# CONTRIBUTION OF SMALLHOLDER FARMERS TO FOREST RAW MATERIALS BASE IN TANZANIA

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## ABSTRACT

Tanzania's forest sector has unrealized opportunities of contributing to socio-economic development and carbon sequestration. Collectively, smallholder tree growers are becoming the most significant suppliers to the industry. This paper provides a concise account of investment opportunities in the Tanzanian forestry sector. It analyses demand, assesses supply, considers industrial capacity and infrastructure. It identifies six potential forestry clusters and discusses investment opportunities. Mafinga cluster holds massive but dispersed private smallholder plantation resources, in addition to significant plantation areas under the government and large companies. There is an opportunity for the establishment of 30,000 ha more of eucalyptus plantations for veneer production. In addition, investments in the utility pole treatment, eucalyptus sawmilling, charcoal production, and eucalyptus veneer making will be viable. Njombe cluster also holds massive but dispersed private smallholder plantation resources, in addition to significant company plantations. There is an opportunity for investment in 263,000 $m^3$ per year in pine sawmilling capacity, in addition to smaller investments in utility pole treatment, veneer production, and charcoal production, among others. The dispersed nature and small scale of most individual smallholder plantations, poor road access and limited electrification are the challenges limiting utilisation of smallholder resources. Infrastructure is however improving, and in the meantime, there are opportunities of building sustainable local processing enterprises in vertical integration with nearby tree growers. The future of the sector will largely depend on how smallholders are nurtured.

**Keywords:** Smallholder Tree Growers; Forest Raw Materials, Demand and Supply.

## INTRODUCTION

There is much potential for investing in the forestry sector of Tanzania, particularly in the Southern Highlands, where many of the nation's forest plantations and forest-based industries are already operating. However, there has not been sufficient information to guide investors on how exactly to capitalise on these opportunities. This paper draws lessons from published studies and technical knowledge of key experts working in the sector. It systematically analyses the demand projections for major wood products and examines the forest plantation resource base and possibilities for expansion. It identifies forest industry clusters and details the opportunities they present. It specifically focuses attention to smallholder tree growers regarding the challenges they face because they are collectively the most important suppliers. Thus, their constraints are worth addressing for the prosperity of the sector.

## FOREST PRODUCTS TRADE BALANCE

The forest products trade balance was negative between 2010 and 2016 (**Fig. 1**). The deficit was mainly due to the imports of paper and paperboard products. In addition, the imports of round wood (including utility poles), plywood, and wood-based panels increased the trade deficit.

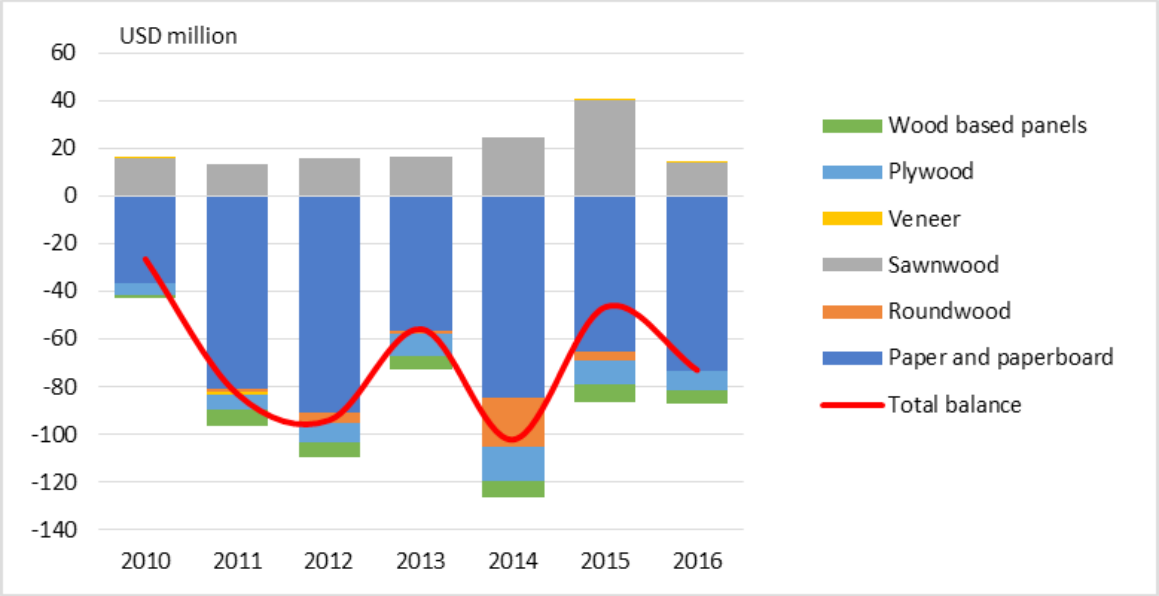


**Figure 1:** Forest Products Trade Balance in Tanzania between 2010 and 2016

**Source:** UN COMTRADE (2017).

## FOREST PRODUCTS DEMAND

The Tanzanian wood products demand was forecasted based on gross domestic product (GDP) development of the country (**Fig. 2**). The projected GDP increase was coupled with specific demand elasticity figures estimated by Buongiorno (2015) and that represent the projected impact of GDP changes in wood products demand. The elasticity was based on long-term observations of wood products demands and the GDP globally. The elasticity is applied in the Global Forest Products Model which is commonly used for analysing global forest products markets.

Although Tanzania's GDP growth has shown signs of slowing down, long-term economic growth was projected to continue to getting strong. The World Bank projects the annual GDP growth pace of 6.9% by 2030 (World Bank, not dated). Beyond 2030, the growth is forecasted to slow down to an annual pace of 4.7% until 2050. Furthermore, according to the United Nation's forecast on population growth, Tanzania's population will grow from 53 million people in 2015 to 124 million people by 2050 which would contribute to the growing of the economy (UN, 2017).

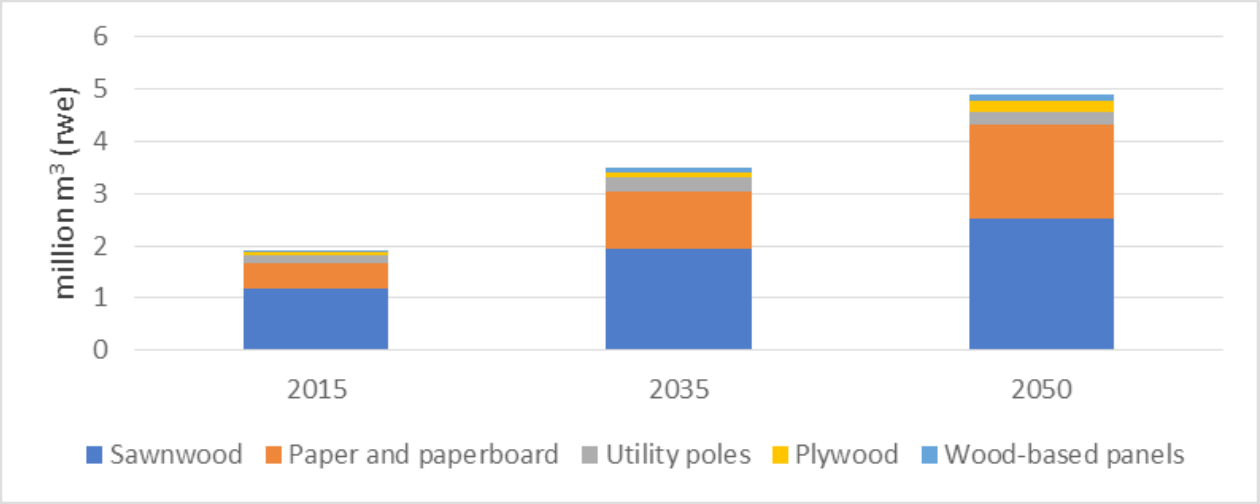


**Figure 2:** Projected demand for plantation wood products in Tanzania from 2015 to 2050

**Sawn Wood**

The current production levels of sawn wood were estimated using the latest estimates of sawn wood production and combining them with historical harvesting volumes from government forests. The demand for sawn wood was quite well balanced in 2015. However, the demand was predicted to increase beyond the processing capacity. The demand for sawn wood will be around 1million $m^3$ in 2050 whereas the current processing capacity is around 0.35 million $m^3$.

**Veneer and Plywood**

There were five main producers of veneer and plywood, Tanganyika Wattle Company (TANWAT), Tanganyika Plywood Ltd, and three Chinese exporters of veneer. Tanzania was largely self-sufficient in veneer. Veneer demand was driven by the requirement of plywood for construction and furniture. Plywood demand was predicted to increase to 170,000 $m^3$ per year from the current demand of around 34,000 $m^3$ per year.

**Utility Poles**

The largest utility pole producers in the Southern Highlands were Tanganyika Wattle Company (TANWAT), Green Resources, and New Forests Company. Utility poles were mostly being made from eucalyptus. The 2015 production capacity was estimated at about 350,000 poles a year or 115,500 $m^3$ of wood. According to interviews with TANESCO and Rural Electrification Agency the total utility pole demand was predicted to cap at 600,000 poles a year, that is 198,000 $m^3$.

**Wood-Based Panels**

Wood-based panels, including medium density fibreboard (MDF), particleboard, and oriented strand board (OSB) were mainly imported to Tanzania. Only small quantities of particleboard were being produced in Tanzania. The demand for wood-based panels was predicted to continue growing, but the quantities remain relatively small. For scale, a viable MDF plant would need to have the capacity of around 100,000 $m^3$. Due to product properties, particleboard does not have significant demand potential in Tanzania. Thus, wood-based panel demand will concentrate on MDF and OSB. There was a clear demand and supply gap for domestic wood-based panels. These products are mostly imported; they require specific infrastructure properties like steady electricity supply that may not be available in Tanzania in the short to medium terms. In the long-term however, these investments may become viable, but the low scale of demand does not warrant an investment for domestic markets.

**Paper and Paperboard**

Uncoated kraft is the only paper grade produced in Tanzania. About half of the uncoated kraft was being exported and the rest was consumed domestically. Most of the uncoated kraft paper is used for packaging. The consumption of pulp and paper in Tanzania is heavily dependent on imports and this may well continue. A steady and secure supply of raw material to warrant a large-scale investment which is required by a mill producing pulp and paper products may not be present in the country during the medium-term. The demand for these products will also remain moderate.

**Round Wood**

The annual round wood production was around 2million $m^3$ in Tanzania. With the forecasted growth in demand of wood products, round wood demand will consequently increase at the current annual average growth rate of 2.8% until 2050.

## FOREST RESOURCES

**Mapped Forest Plantations**

An estimated 80% of Tanzania's plantation forest area is in the Southern Highlands which are the main region in the production of primary wood products for the Tanzanian construction and furniture industries.

University of Turku and FAO mapped the existing forest plantations in the Southern Highlands in 2016 (PFP, 2017).The mapping was done using multi-sensor approach utilizing Landsat OLI, Sentinel-1 and Sentinel-2 satellite images, SRTM Digital Elevation Model and Hansen Global Forest Change data acquired between 2013 and 2016. The classification was done with the supervised Random Forest algorithm. The training data for the supervised classification were collected through the mapping exercise whereby various Tanzanian university students and staff from relevant fields of science participated.

The plantation mapping had good overall accuracy (91.5%). Thus, its estimates on the existing plantation resources were generally correct. However, the mapping had difficulties identifying the recently established plantations (<3 years), and therefore, it probably underestimated the total area of plantations. Also, the approach was limited in its ability to separate plantation age classes and densities, while the species group was captured relatively well.

The plantation mapping data were modified in the further analysis by removing the clearly non-plantation forest areas. This was done with the guidance of the most recent Sentinel-2 satellite image and very-high resolution satellite images which are available at Google Earth. The removal was conservative in its nature, so that only the clearly non-plantation forest areas were removed and unclear areas remained. Approximately 5 % (11,000 ha) of the plantation area was removed.

The final plantation mapping results indicate that there was about 196,000 ha (PFP, 2018) of plantations in the Southern Highlands. About 67% (132,000 ha) of the plantations were pine, 19% (37,000 ha) were eucalyptus, and 13% were wattle (*Acacia mearnsii*) (26,000 ha). Most of the plantations were in Mafinga and Njombe, while Makete, Mbeya and Kilolo also had substantial areas. Pine plantations were distributed throughout these five areas, while eucalyptus was mainly found in Mafinga, Njombe and Mbeya, and most wattle plantations were in Njombe.

Plantations were classified according to ownership; they were Government, Company or Smallholder. All these plantations that were mapped outside the holdings of the government and major companies (Green

Resources Ltd, New Forests Company Ltd, Mufindi Paper Mills Ltd and Tanganyika Plywood Company) were classified as smallholder plantations. Based on the 2016 mapping, smallholders owned most of the plantations (139,000 ha) and these were widely distributed. Most of the Government plantations were in the consolidated blocks in and around Mafinga, while private company plantations were also found in the consolidated blocks in and around Mafinga and Njombe. These consolidated blocks were acquired decades ago when such properties were much more readily available than they are now.

Smallholder plantations were mostly pine (66%), whilst eucalyptus (at 19%) and wattle (at 15%) made up the balance. This compared with the government which favoured pine (at 85%) and companies who balanced pine (33%) with eucalyptus (31%). Most of the smallholder plantations were relatively young with only 28% estimated to be over eight years of age. This compares with 46% in the company plantations and 54% in the Government plantations which were estimated to be over eight years of age.

## FORESTRY VALUE CHAIN

### 2015 Baseline Situation

**Figure 3** depicts the value chain as it was in 2015. The removals from the plantations were around 1.2 million $m^3$ per year and the total round wood consumption by the forest industry was almost 1.6 million $m^3$ per year. Most of the round wood was utilized by the sawmilling industry, over 1.2 million $m^3$. 400,000 $m^3$ of the sawn wood was consumed domestically and over 50,000 $m^3$ were exported. According to the round wood consumption volumes, the residues from the sawn wood production amounted to 860,000 $m^3$.

The second largest industry segment using round wood was the pulp and paper industry, that is, the kraft paper produced by Mufindi Paper Mills. The annual wood use by Mufindi was 200,000 $m^3$ of the pine round wood. All the pine round wood came from the government plantations even though nearby smallholders lacked the markets for large quantities of round wood sourced from first thinnings. Roughly, half of the paper produced was exported. Two-thirds of the overall paper consumption in Tanzania was based on imports. The production of transmission poles required 170,000 $m^3$ of round wood annually. Most of the transmission poles were made from eucalyptus and were used domestically.

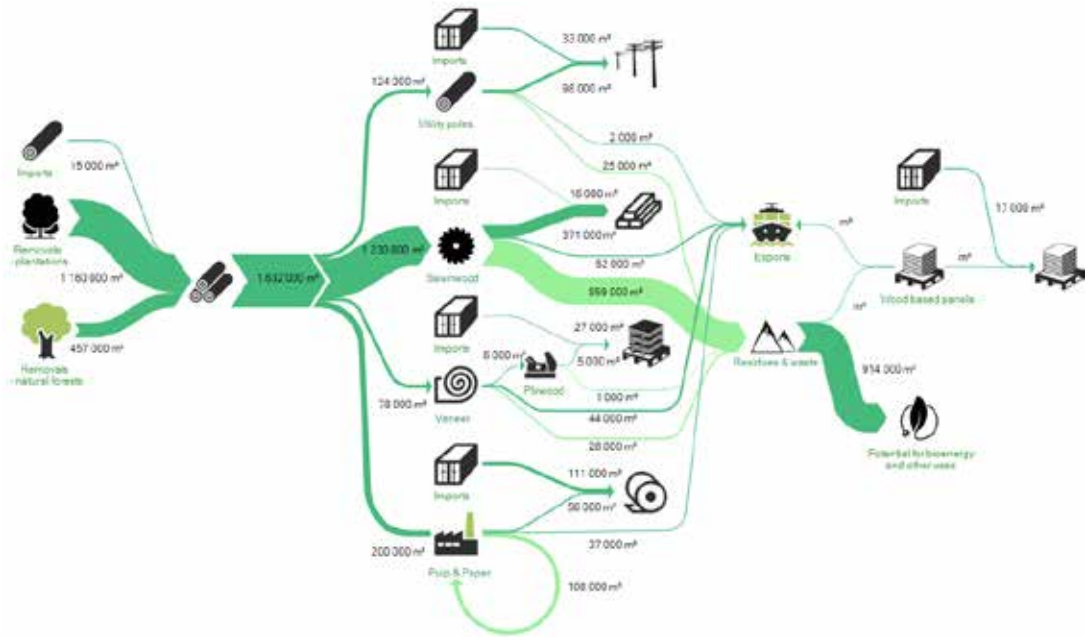


**Figure 3:** Wood value chain in Tanzania during 2015

**Supply-Demand Balance Projections**

If the pine plantations are managed sustainably and utilised efficiently, the current plantation area will suffice for the domestic pine sawn wood markets in the long-term. In the long-term, the pine sawmilling capacity should be renewed to improve recovery rates. More eucalyptus plantations need to be planted to satisfy the increasing pole and veneer demands. In addition to veneer logs, logs for sawn wood would also be produced from the same plantations in sufficient quantities to satisfy the demand for eucalyptus sawn wood. Eucalyptus sawmilling will not be of any significant scale. The supply demand balances for logs varied spatially within the Southern Highlands. These local imbalances require local solutions through clustering (**Fig. 4**).

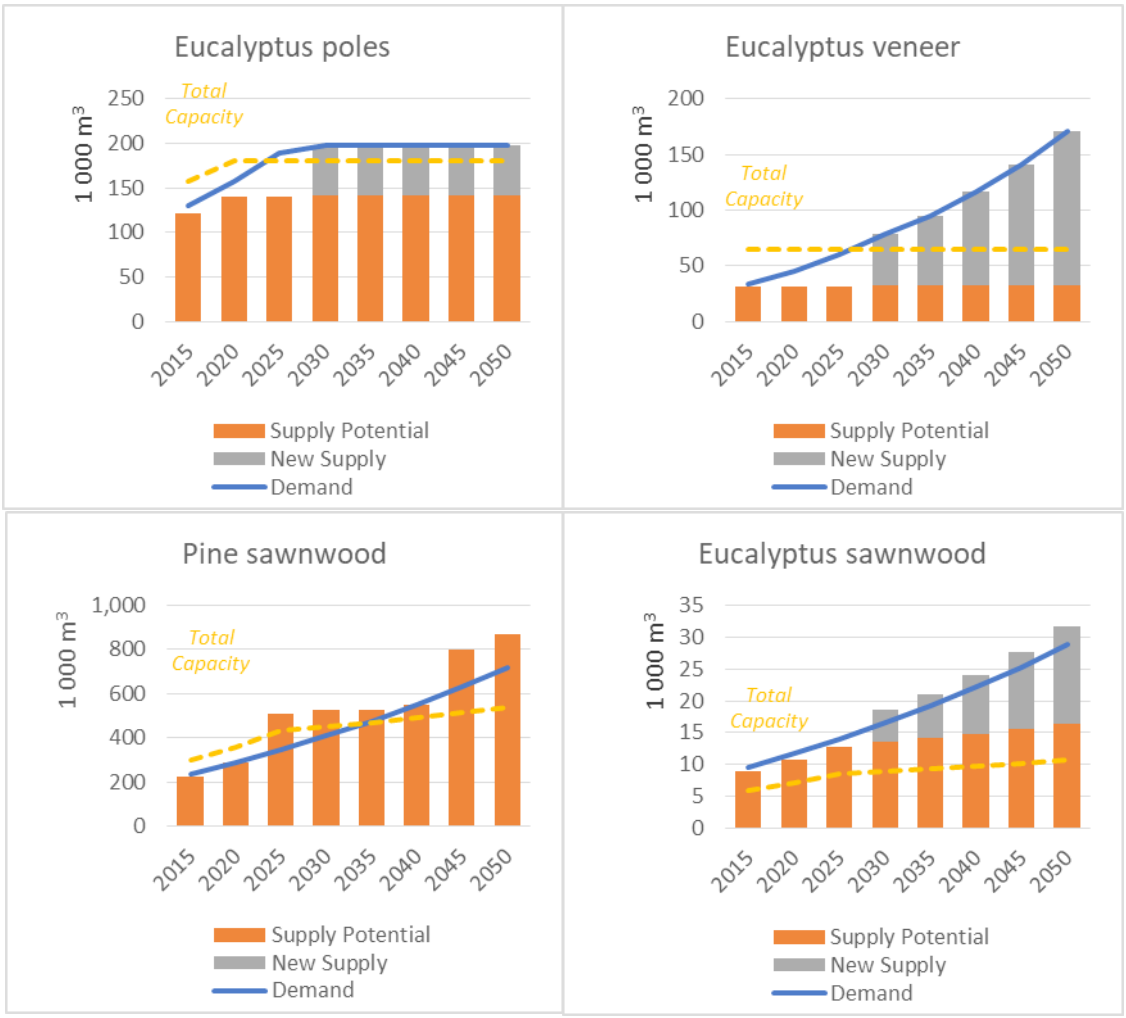


**Figure 4:** Supply-demand balance of key products in Tanzania[3]

In 2050, there will be 1.4 million $m^3$ per year of pulpwood available in Tanzania, which is twice the 2015 situation (**Fig. 5**). Now, there are few viable uses for this raw material in Tanzania. In addition, the pulpwood resource is scattered and a large-scale plant for this raw material, such as pulp mill, seems to be unviable. The situation with regards to pulpwood use may however change in the medium term due to increasing discussions around log grading and development of pulpwood markets in the country.

3 Supply potential refers to the amount of roundwood that is potentially produced with the current plantations; whereas new supply refers to roundwood supply from new proposed plantations.

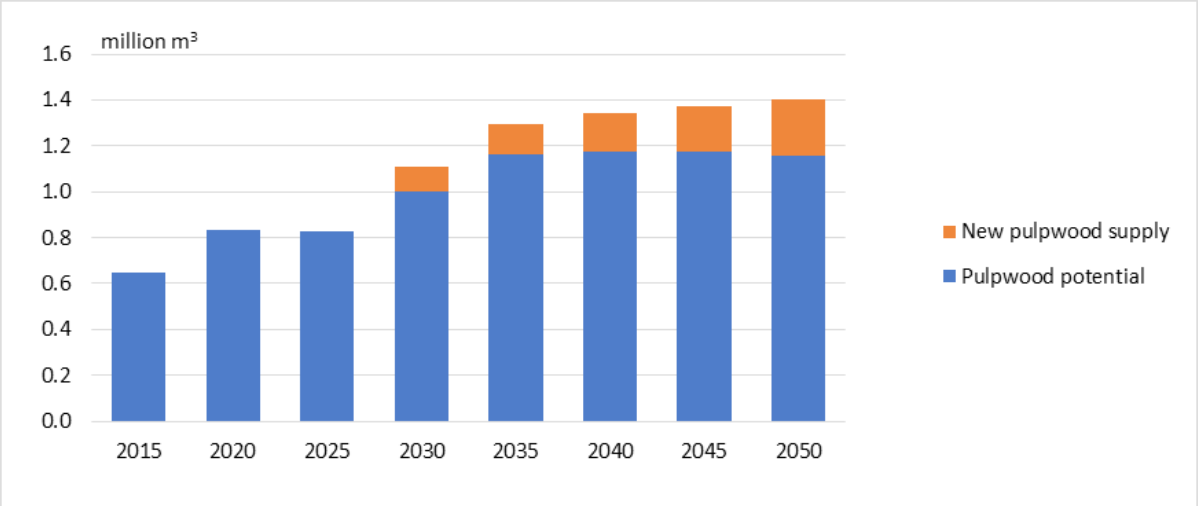


**Figure 5:** Pulpwood supply in Tanzania

Another use of pulpwood might be chipping the material for cost efficient transportation. A properly working rail connection for the Southern Highlands might make the export of chipped pulpwood through sea ports financially viable.

**Forest Industry Development**

In elucidating the forest industry development scenario, it was assumed that the plantation resource base will be expanded, and the domestic production capacity will be increased to meet the forecasted growing demand in Tanzania. If the investments recommended in this study are made, the future wood flows are expected to be as shown in **Fig. 6**.

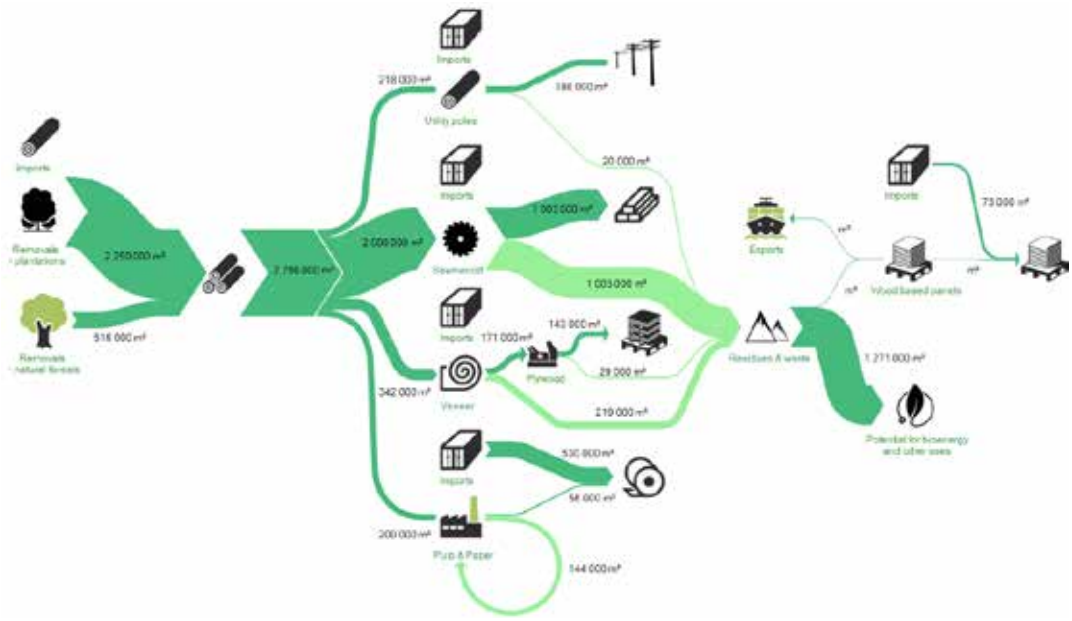

**Figure 6:** Wood flows in Tanzania in 2050

In general, it was estimated that by developing the domestic industrial capacity and wood supply it is possible for Tanzania to become self-sufficient in utility poles, sawn wood, and plywood. The sufficient supply requires, however, that all the harvested areas are replanted after harvesting, and that the forests are managed sustainably to allow for even wood flows. While, there is no need for new pine plantations, the current sawmilling capacity needs to be renewed in the long-term to allow for improved recovery rates

and the overall capacity needs to be increased in the medium-term.

More eucalyptus plantations need to be planted primarily to satisfy the increasing demand for veneer and poles. In the long-term, the processing capacity for eucalyptus wood would need to be increased. The dependency on the imports of pulp and paper products as well as wood-based panels will remain. The forecasted demand of both pulp and paper and wood-based panels are relatively low and are therefore insufficient to justify investments in such production facilities. The consumption of utility poles is expected to cap at some 600,000 poles by 2030 and is expected to remain at that level. Pole consumption is driven by rural electrification, which is expected to intensify soon and then to slow down.

**Bioenergy Potential**

Huge amounts of waste were produced in the forest harvesting and wood industries (**Fig. 5**). These include off-cuts, slabs, bark, chips, and sawdust. In addition, there is no industrial market for pulpwood. Waste can however be a valuable raw material for various purposes and, in fact, efficient cascading use of all the wood assortments gives the forest industry a unique competitive advantage over other sectors.

**Smallholder Organisation**

The Government and larger company plantations benefitted from consolidated land holdings (**Fig. 7**) and vertical integration with the industry under the same ownership, whilst Smallholders on the other hand did not benefit from these advantages. They were mostly a mix of resident villagers and non-resident urban based investors. Smallholders did not share the benefits that come from scale. They were distributed across the landscape and often far from major roads. Plantation size class distribution was estimated by assessing the size class distribution of plantation polygons resulting from the plantation mapping **(Fig. 8).** Such mapping confirmed an extreme size class distribution, with most plantations nation being very small. Many smallholders had benefitted from government and company planting schemes. These company planting schemes were mostly a result of self-interest based corporate responsibility, although there had been some recent discussions on moving from out-growers to contract growing schemes.

Over 9,000 tree growers have been organised into an expanding network of Tree Growers' Associations under the auspices of the Tanzania Tree Growers' Associations Union. They have mostly been organised for efficient planting support and sharing learning. Tree Growers' Associations however are mostly distributed in recent afforestation areas rather than in locations with the established plantations that require silviculture, harvesting, and marketing support.

Most smallholder tree growers were neither integrated with the industry nor organised in groups. They did not access technical extension or finance services. They lacked knowledge about markets and did not know how to produce round wood that the industry needs in a profitable manner.

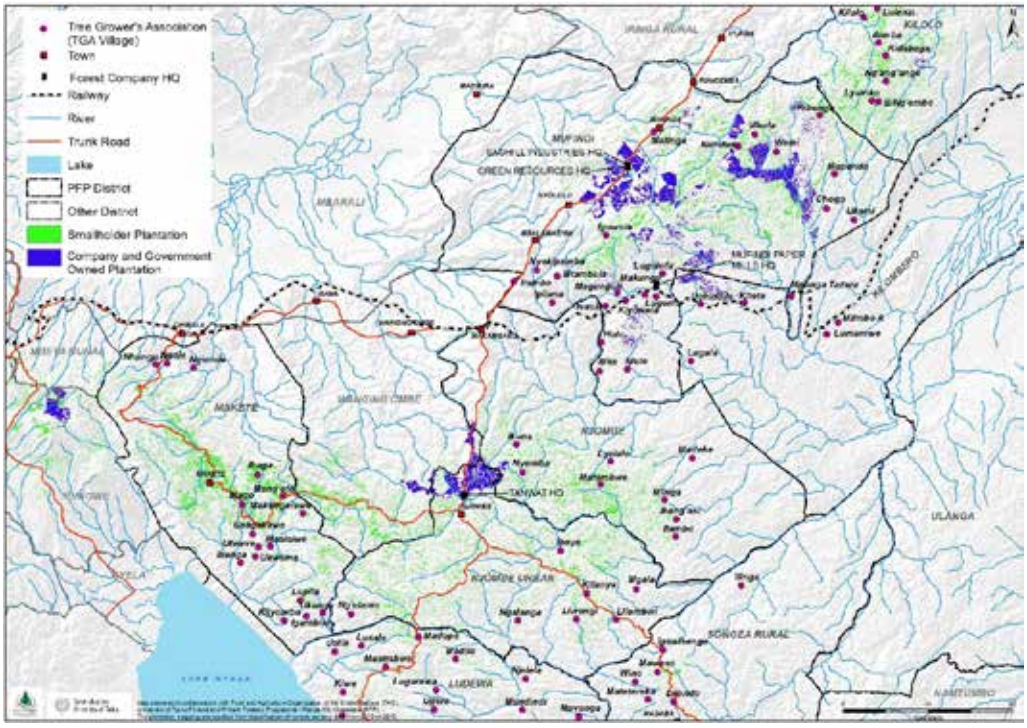


**Figure 7:** Forest plantations by ownership as mapped in 2016, and tree grower's associations in 2018

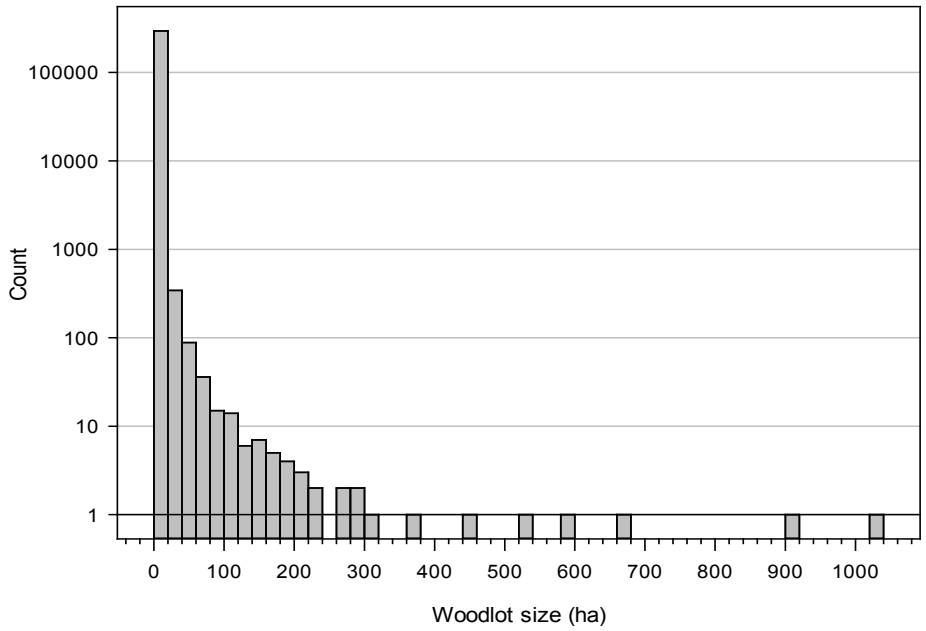


**Figure 8:** Mapped Smallholder Plantation Forest Polygons by Area Size Class

## INDUSTRY CLUSTER ANALYSIS

Six clusters for large-scale industrial development were identified based on: a) distribution of the current plantation resources, b) potential for future plantations, and c) current and planned infrastructure (**Fig. 9**). These clusters had centres in Kilolo, Njombe, Mafinga, Makete, Mbeya, and Songea. More detailed analysis of the clusters focused on the most promising ones: Mafinga and Njombe clusters. These clusters had the best current industrial infrastructure, the largest current wood resource base, and the most suitable land areas for new plantation establishment.

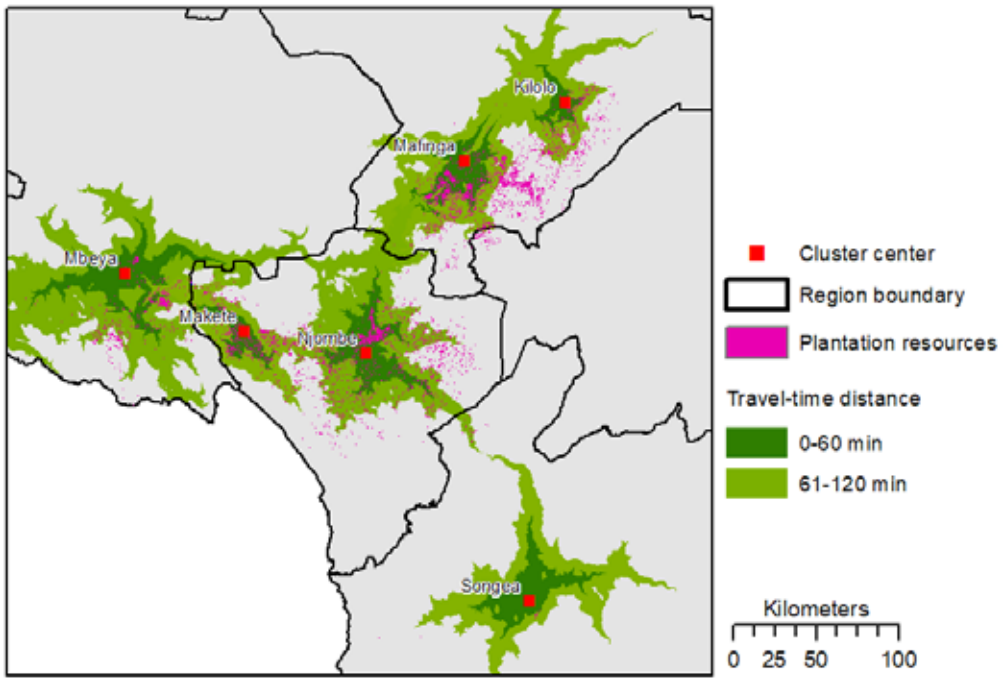


**Figure 9:** Forest plantations, proposed cluster centres, and travel time distances from cluster centres

**Mafinga Cluster**

In addition to current wood resources and processing capacity, the proposed investments into Mafinga cluster would include investing in medium-scale planting of eucalyptus with a veneer log regime, increasing the pine sawmilling capacity moderately, and increasing veneer producing capacity significantly (**Table 1**). Smaller investments are proposed for eucalyptus sawmilling, utility pole treatment, and charcoal briquette manufacturing out of sawdust.

**Table 1:** Proposed Investments – Mafinga Cluster

| Investment 1tem | Scale |
|---|---|
| Planting of eucalyptus with veneer log regime | 30 200 ha |
| Constructing of new pine sawmilling capacity | 130 000 $m^3$ (intake) |
| Constructing of new eucalyptus sawmilling capacity | 33 000 $m^3$ (intake) |
| Constructing of new eucalyptus utility pole treatment capacity | 14 000 $m^3$ (intake) |
| Constructing of new eucalyptus veneer producing capacity | 235 000 $m^3$ (intake) |
| Constructing of new charcoal briquette capacity | 76 800 $m^3$ (intake) |

The profitability measured by Internal Rate on Return (IRR) of the investments which is proposed in the Mafinga cluster would be 23% (**Fig. 10**) if the entire investment is made by one actor. The variation of the IRRs between the products is rather large with forestry being the lowest and utility pole treatment the highest. The scales of these investments are however rather different, and the very high IRR of utility pole production would be on a very small scale. The high IRR for utility pole treatment was a result of a rather low raw material costs and a rather high market price due to very high demand of utility poles compared with the processing capacity while eucalyptus raw material is undervalued.

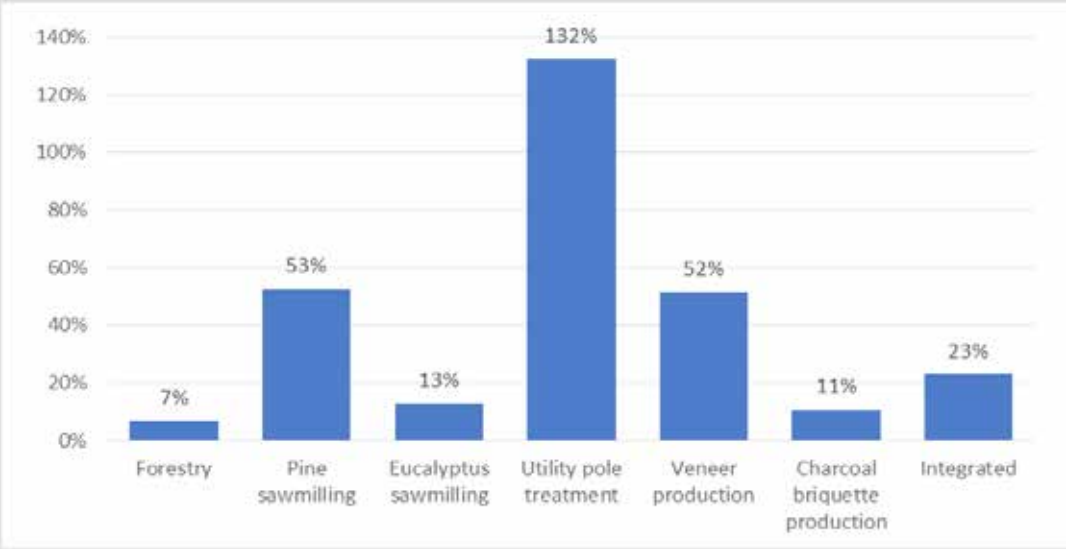


**Figure 10:** Comparison of Internal Rates of Return – Mafinga Cluster

The investment is proposed to be phased as indicated in **Figure 11**. The immediate investment can be done in utilising the sawmilling residues in charcoal briquetting followed by pole treatment, and new plantation establishment and eucalyptus sawmilling. Investments into pine sawmilling will only start at around 2040.

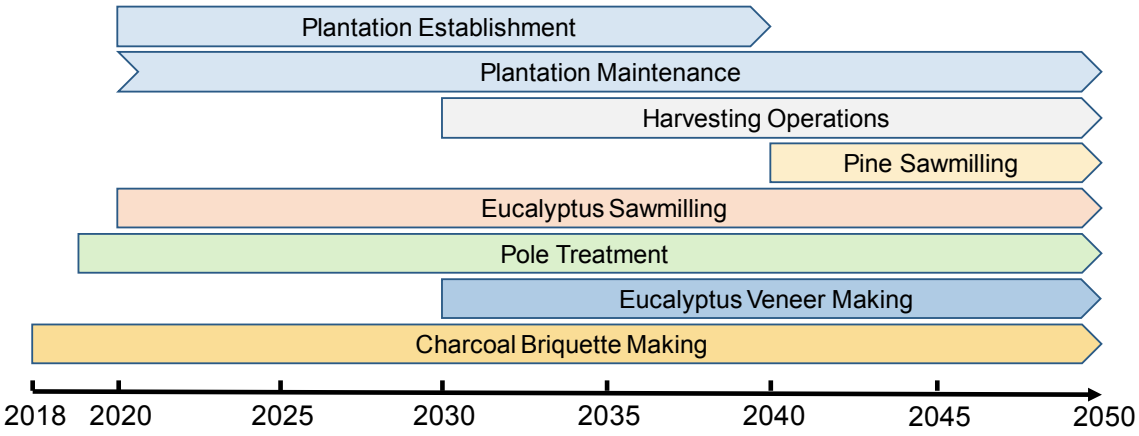


**Figure 11:** Phasing of investment – Mafinga cluster

### Njombe Cluster

In addition to current wood resources and processing capacity, the proposed Njombe cluster would include investment into moderate planting of eucalyptus with a veneer pole regime, significantly increasing the pine sawmilling capacity and increasing the pole treatment capacity (**Table 2**). Smaller investments are proposed for eucalyptus sawmilling, veneer production, and charcoal briquette manufacturing.

**Table 2:** Proposed investments – Njombe cluster

| Investment Item | Scale |
|---|---|
| Planting of eucalyptus with pole regime | 8 400 ha |
| Constructing of new pine sawmilling capacity | 263 000 $m^3$ (intake) |
| Constructing of new eucalyptus sawmilling capacity | 7 200 $m^3$ (intake) |
| Constructing of new eucalyptus utility pole treatment capacity | 36 000 $m^3$ (intake) |
| Constructing of new eucalyptus veneer producing capacity | 2 400 $m^3$ (intake) |
| Constructing of new charcoal briquette capacity | 36 800 $m^3$ (intake) |

The profitability (IRR) of the investments proposed in the Njombe cluster would be 43% if the entire investment is made by one actor (12). The overall profitability of the cluster is rather high here as the scale of pine sawmilling is quite large and it is projected to be relatively profitable. Like in Mafinga, the variation of the IRRs between the products is rather large with forestry being again the lowest and utility pole treatment the highest.

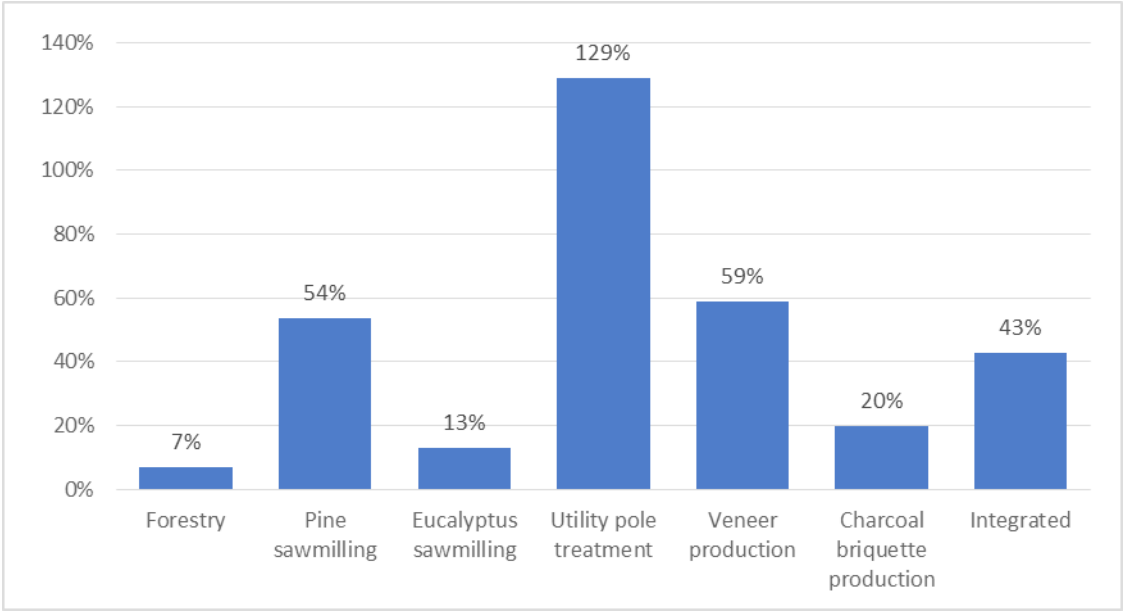


**Figure 12:** Comparison of Internal Rates of Return – Njombe cluster

The investment is proposed to be phased as indicated in Figure 13. The immediate investment can be done in sawmilling for pine and eucalyptus, veneer production, and charcoal briquetting. Investments into pole treatment will follow at around 2025.

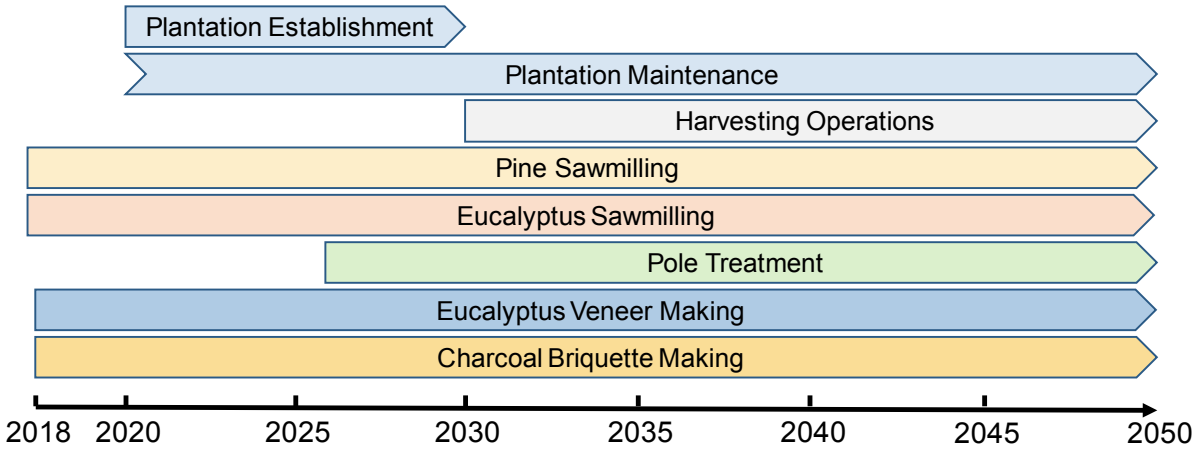


**Figure 13:** Phasing of investment – Njombe cluster

## SUSTAINABILITY

In addition to financial sustainability evidenced above, any investment needs to be socially and environmentally sustainable. The current study assumed that best practices in forestry and forest industries would be followed; for example plantations that are established in compliance with the local environmental laws, and are at least certifiable (even if not certified) under international certification schemes. This means

for example that the plantations are not established in the areas converted from natural forest or other valuable ecosystems, and that adequate buffer zones are applied with streams and other water bodies.

Properly established tree plantations are likely to result in many positive environmental impacts both locally and globally. High yielding plantations sequester carbon efficiently both in above and below ground biomass. Plantations do not require irrigation systems and they have little impact on ground water levels if they are established according to proper site-species matching. As part of this study, a suitability analysis for plantation species was conducted and an important parameter of the analysis is the availability of sufficient rainfall.

Other environmental benefits include for example improved water regulation and relieving of pressure on natural forests and woodlands for wood products and firewood. Plantations do not commonly require chemical fertilisation and they typically reduce soil sedimentation in comparison to many other land uses. Both attributes improve water quality downstream from the plantations with less sediment and nutrient runoff compared with agriculture.

On the social side, it is expected that the plantations will generate much needed income in rural Tanzania, will reduce the pressure for urbanisation, and will create a more stable social situation through more even income distribution. Plantation establishment and more advanced forest industry also create more opportunities for women to be employed in decent working places.

The land for plantation establishment is most likely going to be a combination of smallholder and larger scale industrial plantations. There is a well-known barrier for forest industry for accessing enough land and thus integrating smallholders in their value chains is important to achieve enough scale. To access land, the investor (if foreign) needs to find an agreement with the local communities or seek support from the Tanzania Investment Centre.

## DEVELOPMENT IMPACT

The development impact of an investment into Tanzanian forestry and forest industry is based mostly on income and employment creating. The identified investment opportunities would create some 1,500 decent jobs directly and many more indirectly through the multiplier effect. There would be additional income created in the area as people (employees, service provider etc.) gain business from the investment.

The investments would impact the current negative trade balance. Due to an increase in the demand for paper products, which are not viable for further domestic investments, the forest products trade balance will likely remain negative in the future as well. The investments in plantation establishment, sawmilling, plywood and veneer production will reduce the trade deficit from what it would be if there were no investments into the forestry sector as the target is to become self-sufficient in these products.

The investment into charcoal and briquetting will reduce the pressure on natural forest-based charcoal and thus have a positive impact on reducing forest degradation in natural forests. The plantations that are proposed to be established will also sequester significant amounts of carbon as they grow. This carbon is further stored in long-lived wood products.

## CONCLUSIONS

(i) Seventy per cent (70%) of the Southern Highland's plantations were found to belong to smallholders. The smallholders did most of the recent afforestation and had best access to village land for further expansion.

(ii) The dispersed nature and small sizes of most smallholder plantations, poor road access and limited electrification were the challenges utilisation of smallholder resources. However, there were opportunities of building sustainable local processing enterprises in vertical integration with nearby tree growers. These could be a mix of permanent sawmills where local log supply and infrastructure permit, and semi-mobile and mobile sawmills where log supply and infrastructure are more limiting.

(iii) Some established plantation and wood processing enterprises faced difficulties in securing future round wood supplies whilst nearby smallholders were unable to finance their plantations. Contract growing arrangements could ameliorate these problems if they were of sufficient scale and enforceable.

(iv) Tree Growers' Associations can bring group knowledge and negotiating strength to individual growers. They can also become a bridge between growers and industries.

(v) The future of the sector will largely depend on how smallholders are nurtured, and specific attention needs to be given to their training, infrastructure, and fire protection needs.

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