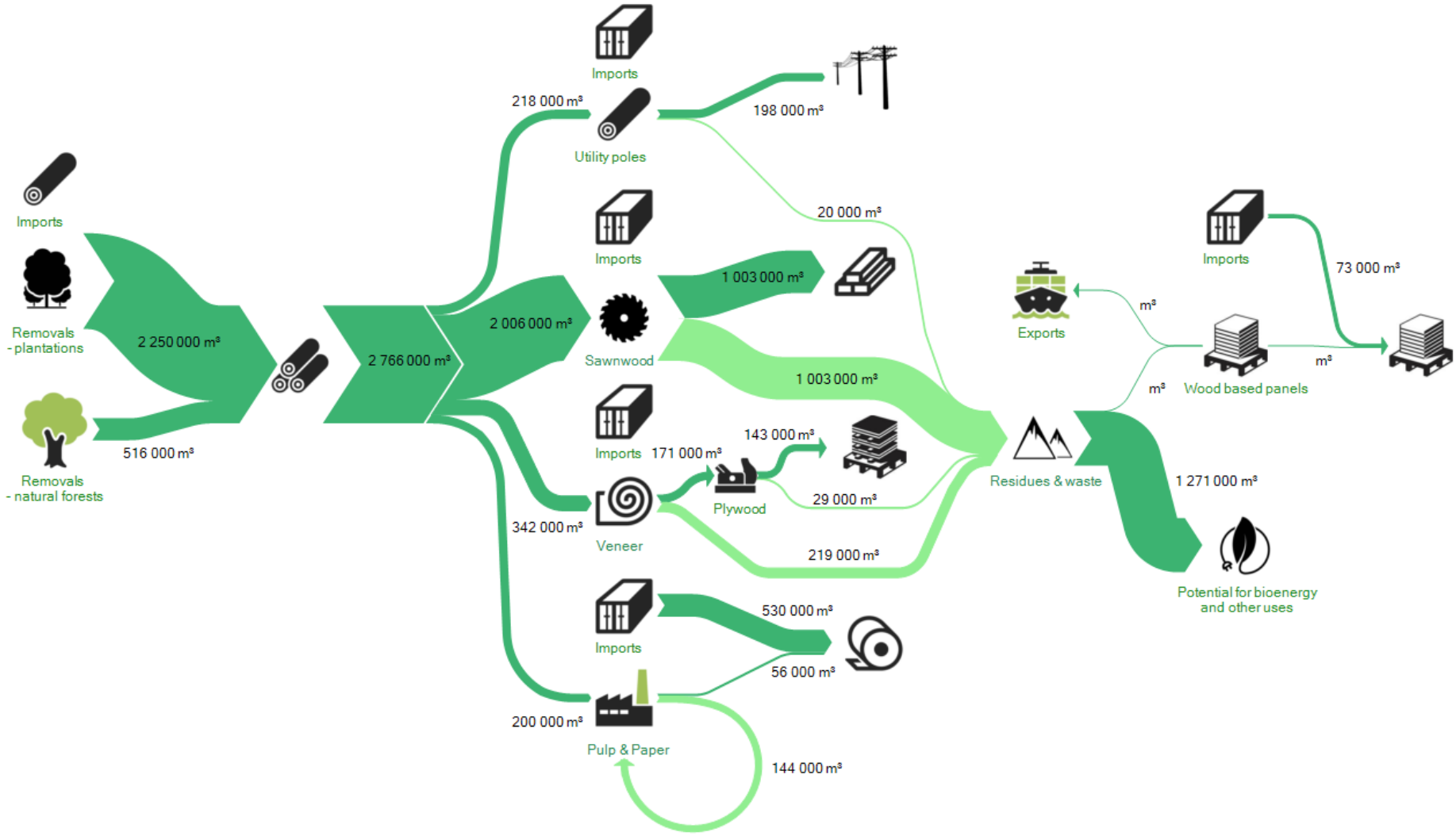
The forest industry development assumed that Tanzania will expand its plantation resource base and increase its domestic production capacity to meet the forecast demand. If the investments recommended in this study are made, future wood flows should be as shown in Figure 4.4.

Through plantation, the future domestic demand for both pine and eucalyptus sawnwood can met and the share of harvesting from natural forests decreased though the volumes will likely continue to increase because the furniture industry now demands large amounts of hardwood sawnwood and is expected to continue demanding indigenous hardwood species since eucalyptus has limited potential to replace these species.

The study concluded that, by developing its domestic industrial capacity and wood supply, Tanzania can become self-sufficient in utility poles, sawnwood, and plywood though it will probably still depend on imports of pulp and paper products as well as wood-based panels because the forecast demand for both is too low to justify investment in their production.

The nation’s consumption of utility poles is expected to cap and level off at about 600,000 poles by 2030 since pole consumption is driven by rural electrification, which is expected to intensify in the near future and then slow down.

Figure 4.4 Wood Flows in Tanzania in 2050



It seems as if the area under pine plantation is enough to satisfy the current demand for products, but the supply will continue to suffice only if all the areas harvested are replanted and forests are managed in a sustainable fashion that allows for even wood flows. While there is no need for establishing new pine plantations, in the medium term, overall sawmilling capacity needs to be increased, and, in the long term, the current recovery rates of sawmills and their capacity as a whole will need to be boosted.

In contrast, more eucalyptus plantations do indeed need to be established, primarily to satisfy the increasing demand for veneer and utility poles. In the long-term, the capacity to process eucalyptus also needs to be increased.

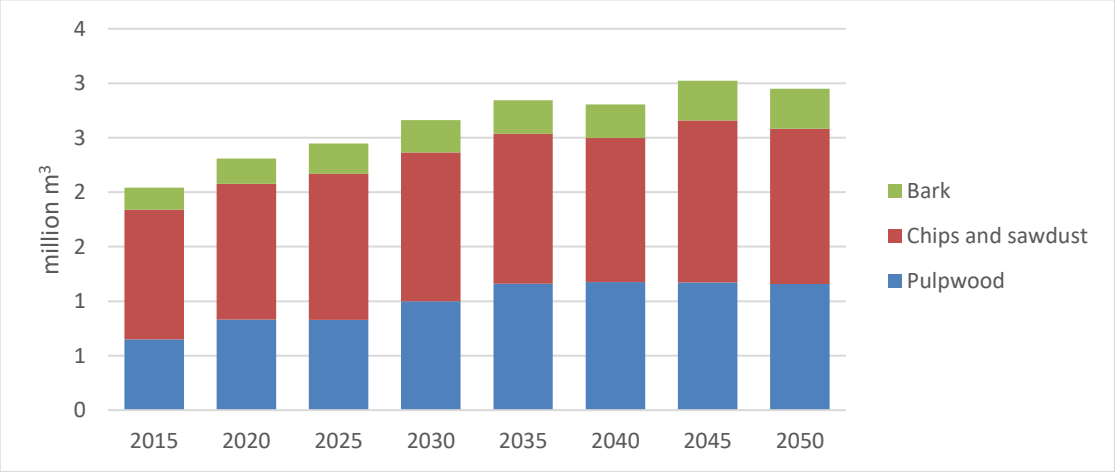
4.4 Bioenergy Potential

The Tanzanian wood industry produces huge amounts of waste (Figure 4.5), including bark, chips and sawdust. There is no industrial use for pulpwood either. Not only can waste be a valuable raw material for various purposes, but the efficient cascading use of all wood assortments can give the forest industry a unique competitive advantage over other sectors.

The most significant bioenergy potential in Tanzania lies in substituting for the household use of charcoal. FAOSTAT data[14] estimates the current wood use for charcoal production is 24 million m^3 per year. Waste from sawmilling could be developed into briquettes that could replace charcoal made from indigenous tree species. Plants which make such wood-waste briquettes already exist in Tanzania, and the technology they use could be adopted on a large scale.

When sawmills make their investment plans, they should consider investing in improved technologies like improved drying technologies and boilers so that by-products from sawmilling can be used efficiently on site.

Figure 4.5 Pulpwood, Residues, and Bark Produced in Tanzania



[14] FAOSTA. 2017. Production and trade statistics. http://www.fao.org/faostat/en/#data

5. POTENTIAL FORESTRY CLUSTERS

5.1 Cluster Definition

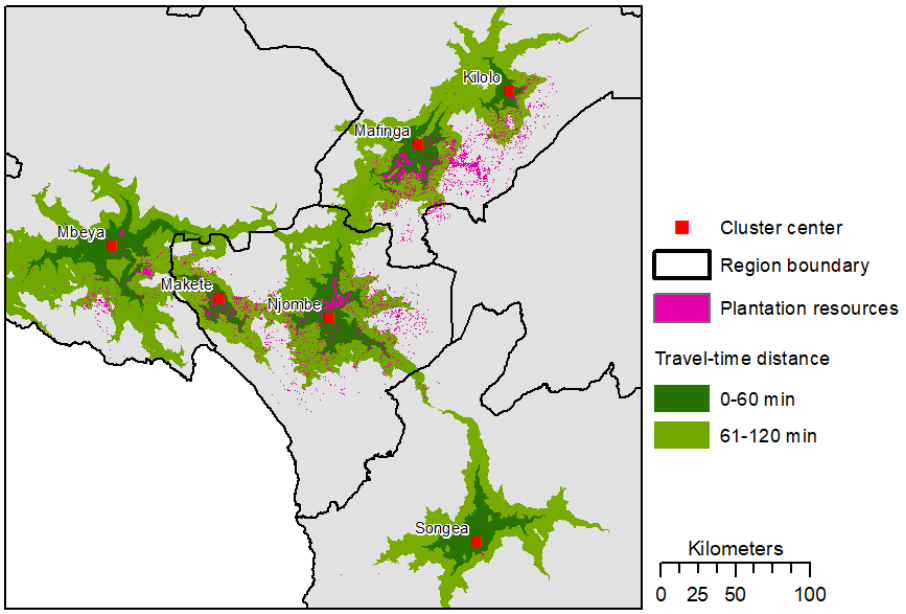
To match the demand identified in Tanzania and to direct investments into industries and areas with ample raw material, the study analysed Tanzania's wood- and wood product-producing areas with the aim of identifying potential clusters for industrial development.

These clusters were identified based on the availability and accessibility of forest resources as well as current and potential future processing capacity using an iterative process which started with the well-established forestry clusters in Njombe and Mafinga. In each iteration, new cluster centres were placed in areas which had substantial available forest resources and were inaccessible to earlier identified clusters. Inaccessibility was defined as being more than two hours' travel time from a cluster centre with processing facilities. The plantation resources used in the study are, for the most part, based on a plantation mapping conducted by FAO and University of Turku[5] in 2016 (See Chapter 3.1)

In the first iteration, the travel times from the processing centres in Njombe and Mafinga to the plantations were calculated with using the "cost distance" tool of ArcMap version 10.5. Travel times were evaluated by estimating average speeds on different road types (trunk: 80 km/h, primary: 70 km/h, secondary: 50 km/h, tertiary: 30 km/h, all other roads: 10 km/h, and no roads: 5 km/h) and then calculating travel-time distances from cluster centres to study areas. Finally, travel-time distances were made visual by overlaying existing plantations with maps showing two hours' travel times.

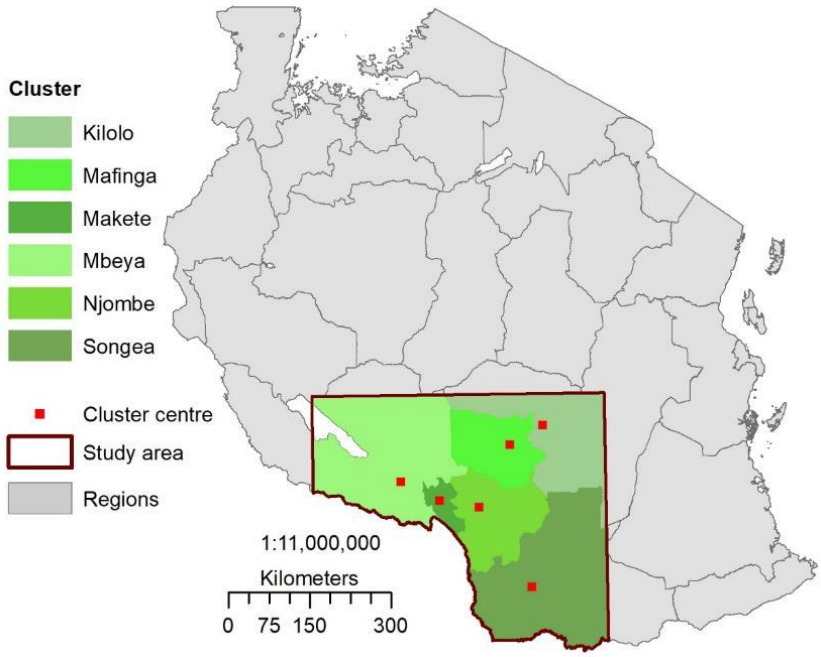
The first iteration revealed that significant plantation resources in the Mbeya cluster were located beyond the two hours' travel times from the first cluster centres. In addition, no cluster centre covered the Songea cluster despite the fact that it is considered to have significant potential for future plantation expansion. For this reason, Songea and Mbeya were added as cluster centres in the second iteration. However, even with their addition, significant plantation resources in Makete and Kilolo districts were still outside any clusters. In the third iteration, then, Makete and Kilolo, too, were added as cluster centres (Figure 5.1).

Figure 5.1 Travel-Time Distances to and from Cluster Centres



Once cluster centres had been defined, all the wards in the study area were assigned to a cluster by measuring the travel-time distances from the ward centres to the cluster centres using road networks and assigning each ward to whichever cluster to which it had the shortest travel-time distance Figure 5.2). Wards were assigned to clusters to link the study's plantation resource data with the clusters it had defined.

Figure 5.2 Forestry Clusters Used in the Study



5.2 Availability of Raw Materials

Most of the Southern Highland's current raw material is found in the Mafinga and Njombe clusters. Figure 5.3 and Figure 5.4 present the wood flows of large-diameter logs of pine and eucalyptus in the region's potential clusters. Wood-flow projections suggest that wood flows in the Songea cluster are miniscule, that those in Kilolo, Makete, and Mbeya are very limited, and that most viable forestry clusters are found around the Mafinga and Njombe clusters.

Wood flows were calculated using University of Turku spatial data and by applying the growth and forest management regimes typical in Tanzania. To allow for the planning of industrial development options at the cluster level, the harvesting times of plantations were optimised to simulate steady or increasing wood flows (it was assumed that industrial players would try to use wood at a steady rate). Since University of Turku data was particularly imperfect in terms of its ability to identify the age-class distribution of forests, these wood flows should be seen as suggestive of long-term wood supply potentials and levels rather than as exact supplies for individual years.

At present, only large-diameter roundwood is fully utilised and has an evident market. Small-diameter roundwood, or pulpwood, has no industrial end-use and is either left behind in forests or sold as fence poles or other non-industrial purpose on an ad hoc basis.

Figure 5.3 Large-Diameter Pine Roundwood Flows from Current Plantations

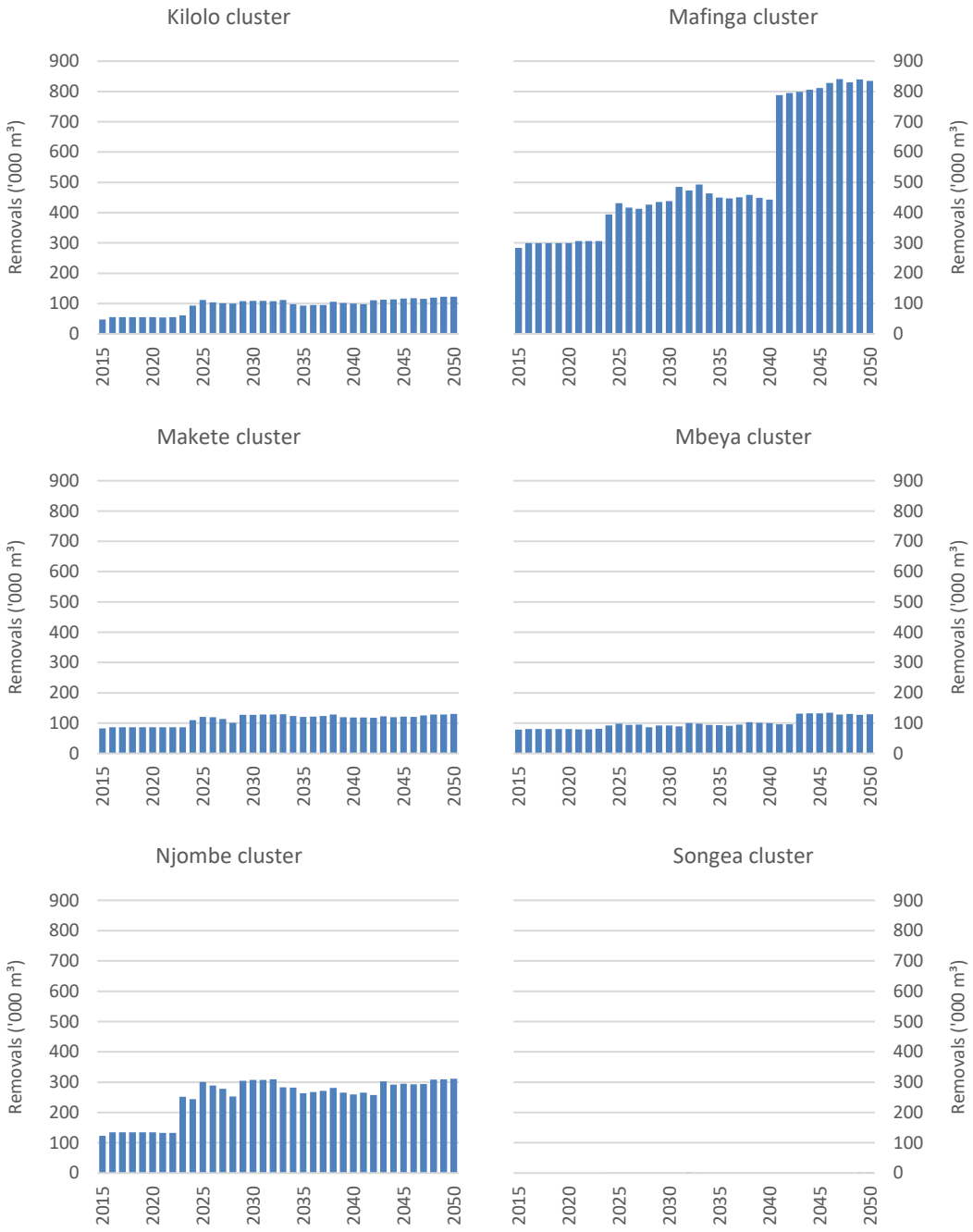
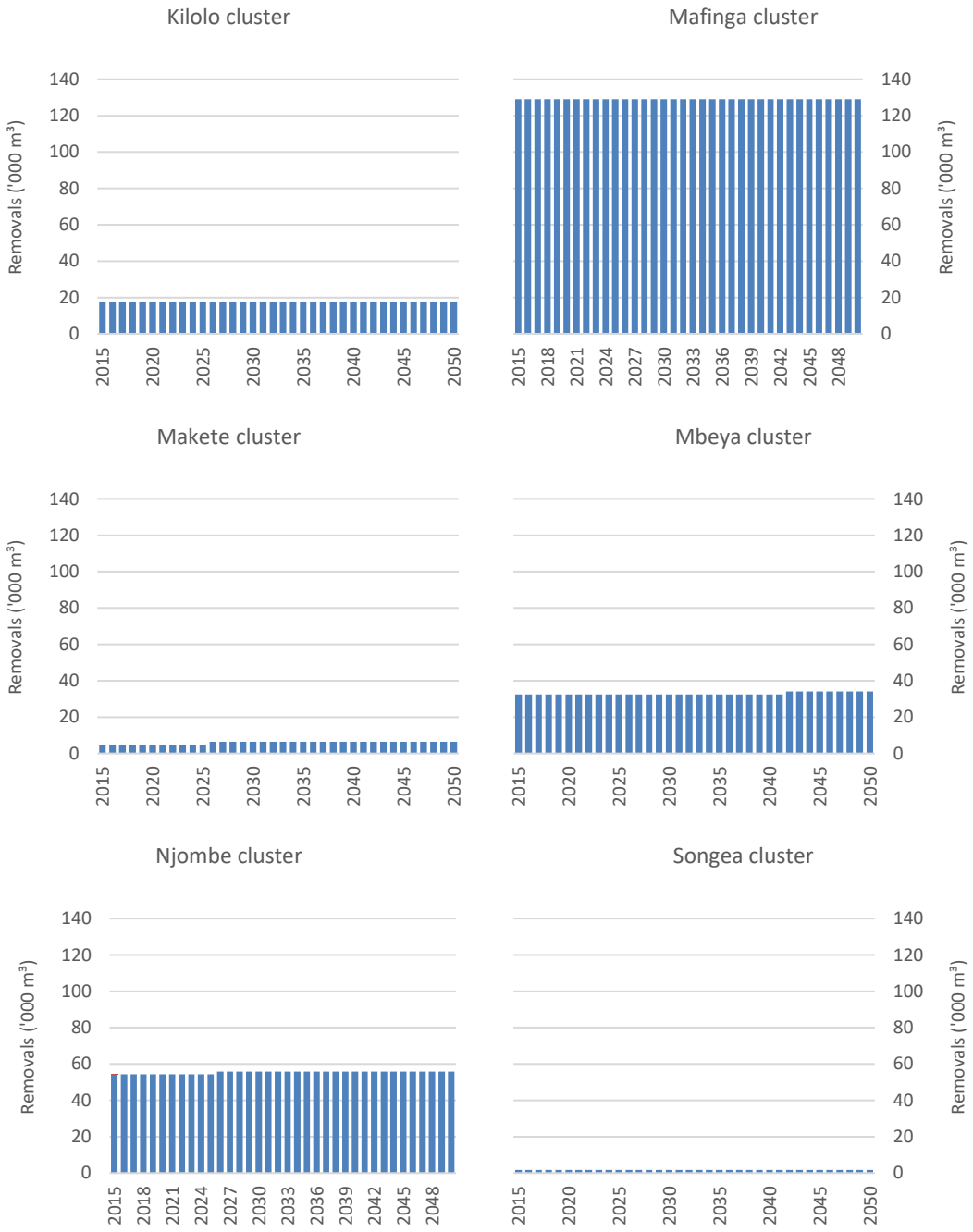


Figure 5.4 Large-Diameter Eucalyptus Roundwood Flows from Current Plantations



In terms of the raw material available, the clusters with the most potential for forest industry development are Mafinga and Njombe. Estimates of roundwood supply and production capacities for Tanzania's main primary forest products are shown in Figure 5.6 and Figure 5.7.

Figure 5.5 Wood Supply from Current Plantations and Production Capacities in Mafinga Cluster

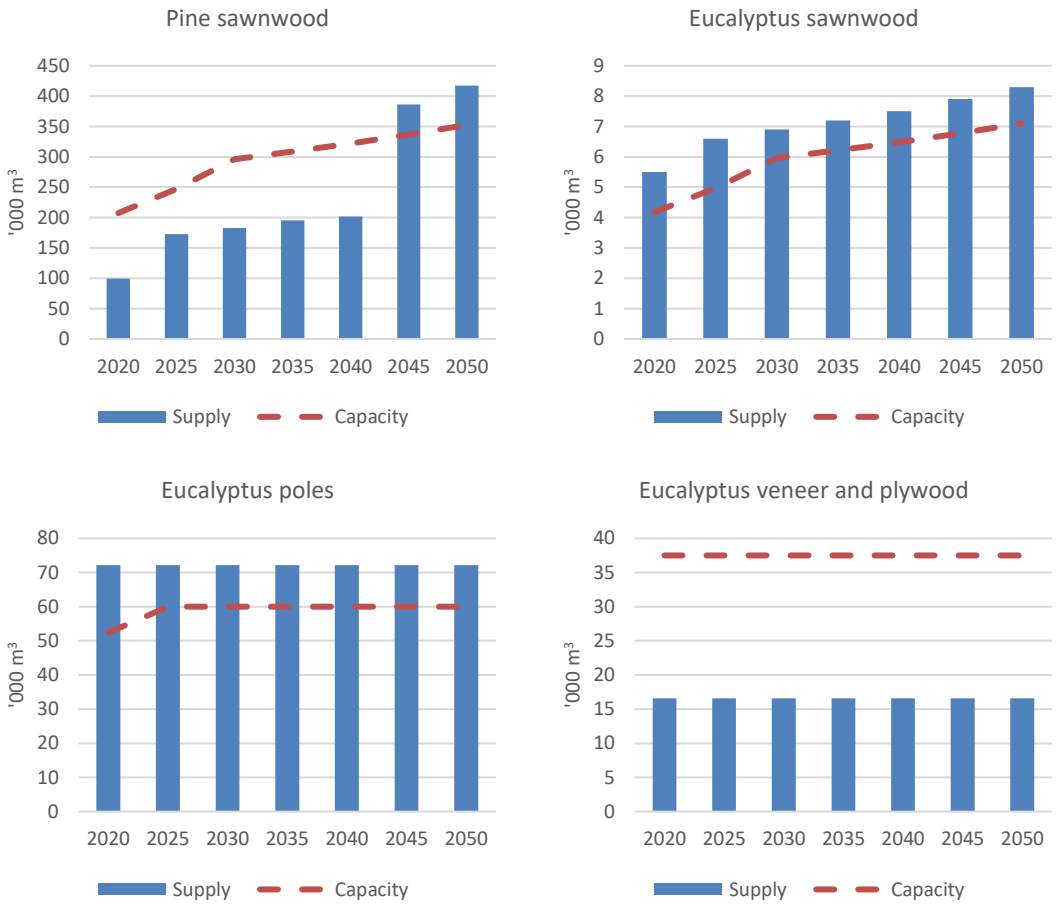
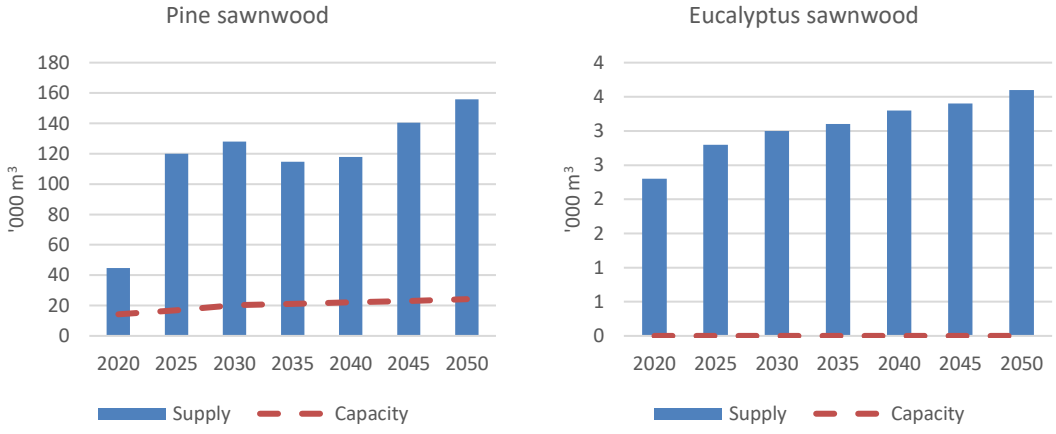
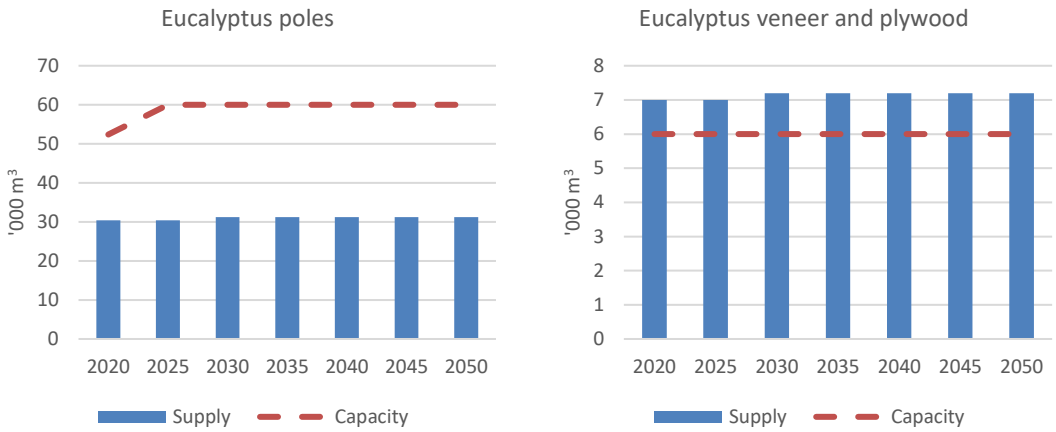


Figure 5.6 Wood Supply from Current Plantations and Production Capacities in Njombe Cluster



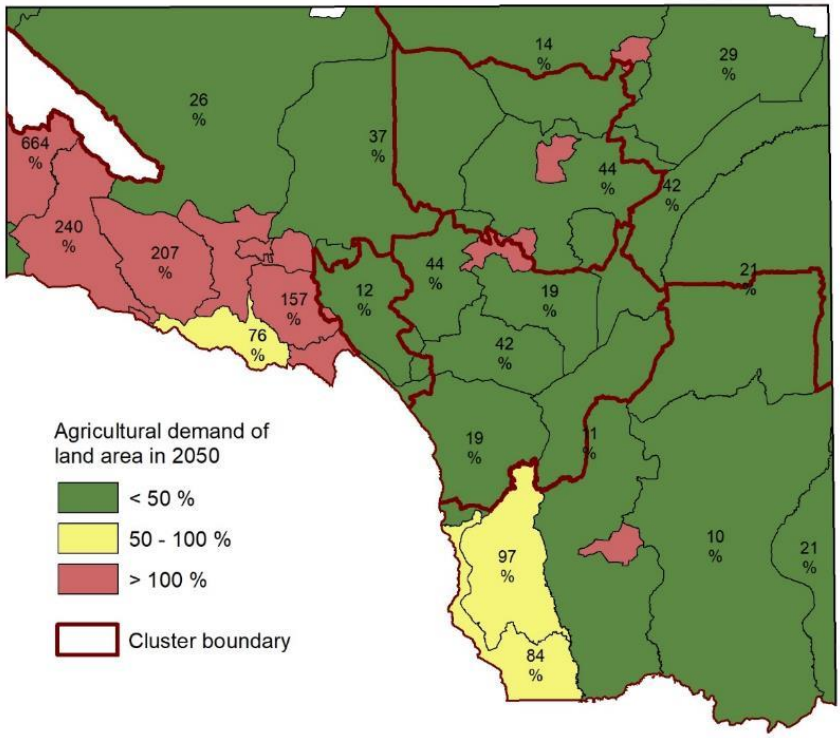


Potential gaps in the supply of wood to forest industries could be filled by planting more areas in the Southern Highlands. The study's analysis of plantation suitability in the Southern Highlands revealed that significant amounts of land are suitable, highly suitable or extremely suitable for plantation forestry, mostly in the Njombe and Mafinga clusters.

The area identified as suitable for plantation, however, may not be available for plantation establishment as multiple criteria have to meet before land can be accessed. To further filter the potential areas for plantation, the study conducted an agricultural pressure analysis to eliminate those areas needed for producing food. Agricultural pressure was also used as one of the variables for suitability mapping in the first place.

The agricultural pressure analysis indicated that agricultural pressure (> 100% of the total land) in the Mbeya region and in some of the townships in the Southern Highlands, such as Iringa, Mafinga, Makambako and Songea (Figure 5.7) is extremely high. Agricultural pressure is high (50-100% of total land) in the districts of Mbinga and Nyassa in the Ruvuma region, but elsewhere it is generally low (< 50% of the total land).

Figure 5.7 Agricultural Pressure by District



The agricultural pressure analysis was carried out by projecting current district-level populations till 2050 while assuming that the current level of land reserved for agriculture in each district per capita remained constant. The growth figures for district population projections were extrapolated by calculating the annual compounded population growth rates for each district.

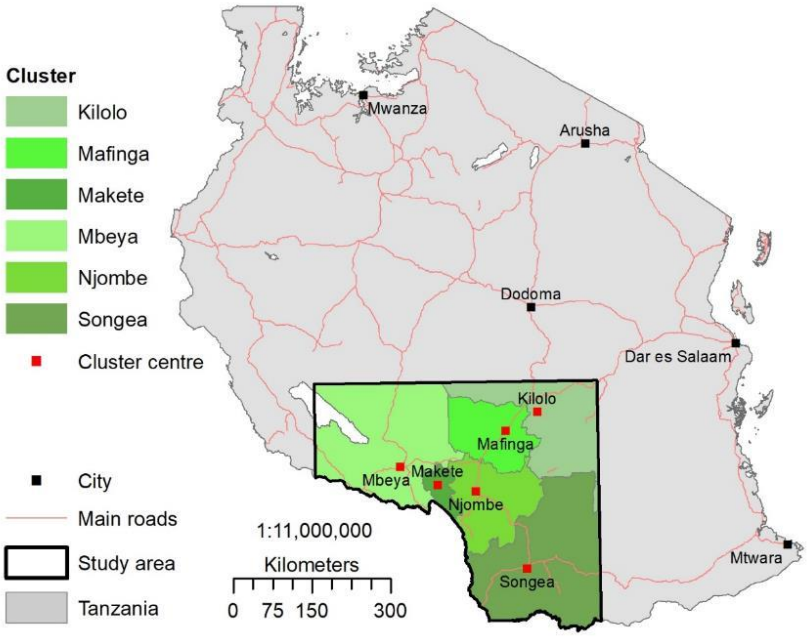
The agricultural pressure analysis flags those areas in the study area with high potential agricultural pressure. The fact the Southern Highlands produce crops for the remainder of the country increases the severity of agricultural pressure in some cases.

Based on the study's findings on biophysical suitability and agricultural pressure, new plantations should target the Njombe, Mafinga and Kilolo clusters in that order. The Makete cluster also has potential for expansion, but its proximity to protected areas and poor infrastructure reduce that potential. The Mbeya and Songea clusters are largely unsuitable for plantation expansion as both have high agricultural pressure.

5.3 Transportation

The transportation network in Tanzania depends on the central corridor highway and a few large feeder roads connecting large cities to that highway. The main roads in the Southern Highlands are the A7, which runs from Dar es Salaam to Iringa and continues as A104 from Iringa through Mbeya all the way to Zambia. A104, which supports much traffic of wood and wood products, is being repaved and widened in 2017 and 2018.

Figure 5.8 Overview Map of Tanzania's Road Network

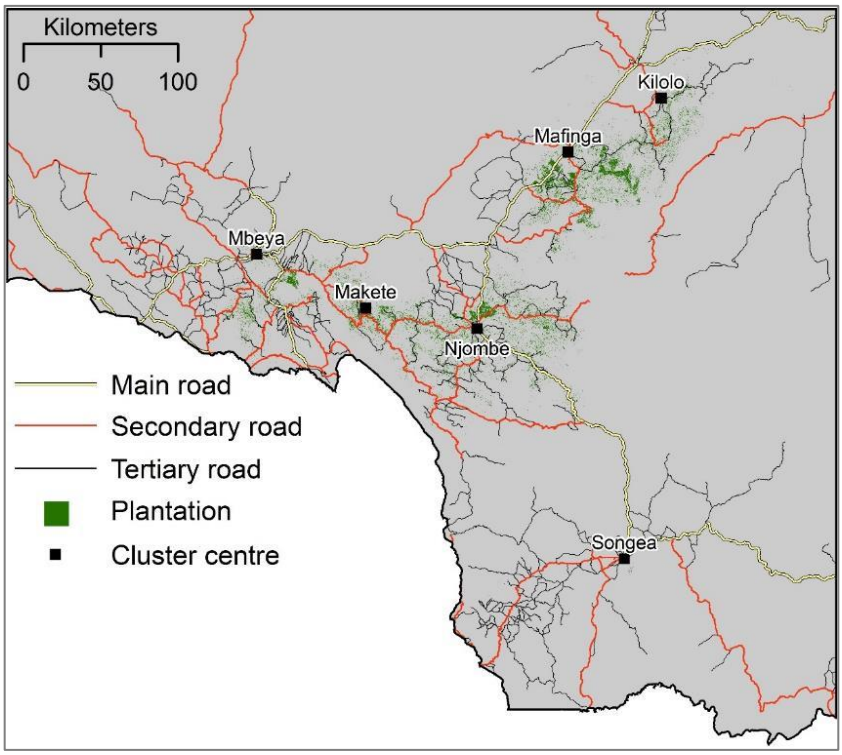


The key road network in the Southern Highlands include the A104 highway connecting Iringa and Mbeya via Mafinga and the B4, a paved road in the far south which runs from Makambako to Songea via Njombe.

The Kilolo and Makete clusters, in contrast, are connected only by secondary roads. The densities of primary and secondary roads are low in the Southern Highlands, so it is tertiary roads that provide access to remote areas. However, tertiary roads are typically in poor condition and impossible or very difficult to travel along during the rainy season.

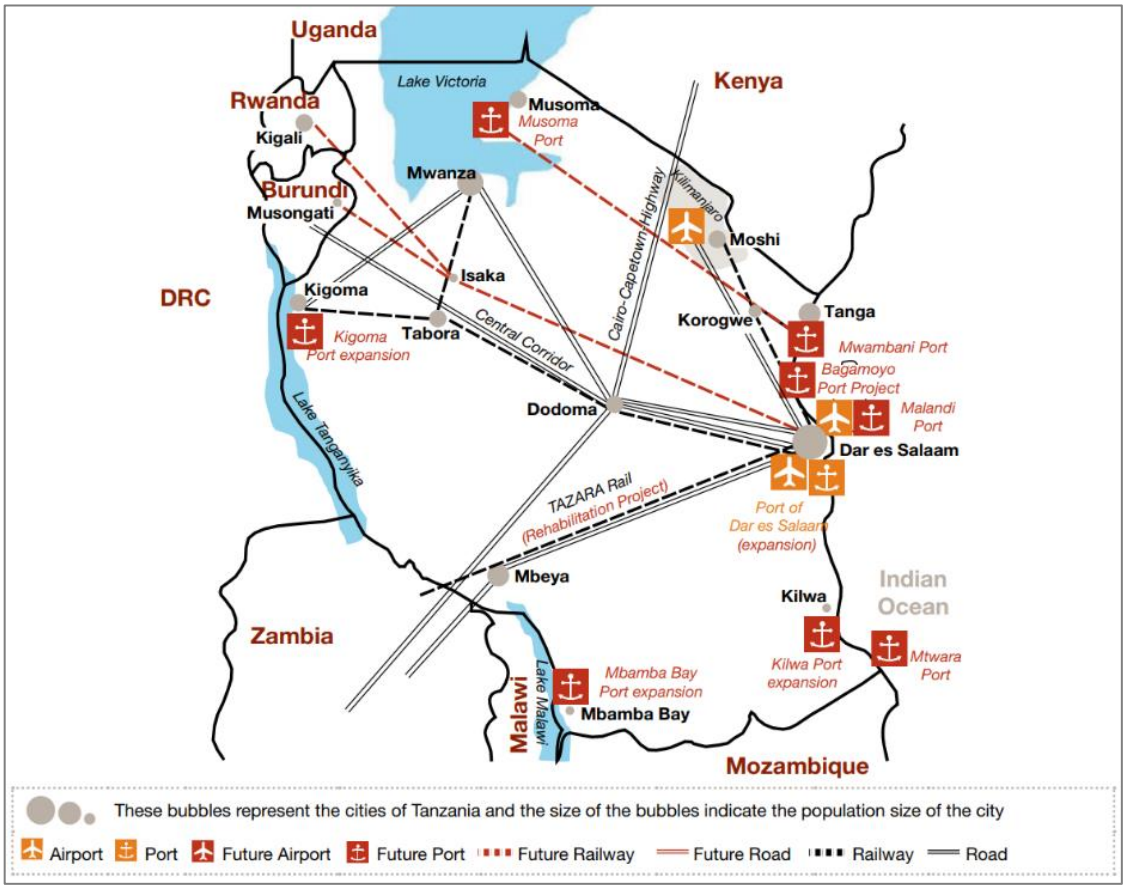
As Figure 5.9 demonstrates, many plantations southeast of Mafinga are inaccessible via large roads. Some plantations can be accessed by existing forest roads, but others will need new forest roads in order to be accessed. Information on the extent of forest roads is lacking, however, and most are in poor condition and cannot be traversed during the rainy season.

Figure 5.9 Road Network in the Southern Highlands



Most of the analysis thus far has concentrated on domestic markets, but Tanzania's seaports are important points for exports. While Tanzanian wood industries produce a lot of by-products that are not currently well utilised, it is possible that unused pulpwood and harvesting waste may become viable options for export in the future. By establishing a connection between chipping in the Southern Highlands and the port in Dar es Salaam using the soon-to-be-rehabilitated TAZARA railway may enable this raw material to be used. There are also plans to establish a railway connection from Songea to Mtwara as part of the development of the Southern corridor of Tanzania, which is spurred on largely by increased interest in mineral excavation in these areas.

Figure 5.10 Overview of Ports, Main Roads, and Railways



Source: PwC (2017)[15]

The main end-market for wood products is in Dar es Salaam. Sawnwood is transported via tarmac roads. The distance from Mafinga to Dar es Salaam is about 560 km and the total transport cost to ship 45 m^3 of sawnwood is approximately USD 1,100, or 24 USD/m^3.

Table 5.1 Average Rates to Transport Sawnwood to Dar Es Salaam

Origin	Km	Total (USD)*	Rate per km (USD)	Rate per km/m^3 (USD)
Songea	950	2 238	2.4	0.052
Mbeya	820	1 714	2.1	0.046
Njombe	710	1 429	2.0	0.045
Makambako	650	1 286	2.0	0.044
Sao Hill	590	1 095	1.9	0.042
Mafinga	560	1 095	2.0	0.043
Iringa	490	952	1.9	0.043

Source: PFP (2016)[1] *Excluding VAT. Note: Delivery of 45 m^3 of sawnwood.

Since utility poles are usually transported to remote rural areas where roads are in poor condition, transporting them usually costs more than transporting other wood products.

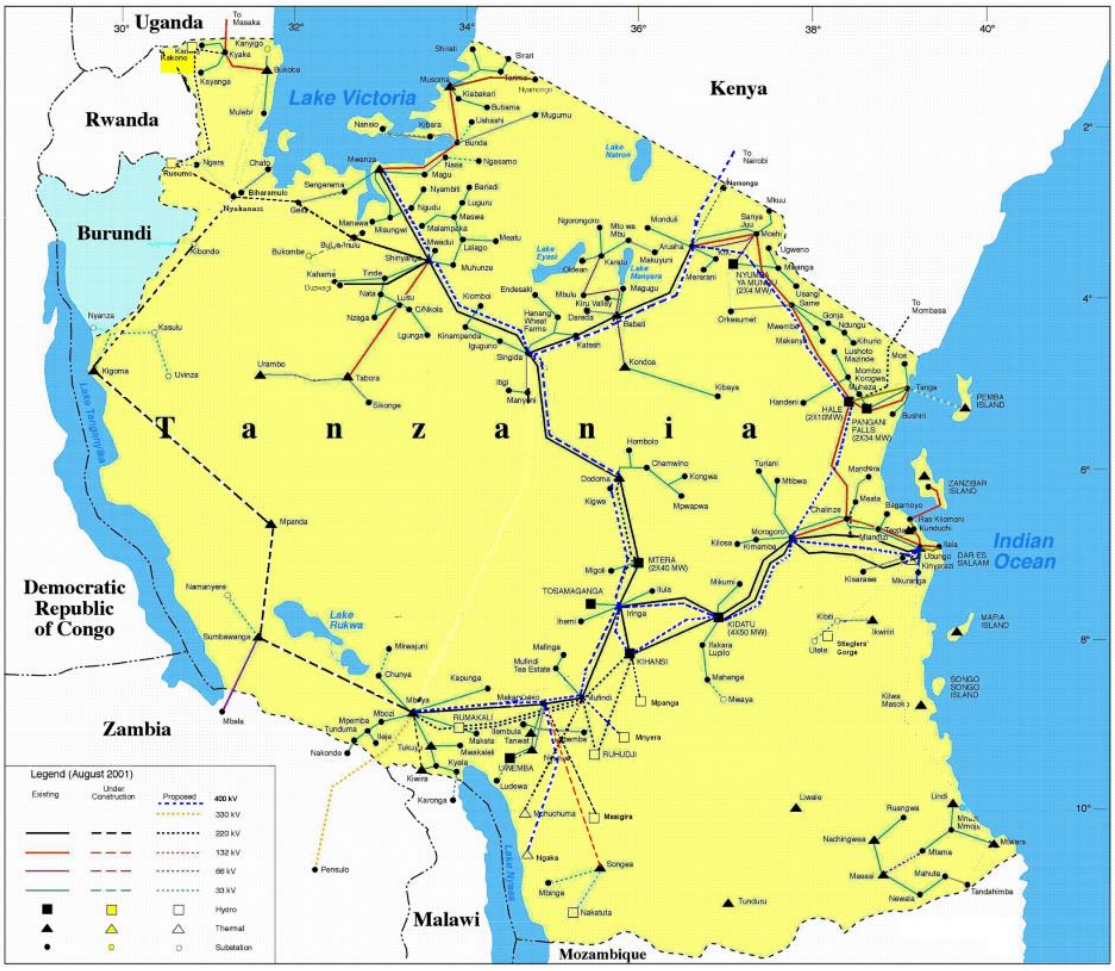
[15] PwC. 2017. Africa gearing up: Future prospects in Africa for the transportation and logistics industry. https://www.pwc.co.za/en/assets/pdf/africa-gearing-up.pdf
PFP takes no stand on the issue of Lake Nyasa.

5.4 Electricity Supply

In Tanzania, the distribution of electricity is concentrated in major cities and the routes connecting those cities. It is difficult to access electricity in rural areas and there are occasional power cuts. Large industry players do not, however, consider these power cuts to be a major problem because they have invested in back-up power generators. Since power from the national grid is significantly cheaper than running a power generator, small operations are unable to invest in their own generators and, as a result, suffer from the unreliable supply of power.

There are four major hydro power plants in close proximity to Iringa, one each in the districts of Mtera, Kidatu, Kihansi and Tosamaganga. A fifth hydropower plant is located in Njombe District in Uwemba (Figure 5.11).

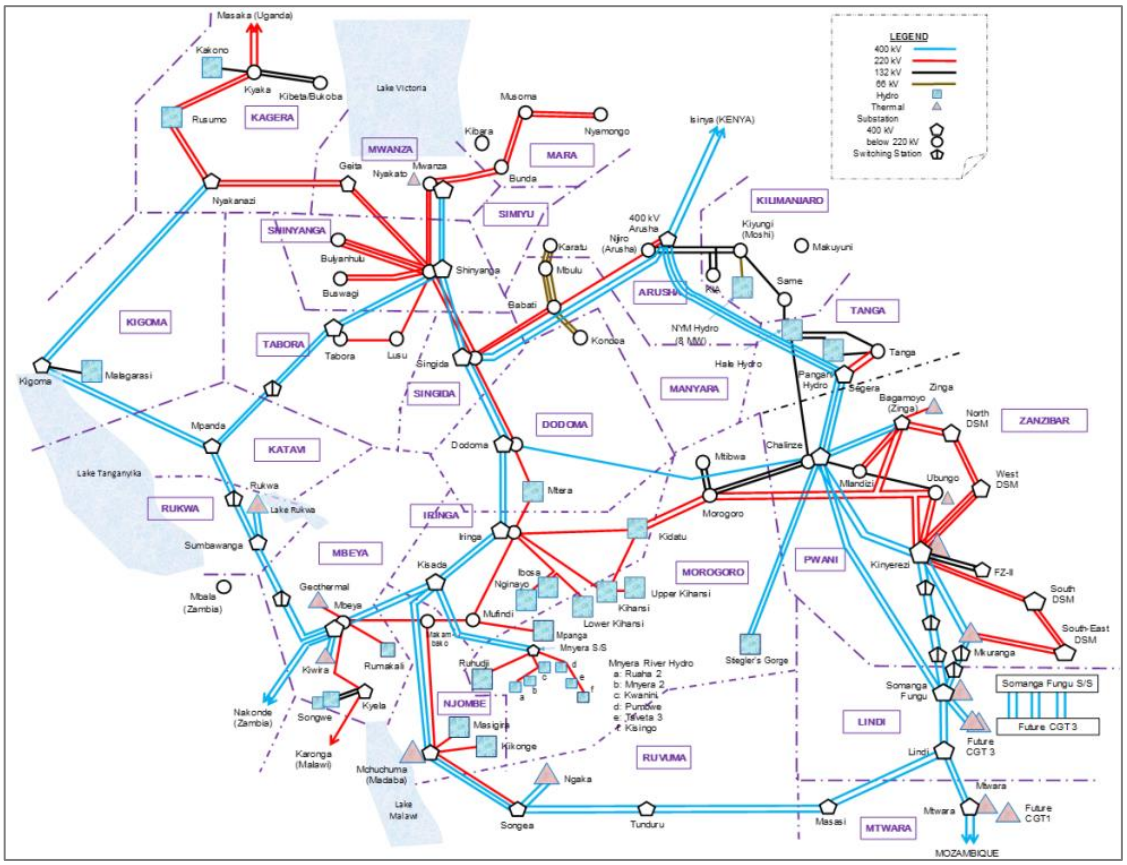
Figure 5.11 The Transmission and Distribution of Electricity in Tanzania



Source: TANESCO

The Tanzanian master plan for the transmission and distribution of electricity by 2040 (Figure 5.12) includes the building of many new hydropower projects in the Southern Highlands and the installation of a high-voltage transmission line between Songea and Mtwara. This plan demonstrated that by 2040 the Southern Highlands will be part of the nation's electricity network rather than just the end of the line for power connections. Since the Southern Highlands is to supply significant amounts of hydropower, it is a priority area for electricity connectivity.

Figure 5.12 Master Plan for the Transmission and Distribution of Electricity by Year 2040



Source: Ministry of Energy and Minerals (2016)[16]

5.5 Skilled Workforce

The forestry sector is labour-intensive: it employs people in all stages of the wood product value chains in the Southern Highlands. Large amounts of labour are required in nursery operations, forest establishment, harvesting, logistics, and wood processing. The majority of the seedling production in the Southern Highlands is currently undertaken by large operators (companies and organisations) which train their employees and, for the most part, exhibit good standards.

Companies and government agencies which establish plantations do so by following typical practices in the forestry industry. Smallholders who establish forest plantations, in contrast, have varying rates of success and do not always have good-quality operations. They need more guidance about appropriate planting densities and soil types.

The manual harvesting methods Tanzanians rely on are similar to those used in most other developing countries but can be significantly improved by providing training in work safety during harvesting, calculating felling direction to minimise damage to other trees, and bucking trees to maximise the commercial wood yield. Training in organising and planning harvesting operations to maximise the utilisation of loader machines to load trucks and minimise the downtime of vehicles is also needed.

[16] Ministry of Energy and Minerals. 2016. Power System Master Plan 2016 [Update].

According to earlier studies, Tanzania lacks technical skill in eucalyptus value chains. Sawing eucalyptus is more challenging than sawing pine. To produce good-quality eucalyptus sawnwood, specific drying and cutting techniques must be used. Training in those techniques as well as in all stages of the eucalyptus value chain, including harvesting, sawnwood processing, drying, and adding value, is needed.

Forest sector know-how in Tanzania can be improved in a number of ways, many of them related to the introduction of modern machinery. In the early stages of the value chain, the most significant improvements involve selecting genetic materials suitable for the Southern Highlands and training employees to produce good-quality seedlings locally. To improve harvesting operations, mechanism would be beneficial and to improve processing, sawmill operators need to be trained to use optimal sawing patterns.

The PFP's initiative to provide vocational training in forestry and forest industries in the Southern Highlands should make more skilled workers available in the area and improve its competitiveness on the investment market.

5.6 Summary of Potential Clusters

The analysis of the six potential clusters in the Southern Highlands reveals that Njombe and Mafinga are the most promising for large-scale industrial development. Table 5.2, which summarises the key characteristics of each cluster shows that Kilolo and Makete are handicapped by poor infrastructure and that Songea and Mbeya lack large-scale plantation resources as well as sufficient area not plagued by environmental and food security issues.

Table 5.2 Summary of Potential Clusters and Assessment of Their Relative Potential for Industrial Development

	Njombe	Mafinga	Kilolo	Makete	Songea	Mbeya
Current plantation resources ('000 ha)	**High** *Pine 40, Eucalyptus 10, Other 11, Total 61*	**High** *Pine 42, Eucalyptus 18, Other 5, Total 65*	**Moderate** *Pine 15, Eucalyptus 3, Other 3, Total 21*	**Moderate** *Pine 20, Eucalyptus 1, Other 4, Total 25*	**Very low** *Pine 0.2, Eucalyptus 0.3, Other 0.1, Total 0.7*	**Moderate** *Pine 14, Eucalyptus 6, Other 3, Total 23*
Average wood supply in 2020-45 ('000 m^3/a)	**High** *Pine 460, Eucalyptus 92, Other 120, Total 672*	**Very high** *Pine 796, Eucalyptus 215, Other 47, Total 1 057*	**Moderate** *Pine 170, Eucalyptus 29, Other 30, Total 229*	**Moderate** *Pine 207, Eucalyptus 10, Other 44, Total 262*	**Very low** *Pine 3, Eucalyptus 3, Other 8, Total 14*	**Moderate** *Pine 162, Eucalyptus 55, Other 37, Total 254*
Current max. production capacity ('000 m^3 rwe)	**Moderate** *Pine 50, Eucalyptus 66, Other 80, Total 197*	**Very high** *Pine 1 221, Eucalyptus 156, Other 70, Total 1 446*	**Moderate** *Pine 67, Eucalyptus 66, Total 133*	**Low** *Pine 20, Total 20*	**Very low** *Pine 0.5, Total 0.5*	**Low** *Pine 19, Total 19*
Suitable land for plantation expansion (million ha)	**Very high** *Pine 1.05, Eucalyptus 0.94*	**Moderate** *Pine 0.42, Eucalyptus 0.38*	**Low** *Pine 0.32, Eucalyptus 0.18*	**Low** *Pine 0.14, Eucalyptus 0.13*	**Very high** *Pine 1.07, Eucalyptus 1.07*	**High** *Pine 0.79, Eucalyptus 0.48,*
Environmental risks identified	**Low**	**Low**	**Low**	**Very high** *Adjacent to protected areas*	**Low**	**Moderate** *Adjacent to protected areas*
Agricultural pressure	**Low**	**Low**	**Low**	**Low**	**High**	**Very high**
Infrastructure	**Good**	**Good**	**Very bad**	**Bad**	**Good**	**Very good**

Njombe cluster

A significant number of new plantations should be established in the Njombe cluster because it is biophysically suitable: it has a large area of suitable land, agricultural pressure is low, infrastructure is good, and the risk of environmental problems low. Of the six clusters, Njombe has the largest area of land suitable for pine (1.05 mil. ha) and eucalyptus (0.94 mil. ha) plantations. More importantly, it has almost half from the total highly and extremely suitable land for pine (0.44 mil. ha) and eucalyptus (0.37 mil. ha). The majority of the suitable land and almost three-quarters of the highly and extremely suitable land is in the allowed zone, a fact which reduces the environmental risk and therefore the cost associated with additional field surveys required for EIAs. Since the projected population and agricultural pressure for 2050 is low, the likelihood of land-use conflicts between forestry, agriculture and other sectors is slim.

Njombe is also well positioned for industrial development as it is situated along a paved and well-maintained road that connects Makambako and Songea. The fact that its electricity supply is currently being upgraded makes it suitable for establishing industries dependent on electricity, especially as from new hydropower plants are slated to increase the electricity generation capacity of the area.

Mafinga cluster

The high biophysical suitability of the Mafinga cluster also warrants developing a significant number of new plantations there. This cluster has a substantial amount of land suitable for pine (0.42 mil. ha) and eucalyptus (0.38 mil. ha) plantations. Approximately one-third and one-quarter of this land is highly or extremely suitable for pine (0.14 mil. ha) and eucalyptus (0.10 mil. ha) plantation respectively. About three-quarters of the suitable, highly, and extremely suitable land is in allowed zones, meaning that costs and environmental risks will be low. Using drought-resistant species would expand the suitable land for pine by 0.26 million ha (63%) and for eucalyptus by 0.19 million ha (50%) for eucalyptuses. Projected agricultural pressure in the cluster is low.

Mafinga is already a hub for plantation wood-based industries but has plenty of room for development. Its infrastructure is better than that in the Njombe cluster, but it has less raw material and a smaller area suitable for new plantation areas.

Kilolo cluster

A decent number of new plantations could be established in the Kilolo cluster and it has a decent amount of suitable land for pine (0.32 mil. ha) and a small amount for eucalyptus (0.18 mil. ha). Approximately one-quarter of the suitable land for pine (0.08 mil. ha) is highly or extremely suitable and over one-third is highly or extremely suitable for eucalyptuses (0.07 mil. ha). Almost all of the land is in allowed zones and using drought-resistant species would expand the amount of land suitable for pines by 0.07 mil. ha (22%) and for eucalyptus by 0.07 mil. ha (36%). The projected agricultural pressure in the cluster is low, but its infrastructure in is poor and the majority of suitable land is located near the Mafinga cluster.

While the cluster does have land, which is suitable for new plantations, its current supply potential is limited, and its infrastructure would need to be improved for it to be able to fully utilise those resources. Since infrastructure in Kilolo is poor, raw material should be processed as close as possible to the source. Since resources are limited, no more than a small-scale operation would be viable, a fact suggesting that the cluster could be developed together with local TGAs or other relevant stakeholders in order to integrate those resources with small-scale industrial activities.

Makete cluster

There is limited potential for expanding plantations in the Makete cluster as there is little of suitable land and several potential environmental problems. The majority of the existing plantations are located on areas defined as “closed woodland” in NAFORMA classification and natural regeneration of pine is causing problems in Kitulo National Park. Besides these issues,

the majority of available land is grasslands with potentially high biodiversity[17]. For these reasons, the risk for environmental conflict is high in Makete cluster[18].

Makete cluster has a small amount of land suitable for pine (0.14 mil. ha) and eucalyptus (0.13 mil. ha). Much of the land in Makete is generally highly or extremely suitable (38–44%), but its quantity is greatly limited by the presence of surrounding national parks and forest reserves and the small total area of the cluster. In addition, almost three-quarters of the suitable land lies in not-preferred zones in grasslands. Using drought-resistant species would not expand the potential for plantation in Makete. Of the six clusters, Makete's projected agricultural pressure is lowest largely because of its declining population, but its infrastructure is, in general, poor.

For reasons that are similar to those applicable in Kilolo, large-scale investment in Makete is unlikely to be viable. Its existing resources are limited and the potential for new plantation areas is even more limited. In addition, the infrastructure of the cluster would require improvement. The current situation does not warrant large-scale investment in industrial activities in Makete cluster.

Songea cluster

New industrial plantations should not be established in the Songea cluster on a large scale. Songea does have a significant amount of suitable land, especially for pine plantation (1.07 mil. ha), but the amount of highly or extremely suitable land is modest. Also, the majority of the suitable, highly suitable and extremely suitable land in Songea, especially that for eucalyptus plantation, is in Mbinga and Nyassa districts, both of which have high projected agricultural pressure.

As the Songea cluster currently has next to no plantations, the projected national demand for domestic wood products can better be satisfied in more favourable clusters and there is little reason to establish plantation forestry and related industries in Songea. That said, there is potential for having smallholders establish plantations outside of Mbinga and Nyassa. In these two districts, there is potential mainly in agroforestry and in areas that are not suitable for agriculture.

Mbeya cluster

New industrial-scale plantations should not be established in the Mbeya cluster because, although it has a significant amount of land suitable for both pine (0.79 mil. ha) and eucalyptus (0.48 mil. ha), a large proportion of which is are highly or extremely suitable, agricultural pressure in this cluster is extremely high. The majority of the districts in this cluster are projected to need more agricultural land in 2050 than they have in total. In addition, the land in Mbeya cluster is largely volcanic and extremely fertile, making it desirable for cash crops and other agricultural production, and there are also some environmental concerns in Mbeya cluster as naturally regenerated pines have encroached on Rungwe Forest Reserve.[19]

Due to the high agricultural pressure caused by nearby Mbeya city, large-scale forestry is not viable in the Mbeya cluster though there is potential for promoting agroforestry practices in general and for establishing smallholder woodlots in areas that are not suitable for agriculture.

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[17] GEF. 2011. Project proposal: Tanzania: Strengthening the protected area network in Southern Tanzania: Improving the effectiveness of national parks in addressing threats to biodiversity. Global Environment Facility. https://info.undp.org/docs/pdc/Documents/TZA/Strengthening%20the%20protected%20area%20network%20in%20Southern%20Tanzania.pdf

[18] Davenport, T.R.B. 2002. Garden of the gods: Kitulo Plateau, a new national park for Tanzania. Wildlife Conservation. June, 15.

[19] Davenport, T. (2004) Invasive pine trees on Mt Rungwe: Problems and solutions. Wildlife Conservation Society, New York.

6. INVESTMENT ANALYSIS OF FORESTRY AND FOREST INDUSTRY CLUSTERS

6.1 Selected Clusters

Considering the analysis of the six potential clusters presented in Chapter 5, the researchers selected two clusters for financial modelling and further analysis, Mafinga and Njombe.

It was assumed that, in both clusters, the current capacity would be maintained by the current operators. The investment potential is shown only for additional capacity.

6.2 Calculation Principles

The outcome of the financial analysis indicates the individual as well as the integrated profitability of forestry operations and wood-processing options. It assumed that wood would be traded at market prices between plantation owners and industrial operators.

All the revenues and expenses are shown in real terms at fixed net prices and valued at mills. The calculation period was 35 years, all revenues and costs were calculated at the end of each year, and the price level corresponded to that of mid-2017. All changes shown in the prices or costs over the calculation period reflect changes in the product mix or quality, productivity, or real prices or costs. The net present value, the IRR, and the earnings before interest, taxes, depreciation, and amortisation (EBITDA) are shown in real terms and before taxes.

The cash flows were calculated as follows:

	REVENUE
–	Operating expenses
–	Fixed investment outlay
–	Change in working capital
=	CASH FLOW BEFORE FINANCING AND TAXES

The one-factor sensitivities of the net present value and the IRR are calculated. The factors considered are product prices, wood prices, labour costs, other costs, and total fixed investment outlay.

The key assumptions used in the financial model are presented in the cash flow calculations in annexes 1 and 2, and consolidated cash flow calculations for the clusters in annexes 3 and 4.

6.3 Mafinga Wood Supply and Industry Cluster

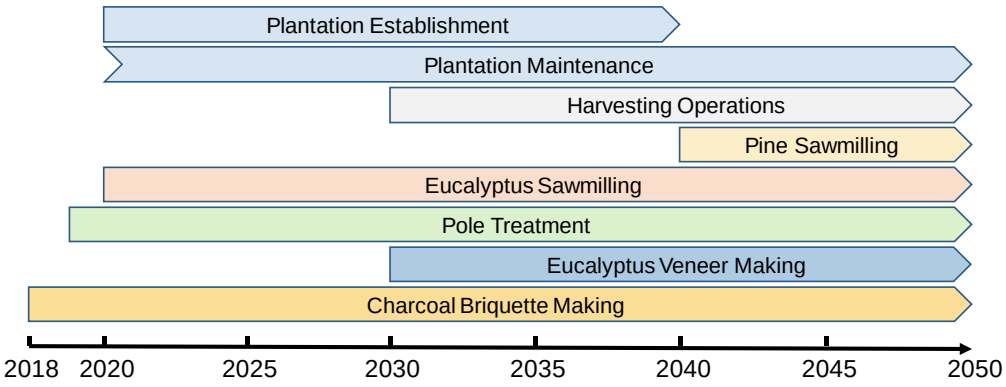
6.3.1 Cluster Overview

The financial analysis of the Mafinga cluster was carried out using the total investment required until 2050 presented in Table 6.1. The major components proposed are to increase the area of eucalyptus plantation by 30,200 ha, increase the capacity of eucalyptus veneer production by an intake of 235,000 m^3, and increase the capacity of the intake of pine sawmilling by 130,000 m^3. The proposed investments are based on the projections for the national demand for plantation wood-based products presented in Chapter 2.

Table 6.1 Proposed Investments in Mafinga Cluster

Investment item	Scale
Planting eucalyptus to harvest veneer logs	30 200 ha
Extending capacity in pine sawmilling	130 000 m^3 (intake)
Building capacity in eucalyptus sawmilling	33 000 m^3 (intake)
Building capacity to treat utility poles	14 000 m^3 (intake)
Building capacity to produce eucalyptus veneer producing capacity	235 000 m^3 (intake)
Building capacity to produce charcoal briquettes	76 800 m^3 (intake)

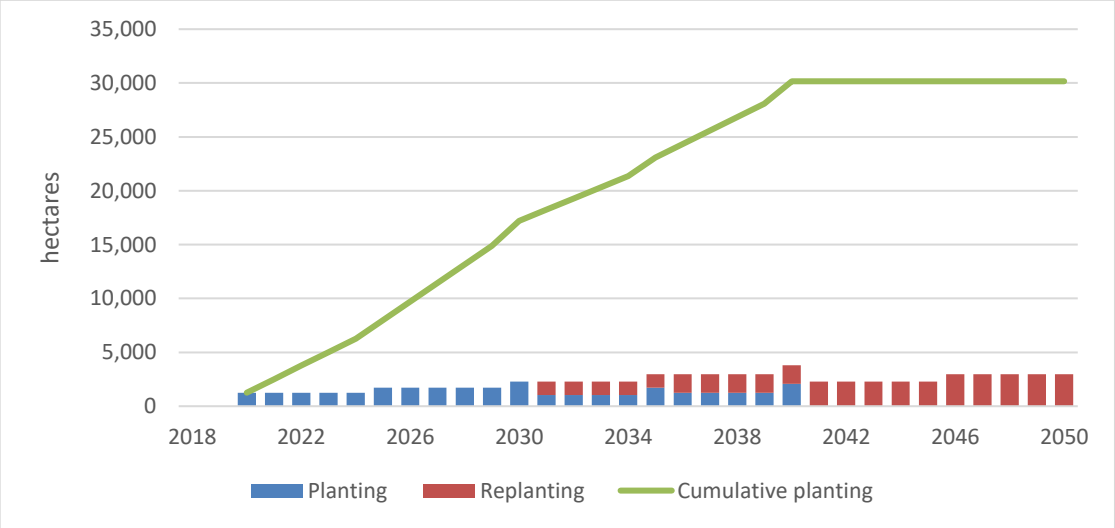
Figure 6.1 Phasing of Investments in Mafinga Cluster



6.3.2 Wood Production

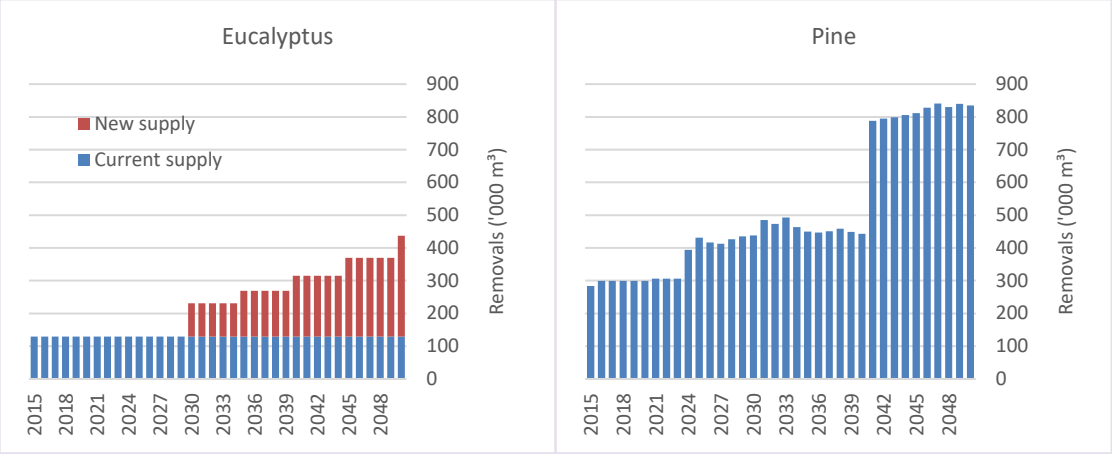
To provide the Mafinga cluster with enough raw material to produce eucalyptus, 30,200 ha of new plantation must be established. The assumed mean annual increment for all new eucalyptus plantations was 13.5 m^3/ha/a with a rotation period of 10 years and the assumed proportions of various wood products of the total output were 40% pulpwood, 54% veneer logs, and 6% sawlogs. A plan for the establishment of additional plantations suitable for the proposed investments is presented in Figure 6.2.

Figure 6.2 New Plantations to be Established in Mafinga Cluster



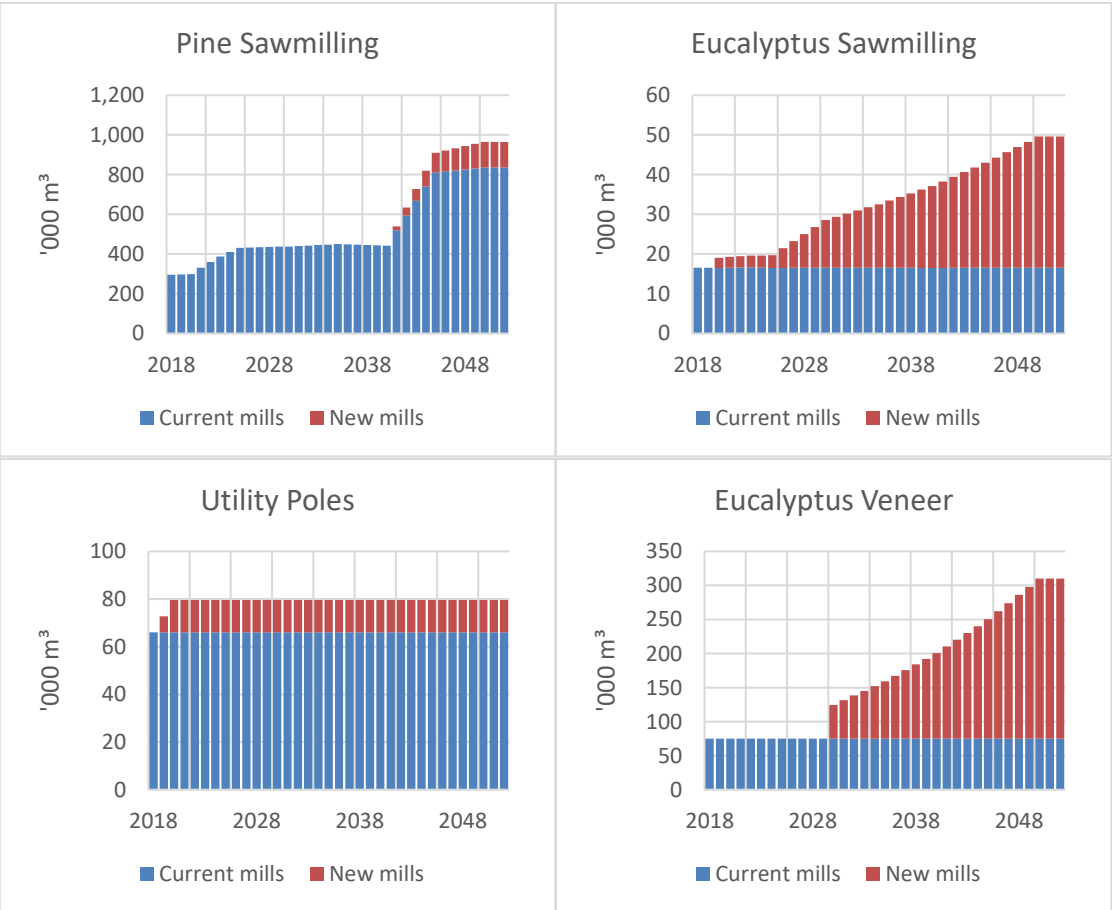
The amount of large-diameter roundwood harvested will increase to over 1.2 million m^3 per year in 2050. The growth in wood flow is presented in Figure 6.3. It includes the outputs from the new plantations established as part of the proposed investments in the Mafinga cluster.

Figure 6.3 Large-Diameter Roundwood Flows in Mafinga Cluster



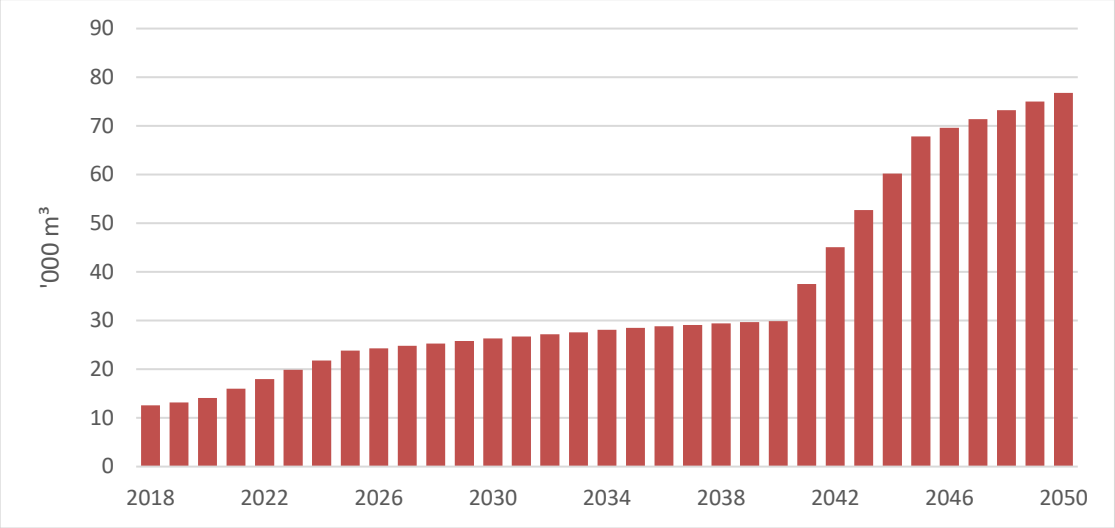
These wood flows will supply sawmills, veneer production facilities, and pole treatment plants as indicated in Figure 6.4 below. The most important primary wood product produced in the Mafinga cluster is and will continue be pine sawmilling. No new plantations are required to meet the demand, and investment in new pine sawmilling capacity is needed only after year 2035 assuming, of course, that existing pine plantations are maintained and managed sustainably. Proportionally, more significant increases in capacity will be required for eucalyptus veneer and sawmilling. The intakes of eucalyptus veneer logs will be four times higher and of eucalyptus sawmilling will be three times higher in 2050 than they are now.

Figure 6.4 Intake Requirements and Plantation Volumes of Wood in Mafinga Cluster



The new charcoal briquette capacity in Mafinga will use the sawdust produced during the primary processing of forest products in the cluster. Investments into new briquette capacity can begin as soon as possible and production may be increased as more waste is produced.

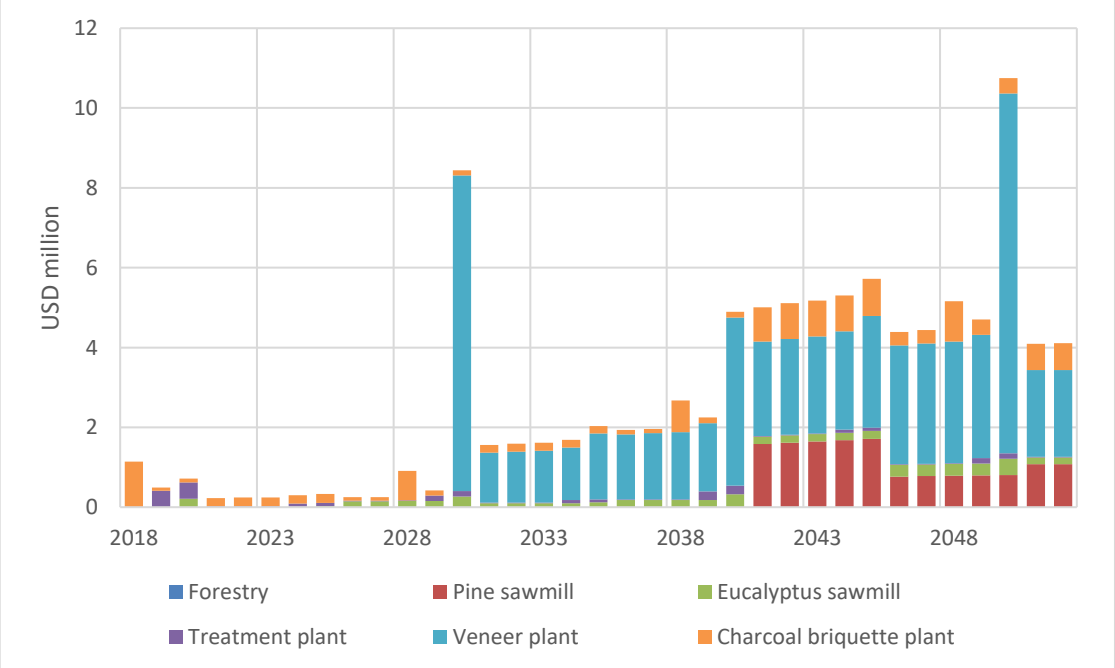
Figure 6.5 Intake Requirements for New Briquette Capacity in Mafinga Cluster



6.3.3 Financial Analysis

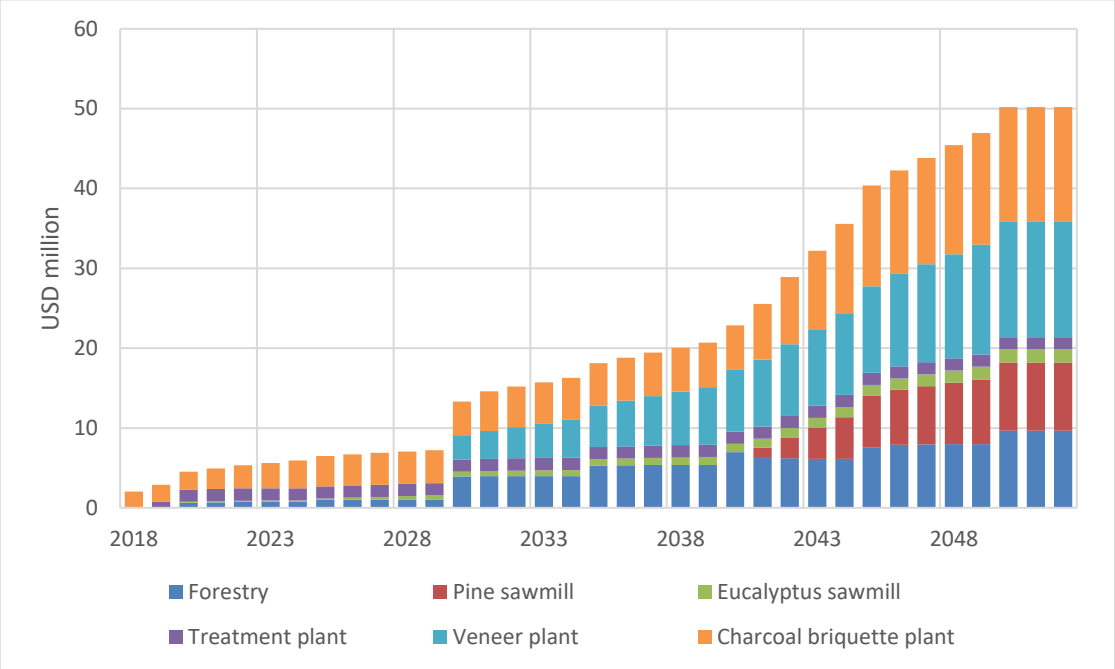
In terms of capital investment, major investments in the capacity for veneer production in the Mafinga cluster will be made starting in around the year 2030. The second significant investment, that in pine sawmilling capacity, will start around 2040. Immediate investment needs are in briquette production.

Figure 6.6 Capital Investment Outlay in Mafinga Cluster



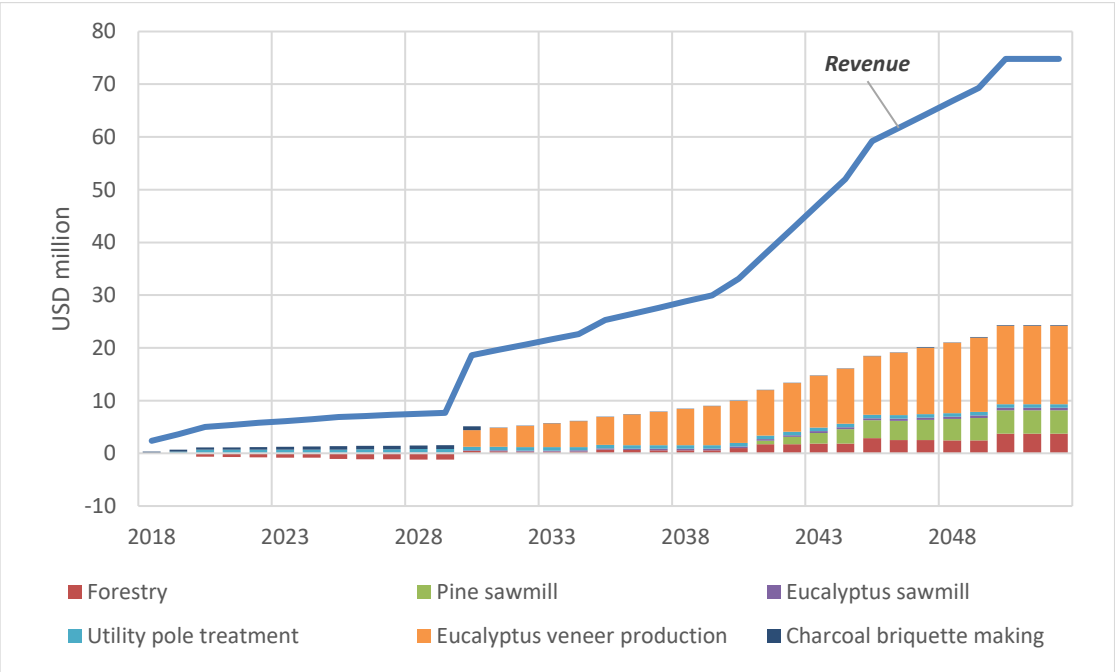
Operating costs will increase throughout the entire proposed investment horizon because the scale of production will increase. The establishment of plantations is classified as an operating cost in this analysis, so it is shown in Figure 6.7.

Figure 6.7 Operating Cost Outlay in Mafinga Cluster



The cluster's earnings before interest, tax, depreciation and amortisation at full capacity are projected to be USD 24 million, or 32% of its revenues. Earnings turn positive in year 2030 (Figure 6.8).

Figure 6.8 Development of Sales Revenue and Earnings before Interest, Tax, Depreciation, and Amortisation Over Time in Mafinga Cluster



The net present values of the proposed investments are presented in Figure 6.9. The discount rate used in this analysis was 12%. The IRRs of the different investments are compared in Figure 6.10. Investing only in plantation forestry returns a negative net present value and veneer production has the highest net present value. The IRR for plantation forestry with the given assumptions was 7%. Unlike previous studies on the profitability of Tanzanian forestry, this analysis attributed the costs of harvesting, forwarding, and transportation to forestry,

thereby decreasing its profitability. The IRRs reveal that utility pole treatment is by far the most profitable of the investment opportunities, followed by pine sawmilling and veneer production. The integrated (or consolidated) return on the total proposed investment in the cluster was 23%. The peculiarly high IRR for utility pole treatment is a result of the low cost of raw material and the high market price for the end-product due to high demand of utility poles in the short-term.

Figure 6.9 Comparison of Net Present Values in Mafinga Cluster

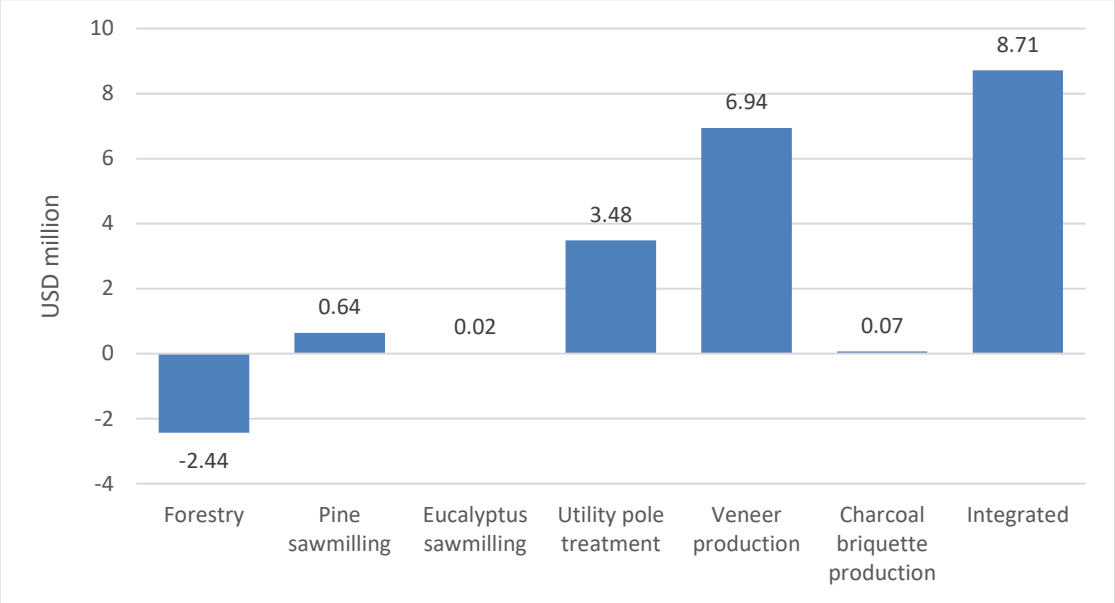
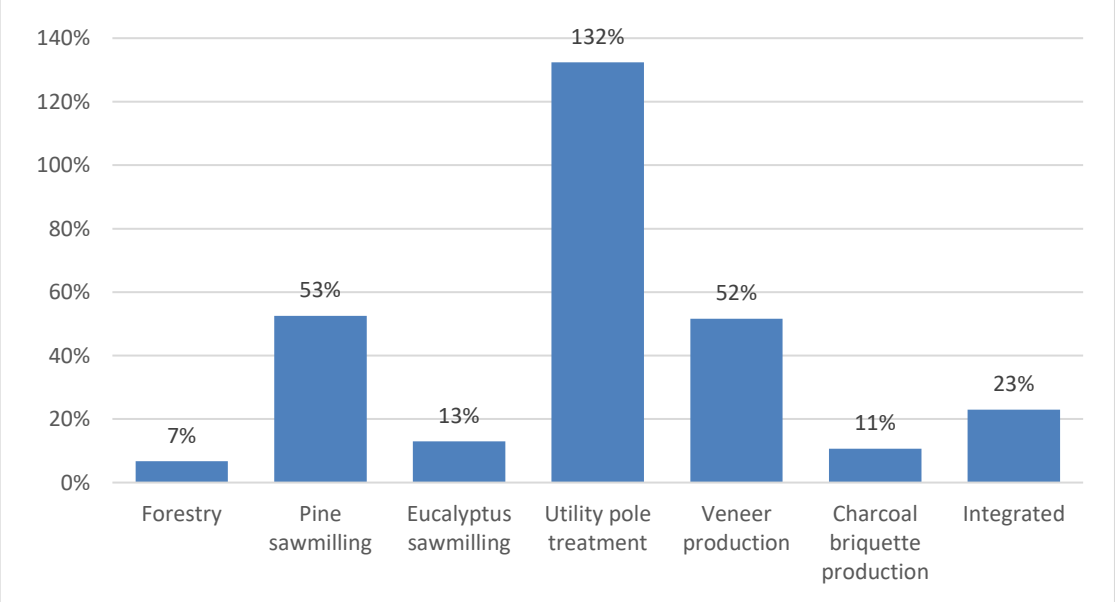


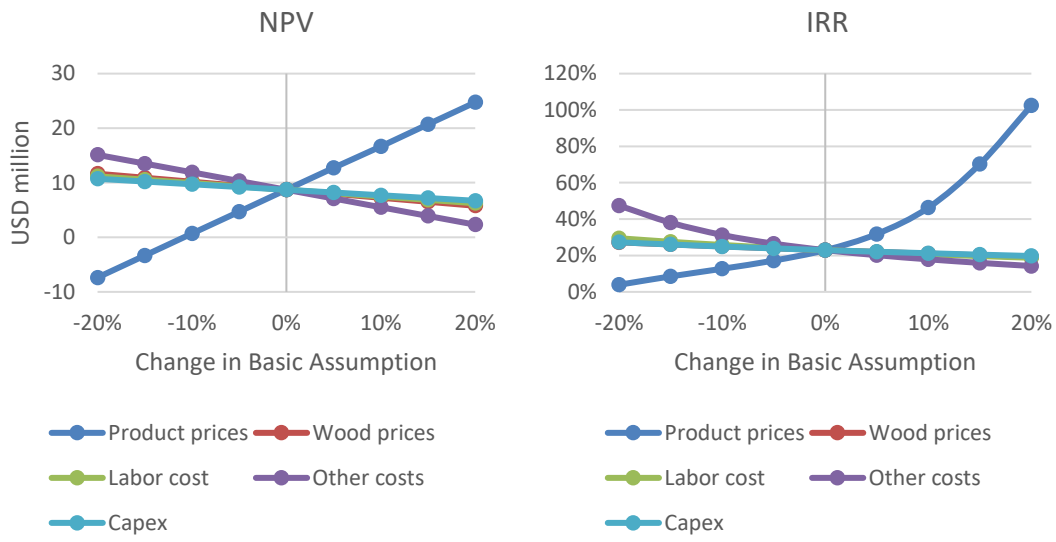
Figure 6.10 Comparison of Internal Rates of Return in Mafinga Cluster



6.3.4 Sensitivity Analysis

Both net present values and IRRs are very sensitive to changes in product prices (Figure 6.11). Net present values turn negative if product prices are just 11% lower than assumed.

Figure 6.11 Sensitivity of Net Present Values and IRRs to Changes in Key Basic Assumptions in Mafinga Cluster



6.4 Njombe Region Wood Supply and Industry Cluster

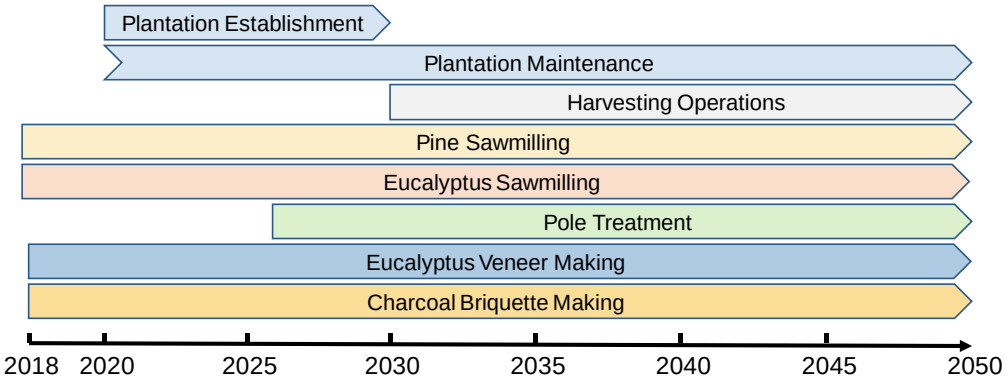
6.4.1 Cluster Overview

A financial analysis of the Njombe cluster was carried out using the total investments required until 2050, as presented in Table 6.2. The major components proposed are increasing the capacity for pine sawmilling by 26, 000 m^3, for pole treatment by 36,000 m^3, and for briquette production by 36,800 m^3. The proposed investments were based on the projections for the national demand for plantation wood products presented in Chapter 4.

Table 6.2 Proposed Investments in Njombe Cluster

Investment item	Scale
Planting eucalyptus to harvest veneer logs	8 400 ha
Extending capacity in pine sawmilling	263 000 m^3 (intake)
Building capacity in eucalyptus sawmilling	7 200 m^3 (intake)
Building capacity to treat utility poles	36 000 m^3 (intake)
Building capacity to produce eucalyptus veneer producing capacity	2 400 m^3 (intake)
Building capacity to produce charcoal briquettes	36 800 m^3 (intake)

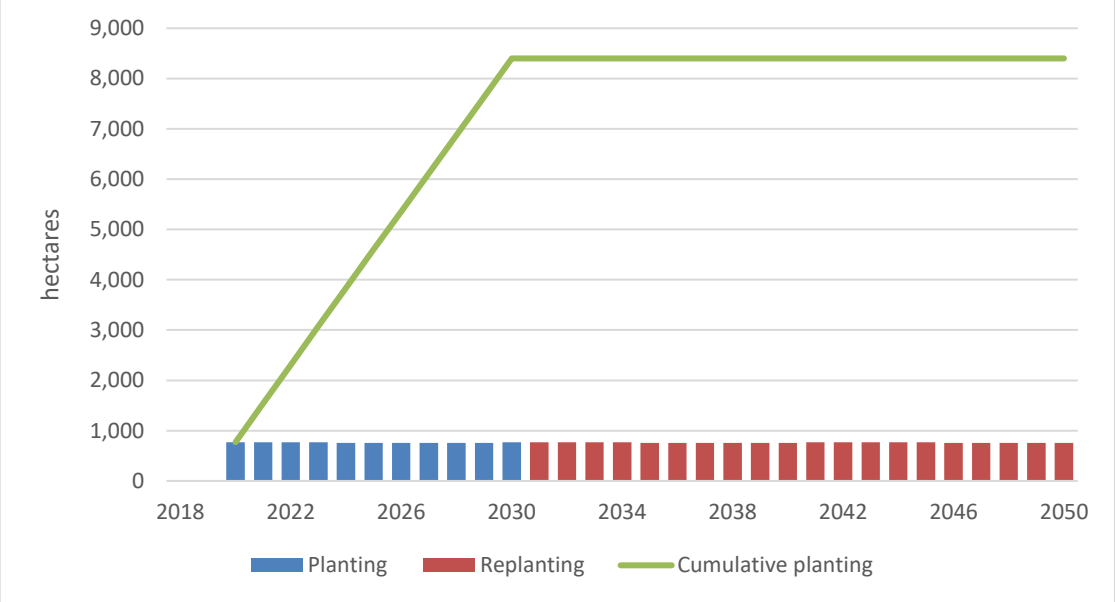
Figure 6.12 Phasing of Investments in Njombe cluster



6.4.2 Wood Production

A total of 8,400 ha of new eucalyptus plantation designed to harvest utility poles is required for to produce enough raw material in the Njombe cluster. The assumed mean annual increment for all new eucalyptus plantations was 13.5 m^3/ha/a with rotation a period of 10 years and the assumed proportions of various wood products in the total output was 40% pulpwood and 60% poles. The plan for plantation establishment according to the proposed investments is presented in Figure 6.13.

Figure 6.13 New Plantations to be Established in Njombe Cluster



In 2050, about 400,000 m^3 of large-diameter roundwood will be harvested. These wood flows are presented in Figure 6.14. The figures for eucalyptus include harvests from the new plantations proposed for establishment in the Njombe cluster.

Large-diameter wood flows (Figure 6.14) will be fed into sawmills, veneer production facilities, and pole treatment plants as indicated in Figure 6.15 below. While there is plenty of raw pine material in the cluster, significant new capacity is required for pine sawmilling. By 2050, if the proposed investment plan is followed, sawmilling capacity will be ten times higher than it is now, the intake of logs for utility poles will increase by some 40%, and veneer production will increase slightly. In addition, there is room for a new small-to-medium eucalyptus sawmill which takes in 7,200 m^3 of logs annually.

Figure 6.14 Large-Diameter Roundwood Flows in Njombe Cluster

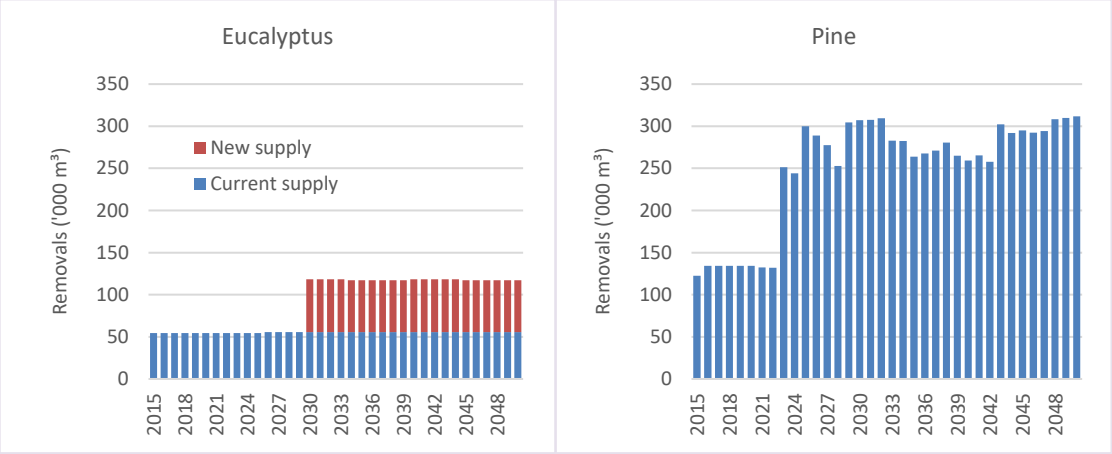
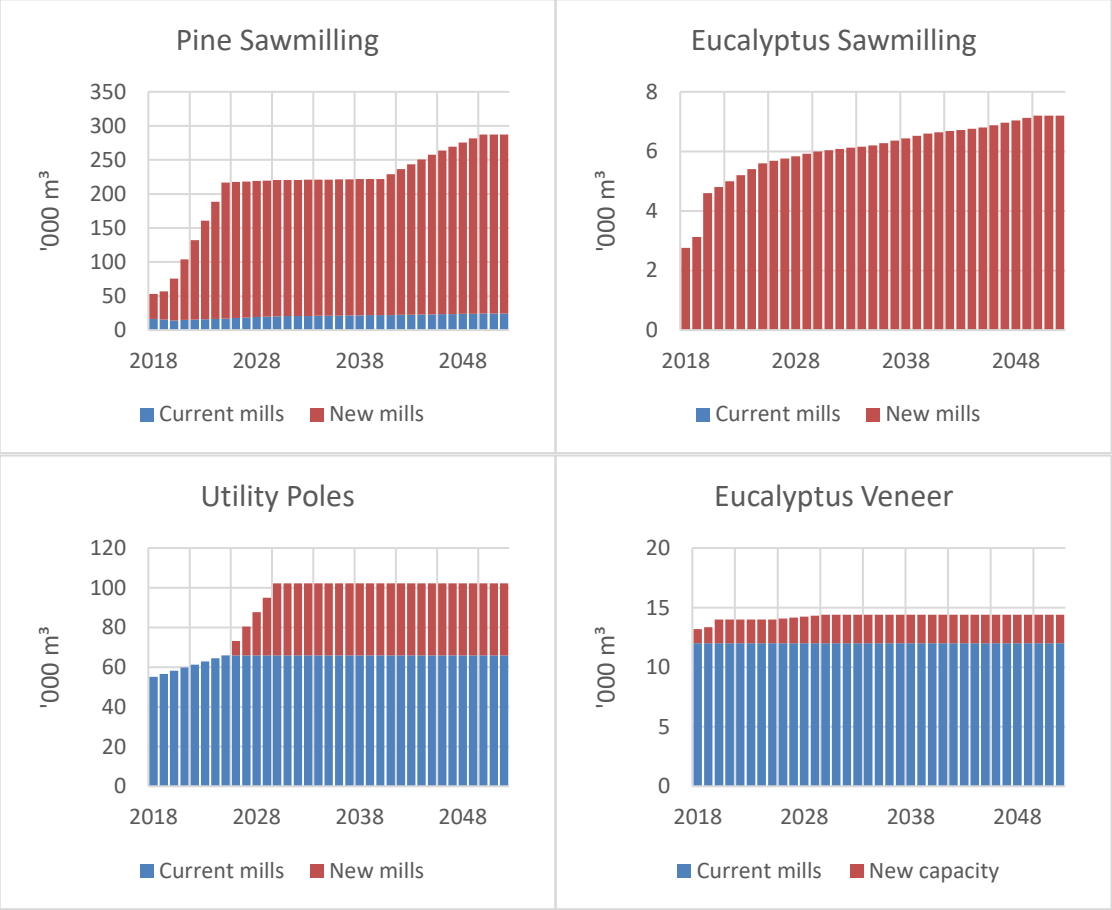
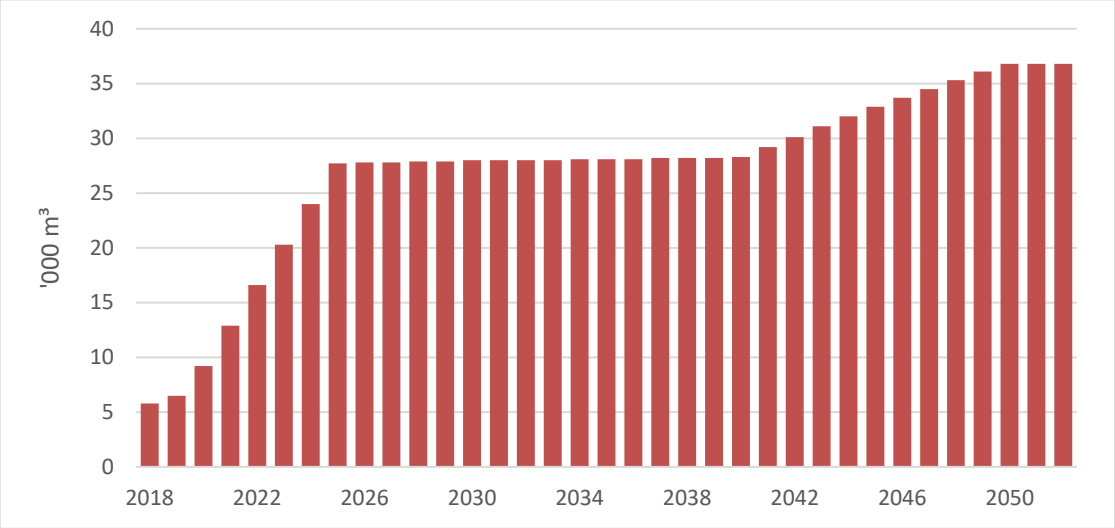


Figure 6.15 Intake Requirements and Plantation Volumes of Wood in Njombe Cluster



The new charcoal briquette capacity in Njombe will use the sawdust produced during the primary processing of forest products in the cluster. Investments into new briquette capacity should begin as soon as possible and production should be increased as more waste is produced.

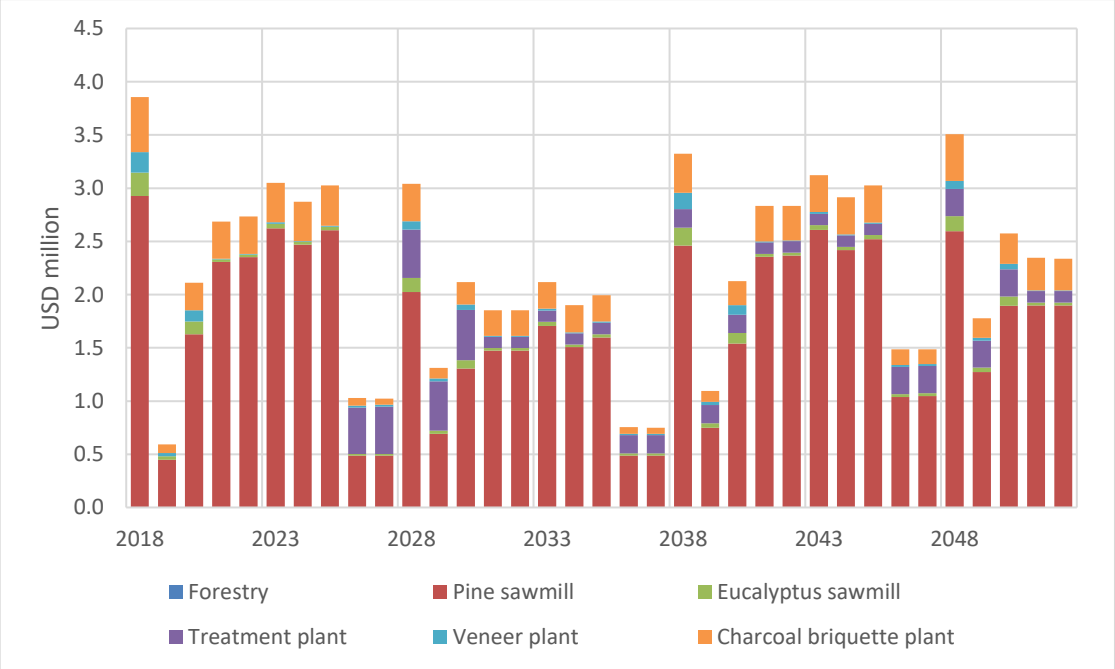
Figure 6.16 Intake Requirements for New Briquette Capacity in Mafinga Cluster



6.4.3 Financial Analysis

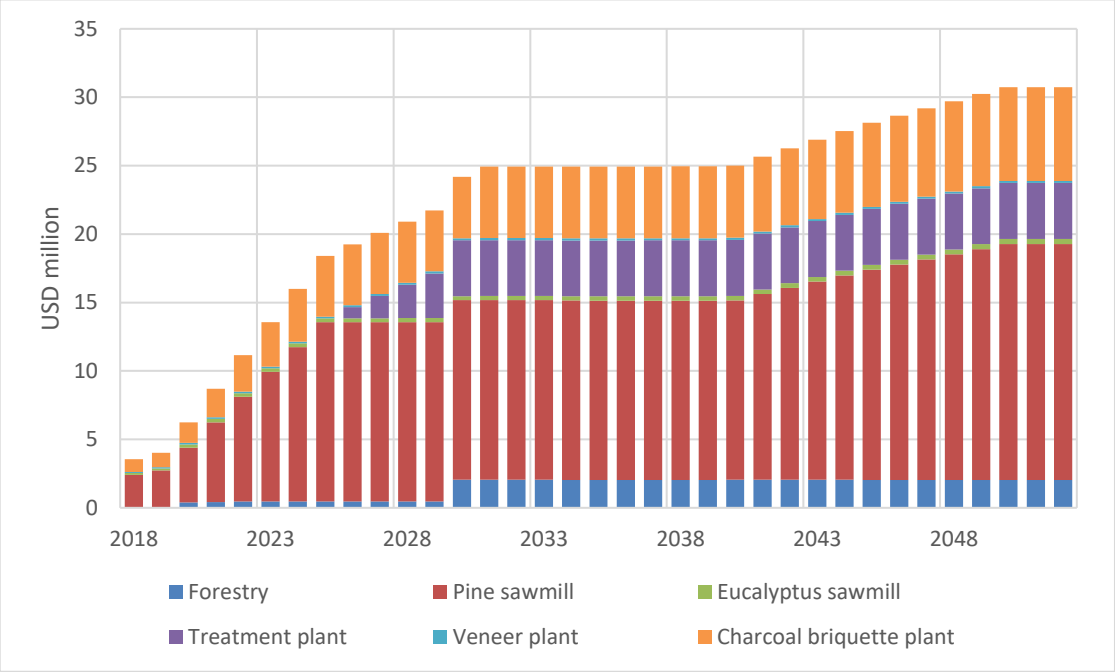
The investment layout for the Njombe cluster is dominated by investment in pine sawmilling. Capital investments into pine sawmilling should start immediately. Other significant investments proposed are the immediate production of briquettes and, from 2026, the operation of a pole treatment plant.

Figure 6.17 Capital Investment Outlay in Njombe Cluster



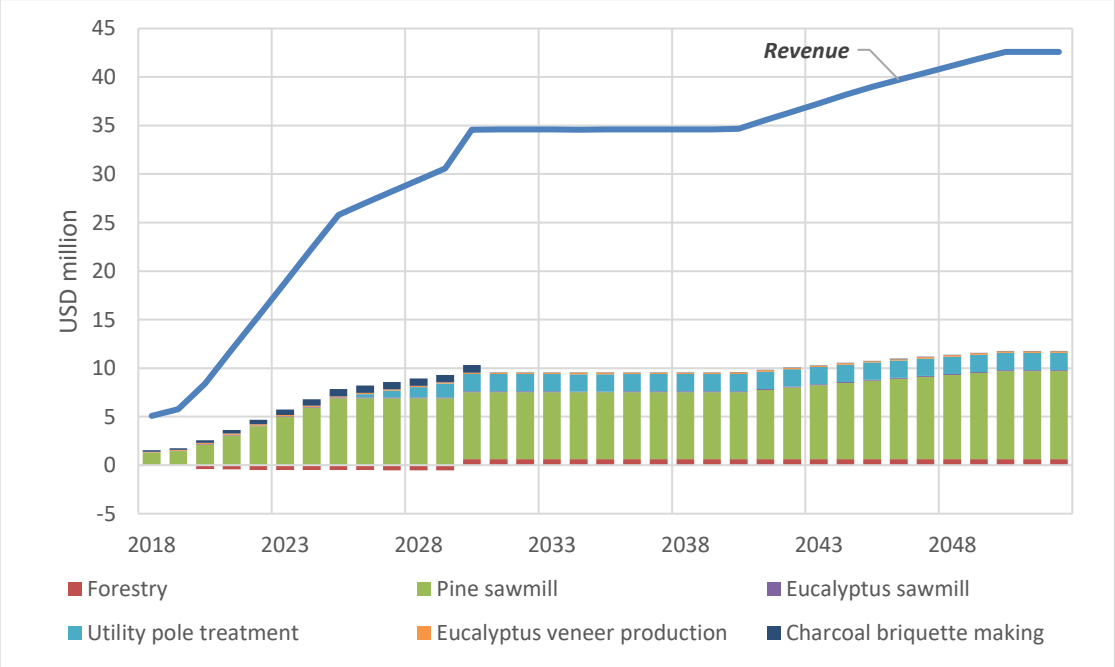
Operating costs increase throughout the entire proposed investment horizon due to the increasing scale of production. The establishment of plantations is, in this analysis, classified as an operating cost, so it is shown in Figure 6.18. The operating costs are dominated by the costs of pine sawmilling because this investment is most significant.

Figure 6.18 Operating Cost Outlay in Njombe Cluster



At full capacity, earnings before interest, tax, depreciation, and amortisation will reach USD 11 million, or 28% of the total revenue. It is positive throughout the investment horizon (Figure 6.19).

Figure 6.19 Development of Sales Revenue and Earnings before Interest, Tax, Depreciation, and Amortisation over Time in Njombe cluster



The net present values of the proposed investments are presented in Figure 6.18. The discount rate used in this analysis was 12%. The IRRs of the different investments are compared in Figure 6.21. Investing only in plantation forestry results in a negative net present value and investing in veneer production results in the highest net present value. The IRR from plantation forestry with the given assumptions is 7%. Unlike some previous studies on

the profitability of the Tanzanian forestry, this analysis attributes the costs of harvesting, forwarding, and transportation to forestry, thereby decreasing its profitability. The IRR of utility pole treatment is highest by far, followed the IRRs of pine sawmilling and veneer production. The integrated return on all the proposed investments in the cluster is 43%. The figure is high, mostly due to the scale and the relative profitability of pine sawmilling. The oddly high IRR of utility pole treatment stems from the low price of raw materials and the high market price for the end product.

Figure 6.20 Comparison of Net Present Values in Njombe Cluster

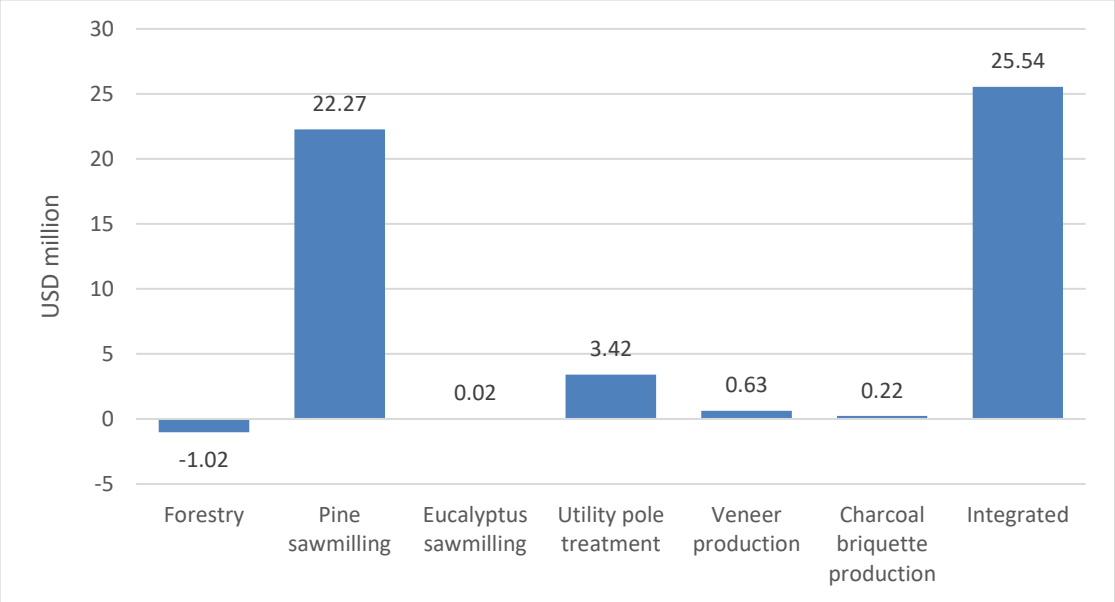
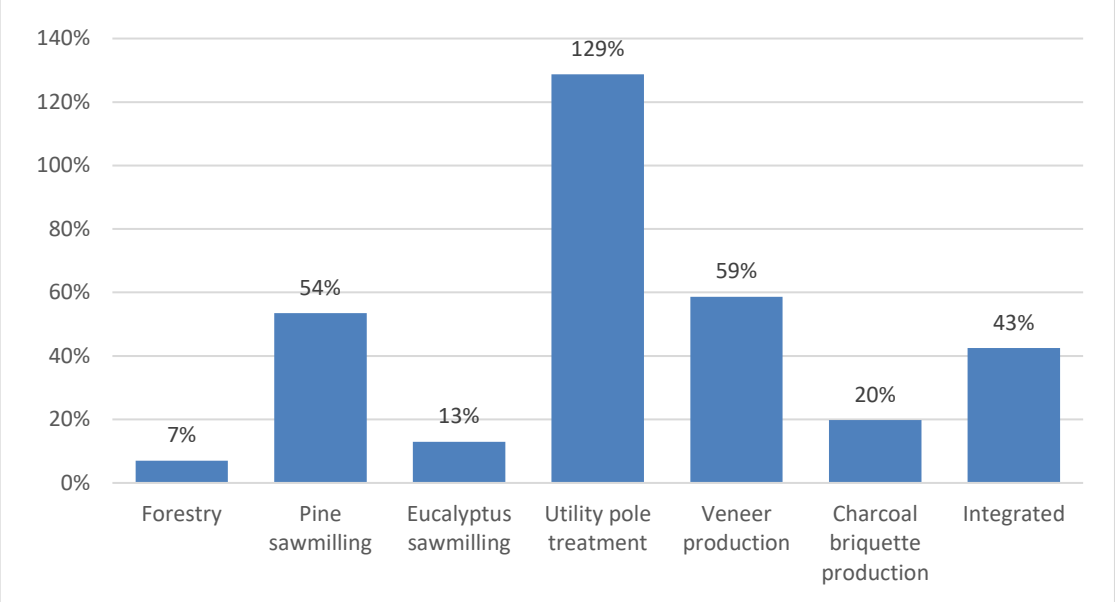


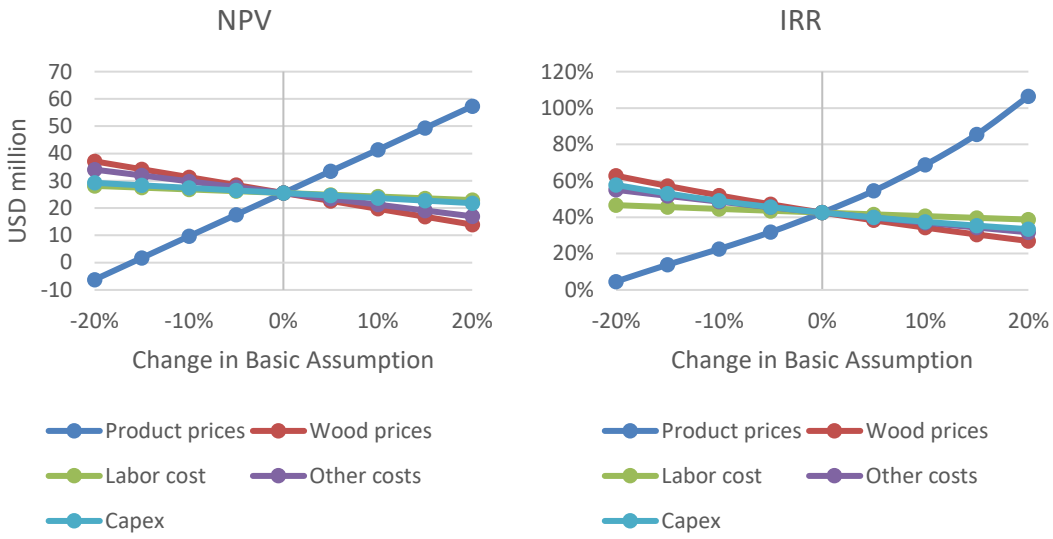
Figure 6.21 Comparison of Internal Rates of Return in Njombe Cluster



6.4.4 Sensitivity Analysis

Both net present values and IRRs are very sensitive to changes in product prices (Figure 6.22). In fact, the net present value turns negative if product prices are just 15% lower than assumed.

Figure 6.22 Sensitivity of Net Present Values and IRRs to Changes in Key Basic Assumptions in Njombe Cluster



7. ECONOMIC, SOCIAL AND ENVIRONMENTAL IMPACTS OF THE CLUSTERS

Investments in plantation forestry and forestry value chains are likely to yield net positive impacts in the area of investment. Positive economic impacts will be realised both on the national and the local level as income in the area increases, meaning more tax revenue for the government, and the nation's trade balance in wood products improves and it moves towards self-sufficiency.

Most of the social impacts will be seen at the local level as stability increases through the generation of employment generation and more equal distribution of income. Even with these changes, however, economic growth will not necessarily be equal, so, in order to avoid conflicts, the outcomes and impacts of the investments should be monitored and appropriate grievance procedures set up to allow for constructive dialogue between investors and community members that may be adversely affected by the investments.

Like economic impacts, environmental impacts will be both local and global. Plantation forestry is likely to sequester carbon efficiently and using plantation wood in wood products will increase the impact of that carbon sequestration effect. Properly designed and implemented plantations will have positive environmental impacts locally as they will improve water regulation and relieve pressure on natural forests and woodlands. Later chapters discuss these impacts in more detail.

7.1 Economic Impacts

The economic impacts of the investment are found at many levels. The government receives additional tax revenues, local economies are improved through increases in income, and the trade balance is improved as reliance on imported wood products decreases.

At full scale, the proposed investments are estimated to generate annual revenues of USD 74.8 million and USD 42.6 million in Mafinga and Njombe clusters respectively. The respective earnings before interest, tax, depreciation and amortisation for the two clusters are estimate at USD 24.4 million and USD 11.8 million. These earnings will result in significant tax revenues as the rate of corporate tax in Tanzania is 30% and that tax is payable from company earnings

Table 7.1 Revenue and Earnings before Interest, Tax, Depreciation and Amortisation Generated through the Proposed Investments

		Mafinga cluster			Njombe cluster		
		2025	2035	2050	2025	2035	2050
REVENUE		6.9	25.3	74.8	25.8	34.6	42.6
EBITDA	Plantations	-1.1	0.7	3.7	-0.5	0.6	0.6
	Pine sawmills	-	-	4.5	6.9	6.9	9.1
	Eucalyptus sawmills	0.0	0.2	0.5	0.1	0.1	0.1
	Utility pole treatment	0.7	0.7	0.7	-	1.8	1.8
	Eucalyptus veneer production	-	5.3	14.9	0.1	0.2	0.2
	Briquette production	0.7	0.0	0.1	0.8	0.0	0.0
	TOTAL EBITDA	0.3	6.9	24.4	7.4	9.6	11.8

Through the multiplier effect, the economic impact of the investments will be more than the direct taxes paid by the companies which invest. The positive economic impacts will impact employees, service providers, and suppliers in the supply chains of the investing companies.[20]

Perhaps more importantly, investments in the forestry sector will increase Tanzania's self-sufficiency in wood products and limit its reliance on imports. By 2050, the nation should no longer need to import sawntimber, veneer, or plywood (Figure 4.4). The imports of fibreboard

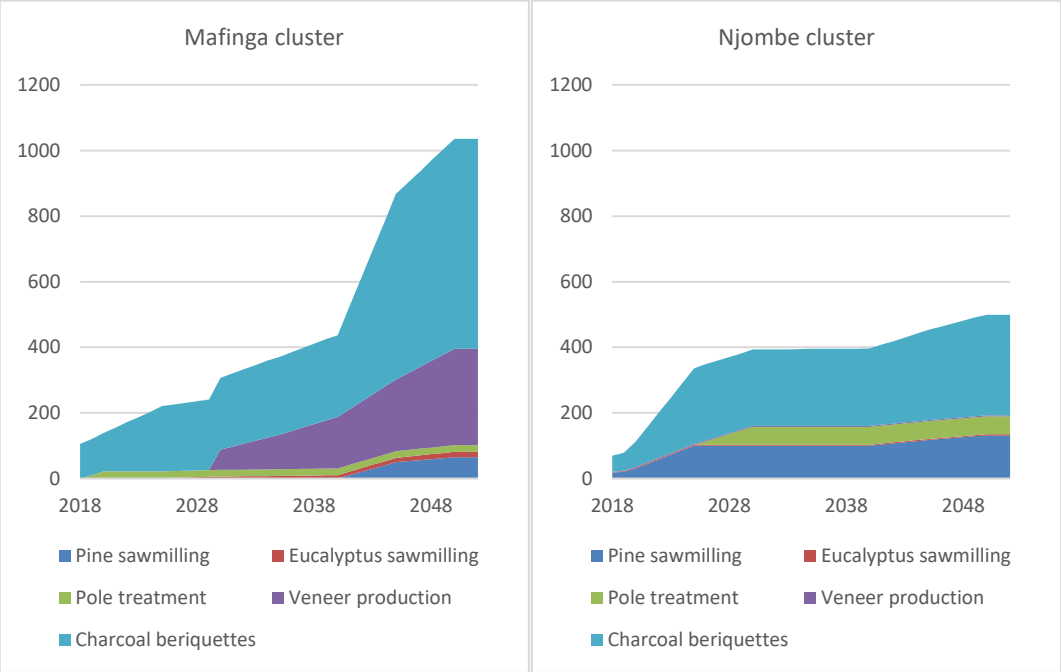
[20] Ingram, V., Van Der Werf, E. Kikulwe, E. and Wesseler, J.H.H. 2016. Evaluating the impacts of plantations and associated forestry operations in Africa—methods and indicators. *International Forestry Review*, *18*(1).

and paper products, however, will keep on rising, and since investment in these products does not seem profitable, the trade deficit in these products is likely to increase though more moderately than without the proposed investments.

7.2 Employment Generation

By 2050, the investments proposed will create a total of almost 1,500 decent industrial jobs in the Mafinga and Njombe clusters. The number of jobs will increase steadily at an average combined rate of 40 jobs each year until 2050. In addition, additional jobs will be created in the value chains of the proposed primary production clusters.

Figure 7.1 Industrial Employment Creation by Product in Mafinga and Njombe Clusters



The figures above include the number of jobs generated in the industries excluding those created in the establishment and maintenance of plantations and nursery operations. The proposed investments in the two clusters include the establishment of 38,564 ha of eucalyptus plantations, an area that will likely create significant amounts of employment as one hectare of planation forest generally generates over 100 man-days of employment during one rotation period.

The ongoing development of vocational training programmes in forestry and forest industries will help ensure that these jobs go to skilled labourers and that existing training institutes (Forestry Training Institute, Olmotonyi and Forest Industries Training Institute, Moshi) will be able to support the development of the proposed forest sector investments.

Gender

Traditionally, the forestry sector in any nation employs both men and women though in different tasks. This is true in Tanzania, too: here, women normally look after tasks like nursery operations and planting seedlings that require a lot of attention, while men take up heavy tasks like harvesting.

The value chain analysis conducted by the PFP in 2016[1] suggested that Tanzanian women are more involved than Tanzanian men in advanced sawmills. Only about 9% of the people who work in dingdong sawmills were women, while women staff in mills with bandsaws comprised 15% of total employees and in mobile sawmills, about 25%. Assuming that this

finding can be extrapolated to mean that women are more likely to be employed in more developed sawmills, the development of the forest industry will likely have a positive impact on women's employment in the clusters selected for investment.

7.3 Environmental Impacts

Tanzanian law requires that an investor or developer carry out an environmental impact assessment (EIA). Under Section 12 of Part IV of the Environmental Management Act No. 20 of 2004, an investor or project proponent, whether government or private, must fulfil the EIA objectives specified in this act as well as in the EIA and Audit Regulations of 2005.

The process begins when an investor or project proponent applies for an EIA certificate, a process which requires him or her to prepare and register a project brief and submit copies of that brief to the National Environment Management Council of Tanzania for screening to see if, indeed, an EIA needs to be carried out. The minister of Environment will approve a project if the National Environment Management Council believes either that it will have no significant negative impact on the environment or that the project brief includes sufficient measures to mitigate any possible negative impacts. If, however, the National Environment Management Council finds that this is not the case, then an EIA must be carried out by certified and registered experts or firms.

Best practice proscribes the establishment of plantations on land converted from natural forests or other valuable habitats, a fact that the suitability analysis used to categorically rule out certain areas of land. Tanzanian law also dictates that plantation be located far away from streams. The study assumed that all the proposed plantations would be set up according to the industry's best practices and reach standards that would make them certifiable under Forest Stewardship Council certification. New forest industries, too, it is assumed, will use the best of practices and meet the highest of environmental standards.

Unlike commercial agriculture, tree plantations in the Southern Highlands do not normally need irrigation or chemical fertiliser. If the sites and species selected match, the proposed plantations will have no significant impact on groundwater levels in the areas targeted for investment.

Establishing properly designed forest plantations may improve biodiversity both by reducing pressure on the wood resource of natural forests[21,22] and by acting as buffer zones which protect natural forests and woodlands and support the development of ecological corridors.[23]

Forests and tree plantations will moderate the impact of hydrological cycles by balancing water runoff, infiltration, and evapotranspiration.[24,25] A well-managed forest understory has a lot of the organic matter that allows for a high volume of water infiltration and reduces runoff. It is the management of a plantation, not its establishment per se, which can result in the development of hydrological detriments. Since forested areas decrease sedimentation, those downstream of a plantation will likely benefit from the resultant in improvement in water quality.[26]

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[21] Pirarda, R., Dal Seccoa, L. and Warmanb, R. 2016. Do timber plantations contribute to forest conservation? *Environmental Science and Policy*, *57,* 122–130.
[22] Bugayong, L.A. 2003. Socioeconomic and environmental benefits of agroforestry practices in a community-based forest management site in the Philippines. The contribution of plantation and agroforestry to rural livelihoods. International Conference on Rural Livelihoods, Forests and Biodiversity, 19–23 May 2003, 2003 Bonn, Germany.
[23] African Forest Forum. 2011. Forest Plantations and Woodlots in Rwanda. African Forest Forum Working Paper Series.
[24] Evans, J. 2009. Planted forests, sustainability, social, environmental. Planted forests, sustainability, social, environmental & CAB International.
[25] Farley, K.A., E.G. Jobbagy and Jackson, R.B. 2005. Effects of afforestation on water yield: a global synthesis with implications for policy. *Global Change Biology*, *11*,1565–1576
[26] Tamene, L.and Bao Le, Q.2015, May. Estimating soil erosion in sub-Saharan Africa based on landscape similarity mapping and using the revised universal soil loss equation (RUSLE). *Nutrient Cycling in Agroecosystems*, *102*(1), 17–31.

Carefully selecting plantation areas and targeting degraded areas will likely have a positive impact on soil quality. Plantations will also increase the total carbon stock in the areas in which they are established.[27] Forested areas, including fast-growing and high-yielding plantations, also sequester carbon at a high rate and accumulate soil carbon.[28] The possibility for adapting to the changing climate should also be considered while selecting species.

7.4 Social Impacts

Land Acquisition

The land needed to carry out the proposed investments, mostly in plantation forestry, will be both public and private. How this land is acquired will vary depending on who owns the land and the scale of investment.

Acquiring large areas of industrial land in Tanzania is difficult, and many companies face restrictions on their ability to access land for plantation. The solution to this problem has often been integrating smallholders into forestry value chains through establishing tree growers' associations (TGAs) or including outgrower schemes. To make such solutions sustainable, there is a need for capacity building and regular monitoring. Such schemes often include first-right-of-refusal clauses that require tree growers to offer their produce to their outgrower partner company first.

The acquisition of large areas of land for plantation is discussed at length in a 2017 PFP[7] study of investment opportunities in Ruvuma District. The study found such large tracts of land can be accessed either through TGAs or the Tanzania Forest Service. An outside investor can partner a local TGA and arrange a joint venture or negotiate with the Tanzania Forest Service to gain access to degraded government forest reserves. If these options are not viable, an investor may need to turn to the Tanzania Investment Centre using a process explained in detail in the PFP's 2017 report "Financial and Economic Analysis of Private Forestry Investment Opportunities in Ruvuma Region." First, an investor would have to apply for a certificate of incentives. This application would provide the Tanzania Investment Centre with information on the project, including its management structure and its financing. If the Tanzania Investment Centre grants certification, it would help the investor find land in which to invest. Ultimately, land acquisition through the Tanzania Investment Centre would require that village land be converted to general land by national, district, and village authorities. This may be a lengthy process, but once this conversion is made, the president would grant the a 99-year right of occupancy or the Tanzania Investment Centre would be the primary holder of the land and transfer derivative rights to the investor for 99 years. A third possibility is that an investor could become part of a joint venture with a local investor.

To help secure a land-based investment with due diligence, an investor can use a framework called "Analytical Framework for Land-Based Investments in African Agriculture" published by New Alliance and Grow Africa. This framework comprises the following five sections:

I. Tenure rights
II. Participation, consultation, and negotiations
III. Grievance mechanism: Dispute resolution
IV. Transparency and corruption
V. Food security, human rights, environmental sustainability, and local capacity-building

[27] Purdon, M. and Lokina, R. 2014. Ex-post evaluation of the additionality of clean development mechanism afforestation projects in Tanzania, Uganda and Moldova. Working paper, No 166/Working paper No 149. Lonond, U.K.: Grantham Research Institute on Climate Change and the Environment and the Centre for Climate Change Economics and Policy Grantham.
[28] Vågen, T.G., Lal, R. and. Singh, B. R, . Soil carbon sequestration in sub-Saharan Africa: Areview. *Land Degradation and Development.*

The framework guides an investor through the acquisition process and helps him or her identify its risks, which may have been incurred even before he or she purchases the land.

Community Engagement

Establishing a plantation with the support of a local community gives an investor more security in its operation. In particular, collaborating with a community and reaching a clear understanding of how benefits will be shared creates a stable local environment. In addition, since investing in the development of rural areas also reduces pressure for migration and urbanisation, it can increase stability country-wide, too. Benefit-sharing is discussed in more detail in the PFP's 2017 report "Financial and Economic Analysis of Private Forestry Investment Opportunities in Ruvuma Region."

Societal Benefits

The extensive land use of tree plantation, which results in low yields over large areas, rather than the intensive land use of agriculture, which results in low yields over small areas, can, on a broad level, benefit society and provide more land for establishing protected areas and for developing agriculture to improve food security.

The increasing rates of urbanisation and urban unemployment in Tanzania can be reduced by developing rural areas and promoting sustainable investments in forestry and agriculture. The creation of business opportunities, not just for foreign investors but also for small-scale entrepreneurs in rural areas, is key, and will, in all likelihood, occur in conjunction with large investments.

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Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy Sectors
CASH FLOW CALCULATION
Mafinga Cluster
Plantations

		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Plantation area													
Eucalyptus	ha	-	-	1 254	2 507	3 761	5 014	6 268	7 994	9 720	11 446	13 172	14 898
Total plantation area	ha	-	-	1 254	2 507	3 761	5 014	6 268	7 994	9 720	11 446	13 172	14 898
Wood flow (commercial volume)													
Eucalyptus													
large diameter	m³	-	-	-	-	-	-	-	-	-	-	-	-
small diameter	m³	-	-	-	-	-	-	-	-	-	-	-	-
Total wood flow	m³	-	-	-	-	-	-	-	-	-	-	-	-
REVENUE													
Price at the mill													
Eucalyptus													
large diameter	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73
small diameter	USD/m³	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64
Sales (purchases)													
Eucalyptus													
large diameter	m³	-	-	-	-	-	-	-	-	-	-	-	-
small diameter	m³	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL REVENUE	**USD '000**	-	-	-	-	-	-	-	-	-	-	-	-
PLANTATION ESTABLISHMENT AND MAINTENANCE COSTS													
Establishment	USD '000	-	-	627	627	627	627	627	863	863	863	863	863
Maintenance	USD '000	-	-	-	63	125	125	125	125	149	173	173	173
Total silviculture cost	**USD '000**	-	-	**627**	**689**	**752**	**752**	**752**	**988**	**1 012**	**1 036**	**1 036**	**1 036**
HARVESTING COSTS													
Harvesting (including CAPEX)													
Eucalyptus													
large diameter	USD/m³	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15
small diameter	USD/m³	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15
Skidding and loading													
Eucalyptus													
large diameter	USD/m³	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63
small diameter	USD/m³	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63
Transportation													
Eucalyptus													
large diameter	USD/m³	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59
small diameter	USD/m³	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59
Total harvesting cost	**USD '000**	-	-	-	-	-	-	-	-	-	-	-	-
General and administrative costs	USD '000	-	-	13	25	38	50	63	80	97	114	132	149
	USD '000	-	-	**13**	**25**	**38**	**50**	**63**	**80**	**97**	**114**	**132**	**149**
Land													
Rent	USD/ha	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46
Land area	ha	-	-	1 254	2 507	3 761	5 014	6 268	7 994	9 720	11 446	13 172	14 898
Total land rent	**USD '000**	-	-	**1**	**1**	**2**	**2**	**3**	**4**	**4**	**5**	**6**	**7**
TOTAL OPERATION COSTS	**USD '000**	-	-	**640**	**716**	**791**	**805**	**818**	**1 072**	**1 114**	**1 155**	**1 173**	**1 191**
EBITDA	**USD '000**	-	-	**(640)**	**(716)**	**(791)**	**(805)**	**(818)**	**(1 072)**	**(1 114)**	**(1 155)**	**(1 173)**	**(1 191)**
EBITDA margin		*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*
CAPEX													
Change in working capital	**USD '000**	-	-	**94**	**9**	**9**	-	-	**35**	**4**	**4**	-	-
CASH FLOW	**USD '000**	-	-	**(734)**	**(725)**	**(801)**	**(805)**	**(818)**	**(1 107)**	**(1 117)**	**(1 159)**	**(1 173)**	**(1 191)**

IRR	6,7 %
NPV, USD million	(2,4)
Cost price of roundwood, USD/m³	32
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioene
CASH FLOW CALCULATION
Mafinga Cluster
Plantations

		2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Plantation area											
Eucalyptus	ha	17 194	18 237	19 280	20 323	21 366	23 089	24 339	25 590	26 841	28 091
Total plantation area	ha	17 194	18 237	19 280	20 323	21 366	23 089	24 339	25 590	26 841	28 091
Wood flow (commercial volume)											
Eucalyptus											
large diameter	m³	101 536	101 536	101 536	101 536	101 536	139 806	139 806	139 806	139 806	139 806
small diameter	m³	67 690	67 690	67 690	67 690	67 690	93 204	93 204	93 204	93 204	93 204
Total wood flow	m³	169 226	169 226	169 226	169 226	169 226	233 010	233 010	233 010	233 010	233 010
REVENUE											
Price at the mill											
Eucalyptus											
large diameter	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73
small diameter	USD/m³	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64
Sales (purchases)											
Eucalyptus											
large diameter	m³	101 536	101 536	101 536	101 536	101 536	139 806	139 806	139 806	139 806	139 806
small diameter	m³	67 690	67 690	67 690	67 690	67 690	93 204	93 204	93 204	93 204	93 204
TOTAL REVENUE	**USD '000**	**4 518**	**4 518**	**4 518**	**4 518**	**4 518**	**6 221**	**6 221**	**6 221**	**6 221**	**6 221**
PLANTATION ESTABLISHMENT AND MAINTENANCE COSTS											
Establishment	USD '000	1 148	1 148	1 148	1 148	1 148	1 488	1 488	1 488	1 488	1 488
Maintenance	USD '000	173	201	230	230	230	230	264	298	298	298
Total silviculture cost	**USD '000**	**1 321**	**1 349**	**1 378**	**1 378**	**1 378**	**1 718**	**1 752**	**1 786**	**1 786**	**1 786**
HARVESTING COSTS											
Harvesting (including CAPEX)											
Eucalyptus											
large diameter	USD/m³	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15
small diameter	USD/m³	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15
Skidding and loading											
Eucalyptus											
large diameter	USD/m³	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63
small diameter	USD/m³	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63
Transportation											
Eucalyptus											
large diameter	USD/m³	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59
small diameter	USD/m³	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59
Total harvesting cost	**USD '000**	**2 600**	**2 600**	**2 600**	**2 600**	**2 600**	**3 581**	**3 581**	**3 581**	**3 581**	**3 581**
General and administrative costs	USD '000	172	182	193	203	214	231	243	256	268	281
	USD '000	**172**	**182**	**193**	**203**	**214**	**231**	**243**	**256**	**268**	**281**
Land											
Rent	USD/ha	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46
Land area	ha	17 194	18 237	19 280	20 323	21 366	23 089	24 339	25 590	26 841	28 091
Total land rent	**USD '000**	**8**	**8**	**9**	**9**	**10**	**11**	**11**	**12**	**12**	**13**
TOTAL OPERATION COSTS	**USD '000**	**4 101**	**4 141**	**4 180**	**4 191**	**4 202**	**5 540**	**5 587**	**5 634**	**5 647**	**5 660**
EBITDA	**USD '000**	**417**	**377**	**338**	**327**	**316**	**681**	**634**	**586**	**573**	**560**
EBITDA margin		*9 %*	*8 %*	*7 %*	*7 %*	*7 %*	*11 %*	*10 %*	*9 %*	*9 %*	*9 %*
CAPEX											
Change in working capital	**USD '000**	**433**	**4**	**4**	**-**	**-**	**198**	**5**	**5**	**-**	**-**
CASH FLOW	**USD '000**	**(16)**	**373**	**334**	**327**	**316**	**483**	**628**	**581**	**573**	**560**

IRR	6,7 %
NPV, USD million	(2,4)
Cost price of roundwood, USD/m³	32
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioene
CASH FLOW CALCULATION
Mafinga Cluster
Plantations

		2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
Plantation area											
Eucalyptus	ha	30 163	30 163	30 163	30 163	30 163	30 163	30 163	30 163	30 163	30 163
Total plantation area	ha	30 163	30 163	30 163	30 163	30 163	30 163	30 163	30 163	30 163	30 163
Wood flow (commercial volume)											
Eucalyptus											
large diameter	m³	186 009	186 009	186 009	186 009	186 009	241 109	241 109	241 109	241 109	241 109
small diameter	m³	124 006	124 006	124 006	124 006	124 006	160 739	160 739	160 739	160 739	160 739
Total wood flow	m³	310 015	310 015	310 015	310 015	310 015	401 848	401 848	401 848	401 848	401 848
REVENUE											
Price at the mill											
Eucalyptus											
large diameter	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73
small diameter	USD/m³	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64
Sales (purchases)											
Eucalyptus											
large diameter	m³	186 009	186 009	186 009	186 009	186 009	241 109	241 109	241 109	241 109	241 109
small diameter	m³	124 006	124 006	124 006	124 006	124 006	160 739	160 739	160 739	160 739	160 739
TOTAL REVENUE	**USD '000**	**8 277**	**8 277**	**8 277**	**8 277**	**8 277**	**10 728**	**10 728**	**10 728**	**10 728**	**10 728**
PLANTATION ESTABLISHMENT AND MAINTENANCE COSTS											
Establishment	USD '000	1 899	1 148	1 148	1 148	1 148	1 148	1 488	1 488	1 488	1 488
Maintenance	USD '000	298	339	305	230	230	230	230	264	298	298
Total silviculture cost	**USD '000**	**2 196**	**1 487**	**1 453**	**1 378**	**1 378**	**1 378**	**1 718**	**1 752**	**1 786**	**1 786**
HARVESTING COSTS											
Harvesting (including CAPEX)											
Eucalyptus											
large diameter	USD/m³	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15
small diameter	USD/m³	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15
Skidding and loading											
Eucalyptus											
large diameter	USD/m³	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63
small diameter	USD/m³	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63
Transportation											
Eucalyptus											
large diameter	USD/m³	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59
small diameter	USD/m³	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59
Total harvesting cost	**USD '000**	**4 764**	**4 764**	**4 764**	**4 764**	**4 764**	**6 175**	**6 175**	**6 175**	**6 175**	**6 175**
General and administrative costs	USD '000	302	302	302	302	302	302	302	302	302	302
	USD '000	**302**	**302**	**302**	**302**	**302**	**302**	**302**	**302**	**302**	**302**
Land											
Rent	USD/ha	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46
Land area	ha	30 163	30 163	30 163	30 163	30 163	30 163	30 163	30 163	30 163	30 163
Total land rent	**USD '000**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**	**14**
TOTAL OPERATION COSTS	**USD '000**	**7 276**	**6 566**	**6 532**	**6 457**	**6 457**	**7 868**	**8 209**	**8 243**	**8 277**	**8 277**
EBITDA	**USD '000**	**1 001**	**1 710**	**1 744**	**1 819**	**1 819**	**2 860**	**2 520**	**2 486**	**2 452**	**2 452**
EBITDA margin		*12 %*	*21 %*	*21 %*	*22 %*	*22 %*	*27 %*	*23 %*	*23 %*	*23 %*	*23 %*
CAPEX											
Change in working capital	**USD '000**	**239**	**(106)**	**(5)**	**(11)**	**-**	**212**	**51**	**5**	**5**	**-**
CASH FLOW	**USD '000**	**762**	**1 817**	**1 749**	**1 831**	**1 819**	**2 648**	**2 469**	**2 481**	**2 446**	**2 452**

IRR	6,7 %
NPV, USD million	(2,4)
Cost price of roundwood, USD/m³	32
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioene
CASH FLOW CALCULATION
Mafinga Cluster
Plantations

		2050	2051	2052
Plantation area				
Eucalyptus	ha	30 163	30 163	30 163
Total plantation area	ha	30 163	30 163	30 163
Wood flow (commercial volume)				
Eucalyptus				
large diameter	m³	307 587	307 587	307 587
small diameter	m³	205 058	205 058	205 058
Total wood flow	m³	512 646	512 646	512 646
REVENUE				
Price at the mill				
Eucalyptus				
large diameter	USD/m³	30,73	30,73	30,73
small diameter	USD/m³	20,64	20,64	20,64
Sales (purchases)				
Eucalyptus				
large diameter	m³	307 587	307 587	307 587
small diameter	m³	205 058	205 058	205 058
TOTAL REVENUE	**USD '000**	**13 686**	**13 686**	**13 686**
PLANTATION ESTABLISHMENT AND MAINTENANCE COSTS				
Establishment	USD '000	1 488	1 488	1 488
Maintenance	USD '000	298	298	298
Total silviculture cost	**USD '000**	**1 786**	**1 786**	**1 786**
HARVESTING COSTS				
Harvesting (including CAPEX)				
Eucalyptus				
large diameter	USD/m³	1,15	1,15	1,15
small diameter	USD/m³	1,15	1,15	1,15
Skidding and loading				
Eucalyptus				
large diameter	USD/m³	9,63	9,63	9,63
small diameter	USD/m³	9,63	9,63	9,63
Transportation				
Eucalyptus				
large diameter	USD/m³	4,59	4,59	4,59
small diameter	USD/m³	4,59	4,59	4,59
Total harvesting cost	**USD '000**	**7 878**	**7 878**	**7 878**
General and administrative costs	USD '000	302	302	302
	USD '000	**302**	**302**	**302**
Land				
Rent	USD/ha	0,46	0,46	0,46
Land area	ha	30 163	30 163	30 163
Total land rent	**USD '000**	**14**	**14**	**14**
TOTAL OPERATION COSTS	**USD '000**	**9 979**	**9 979**	**9 979**
EBITDA	**USD '000**	**3 707**	**3 707**	**3 707**
EBITDA margin		*27 %*	*27 %*	*27 %*
CAPEX				
Change in working capital	**USD '000**	**255**	-	-
CASH FLOW	**USD '000**	**3 452**	**3 707**	**3 707**

IRR	6,7 %
NPV, USD million	(2,4)
Cost price of roundwood, USD/m³	32
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy Sectors
CASH FLOW CALCULATION
Mafinga Cluster
Pine sawmilling

		2018	2019	2020	2021	2022	2023
Wood intake	m³	-	-	-	-	-	-
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Lumber							
Price, ex works	USD/m³	200	200	200	200	200	200
Output/sales	m³	-	-	-	-	-	-
Total	USD '000	-	-	-	-	-	-
TOTAL REVENUE	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	45,87	45,87	45,87	45,87	45,87	45,87
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	-	-	-	-	-	-
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	-	-	-	-	-	-
Other fixed	USD '000	-	-	-	-	-	-
Total fixed costs	USD '000	-	-	-	-	-	-
TOTAL COST	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
EBITDA	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
EBITDA margin		*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*
CAPEX							
Investment capex							
Site and infrastructure	USD '000	-	-	-	-	-	-
Buildings	USD '000	-	-	-	-	-	-
Machinery	USD '000	-	-	-	-	-	-
Equipment	USD '000	-	-	-	-	-	-
Contingency, 25%	USD '000	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	-	-	-	-	-	-
TOTAL CAPEX	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
Change in working capital	USD '000	-	-	-	-	-	-
CASH FLOW	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**

IRR	52,5 %
NPV, USD million	0,6
Wood-paying capability, USD/m³ (at roadside)	63
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Pine sawmilling

		2024	2025	2026	2027	2028	2029
Wood intake	m³	-	-	-	-	-	-
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Lumber							
Price, ex works	USD/m³	200	200	200	200	200	200
Output/sales	m³	-	-	-	-	-	-
Total	USD '000	-	-	-	-	-	-
TOTAL REVENUE	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	45,87	45,87	45,87	45,87	45,87	45,87
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	-	-	-	-	-	-
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	-	-	-	-	-	-
Other fixed	USD '000	-	-	-	-	-	-
Total fixed costs	USD '000	-	-	-	-	-	-
TOTAL COST	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
EBITDA	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
EBITDA margin		*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*
CAPEX							
Investment capex							
Site and infrastructure	USD '000	-	-	-	-	-	-
Buildings	USD '000	-	-	-	-	-	-
Machinery	USD '000	-	-	-	-	-	-
Equipment	USD '000	-	-	-	-	-	-
Contingency, 25%	USD '000	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	-	-	-	-	-	-
TOTAL CAPEX	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
Change in working capital	USD '000	-	-	-	-	-	-
CASH FLOW	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**

IRR	52,5 %
NPV, USD million	0,6
Wood-paying capability, USD/m³ (at roadside)	63
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Pine sawmilling

		2030	2031	2032	2033	2034	2035
Wood intake	m³	-	-	-	-	-	-
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Lumber							
Price, ex works	USD/m³	200	200	200	200	200	200
Output/sales	m³	-	-	-	-	-	-
Total	USD '000	-	-	-	-	-	-
TOTAL REVENUE	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	45,87	45,87	45,87	45,87	45,87	45,87
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	-	-	-	-	-	-
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	-	-	-	-	-	-
Other fixed	USD '000	-	-	-	-	-	-
Total fixed costs	USD '000	-	-	-	-	-	-
TOTAL COST	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
EBITDA	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
EBITDA margin		*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*
CAPEX							
Investment capex							
Site and infrastructure	USD '000	-	-	-	-	-	-
Buildings	USD '000	-	-	-	-	-	-
Machinery	USD '000	-	-	-	-	-	-
Equipment	USD '000	-	-	-	-	-	-
Contingency, 25%	USD '000	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	-	-	-	-	-	-
TOTAL CAPEX	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
Change in working capital	USD '000	-	-	-	-	-	-
CASH FLOW	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**

IRR	52,5 %
NPV, USD million	0,6
Wood-paying capability, USD/m³ (at roadside)	63
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Pine sawmilling

		2036	2037	2038	2039	2040	2041
Wood intake	m³	-	-	-	-	-	19 880
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Lumber							
Price, ex works	USD/m³	200	200	200	200	200	200
Output/sales	m³	-	-	-	-	-	9 940
Total	USD '000	-	-	-	-	-	1 988
TOTAL REVENUE	**USD '000**	**-**	**-**	**-**	**-**	**-**	**1 988**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	45,87	45,87	45,87	45,87	45,87	45,87
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	-	-	-	-	-	1 178
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	-	-	-	-	-	10
Other fixed	USD '000	-	-	-	-	-	63
Total fixed costs	USD '000	-	-	-	-	-	125
TOTAL COST	**USD '000**	**-**	**-**	**-**	**-**	**-**	**1 303**
EBITDA	**USD '000**	**-**	**-**	**-**	**-**	**-**	**685**
EBITDA margin		*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*34 %*
CAPEX							
Investment capex							
Site and infrastructure	USD '000	-	-	-	-	-	174
Buildings	USD '000	-	-	-	-	-	236
Machinery	USD '000	-	-	-	-	-	708
Equipment	USD '000	-	-	-	-	-	124
Contingency, 25%	USD '000	-	-	-	-	-	311
Ongoing capex (2% of initial investment)	USD '000	-	-	-	-	-	31
TOTAL CAPEX	**USD '000**	**-**	**-**	**-**	**-**	**-**	**1 584**
Change in working capital	USD '000	-	-	-	-	-	300
CASH FLOW	**USD '000**	**-**	**-**	**-**	**-**	**-**	**(1 199)**

IRR	52,5 %
NPV, USD million	0,6
Wood-paying capability, USD/m³ (at roadside)	63
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Pine sawmilling

		2042	2043	2044	2045	2046	2047
Wood intake	m³	39 760	59 640	79 520	99 400	105 520	111 640
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Lumber							
Price, ex works	USD/m³	200	200	200	200	200	200
Output/sales	m³	19 880	29 820	39 760	49 700	52 760	55 820
Total	USD '000	3 976	5 964	7 952	9 940	10 552	11 164
TOTAL REVENUE	**USD '000**	**3 976**	**5 964**	**7 952**	**9 940**	**10 552**	**11 164**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	45,87	45,87	45,87	45,87	45,87	45,87
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	2 356	3 533	4 711	5 889	6 252	6 614
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	20	30	40	50	53	56
Other fixed	USD '000	125	188	250	313	332	352
Total fixed costs	USD '000	250	376	501	626	665	703
TOTAL COST	**USD '000**	**2 606**	**3 909**	**5 212**	**6 515**	**6 916**	**7 318**
EBITDA	**USD '000**	**1 370**	**2 055**	**2 740**	**3 425**	**3 636**	**3 846**
EBITDA margin		*34 %*	*34 %*	*34 %*	*34 %*	*34 %*	*34 %*
CAPEX							
Investment capex							
Site and infrastructure	USD '000	174	174	174	174	54	54
Buildings	USD '000	236	236	236	236	73	73
Machinery	USD '000	708	708	708	708	218	218
Equipment	USD '000	124	124	124	124	163	163
Contingency, 25%	USD '000	311	311	311	311	96	96
Ongoing capex (2% of initial investment)	USD '000	62	93	124	155	165	174
TOTAL CAPEX	**USD '000**	**1 615**	**1 646**	**1 677**	**1 708**	**767**	**777**
Change in working capital	USD '000	300	300	300	300	100	100
CASH FLOW	**USD '000**	**(545)**	**108**	**762**	**1 416**	**2 768**	**2 970**

IRR	52,5 %
NPV, USD million	0,6
Wood-paying capability, USD/m³ (at roadside)	63
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Pine sawmilling

		2048	2049	2050	2051	2052
Wood intake	m³	117 760	123 880	130 000	130 000	130 000
Recovery		50 %	50 %	50 %	50 %	50 %
REVENUE						
Lumber						
Price, ex works	USD/m³	200	200	200	200	200
Output/sales	m³	58 880	61 940	65 000	65 000	65 000
Total	USD '000	11 776	12 388	13 000	13 000	13 000
TOTAL REVENUE	**USD '000**	**11 776**	**12 388**	**13 000**	**13 000**	**13 000**
COST						
Variable costs						
Wood						
price at the mill-gate	USD/m³	45,87	45,87	45,87	45,87	45,87
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00
Electricity						
price	USD/kWh	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	6 977	7 339	7 702	7 702	7 702
Fixed costs						
Labor						
average pay	USD/month	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %
staff	people	59	62	65	65	65
Other fixed	USD '000	371	390	410	410	410
Total fixed costs	USD '000	742	780	819	819	819
TOTAL COST	**USD '000**	**7 719**	**8 120**	**8 521**	**8 521**	**8 521**
EBITDA	**USD '000**	**4 057**	**4 268**	**4 479**	**4 479**	**4 479**
EBITDA margin		*34 %*	*34 %*	*34 %*	*34 %*	*34 %*
CAPEX						
Investment capex						
Site and infrastructure	USD '000	54	54	54	-	-
Buildings	USD '000	73	73	73	-	-
Machinery	USD '000	218	218	218	708	708
Equipment	USD '000	163	163	163	163	163
Contingency, 25%	USD '000	96	96	96	-	-
Ongoing capex (2% of initial investment)	USD '000	184	194	203	203	203
TOTAL CAPEX	**USD '000**	**786**	**796**	**806**	**1 074**	**1 074**
Change in working capital	USD '000	100	100	100	-	(2 000)
CASH FLOW	**USD '000**	**3 171**	**3 372**	**3 573**	**3 405**	**5 405**

IRR	52,5 %
NPV, USD million	0,6
Wood-paying capability, USD/m³ (at roadside)	63
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy Sectors
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus sawmilling

		2018	2019	2020	2021	2022	2023
Wood intake	m³	-	-	2 600	2 720	2 840	2 960
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Lumber							
Price, ex works	USD/m³	130	130	130	130	130	130
Output/sales	m³	-	-	1 300	1 360	1 420	1 480
Total	USD '000	-	-	169	177	185	192
TOTAL REVENUE	**USD '000**	**-**	**-**	**169**	**177**	**185**	**192**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	-	-	115	120	125	131
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	-	-	1	1	1	1
Other fixed	USD '000	-	-	8	9	9	9
Total fixed costs	USD '000	-	-	16	17	18	19
TOTAL COST	**USD '000**	**-**	**-**	**131**	**137**	**143**	**149**
EBITDA	**USD '000**	**-**	**-**	**38**	**40**	**41**	**43**
EBITDA margin		*0 %*	*0 %*	*22 %*	*22 %*	*22 %*	*22 %*
CAPEX							
Investment capex							
Site and infrastructure	USD '000	-	-	23	1	1	1
Buildings	USD '000	-	-	31	1	1	1
Machinery	USD '000	-	-	93	4	4	4
Equipment	USD '000	-	-	16	1	1	1
Contingency, 25%	USD '000	-	-	41	2	2	2
Ongoing capex (2% of initial investment)	USD '000	-	-	4	4	4	5
TOTAL CAPEX	**USD '000**	**-**	**-**	**207**	**14**	**14**	**14**
Change in working capital	USD '000	-	-	-	-	-	-
CASH FLOW	**USD '000**	**-**	**-**	**(169)**	**26**	**28**	**29**

IRR	13,0 %
NPV, USD million	0,0
Wood-paying capability, USD/m³ (at roadside)	31
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus sawmilling

		2024	2025	2026	2027	2028	2029
Wood intake	m³	3 080	3 200	4 960	6 720	8 480	10 240
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Lumber							
Price, ex works	USD/m³	130	130	130	130	130	130
Output/sales	m³	1 540	1 600	2 480	3 360	4 240	5 120
Total	USD '000	200	208	322	437	551	666
TOTAL REVENUE	**USD '000**	**200**	**208**	**322**	**437**	**551**	**666**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	136	141	219	296	374	452
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	2	2	2	3	4	5
Other fixed	USD '000	10	10	16	21	27	32
Total fixed costs	USD '000	19	20	31	42	53	65
TOTAL COST	**USD '000**	**155**	**161**	**250**	**339**	**427**	**516**
EBITDA	**USD '000**	**45**	**47**	**72**	**98**	**124**	**149**
EBITDA margin		*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*
CAPEX							
Investment capex							
Site and infrastructure	USD '000	1	1	15	15	15	15
Buildings	USD '000	1	1	21	21	21	21
Machinery	USD '000	4	4	63	63	63	63
Equipment	USD '000	1	17	12	12	12	12
Contingency, 25%	USD '000	2	2	28	28	28	28
Ongoing capex (2% of initial investment)	USD '000	5	5	8	11	13	16
TOTAL CAPEX	**USD '000**	**14**	**31**	**146**	**149**	**152**	**154**
Change in working capital	USD '000	-	-	-	100	-	-
CASH FLOW	**USD '000**	**31**	**16**	**(74)**	**(151)**	**(28)**	**(5)**

IRR	13,0 %
NPV, USD million	0,0
Wood-paying capability, USD/m³ (at roadside)	31
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus sawmilling

		2030	2031	2032	2033	2034	2035
Wood intake	m³	12 000	12 800	13 600	14 400	15 200	16 000
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Lumber							
Price, ex works	USD/m³	130	130	130	130	130	130
Output/sales	m³	6 000	6 400	6 800	7 200	7 600	8 000
Total	USD '000	780	832	884	936	988	1 040
TOTAL REVENUE	**USD '000**	**780**	**832**	**884**	**936**	**988**	**1 040**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	529	565	600	635	670	706
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	6	6	7	7	8	8
Other fixed	USD '000	38	40	43	45	48	50
Total fixed costs	USD '000	76	81	86	91	96	101
TOTAL COST	**USD '000**	**605**	**645**	**686**	**726**	**766**	**807**
EBITDA	**USD '000**	**175**	**187**	**198**	**210**	**222**	**233**
EBITDA margin		*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*
CAPEX							
Investment capex							
Site and infrastructure	USD '000	15	7	7	7	7	7
Buildings	USD '000	21	10	10	10	10	10
Machinery	USD '000	155	33	33	33	33	33
Equipment	USD '000	28	17	17	17	17	33
Contingency, 25%	USD '000	28	13	13	13	13	13
Ongoing capex (2% of initial investment)	USD '000	19	20	21	23	24	25
TOTAL CAPEX	**USD '000**	**266**	**99**	**100**	**101**	**102**	**120**
Change in working capital	USD '000	-	-	-	-	-	100
CASH FLOW	**USD '000**	**(91)**	**88**	**99**	**109**	**120**	**14**

IRR	13,0 %
NPV, USD million	0,0
Wood-paying capability, USD/m³ (at roadside)	31
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus sawmilling

		2036	2037	2038	2039	2040	2041
Wood intake	m³	16 920	17 840	18 760	19 680	20 600	21 760
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Lumber							
Price, ex works	USD/m³	130	130	130	130	130	130
Output/sales	m³	8 460	8 920	9 380	9 840	10 300	10 880
Total	USD '000	1 100	1 160	1 219	1 279	1 339	1 414
TOTAL REVENUE	**USD '000**	**1 100**	**1 160**	**1 219**	**1 279**	**1 339**	**1 414**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	746	787	827	868	909	960
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	8	9	9	10	10	11
Other fixed	USD '000	53	56	59	62	65	69
Total fixed costs	USD '000	107	112	118	124	130	137
TOTAL COST	**USD '000**	**853**	**899**	**946**	**992**	**1 038**	**1 097**
EBITDA	**USD '000**	**247**	**260**	**274**	**287**	**301**	**318**
EBITDA margin		*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*
CAPEX							
Investment capex							
Site and infrastructure	USD '000	8	8	8	8	8	10
Buildings	USD '000	11	11	11	11	42	15
Machinery	USD '000	95	95	95	95	188	74
Equipment	USD '000	23	23	23	23	39	30
Contingency, 25%	USD '000	14	14	14	14	14	18
Ongoing capex (2% of initial investment)	USD '000	26	28	29	31	32	34
TOTAL CAPEX	**USD '000**	**178**	**179**	**181**	**182**	**323**	**181**
Change in working capital	USD '000	-	-	-	-	-	-
CASH FLOW	**USD '000**	**69**	**81**	**93**	**105**	**(23)**	**136**

IRR	13,0 %
NPV, USD million	0,0
Wood-paying capability, USD/m³ (at roadside)	31
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus sawmilling

		2042	2043	2044	2045	2046	2047
Wood intake	m³	22 920	24 080	25 240	26 400	27 720	29 040
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Lumber							
Price, ex works	USD/m³	130	130	130	130	130	130
Output/sales	m³	11 460	12 040	12 620	13 200	13 860	14 520
Total	USD '000	1 490	1 565	1 641	1 716	1 802	1 888
TOTAL REVENUE	**USD '000**	**1 490**	**1 565**	**1 641**	**1 716**	**1 802**	**1 888**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	1 011	1 062	1 113	1 164	1 223	1 281
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	11	12	13	13	14	15
Other fixed	USD '000	72	76	80	83	87	91
Total fixed costs	USD '000	144	152	159	166	175	183
TOTAL COST	**USD '000**	**1 155**	**1 214**	**1 272**	**1 331**	**1 397**	**1 464**
EBITDA	**USD '000**	**334**	**351**	**368**	**385**	**404**	**424**
EBITDA margin		*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*
CAPEX							
Investment capex							
Site and infrastructure	USD '000	10	10	10	10	12	12
Buildings	USD '000	15	15	15	15	37	37
Machinery	USD '000	74	74	74	74	143	143
Equipment	USD '000	30	30	30	46	38	38
Contingency, 25%	USD '000	18	18	18	18	21	21
Ongoing capex (2% of initial investment)	USD '000	36	38	39	41	43	45
TOTAL CAPEX	**USD '000**	**183**	**185**	**187**	**205**	**293**	**295**
Change in working capital	USD '000	-	-	-	100	-	-
CASH FLOW	**USD '000**	**151**	**166**	**182**	**80**	**112**	**129**

IRR	13,0 %
NPV, USD million	0,0
Wood-paying capability, USD/m³ (at roadside)	31
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy S
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus sawmilling

		2048	2049	2050	2051	2052
Wood intake	m³	30 360	31 680	33 000	33 000	33 000
Recovery		50 %	50 %	50 %	50 %	50 %
REVENUE						
Lumber						
Price, ex works	USD/m³	130	130	130	130	130
Output/sales	m³	15 180	15 840	16 500	16 500	16 500
Total	USD '000	1 973	2 059	2 145	2 145	2 145
TOTAL REVENUE	**USD '000**	**1 973**	**2 059**	**2 145**	**2 145**	**2 145**
COST						
Variable costs						
Wood						
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00
Electricity						
price	USD/kWh	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	1 339	1 397	1 456	1 456	1 456
Fixed costs						
Labor						
average pay	USD/month	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %
staff	people	15	16	17	17	17
Other fixed	USD '000	96	100	104	104	104
Total fixed costs	USD '000	191	200	208	208	208
TOTAL COST	**USD '000**	**1 530**	**1 597**	**1 663**	**1 663**	**1 663**
EBITDA	**USD '000**	**443**	**462**	**482**	**482**	**482**
EBITDA margin		*22 %*	*22 %*	*22 %*	*22 %*	*22 %*
CAPEX						
Investment capex						
Site and infrastructure	USD '000	12	12	12	-	-
Buildings	USD '000	37	37	37	10	10
Machinery	USD '000	143	143	235	74	74
Equipment	USD '000	38	38	54	38	38
Contingency, 25%	USD '000	21	21	21	-	-
Ongoing capex (2% of initial investment)	USD '000	47	50	52	52	52
TOTAL CAPEX	**USD '000**	**297**	**299**	**410**	**173**	**173**
Change in working capital	USD '000	-	-	-	-	(300)
CASH FLOW	**USD '000**	**146**	**163**	**72**	**308**	**608**

IRR	13,0 %
NPV, USD million	0,0
Wood-paying capability, USD/m³ (at roadside)	31
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy Sectors
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus pole treatment

		2018	2019	2020	2021	2022	2023
Wood intake	m³	-	6 778	13 556	13 556	13 556	13 556
Recovery		90 %	90 %	90 %	90 %	90 %	90 %
REVENUE							
Poles							
Price, ex works	USD/m³	180	180	180	180	180	180
Output/sales	m³	-	6 100	12 200	12 200	12 200	12 200
Total	USD '000	-	1 098	2 196	2 196	2 196	2 196
TOTAL REVENUE	**USD '000**	**-**	**1 098**	**2 196**	**2 196**	**2 196**	**2 196**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	1,11	1,11	1,11	1,11	1,11	1,11
Chemicals	USD/m³	62,30	62,30	62,30	62,30	62,30	62,30
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	10	10	10	10	10	10
Spare parts	USD/m³	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	-	637	1 273	1 273	1 273	1 273
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	-	10	20	20	20	20
Other fixed	USD '000	-	64	128	128	128	128
Total fixed costs	USD '000	-	128	256	256	256	256
TOTAL COST	**USD '000**	**-**	**765**	**1 529**	**1 529**	**1 529**	**1 529**
EBITDA	**USD '000**	**-**	**333**	**667**	**667**	**667**	**667**
EBITDA margin		*0 %*	*30 %*	*30 %*	*30 %*	*30 %*	*30 %*
CAPEX							
Investment capex							
Site improvement and buildings	USD '000	-	122	122	-	-	-
Heavy machinery	USD '000	-	77	77	-	-	-
Machinery	USD '000	-	61	61	-	-	-
Equipment	USD '000	-	61	61	-	-	-
Contingency, 25%	USD '000	-	80	80	-	-	-
Ongoing capex (2% of initial investment)	USD '000	-	8	16	16	16	16
TOTAL CAPEX	**USD '000**	**-**	**408**	**416**	**16**	**16**	**16**
Change in working capital	USD '000	-	200	100	-	-	-
CASH FLOW	**USD '000**	**-**	**(275)**	**150**	**651**	**651**	**651**

IRR	132,4 %
NPV, USD million	3,5
Wood-paying capability, USD/m³ (at roadside)	68
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus pole treatment

		2024	2025	2026	2027	2028	2029
Wood intake	m³	13 556	13 556	13 556	13 556	13 556	13 556
Recovery		90 %	90 %	90 %	90 %	90 %	90 %
REVENUE							
Poles							
Price, ex works	USD/m³	180	180	180	180	180	180
Output/sales	m³	12 200	12 200	12 200	12 200	12 200	12 200
Total	USD '000	2 196	2 196	2 196	2 196	2 196	2 196
TOTAL REVENUE	**USD '000**	**2 196**	**2 196**	**2 196**	**2 196**	**2 196**	**2 196**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	1,11	1,11	1,11	1,11	1,11	1,11
Chemicals	USD/m³	62,30	62,30	62,30	62,30	62,30	62,30
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	10	10	10	10	10	10
Spare parts	USD/m³	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	1 273	1 273	1 273	1 273	1 273	1 273
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	20	20	20	20	20	20
Other fixed	USD '000	128	128	128	128	128	128
Total fixed costs	USD '000	256	256	256	256	256	256
TOTAL COST	**USD '000**	**1 529**	**1 529**	**1 529**	**1 529**	**1 529**	**1 529**
EBITDA	**USD '000**	**667**	**667**	**667**	**667**	**667**	**667**
EBITDA margin		*30 %*	*30 %*	*30 %*	*30 %*	*30 %*	*30 %*
CAPEX							
Investment capex							
Site improvement and buildings	USD '000	-	-	-	-	-	-
Heavy machinery	USD '000	-	-	-	-	-	-
Machinery	USD '000	-	-	-	-	-	61
Equipment	USD '000	61	61	-	-	-	61
Contingency, 25%	USD '000	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	16	16	16	16	16	16
TOTAL CAPEX	**USD '000**	**77**	**77**	**16**	**16**	**16**	**138**
Change in working capital	USD '000	-	-	-	-	-	-
CASH FLOW	**USD '000**	**590**	**590**	**651**	**651**	**651**	**529**

IRR	132,4 %
NPV, USD million	3,5
Wood-paying capability, USD/m³ (at roadside)	68
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus pole treatment

		2030	2031	2032	2033	2034	2035
Wood intake	m³	13 556	13 556	13 556	13 556	13 556	13 556
Recovery		90 %	90 %	90 %	90 %	90 %	90 %
REVENUE							
Poles							
Price, ex works	USD/m³	180	180	180	180	180	180
Output/sales	m³	12 200	12 200	12 200	12 200	12 200	12 200
Total	USD '000	2 196	2 196	2 196	2 196	2 196	2 196
TOTAL REVENUE	**USD '000**	**2 196**	**2 196**	**2 196**	**2 196**	**2 196**	**2 196**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	1,11	1,11	1,11	1,11	1,11	1,11
Chemicals	USD/m³	62,30	62,30	62,30	62,30	62,30	62,30
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	10	10	10	10	10	10
Spare parts	USD/m³	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	1 273	1 273	1 273	1 273	1 273	1 273
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	20	20	20	20	20	20
Other fixed	USD '000	128	128	128	128	128	128
Total fixed costs	USD '000	256	256	256	256	256	256
TOTAL COST	**USD '000**	**1 529**	**1 529**	**1 529**	**1 529**	**1 529**	**1 529**
EBITDA	**USD '000**	**667**	**667**	**667**	**667**	**667**	**667**
EBITDA margin		*30 %*	*30 %*	*30 %*	*30 %*	*30 %*	*30 %*
CAPEX							
Investment capex							
Site improvement and buildings	USD '000	-	-	-	-	-	-
Heavy machinery	USD '000	-	-	-	-	-	-
Machinery	USD '000	61	-	-	-	-	-
Equipment	USD '000	61	-	-	-	61	61
Contingency, 25%	USD '000	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	16	16	16	16	16	16
TOTAL CAPEX	**USD '000**	**138**	**16**	**16**	**16**	**77**	**77**
Change in working capital	USD '000	-	-	-	-	-	-
CASH FLOW	**USD '000**	**529**	**651**	**651**	**651**	**590**	**590**

IRR	132,4 %
NPV, USD million	3,5
Wood-paying capability, USD/m³ (at roadside)	68
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus pole treatment

		2036	2037	2038	2039	2040	2041
Wood intake	m³	13 556	13 556	13 556	13 556	13 556	13 556
Recovery		90 %	90 %	90 %	90 %	90 %	90 %
REVENUE							
Poles							
Price, ex works	USD/m³	180	180	180	180	180	180
Output/sales	m³	12 200	12 200	12 200	12 200	12 200	12 200
Total	USD '000	2 196	2 196	2 196	2 196	2 196	2 196
TOTAL REVENUE	**USD '000**	**2 196**	**2 196**	**2 196**	**2 196**	**2 196**	**2 196**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	1,11	1,11	1,11	1,11	1,11	1,11
Chemicals	USD/m³	62,30	62,30	62,30	62,30	62,30	62,30
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	10	10	10	10	10	10
Spare parts	USD/m³	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	1 273	1 273	1 273	1 273	1 273	1 273
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	20	20	20	20	20	20
Other fixed	USD '000	128	128	128	128	128	128
Total fixed costs	USD '000	256	256	256	256	256	256
TOTAL COST	**USD '000**	**1 529**	**1 529**	**1 529**	**1 529**	**1 529**	**1 529**
EBITDA	**USD '000**	**667**	**667**	**667**	**667**	**667**	**667**
EBITDA margin		*30 %*	*30 %*	*30 %*	*30 %*	*30 %*	*30 %*
CAPEX							
Investment capex							
Site improvement and buildings	USD '000	-	-	-	-	-	-
Heavy machinery	USD '000	-	-	-	77	77	-
Machinery	USD '000	-	-	-	61	61	-
Equipment	USD '000	-	-	-	61	61	-
Contingency, 25%	USD '000	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	16	16	16	16	16	16
TOTAL CAPEX	**USD '000**	**16**	**16**	**16**	**215**	**215**	**16**
Change in working capital	USD '000	-	-	-	-	-	-
CASH FLOW	**USD '000**	**651**	**651**	**651**	**452**	**452**	**651**

IRR	132,4 %
NPV, USD million	3,5
Wood-paying capability, USD/m³ (at roadside)	68
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus pole treatment

		2042	2043	2044	2045	2046	2047
Wood intake	m³	13 556	13 556	13 556	13 556	13 556	13 556
Recovery		90 %	90 %	90 %	90 %	90 %	90 %
REVENUE							
Poles							
Price, ex works	USD/m³	180	180	180	180	180	180
Output/sales	m³	12 200	12 200	12 200	12 200	12 200	12 200
Total	USD '000	2 196	2 196	2 196	2 196	2 196	2 196
TOTAL REVENUE	**USD '000**	**2 196**	**2 196**	**2 196**	**2 196**	**2 196**	**2 196**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	1,11	1,11	1,11	1,11	1,11	1,11
Chemicals	USD/m³	62,30	62,30	62,30	62,30	62,30	62,30
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	10	10	10	10	10	10
Spare parts	USD/m³	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	1 273	1 273	1 273	1 273	1 273	1 273
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	20	20	20	20	20	20
Other fixed	USD '000	128	128	128	128	128	128
Total fixed costs	USD '000	256	256	256	256	256	256
TOTAL COST	**USD '000**	**1 529**	**1 529**	**1 529**	**1 529**	**1 529**	**1 529**
EBITDA	**USD '000**	**667**	**667**	**667**	**667**	**667**	**667**
EBITDA margin		*30 %*	*30 %*	*30 %*	*30 %*	*30 %*	*30 %*
CAPEX							
Investment capex							
Site improvement and buildings	USD '000	-	-	-	-	-	-
Heavy machinery	USD '000	-	-	-	-	-	-
Machinery	USD '000	-	-	-	-	-	-
Equipment	USD '000	-	-	61	61	-	-
Contingency, 25%	USD '000	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	16	16	16	16	16	16
TOTAL CAPEX	**USD '000**	**16**	**16**	**77**	**77**	**16**	**16**
Change in working capital	USD '000	-	-	-	-	-	-
CASH FLOW	**USD '000**	**651**	**651**	**590**	**590**	**651**	**651**

IRR	132,4 %
NPV, USD million	3,5
Wood-paying capability, USD/m³ (at roadside)	68
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus pole treatment

		2048	2049	2050	2051	2052
Wood intake	m³	13 556	13 556	13 556	13 556	13 556
Recovery		90 %	90 %	90 %	90 %	90 %
REVENUE						
Poles						
Price, ex works	USD/m³	180	180	180	180	180
Output/sales	m³	12 200	12 200	12 200	12 200	12 200
Total	USD '000	2 196	2 196	2 196	2 196	2 196
TOTAL REVENUE	**USD '000**	**2 196**	**2 196**	**2 196**	**2 196**	**2 196**
COST						
Variable costs						
Wood						
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	1,11	1,11	1,11	1,11	1,11
Chemicals	USD/m³	62,30	62,30	62,30	62,30	62,30
Electricity						
price	USD/kWh	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	10	10	10	10	10
Spare parts	USD/m³	2,00	2,00	2,00	2,00	2,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	1 273	1 273	1 273	1 273	1 273
Fixed costs						
Labor						
average pay	USD/month	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %
staff	people	20	20	20	20	20
Other fixed	USD '000	128	128	128	128	128
Total fixed costs	USD '000	256	256	256	256	256
TOTAL COST	**USD '000**	**1 529**	**1 529**	**1 529**	**1 529**	**1 529**
EBITDA	**USD '000**	**667**	**667**	**667**	**667**	**667**
EBITDA margin		*30 %*	*30 %*	*30 %*	*30 %*	*30 %*
CAPEX						
Investment capex						
Site improvement and buildings	USD '000	-	-	-	-	-
Heavy machinery	USD '000	-	-	-	-	-
Machinery	USD '000	-	61	61	-	-
Equipment	USD '000	-	61	61	-	-
Contingency, 25%	USD '000	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	16	16	16	16	16
TOTAL CAPEX	**USD '000**	**16**	**138**	**138**	**16**	**16**
Change in working capital	USD '000	-	-	-	-	(300)
CASH FLOW	**USD '000**	**651**	**529**	**529**	**651**	**951**

IRR	132,4 %
NPV, USD million	3,5
Wood-paying capability, USD/m³ (at roadside)	68
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy Sectors
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus veneer production

		2018	2019	2020	2021	2022	2023
Wood intake	m³	-	-	-	-	-	-
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Plywood							
Price, ex works	USD/m³	250	250	250	250	250	250
Output/sales	m³	-	-	-	-	-	-
Total	USD '000	-	-	-	-	-	-
TOTAL REVENUE	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	150	150	150	150	150	150
Spare parts	USD/m³	7,00	7,00	7,00	7,00	7,00	7,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	-	-	-	-	-	-
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	-	-	-	-	-	-
Other fixed	USD '000	-	-	-	-	-	-
Total fixed costs	USD '000	-	-	-	-	-	-
TOTAL COST	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
EBITDA	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
EBITDA margin		*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*
CAPEX							
Investment capex							
Site improvement and buildings	USD '000	-	-	-	-	-	-
Heavy machinery	USD '000	-	-	-	-	-	-
Machinery	USD '000	-	-	-	-	-	-
Equipment	USD '000	-	-	-	-	-	-
Contingency, 25%	USD '000	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	-	-	-	-	-	-
TOTAL CAPEX	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
Change in working capital	USD '000	-	-	-	-	-	-
CASH FLOW	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**

IRR	51,7 %
NPV, USD million	6,9
Wood-paying capability, USD/m³ (at roadside)	65
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus veneer production

		2024	2025	2026	2027	2028	2029
Wood intake	m³	-	-	-	-	-	-
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Plywood							
Price, ex works	USD/m³	250	250	250	250	250	250
Output/sales	m³	-	-	-	-	-	-
Total	USD '000	-	-	-	-	-	-
TOTAL REVENUE	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	150	150	150	150	150	150
Spare parts	USD/m³	7,00	7,00	7,00	7,00	7,00	7,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	-	-	-	-	-	-
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	-	-	-	-	-	-
Other fixed	USD '000	-	-	-	-	-	-
Total fixed costs	USD '000	-	-	-	-	-	-
TOTAL COST	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
EBITDA	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
EBITDA margin		*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*
CAPEX							
Investment capex							
Site improvement and buildings	USD '000	-	-	-	-	-	-
Heavy machinery	USD '000	-	-	-	-	-	-
Machinery	USD '000	-	-	-	-	-	-
Equipment	USD '000	-	-	-	-	-	-
Contingency, 25%	USD '000	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	-	-	-	-	-	-
TOTAL CAPEX	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**
Change in working capital	USD '000	-	-	-	-	-	-
CASH FLOW	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**

IRR	51,7 %
NPV, USD million	6,9
Wood-paying capability, USD/m³ (at roadside)	65
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus veneer production

		2030	2031	2032	2033	2034	2035
Wood intake	m³	49 600	56 480	63 360	70 240	77 120	84 000
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Plywood							
Price, ex works	USD/m³	250	250	250	250	250	250
Output/sales	m³	24 800	28 240	31 680	35 120	38 560	42 000
Total	USD '000	6 200	7 060	7 920	8 780	9 640	10 500
TOTAL REVENUE	**USD '000**	**6 200**	**7 060**	**7 920**	**8 780**	**9 640**	**10 500**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	150	150	150	150	150	150
Spare parts	USD/m³	7,00	7,00	7,00	7,00	7,00	7,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	2 281	2 597	2 914	3 230	3 546	3 863
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	62	71	79	88	96	105
Other fixed	USD '000	391	445	499	553	607	662
Total fixed costs	USD '000	781	890	998	1 106	1 215	1 323
TOTAL COST	**USD '000**	**3 062**	**3 487**	**3 911**	**4 336**	**4 761**	**5 186**
EBITDA	**USD '000**	**3 138**	**3 573**	**4 009**	**4 444**	**4 879**	**5 314**
EBITDA margin		*51 %*	*51 %*	*51 %*	*51 %*	*51 %*	*51 %*
CAPEX							
Investment capex							
Site improvement and buildings	USD '000	310	43	43	43	43	43
Heavy machinery	USD '000	3 410	473	473	473	473	473
Machinery	USD '000	2 170	301	301	301	301	301
Equipment	USD '000	310	43	43	43	43	353
Contingency, 25%	USD '000	1 550	215	215	215	215	215
Ongoing capex (2% of initial investment)	USD '000	155	177	198	220	241	263
TOTAL CAPEX	**USD '000**	**7 905**	**1 252**	**1 273**	**1 295**	**1 316**	**1 648**
Change in working capital	USD '000	900	200	100	100	100	200
CASH FLOW	**USD '000**	**(5 667)**	**2 122**	**2 636**	**3 049**	**3 463**	**3 467**

IRR	51,7 %
NPV, USD million	6,9
Wood-paying capability, USD/m³ (at roadside)	65
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus veneer production

		2036	2037	2038	2039	2040	2041
Wood intake	m³	92 320	100 640	108 960	117 280	125 600	135 520
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Plywood							
Price, ex works	USD/m³	250	250	250	250	250	250
Output/sales	m³	46 160	50 320	54 480	58 640	62 800	67 760
Total	USD '000	11 540	12 580	13 620	14 660	15 700	16 940
TOTAL REVENUE	**USD '000**	**11 540**	**12 580**	**13 620**	**14 660**	**15 700**	**16 940**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	150	150	150	150	150	150
Spare parts	USD/m³	7,00	7,00	7,00	7,00	7,00	7,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	4 245	4 628	5 010	5 393	5 776	6 232
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	115	126	136	147	157	169
Other fixed	USD '000	727	793	858	924	989	1 067
Total fixed costs	USD '000	1 454	1 585	1 716	1 847	1 978	2 134
TOTAL COST	**USD '000**	**5 699**	**6 213**	**6 727**	**7 240**	**7 754**	**8 366**
EBITDA	**USD '000**	**5 841**	**6 367**	**6 893**	**7 420**	**7 946**	**8 574**
EBITDA margin		*51 %*	*51 %*	*51 %*	*51 %*	*51 %*	*51 %*
CAPEX							
Investment capex							
Site improvement and buildings	USD '000	52	52	52	52	52	62
Heavy machinery	USD '000	572	572	572	572	572	682
Machinery	USD '000	364	364	364	364	2 534	735
Equipment	USD '000	95	95	95	95	405	157
Contingency, 25%	USD '000	260	260	260	260	260	310
Ongoing capex (2% of initial investment)	USD '000	289	315	341	367	393	424
TOTAL CAPEX	**USD '000**	**1 632**	**1 658**	**1 684**	**1 710**	**4 216**	**2 370**
Change in working capital	USD '000	100	200	100	200	200	100
CASH FLOW	**USD '000**	**4 109**	**4 510**	**5 110**	**5 510**	**3 531**	**6 104**

IRR	51,7 %
NPV, USD million	6,9
Wood-paying capability, USD/m³ (at roadside)	65
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus veneer production

		2042	2043	2044	2045	2046	2047
Wood intake	m³	145 440	155 360	165 280	175 200	187 160	199 120
Recovery		50 %	50 %	50 %	50 %	50 %	50 %
REVENUE							
Plywood							
Price, ex works	USD/m³	250	250	250	250	250	250
Output/sales	m³	72 720	77 680	82 640	87 600	93 580	99 560
Total	USD '000	18 180	19 420	20 660	21 900	23 395	24 890
TOTAL REVENUE	**USD '000**	**18 180**	**19 420**	**20 660**	**21 900**	**23 395**	**24 890**
COST							
Variable costs							
Wood							
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Electricity							
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	150	150	150	150	150	150
Spare parts	USD/m³	7,00	7,00	7,00	7,00	7,00	7,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	6 688	7 144	7 600	8 056	8 606	9 156
Fixed costs							
Labor							
average pay	USD/month	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %
staff	people	182	194	207	219	234	249
Other fixed	USD '000	1 145	1 223	1 302	1 380	1 474	1 568
Total fixed costs	USD '000	2 291	2 447	2 603	2 759	2 948	3 136
TOTAL COST	**USD '000**	**8 979**	**9 591**	**10 203**	**10 816**	**11 554**	**12 292**
EBITDA	**USD '000**	**9 201**	**9 829**	**10 457**	**11 084**	**11 841**	**12 598**
EBITDA margin		*51 %*	*51 %*	*51 %*	*51 %*	*51 %*	*51 %*
CAPEX							
Investment capex							
Site improvement and buildings	USD '000	62	62	62	62	75	75
Heavy machinery	USD '000	682	682	682	682	822	822
Machinery	USD '000	735	735	735	735	887	887
Equipment	USD '000	157	157	157	467	232	232
Contingency, 25%	USD '000	310	310	310	310	374	374
Ongoing capex (2% of initial investment)	USD '000	455	486	517	548	585	622
TOTAL CAPEX	**USD '000**	**2 401**	**2 432**	**2 463**	**2 804**	**2 975**	**3 012**
Change in working capital	USD '000	200	200	200	200	200	200
CASH FLOW	**USD '000**	**6 601**	**7 198**	**7 794**	**8 081**	**8 666**	**9 386**

IRR	51,7 %
NPV, USD million	6,9
Wood-paying capability, USD/m³ (at roadside)	65
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Mafinga Cluster
Eucalyptus veneer production

		2048	2049	2050	2051	2052
Wood intake	m³	211 080	223 040	235 000	235 000	235 000
Recovery		50 %	50 %	50 %	50 %	50 %
REVENUE						
Plywood						
Price, ex works	USD/m³	250	250	250	250	250
Output/sales	m³	105 540	111 520	117 500	117 500	117 500
Total	USD '000	26 385	27 880	29 375	29 375	29 375
TOTAL REVENUE	**USD '000**	**26 385**	**27 880**	**29 375**	**29 375**	**29 375**
COST						
Variable costs						
Wood						
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00
Electricity						
price	USD/kWh	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	150	150	150	150	150
Spare parts	USD/m³	7,00	7,00	7,00	7,00	7,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	9 706	10 256	10 806	10 806	10 806
Fixed costs						
Labor						
average pay	USD/month	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %
staff	people	264	279	294	294	294
Other fixed	USD '000	1 662	1 756	1 851	1 851	1 851
Total fixed costs	USD '000	3 325	3 513	3 701	3 701	3 701
TOTAL COST	**USD '000**	**13 031**	**13 769**	**14 507**	**14 507**	**14 507**
EBITDA	**USD '000**	**13 354**	**14 111**	**14 868**	**14 868**	**14 868**
EBITDA margin		*51 %*	*51 %*	*51 %*	*51 %*	*51 %*
CAPEX						
Investment capex						
Site improvement and buildings	USD '000	75	75	75	-	-
Heavy machinery	USD '000	822	822	4 232	473	473
Machinery	USD '000	887	887	3 057	735	735
Equipment	USD '000	232	232	542	232	232
Contingency, 25%	USD '000	374	374	374	-	-
Ongoing capex (2% of initial investment)	USD '000	660	697	734	734	734
TOTAL CAPEX	**USD '000**	**3 049**	**3 087**	**9 014**	**2 174**	**2 174**
Change in working capital	USD '000	300	200	200	-	-
CASH FLOW	**USD '000**	**10 005**	**10 824**	**5 653**	**12 693**	**12 693**

IRR	51,7 %
NPV, USD million	6,9
Wood-paying capability, USD/m³ (at roadside)	65
Discount rate	12 %

		2018	2019	2020	2021	2022	2023	2024
Wood intake	m³	12 600	13 200	14 100	16 000	18 000	19 900	21 800
Wood density	t/m³	0,500	0,500	0,500	0,500	0,500	0,500	0,500
REVENUE								
Charcoal briquettes								
Price	USD/t	300	300	300	300	300	300	300
Output/sales	t	7 900	8 300	8 800	10 000	11 300	12 400	13 600
Total	USD '000	2 370	2 490	2 640	3 000	3 390	3 720	4 080
TOTAL REVENUE	**USD '000**	**2 370**	**2 490**	**2 640**	**3 000**	**3 390**	**3 720**	**4 080**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/t	25,00	25,00	25,00	25,00	25,00	25,00	25,00
unit consumption	t/t	0,800	0,800	0,800	0,800	0,800	0,800	0,800
Supplies	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/t	555	555	555	555	555	555	555
Chemicals								
price	USD/t	32,00	32,00	32,00	32,00	32,00	32,00	32,00
unit consumption	t/t	0,200	0,200	0,200	0,200	0,200	0,200	0,200
Spare parts	USD/t	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	697	732	778	884	997	1 096	1 202
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	105	111	117	133	151	165	181
Other fixed	USD '000	664	697	739	840	949	1 042	1 142
Total fixed costs	USD '000	1 327	1 394	1 478	1 680	1 898	2 083	2 285
TOTAL COST	**USD '000**	**2 025**	**2 127**	**2 256**	**2 564**	**2 896**	**3 179**	**3 487**
EBITDA	**USD '000**	**345**	**363**	**384**	**437**	**494**	**541**	**593**
EBITDA margin		*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*
CAPEX								
Investment capex								
Pre-production costs	USD '000	210	11	13	32	35	29	32
Site improvement	USD '000	31	2	2	5	5	4	5
Buildings and machinery	USD '000	629	32	40	96	104	88	96
Equipment	USD '000	22	1	1	3	4	25	5
Contingency, 25%	USD '000	223	11	14	34	37	31	34
Ongoing capex (2% of initial investment)	USD '000	22	23	25	28	32	35	38
TOTAL CAPEX	**USD '000**	**1 138**	**80**	**95**	**198**	**216**	**213**	**209**
Change in working capital	USD '000	356	18	23	54	59	50	54
CASH FLOW	**USD '000**	**(1 148)**	**265**	**266**	**185**	**220**	**278**	**330**

IRR	10,6 %
NPV, USD million	0,1
Wood-paying capability, USD/m³ (at roadside)	13
Discount rate	12 %

		2025	2026	2027	2028	2029	2030	2031
Wood intake	m³	23 800	24 300	24 800	25 300	25 800	26 300	26 700
Wood density	t/m³	0,500	0,500	0,500	0,500	0,500	0,500	0,500
REVENUE								
Charcoal briquettes								
Price	USD/t	300	300	300	300	300	300	300
Output/sales	t	14 900	15 200	15 500	15 800	16 100	16 400	16 700
Total	USD '000	4 470	4 560	4 650	4 740	4 830	4 920	5 010
TOTAL REVENUE	**USD '000**	**4 470**	**4 560**	**4 650**	**4 740**	**4 830**	**4 920**	**5 010**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/t	25,00	25,00	25,00	25,00	25,00	25,00	25,00
unit consumption	t/t	0,800	0,800	0,800	0,800	0,800	0,800	0,800
Supplies	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/t	555	555	555	555	555	555	555
Chemicals								
price	USD/t	32,00	32,00	32,00	32,00	32,00	32,00	32,00
unit consumption	t/t	0,200	0,200	0,200	0,200	0,200	0,200	0,200
Spare parts	USD/t	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	1 316	1 343	1 369	1 396	1 423	1 450	1 475
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	199	203	207	211	215	219	223
Other fixed	USD '000	1 252	1 277	1 302	1 327	1 352	1 378	2 104
Total fixed costs	USD '000	2 503	2 554	2 604	2 654	2 705	2 755	3 507
TOTAL COST	**USD '000**	**3 819**	**3 896**	**3 973**	**4 051**	**4 128**	**4 205**	**4 982**
EBITDA	**USD '000**	**651**	**664**	**677**	**689**	**702**	**715**	**28**
EBITDA margin		*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*1 %*
CAPEX								
Investment capex								
Pre-production costs	USD '000	35	8	8	8	8	8	8
Site improvement	USD '000	5	1	1	1	1	1	1
Buildings and machinery	USD '000	104	24	24	653	56	64	119
Equipment	USD '000	5	4	5	26	5	6	5
Contingency, 25%	USD '000	37	8	8	8	8	8	8
Ongoing capex (2% of initial investment)	USD '000	42	43	44	45	45	46	47
TOTAL CAPEX	**USD '000**	**227**	**89**	**90**	**742**	**124**	**134**	**189**
Change in working capital	USD '000	59	14	14	14	14	14	14
CASH FLOW	**USD '000**	**365**	**562**	**573**	**(66)**	**565**	**568**	**(175)**

IRR	10,6 %
NPV, USD million	0,1
Wood-paying capability, USD/m³ (at roadside)	13
Discount rate	12 %

		2032	2033	2034	2035	2036	2037	2038
Wood intake	m^3	27 200	27 600	28 100	28 500	28 800	29 100	29 400
Wood density	t/m^3	0,500	0,500	0,500	0,500	0,500	0,500	0,500
REVENUE								
Charcoal briquettes								
Price	USD/t	300	300	300	300	300	300	300
Output/sales	t	17 000	17 300	17 600	17 800	18 000	18 200	18 400
Total	USD '000	5 100	5 190	5 280	5 340	5 400	5 460	5 520
TOTAL REVENUE	**USD '000**	**5 100**	**5 190**	**5 280**	**5 340**	**5 400**	**5 460**	**5 520**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/t	25,00	25,00	25,00	25,00	25,00	25,00	25,00
unit consumption	t/t	0,800	0,800	0,800	0,800	0,800	0,800	0,800
Supplies	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/t	555	555	555	555	555	555	555
Chemicals								
price	USD/t	32,00	32,00	32,00	32,00	32,00	32,00	32,00
unit consumption	t/t	0,200	0,200	0,200	0,200	0,200	0,200	0,200
Spare parts	USD/t	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	1 502	1 527	1 554	1 573	1 590	1 608	1 625
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	227	231	235	237	240	243	245
Other fixed	USD '000	2 142	2 180	2 218	2 243	2 268	2 293	2 318
Total fixed costs	USD '000	3 570	3 633	3 696	3 738	3 780	3 822	3 864
TOTAL COST	**USD '000**	**5 072**	**5 160**	**5 250**	**5 311**	**5 370**	**5 430**	**5 489**
EBITDA	**USD '000**	**28**	**30**	**30**	**29**	**30**	**30**	**31**
EBITDA margin		*1 %*	*1 %*	*1 %*	*1 %*	*1 %*	*1 %*	*1 %*
CAPEX								
Investment capex								
Pre-production costs	USD '000	8	8	8	5	5	5	5
Site improvement	USD '000	1	1	1	1	1	1	32
Buildings and machinery	USD '000	127	112	119	119	40	40	669
Equipment	USD '000	5	27	6	6	6	6	28
Contingency, 25%	USD '000	8	8	8	6	6	6	6
Ongoing capex (2% of initial investment)	USD '000	48	49	50	50	51	51	52
TOTAL CAPEX	**USD '000**	**198**	**205**	**193**	**188**	**108**	**109**	**792**
Change in working capital	USD '000	14	14	14	9	9	9	9
CASH FLOW	**USD '000**	**(184)**	**(189)**	**(177)**	**(168)**	**(87)**	**(88)**	**(770)**

IRR	10,6 %
NPV, USD million	0,1
Wood-paying capability, USD/m^3 (at roadside)	13
Discount rate	12 %

		2039	2040	2041	2042	2043	2044	2045
Wood intake	m³	29 700	29 900	37 500	45 100	52 700	60 200	67 800
Wood density	t/m³	0,500	0,500	0,500	0,500	0,500	0,500	0,500
REVENUE								
Charcoal briquettes								
Price	USD/t	300	300	300	300	300	300	300
Output/sales	t	18 600	18 700	23 400	28 200	32 900	37 600	42 400
Total	USD '000	5 580	5 610	7 020	8 460	9 870	11 280	12 720
TOTAL REVENUE	**USD '000**	**5 580**	**5 610**	**7 020**	**8 460**	**9 870**	**11 280**	**12 720**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/t	25,00	25,00	25,00	25,00	25,00	25,00	25,00
unit consumption	t/t	0,800	0,800	0,800	0,800	0,800	0,800	0,800
Supplies	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/t	555	555	555	555	555	555	555
Chemicals								
price	USD/t	32,00	32,00	32,00	32,00	32,00	32,00	32,00
unit consumption	t/t	0,200	0,200	0,200	0,200	0,200	0,200	0,200
Spare parts	USD/t	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	1 643	1 652	2 068	2 491	2 907	3 322	3 746
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	248	249	312	376	439	501	565
Other fixed	USD '000	2 344	2 356	2 948	3 553	4 145	4 738	5 342
Total fixed costs	USD '000	3 906	3 927	4 914	5 922	6 909	7 896	8 904
TOTAL COST	**USD '000**	**5 549**	**5 579**	**6 982**	**8 413**	**9 816**	**11 218**	**12 650**
EBITDA	**USD '000**	**31**	**31**	**38**	**47**	**54**	**62**	**70**
EBITDA margin		*1 %*	*1 %*	*1 %*	*1 %*	*1 %*	*1 %*	*1 %*
CAPEX								
Investment capex								
Pre-production costs	USD '000	5	3	125	127	125	125	127
Site improvement	USD '000	2	2	23	24	23	23	24
Buildings and machinery	USD '000	72	72	494	510	486	494	502
Equipment	USD '000	7	7	19	19	41	20	20
Contingency, 25%	USD '000	6	3	133	136	133	133	136
Ongoing capex (2% of initial investment)	USD '000	53	53	66	80	93	106	120
TOTAL CAPEX	**USD '000**	**144**	**139**	**860**	**896**	**900**	**901**	**929**
Change in working capital	USD '000	9	5	212	216	212	212	216
CASH FLOW	**USD '000**	**(122)**	**(113)**	**(1 034)**	**(1 065)**	**(1 058)**	**(1 051)**	**(1 075)**

IRR	10,6 %
NPV, USD million	0,1
Wood-paying capability, USD/m³ (at roadside)	13
Discount rate	12 %

		2046	2047	2048	2049	2050	2051	2052
Wood intake	m³	69 600	71 400	73 200	75 000	76 800	76 800	76 800
Wood density	t/m³	0,500	0,500	0,500	0,500	0,500	0,500	0,500
REVENUE								
Charcoal briquettes								
Price	USD/t	300	300	300	300	300	300	300
Output/sales	t	43 500	44 600	45 800	46 900	48 000	48 000	48 000
Total	USD '000	13 050	13 380	13 740	14 070	14 400	14 400	14 400
TOTAL REVENUE	**USD '000**	**13 050**	**13 380**	**13 740**	**14 070**	**14 400**	**14 400**	**14 400**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/t	25,00	25,00	25,00	25,00	25,00	25,00	25,00
unit consumption	t/t	0,800	0,800	0,800	0,800	0,800	0,800	0,800
Supplies	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/t	555	555	555	555	555	555	555
Chemicals								
price	USD/t	32,00	32,00	32,00	32,00	32,00	32,00	32,00
unit consumption	t/t	0,200	0,200	0,200	0,200	0,200	0,200	0,200
Spare parts	USD/t	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	3 843	3 941	4 045	4 143	4 241	4 241	4 241
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	580	595	611	625	640	640	640
Other fixed	USD '000	5 481	5 620	5 771	5 909	6 048	6 048	6 048
Total fixed costs	USD '000	9 135	9 366	9 618	9 849	10 080	10 080	10 080
TOTAL COST	**USD '000**	**12 978**	**13 307**	**13 663**	**13 992**	**14 321**	**14 321**	**14 321**
EBITDA	**USD '000**	**72**	**73**	**77**	**78**	**79**	**79**	**79**
EBITDA margin		*1 %*	*1 %*	*1 %*	*1 %*	*1 %*	*1 %*	*1 %*
CAPEX								
Investment capex								
Pre-production costs	USD '000	29	29	32	29	29	-	-
Site improvement	USD '000	6	6	6	6	6	1	1
Buildings and machinery	USD '000	127	127	765	159	159	494	510
Equipment	USD '000	22	23	44	23	23	22	23
Contingency, 25%	USD '000	31	31	34	31	31	-	-
Ongoing capex (2% of initial investment)	USD '000	123	126	129	132	136	136	136
TOTAL CAPEX	**USD '000**	**338**	**342**	**1 010**	**381**	**384**	**653**	**669**
Change in working capital	USD '000	50	50	54	50	50	-	-
CASH FLOW	**USD '000**	**(316)**	**(318)**	**(988)**	**(352)**	**(354)**	**(574)**	**(590)**

IRR	10,6 %
NPV, USD million	0,1
Wood-paying capability, USD/m³ (at roadside)	13
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy Sectors
CASH FLOW CALCULATION
Njombe Cluster
Plantations

		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029
Plantation area													
Eucalyptus	ha	-	-	770	1 540	2 310	3 081	3 839	4 597	5 356	6 114	6 872	7 631
Total plantation area	ha	-	-	770	1 540	2 310	3 081	3 839	4 597	5 356	6 114	6 872	7 631
Wood flow (commercial volume)													
Eucalyptus													
large diameter	m³	-	-	-	-	-	-	-	-	-	-	-	-
small diameter	m³	-	-	-	-	-	-	-	-	-	-	-	-
Total wood flow	m³	-	-	-	-	-	-	-	-	-	-	-	-
REVENUE													
Price at the mill													
Eucalyptus													
large diameter	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73
small diameter	USD/m³	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64
Sales (purchases)													
Eucalyptus													
large diameter	m³	-	-	-	-	-	-	-	-	-	-	-	-
small diameter	m³	-	-	-	-	-	-	-	-	-	-	-	-
TOTAL REVENUE	**USD '000**	-	-	-	-	-	-	-	-	-	-	-	-
PLANTATION ESTABLISHMENT AND MAINTENANCE COSTS													
Establishment	USD '000	-	-	385	385	385	385	379	379	379	379	379	379
Maintenance	USD '000	-	-	-	39	77	77	77	76	76	76	76	76
Total silviculture cost	**USD '000**	-	-	385	424	462	462	456	456	455	455	455	455
HARVESTING COSTS													
Harvesting (including CAPEX)													
Eucalyptus													
large diameter	USD/m³	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15
small diameter	USD/m³	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15
Skidding and loading													
Eucalyptus													
large diameter	USD/m³	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63
small diameter	USD/m³	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63
Transportation													
Eucalyptus													
large diameter	USD/m³	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59
small diameter	USD/m³	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59
Total harvesting cost	**USD '000**	-	-	-	-	-	-	-	-	-	-	-	-
General and administrative costs	USD '000	-	-	8	15	23	31	38	46	54	61	69	76
	USD '000	-	-	**8**	**15**	**23**	**31**	**38**	**46**	**54**	**61**	**69**	**76**
Land													
Rent	USD/ha	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46
Land area	ha	-	-	770	1 540	2 310	3 081	3 839	4 597	5 356	6 114	6 872	7 631
Total land rent	**USD '000**	-	-	**0**	**1**	**1**	**1**	**2**	**2**	**2**	**3**	**3**	**4**
TOTAL OPERATION COSTS	**USD '000**	-	-	**393**	**440**	**486**	**494**	**496**	**504**	**511**	**519**	**527**	**535**
EBITDA	**USD '000**	-	-	**(393)**	**(440)**	**(486)**	**(494)**	**(496)**	**(504)**	**(511)**	**(519)**	**(527)**	**(535)**
EBITDA margin		*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*
CAPEX													
Change in working capital	**USD '000**	-	-	**58**	**6**	**6**	-	**(1)**	**(0)**	**(0)**	-	-	**(0)**
CASH FLOW	**USD '000**	-	-	**(451)**	**(445)**	**(492)**	**(494)**	**(495)**	**(504)**	**(511)**	**(519)**	**(527)**	**(535)**

IRR	7,0 %
NPV, USD million	(1,0)
Cost price of roundwood, USD/m³	32
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioene
CASH FLOW CALCULATION
Njombe Cluster
Plantations

		2030	2031	2032	2033	2034	2035	2036	2037	2038	2039
Plantation area											
Eucalyptus	ha	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401
Total plantation area	ha	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401
Wood flow (commercial volume)											
Eucalyptus											
large diameter	m³	62 382	62 382	62 382	62 382	61 426	61 426	61 426	61 426	61 426	61 426
small diameter	m³	41 588	41 588	41 588	41 588	40 951	40 951	40 951	40 951	40 951	40 951
Total wood flow	m³	103 971	103 971	103 971	103 971	102 376	102 376	102 376	102 376	102 376	102 376
REVENUE											
Price at the mill											
Eucalyptus											
large diameter	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73
small diameter	USD/m³	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64
Sales (purchases)											
Eucalyptus											
large diameter	m³	62 382	62 382	62 382	62 382	61 426	61 426	61 426	61 426	61 426	61 426
small diameter	m³	41 588	41 588	41 588	41 588	40 951	40 951	40 951	40 951	40 951	40 951
TOTAL REVENUE	**USD '000**	**2 776**	**2 776**	**2 776**	**2 776**	**2 733**	**2 733**	**2 733**	**2 733**	**2 733**	**2 733**
PLANTATION ESTABLISHMENT AND MAINTENANCE COSTS											
Establishment	USD '000	385	385	385	385	385	379	379	379	379	379
Maintenance	USD '000	76	76	77	77	77	77	76	76	76	76
Total silviculture cost	**USD '000**	**461**	**462**	**462**	**462**	**462**	**456**	**456**	**455**	**455**	**455**
HARVESTING COSTS											
Harvesting (including CAPEX)											
Eucalyptus											
large diameter	USD/m³	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15
small diameter	USD/m³	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15
Skidding and loading											
Eucalyptus											
large diameter	USD/m³	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63
small diameter	USD/m³	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63
Transportation											
Eucalyptus											
large diameter	USD/m³	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59
small diameter	USD/m³	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59
Total harvesting cost	**USD '000**	**1 598**	**1 598**	**1 598**	**1 598**	**1 573**	**1 573**	**1 573**	**1 573**	**1 573**	**1 573**
General and administrative costs	USD '000	84	84	84	84	84	84	84	84	84	84
	USD '000	**84**	**84**	**84**	**84**	**84**	**84**	**84**	**84**	**84**	**84**
Land											
Rent	USD/ha	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46
Land area	ha	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401
Total land rent	**USD '000**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
TOTAL OPERATION COSTS	**USD '000**	**2 146**	**2 147**	**2 148**	**2 148**	**2 123**	**2 117**	**2 117**	**2 116**	**2 116**	**2 116**
EBITDA	**USD '000**	**629**	**629**	**628**	**628**	**610**	**616**	**616**	**617**	**617**	**617**
EBITDA margin		*23 %*	*23 %*	*23 %*	*23 %*	*22 %*	*23 %*	*23 %*	*23 %*	*23 %*	*23 %*
CAPEX											
Change in working capital	**USD '000**	**241**	**0**	**0**	**-**	**(4)**	**(1)**	**(0)**	**(0)**	**-**	**(0)**
CASH FLOW	**USD '000**	**389**	**629**	**628**	**628**	**614**	**617**	**617**	**617**	**617**	**617**

IRR	7,0 %
NPV, USD million	(1,0)
Cost price of roundwood, USD/m³	32
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioene
CASH FLOW CALCULATION
Njombe Cluster
Plantations

		2040	2041	2042	2043	2044	2045	2046	2047	2048	2049
Plantation area											
Eucalyptus	ha	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401
Total plantation area	ha	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401
Wood flow (commercial volume)											
Eucalyptus											
large diameter	m³	62 382	62 382	62 382	62 382	62 382	61 426	61 426	61 426	61 426	61 426
small diameter	m³	41 588	41 588	41 588	41 588	41 588	40 951	40 951	40 951	40 951	40 951
Total wood flow	m³	103 971	103 971	103 971	103 971	103 971	102 376	102 376	102 376	102 376	102 376
REVENUE											
Price at the mill											
Eucalyptus											
large diameter	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73	30,73
small diameter	USD/m³	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64	20,64
Sales (purchases)											
Eucalyptus											
large diameter	m³	62 382	62 382	62 382	62 382	62 382	61 426	61 426	61 426	61 426	61 426
small diameter	m³	41 588	41 588	41 588	41 588	41 588	40 951	40 951	40 951	40 951	40 951
TOTAL REVENUE	**USD '000**	**2 776**	**2 776**	**2 776**	**2 776**	**2 776**	**2 733**	**2 733**	**2 733**	**2 733**	**2 733**
PLANTATION ESTABLISHMENT AND MAINTENANCE COSTS											
Establishment	USD '000	379	385	385	385	385	385	379	379	379	379
Maintenance	USD '000	76	76	76	77	77	77	77	76	76	76
Total silviculture cost	**USD '000**	**455**	**461**	**462**	**462**	**462**	**462**	**456**	**456**	**455**	**455**
HARVESTING COSTS											
Harvesting (including CAPEX)											
Eucalyptus											
large diameter	USD/m³	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15
small diameter	USD/m³	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15	1,15
Skidding and loading											
Eucalyptus											
large diameter	USD/m³	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63
small diameter	USD/m³	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63	9,63
Transportation											
Eucalyptus											
large diameter	USD/m³	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59
small diameter	USD/m³	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59	4,59
Total harvesting cost	**USD '000**	**1 598**	**1 598**	**1 598**	**1 598**	**1 598**	**1 573**	**1 573**	**1 573**	**1 573**	**1 573**
General and administrative costs	USD '000	84	84	84	84	84	84	84	84	84	84
	USD '000	**84**	**84**	**84**	**84**	**84**	**84**	**84**	**84**	**84**	**84**
Land											
Rent	USD/ha	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46	0,46
Land area	ha	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401	8 401
Total land rent	**USD '000**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**	**4**
TOTAL OPERATION COSTS	**USD '000**	**2 141**	**2 146**	**2 147**	**2 148**	**2 148**	**2 123**	**2 117**	**2 117**	**2 116**	**2 116**
EBITDA	**USD '000**	**635**	**629**	**629**	**628**	**628**	**610**	**616**	**616**	**617**	**617**
EBITDA margin		*23 %*	*23 %*	*23 %*	*23 %*	*23 %*	*22 %*	*23 %*	*23 %*	*23 %*	*23 %*
CAPEX											
Change in working capital	**USD '000**	**4**	**1**	**0**	**0**	**-**	**(4)**	**(1)**	**(0)**	**(0)**	**-**
CASH FLOW	**USD '000**	**631**	**628**	**629**	**628**	**628**	**614**	**617**	**617**	**617**	**617**

IRR	7,0 %
NPV, USD million	(1,0)
Cost price of roundwood, USD/m³	32
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioene
CASH FLOW CALCULATION
Njombe Cluster
Plantations

		2050	2051	2052
Plantation area				
Eucalyptus	ha	8 401	8 401	8 401
Total plantation area	ha	8 401	8 401	8 401
Wood flow (commercial volume)				
Eucalyptus				
large diameter	m³	61 426	61 426	61 426
small diameter	m³	40 951	40 951	40 951
Total wood flow	m³	102 376	102 376	102 376
REVENUE				
Price at the mill				
Eucalyptus				
large diameter	USD/m³	30,73	30,73	30,73
small diameter	USD/m³	20,64	20,64	20,64
Sales (purchases)				
Eucalyptus				
large diameter	m³	61 426	61 426	61 426
small diameter	m³	40 951	40 951	40 951
TOTAL REVENUE	**USD '000**	**2 733**	**2 733**	**2 733**
PLANTATION ESTABLISHMENT AND MAINTENANCE COSTS				
Establishment	USD '000	379	379	379
Maintenance	USD '000	76	76	76
Total silviculture cost	**USD '000**	**455**	**455**	**455**
HARVESTING COSTS				
Harvesting (including CAPEX)				
Eucalyptus				
large diameter	USD/m³	1,15	1,15	1,15
small diameter	USD/m³	1,15	1,15	1,15
Skidding and loading				
Eucalyptus				
large diameter	USD/m³	9,63	9,63	9,63
small diameter	USD/m³	9,63	9,63	9,63
Transportation				
Eucalyptus				
large diameter	USD/m³	4,59	4,59	4,59
small diameter	USD/m³	4,59	4,59	4,59
Total harvesting cost	**USD '000**	**1 573**	**1 573**	**1 573**
General and administrative costs	USD '000	84	84	84
	USD '000	**84**	**84**	**84**
Land				
Rent	USD/ha	0,46	0,46	0,46
Land area	ha	8 401	8 401	8 401
Total land rent	**USD '000**	**4**	**4**	**4**
TOTAL OPERATION COSTS	**USD '000**	**2 116**	**2 116**	**2 116**
EBITDA	**USD '000**	**617**	**617**	**617**
EBITDA margin		*23 %*	*23 %*	*23 %*
CAPEX				
Change in working capital	**USD '000**	**(0)**	-	-
CASH FLOW	**USD '000**	**617**	**617**	**617**

IRR	7,0 %
NPV, USD million	(1,0)
Cost price of roundwood, USD/m³	32
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy Sectors
CASH FLOW CALCULATION
Njombe Cluster
Pine sawmilling

		2018	2019	2020	2021	2022	2023	2024
Wood intake	m³	36 720	41 616	61 200	88 960	116 720	144 480	172 240
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Lumber								
Price, ex works	USD/m³	200	200	200	200	200	200	200
Output/sales	m³	18 360	20 808	30 600	44 480	58 360	72 240	86 120
Total	USD '000	3 672	4 162	6 120	8 896	11 672	14 448	17 224
TOTAL REVENUE	**USD '000**	**3 672**	**4 162**	**6 120**	**8 896**	**11 672**	**14 448**	**17 224**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	45,87	45,87	45,87	45,87	45,87	45,87	45,87
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	2 176	2 466	3 626	5 271	6 915	8 560	10 205
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	18	21	31	44	58	72	86
Other fixed	USD '000	116	131	193	280	368	455	543
Total fixed costs	USD '000	231	262	386	560	735	910	1 085
TOTAL COST	**USD '000**	**2 407**	**2 728**	**4 011**	**5 831**	**7 651**	**9 470**	**11 290**
EBITDA	**USD '000**	**1 265**	**1 434**	**2 109**	**3 065**	**4 021**	**4 978**	**5 934**
EBITDA margin		*34 %*	*34 %*	*34 %*	*34 %*	*34 %*	*34 %*	*34 %*
CAPEX								
Investment capex								
Site and infrastructure	USD '000	321	43	171	243	243	243	243
Buildings	USD '000	436	58	233	330	330	330	330
Machinery	USD '000	1 308	174	698	989	989	989	989
Equipment	USD '000	230	31	122	174	174	403	204
Contingency, 25%	USD '000	574	77	306	434	434	434	434
Ongoing capex (2% of initial investment)	USD '000	57	65	96	139	182	226	269
TOTAL CAPEX	**USD '000**	**2 926**	**448**	**1 626**	**2 308**	**2 351**	**2 624**	**2 468**
Change in working capital	USD '000	551	49	300	400	500	400	400
CASH FLOW	**USD '000**	**(2 212)**	**937**	**183**	**357**	**1 170**	**1 954**	**3 066**

IRR	53,5 %
NPV, USD million	22,3
Wood-paying capability, USD/m³ (at roadside)	66
Discount rate	12 %

		2025	2026	2027	2028	2029	2030	2031
Wood intake	m³	200 000	200 000	200 000	200 000	200 000	200 000	200 000
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Lumber								
Price, ex works	USD/m³	200	200	200	200	200	200	200
Output/sales	m³	100 000	100 000	100 000	100 000	100 000	100 000	100 000
Total	USD '000	20 000	20 000	20 000	20 000	20 000	20 000	20 000
TOTAL REVENUE	**USD '000**	**20 000**	**20 000**	**20 000**	**20 000**	**20 000**	**20 000**	**20 000**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	45,87	45,87	45,87	45,87	45,87	45,87	45,87
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	11 849	11 849	11 849	11 849	11 849	11 849	11 849
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	100	100	100	100	100	100	100
Other fixed	USD '000	630	630	630	630	630	630	630
Total fixed costs	USD '000	1 260	1 260	1 260	1 260	1 260	1 260	1 260
TOTAL COST	**USD '000**	**13 109**	**13 109**	**13 109**	**13 109**	**13 109**	**13 109**	**13 109**
EBITDA	**USD '000**	**6 891**	**6 891**	**6 891**	**6 891**	**6 891**	**6 891**	**6 891**
EBITDA margin		*34 %*	*34 %*	*34 %*	*34 %*	*34 %*	*34 %*	*34 %*
CAPEX								
Investment capex								
Site and infrastructure	USD '000	243	-	-	-	-	-	-
Buildings	USD '000	330	-	-	-	-	-	-
Machinery	USD '000	989	-	-	1 308	174	698	989
Equipment	USD '000	296	174	174	403	204	296	174
Contingency, 25%	USD '000	434	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	313	313	313	313	313	313	313
TOTAL CAPEX	**USD '000**	**2 604**	**486**	**486**	**2 024**	**691**	**1 306**	**1 475**
Change in working capital	USD '000	400	-	-	-	-	-	-
CASH FLOW	**USD '000**	**3 887**	**6 405**	**6 405**	**4 867**	**6 200**	**5 585**	**5 416**

IRR	53,5 %
NPV, USD million	22,3
Wood-paying capability, USD/m³ (at roadside)	66
Discount rate	12 %

		2032	2033	2034	2035	2036	2037	2038
Wood intake	m³	200 000	200 000	200 000	200 000	200 000	200 000	200 000
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Lumber								
Price, ex works	USD/m³	200	200	200	200	200	200	200
Output/sales	m³	100 000	100 000	100 000	100 000	100 000	100 000	100 000
Total	USD '000	20 000	20 000	20 000	20 000	20 000	20 000	20 000
TOTAL REVENUE	**USD '000**	**20 000**	**20 000**	**20 000**	**20 000**	**20 000**	**20 000**	**20 000**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	45,87	45,87	45,87	45,87	45,87	45,87	45,87
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	11 849	11 849	11 849	11 849	11 849	11 849	11 849
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	100	100	100	100	100	100	100
Other fixed	USD '000	630	630	630	630	630	630	630
Total fixed costs	USD '000	1 260	1 260	1 260	1 260	1 260	1 260	1 260
TOTAL COST	**USD '000**	**13 109**	**13 109**	**13 109**	**13 109**	**13 109**	**13 109**	**13 109**
EBITDA	**USD '000**	**6 891**	**6 891**	**6 891**	**6 891**	**6 891**	**6 891**	**6 891**
EBITDA margin		*34 %*	*34 %*	*34 %*	*34 %*	*34 %*	*34 %*	*34 %*
CAPEX								
Investment capex								
Site and infrastructure	USD '000	-	-	-	-	-	-	-
Buildings	USD '000	-	-	-	-	-	-	436
Machinery	USD '000	989	989	989	989	-	-	1 308
Equipment	USD '000	174	403	204	296	174	174	403
Contingency, 25%	USD '000	-	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	313	313	313	313	313	313	313
TOTAL CAPEX	**USD '000**	**1 475**	**1 704**	**1 506**	**1 597**	**486**	**486**	**2 460**
Change in working capital	USD '000	-	-	-	-	-	-	-
CASH FLOW	**USD '000**	**5 416**	**5 186**	**5 385**	**5 293**	**6 405**	**6 405**	**4 431**

IRR	53,5 %
NPV, USD million	22,3
Wood-paying capability, USD/m³ (at roadside)	66
Discount rate	12 %

		2039	2040	2041	2042	2043	2044	2045
Wood intake	m³	200 000	200 000	206 920	213 840	220 760	227 680	234 600
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Lumber								
Price, ex works	USD/m³	200	200	200	200	200	200	200
Output/sales	m³	100 000	100 000	103 460	106 920	110 380	113 840	117 300
Total	USD '000	20 000	20 000	20 692	21 384	22 076	22 768	23 460
TOTAL REVENUE	**USD '000**	**20 000**	**20 000**	**20 692**	**21 384**	**22 076**	**22 768**	**23 460**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	45,87	45,87	45,87	45,87	45,87	45,87	45,87
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	11 849	11 849	12 259	12 669	13 079	13 489	13 899
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	100	100	103	107	110	114	117
Other fixed	USD '000	630	630	652	674	695	717	739
Total fixed costs	USD '000	1 260	1 260	1 304	1 347	1 391	1 434	1 478
TOTAL COST	**USD '000**	**13 109**	**13 109**	**13 563**	**14 016**	**14 470**	**14 924**	**15 377**
EBITDA	**USD '000**	**6 891**	**6 891**	**7 129**	**7 368**	**7 606**	**7 844**	**8 083**
EBITDA margin		*34 %*	*34 %*	*34 %*	*34 %*	*34 %*	*34 %*	*34 %*
CAPEX								
Investment capex								
Site and infrastructure	USD '000	-	-	61	61	61	61	61
Buildings	USD '000	58	233	412	412	412	412	412
Machinery	USD '000	174	698	1 235	1 235	1 235	1 235	1 235
Equipment	USD '000	204	296	217	217	446	247	339
Contingency, 25%	USD '000	-	-	108	108	108	108	108
Ongoing capex (2% of initial investment)	USD '000	313	313	323	334	345	356	367
TOTAL CAPEX	**USD '000**	**749**	**1 539**	**2 356**	**2 367**	**2 607**	**2 419**	**2 522**
Change in working capital	USD '000	-	-	100	100	100	100	100
CASH FLOW	**USD '000**	**6 142**	**5 352**	**4 673**	**4 901**	**4 899**	**5 325**	**5 461**

IRR	53,5 %
NPV, USD million	22,3
Wood-paying capability, USD/m³ (at roadside)	66
Discount rate	12 %

		2046	2047	2048	2049	2050	2051	2052
Wood intake	m³	240 320	246 040	251 760	257 480	263 200	263 200	263 200
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Lumber								
Price, ex works	USD/m³	200	200	200	200	200	200	200
Output/sales	m³	120 160	123 020	125 880	128 740	131 600	131 600	131 600
Total	USD '000	24 032	24 604	25 176	25 748	26 320	26 320	26 320
TOTAL REVENUE	**USD '000**	**24 032**	**24 604**	**25 176**	**25 748**	**26 320**	**26 320**	**26 320**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	45,87	45,87	45,87	45,87	45,87	45,87	45,87
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	14 238	14 577	14 916	15 255	15 594	15 594	15 594
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	120	123	126	129	132	132	132
Other fixed	USD '000	757	775	793	811	829	829	829
Total fixed costs	USD '000	1 514	1 550	1 586	1 622	1 658	1 658	1 658
TOTAL COST	**USD '000**	**15 752**	**16 127**	**16 502**	**16 877**	**17 252**	**17 252**	**17 252**
EBITDA	**USD '000**	**8 280**	**8 477**	**8 674**	**8 871**	**9 068**	**9 068**	**9 068**
EBITDA margin		*34 %*	*34 %*	*34 %*	*34 %*	*34 %*	*34 %*	*34 %*
CAPEX								
Investment capex								
Site and infrastructure	USD '000	50	50	50	50	50	-	-
Buildings	USD '000	68	68	68	68	68	-	-
Machinery	USD '000	204	204	1 512	378	901	1 235	1 235
Equipment	USD '000	253	253	482	283	375	253	253
Contingency, 25%	USD '000	89	89	89	89	89	-	-
Ongoing capex (2% of initial investment)	USD '000	376	384	393	402	411	411	411
TOTAL CAPEX	**USD '000**	**1 039**	**1 048**	**2 595**	**1 271**	**1 895**	**1 899**	**1 899**
Change in working capital	USD '000	100	100	100	100	-	-	(3 900)
CASH FLOW	**USD '000**	**7 141**	**7 329**	**5 979**	**7 500**	**7 173**	**7 169**	**11 069**

IRR	53,5 %
NPV, USD million	22,3
Wood-paying capability, USD/m³ (at roadside)	66
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy Sectors
CASH FLOW CALCULATION
Njombe Cluster
Eucalyptus sawmilling

		2018	2019	2020	2021	2022	2023	2024
Wood intake	m³	2 760	3 128	4 600	4 800	5 000	5 200	5 400
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Lumber								
Price, ex works	USD/m³	130	130	130	130	130	130	130
Output/sales	m³	1 380	1 564	2 300	2 400	2 500	2 600	2 700
Total	USD '000	179	203	299	312	325	338	351
TOTAL REVENUE	**USD '000**	**179**	**203**	**299**	**312**	**325**	**338**	**351**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	122	138	203	212	221	229	238
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	1	2	2	2	3	3	3
Other fixed	USD '000	9	10	14	15	16	16	17
Total fixed costs	USD '000	17	20	29	30	32	33	34
TOTAL COST	**USD '000**	**139**	**158**	**232**	**242**	**252**	**262**	**272**
EBITDA	**USD '000**	**40**	**46**	**67**	**70**	**73**	**76**	**79**
EBITDA margin		*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*
CAPEX								
Investment capex								
Site and infrastructure	USD '000	24	3	13	2	2	2	2
Buildings	USD '000	33	4	17	2	2	2	2
Machinery	USD '000	98	13	52	7	7	7	7
Equipment	USD '000	17	2	9	1	1	19	4
Contingency, 25%	USD '000	43	6	23	3	3	3	3
Ongoing capex (2% of initial investment)	USD '000	4	5	7	8	8	8	8
TOTAL CAPEX	**USD '000**	**220**	**34**	**122**	**23**	**23**	**41**	**26**
Change in working capital	USD '000	-	-	-	-	-	100	-
CASH FLOW	**USD '000**	**(180)**	**12**	**(55)**	**47**	**50**	**(65)**	**52**

IRR	12,9 %
NPV, USD million	0,0
Wood-paying capability, USD/m³ (at roadside)	31
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Njombe Cluster
Eucalyptus sawmilling

		2025	2026	2027	2028	2029	2030	2031
Wood intake	m³	5 600	5 680	5 760	5 840	5 920	6 000	6 040
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Lumber								
Price, ex works	USD/m³	130	130	130	130	130	130	130
Output/sales	m³	2 800	2 840	2 880	2 920	2 960	3 000	3 020
Total	USD '000	364	369	374	380	385	390	393
TOTAL REVENUE	**USD '000**	**364**	**369**	**374**	**380**	**385**	**390**	**393**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	247	251	254	258	261	265	266
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	3	3	3	3	3	3	3
Other fixed	USD '000	18	18	18	18	19	19	19
Total fixed costs	USD '000	35	36	36	37	37	38	38
TOTAL COST	**USD '000**	**282**	**286**	**290**	**294**	**298**	**302**	**304**
EBITDA	**USD '000**	**82**	**83**	**84**	**85**	**86**	**88**	**88**
EBITDA margin		*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*
CAPEX								
Investment capex								
Site and infrastructure	USD '000	2	1	1	1	1	1	0
Buildings	USD '000	2	1	1	1	1	1	0
Machinery	USD '000	7	3	3	101	16	55	9
Equipment	USD '000	10	2	2	19	4	11	2
Contingency, 25%	USD '000	3	1	1	1	1	1	1
Ongoing capex (2% of initial investment)	USD '000	9	9	9	9	9	9	9
TOTAL CAPEX	**USD '000**	**34**	**16**	**17**	**132**	**32**	**79**	**21**
Change in working capital	USD '000	-	-	-	-	-	-	-
CASH FLOW	**USD '000**	**48**	**67**	**68**	**(47)**	**54**	**9**	**67**

IRR	12,9 %
NPV, USD million	0,0
Wood-paying capability, USD/m³ (at roadside)	31
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Njombe Cluster
Eucalyptus sawmilling

		2032	2033	2034	2035	2036	2037	2038
Wood intake	m³	6 080	6 120	6 160	6 200	6 280	6 360	6 440
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Lumber								
Price, ex works	USD/m³	130	130	130	130	130	130	130
Output/sales	m³	3 040	3 060	3 080	3 100	3 140	3 180	3 220
Total	USD '000	395	398	400	403	408	413	419
TOTAL REVENUE	**USD '000**	**395**	**398**	**400**	**403**	**408**	**413**	**419**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	268	270	272	273	277	281	284
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	3	3	3	3	3	3	3
Other fixed	USD '000	19	19	19	20	20	20	20
Total fixed costs	USD '000	38	39	39	39	40	40	41
TOTAL COST	**USD '000**	**306**	**309**	**311**	**313**	**317**	**321**	**325**
EBITDA	**USD '000**	**89**	**89**	**90**	**90**	**92**	**93**	**94**
EBITDA margin		*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*
CAPEX								
Investment capex								
Site and infrastructure	USD '000	0	0	0	0	1	1	1
Buildings	USD '000	0	0	0	0	1	1	34
Machinery	USD '000	9	9	9	9	6	6	104
Equipment	USD '000	2	19	4	11	3	3	20
Contingency, 25%	USD '000	1	1	1	1	1	1	1
Ongoing capex (2% of initial investment)	USD '000	10	10	10	10	10	10	10
TOTAL CAPEX	**USD '000**	**22**	**39**	**24**	**31**	**21**	**21**	**170**
Change in working capital	USD '000	-	-	-	-	-	-	-
CASH FLOW	**USD '000**	**67**	**50**	**66**	**60**	**71**	**72**	**(76)**

IRR	12,9 %
NPV, USD million	0,0
Wood-paying capability, USD/m³ (at roadside)	31
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Njombe Cluster
Eucalyptus sawmilling

		2039	2040	2041	2042	2043	2044	2045
Wood intake	m³	6 520	6 600	6 640	6 680	6 720	6 760	6 800
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Lumber								
Price, ex works	USD/m³	130	130	130	130	130	130	130
Output/sales	m³	3 260	3 300	3 320	3 340	3 360	3 380	3 400
Total	USD '000	424	429	432	434	437	439	442
TOTAL REVENUE	**USD '000**	**424**	**429**	**432**	**434**	**437**	**439**	**442**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	288	291	293	295	296	298	300
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	3	3	3	3	3	3	3
Other fixed	USD '000	21	21	21	21	21	21	21
Total fixed costs	USD '000	41	42	42	42	42	43	43
TOTAL COST	**USD '000**	**329**	**333**	**335**	**337**	**339**	**341**	**343**
EBITDA	**USD '000**	**95**	**96**	**97**	**97**	**98**	**99**	**99**
EBITDA margin		*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*
CAPEX								
Investment capex								
Site and infrastructure	USD '000	1	1	0	0	0	0	0
Buildings	USD '000	5	18	3	3	3	3	3
Machinery	USD '000	19	58	10	10	10	10	10
Equipment	USD '000	5	12	3	3	20	5	12
Contingency, 25%	USD '000	1	1	1	1	1	1	1
Ongoing capex (2% of initial investment)	USD '000	10	10	10	10	11	11	11
TOTAL CAPEX	**USD '000**	**41**	**101**	**27**	**27**	**44**	**29**	**36**
Change in working capital	USD '000	-	-	-	-	-	-	-
CASH FLOW	**USD '000**	**54**	**(4)**	**70**	**70**	**54**	**69**	**63**

IRR	12,9 %
NPV, USD million	0,0
Wood-paying capability, USD/m³ (at roadside)	31
Discount rate	12 %

		2046	2047	2048	2049	2050	2051	2052
Wood intake	m³	6 880	6 960	7 040	7 120	7 200	7 200	7 200
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Lumber								
Price, ex works	USD/m³	130	130	130	130	130	130	130
Output/sales	m³	3 440	3 480	3 520	3 560	3 600	3 600	3 600
Total	USD '000	447	452	458	463	468	468	468
TOTAL REVENUE	**USD '000**	**447**	**452**	**458**	**463**	**468**	**468**	**468**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	75	75	75	75	75	75	75
Spare parts	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Other	USD/m³	10,00	10,00	10,00	10,00	10,00	10,00	10,00
Total variable cost	USD '000	303	307	311	314	318	318	318
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	3	3	4	4	4	4	4
Other fixed	USD '000	22	22	22	22	23	23	23
Total fixed costs	USD '000	43	44	44	45	45	45	45
TOTAL COST	**USD '000**	**347**	**351**	**355**	**359**	**363**	**363**	**363**
EBITDA	**USD '000**	**100**	**102**	**103**	**104**	**105**	**105**	**105**
EBITDA margin		*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*	*22 %*
CAPEX								
Investment capex								
Site and infrastructure	USD '000	1	1	1	1	1	-	-
Buildings	USD '000	2	2	2	2	2	0	0
Machinery	USD '000	9	9	107	22	61	10	10
Equipment	USD '000	3	3	21	6	12	3	3
Contingency, 25%	USD '000	1	1	1	1	1	-	-
Ongoing capex (2% of initial investment)	USD '000	11	11	11	11	11	11	11
TOTAL CAPEX	**USD '000**	**26**	**27**	**142**	**42**	**89**	**25**	**25**
Change in working capital	USD '000	-	-	-	-	-	-	(100)
CASH FLOW	**USD '000**	**74**	**75**	**(40)**	**62**	**17**	**80**	**180**

IRR	12,9 %
NPV, USD million	0,0
Wood-paying capability, USD/m³ (at roadside)	31
Discount rate	12 %

Private Forestry Programme
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CASH FLOW CALCULATION
Njombe Cluster
Eucalyptus pole treatment

		2018	2019	2020	2021	2022	2023	2024
Wood intake	m³	-	-	-	-	-	-	-
Recovery		90 %	90 %	90 %	90 %	90 %	90 %	90 %
REVENUE								
Poles								
Price, ex works	USD/m³	180	180	180	180	180	180	180
Output/sales	m³	-	-	-	-	-	-	-
Total	USD '000	-	-	-	-	-	-	-
TOTAL REVENUE	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	1,11	1,11	1,11	1,11	1,11	1,11	1,11
Chemicals	USD/m³	62,30	62,30	62,30	62,30	62,30	62,30	62,30
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	10	10	10	10	10	10	10
Spare parts	USD/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	-	-	-	-	-	-	-
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	-	-	-	-	-	-	-
Other fixed	USD '000	-	-	-	-	-	-	-
Total fixed costs	USD '000	-	-	-	-	-	-	-
TOTAL COST	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
EBITDA	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
EBITDA margin		*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*	*0 %*
CAPEX								
Investment capex								
Site improvement and buildings	USD '000	-	-	-	-	-	-	-
Heavy machinery	USD '000	-	-	-	-	-	-	-
Machinery	USD '000	-	-	-	-	-	-	-
Equipment	USD '000	-	-	-	-	-	-	-
Contingency, 25%	USD '000	-	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	-	-	-	-	-	-	-
TOTAL CAPEX	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Change in working capital	USD '000	-	-	-	-	-	-	-
CASH FLOW	**USD '000**	**-**	**-**	**-**	**-**	**-**	**-**	**-**

IRR	128,7 %
NPV, USD million	3,4
Wood-paying capability, USD/m³ (at roadside)	68
Discount rate	12 %

		2025	2026	2027	2028	2029	2030	2031
Wood intake	m³	-	7 244	14 489	21 733	28 978	36 222	36 222
Recovery		90 %	90 %	90 %	90 %	90 %	90 %	90 %
REVENUE								
Poles								
Price, ex works	USD/m³	180	180	180	180	180	180	180
Output/sales	m³	-	6 520	13 040	19 560	26 080	32 600	32 600
Total	USD '000	-	1 174	2 347	3 521	4 694	5 868	5 868
TOTAL REVENUE	**USD '000**	**-**	**1 174**	**2 347**	**3 521**	**4 694**	**5 868**	**5 868**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	1,11	1,11	1,11	1,11	1,11	1,11	1,11
Chemicals	USD/m³	62,30	62,30	62,30	62,30	62,30	62,30	62,30
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	10	10	10	10	10	10	10
Spare parts	USD/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	-	680	1 361	2 041	2 721	3 402	3 402
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	-	11	22	33	43	54	54
Other fixed	USD '000	-	68	137	205	274	342	342
Total fixed costs	USD '000	-	137	274	411	548	685	685
TOTAL COST	**USD '000**	**-**	**817**	**1 635**	**2 452**	**3 269**	**4 086**	**4 086**
EBITDA	**USD '000**	**-**	**356**	**713**	**1 069**	**1 425**	**1 782**	**1 782**
EBITDA margin		*0 %*	*30 %*	*30 %*	*30 %*	*30 %*	*30 %*	*30 %*
CAPEX								
Investment capex								
Site improvement and buildings	USD '000	-	130	130	130	130	130	-
Heavy machinery	USD '000	-	82	82	82	82	82	-
Machinery	USD '000	-	65	65	65	65	65	-
Equipment	USD '000	-	65	65	65	65	65	65
Contingency, 25%	USD '000	-	86	86	86	86	86	-
Ongoing capex (2% of initial investment)	USD '000	-	9	17	26	34	43	43
TOTAL CAPEX	**USD '000**	**-**	**436**	**445**	**454**	**462**	**471**	**108**
Change in working capital	USD '000	-	200	200	100	200	200	-
CASH FLOW	**USD '000**	**-**	**(280)**	**68**	**515**	**763**	**1 111**	**1 674**

IRR	128,7 %
NPV, USD million	3,4
Wood-paying capability, USD/m³ (at roadside)	68
Discount rate	12 %

		2032	2033	2034	2035	2036	2037	2038
Wood intake	m³	36 222	36 222	36 222	36 222	36 222	36 222	36 222
Recovery		90 %	90 %	90 %	90 %	90 %	90 %	90 %
REVENUE								
Poles								
Price, ex works	USD/m³	180	180	180	180	180	180	180
Output/sales	m³	32 600	32 600	32 600	32 600	32 600	32 600	32 600
Total	USD '000	5 868	5 868	5 868	5 868	5 868	5 868	5 868
TOTAL REVENUE	**USD '000**	**5 868**	**5 868**	**5 868**	**5 868**	**5 868**	**5 868**	**5 868**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	1,11	1,11	1,11	1,11	1,11	1,11	1,11
Chemicals	USD/m³	62,30	62,30	62,30	62,30	62,30	62,30	62,30
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	10	10	10	10	10	10	10
Spare parts	USD/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	3 402	3 402	3 402	3 402	3 402	3 402	3 402
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	54	54	54	54	54	54	54
Other fixed	USD '000	342	342	342	342	342	342	342
Total fixed costs	USD '000	685	685	685	685	685	685	685
TOTAL COST	**USD '000**	**4 086**	**4 086**	**4 086**	**4 086**	**4 086**	**4 086**	**4 086**
EBITDA	**USD '000**	**1 782**	**1 782**	**1 782**	**1 782**	**1 782**	**1 782**	**1 782**
EBITDA margin		*30 %*	*30 %*	*30 %*	*30 %*	*30 %*	*30 %*	*30 %*
CAPEX								
Investment capex								
Site improvement and buildings	USD '000	-	-	-	-	-	-	-
Heavy machinery	USD '000	-	-	-	-	-	-	-
Machinery	USD '000	-	-	-	-	65	65	65
Equipment	USD '000	65	65	65	65	65	65	65
Contingency, 25%	USD '000	-	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	43	43	43	43	43	43	43
TOTAL CAPEX	**USD '000**	**108**	**108**	**108**	**108**	**173**	**173**	**173**
Change in working capital	USD '000	-	-	-	-	-	-	-
CASH FLOW	**USD '000**	**1 674**	**1 674**	**1 674**	**1 674**	**1 609**	**1 609**	**1 609**

IRR	128,7 %
NPV, USD million	3,4
Wood-paying capability, USD/m³ (at roadside)	68
Discount rate	12 %

		2039	2040	2041	2042	2043	2044	2045
Wood intake	m³	36 222	36 222	36 222	36 222	36 222	36 222	36 222
Recovery		90 %	90 %	90 %	90 %	90 %	90 %	90 %
REVENUE								
Poles								
Price, ex works	USD/m³	180	180	180	180	180	180	180
Output/sales	m³	32 600	32 600	32 600	32 600	32 600	32 600	32 600
Total	USD '000	5 868	5 868	5 868	5 868	5 868	5 868	5 868
TOTAL REVENUE	**USD '000**	**5 868**	**5 868**	**5 868**	**5 868**	**5 868**	**5 868**	**5 868**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	1,11	1,11	1,11	1,11	1,11	1,11	1,11
Chemicals	USD/m³	62,30	62,30	62,30	62,30	62,30	62,30	62,30
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	10	10	10	10	10	10	10
Spare parts	USD/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	3 402	3 402	3 402	3 402	3 402	3 402	3 402
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	54	54	54	54	54	54	54
Other fixed	USD '000	342	342	342	342	342	342	342
Total fixed costs	USD '000	685	685	685	685	685	685	685
TOTAL COST	**USD '000**	**4 086**	**4 086**	**4 086**	**4 086**	**4 086**	**4 086**	**4 086**
EBITDA	**USD '000**	**1 782**	**1 782**	**1 782**	**1 782**	**1 782**	**1 782**	**1 782**
EBITDA margin		*30 %*	*30 %*	*30 %*	*30 %*	*30 %*	*30 %*	*30 %*
CAPEX								
Investment capex								
Site improvement and buildings	USD '000	-	-	-	-	-	-	-
Heavy machinery	USD '000	-	-	-	-	-	-	-
Machinery	USD '000	65	65	-	-	-	-	-
Equipment	USD '000	65	65	65	65	65	65	65
Contingency, 25%	USD '000	-	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	43	43	43	43	43	43	43
TOTAL CAPEX	**USD '000**	**173**	**173**	**108**	**108**	**108**	**108**	**108**
Change in working capital	USD '000	-	-	-	-	-	-	-
CASH FLOW	**USD '000**	**1 609**	**1 609**	**1 674**	**1 674**	**1 674**	**1 674**	**1 674**

IRR	128,7 %
NPV, USD million	3,4
Wood-paying capability, USD/m³ (at roadside)	68
Discount rate	12 %

		2046	2047	2048	2049	2050	2051	2052
Wood intake	m³	36 222	36 222	36 222	36 222	36 222	36 222	36 222
Recovery		90 %	90 %	90 %	90 %	90 %	90 %	90 %
REVENUE								
Poles								
Price, ex works	USD/m³	180	180	180	180	180	180	180
Output/sales	m³	32 600	32 600	32 600	32 600	32 600	32 600	32 600
Total	USD '000	5 868	5 868	5 868	5 868	5 868	5 868	5 868
TOTAL REVENUE	**USD '000**	**5 868**	**5 868**	**5 868**	**5 868**	**5 868**	**5 868**	**5 868**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	1,11	1,11	1,11	1,11	1,11	1,11	1,11
Chemicals	USD/m³	62,30	62,30	62,30	62,30	62,30	62,30	62,30
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	10	10	10	10	10	10	10
Spare parts	USD/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	3 402	3 402	3 402	3 402	3 402	3 402	3 402
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	54	54	54	54	54	54	54
Other fixed	USD '000	342	342	342	342	342	342	342
Total fixed costs	USD '000	685	685	685	685	685	685	685
TOTAL COST	**USD '000**	**4 086**	**4 086**	**4 086**	**4 086**	**4 086**	**4 086**	**4 086**
EBITDA	**USD '000**	**1 782**	**1 782**	**1 782**	**1 782**	**1 782**	**1 782**	**1 782**
EBITDA margin		*30 %*	*30 %*	*30 %*	*30 %*	*30 %*	*30 %*	*30 %*
CAPEX								
Investment capex								
Site improvement and buildings	USD '000	-	-	-	-	-	-	-
Heavy machinery	USD '000	82	82	82	82	82	-	-
Machinery	USD '000	65	65	65	65	65	-	-
Equipment	USD '000	65	65	65	65	65	65	65
Contingency, 25%	USD '000	-	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	43	43	43	43	43	43	43
TOTAL CAPEX	**USD '000**	**255**	**255**	**255**	**255**	**255**	**108**	**108**
Change in working capital	USD '000	-	-	-	-	-	-	(900)
CASH FLOW	**USD '000**	**1 527**	**1 527**	**1 527**	**1 527**	**1 527**	**1 674**	**2 574**

IRR	128,7 %
NPV, USD million	3,4
Wood-paying capability, USD/m³ (at roadside)	68
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy Sectors
CASH FLOW CALCULATION
Njombe Cluster
Eucalyptus veneer production

		2018	2019	2020	2021	2022	2023	2024
Wood intake	m³	1 200	1 360	2 000	2 000	2 000	2 000	2 000
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Plywood								
Price, ex works	USD/m³	250	250	250	250	250	250	250
Output/sales	m³	600	680	1 000	1 000	1 000	1 000	1 000
Total	USD '000	150	170	250	250	250	250	250
TOTAL REVENUE	**USD '000**	**150**	**170**	**250**	**250**	**250**	**250**	**250**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	150	150	150	150	150	150	150
Spare parts	USD/m³	7,00	7,00	7,00	7,00	7,00	7,00	7,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	55	63	92	92	92	92	92
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	2	2	3	3	3	3	3
Other fixed	USD '000	9	11	16	16	16	16	16
Total fixed costs	USD '000	19	21	32	32	32	32	32
TOTAL COST	**USD '000**	**74**	**84**	**123**	**123**	**123**	**123**	**123**
EBITDA	**USD '000**	**76**	**86**	**127**	**127**	**127**	**127**	**127**
EBITDA margin		*51 %*	*51 %*	*51 %*	*51 %*	*51 %*	*51 %*	*51 %*
CAPEX								
Investment capex								
Site improvement and buildings	USD '000	8	1	4	-	-	-	-
Heavy machinery	USD '000	83	11	44	-	-	-	-
Machinery	USD '000	53	7	28	-	-	-	-
Equipment	USD '000	8	1	4	-	-	8	1
Contingency, 25%	USD '000	38	5	20	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	4	4	6	6	6	6	6
TOTAL CAPEX	**USD '000**	**191**	**29**	**106**	**6**	**6**	**14**	**7**
Change in working capital	USD '000	23	(23)	-	-	-	-	-
CASH FLOW	**USD '000**	**(138)**	**79**	**20**	**120**	**120**	**113**	**119**

IRR	58,6 %
NPV, USD million	0,6
Wood-paying capability, USD/m³ (at roadside)	70
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Njombe Cluster
Eucalyptus veneer production

		2025	2026	2027	2028	2029	2030	2031
Wood intake	m³	2 000	2 080	2 160	2 240	2 320	2 400	2 400
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Plywood								
Price, ex works	USD/m³	250	250	250	250	250	250	250
Output/sales	m³	1 000	1 040	1 080	1 120	1 160	1 200	1 200
Total	USD '000	250	260	270	280	290	300	300
TOTAL REVENUE	**USD '000**	**250**	**260**	**270**	**280**	**290**	**300**	**300**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	150	150	150	150	150	150	150
Spare parts	USD/m³	7,00	7,00	7,00	7,00	7,00	7,00	7,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	92	96	99	103	107	110	110
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	3	3	3	3	3	3	3
Other fixed	USD '000	16	16	17	18	18	19	19
Total fixed costs	USD '000	32	33	34	35	37	38	38
TOTAL COST	**USD '000**	**123**	**128**	**133**	**138**	**143**	**148**	**148**
EBITDA	**USD '000**	**127**	**132**	**137**	**142**	**147**	**152**	**152**
EBITDA margin		*51 %*	*51 %*	*51 %*	*51 %*	*51 %*	*51 %*	*51 %*
CAPEX								
Investment capex								
Site improvement and buildings	USD '000	-	1	1	1	1	1	-
Heavy machinery	USD '000	-	6	6	6	6	6	-
Machinery	USD '000	-	4	4	56	11	32	-
Equipment	USD '000	4	1	1	8	2	5	1
Contingency, 25%	USD '000	-	3	3	3	3	3	-
Ongoing capex (2% of initial investment)	USD '000	6	7	7	7	7	8	8
TOTAL CAPEX	**USD '000**	**10**	**19**	**19**	**80**	**28**	**52**	**8**
Change in working capital	USD '000	-	-	-	-	-	-	-
CASH FLOW	**USD '000**	**116**	**113**	**117**	**62**	**119**	**100**	**144**

IRR	58,6 %
NPV, USD million	0,6
Wood-paying capability, USD/m³ (at roadside)	70
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy
CASH FLOW CALCULATION
Njombe Cluster
Eucalyptus veneer production

		2032	2033	2034	2035	2036	2037	2038
Wood intake	m³	2 400	2 400	2 400	2 400	2 400	2 400	2 400
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Plywood								
Price, ex works	USD/m³	250	250	250	250	250	250	250
Output/sales	m³	1 200	1 200	1 200	1 200	1 200	1 200	1 200
Total	USD '000	300	300	300	300	300	300	300
TOTAL REVENUE	**USD '000**	**300**	**300**	**300**	**300**	**300**	**300**	**300**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	150	150	150	150	150	150	150
Spare parts	USD/m³	7,00	7,00	7,00	7,00	7,00	7,00	7,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	110	110	110	110	110	110	110
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	3	3	3	3	3	3	3
Other fixed	USD '000	19	19	19	19	19	19	19
Total fixed costs	USD '000	38	38	38	38	38	38	38
TOTAL COST	**USD '000**	**148**	**148**	**148**	**148**	**148**	**148**	**148**
EBITDA	**USD '000**	**152**	**152**	**152**	**152**	**152**	**152**	**152**
EBITDA margin		*51 %*	*51 %*	*51 %*	*51 %*	*51 %*	*51 %*	*51 %*
CAPEX								
Investment capex								
Site improvement and buildings	USD '000	-	-	-	-	-	-	-
Heavy machinery	USD '000	-	-	-	-	-	-	83
Machinery	USD '000	-	-	-	-	4	4	56
Equipment	USD '000	1	8	2	5	1	1	8
Contingency, 25%	USD '000	-	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	8	8	8	8	8	8	8
TOTAL CAPEX	**USD '000**	**8**	**16**	**9**	**12**	**12**	**12**	**154**
Change in working capital	USD '000	-	-	-	-	-	-	-
CASH FLOW	**USD '000**	**144**	**136**	**143**	**140**	**140**	**140**	**(2)**

IRR	58,6 %
NPV, USD million	0,6
Wood-paying capability, USD/m³ (at roadside)	70
Discount rate	12 %

		2039	2040	2041	2042	2043	2044	2045
Wood intake	m³	2 400	2 400	2 400	2 400	2 400	2 400	2 400
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Plywood								
Price, ex works	USD/m³	250	250	250	250	250	250	250
Output/sales	m³	1 200	1 200	1 200	1 200	1 200	1 200	1 200
Total	USD '000	300	300	300	300	300	300	300
TOTAL REVENUE	**USD '000**	**300**	**300**	**300**	**300**	**300**	**300**	**300**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	150	150	150	150	150	150	150
Spare parts	USD/m³	7,00	7,00	7,00	7,00	7,00	7,00	7,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	110	110	110	110	110	110	110
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	3	3	3	3	3	3	3
Other fixed	USD '000	19	19	19	19	19	19	19
Total fixed costs	USD '000	38	38	38	38	38	38	38
TOTAL COST	**USD '000**	**148**	**148**	**148**	**148**	**148**	**148**	**148**
EBITDA	**USD '000**	**152**	**152**	**152**	**152**	**152**	**152**	**152**
EBITDA margin		*51 %*	*51 %*	*51 %*	*51 %*	*51 %*	*51 %*	*51 %*
CAPEX								
Investment capex								
Site improvement and buildings	USD '000	-	-	-	-	-	-	-
Heavy machinery	USD '000	11	44	-	-	-	-	-
Machinery	USD '000	11	32	-	-	-	-	-
Equipment	USD '000	2	5	1	1	8	2	5
Contingency, 25%	USD '000	-	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	8	8	8	8	8	8	8
TOTAL CAPEX	**USD '000**	**31**	**88**	**8**	**8**	**16**	**9**	**12**
Change in working capital	USD '000	-	-	-	-	-	-	-
CASH FLOW	**USD '000**	**121**	**64**	**144**	**144**	**136**	**143**	**140**

IRR	58,6 %
NPV, USD million	0,6
Wood-paying capability, USD/m³ (at roadside)	70
Discount rate	12 %

		2046	2047	2048	2049	2050	2051	2052
Wood intake	m³	2 400	2 400	2 400	2 400	2 400	2 400	2 400
Recovery		50 %	50 %	50 %	50 %	50 %	50 %	50 %
REVENUE								
Plywood								
Price, ex works	USD/m³	250	250	250	250	250	250	250
Output/sales	m³	1 200	1 200	1 200	1 200	1 200	1 200	1 200
Total	USD '000	300	300	300	300	300	300	300
TOTAL REVENUE	**USD '000**	**300**	**300**	**300**	**300**	**300**	**300**	**300**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/m³	30,73	30,73	30,73	30,73	30,73	30,73	30,73
unit consumption	m³/m³	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Supplies	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/m³	150	150	150	150	150	150	150
Spare parts	USD/m³	7,00	7,00	7,00	7,00	7,00	7,00	7,00
Other	USD/m³	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	110	110	110	110	110	110	110
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	3	3	3	3	3	3	3
Other fixed	USD '000	19	19	19	19	19	19	19
Total fixed costs	USD '000	38	38	38	38	38	38	38
TOTAL COST	**USD '000**	**148**	**148**	**148**	**148**	**148**	**148**	**148**
EBITDA	**USD '000**	**152**	**152**	**152**	**152**	**152**	**152**	**152**
EBITDA margin		*51 %*	*51 %*	*51 %*	*51 %*	*51 %*	*51 %*	*51 %*
CAPEX								
Investment capex								
Site improvement and buildings	USD '000	-	-	-	-	-	-	-
Heavy machinery	USD '000	6	6	6	6	6	-	-
Machinery	USD '000	4	4	56	11	32	-	-
Equipment	USD '000	1	1	8	2	5	1	1
Contingency, 25%	USD '000	-	-	-	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	8	8	8	8	8	8	8
TOTAL CAPEX	**USD '000**	**17**	**17**	**77**	**25**	**49**	**8**	**8**
Change in working capital	USD '000	-	-	-	-	-	-	-
CASH FLOW	**USD '000**	**135**	**135**	**75**	**127**	**103**	**144**	**144**

IRR	58,6 %
NPV, USD million	0,6
Wood-paying capability, USD/m³ (at roadside)	70
Discount rate	12 %

CASH FLOW CALCULATION
Njombe Cluster
Charcoal briquette making

		2018	2019	2020	2021	2022	2023	2024
Wood intake	m^3	5 800	6 500	9 200	12 900	16 600	20 300	24 000
Wood density	t/m^3	0,500	0,500	0,500	0,500	0,500	0,500	0,500
REVENUE								
Charcoal briquettes								
Price	USD/t	300	300	300	300	300	300	300
Output/sales	t	3 600	4 100	5 800	8 100	10 400	12 700	15 000
Total	USD '000	1 080	1 230	1 740	2 430	3 120	3 810	4 500
TOTAL REVENUE	**USD '000**	**1 080**	**1 230**	**1 740**	**2 430**	**3 120**	**3 810**	**4 500**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/t	25,00	25,00	25,00	25,00	25,00	25,00	25,00
unit consumption	t/t	0,800	0,800	0,800	0,800	0,800	0,800	0,800
Supplies	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/t	555	555	555	555	555	555	555
Chemicals								
price	USD/t	32,00	32,00	32,00	32,00	32,00	32,00	32,00
unit consumption	t/t	0,200	0,200	0,200	0,200	0,200	0,200	0,200
Spare parts	USD/t	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	319	361	511	715	918	1 122	1 325
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	48	55	77	108	139	169	200
Other fixed	USD '000	302	344	487	680	874	1 067	1 260
Total fixed costs	USD '000	605	689	974	1 361	1 747	2 134	2 520
TOTAL COST	**USD '000**	**923**	**1 050**	**1 486**	**2 076**	**2 666**	**3 255**	**3 845**
EBITDA	**USD '000**	**157**	**180**	**254**	**354**	**454**	**555**	**655**
EBITDA margin		*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*
CAPEX								
Investment capex								
Pre-production costs	USD '000	96	13	45	61	61	61	61
Site improvement	USD '000	14	2	7	9	9	9	9
Buildings and machinery	USD '000	287	40	135	183	183	183	183
Equipment	USD '000	10	1	5	6	6	17	8
Contingency, 25%	USD '000	102	14	48	65	65	65	65
Ongoing capex (2% of initial investment)	USD '000	10	12	16	23	29	36	42
TOTAL CAPEX	**USD '000**	**519**	**82**	**257**	**348**	**354**	**371**	**369**
Change in working capital	USD '000	162	23	77	104	104	104	104
CASH FLOW	**USD '000**	**(524)**	**75**	**(79)**	**(97)**	**(3)**	**80**	**183**

IRR	19,8 %
NPV, USD million	0,2
Wood-paying capability, USD/m^3 (at mill gate)	14
Discount rate	12 %

		2025	2026	2027	2028	2029	2030	2031
Wood intake	m³	27 700	27 800	27 800	27 900	27 900	28 000	28 000
Wood density	t/m³	0,500	0,500	0,500	0,500	0,500	0,500	0,500
REVENUE								
Charcoal briquettes								
Price	USD/t	300	300	300	300	300	300	300
Output/sales	t	17 300	17 400	17 400	17 400	17 400	17 500	17 500
Total	USD '000	5 190	5 220	5 220	5 220	5 220	5 250	5 250
TOTAL REVENUE	**USD '000**	**5 190**	**5 220**	**5 220**	**5 220**	**5 220**	**5 250**	**5 250**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/t	25,00	25,00	25,00	25,00	25,00	25,00	25,00
unit consumption	t/t	0,800	0,800	0,800	0,800	0,800	0,800	0,800
Supplies	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/t	555	555	555	555	555	555	555
Chemicals								
price	USD/t	32,00	32,00	32,00	32,00	32,00	32,00	32,00
unit consumption	t/t	0,200	0,200	0,200	0,200	0,200	0,200	0,200
Spare parts	USD/t	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	1 529	1 537	1 537	1 538	1 538	1 546	1 546
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	231	232	232	232	232	233	233
Other fixed	USD '000	1 453	1 462	1 462	1 462	1 462	1 470	2 205
Total fixed costs	USD '000	2 906	2 923	2 923	2 923	2 923	2 940	3 675
TOTAL COST	**USD '000**	**4 435**	**4 460**	**4 460**	**4 461**	**4 461**	**4 486**	**5 221**
EBITDA	**USD '000**	**755**	**760**	**760**	**759**	**759**	**764**	**29**
EBITDA margin		*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*15 %*	*1 %*
CAPEX								
Investment capex								
Pre-production costs	USD '000	61	3	-	-	-	3	-
Site improvement	USD '000	9	0	-	-	-	0	-
Buildings and machinery	USD '000	183	8	-	287	40	143	183
Equipment	USD '000	11	7	6	17	8	12	7
Contingency, 25%	USD '000	65	3	-	-	-	3	-
Ongoing capex (2% of initial investment)	USD '000	49	49	49	49	49	49	49
TOTAL CAPEX	**USD '000**	**379**	**70**	**56**	**353**	**97**	**210**	**239**
Change in working capital	USD '000	104	5	-	-	-	5	-
CASH FLOW	**USD '000**	**273**	**686**	**704**	**406**	**662**	**549**	**(211)**

IRR	19,8 %
NPV, USD million	0,2
Wood-paying capability, USD/m³ (at mill gate)	14
Discount rate	12 %

CASH FLOW CALCULATION
Njombe Cluster
Charcoal briquette making

		2032	2033	2034	2035	2036	2037	2038
Wood intake	m^3	28 000	28 000	28 100	28 100	28 100	28 200	28 200
Wood density	t/m^3	0,500	0,500	0,500	0,500	0,500	0,500	0,500
REVENUE								
Charcoal briquettes								
Price	USD/t	300	300	300	300	300	300	300
Output/sales	t	17 500	17 500	17 600	17 600	17 600	17 600	17 600
Total	USD '000	5 250	5 250	5 280	5 280	5 280	5 280	5 280
TOTAL REVENUE	**USD '000**	**5 250**	**5 250**	**5 280**	**5 280**	**5 280**	**5 280**	**5 280**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/t	25,00	25,00	25,00	25,00	25,00	25,00	25,00
unit consumption	t/t	0,800	0,800	0,800	0,800	0,800	0,800	0,800
Supplies	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/t	555	555	555	555	555	555	555
Chemicals								
price	USD/t	32,00	32,00	32,00	32,00	32,00	32,00	32,00
unit consumption	t/t	0,200	0,200	0,200	0,200	0,200	0,200	0,200
Spare parts	USD/t	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	1 546	1 546	1 554	1 554	1 554	1 555	1 555
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	233	233	235	235	235	235	235
Other fixed	USD '000	2 205	2 205	2 218	2 218	2 218	2 218	2 218
Total fixed costs	USD '000	3 675	3 675	3 696	3 696	3 696	3 696	3 696
TOTAL COST	**USD '000**	**5 221**	**5 221**	**5 250**	**5 250**	**5 250**	**5 251**	**5 251**
EBITDA	**USD '000**	**29**	**29**	**30**	**30**	**30**	**29**	**29**
EBITDA margin		*1 %*	*1 %*	*1 %*	*1 %*	*1 %*	*1 %*	*1 %*
CAPEX								
Investment capex								
Pre-production costs	USD '000	-	-	3	-	-	-	-
Site improvement	USD '000	-	-	0	-	-	-	14
Buildings and machinery	USD '000	183	183	191	183	8	-	287
Equipment	USD '000	6	17	8	12	7	6	17
Contingency, 25%	USD '000	-	-	3	-	-	-	-
Ongoing capex (2% of initial investment)	USD '000	49	49	50	50	50	50	50
TOTAL CAPEX	**USD '000**	**239**	**249**	**255**	**245**	**64**	**56**	**367**
Change in working capital	USD '000	-	-	5	-	-	-	-
CASH FLOW	**USD '000**	**(210)**	**(220)**	**(230)**	**(215)**	**(35)**	**(28)**	**(339)**

IRR	19,8 %
NPV, USD million	0,2
Wood-paying capability, USD/m^3 (at mill gate)	14
Discount rate	12 %

CASH FLOW CALCULATION
Njombe Cluster
Charcoal briquette making

		2039	2040	2041	2042	2043	2044	2045
Wood intake	m^3	28 200	28 300	29 200	30 100	31 100	32 000	32 900
Wood density	t/m^3	0,500	0,500	0,500	0,500	0,500	0,500	0,500
REVENUE								
Charcoal briquettes								
Price	USD/t	300	300	300	300	300	300	300
Output/sales	t	17 600	17 700	18 300	18 800	19 400	20 000	20 600
Total	USD '000	5 280	5 310	5 490	5 640	5 820	6 000	6 180
TOTAL REVENUE	**USD '000**	**5 280**	**5 310**	**5 490**	**5 640**	**5 820**	**6 000**	**6 180**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/t	25,00	25,00	25,00	25,00	25,00	25,00	25,00
unit consumption	t/t	0,800	0,800	0,800	0,800	0,800	0,800	0,800
Supplies	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/t	555	555	555	555	555	555	555
Chemicals								
price	USD/t	32,00	32,00	32,00	32,00	32,00	32,00	32,00
unit consumption	t/t	0,200	0,200	0,200	0,200	0,200	0,200	0,200
Spare parts	USD/t	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	1 555	1 564	1 616	1 661	1 715	1 767	1 819
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	235	236	244	251	259	267	275
Other fixed	USD '000	2 218	2 230	2 306	2 369	2 444	2 520	2 596
Total fixed costs	USD '000	3 696	3 717	3 843	3 948	4 074	4 200	4 326
TOTAL COST	**USD '000**	**5 251**	**5 281**	**5 459**	**5 609**	**5 789**	**5 967**	**6 145**
EBITDA	**USD '000**	**29**	**29**	**31**	**31**	**31**	**33**	**35**
EBITDA margin		*1 %*	*1 %*	*1 %*	*1 %*	*1 %*	*1 %*	*1 %*
CAPEX								
Investment capex								
Pre-production costs	USD '000	-	3	16	13	16	16	16
Site improvement	USD '000	2	7	11	11	11	11	11
Buildings and machinery	USD '000	40	151	231	223	231	239	231
Equipment	USD '000	8	12	8	8	18	10	14
Contingency, 25%	USD '000	-	3	17	14	17	17	17
Ongoing capex (2% of initial investment)	USD '000	50	50	52	53	55	57	58
TOTAL CAPEX	**USD '000**	**100**	**226**	**336**	**323**	**349**	**350**	**347**
Change in working capital	USD '000	-	5	27	23	27	27	27
CASH FLOW	**USD '000**	**(71)**	**(201)**	**(331)**	**(314)**	**(344)**	**(344)**	**(339)**

IRR	19,8 %
NPV, USD million	0,2
Wood-paying capability, USD/m^3 (at mill gate)	14
Discount rate	12 %

CASH FLOW CALCULATION
Njombe Cluster
Charcoal briquette making

		2046	2047	2048	2049	2050	2051	2052
Wood intake	m^3	33 700	34 500	35 300	36 100	36 800	36 800	36 800
Wood density	t/m^3	0,500	0,500	0,500	0,500	0,500	0,500	0,500
REVENUE								
Charcoal briquettes								
Price	USD/t	300	300	300	300	300	300	300
Output/sales	t	21 100	21 600	22 100	22 600	23 000	23 000	23 000
Total	USD '000	6 330	6 480	6 630	6 780	6 900	6 900	6 900
TOTAL REVENUE	**USD '000**	**6 330**	**6 480**	**6 630**	**6 780**	**6 900**	**6 900**	**6 900**
COST								
Variable costs								
Wood								
price at the mill-gate	USD/t	25,00	25,00	25,00	25,00	25,00	25,00	25,00
unit consumption	t/t	0,800	0,800	0,800	0,800	0,800	0,800	0,800
Supplies	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Electricity								
price	USD/kWh	0,09	0,09	0,09	0,09	0,09	0,09	0,09
unit consumption	kWh/t	555	555	555	555	555	555	555
Chemicals								
price	USD/t	32,00	32,00	32,00	32,00	32,00	32,00	32,00
unit consumption	t/t	0,200	0,200	0,200	0,200	0,200	0,200	0,200
Spare parts	USD/t	2,00	2,00	2,00	2,00	2,00	2,00	2,00
Other	USD/t	5,00	5,00	5,00	5,00	5,00	5,00	5,00
Total variable cost	USD '000	1 863	1 908	1 952	1 996	2 032	2 032	2 032
Fixed costs								
Labor								
average pay	USD/month	500	500	500	500	500	500	500
fringe benefits		5 %	5 %	5 %	5 %	5 %	5 %	5 %
staff	people	281	288	295	301	307	307	307
Other fixed	USD '000	2 659	2 722	2 785	2 848	2 898	2 898	2 898
Total fixed costs	USD '000	4 431	4 536	4 641	4 746	4 830	4 830	4 830
TOTAL COST	**USD '000**	**6 294**	**6 444**	**6 593**	**6 742**	**6 862**	**6 862**	**6 862**
EBITDA	**USD '000**	**36**	**36**	**37**	**38**	**38**	**38**	**38**
EBITDA margin		*1 %*	*1 %*	*1 %*	*1 %*	*1 %*	*1 %*	*1 %*
CAPEX								
Investment capex								
Pre-production costs	USD '000	13	13	13	13	11	-	-
Site improvement	USD '000	2	2	2	2	2	-	-
Buildings and machinery	USD '000	48	40	327	80	183	231	223
Equipment	USD '000	10	9	20	11	15	10	9
Contingency, 25%	USD '000	14	14	14	14	11	-	-
Ongoing capex (2% of initial investment)	USD '000	60	61	62	64	65	65	65
TOTAL CAPEX	**USD '000**	**147**	**140**	**438**	**184**	**287**	**306**	**297**
Change in working capital	USD '000	23	23	23	23	18	-	-
CASH FLOW	**USD '000**	**(134)**	**(126)**	**(423)**	**(169)**	**(267)**	**(268)**	**(259)**

IRR	19,8 %
NPV, USD million	0,2
Wood-paying capability, USD/m^3 (at mill gate)	14
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy Sectors
CONSOLIDATED CASH FLOW CALCULATION
Mafinga Cluster

		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
REVENUE																			
Roundwood	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	4 518	4 518	4 518	4 518	4 518	6 221
Pine lumber	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus lumber	USD '000	-	-	169	177	185	192	200	208	322	437	551	666	780	832	884	936	988	1 040
Utility poles	USD '000	-	1 098	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196
Eucalyptus veneer	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	6 200	7 060	7 920	8 780	9 640	10 500
Charcoal briquettes	USD '000	2 370	2 490	2 640	3 000	3 390	3 720	4 080	4 470	4 560	4 650	4 740	4 830	4 920	5 010	5 100	5 190	5 280	5 340
Total revenue	**USD '000**	**2 370**	**3 588**	**5 005**	**5 373**	**5 771**	**6 108**	**6 476**	**6 874**	**7 078**	**7 283**	**7 487**	**7 692**	**18 614**	**19 616**	**20 618**	**21 620**	**22 622**	**25 297**
OPERATING EXPENSES																			
Plantations	USD '000	-	-	(627)	(689)	(752)	(752)	(752)	(988)	(1 012)	(1 036)	(1 036)	(1 036)	(3 921)	(3 950)	(3 978)	(3 978)	(3 978)	(5 299)
Pine sawmilling	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus sawmilling	USD '000	-	-	(131)	(137)	(143)	(149)	(155)	(161)	(250)	(339)	(427)	(516)	(605)	(645)	(686)	(726)	(766)	(807)
Eucalyptus pole treatment	USD '000	-	(765)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)
Eucalyptus veneer production	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	(3 062)	(3 487)	(3 911)	(4 336)	(4 761)	(5 186)
Charcoal briquette making	USD '000	(2 025)	(2 127)	(2 256)	(2 564)	(2 896)	(3 179)	(3 487)	(3 819)	(3 896)	(3 973)	(4 051)	(4 128)	(4 205)	(4 982)	(5 072)	(5 160)	(5 250)	(5 311)
General and administration	USD '000	-	-	(13)	(25)	(38)	(50)	(63)	(80)	(97)	(114)	(132)	(149)	(172)	(182)	(193)	(203)	(214)	(231)
Land rent	USD '000	-	-	(1)	(1)	(2)	(2)	(3)	(4)	(4)	(5)	(6)	(7)	(8)	(8)	(9)	(9)	(10)	(11)
Total cost	**USD '000**	**(2 025)**	**(2 891)**	**(4 556)**	**(4 946)**	**(5 360)**	**(5 663)**	**(5 989)**	**(6 582)**	**(6 789)**	**(6 997)**	**(7 181)**	**(7 365)**	**(13 502)**	**(14 784)**	**(15 378)**	**(15 943)**	**(16 508)**	**(18 372)**
EBITDA	**USD '000**	**345**	**697**	**449**	**427**	**411**	**446**	**487**	**292**	**289**	**286**	**307**	**327**	**5 112**	**4 832**	**5 240**	**5 677**	**6 113**	**6 924**
EBITDA margin		*14,6 %*	*19,4 %*	*9,0 %*	*8,0 %*	*7,1 %*	*7,3 %*	*7,5 %*	*4,3 %*	*4,1 %*	*3,9 %*	*4,1 %*	*4,3 %*	*27,5 %*	*24,6 %*	*25,4 %*	*26,3 %*	*27,0 %*	*27,4 %*
CAPEX																			
Forestry	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pine sawmill	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus sawmill	USD '000	-	-	(207)	(14)	(14)	(14)	(14)	(31)	(146)	(149)	(152)	(154)	(266)	(99)	(100)	(101)	(102)	(120)
Treatment plant	USD '000	-	(408)	(416)	(16)	(16)	(16)	(77)	(77)	(16)	(16)	(16)	(138)	(138)	(16)	(16)	(16)	(77)	(77)
Veneer plant	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	(7 905)	(1 252)	(1 273)	(1 295)	(1 316)	(1 648)
Charcoal briquette plant	USD '000	(1 138)	(80)	(95)	(198)	(216)	(213)	(209)	(227)	(89)	(90)	(742)	(124)	(134)	(189)	(198)	(205)	(193)	(188)
Total capex	**USD '000**	**(1 138)**	**(488)**	**(719)**	**(227)**	**(245)**	**(243)**	**(300)**	**(335)**	**(251)**	**(255)**	**(909)**	**(416)**	**(8 442)**	**(1 555)**	**(1 587)**	**(1 617)**	**(1 688)**	**(2 032)**
Change in working capital																			
Forestry	USD '000	-	-	(94)	(9)	(9)	-	-	(35)	(4)	(4)	-	-	(433)	(4)	(4)	-	-	(198)
Pine sawmill	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Eucalyptus sawmill	USD '000	-	-	-	-	-	-	-	-	-	(100)	-	-	-	-	-	-	-	(100)
Treatment plant	USD '000	-	(200)	(100)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Veneer plant	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	(900)	(200)	(100)	(100)	(100)	(200)
Charcoal briquette plant	USD '000	(356)	(18)	(23)	(54)	(59)	(50)	(54)	(59)	(14)	(14)	(14)	(14)	(14)	(14)	(14)	(14)	(14)	(9)
Total	**USD '000**	**(356)**	**(218)**	**(217)**	**(63)**	**(68)**	**(50)**	**(54)**	**(94)**	**(17)**	**(117)**	**(14)**	**(14)**	**(1 346)**	**(218)**	**(118)**	**(114)**	**(114)**	**(507)**
CASH FLOW	**USD '000**	**(1 148)**	**(10)**	**(487)**	**136**	**98**	**154**	**133**	**(136)**	**21**	**(86)**	**(616)**	**(103)**	**(4 677)**	**3 059**	**3 535**	**3 947**	**4 312**	**4 385**

IRR	**23,0 %**
NPV	**$9m**
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Indust
CONSOLIDATED CASH FLOW CALCULATION
Mafinga Cluster

		2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052
REVENUE																		
Roundwood	USD '000	6 221	6 221	6 221	6 221	8 277	8 277	8 277	8 277	8 277	10 728	10 728	10 728	10 728	10 728	13 686	13 686	13 686
Pine lumber	USD '000	-	-	-	-	-	1 988	3 976	5 964	7 952	9 940	10 552	11 164	11 776	12 388	13 000	13 000	13 000
Eucalyptus lumber	USD '000	1 100	1 160	1 219	1 279	1 339	1 414	1 490	1 565	1 641	1 716	1 802	1 888	1 973	2 059	2 145	2 145	2 145
Utility poles	USD '000	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196	2 196
Eucalyptus veneer	USD '000	11 540	12 580	13 620	14 660	15 700	16 940	18 180	19 420	20 660	21 900	23 395	24 890	26 385	27 880	29 375	29 375	29 375
Charcoal briquettes	USD '000	5 400	5 460	5 520	5 580	5 610	7 020	8 460	9 870	11 280	12 720	13 050	13 380	13 740	14 070	14 400	14 400	14 400
Total revenue	**USD '000**	**26 457**	**27 616**	**28 776**	**29 936**	**33 122**	**37 835**	**42 578**	**47 292**	**52 005**	**59 200**	**61 723**	**64 246**	**66 799**	**69 321**	**74 802**	**74 802**	**74 802**
OPERATING EXPENSES																		
Plantations	USD '000	(5 333)	(5 367)	(5 367)	(5 367)	(6 960)	(6 251)	(6 217)	(6 142)	(6 142)	(7 553)	(7 893)	(7 927)	(7 961)	(7 961)	(9 664)	(9 664)	(9 664)
Pine sawmilling	USD '000	-	-	-	-	-	(1 303)	(2 606)	(3 909)	(5 212)	(6 515)	(6 916)	(7 318)	(7 719)	(8 120)	(8 521)	(8 521)	(8 521)
Eucalyptus sawmilling	USD '000	(853)	(899)	(946)	(992)	(1 038)	(1 097)	(1 155)	(1 214)	(1 272)	(1 331)	(1 397)	(1 464)	(1 530)	(1 597)	(1 663)	(1 663)	(1 663)
Eucalyptus pole treatment	USD '000	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)	(1 529)
Eucalyptus veneer production	USD '000	(5 699)	(6 213)	(6 727)	(7 240)	(7 754)	(8 366)	(8 979)	(9 591)	(10 203)	(10 816)	(11 554)	(12 292)	(13 031)	(13 769)	(14 507)	(14 507)	(14 507)
Charcoal briquette making	USD '000	(5 370)	(5 430)	(5 489)	(5 549)	(5 579)	(6 982)	(8 413)	(9 816)	(11 218)	(12 650)	(12 978)	(13 307)	(13 663)	(13 992)	(14 321)	(14 321)	(14 321)
General and administration	USD '000	(243)	(256)	(268)	(281)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)	(302)
Land rent	USD '000	(11)	(12)	(12)	(13)	(14)	(14)	(14)	(14)	(14)	(14)	(14)	(14)	(14)	(14)	(14)	(14)	(14)
Total cost	**USD '000**	**(19 039)**	**(19 705)**	**(20 338)**	**(20 970)**	**(23 176)**	**(25 844)**	**(29 215)**	**(32 517)**	**(35 893)**	**(40 709)**	**(42 584)**	**(44 153)**	**(45 749)**	**(47 284)**	**(50 521)**	**(50 521)**	**(50 521)**
EBITDA	**USD '000**	**7 418**	**7 911**	**8 438**	**8 965**	**9 945**	**11 991**	**13 363**	**14 775**	**16 112**	**18 491**	**19 139**	**20 093**	**21 049**	**22 037**	**24 281**	**24 281**	**24 281**
EBITDA margin		*28,0 %*	*28,6 %*	*29,3 %*	*29,9 %*	*30,0 %*	*31,7 %*	*31,4 %*	*31,2 %*	*31,0 %*	*31,2 %*	*31,0 %*	*31,3 %*	*31,5 %*	*31,8 %*	*32,5 %*	*32,5 %*	*32,5 %*
CAPEX																		
Forestry	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pine sawmill	USD '000	-	-	-	-	-	(1 584)	(1 615)	(1 646)	(1 677)	(1 708)	(767)	(777)	(786)	(796)	(806)	(1 074)	(1 074)
Eucalyptus sawmill	USD '000	(178)	(179)	(181)	(182)	(323)	(181)	(183)	(185)	(187)	(205)	(293)	(295)	(297)	(299)	(410)	(173)	(173)
Treatment plant	USD '000	(16)	(16)	(16)	(215)	(215)	(16)	(16)	(16)	(77)	(77)	(16)	(16)	(16)	(138)	(138)	(16)	(16)
Veneer plant	USD '000	(1 632)	(1 658)	(1 684)	(1 710)	(4 216)	(2 370)	(2 401)	(2 432)	(2 463)	(2 804)	(2 975)	(3 012)	(3 049)	(3 087)	(9 014)	(2 174)	(2 174)
Charcoal briquette plant	USD '000	(108)	(109)	(792)	(144)	(139)	(860)	(896)	(900)	(901)	(929)	(338)	(342)	(1 010)	(381)	(384)	(653)	(669)
Total capex	**USD '000**	**(1 933)**	**(1 962)**	**(2 672)**	**(2 251)**	**(4 892)**	**(5 011)**	**(5 111)**	**(5 179)**	**(5 305)**	**(5 723)**	**(4 389)**	**(4 441)**	**(5 159)**	**(4 700)**	**(10 751)**	**(4 090)**	**(4 106)**
Change in working capital																		
Forestry	USD '000	(5)	(5)	-	-	(239)	106	5	11	-	(212)	(51)	(5)	(5)	-	(255)	-	-
Pine sawmill	USD '000	-	-	-	-	-	(300)	(300)	(300)	(300)	(300)	(100)	(100)	(100)	(100)	(100)	-	2 000
Eucalyptus sawmill	USD '000	-	-	-	-	-	-	-	-	-	(100)	-	-	-	-	-	-	300
Treatment plant	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	300
Veneer plant	USD '000	(100)	(200)	(100)	(200)	(200)	(100)	(200)	(200)	(200)	(200)	(200)	(200)	(300)	(200)	(200)	-	-
Charcoal briquette plant	USD '000	(9)	(9)	(9)	(9)	(5)	(212)	(216)	(212)	(212)	(216)	(50)	(50)	(54)	(50)	(50)	-	-
Total	**USD '000**	**(114)**	**(214)**	**(109)**	**(209)**	**(444)**	**(505)**	**(711)**	**(700)**	**(712)**	**(1 028)**	**(401)**	**(355)**	**(459)**	**(350)**	**(605)**	**-**	**2 600**
CASH FLOW	**USD '000**	**5 370**	**5 735**	**5 657**	**6 506**	**4 609**	**6 475**	**7 541**	**8 895**	**10 096**	**11 741**	**14 350**	**15 297**	**15 432**	**16 988**	**12 925**	**20 191**	**22 774**

IRR	**23,0 %**
NPV	**$9m**
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Industry and Bioenergy Sectors
CONSOLIDATED CASH FLOW CALCULATION
Njombe Cluster

		2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
REVENUE																			
Roundwood	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	2 776	2 776	2 776	2 776	2 733	2 733
Pine lumber	USD '000	3 672	4 162	6 120	8 896	11 672	14 448	17 224	20 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000	20 000
Eucalyptus lumber	USD '000	179	203	299	312	325	338	351	364	369	374	380	385	390	393	395	398	400	403
Utility poles	USD '000	-	-	-	-	-	-	-	-	1 174	2 347	3 521	4 694	5 868	5 868	5 868	5 868	5 868	5 868
Eucalyptus veneer	USD '000	150	170	250	250	250	250	250	250	260	270	280	290	300	300	300	300	300	300
Charcoal briquettes	USD '000	1 080	1 230	1 740	2 430	3 120	3 810	4 500	5 190	5 220	5 220	5 220	5 220	5 250	5 250	5 250	5 250	5 280	5 280
Total revenue	**USD '000**	**5 081**	**5 765**	**8 409**	**11 888**	**15 367**	**18 846**	**22 325**	**25 804**	**27 023**	**28 212**	**29 400**	**30 589**	**34 584**	**34 586**	**34 589**	**34 592**	**34 582**	**34 584**
OPERATING EXPENSES																			
Plantations	USD '000	-	-	(385)	(424)	(462)	(462)	(456)	(456)	(455)	(455)	(455)	(455)	(2 059)	(2 059)	(2 060)	(2 060)	(2 035)	(2 029)
Pine sawmilling	USD '000	(2 407)	(2 728)	(4 011)	(5 831)	(7 651)	(9 470)	(11 290)	(13 109)	(13 109)	(13 109)	(13 109)	(13 109)	(13 109)	(13 109)	(13 109)	(13 109)	(13 109)	(13 109)
Eucalyptus sawmilling	USD '000	(139)	(158)	(232)	(242)	(252)	(262)	(272)	(282)	(286)	(290)	(294)	(298)	(302)	(304)	(306)	(309)	(311)	(313)
Eucalyptus pole treatment	USD '000	-	-	-	-	-	-	-	-	(817)	(1 635)	(2 452)	(3 269)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)
Eucalyptus veneer production	USD '000	(74)	(84)	(123)	(123)	(123)	(123)	(123)	(123)	(128)	(133)	(138)	(143)	(148)	(148)	(148)	(148)	(148)	(148)
Charcoal briquette making	USD '000	(923)	(1 050)	(1 486)	(2 076)	(2 666)	(3 255)	(3 845)	(4 435)	(4 460)	(4 460)	(4 461)	(4 461)	(4 486)	(5 221)	(5 221)	(5 221)	(5 250)	(5 250)
General and administration	USD '000	-	-	(8)	(15)	(23)	(31)	(38)	(46)	(54)	(61)	(69)	(76)	(84)	(84)	(84)	(84)	(84)	(84)
Land rent	USD '000	-	-	(0)	(1)	(1)	(1)	(2)	(2)	(2)	(3)	(3)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total cost	**USD '000**	**(3 543)**	**(4 020)**	**(6 246)**	**(8 712)**	**(11 178)**	**(13 605)**	**(16 027)**	**(18 454)**	**(19 312)**	**(20 147)**	**(20 982)**	**(21 816)**	**(24 279)**	**(25 017)**	**(25 019)**	**(25 021)**	**(25 028)**	**(25 024)**
EBITDA	**USD '000**	**1 538**	**1 745**	**2 163**	**3 176**	**4 189**	**5 241**	**6 298**	**7 350**	**7 710**	**8 065**	**8 418**	**8 773**	**10 305**	**9 570**	**9 570**	**9 570**	**9 554**	**9 560**
EBITDA margin		*30,3 %*	*30,3 %*	*25,7 %*	*26,7 %*	*27,3 %*	*27,8 %*	*28,2 %*	*28,5 %*	*28,5 %*	*28,6 %*	*28,6 %*	*28,7 %*	*29,8 %*	*27,7 %*	*27,7 %*	*27,7 %*	*27,6 %*	*27,6 %*
CAPEX																			
Forestry	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pine sawmill	USD '000	(2 926)	(448)	(1 626)	(2 308)	(2 351)	(2 624)	(2 468)	(2 604)	(486)	(486)	(2 024)	(691)	(1 306)	(1 475)	(1 475)	(1 704)	(1 506)	(1 597)
Eucalyptus sawmill	USD '000	(220)	(34)	(122)	(23)	(23)	(41)	(26)	(34)	(16)	(17)	(132)	(32)	(79)	(21)	(22)	(39)	(24)	(31)
Treatment plant	USD '000	-	-	-	-	-	-	-	-	(436)	(445)	(454)	(462)	(471)	(108)	(108)	(108)	(108)	(108)
Veneer plant	USD '000	(191)	(29)	(106)	(6)	(6)	(14)	(7)	(10)	(19)	(19)	(80)	(28)	(52)	(8)	(8)	(16)	(9)	(12)
Charcoal briquette plant	USD '000	(519)	(82)	(257)	(348)	(354)	(371)	(369)	(379)	(70)	(56)	(353)	(97)	(210)	(239)	(239)	(249)	(255)	(245)
Total capex	**USD '000**	**(3 856)**	**(593)**	**(2 111)**	**(2 685)**	**(2 735)**	**(3 050)**	**(2 871)**	**(3 026)**	**(1 028)**	**(1 022)**	**(3 042)**	**(1 310)**	**(2 118)**	**(1 852)**	**(1 851)**	**(2 116)**	**(1 901)**	**(1 993)**
Change in working capital																			
Forestry	USD '000	-	-	(58)	(6)	(6)	-	1	0	0	-	-	0	(241)	(0)	(0)	-	4	1
Pine sawmill	USD '000	(551)	(49)	(300)	(400)	(500)	(400)	(400)	(400)	-	-	-	-	-	-	-	-	-	-
Eucalyptus sawmill	USD '000	-	-	-	-	-	(100)	-	-	-	-	-	-	-	-	-	-	-	-
Treatment plant	USD '000	-	-	-	-	-	-	-	-	(200)	(200)	(100)	(200)	(200)	-	-	-	-	-
Veneer plant	USD '000	(23)	23	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Charcoal briquette plant	USD '000	(162)	(23)	(77)	(104)	(104)	(104)	(104)	(104)	(5)	-	-	-	(5)	-	-	-	(5)	-
Total	**USD '000**	**(735)**	**(49)**	**(434)**	**(509)**	**(609)**	**(604)**	**(503)**	**(503)**	**(204)**	**(200)**	**(100)**	**(200)**	**(445)**	**(0)**	**(0)**	**-**	**(1)**	**1**
CASH FLOW	**USD '000**	**(3 053)**	**1 103**	**(382)**	**(18)**	**845**	**1 587**	**2 925**	**3 821**	**6 478**	**6 843**	**5 277**	**7 263**	**7 742**	**7 718**	**7 718**	**7 454**	**7 652**	**7 569**

IRR	**42,5 %**
NPV	**$26m**
Discount rate	12 %

Private Forestry Programme
Investment Opportunities in Tanzanian Forest Indust
CONSOLIDATED CASH FLOW CALCULATION
Njombe Cluster

		2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	2051	2052
REVENUE																		
Roundwood	USD '000	2 733	2 733	2 733	2 733	2 776	2 776	2 776	2 776	2 776	2 733	2 733	2 733	2 733	2 733	2 733	2 733	2 733
Pine lumber	USD '000	20 000	20 000	20 000	20 000	20 000	20 692	21 384	22 076	22 768	23 460	24 032	24 604	25 176	25 748	26 320	26 320	26 320
Eucalyptus lumber	USD '000	408	413	419	424	429	432	434	437	439	442	447	452	458	463	468	468	468
Utility poles	USD '000	5 868	5 868	5 868	5 868	5 868	5 868	5 868	5 868	5 868	5 868	5 868	5 868	5 868	5 868	5 868	5 868	5 868
Eucalyptus veneer	USD '000	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300	300
Charcoal briquettes	USD '000	5 280	5 280	5 280	5 280	5 310	5 490	5 640	5 820	6 000	6 180	6 330	6 480	6 630	6 780	6 900	6 900	6 900
Total revenue	**USD '000**	**34 589**	**34 595**	**34 600**	**34 605**	**34 683**	**35 557**	**36 402**	**37 277**	**38 151**	**38 983**	**39 710**	**40 438**	**41 165**	**41 892**	**42 589**	**42 589**	**42 589**
OPERATING EXPENSES																		
Plantations	USD '000	(2 029)	(2 028)	(2 028)	(2 028)	(2 053)	(2 059)	(2 059)	(2 060)	(2 060)	(2 035)	(2 029)	(2 029)	(2 028)	(2 028)	(2 028)	(2 028)	(2 028)
Pine sawmilling	USD '000	(13 109)	(13 109)	(13 109)	(13 109)	(13 109)	(13 563)	(14 016)	(14 470)	(14 924)	(15 377)	(15 752)	(16 127)	(16 502)	(16 877)	(17 252)	(17 252)	(17 252)
Eucalyptus sawmilling	USD '000	(317)	(321)	(325)	(329)	(333)	(335)	(337)	(339)	(341)	(343)	(347)	(351)	(355)	(359)	(363)	(363)	(363)
Eucalyptus pole treatment	USD '000	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)	(4 086)
Eucalyptus veneer production	USD '000	(148)	(148)	(148)	(148)	(148)	(148)	(148)	(148)	(148)	(148)	(148)	(148)	(148)	(148)	(148)	(148)	(148)
Charcoal briquette making	USD '000	(5 250)	(5 251)	(5 251)	(5 251)	(5 281)	(5 459)	(5 609)	(5 789)	(5 967)	(6 145)	(6 294)	(6 444)	(6 593)	(6 742)	(6 862)	(6 862)	(6 862)
General and administration	USD '000	(84)	(84)	(84)	(84)	(84)	(84)	(84)	(84)	(84)	(84)	(84)	(84)	(84)	(84)	(84)	(84)	(84)
Land rent	USD '000	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Total cost	**USD '000**	**(25 027)**	**(25 032)**	**(25 036)**	**(25 040)**	**(25 098)**	**(25 737)**	**(26 344)**	**(26 980)**	**(27 614)**	**(28 223)**	**(28 745)**	**(29 273)**	**(29 800)**	**(30 328)**	**(30 827)**	**(30 827)**	**(30 827)**
EBITDA	**USD '000**	**9 562**	**9 563**	**9 564**	**9 565**	**9 585**	**9 820**	**10 058**	**10 297**	**10 538**	**10 760**	**10 965**	**11 165**	**11 364**	**11 564**	**11 762**	**11 762**	**11 762**
EBITDA margin		*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*	*27,6 %*
CAPEX																		
Forestry	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pine sawmill	USD '000	(486)	(486)	(2 460)	(749)	(1 539)	(2 356)	(2 367)	(2 607)	(2 419)	(2 522)	(1 039)	(1 048)	(2 595)	(1 271)	(1 895)	(1 899)	(1 899)
Eucalyptus sawmill	USD '000	(21)	(21)	(170)	(41)	(101)	(27)	(27)	(44)	(29)	(36)	(26)	(27)	(142)	(42)	(89)	(25)	(25)
Treatment plant	USD '000	(173)	(173)	(173)	(173)	(173)	(108)	(108)	(108)	(108)	(108)	(255)	(255)	(255)	(255)	(255)	(108)	(108)
Veneer plant	USD '000	(12)	(12)	(154)	(31)	(88)	(8)	(8)	(16)	(9)	(12)	(17)	(17)	(77)	(25)	(49)	(8)	(8)
Charcoal briquette plant	USD '000	(64)	(56)	(367)	(100)	(226)	(336)	(323)	(349)	(350)	(347)	(147)	(140)	(438)	(184)	(287)	(306)	(297)
Total capex	**USD '000**	**(756)**	**(748)**	**(3 323)**	**(1 093)**	**(2 125)**	**(2 834)**	**(2 832)**	**(3 123)**	**(2 915)**	**(3 025)**	**(1 485)**	**(1 486)**	**(3 507)**	**(1 777)**	**(2 574)**	**(2 346)**	**(2 337)**
Change in working capital																		
Forestry	USD '000	0	0	-	0	(4)	(1)	(0)	(0)	-	4	1	0	0	-	0	-	-
Pine sawmill	USD '000	-	-	-	-	-	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	(100)	-	-	3 900
Eucalyptus sawmill	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	100
Treatment plant	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	900
Veneer plant	USD '000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Charcoal briquette plant	USD '000	-	-	-	-	(5)	(27)	(23)	(27)	(27)	(27)	(23)	(23)	(23)	(23)	(18)	-	-
Total	**USD '000**	**0**	**0**	**-**	**0**	**(8)**	**(128)**	**(123)**	**(127)**	**(127)**	**(123)**	**(122)**	**(122)**	**(122)**	**(123)**	**(18)**	**-**	**4 900**
CASH FLOW	**USD '000**	**8 806**	**8 815**	**6 240**	**8 472**	**7 452**	**6 858**	**7 103**	**7 046**	**7 495**	**7 612**	**9 359**	**9 556**	**7 735**	**9 664**	**9 169**	**9 416**	**14 324**

IRR	**42,5 %**
NPV	**$26m**
Discount rate	12 %

ANNEX 5 SPATIAL MULTI-CRITERIA ANALYSIS

This annex complements the main document's description of its SMCA.

Data for the SMCA

Datasets Used in the SMCAs

Variable	Dataset	Source
Annual precipitation (mm)	WorldClim 1.4 - *Annual precipitation* (bio12)	Hijmans et al. 2005.[29] http://www.worldclim.org/
Growing season temperature (° C)	WorldClim 1.4 - Mean temperature of the wettest quarter (bio8)	Hijmans et al. 2005.[29] http://www.worldclim.org/
Slope (°)	Derived from SRTM DEM	NASA / NGA https://earthexplorer.usgs.gov/
Topographical ruggedness (m)	Derived from SRTM DEM	NASA / NGA https://earthexplorer.usgs.gov/
Soil depth (cm)	SoilGrids – Depth to bedrock (BDRICM_M_250m)	ISRIC -World Soil Information https://soilgrids.org/
Soil fertility	SoilGrids - Cation-exchange capacity (CECSOL_M_sl2_250m)	ISRIC -World Soil Information https://soilgrids.org/
Soil drainage	SoilGrids – Bulk density (BLDFIE_M_sl2_250m)	ISRIC -World Soil Information https://soilgrids.org/
Distance from roads	Open Street Map – gis.osm.roads.free	Open Street Map http://planet.openstreetmap.org/
Land cover	NAFORMA land cover classification	NAFORMA / PFP
Protected areas	Tanzania Protected Areas	PFP / UTU

Climatic data was acquired from WolrdClim – Global Climate Database (version 1.4) (Hijmans et al. 2005). Two bioclimatic variables were used in the analysis: *annual precipitation* and *mean temperature of the wettest quarter*. The latter variable was selected instead of annual mean temperature as it is a more meaningful figure for the mean temperature during the growing season. The global climate models for 2050 presented in the Intergovernmental Panel on Climate Change Fifth Assessment Report were used with Representative Concentration Pathway (RCP) 4.5. The year 2050 was selected as that year was also used for the study's demand forecasts. RCP 4.5 represents and intermediate greenhouse gas concentration trajectory that is line with the targets of the Paris Agreement (Salawitch et al., 2017). The variables used were ensembles of GCMs HadGEM2-ES, MPI-ESM-LR and MRI-CGCM3 as these variables are considered accurate for Sub-Saharan and East Africa.

Topographic variables were derived from the Shuttle Radar Topographic Mission (SRTM) Digital Elevation Model (DEM) with 1-Arc second (~ 30 m) spatial resolution. Slope was calculated from the DEM, while topographic ruggedness was calculated as a standard deviation of elevation with a 1 km kernel around each pixel. Since the standard deviation of elevation describes how much variation there is in elevation in the kernel area, high values indicate that the landscape is very rugged and low values that it is not.

Soil variables were acquired directly from the SoilGrids database. This variable uses the cation exchange capacity (CAC) at the depth of 5 cm. Its unit is the amount of positive charge that can be exchanged per kilogram of soil ($cmol_c/kg$). CAC is often used as an indicator of soil fertility as it indicates the capacity of the soil to retain nutrients in plant-available form. The soil drainage variable uses bulk density (kg/m^3) as an indicator as the two phenomena are

[29] Hijmans, R.J., Cameron, S.E., Parra, J.L., Jones, P.G., and Jarvis, A. (2005). Very high resolution interpolated climate surfaces for global land areas. *International Journal of Climatology*, *25*, 1965–1978.

inversely related, meaning that, as the bulk density of soil decreases, its pore spaces increase, making its drainage capacity also increase. Like CAC, the bulk density data used was also at a depth of 5 cm. Depth to bedrock up to 200 cm was also acquired from the SoilGrids database.

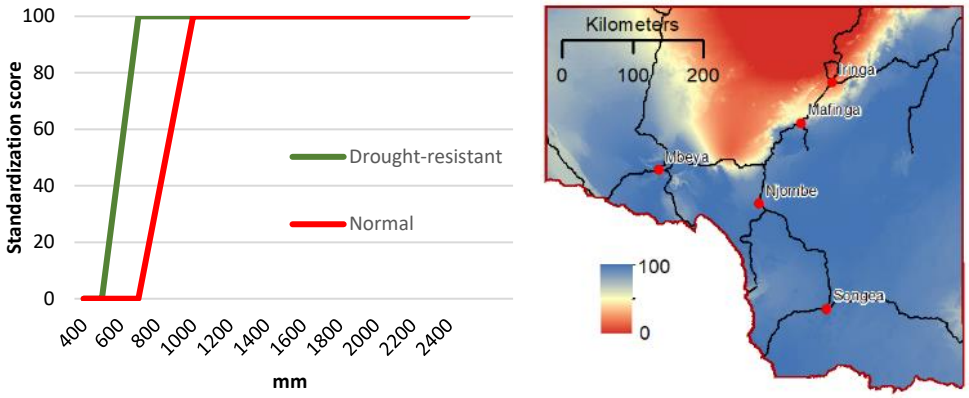
The **distance-to-main-roads** variable was calculated using Open Street Map, a freely available road dataset. Based on field observations, roads were classified as *trunk, primary, secondary*, or *tertiary*. These road classifications were chosen as either trucks or tractors can travel on them.

Standardisation of variables

The variables used in an SMCA must be standardised to equal scales according to their relationship to the land allocation target. To standardise the variables, this study used a scale from 0 to 100, with 100 representing areas most suitable for plantation and 0 representing areas least suitable. Various forms of membership functions were used to produce the standardisations and the final results were presented to experts at the PFP for modification and validation. The variable *annual rainfall* was standardised separately for normal and drought-resistant species and the variable *growing season temperature* was standardised separately for pine and eucalyptus, but the standardisations of all other variables were constant.

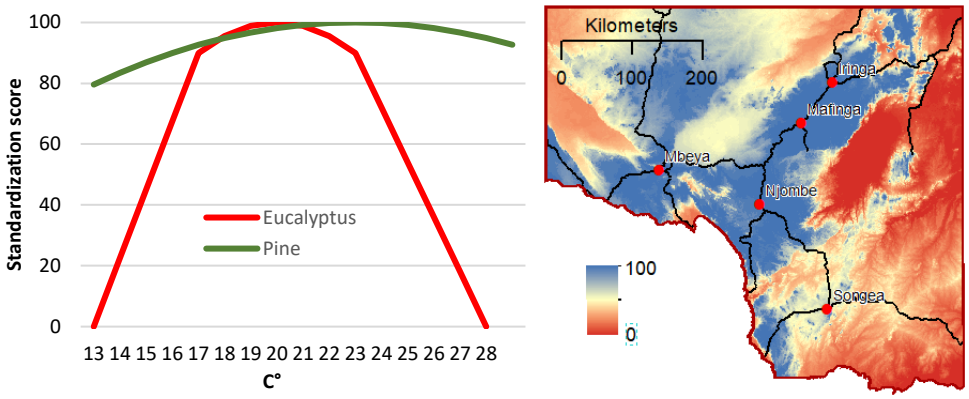
The *annual rainfall* variable was standardised according to site requirements. For *Eucalyptus grandis* and *Pinus patula*, areas with over 1,000 mm of precipitation received a score of maximum score of 100. The score increased linearly between 700 mm, the lowest possible requirement for a suitable site, and 1000 mm. On the advice of participating experts, the FAO's site requirements were modified so that rainfall above the optimal maximum limit would not negatively impact suitability. For drought-resistant species, the maximum score was awarded at 700 mm and the score increased linearly between 500 mm and 700 mm.

Standardisation of the precipitation data for the SMCAs



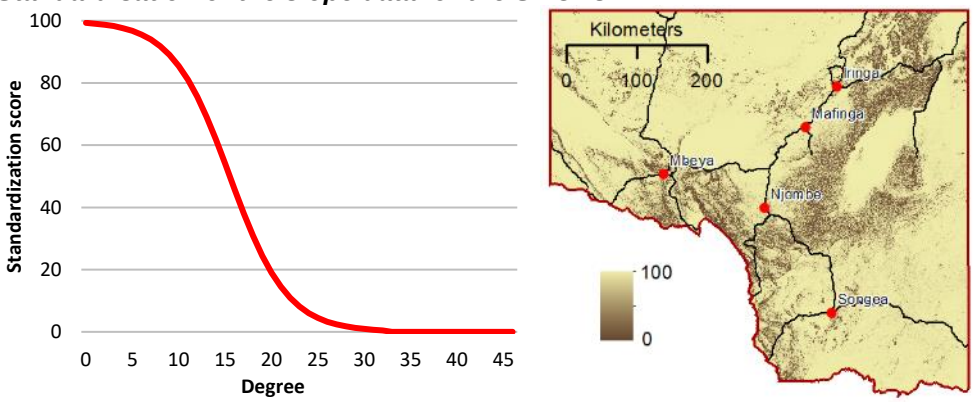
Growing season temperature was standardised according to site requirements. For pine, the membership function was a second order polynomial which was awarded a standardisation score of 90 at 16 °C and again at 30 °C. A score of 100 was awarded at 23 °C. The membership function for eucalyptus was also a second order polynomial between 17 °C and 23 °C. It increased linearly below 17 °C and decreased linearly above 23 °C.

Standardisation of the temperature data for the SMCAs



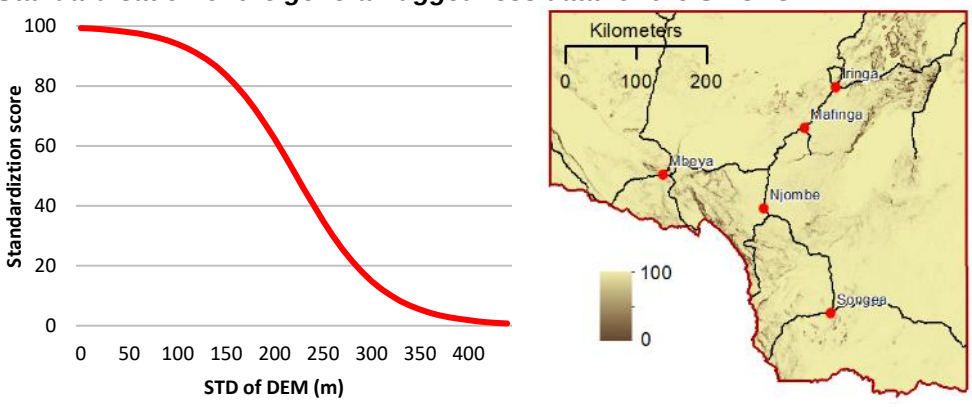
The *slope* variable was standardised so that areas with low slopes were more suitable for plantation than areas with high slopes as the management and harvesting of tree plantations is easier and more cost-efficient on flat areas. The membership function was a decreasing sigmoidal function until 31°; when any higher slope was calculated, a standardised value of zero was awarded. This particular zero limit was adopted because the FDT's plantation guidelines suggest that the maximum slope for plantation be 60 % (≈ 31°).

Standardisation of the slope data for the SMCAs



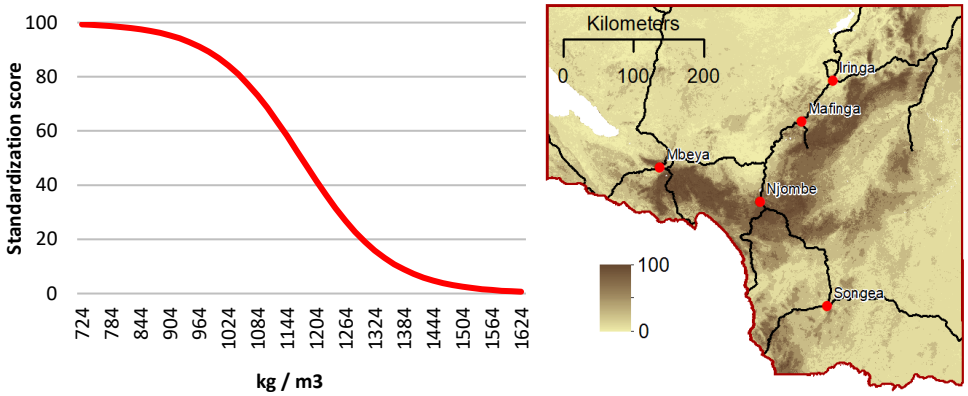
The *general topographic ruggedness* variable was standardised so that smooth, regular areas received higher suitability scores than rugged areas, again mainly because management and harvesting are easier on smooth, regular land. The membership function was a decreasing sigmoidal function which reached the value of zero at the highest value of standard deviation, 400 m.

Standardisation of the general ruggedness data for the SMCAs



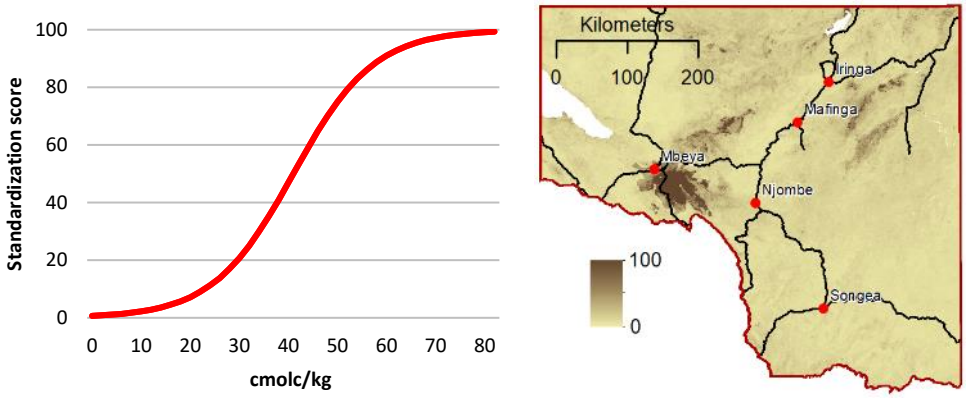
Although the site requirements of the indicator species, pine and eucalyptus, suggest that well-drained soils are preferred, standardisation was done in an opposite manner such that areas with the poorest drainage received the highest standardisation values because the soils in the study area are already well drained on a global scale and areas with high drainage and low bulk density values exhibit excessive drainage. For this reason, the plantations in the study area are generally located in areas with high bulk density and low drainage. The membership function used was a decreasing sigmoidal function which was awarded the lowest standardisation score at the highest bulk density value.

Standardisation of soil drainage data for the SMCAs



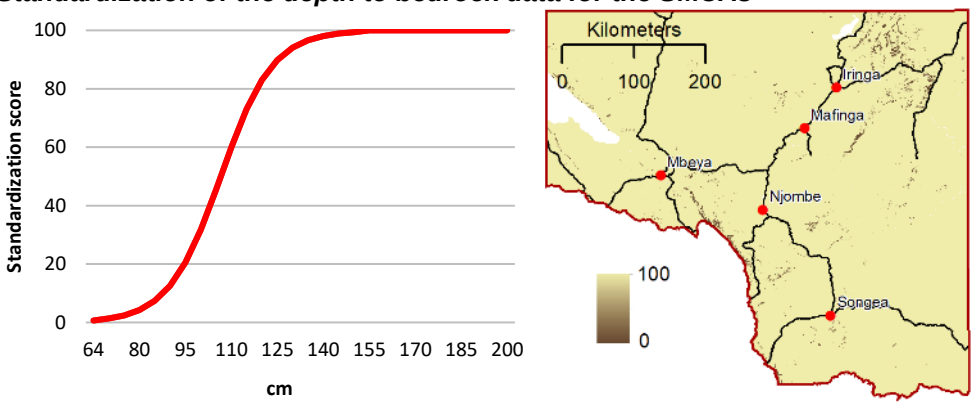
The *soil fertility* variable was standardised so that areas with the highest fertility received the highest standardisation scores as better soil fertility increases tree growth. The membership function was an increasing sigmoidal function with a maximum of around 80 $cmol_c/kg$.

Standardization of the soil fertility data for the SMCAs



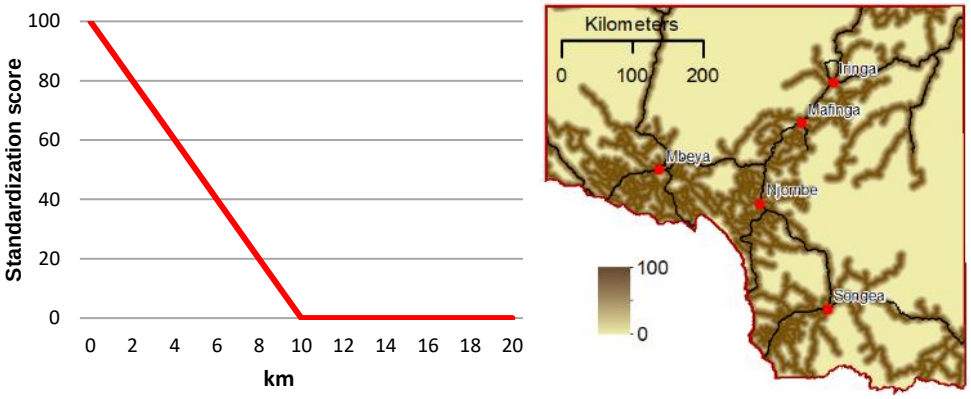
Standardisation for the variable *depth to bedrock* was calculated so that the membership function reached a maximum score of 100 at 150 cm. Lower depths were calculated using an increasing sigmoidal function.

Standardization of the depth to bedrock data for the SMCAs



The *distance-to-roads* variable was standardised using a linearly decreasing membership function until 10 km, after which distance the value awarded was zero.

Standardisation of the distance-to-roads data for the SMCAs



Accuracy of the results

An accuracy assessment revealed that the results for areas identified as highly suitable (91.5% producer accuracy) and not suitable (75.9 %) are very accurate. The overall accuracy (59.5 %) of the suitability classification is much lower due to the misclassification of highly suitable land areas as only suitable. In other words, areas identified as highly suitable in the field are often identified only as suitable in the classification. This means that the suitability analysis underestimated the proportion of highly suitable areas and overestimated the proportion of suitable areas.

Accuracy assessment confusion matrix for the SMCA

	Field data				
	Highly suitable	Suitable	Not suitable	Total	Producer accuracy
Highly suitable	43	2	2	47	91,5 %
Suitable	30	7	8	45	15,6 %
Not suitable	6	1	22	29	75,9 %
Total	79	10	32	121	
User accuracy	54,4 %	70,0 %	68,8 %		
Overall accuracy	59,5 %				

Cluster-level suitability for pine

The pine suitability results at the cluster level reveal that 28.3 % of suitable land is in Songea 27.6 % in Njombe, 20.9 % in Mbeya, 11.0 % in Mafinga, 8.3 % in Kilolo, and 3.9 % in Makete. However, the figure for Songea was inflated by the large amount of land classed as suitable which is probably not appropriate for industrial-scale tree planting. Of the land classified as

highly or extremely suitable, 45.6 % is in Njombe, 15.3 % in Mbeya, 15.1 % in Mafinga, 8.9 % in Songea, 8.5 % in Kilolo, and 6.7 % in Makete. Using the suitability results of drought-resistant pine does not change the cluster-level proportions of highly and extremely suitable land, but it does significantly increase the amount of land in Mafinga and Mbeya clusters that is classed as suitable.

Cluster-level results for pine suitability

Kilolo	Pine (in 1,000 ha)			Drought-resistant pine (in 1,000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	189	45	234	232	50	282
Highly suitable	44	4	48	55	4	58
Extremely suitable	33	0	33	42	0	42
Total	266	49	315	329	54	383

Mafinga	Pine (in 1000 ha)			Drought-resistant pine (in 1000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	188	87	274	387	142	529
Highly suitable	79	19	97	85	19	104
Extremely suitable	38	8	47	40	9	48
Total	304	114	418	511	170	681

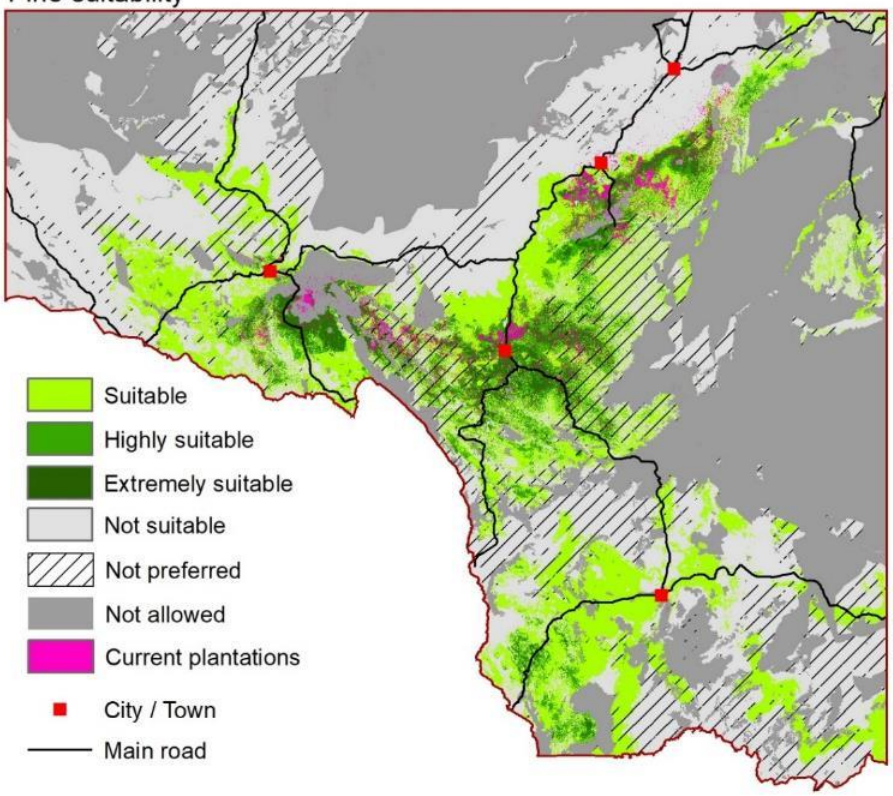
Njombe	Pine (in 1,000 ha)			Drought-resistant pine (in 1,000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	360	252	613	422	265	688
Highly suitable	176	79	256	176	79	256
Extremely suitable	141	40	180	141	40	180
Total	677	371	1049	739	384	1123

Makete	Pine (in 1,000 ha)			Drought-resistant pine (in 1,000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	20	61	80	20	63	83
Highly suitable	8	27	35	8	27	35
Extremely suitable	12	16	29	12	16	29
Total	40	104	144	40	106	146

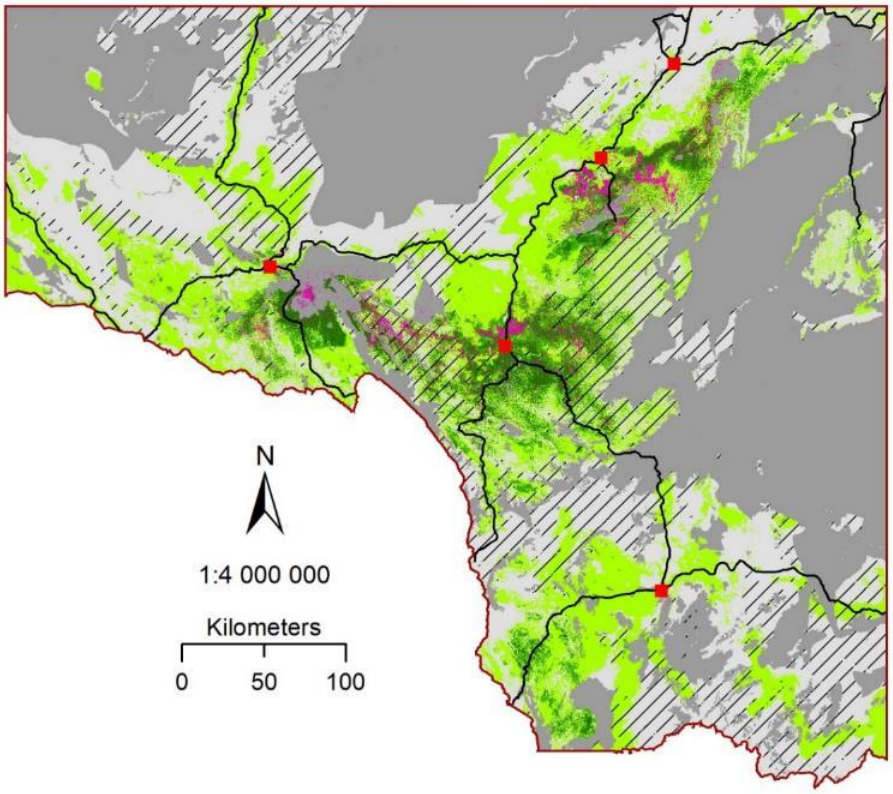
Mbeya	Pine (in 1,000 ha)			Drought-resistant pine (in 1,000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	510	135	645	734	237	971
Highly suitable	64	6	70	64	6	70
Extremely suitable	74	2	76	74	2	76
Total	647	143	791	872	245	1118

Songea	Pine (in 1,000 ha)			Drought-resistant pine (in 1,000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	766	223	989	766	224	990
Highly suitable	64	1	65	64	1	65
Extremely suitable	20	0	20	20	0	20
Total	850	224	1074	850	225	1076

Pine suitability



Drought-resistant pine suitability



Cluster-level suitability for eucalyptus

Of the total land classed as suitable for eucalyptus, 40.0 % is in Njombe, 20.4 % in Mbeya, 16.1 % in Mafinga, 10.0 % in Songea, 7.8 % Kilolo and 5.6 % in Makete. OF the total highly and extremely suitable land 49.0 % is in Njombe, 14.7 % in Mbeya, 13.7 % in Mafinga, 9.0 % in Kilolo, 6.8 % in Makete, and 5.4 % in Songea. Planting drought-resistant eucalyptus species does not significantly increase the proportion of highly or extremely suitable classes, but it does increase the amount of land classed as suitable in the clusters of Kilolo, Mafinga and Mbeya.

Cluster-level results for eucalyptus suitability

Kilolo	Pine (in 1,000 ha)			Drought-resistant pine (in 1,000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	101	14	115	143	18	161
Highly suitable	40	2	42	51	2	53
Extremely suitable	26	0	26	33	0	33
Total	166	16	182	226	20	247

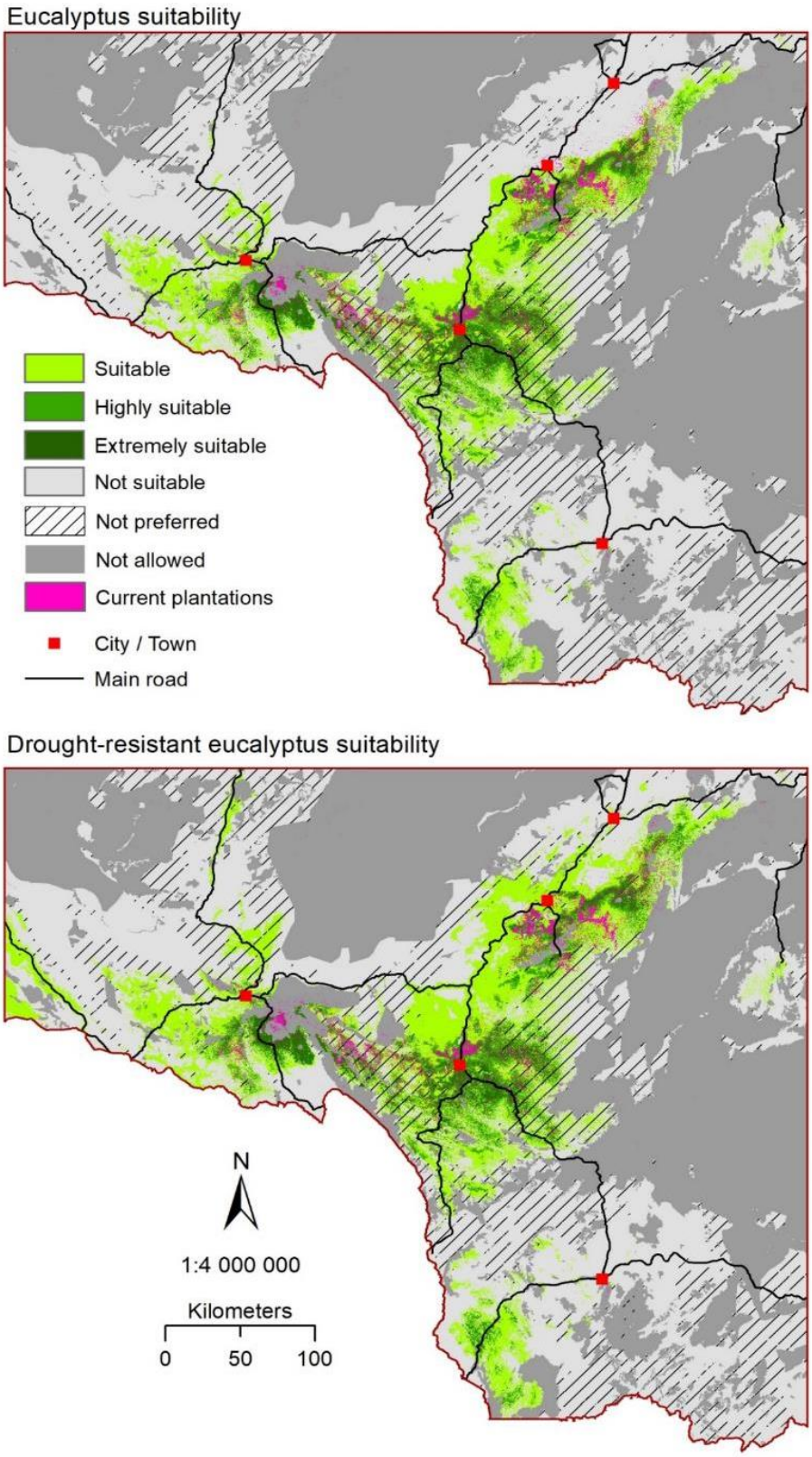
Mafinga	Pine (in 1,000 ha)			Drought-resistant pine (in 1,000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	207	65	272	363	91	454
Highly suitable	67	12	79	73	12	85
Extremely suitable	21	3	24	22	3	25
Total	296	80	376	459	106	565

Njombe	Pine (in 1,000 ha)			Drought-resistant pine (in 1,000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	357	211	568	410	217	627
Highly suitable	176	62	237	176	62	237
Extremely suitable	106	26	132	106	26	132
Total	639	298	937	692	305	996

Makete	Pine (in 1,000 ha)			Drought-resistant pine (in 1,000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	20	62	81	20	62	82
Highly suitable	9	23	32	9	23	32
Extremely suitable	8	11	19	8	11	19
Total	37	96	132	37	96	132

Mbeya	Pine (in 1,000 ha)			Drought-resistant pine (in 1,000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	296	61	357	435	105	540
Highly suitable	53	5	59	53	5	59
Extremely suitable	60	1	62	60	1	62
Total	410	68	478	549	112	660

Songea	Pine (in 1,000 ha)			Drought-resistant pine (in 1,000 ha)		
	Allowed	NPZ*	Total	Allowed	NPZ*	Total
Suitable	189	5	194	189	5	194
Highly suitable	32	0	32	32	0	32
Extremely suitable	9	0	9	9	0	9
Total	230	5	235	230	5	235



Recommendations for planting in the proposed clusters

The plantation suitability analysis of the Southern Highlands shows that significant amounts of land are suitable for plantation forestry. Most of the suitable, highly suitable, and extremely suitable land for plantation lies in the clusters of Njombe and Mafinga.

Proportion of suitable land classes by cluster

Pine	Suitable land	Highly or extremely suitable land
Njombe	54,5 %	60,1 %
Mafinga	21,7 %	19,9 %
Kilolo	16,4 %	11,2 %
Makete	7,5 %	8,8 %
Total	100%	100%

Eucalyptus	Suitable land	Highly or extremely suitable land
Njombe	57,6 %	62,4 %
Mafinga	23,1 %	17,4 %
Kilolo	11,2 %	11,5 %
Makete	8,1 %	8,6 %
Total	100%	100%

Future plantations should be established in the suggested clusters based on the proportion of suitable land each cluster has. Depending on whether the focus is industrial or smallholder plantations, weight should be given either to the total amount of suitable land or the amount of highly and extremely suitable land. Other factors such as environmental concerns, agricultural pressure, and infrastructure should also be considered so that the proportion of total plantations in each cluster is reduced in any cluster with potential problems in those areas.

Njombe cluster

The Njombe cluster has the largest combined area of land suitable for pine (1.05 mil. ha) and eucalyptus (0.94 mil. ha) plantation. More importantly, it has almost half of the total highly and extremely suitable land for pines (0.44 mil. ha) and eucalyptuses (0.37 mil. ha). The majority of suitable land and almost three-quarters of the highly and extremely suitable land is in allowed zones, a fact which reduces the risk of environmental conflicts and the cost of the additional field surveys needed to conduct EIAs. In addition, the population and agricultural pressure of projected for 2050 are both low, so there should be little land-use conflict between forestry and agriculture or other sectors.

The majority of new plantations should be established in Njombe cluster. The cluster has a large area of suitable land, low agricultural pressure, and good infrastructure, and is at low risk for environmental problems.

Mafinga cluster

Mafinga cluster has substantial amount of suitable land for pine (0,42 mil. ha) and eucalyptus (0,38 mil. ha) plantations. Approximately 1/3 of this land can be considered highly or extremely suitable for pines (0,14 mil. ha) and about ¼ for eucalyptuses (0,10 mil. ha). About ¾ of the suitable as well as highly and extremely suitable land are in allowed zone, reducing the costs and risks for environmental conflicts. Also, using drought-resistant species would expand the suitable land for pines by 0,26 mil. ha (63 %) and by 0,19 mil. ha (50 %) for eucalyptuses. The projected agricultural pressure is also low in the cluster.

Significant amount from the new plantations should be targeted to Mafinga cluster. The cluster has substantial suitable land resources, agricultural pressure is low, infrastructure is good and risk for environmental problems low.

Kilolo cluster

The Kilolo cluster has a decent amount of suitable land for pine (0,32 mil. ha) and a small amount for eucalyptus (0.18 mil. ha). Approximately, one-quarter of the land suitable for pine plantation is highly or extremely suitable (0.08 mil. ha) and over one-third if the land suitable for eucalyptus (0.07 mil. ha) is. Almost all of the land is in allowed zones, and the use of

drought-resistant species would expand the area of land suitable for pines by 0.07 mil. ha (22 %) and for eucalyptus by 0.07 mil. ha (36 %). Projected agricultural pressure is low, but the infrastructure in the cluster is poor and the majority of suitable land is located near the Mafinga cluster.

A decent proportion of the new plantations should be established in Kilolo cluster, but its infrastructure needs to be improved so that it can fully utilise its resources. The cluster has a decent area of suitable land and both agricultural pressure and the risk for environmental problems is low, but its infrastructure is relatively poor. Also, it might not be feasible to develop this cluster independently, especially if accessibility to and from Mafinga is improved.

Makete cluster

The Makete cluster has a small amount of suitable land for pine (0.14 mil. ha) and eucalyptus (0.13 mil. ha) plantation. The land is generally highly or extremely suitable (38–44 %), but its quantity is limited by surrounding national parks and forest reserves as well as the small total area of the cluster. In addition, almost three-quarters of the suitable land lies in grasslands, which are not-preferred zones. Using drought-resistant species would not expand the potential in Makete. The agricultural pressure projected is the lowest of the six clusters largely due to the declining population in the cluster. Infrastructure is generally poor and would need to be improved.

There is limited potential for plantation expansion in Makete cluster due to small amount of suitable land and potential environmental problems. Majority of existing plantations are established to areas defined as “closed woodland” by National Forestry Resource Monitoring and Assessment (NAFORMA) classification and the natural regeneration of pine trees is causing problems in Kitulo National Park. In addition, the majority of suitable land is grasslands, which itself likely has high biodiversity. These facts suggest that the risk of environmental conflict in Makete cluster is high.

Songea cluster

The Songea cluster has a significant amount of suitable land, especially for pines (1.07 mil. ha), but the amount of highly or extremely suitable land is modest. Also, the majority of the suitable, highly suitable and extremely suitable land, especially for eucalyptus, lies in the districts of Mbinga and Nyassa, which both have high projected agriculture pressure for future agricultural demand.

For these reasons, ***new plantations should not be established in the Songea cluster on a large scale.*** That said, there is potential for having smallholders establish plantations outside of the districts of Mbinga and Nyassa. Within these two districts, there is potential mainly in agroforestry and in areas that are not suitable for agriculture.

Mbeya cluster

The Mbeya cluster has a significant amount of suitable land for both pine (0.79 mil. ha) and eucalyptus (0.48 mil. ha) plantation, and a large proportion of that land is highly or extremely suitable. However, agricultural pressure is extremely high in the cluster. The majority of the districts in the cluster are projected to need more agricultural land in 2050 than they have in total. In addition, the land in the Mbeya cluster is largely volcanic and extremely fertile, making it desirable for cash crops and other agricultural production. There are also some environmental concerns in Mbeya cluster as naturally regenerated pines have encroached on Rungwe Forest Reserve (Davenport, 2004).

For these reasons, ***new plantations should not be established in Mbeya cluster on a large scale*** though there is potential for promoting agroforestry practices in general and for establishing plantations on smallholders’ woodlots in areas that are not suitable for agriculture.

ANNEX 6 VALIDATION WORKSHOP COMMENTS

Comment	Response
District boundaries could be included in the cluster maps.	District boundaries were intentionally left out because the analysis estimated the total raw material available in each cluster regardless of district boundaries.
In reality, agricultural pressure appears in a different manner than the study suggests as people establishing small woodlots on their agricultural plots.	This comment was noted, and it was explained that the agricultural pressure was used as an indicator to show areas where we should be careful in terms of food security.
Food security and its link to rural-urban migration and migrants' planting of trees rather than food crops in agricultural fields in their places of origin should be considered.	This phenomenon was acknowledged, but the modelling currently available cannot capture this issue. Agricultural pressure modelling was included just to flag risks.
Even though projections of the supply of plantation wood may show sufficient volume in relation to processing capacity, the volume of good-quality raw material is not sufficient for all end products.	This observation was noted. The assumptions of the study were conservative in order to avoid overestimation.
Why was pulpwood not included in the study?	At present, there was is no demand for pulpwood. In addition, since this resource is scattered around the landscape using it as a raw material would not be viable.
Why was Northern Tanzania not included in the investment cluster analysis?	The terms of reference for the study only included the Southern Highlands area.
Since the maps presented lack coordinates, they should be added. Sometimes the fact that investors are not prepared to follow the steps needed for the investment can delay investment. It was suggested that the report could be revised so it does not suggest that the investment process takes several years. The potential for pulp mill schemes should be included in the report.	The maps are clear in terms of location: the study area is clearly delineated and its location within Tanzania is clear. Coordinates would not make much of a difference on the study's maps as those coordinates could be no less than 111 km apart. Participants agreed that the text regarding access to land could be made less discouraging but that, at heart, access to land is not easy. Pulp mill establishment is discussed in the report, but since the scattering of pulpwood resources render such an initiative unfeasible, it was not included as a scheme. Chapter 7.4 was slightly revised in response to this comment.
It is important to follow correct, well-laid procedures in order to attract the discussed investments. It is not the case that it will be difficult to attract such investment.	Perhaps one successful large-scale investment executed according to the set procedures would set an example that would be very helpful in facilitating other such investments.
The recent market study conducted by the FDT suggested that there may be an oversupply of some resource in some areas. The quality of the resources, such as the diameters of logs, should be considered as much as the quantity of those resources.	The overall findings of the FDT study and this study are roughly the same. Though the PFP study has a slightly more conservative demand scenario, both studies report a similar supply of raw material at the national level. The PFP study is more penetrating than the FDT study in that it examines not just the national but also wood supply and demand at the cluster level. Participants discussed the differences in assumptions made by the two studies and accounted for their disparities. The key assumptions of this study were then added as Annex 3.
The timing of the suggested pole treatment investments in Mafinga cluster may not be accurate as the required supply of high-quality eucalyptus raw material may not be sufficient to meet the demand that investment generates.	The study's wood flow modelling used moderate assumptions that took into consideration possible problems with the quality of the resources.

Comment	Response
The message of the study should be tailored to different stakeholder groups in order to make it easier to interpret results and dissemination more efficient. Since access to finance is a challenge for potentially willing local investors, the message that these investments are feasible should be shared with the financial sector as well.	Communicating the findings of the report to the financial sector is, in fact, one of the outcomes included in the terms of reference for the study. Both this technical report and the parallel investment climate study will be used to draft stakeholder-specific recommendations.
Experience in conducting land evaluations suggests that investors must follow the correct procedures and compensate local people adequately.	This recommendation was agreed to, and, after discussing tools that could be used to agree on procedures with local participation, a reference to a sample framework, the Analytical Framework for Land-Based Investments in African Agriculture, was added.
The section of the report on the importance of not causing the deforestation of native forests contradicts the principles of sustainability by suggesting that plantations be established on arable land.	This is a misunderstanding of the intentions of the report. The report does not promote jeopardising either food production or natural forests by establishing plantations.
Agriculture and tree planting can be complementary land uses and EIAs can be used to prevent conflict.	The comment was acknowledged.
The report does not use the name ”Lake Nyasa”; instead, it calls this body of water “Lake Malawi.”	It is clearly cited under the map mentioned that it was prepared by another company. The PFP does not take a stand on the issue of Lake Nyasa, and the researchers added a footnote to this effect.

ANNEX 7 KEY PLANTATION MANAGEMENT ASSUMPTIONS USED IN THE STUDY

Species	Ownership type	MAI, m^3/ha/a	UMAI, m^3/ha/a	Rotation (years)	Share of small diameter (10-20 cm)
Eucalyptus	Private/smallholder	10	8.5	10	25%
	Company	15.9	13.5	10	25%
	Government	15.9	13.5	12	25%
Pine	Private/smallholder	11.1	9.4	10	25%
	Company	18.4	15.6	18	20%
	Government	18.4	15.6	25	20%
Acacia	Private/smallholder	12	10.2	10	25%
	Company	12	10.2	15	20%
	Government	12	10.2	15	20%
Teak	Private/smallholder	9.4	8.0	20	20%
	Company	12.9	11.0	20	20%
	Government	11.5	9.8	25	20%
Other	Private/smallholder	11.3	9.6	10	25%
	Company	15.8	13.4	20	20%
	Government	15.8	13.4	20	20%

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