Tanzania Forest Fund
For sustainable financing of forest Management

Proceedings of the 1st TAFORI Scientific Conference on Forestry Research for Sustainable Industrial Economy in Tanzania

October, 2018

Editors

J.F. Kessy, C.P. Balama, P.J. Kagosi, S. Bakengesa, N.E. Pima, M.A. Mndolwa and S.E. Nkya

Proceedings of the 1st TAFORI Scientific Conference on Forestry Research for Sustainable Industrial Economy in Tanzania

Held at TAFORI Headquarters, Morogoro, Tanzania
24th - 25th April 2018

Editors

J.F. Kessy, C.P. Balama, P.J. Kagosi, S. Bakengesa, N.E. Pima, M.A. Mndolwa and S.E. Nkya

Organised by the Tanzania Forestry Research Institute (TAFORI) and Tanzania Forest Fund (TaFF)

Financially Supported by:
Tanzania Forest Fund (TaFF) of the Ministry of Natural Resources and Tourism (MNRT)

Tanzania Forestry Research Institute (TAFORI),
Dar es Salaam – Morogoro Highway,
P.O. Box 1854, Morogoro, Tanzania.
Tel: +255 23 260 4532/4498/3725; Fax: +255 23 260 3725;
E- mail: tafori@tafori.or.tz; Website: www.tafori.or.tz

REMARKS FROM THE BOARD CHAIRMAN

For over 50 years of independence, Tanzania has made attempts of advancing in science and technology. However, the outcomes of these attempts in research and development in forestry have remained relatively low which can partly be attributed to inadequate capacity especially on financial resource for research. Experiences in developed countries indicate that expenditures in research are high, unlike in developing countries where expenditures in research are still low. For the past decade however the importance of forestry research as an important prerequisite for advancing forestry and beekeeping sub-sectors in the country has gained recognition of policy and decision makers at all levels. Despite the immense potential in contributing significantly to Tanzania's economic growth, the contribution of forestry and beekeeping to the GDP is reckoned to be astonishingly low (3 to 4%).

In addition, research information on availability, accessibility and processing technologies is needed to ensure sustainability of forestry-based industries and their contribution to economic growth. it is also crucial that the available information, as a result of research in forestry, reaches stakeholders especially those in policy and decision making positions so that they are well informed and enable them make appropriate decisions leading to focused policies including purposeful guidelines, rules and regulations for the benefits of all. Forestry research must realign its strategies with the national aspirations towards achieving the country's vision 2025 as well as making Tanzania a middle-income earner accompanied by improved livelihoods. This important national quest will be realized through implementation of the industrialization policy and strategies. In this context, TAFORI with the financial support Tanzania Forest Fund (TaFF) organized the first National Scientific Conference as one way of communicating forestry research findings to stakeholders and indicate the potential of forestry research in contributing to attaining sustainable industrial economy in Tanzania.

The conference proceedings generated valuable information on forestry research and wood-based materials for industries in Tanzania including useful recommendations to ensure sustainable supply of forest products. This document will be especially beneficial to forest plantation managers, researchers, trainers, policy makers, Non-Governmental Organisation (NGOs), private forest practitioners, and smallholder and large industries involved in the production and utilization of forest products. Furthermore, the conference built a professional network for learning and sharing knowledge and experiences among researchers and other stakeholders for the benefits of the country.

A conference of this magnitude could not be realized without the tremendous and generous financial support from TaFF; thus the support is gratefully acknowledged. Special note of gratitude goes to the Minister of Natural Resources and Tourism, Honourable Dr. Hamisi A. Kigwangalla (MP) for accepting to be the Chief Guest of the conference. Last but not least, thanks are extended to TAFORI Acting Director General and conference organizing committee who contributed much in preparation of the conference and in the final delivery of the conference proceedings.

Dr. Felician Kilahama
Chairman, TAFORI Board of Directors,
Tanzania Forestry Research Institute,
P.O. Box 1854, Morogoro

OCTOBER, 2018

PREFACE

The 1st TAFORI Scientific Conference on Forestry Research focusing on Sustainable Industrial Economy was held at TAFORI Headquarters, Morogoro on 24th – 25th April 2018. The objective of the conference was to set a platform for forestry stakeholders to discuss the contribution of forestry research to Tanzania industrial economy. This objective is in line with the focus of the 5th phase Government of Tanzania which is **developing industrial economy to meet the Development Vision 2025 goals**. The main theme of the conference was "Forestry Research for Sustainable Industrial Economy". The Conference sub-themes were: Forestry research on solving deforestation and forest degradation; forestry research for propelling industrial economy; Forestry research under climate change scenario; financing forestry research for achievable industrial economy; and coordination and regulation of forestry research in Tanzania.

This was the first conference of its kind that brought together 85 forestry stakeholders from 18 institutions (Annex III). The conference was officially opened by Hon. Dr. Hamisi A. Kigwangalla (MP) the Minister for Natural Resources and Tourism. A key note address was delivered by the Director of Forestry and Beekeeping Division, Dr. Ezekiel E. Mwakalukwa; and 15 papers were presented by different forestry stakeholders (Annex II). The keynote paper addressed the importance of forestry research in ensuring sustainable utilization of forest resources, providing solutions for the challenges in the forestry industries. Other important aspects addressed include innovating modern technologies that will ensure sustainable industrial development, setting standards and prices of forest products. The conference was officially closed by the Director of Forestry and Beekeeping Division, Dr. Ezekiel E. Mwakalukwa.

This document consists of a compilation of all papers and speeches presented during the conference cutting across all the conference themes. The papers presented fall in four categories. The first category (Part A) consists of scientific papers of original quality which were prepared from scientifically primary collected and analysed data by authors. The second category (Part B) is made up of good quality presentations that document best practices, case studies and lessons of experience from various practioners in the forest and energy sub-sectors. The third category (Part C) of this document consists of various speeches which were given during the workshop. The fourth category (Part D) consists of annexes.

The conference drew 22 deliberations addressing issues of forestry research funding, tree planting strategies, wood energy, and the adoption of new technical orders on rotation age of some commercial plantation tree species. Other issues include the actual contribution of forest sector in the Gross Domestic Product (GDP), and efficient wood processing and utilisation technologies (Annex I).

The success of the conference was a result of collective efforts of a large number of individuals. Special thanks should go to Tanzania Forest Fund (TaFF) for funding this Conference without which the Conference would have not been possible. Much appreciation is extended to Dr. Dugushilu Mafunda for being the conference facilitator. Thanks to TAFORI Board of Directors, TAFORI Management and TAFORI Staff for their advice to make this important occasion to happen. I would also like to thank members of the conference organising committee as well as editors of the proceedings for their tireless working spirit.

Dr. Revocatus Petro Mushumbusi
Acting Director General,
Tanzania Forestry Research Institute,
P.O. Box 1854,
Morogoro.

October, 2018

TABLE OF CONTENTS

PART A

SCIENTIFIC PRESENTATIONS

ROTATION AGE AND FIBRE LENGTH OF *PINUS PATULA* AT SAO HILL FOREST PLANTATION, TANZANIA

[*1]Laswai, F., [2]Malimbwi, R.E., [2]Chamshama, S.A.O., [2]Abdallah, J.M., [1]Balama, C., [1]Pima, N.E., [2]Mugasha, W.A. and [2]Mauya, E

[1]Tanzania Forestry Research Institute, P.O. Box 1854, Morogoro
[2] College of Forestry, Wildlife and Tourism, Sokoine University of Agriculture, Morogoro
*Correspondence Author: laswayf@yahoo.co.uk or francis.laswai@tafori.or.tz

ABSTRACT

This study determined the rotation age of *Pinus patula* grown at Sao Hill forest plantation based on growth, yield, wood properties, and economic analysis. Previous Technical Orders on rotation age were not based on these considerations. Growth, yield, wood properties, revenue, and management costs data were collected and analysed using standard procedures. The results indicate that there were fewer and lighter prunings and thinnings than specified in the respective schedules. Many trees were found to have breast height diameter below 40 cm in all compartments except one. Growth and yield results showed that for *P. patula* grown at Sao Hill, the equity point of Mean Annual Increment (MAI) and Current Annual Increment (CAI) were achieved at between 16 and 17 years with the maximum MAI being maintained until about 20 years. Basic density and mechanical properties showed that strong wood was obtained when trees were 16 years and above and these properties increased with age. The mean fibre length for 5 - 25 years old *P. patula* was found to range from 2.29 to 3.53 mm and increased with age. Fibre lengths from 11 years and above exceed the minimum (3 mm) considered suitable for pulp and paper production. Based on economic analysis, net present value (NPV) was attained at between 16 and 17 years. Based on considerations of growth and yield, wood properties and economics of rotation age; *P. patula* from Sao Hill is recommended to be harvested at 18 years for timber and 11 years for pulp and paper production.

Keywords: Rotation age, fibre length, *Pinus patula*, Sao Hill Forest Plantation

INTRODUCTION

Large scale forest plantations based on exotic tree species commenced in various parts of the country in the early 1950s. The objectives of establishing forest plantations were to ensure sustainable supply of forest products to the forest based industries, communities, and to have the supply for export. A total of 19 state owned industrial plantations have been established covering about 95,000 ha (MNRT, 2015). Of the 19 plantations, Sao Hill which was established in 1939 is the largest with a total area of 135,903 ha of which 86,000 ha are good for planting trees. Currently, the planted area in Sao Hill plantation is 56,000 ha while about 30,000 ha are reserved for extension (Management plan, 2017). The main species planted at Sao Hill are *Pinus patula*, *P. elliottii,* and *E. saligna* (Ngaga, 2011).

The management of public sector plantations including Sao Hill is guided by Technical Orders, which have been revised regularly as relevant research information became available. Rotation age for sawn timber has varied since the1950s. In 1956, the first Technical Order for thinning *P. patula, P. radiata, C. lusitanica* and C. *benthamii* was issued and had 6 thinnings and rotation age of 40 years (Forest Department, 1956). In 1962, a revised Technical Order for *P. patula* and *C. lusitanica* was issued. The Technical Order too had

5 thinnings and the rotation ages were reduced to 25 years for site class I, 30 years for site class II, and 35 years for site class III (Forest Division, 1962). The thinning schedule for *P. patula* was revised in 1970 by reducing thinnings from 5 to 4 (Forest Division, 1970) while the rotation ages were retained. In 2003, a Technical Order was issued for Pines, Cypress and *T. grandis* with the rotation age of 25 - 30 years for Pines and Cypress, and 30 - 40 years for Teak (FBD, 2003).

This study reviewed the rotation ages of *Pinus patula* at Sao Hill forest plantation based on growth yield, wood properties, and economic analysis of which in the previous technical orders were not considered.

METHODOLOGY

Study Area

The research was conducted at Sao Hill Forest Plantation (8°15' – 8° 41' S and 35° 6'– 35° 45' E), Iringa Region in the Southern Highlands of Tanzania. The altitude of the study area ranges from 1400 to 2000 m.a.s.l. The area receives annual rainfall ranging from 750 to 2010 mm (**Fig. 1**) falling between November and April, and temperatures range from 15°C to 25°C per annum (MDC, 2006; Ngaga, 2011). The soil is moderately acidic, well drained and of various types mainly dystricnitosols in association with orthicacrisols (Ngegba, 1998; Ngaga, 2011). The plantation is divided into four divisions namely: Division I, II, III and IV with an area of 17,140.13 ha, 10,239.18 ha, 49,480 ha and 23,370 ha respectively (Sao Hill Forest Plantation, 2013).

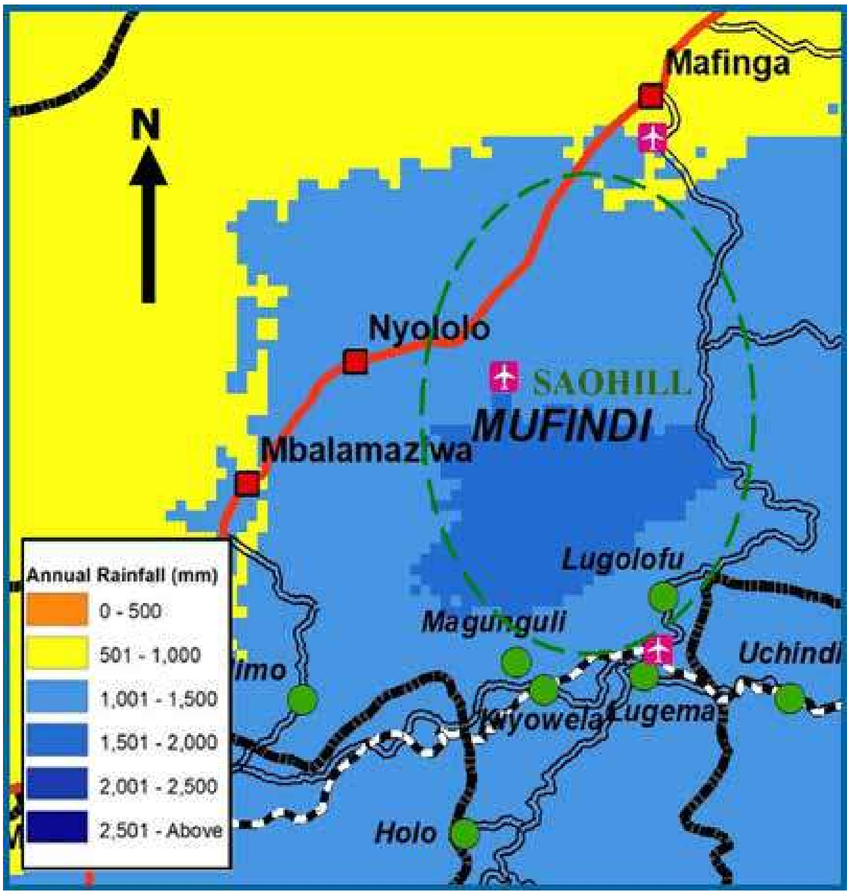


Figure 1: Sketch of Rainfall distribution in some parts of the Sao Hill Forest Plantation
Source: PFP (2017)

Methods

Growth and yield data

The sampling design used was systematic. Data collection was guided by the requirements of different models that needed to be developed before being integrated to a yield model. The data capture for developing the models was carried out in temporary sample plots, 60 - 100 per plantation with circular shape and variable sizes (to contain 15 – 20 trees) distributed to cover site and age variations in the plantation. In each plot, the following measurements were taken: diameter at breast height (Dbh) of all trees, bark thickness, height of the sample trees (intermediate Dbh), and dominant height of 2 to 3 fattest trees per plot. In addition, one dominant tree in each plot with the age of above 15 years old was felled for ring counting. Each tree was cross-cut at an interval of 4 m and annual growth rings were counted at the top end of each log.

Wood utilization properties data

Sampling design was purposive whereby trees which were free from defects and of three sizes were selected for physical, mechanical, and fibre length determination. A total of 252 wood disk samples from trees aged from 5 to 30 years and 132 wood billets from trees aged from 15 – 30 years were collected for physical and fibre length and mechanical properties test sample extraction, respectively in the four forest divisions. Each age was represented by three trees: large, medium, and small sized Dbh. Five cm (width) disks and billets with 120 cm long were cut from the felled trees at Dbh, 25%, 50% and 75% of the total tree height. The wood samples were subjected to air drying before testing.

Physical and Mechanical properties

Physical and mechanical properties were determined using various methods as follows:

Moisture content: Wood samples were weighed green and oven dried at 103 ± 2^0C to constant weight. The weight of each sample was recorded for the determination of moisture content.

Basic density (BD): For each tree, 20 specimens were measured (10 butt, 6 middle, and 4 top). The volume of each specimen was determined by water displacement method. The samples were dried at 103 ± 2°C to constant weight.

Static bending: This was measured using Hounsfield Tensometer machine. In this test, 30 specimens per tree (10 butt, 10 middle, and 10 top) were measured. A specimen measuring 20 x 20 x 300 millimetre (mm) was supported over a span length of 280 mm. The load of the force plate and the corresponding deflection were recorded from the dial gauge manually. Modulus of Elasticity (MOE) and Modulus of Rupture (MOR) were determined.

Impact bending (IB): This was measured using Hatt Turner Machine. A total of 15 specimens per tree were measured (5 butt, 5 middle and 5 top). A hammer with a weight of 1.5 kilogrammes (kg) was released towards a stationary specimen (20 x 20 x 300 mm) at variable distances until the breakage and the height of hammer drop was recorded in cm.

Compression parallel to the grain (CPG): In this test, 30 specimens per tree (10 butt, 10 middle, and 10 top) were measured. CPG was measured using Hounsfield Tensometer machine. Each specimen with the dimensions of 20 x 20 x 60 mm was compressed in the direction of the length of a sample at a constant rate. The force that caused the crushing of the wood was recorded.

Shear strength (SS): A total of 30 specimens per tree (10 butt, 10 middle, and 10 top) were measured for

SS. SS was measured using Hounsfield Tensometer machine. Specimens with dimensions of 20 x 20 x 20 mm were each subjected to a force which tends to force one portion of it to move over the other in the direction parallel to grains using machine. This aimed at measuring the ability of wood to resist the force. The maximum force used in this test was recorded.

Hardness of wood (Hard): A total of 30 specimens per tree (10 butt, 10 middle, and 10 top) were measured for hardness of the wood using Hounsfield Tensometer machine. Specimens with dimensions of 2 x 2 x 4.5 cm were used and whose maximum load which was required to penetrate a steel ball of 1.128 cm to half of its diameter radially, tangentially, or end surfaces of the specimen was determined and recorded.

Fibre length (FL)

A total of 9 specimen splinters measuring 2 x 2 x 10 mm per tree (3 at Dbh, 2 at 25%, 2 at 50% and 2 at 75%) were taken. Splinters were macerated with a 1:1 solution of glacial acetic acid and hydrogen peroxide at about 60°C for a period of 24 hours for cell dissociation. After maceration, pulps were washed with distilled water and then shaken gently in the distilled water until individual fibres of the wood were separated. The macerated fibres were thoroughly mixed and then stained with safranin solution and spread on a glass slide. Thirty straight and unbroken fibres from each sample (equivalent to a total of 270 fibres per tree) were randomly selected for measurement using a projecting microscope to obtain the mean fibre length from each age.

Economic Rotation Age

In order to estimate the net present value (NPV) at the respective age of forest stands, the following were collected: data of growing stock of each site class for each forest plantation (Malimbwi *et al.,* 2016), revenues in Tanzania Shillings per cubic meter (TZS/m^3), and management costs (TZS/ha). It was assumed that only a single product that is timber at rotation age and thinning at 10 and 15 years would be harvested from the forest stands. Interest rates were obtained from literature and commercial bank data.

Data Analysis

Growth and yield data

The analysis of data on growth and yield involved the determination of site index curves model, height-Dbh model, single tree volume model, basal area growth model, stand volume model, mortality model, and simulation of thinning (Malimbwi *et al.,* 2016). These models were eventually integrated into growth and yield models (Malimbwi *et al.,* 2016).

Wood utilisation properties

The determination of fibre length, moisture content, BD, MOE, MOR, HARD, IB, CPG and SS were done using standard procedures as described in the British Standards (1957), ISO (1975) and Franklin Method (Smook, 2003; San *et al.,* 2016). The variations were determined using analysis of variance (ANOVA) procedure to compare means at $p \leq 0.05$.

Economic analysis of rotation age

The average net value was calculated for the period between 10 years and 25 years of age. The standing and thinning volumes were estimated by the present cutting value method (Osavec *et al.,* 2011) and the current annual increment (CAI) and the mean annual increment (MAI) data from Malimbwi *et al.* (2016). Nursery, land preparation, planting, beating up, weeding, pruning, thinning and the like including overheads were used to estimate the costs. These costs were assumed to decrease by 0.05% with an increase in the age of the plantation. This means that young plantations had higher costs than older ones. The net value was calculated by multiplying the average revenue in TZS/m^3 by the attained volume due to the standing trees and thinning. The overall interest rate of commercial banks in Tanzania is around 16% and 14%. Therefore, for the determination of the NPV in this study, an interest of 15% was used.

$$NPV = P \ (B - C).$$

Where: *NPV* = net present value at a discount rate *r* using the discount factor $1/(1+r)^t$, for year *t*,

B = benefits, and

C = costs.

The NPV was estimated for each age. Rotation age was the age with highest NPV.

RESULTS AND DISCUSSION

Spacing, Pruning, and Thinning Operations in the Assessed Compartments

The data for this study were taken from *P. patula* grown at initial spacings of 2.5 x 2.5 m, 2.5 x 3.0 m and 3.0 x 3.0 m. Since 2003, spacing for *P. patula* has been changed to 3.0 x 3.0 m (FBD, 2003). Pruning and thinning are silvicultural operations which are carried out in the plantations to produce knot free timber and utilizable size (40 cm mean Dbh at rotation age) respectively. Knot free timber is expected to fetch a higher price than timber with knots, and which is sufficient to off-set the pruning costs. Pruning and thinning operations in the assessed compartments are shown in **Table 1**. The Table shows that two compartments in Division 1 at the ages of 21 and 22 years received all three prunings while those at the age of 19 years received two prunings. Two compartments of *P. patula* with 15 and 23 years received one pruning (i.e. access pruning). In Division 2, the compartment with trees at the age of 30 years received all three prunings while trees at the ages of 16 and 18 years received one pruning, that is, access pruning only **(Table 1).**

Table 1: Pruning and thinning history for *P. patula* at Sao Hill forest plantation

Division & Compartment	Age (years)	No of prunings	No of thinnings
Division No. 1 (Irundi Sao Hill)			
1 Irundi No.4aii (1/ID/4aii)	23	1 (Access pruning)	1
1 Irundi No.5C (1/R/5C)	21	3	2
1 Irundi No.6F (1/R/6F)	22	3	2
1 Irundi No.8a (1/R/8a)	19	2	2
1 Irundi No.12ai/4 (1/R/12ai/4)	15	1 (Access pruning)	2
Division No. 2 (Kibidula & Matanana Sao Hill)			
2Kibidula No. 2-23 (2KB 2-23)	16	1(Access pruning)	2
2Matanana No. 4-3 (2MT 4-3)	18	1(Access pruning)	1
2Matanana No. 5-9 (2MT 5-9)	30	3	1 Mechanical
Division No. 3 (Ihalimba Sao Hill)			
3Ihalimba No 4-3 (3KL4-3)	25	1(Access pruning)	2
Division No. 4 (Magunguli Sao Hill)			
4Magunguli No. 2 (4MAG2)	20	1 (Access pruning)	1
4Magunguli No. 1-1 (4MAG1-1)	28	1(Access pruning)	2

Thinning operations were found to be fewer and lighter than specified in the respective schedules, resulting in many small diameters stems per ha (SPH) **(Fig. 2 and 3).** Figure 2 shows that all compartments except one had Dbh lower than the recommended 40 cm at the rotation age (Forest Division, 1970). Figure 3 shows further that all compartments except one had higher stocking than recommended in the Technical Order. The main reason given for the neglect of pruning and thinning operations is budgetary constraints. The neglect of both pruning and thinning operations in public sector plantations has been pointed out in previous studies (Chamshama and Nshubemuki, 2011; Nshubemuki *et al.,* 2011). This causes knotty and small diameters trees resulting in poor quality timber, low recovery, and consequently low financial returns.

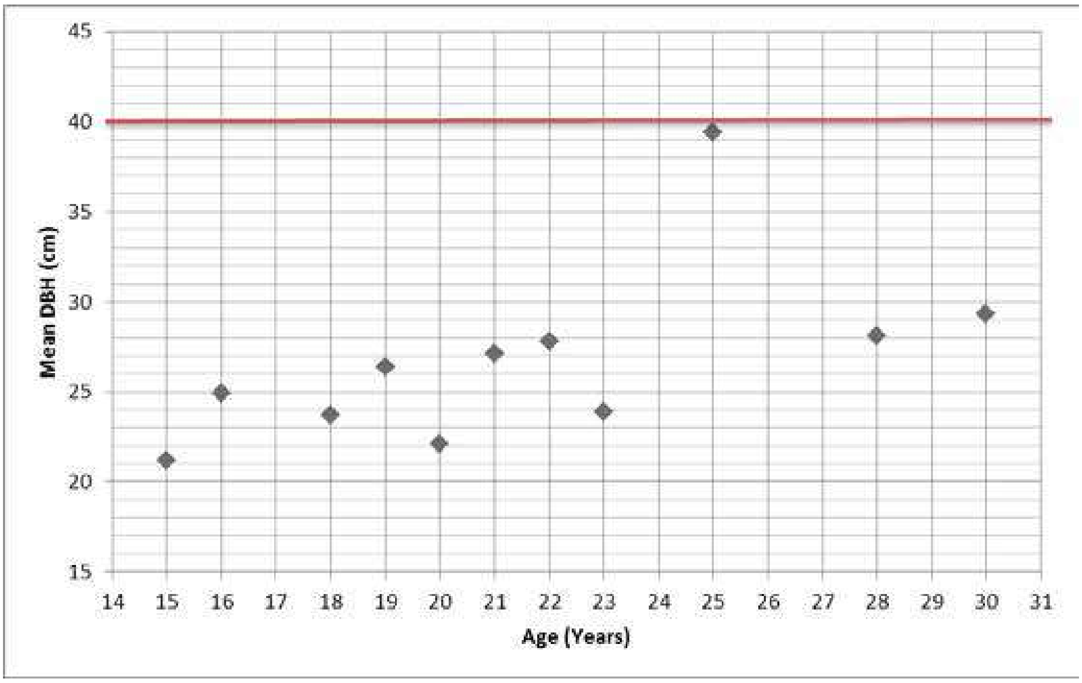


Figure 2: Mean Dbh against age for *P. patula* at Sao Hill Forest Plantation

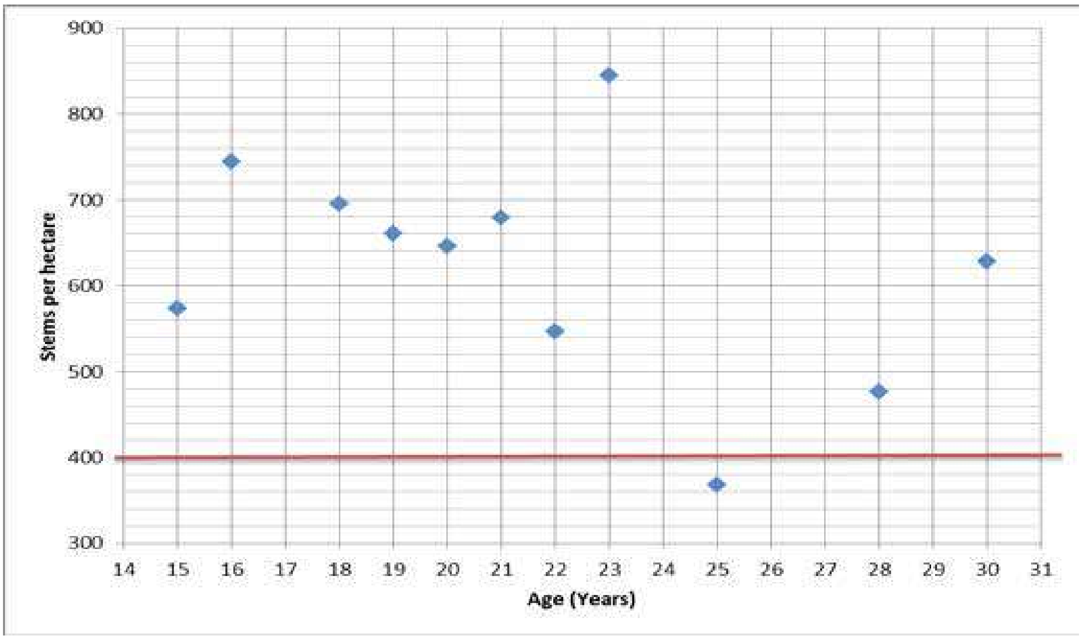


Figure 3: Mean SPH against age for *P. patula* at Sao Hill Forest Plantation

Growth and Yield

The composite models for developing yield tables for *P. patula* were developed as shown in **Table 2.** All the models had good fits with R^2 ranging from 0.75 (Height - Dbh model) to 0. 99 (stand volume model). The site index curves depict height growth driven by age for four site classes for each species **(Fig. 4).** The stand basal area is a function of the surviving number of stems and the dominant height at that particular age. The stand volume is explained by dominant height and stand basal area with almost a perfect fit of R^2 0.99 from the raw data. The integration of these models resulted into the yield tables for *P. patula* (Malimbwi *et al.,* 2016).

Table 2: Composite models for yield table development of *P. patula* in Sao Hill forest plantation

Model name	Equation	R^2	n
Site index curves model	$Hdom = 1.564354 \times site \times (1 - \exp(-0.092288 \times Age))^{1.571869}$	0.95	1130
Height-Dbh model	$height = 1.3 + \frac{dbh^2}{13.63898 + 0.026482 \times \text{dbh}^2}$	0.75	793
Single tree volume model	$vol = \exp(-9.04925 + 1.14781 \times \ln(height) + 1.5496 \times \ln(dbh))$	0.85	154
Basal area growth model	BA = $\exp(-5.2143 + 0.6539 \times \ln(N) + 1.3984 \times \ln(Hdom)$ $\exp(-5.2143 + 0.6539 \times \ln(N) + 1.3984 \times \ln(Hdom))$	0.96	373
Stand volume model	$Stand\ vol = \exp(0.6366 + 1.1176 \times \ln(BA) + 0.4472 \times \ln(Hdom))$	0.99	328
Mortality model	$N2 = 1408 \times exp(-0.0341 \times Age)$		120

Where; Hdom = dominant height (m); dbh = diameter at breast height (cm), site = site index (m); BA = stand basal area M^2/ha); volume = single tree volume (m^3); Volume = stand volume m^3/ha)

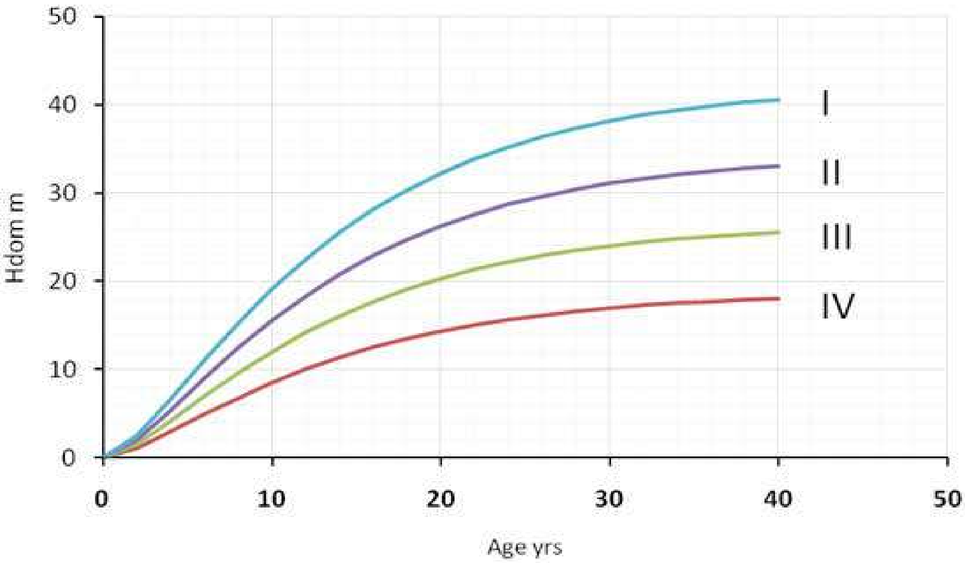


Figure 4: Site index curves for *P. patula* in Sao Hill Forest Plantation

Source: Malimbwi *et al.* (2016)

For a compartment of known age and dominant height, the site class is selected from the site index curves (**Fig. 4**) which in turn indicates the appropriate yield class for forecasting yield from the yield table.

Optimum Rotation Age Based on Growth

Optimal rotation age is the age when volume MAI is at maximum. It is also the age when MAI is equal to volume CAI. The equity point of MAI and CAI was achieved between 16 and 17 years with the maximum MAI being maintained until about 20 years when it starts falling irrespective of the site classes **(Fig. 5).** This could be attributed to improper management of the sites as the yield table assumed the properly managed stands while the empirical data were from improperly managed stands. It is expected that data from properly managed stands would differentiate rotation age by site classes whereby better sites are expected to mature earlier than poorer sites.

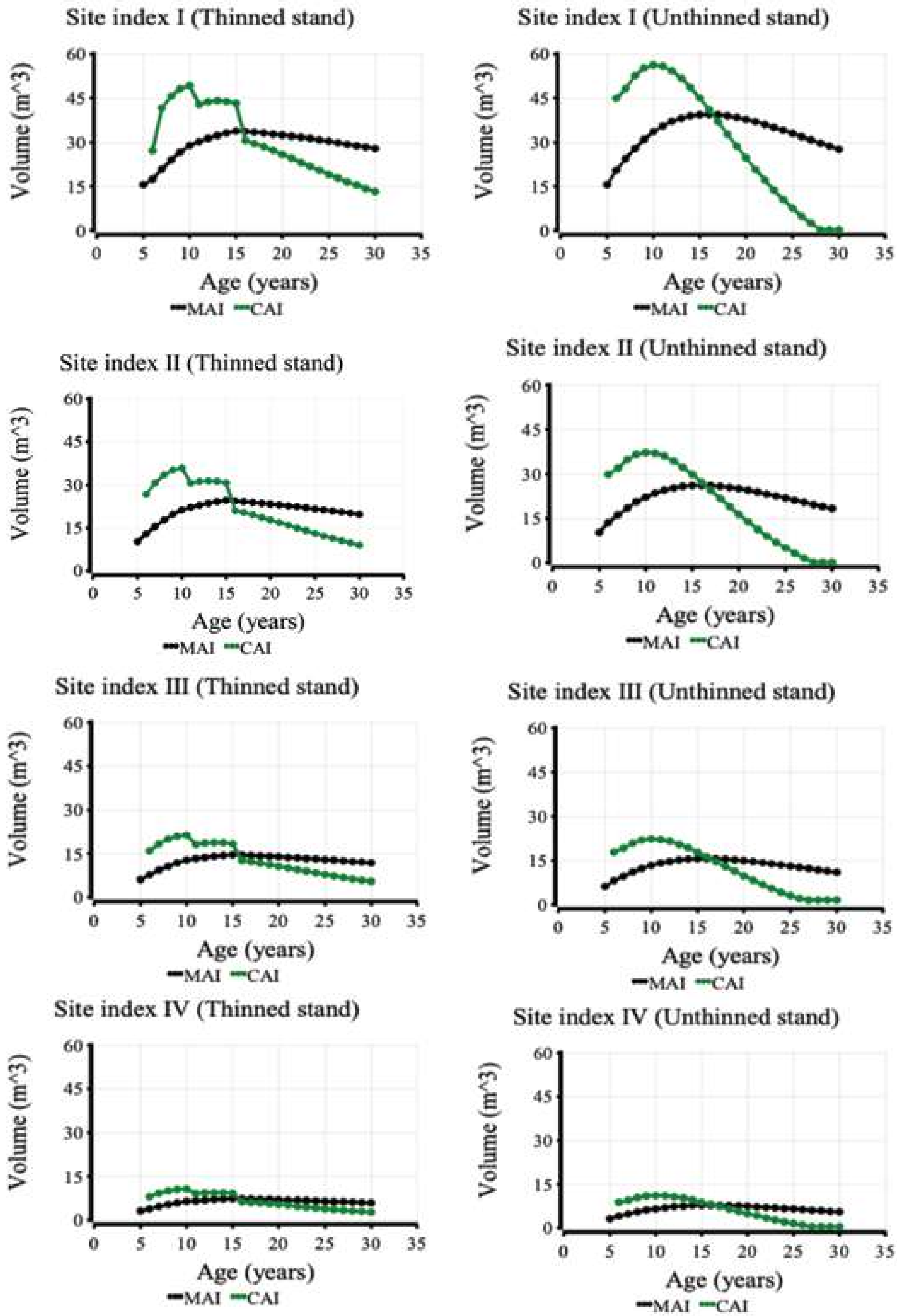


Figure 5: MAI and CAI for thinned and unthinned stands of *P. patula* for different site classes in Sao Hill Forest Plantation

Source: Malimbwi *et al.* (2016)

Taking into account all these observations, the yield studies recommend rotation ages for *P. patula* in Tanzania to be from 18 years of age (Malimbwi, 2016a&b) irrespective of the site class. Earlier rotation age for this species was 25 years. This study therefore shows that the rotation ages of *P. patula* which is grown at Sao Hill forest plantation could be reduced without affecting annual volume growth.

Wood Properties

Basic density of P. Patula

The BD of *P. patula* wood from Sao Hill Forest Plantation ranged from 330.8 to 433.3 kg/m^3 and increased with age from 15 to 19 years and then dropped at years 20 and 21 and increased at year 28, and dropped again when the trees attained 30 years of age **(Table 3).** Based on FAO (2010) standards, wood from *P. patula* harvested from the plantation below 18 years was weak since it had BD which was less or equal to 400 kg/m^3. According to FAO (2010), wood with BD ≥ 401 and ≤ 500 is fairly strong hence *P. patula* can be harvested at age ≥ 18 years.

Table 3: Mean basic density for *P. patula* grown in Sao Hill Forest Plantation

Test Parameter	Age (Years)										
	15	**16**	**18**	**19**	**20**	**21**	**22**	**23**	**25**	**28**	**30**
BD in Kg/m^3	330.8 *(0.06)	355.3 (0.09)	402.7 (0.09)	413.9 (0.07)	404.3 (0.09)	401.5 (0.05)	409.8 (0.07)	412.4 (0.08)	414.3 (0.09)	433.3 (0.11)	407.6 (0.09)

*Values in brackets are the standard deviations

Mechanical properties

The mean strength properties for *P. patula* wood are shown in **Table 4**. The mean strength properties between 18 – 19 and 21 - 25 years old trees did not differ significantly ($p \leq 0.05$), but differed from those of 20 and 28 years ($p \geq 0.05$). The significant differences which were obtained might be contributed by the variety of *P. patula* planted, seed source, soil in the site and climatic condition. Wood from 15 years old tree was weak and that of 16 years was fairly strong. Strong wood was from 18 years and above. The minimum and maximum values for MOE were 7135 and 9567 N/mm^2 respectively, MOR were 53 and 77 N/mm^2 respectively, CPG were 29 and 40 N/mm^2 respectively, impact bending were 42 and 59 cm respectively, hardness were 2085 and 3262 N respectively and then SS were 14.5 and 21.7 N/mm^2 respectively **(Table 4).** The MOE, MOR, CPG and SS obtained in this study are within the values of *P. patula* of 17, 22 and 30 years old from Kenya and 15 and 25 years recorded by Bryce (1967) and revised by Chihongo (1999) but are a little bit higher than that of Kiwira and Kawetire forest plantations which is reported by Laswai *et al.* (2016). The differences seen might have been caused by climatic condition, soils, seed sources, and management practices. The FAO (2010) standards for mechanical properties are usually based on four strength properties namely MOE, MOR, CPG and SS. The minimum values of strength properties for wood to be considered strong are MOE ≥7500N/mm^2; MOR ≥ 20 N/mm^2 and CPG values ≥ 13N/mm^2 (FAO, 2010). Based on these standards, the minimum age for harvesting *P. patula* at Sao Hill should be 18 years.

Table 4: Strength properties of *P. patula* from Sao Hill forest plantation

Test parameter	Age (Years)										
	15	**16**	**18**	**19**	**20**	**21**	**22**	**23**	**25**	**28**	**30**
MOE (N/mm^2)	7135	7605	8568	8466	9567	8574	8549	8564	8446	8959	8638
MOR (N/mm^2)	53	58	67	67	77	65	69	67	60	71	68
Comp (CPG) (N/mm^2)	29.0	34.2	36.2	35.7	40.2	35.1	35.9	35.5	36.7	38.7	35.9
Shear(N/mm^2)	13.7	15.6	16.4	16.9	20.1	16.4	16.6	16.9	16.9	19	17.3
Hardness (N)	2085	2433	2556	2663	3262	2481	2471	2421	2501	3265	2468
Impact bending (cm)	42.9	45.9	56.1	56.4	57.9	56.9	56.6	56.9	57.4	59.4	58.2

Fibre length

Fibre length results for *P. patula* are presented in **Table 5**. They ranged from 0.26 to 6.98 mm and increased with age, with the mean values ranging from 2.29 to 3.53 mm. A rapid increase occurred in the first 10 years. The fibre lengths of the current study are within the values reported for Pine species (Muneri and Balodis, 1998; Shimoyama and Wiecheteck, 1993 in de Almeida *et al.,* 2016; Anoop *et al.,* 2014; Castelo *et al.,* 2008 in de Almeida *et al.,* 2016).

Fibre length generally influences the tearing strength of paper. The greater the fibre length, the higher the tearing resistance is. However, as Zobel and van Buijtenen (1989) reported, cell size has no significant effect on tensile strength of paper. This may also apply to *P. patula* at Sao Hill Forest Plantation.

Based on International Association of Wood Anatomists (IAWA) classification, the fibres of all major softwood species of the world are long. In general, the higher the fibre length of a specific species, the more suitable it is for the production of paper. But researches have shown that the suitability threshold of tracheid fibres for softwood species which is commonly used for papermaking have fibres of approximately 3 mm long with good tear strength. Trees with the age of 11 years and above were found to have fibre with 3 mm and above, and hence *P. patula* of 11 years old at Sao Hill Forest Plantation has fibre length within this range and hence is suitable for paper production.

Table 5: Fibre length of *Pinus patula* from Sao Hill Forest Plantation

Age	Mean	SD	Minimum	Maximum
5	2.29	0.67	1.02	4.86
6	2.47	0.85	0.86	5.56
7	2.52	0.69	0.79	5.55
8	2.62	0.83	0.99	5.31
9	2.63	0.82	1.26	5.90
10	2.81	0.81	0.63	5.78
11	3.17	0.90	0.86	6.80
12	3.15	1.12	0.69	6.57
13	3.16	1.11	0.63	6.53
14	3.33	1.06	1.24	6.54
15	2.84	0.96	0.53	6.73
18	3.44	1.38	0.26	6.85
20	3.53	1.28	0.90	6.98
22	3.07	1.10	1.00	6.83
25	3.46	1.17	0.75	6.89

Economic Analysis of Rotation Age

The costs for the estimation of the rotation age were the average of the silviculture, protection, road maintenance, culverts, bridges, and administration costs of the plantations.

Management costs

The management costs included direct costs (Silviculture and Protection costs) and indirect costs (Maintenance and administrative costs) as indicated in **Table 6.**

Table 6: Management costs estimates (TZS) for *P. patula* grown at Sao Hill Forest Plantation per ha

Age	Nursery costs	Land preparation	Planting	beating Up	Weeding	Pruning	Protection(Patrol, fire line, boundary clearing & fire campaign)
5	1,224,000	153000	153,000	45,900	122,400	122,400	622200
6	1,236,240	154,530	154,530	46,359	123,624	123,624	628,422
7	1,248,602	156,075	156,075	46,823	124,860	124,860	634,706
8	1,261,088	157,636	157,636	47,291	126,109	126,109	641,053
9	1,273,699	159,212	159,212	47,764	127,370	127,370	647,464
10	1,286,436	160,805	160,805	48,241	128,644	128,644	653,938
11	1,299,301	162,413	162,413	48,724	129,930	129,930	660,478
12	1,312,294	164,037	164,037	49,211	131,229	131,229	667,083
13	1,325,417	165,677	165,677	49,703	132,542	132,542	673,753
14	1,338,671	167,334	167,334	50,200	133,867	133,867	680,491
15	1,352,057	169,007	169,007	50,702	135,206	135,206	687,296
16	1,365,578	170,697	170,697	51,209	136,558	136,558	694,169
17	1,379,234	172,404	172,404	51,721	137,923	137,923	701,111
18	1,393,026	174,128	174,128	52,238	139,303	139,303	708,122
19	1,406,956	175,870	175,870	52,761	140,696	140,696	715,203
20	1,421,026	177,628	177,628	53,288	142,103	142,103	722,355
21	1,435,236	179,405	179,405	53,821	143,524	143,524	729,578
22	1,449,589	181,199	181,199	54,360	144,959	144,959	736,874
23	1,464,085	183,011	183,011	54,903	146,408	146,408	744,243
24	1,478,725	184,841	184,841	55,452	147,873	147,873	751,685
25	1,493,513	186,689	186,689	56,007	149,351	149,351	759,202
26	1,508,448	188,556	188,556	56,567	150,845	150,845	766,794

Revenues

Table 7 shows that revenue is dependent on age and volume of the trees. The actual revenues are not segregated by species but the dominant species is *P. patula,* therefore most of the revenues are assumed to be generated from this species. The lowest revenue TZS 15.5 billion was recorded in 2008/2009 and the highest was TZS 36.1 billion which was recorded in year 2015/2016. On average, *P. patula* yielded revenue of TZS 11,896,208.00.

Table 7: Revenues for *P. patula* in Sao Hill Forest Plantation

Age	Volume (m^3)	Total revenue (TZS)
5	51.3	216,794
6	78	329,628
7	108.7	459,366
8	142.3	601,360
9	177.6	750,538
10	155.7	657,988
11	186.3	787,304
12	217.5	919,155
13	249	1,052,274
14	280.3	1,184,548
15	218.2	922,113
16	239.2	1,010,859
17	259.6	1,097,070
18	279.2	1,179,899
19	297.9	1,258,925
20	315.7	1,334,148
21	332.6	1,405,568
22	348.5	1,472,761
23	363.4	1,535,728
24	377.5	1,595,315
25	390.5	1,650,253
26	402.7	1,701,810
27	414.1	1,749,987
28	424.6	1,794,360
29	434.4	1,835,774
30	443.5	1,874,231

Economic Rotation Age Estimation

The estimations of the *P. patula* stand value (clear-felling and thinning) and forest management costs (silvicultural costs and administrative and infrastructure maintenance costs) from **Figure 6**, show that the optimum economic rotation is between 15 and 16 years. The growth data used were for site class II because this is the average site class at Sao Hill Forest Plantation. Therefore, it is economically reasonable to start harvesting *P. patula* stands at 16 years old. This implies that the age of between 16 and 17 years is the growth period that generates maximum value from a stand of timber at Sao Hill Forest Plantation.

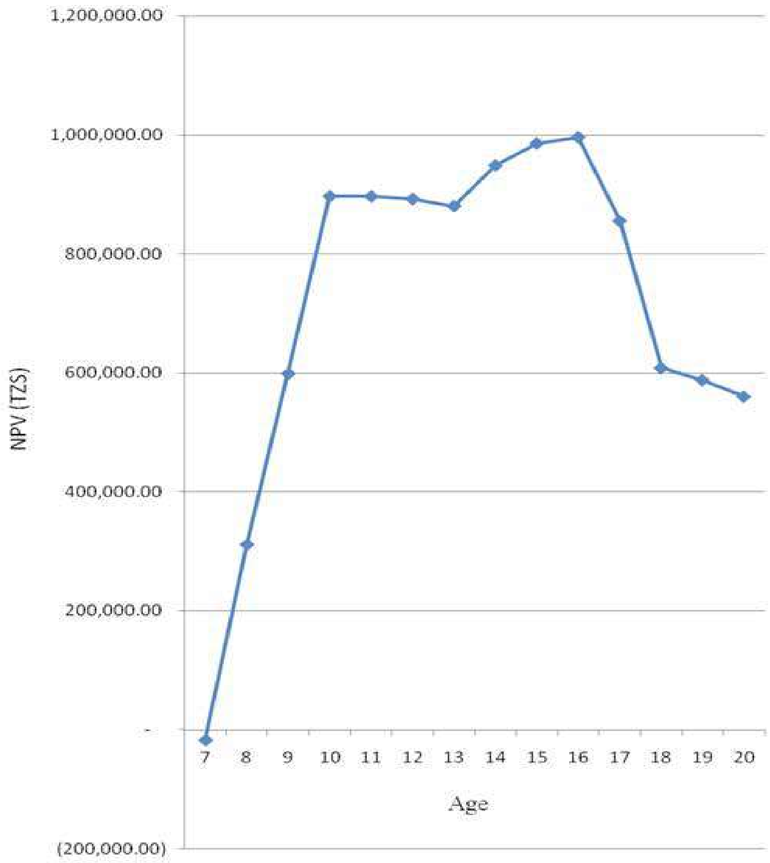


Figure 6: Economic rotation age of *P. patula* at Sao Hill Forest Plantation for site class II

CONCLUSION AND RECOMMENDATIONS

Compartments grown with *P. patula* at Sao Hill forest plantation, received fewer and lighter pruning and thinning operations than specified in the respective schedules, resulting in many small diameter stems. Based on economic analysis, the optimum rotation age for *P. patula* is between 16 and 17 years. Based on growth and yield, wood properties and on economics of rotation age, *P. patula* from Sao Hill forest plantation is recommended to be harvested at 18 years. With proper thinning, trees will attain the recommended mean diameter and thus improve recovery. However, the thinning schedule for *P. patula* needs to be revised taking into consideration the shortening of the rotation age. The test of *P. patula* wood from improved trees is needed once the trees reach 15 years old to see if the rotation age could be reduced further. For commercial purposes, *P. patula* can be harvested at the age from 11 years old for production of pulp and paper and 18 years for timber.

ACKNOWLEDGEMENT

Tanzania Forestry Research Institute (TAFORI) and Sokoine University of Agriculture (SUA) would like to thank Tanzania Forest Services Agency (TFS) for supporting this research. Also TAFORI staffs are thanked for collecting, processing and testing wood samples as well as SUA staff for testing samples of fibre length. Different persons engaged in this research project, especially Plantation and Divisional Managers, are also acknowledged for their assistance.

REFERENCES

Almeida, C.C.F., Rios, P.D., Cunha, A.B., Ampesan, C.G.M, Spanhol, A., Kniess, D.D.C. and Vieira, H.C. 2015. Tracheid morphology of *Cupressus lusitanica* Mill. Wood for pulp production. In: *The Proceedings of 7th International Colloquium on Eucalyptus Pulp*, May 26-29, 2015. Victoria, Espirito Santo, Brazil.

Anoop, E.V., Ajayghosh, V., Nijil, J.M. and Jijeesh, C.M. 2014. Evaluation of pulp wood quality of selected tropical pines raised in the high ranges of Idukki District, Kerala. *Journal of Tropical Agriculture,* 521: 59 – 66.

British standard 373. 1957. *Methods of testing small clear specimens of Timber*. British Standard Institution. London. 27pp.

Bryce, J.M. 1967. *Text book of Commercial Timbers of Tanzania.* Forest Division, Ministry of Agriculture and Cooperatives. 286pp.

Chamshama, S.A.O. and Nshubemuki, L. 2011. Plantation forestry management in Tanzania: Current situation and future focus. In: *The Proceedings of the Workshop on Insect Pests, Diseases and Soil Problems in Forest Plantations*. (Nshubemuki *et al*. Eds.), TAFORI/SUA. pp. 45-75.

Chihongo, A.W. 2003. *Text book of commercial Timbers of Tanzania.* Revised Version, Third Edition. Tanzania Forestry Research Institute, Morogoro, Tanzania. 315pp.

de Almeida, C.C.F., Rios, P.D., da Cunha, A.B., Ampessan, C.G.M. and Spanhol, A. 2016. Applicability evaluation of *Cupressus lusitanica* for pulp production. Maderas. *Ciencia y tecnología,* 184: 651 - 662,

FAO. 2010. Wood density classification. www.fao.org/docrep/015/i2433/i2433e02.

FBD. 2003. *Technical Specifications for Management of Forest Plantations in Tanzania.* Forestry and Beekeeping Division, Ministry of Natural Resources and Tourism. Dar es Salaam, Tanzania. 8pp.

Ferriera, A.L., Severo, E.T.D. and Calonego, F.W. 2011. Determination of fiber length and juvenile and mature wood zones from Hevea brasiliensis trees grown in Brazil. *Europen Journal of Wood Production*, 69: 659–662

Forest Department. 1956. *Thinning schedules*. Forest Department Technical Order No. 1 of 1956 Forest Department, Ministry of Lands, Forests and Wildlife, Morogoro. 4pp.

Forest Division. 1962. *Pruning and Thinning Schedules Cancelling T.O.S. 1 and 2 of 1956*. Forest Department Technical Order No. 17 of 1962. Forest Department, Ministry of Lands, Forests and Wildlife, Dar- es- Salaam. 6pp.

Forest Division. 1970. *Omission of first thinning in pines*. Technical Order No. 24, Forest Division, Dar es Salaam. 5pp.

Hyytiainen, K. 1992. *Forest Management Plan for Longuza Teak Plantation*. Technical Paper No. 2. FBD/Forest and Park Services. 102pp.

ISO 3133. 1975. *Wood Determination of Ultimate Strength in Static Bending*. First edition. UDC 674.03.539.384. Switzerland.

Laswai, F., Malimbwi, R.E., Chamshama, S.A.O. and Abdallah, J.M. 2016. Determination of Rotation age of *Pinus patula* and *Tectona grandis* in some public sector Forest plantations, Tanzania. *Journal of Tanzania Association of Foresters.*

Malimbwi, R.E., Mugasha, W.A. and Mauya, E. 2016. *Pinus patula* Yield Tables for Sao Hill Forest Plantations, Tanzania. Department of Forest Resources Assessment and Management, College of Forestry, Wildlife and Tourism, Sokoine University of Agriculture.

Malimbwi, R.E. 2016a. *Development of yield tables for seven Tanzania Forest Service Agency forest plantations in Tanzania*. Yield tables for *Pinus Patula* Forest plantations. Report. Department of Forest Resources Assessment& Management, Sokoine University of Agriculture. 40pp.

Malimbwi, R.E. 2016b. *Development of yield tables for seven Tanzania Forest Service Agency forest plantations in Tanzania*. Yield tables for *Tectona grandis* forest plantations. Report. Department of Forest Resources Assessment& Management, Sokoine University of Agriculture. 38pp.

MNRT. 2015. *Budget Speech for 2015/2016*. Ministry of Natural Resources and Tourism, Dar Es Salaam. 16pp.

Mtuy, M.C.P. 1996. *Forest Plantation Management in Tanzania: Past, Present and Future*. Faculty of Forestry, Sokoine University of Agriculture. Record No. 63: 4-6.

Muneri, A. and Balodis, V. 1998. Variation in wood density and tracheid length in *Pinus patula* grown in Zimbabwe. *South African Forestry Journal,* 182: 41 - 50

Ngaga, Y.M. 2011. *An analytical study of public forest plantations in Tanzania*. African Forest Forum, Nairobi, Kenya. 112pp.

Nshubemuki, L., Chamshama, S.A.O. and Mugasha, A.G. 2001. *Technical Specifications on Management of Forest Plantations in Tanzania*. Forestry and Beekeeping Division. Ministry of Natural Resources and Tourism, Dar es Salaam. 50pp.

Osavec, S., Beljan, K., Krajter, S. and Peršun, D. 2011. Calculation of Economic Rotation Period for Even-Aged Stand in Croatia. *South-east Eur. For.* 22: 109-113

SAS. 2000. *SAS Version 8*. SAS Institute Inc., Cary, N. C, USA. 1028pp.

Zobel, B. J. and Van Buijtenen, J. P. 1989. *Wood Variation: Its Causes and Control*. Springer Verlag, New York. 363pp.

AVAILABILITY OF FOREST PRODUCTS TO SUPPORT INDUSTRIES IN TANZANIA: CHALLENGES AND OPPORTUNITIES

Kilongo, M.

Tanzania Forest Services (TFS) Agency
P.O. Box 40832, Dar es Salaam
Corresponding author email: makilongo@yahoo.com

ABSTRACT

Primary forest based industries in the country play a major role in the conversion of forest products into various end uses. The current study was conducted to assess demand and supply of raw materials, the means of allocating raw materials, the challenges and opportunities of the availability and production of raw materials for forest industries. The study was conducted in Tanzania mainland covering seven zones and 23 forest plantations under TFS jurisdiction. Structured questionnaire were used for data collection. The data were then coded, compiled, and analysed using SPSS and Ms excel. The results indicate that primary wood based industries were either active (44%) or inactive (45%) with small proportions (11%) being dormant and their actual installed, annual wood demand and utilized capacities were 2,541,918 m^3, 1,559,332 m^3 and 554,752 m^3 respectively. The finding revealed that the total annual wood allocated for all primary wood based industries increases yearly due to the growing market demand of wood for construction purpose or other development activities. The finding revealed further that the increasing demand of industrial round wood created a lot of challenges that affected day-to-day operations. Example of such challenges include political leaders banning harvesting of forest products. Finally, there is existing potential for government, individual, private or community for expanding areas for establishment of new forest plantations in order to increase supply of raw wood material for wood based industries.

Key word: Wood based industries, Forest industries, Availability of wood, Opportunities and Challenges

INTRODUCTION

Tanzania covers an area of about 945,000 km^2 out of which 888,600 km^2 (94%) is land. According to the recent National Forestry Resources Monitoring and Assessment (NAFORMA, 2015) report, the growing stock based on the vegetation cover types is categorized into woodlands (73.9%), forests (11.3%), cultivated lands (7.8%), bush lands (4.2%), grasslands (1.4%), water (0.3%) and others (1.0%) (MNRT, 2015). The total wood volume of Tanzania mainland is 3.3 billion m^3, whereby 97% comes from trees of natural origin and only 3% comes from planted trees. The average wood volume is 37.9 m^3/ha across all land cover types, varying from 1 m^3/ha in open grasslands to 171 m^3/ha in humid montane forests. The standing volume of wood per capita is 74.4m^3 (NAFORMA 2015).

Forest products provide an income for small holder rural communities in the tropics, and contribute significantly to their well-being (Bryon and Arnold 1999, Reyes- Garcia *et al.,* 2015). Primary forest based industries in the country play a major role in conversion of forest products into various end uses. Many private companies and individuals have invested in the production facilities, which use raw materials from the forest resource in both the natural and plantation forests (Ngaga, 2011). The major conversion from forest based industries is focused on the production of sawn timber, poles, fibreboards, chipboards, plywood, pulp and paper manufacturing. These industries play a significant contribution in the utilization of forest products in terms of value addition and employment creation. It is in this regard that in 2012, the Tanzania Government issued a Circular No .1 of Public Service Furniture that banned the importation of furniture, which is used in public offices with the aim of ensuring value for money and empowerment of forest industries in the country. Tanzania Forest Services Agency (TFS) is strategizing to enhance the contribution of forest sector to the Gross Domestic Product (GDP), increase export earnings and share of the total employment as stipulated in the Five Years Development Plan II (FYDP II) ending in 2019.

Despite the importance of forests in the country; high deforestation and forest degradation rates have been witnessed taking place in both reserved and unreserved forests. Forests in general lands have no properly defined management regime, they also have open access hence facing severe deforestation and forest degradation which results in dynamics of forest cover (Kajembe and Mwihomeke, 2001). According to a study by the National Carbon Monitoring Centre (NCMC, 2018); the annual rate of forest loss is estimated at 469,420 ha per year. NAFORMA report (URT, 2015) revealed that widespread deforestation and forest degradation results into multiplier negative impacts all the way to the forest based industries. The loss is contributed by, among other factors, the growing demand for land for agriculture, encroachment, uncontrolled wildfires and illegal harvesting (Ngaga, 2011). It was estimated that by 2017, there would be a significant drop in wood supply from government forest plantations and natural forests because of a decline in harvesting levels at Sao Hill Forest Plantation (Mwamakibullah, 2016).

The construction industry which includes residential and development projects consumes about 62% of the total 1.46 million m^3 of sawn wood produced annually in Tanzania (Indufor, 2010). Despite the contribution of forest industries to the national economy growth via taxes and fees, and its crucial role of improving livelihoods of the local communities, there are still research gaps on the availability of forest products to support these industries and the associated challenges and opportunities. Also unreliable information on the increase in public and private forest plantations creates difficult in securing enough wood raw materials. This has, in turn, created uncertainty for long term investments (Ngaga, 2011). It is against this background that a study to determine the availability of forest products to support industries in Tanzania was carried out. Specifically, the study assessed the demand and supply of forest products to support industries, determined the means of allocating forest products to the existing primary wood industries, identified challenges on the availability of forest products in supporting industries, and assessed the opportunities for the production of forest products to support forest industries.

METHODOLOGY

Study Area

The study area involved (**Fig. 1**) seven TFS administrative zones (Southern Zone (SZ), Southern Highland Zone (SHZ), Northern Zone (NZ), Eastern Zone (EZ), Western Zone (WZ), Central Zone (CZ) and the Lake Zone (LZ)) and 23 forest plantations under TFS jurisdiction. Tanzania is located between Latitude 1° and 12° South and Longitude 29° and 41° East (URT, 2012). The total area of the country is 945,000 km^2 of which 881,000 km^2 are on the mainland and 2,000 km^2 are on the islands of Zanzibar (URT, 2007). The country shares boarders with Kenya and Uganda to the Northern part, Rwanda, Burundi and the Democratic Republic of Congo to the Western part; Zambia, Malawi and Mozambique to the Southern part, and the Indian ocean to the Eastern part (URT, 2007).

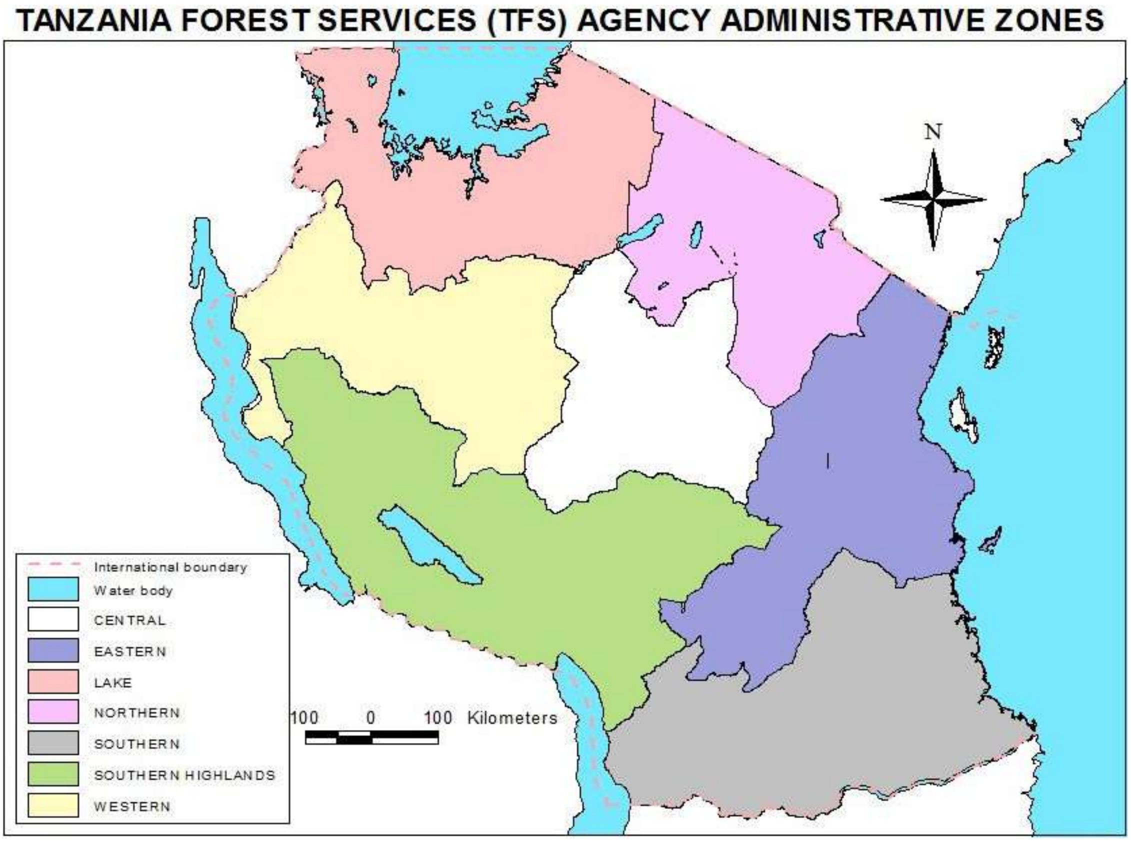


Figure 1: Location of the study area

Source: URT (2012)

Data Collection and Analysis

Primary data were collected via structured questionnaire that included closed and open ended questions. Secondary data were collected through desk work and review of TFS documents and other relevant documents. Participant observation was done where the researcher had the opportunity of comparing what the respondents reported against what were really observed in primary wood based industries. The information collected was coded and the data were compiled and analysed using Statistical Package for Social Sciences (SPSS) and Ms excel. For questionnaire data, descriptive statistics (such as frequencies and percentages) was used to summarize the data and correlation was used to compare the availability of forest products to support primary wood based industries.

RESULTS AND DISCUSSION

Demand and Supply of Forest Products to Support Forest Based Industries

The finding revealed that there are about 630 primary wood based industries in the country which include: 609 sawmills, 9 wood based panels industries, 9 pole treatment, 2 wattle extracts, and 1 sandalwood oil and spent dust **(Table 1).** Most of the surveyed primary wood based industries were either active (44%) or inactive (were not in operation during the survey time) (45%) with small proportions (11%) being dormant (were closed). In terms of size, majority of the primary wood based industries were categorized as small (75%) followed by medium and large in small proportions. There is a decreasing trend of primary wood based industries from small to large category, with small change of many of the small industries shifting from small to medium in the Southern Highlands Zone (SHZ). The survey revealed further that the total installed, annual wood demands and utilized capacities of all primary wood based industries were

4,321,893 m³, 2,542,614 m³ and 703,495 m³ respectively. However, on the basis of the active primary wood based industries the actual installed, annual wood demand and utilized capacities were 2,541,918 m³, 1,559,332 m³ and 554,752 m³ respectively.

From the survey, the actual annual hardwood and soft wood demands by active primary wood based industries were 487,722 m³ and 1,072,610 m³, respectively. The *Tectona grandis* and *Eucalyptus* spp account for 57% of the annual hardwood demanded by active primary wood based industries.

Table 1: Distribution of Forests industries in Tanzania

Industry type	Total	%	Distribution of forest industries in TFS Zones					
			NZ	SHZ	WZ	EZ	LZ	SZ
Sawmills	609	96.67	269	143	74	26	83	14
Wood based panels	9	1.43	3	5	0	1	0	0
Pole treatment	9	1.43	2	7	0	0	0	0
Wattle extracts	2	0.31	1	1	00	0	0	0
Sandalwood oil & Spent dust	1	0.16	1	0		0	0	0
Total	**630**	**100**	**276**	**156**	**74**	**27**	**83**	**14**

However, there is only 1,369,260 m³ (848,933 m³) from plantations and 520,327 m³ from Natural Forests for harvesting at a sustainable level per year from the central Government forest reserves (Natural Forests and Plantation) (TFS, 2018) **(Tables 2a and 2b).** The value from the plantations is slightly higher than the value reported by FAO (2014) of 1,034,765 m³ per year from Industrial round wood production plantation in Tanzania. The consumption exceeds the sustainable supply causing an annual wood deficit of 191,072 m³ to the primary wood based industries. Since the annual growth of the natural vegetation types is low compared to plantations, the deficit might be covered illegally from strictly "protected areas" for example the national parks, game reserves, and nature reserves or exceeding the permitted harvesting levels causing huge damage to natural forests.

Table 2a: List of Forest plantations with allowable cut volumes

No	Name of forest plantation	Allowable cut volume 2017/18	Harvested volume up to March, 2018	Allocated volume for harvesting 2018/2019
1	Buhindi	31,218.32	21,546.32	51,070.00
2	Sao Hill	651,475.00	403,905.00	610,000.00
3	Kiwira	28,500.00	18,894.30	25,500.00
4	Kawetire	15,414.00	6,056.62	11,086.00
5	Shume	37,509.90	23,127.00	31,489.00
6	West Kilimanjaro	20,000.00	13,335.35	30,619.00
7	North Kilimanjaro	33,000.00	25,740.29	30,000.00
8	Longuza	11,000.00	6,813.03	11,000.00
9	Mtibwa	10,000.00	9,014.10	10,469.00
10	Rubya	2,800.00	2,658.44	12,000.00
11	Meru	23,800.00	14,545.443	19,700.00
12	Rubare			6,000.00
Grand total		**864,717.22**	**545,635.90 (63%)**	**848,933.00**

Table 2b: List of production forest reserves and their annual allowable cut volumes

SN	Name of Forest reserve	Allowable cut volume (According to management plans)	Actual volume to be harvested (only 10%) for 2018/2018
1	Inyonga	343,255	34,326
2	Uvinza	27,091	2,709
3	Nyahua Mbuga	1,418,570	141,857
4	Ugalla North	1,319,106	131,911
5	Msaginia	22,848	2,285
6	North East Mpanda	209,007	20,901
7	Mlele Hills	173,504	17,350
8	Ugalla river	155,515	15,552
9	Mpanda line	116,882	11,688
10	Uyui Kigwa Rubaga	39,539	3,954
11	Rungwa river	161,495	16,150
12	Mitarure	25,457	2,546
13	Ndechela	1,574	158
14	Nyera Kipelele	14,364	144
15	Pindiro	205,273	20,527
16	Mitundu Mbeya	296,644	29,664
17	Mbinga maji	39,245	3,925
18	Ngarama south	52,877	5,288
19	Muhuwesi	46,694	4,669
20	Rungo	2,429	243
21	Kitope	647	65
22	Matapwa	6,090	609
23	Matogoro B	10	0
24	Kipembawe	538,064	53,806
Total		**5,216,181**	**520,327.00**

Similar observations were made by Frontier-Tanzania, (2005), Malimbwi *et al.* (2005), Forestry and Beekeeping Division, (2005) who assessed different forests conditions in the country and revealed a lot of anthropogenic activities inside forest reserves including encroachment (for agriculture), illegal activities such as mining, pit-sawing, harvesting for building materials, firewood collection, and collection of medicinal plants. Therefore, there is a high potential for TFS, the private forestry sector, local authority, communities, and individual of using this opportunity of wood demand for the expansion of forest plantations and establishment of new forests in order to address these challenges.

Allocation of Forest Products to the Existing Primary Wood Based Industries

The survey revealed that the total annual wood allocated for all primary wood based industries in 2018/2019 was 848,933 m^3 from plantations and 520,327 m^3 from Natural Forests in the government plantation allocation trends since 1992 (**Fig. 2**). Furthermore, the finding revealed that the annual hardwood and soft wood demands in for the smooth running of active primary wood based industries were 487,722 m^3 and 1,072,610 m^3, respectively. The amount of soft wood allocated seems to be lower than the market demand, creating the opportunity for the importation of soft wood or expansion of softwood tree planting areas in forest plantations.

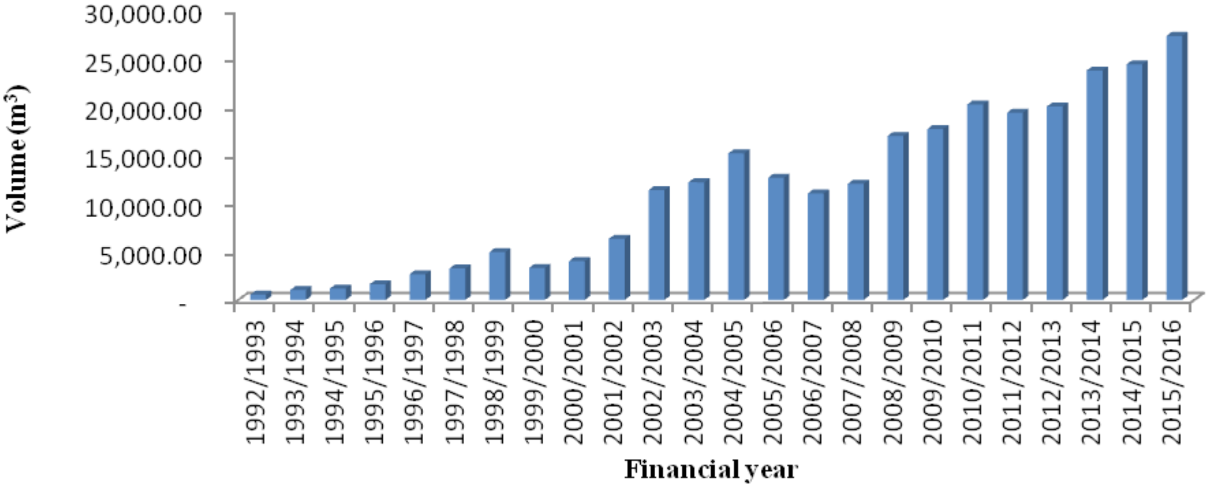


Figure 2: Available wood volume from Government plantations - trends From 1992/1993 - 2015/2016 financial years

The utilized capacity of primary wood based industries is lower than the annual wood demand by particular firms (**Table 3**).

Table 3: Wood product requirement from Plantation and Natural Forests

Activeness of the PWBI	Total volume per year (m^3)		
	Installed capacity	Annual wood demands	Utilizing capacity (m^3)
Active PWBI	2,541,918	1,559,332	554,752
Inactive PWBI	4,321,893	2,542,614	703,495

Figure 2 shows that, there was a gradual increase of allocated volume from government plantations due to the growing market demand of wood in Tanzania. For example in year 2001/2002, the allocated volume was almost double that of the previous year (2000/2001). At the same time from year 2007/2008 to 2014/2015, the volume was almost doubled. With this increasing market demand for wood and a decline in the harvesting levels at Sao Hill Forest Plantation and other government plantations due to underage, more than 50% of industrial round wood will be supplied by private plantations. Similar observations are reported by ICPF (2013) and Mwamakibullah (2016). Furthermore, Mwamakibullah (2016) predicts a significant drop in wood supply from government forest plantations and natural forests because of a decline in the harvesting levels at Sao Hill Forest Plantation by 2025 which is the major supplier of wood in the country, but who unfortunately has more than 50% of the planted area as underage.

Challenges on Availability of Forest Products to Support Forest Industries

National governments, civil society groups, the private sector and local communities have been looking for alternative ways of supplying industrial round wood. The increasing internal demand for raw material and for exportation had created a lot of challenges such as political influence in the forestry sector and that had affected some day-to-day operations, good examples include cases where some politicians ban the harvesting of forest products. Furthermore, some district councils use revenue collection agents a situation that lead to law violations as they do not adhere to legal requirements or procedures such as charging minimum fines. Poor compliance and weak law enforcement on the trade of forest products prompt over-exploitation and acceleration of forest degradation despite the presence of forest act that cuts across both Central and Local Government forests. The presence of parallel government structures in the management of forests at the Ministry of Natural Resources and Tourism (MNRT) and at the President's Office - Regional

Administration and Local Government (PO - RALG) increased the management challenges leading to a decrease in the availability of round wood in a sustainable manner at a district level. Due to this deficit of industrial round wood security staff/forest guard, stationed at checkpoints or inside the natural Forest Reserves and those engaged in patrols and evictions were put at risk situation during the discharge of their daily duties. Therefore, balancing the pressing needs of the present generation in primary wood industries and other uses with the needs of the future generations is a huge task and requires adequate political priority and resources.

Opportunities for Production of Forest Products in Supporting Forest Industries

Forest wood based industries growth closely depends on the synergies between raw materials from the forest, new knowledge/technology of processing and which have made major advances in technological wood product quality and human capital. Tanzania is implementing the second series of Five Year Development Plans for 2025 which aim at transforming Tanzania into a middle-income country by 2025 (URT, 2011). The effective supply of raw material from forests (both timber and none timber) will ensure business growth, employment creation, income generation and ultimate improvement of wellbeing in the urban and in the rural areas. These can be done through the expansion of tree planting areas in forest plantations and the establishment of bee reserves and apiaries in the zones, upgrading of forest reserves to the natural forest reserves, development of ecotourism sites, and the enhancement of in-situ conservation and rehabilitation of degraded areas. The expansion and the establishment of new forest plantations in different areas with favourable growing conditions would lead to the diversifying and an increase of the supply of raw material for wood based industries.

CONCLUSION AND RECOMMENDATIONS

Forest resources provide considerable social and economic potential, unique natural ecosystems rich in biological diversity and wildlife habitats. They also provide numerous goods and services both in the national economy and to the society at large. Therefore, in order to have a sustainable development of wood industries in the country, we must devote more effort on the commercial industrial plantations.

REFERENCE

Evans, J. 2009. Planted forests: uses, impacts and sustainability. Rome, Italy. FAO and CAB International. Available at: http://www.fao.org/forestry/24489-0e54aef5c0bee7238cf5ebd97931a4bb7.pdf.

FBD. 2005. Evaluation of sawmills and other primary wood industries in Tanzania. Forest and Beekeeping Division, Ministry of Natural Resources and Tourism.

ICPF. 2013. Planted forests are a vital resource for future green economies. Summary report of the 3rd International Congress on Planted Forests. Available at: http://www.fao.org/forestry/37902083cc16479b4b28d8d4873338b79bef41.pdf

Jürgensen, C., Kollert, W., Lebedy, A. 2014. FAO 2014: Assessment of industrial round wood production from planted forests.44p: Planted Forests and Trees Working Paper Series Working Paper No.48

Kajembe, G.C., and Mwihomeka, S.T. 2001. *The role of local knowledge and practices in the management of natural resources of the Miombo woodlands.* Consultancy Report. Participatory Management of Natural Resources, Ministry of Natural Resources and Tourism, Dar es Salaam, Tanzania. 74pp.

Kaoneka, A.R.S. 1990. Measures to contain the problem of encroachment in natural forests. Proceeding of Joint seminar/workshop on 'Management of Natural forests of Tanzania' Sokoine University of Agriculture and Agricultural University of Norway. Olmotonyi. Arusha. Tanzania 5–10th Dec. 1988.

Malimbwi, R.E., Zahabu, E. and Monela, G.C. 2005. Charcoal potential of Miombo woodlands at Kitulangalo, Tanzania. *Journal of Tropical Forests Science*, 17: 197-210.

MLHHSD. 2013. Ministry of Lands, Housing and Human Settlements Development 2013: Ramani na Vipimo "Maeneo ya Nchi" paper.

Mwamakimbullah, R. 2016. Private forestry sector in Tanzania: Status and Potential. AFF Report. African Forest Forum, Nairobi.

Ngaga, Y.M. 2011. Forest Plantation and Woodlots in Tanzania. *African Forest Forum Working Paper Series*1:16. 79-80pp.

TFS. 2018. Annual Business Plans (For 2015/16, 2016/2017, 2017/18 & 2018/2019).

TFS. 2014. Three years Implementation Report for the Financial Year 2011/12- 2013/2014.

UNIDO. 2013. *"Sustaining Employment Growth: The Role of manufacturing and Structural Change*", United Nations Industrial Development Organisation Vienna International Centre P.O. Box 3001400 Vienna, Austria.

URT. 2012. *Population and Housing Census.* National Bureau of Statistics, Dar es Salaam, Tanzania. 264pp.

URT. 2015. National forest resources monitoring and assessment of Tanzania mainland (NAFORMA): Main Results. Ministry of Natural Resources and Tourism.

URT. 2011. *Integrated Industrial Development Strategy 2025* "A strategy Report prepared by the Ministry of Industry and Trade Dar es Salaam, Tanzania.

ECONOMIC VALUE OF IMPORTED WOOD BASED PRODUCTS IN TANZANIA

***Abdallah, J.M. and Masaka, K.**

Department of Forest and Environmental Economics
Box 3011 Chuo Kikuu Morogoro, Tanzania
Tel: 0787255301 or 0655255301
*Corresponding author email: abdallah@suanet.ac.tz

ABSTRACT

The Government emphasizes a new direction for the country's economy. It commits her resources to inclusive economic growth through industrialization. This means that more investment on wood processing industries is required. Information on economic value of imported wood based products is important to inform development policies in Tanzania. Therefore, the overarching aim of this study was to provide insight into the values of wood based products import streams to Tanzania by focusing on the types of wood products imported, their values, and countries of origin; and to recommend investment opportunities to reduce the balance of trade. Methods used were literature review, and the collection of export and import statistics of between 2007 and 2018 from Tanzania Revenue Authority (TRA) Headquarters in Dar es Salaam. The Common External Tariff 2012 Version was used to filter codes of the sections and heads referring wood based products before formal request was made to the TRA Headquarters on the relevant codes. The data were analyzed mainly using Excel software. The results show that wood products which have been imported to Tanzania since 2007 exhibited a volatile trend. There was an increase in the imports of wood based products between year 2007 and 2013, while a high-pitched increase (by about 87%) was between 2013 and 2015, followed by a steady decrease between 2015 and 2017. Wood Based products (poles) treated with paint, stains, creosote or other preservatives were the main products that had the highest value (TZS 27.7 billion in 2014) compared to other products imported between 2007 and 2018. Some of the products imported include clothes' hangers, wood charcoal, and fuel wood, in logs, billets, twigs, faggots or similar forms. It is possible to save the foreign money spent to import some of these products by investing in industries in Tanzania to produce them locally.

Key words: Imports, Wood based products, Balance of trade, Tanzania

INTRODUCTION

The Tanzanian government is implementing various measures to strengthen fiscal management. Therefore, each sector is making efforts to deliver a substantial contribution to the new country's initiatives. The manufacturing sector, among others, is at the central focus of the new approaches suggested by the country. The present Government aims at stabilizing the economic capacity of the country through sustainable utilization of our readily available resources and enable industrial opportunities in country.

However, Tanzania's economic growth is relatively high, it has not yet accelerated job creation. Poverty remains substantial in Tanzania with around 12 million Tanzanians still under the poverty line. At the same time, about 800,000 young Tanzanians enter the job market every year (World Bank Group, 2014) where productive opportunities including wood industries are poorly exploited.

The Government emphasizes on a new direction for the economy. It is prioritizing the industrialization where most of the resources are required to be processed at various nodes along the value chain to ensure economic growth. This means that more industries are required to process and manufacture products of various forms and origins (World Bank Group, 2014). The industrial products are supposed to increase competitiveness of Tanzania in the domestic, regional (East Africa Community Common Markets and the Southern African Development Community (SADC)), and in the global markets (URT, 2010).

This paper aims at analyzing the contribution of wood based products towards the economy of Tanzania. Much attention in literatures on wood based products in Tanzania is mainly paid on export and domestic products and trade. However given the country's current state of affairs, information on economic value of imported wood based products is important in informing policies including those on development of relevant industries in Tanzania.

Wood product demand is driven largely by the construction, furniture and paper activities. Other sectors using wood are power transmission (using eucalyptus poles) and the transport sector consuming wood in the form of pallets and packaging materials such as boxes. Specifically, this paper provides insights into values of wood based products import streams to Tanzania by focusing on the types of the products imported, the values of the products, and countries of origin; and recommends investment opportunities to reduce the trade deficit on wood based products.

METHODOLOGY

The main methods used were literature review, and the collection of export and import statistics from Tanzania Revenue Authority (TRA) Headquarter in Dar es Salaam. Export and import data from year 2007 to 2018 on wood based products were also collected. The Common External Tariff 2012 Version was used to filter codes of sections and heads referring wood based products before formal request was made to the TRA Headquarters on the relevant codes. The data were analyzed mainly using Excel programme. To calculate the trade deficit (Balance of trade deficit), the total value of annual exports was determined from the total value of imports.

RESULTS AND DISCUSSION

Wood based products import value

Results (**Fig. 1**) show that, wood products which are imported to Tanzania have been exhibiting volatile trend from 2007 to date. There were increases in the imports of wood based products between year 2007 and 2013 which was followed by a high-pitched increase (by about 87%) between 2013 and 2015. This increase was mainly attributed to a substantial importation of transmission poles from South Africa (Indufor, 2011). Large scale imports of poles for electricity transmission were done by TANESCO since the domestic production could not supply the desired level. In 2015, the total import volume was about 200,000 m^3. Moreover, wood products from South Africa were comparatively expensive. Between 2013 and 2015, the prices ranged from 600 USD to 800 USD per tonne (about 300 USD to 400 USD per pole) (Indufor, 2011).

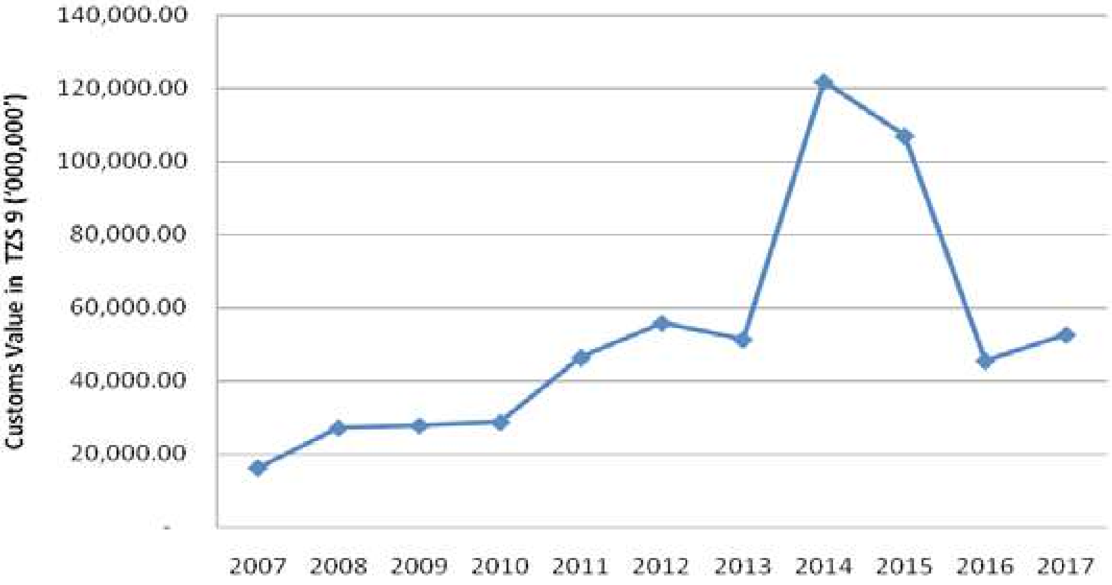


Figure 1: Trend of the import value of the wood based products to Tanzania

The projections by FDT (2017) show that, the demand for wood products is expected to grow sharply, more than double in round wood equivalent between 2013 (national consumption of 2.3 million m^3 rwe) and 2035 (5.2 million m^3 rwe), driven primarily by the construction sector and paper consumption. Therefore, a steady decrease between 2015 and 2017 does not imply reduced demand for wood based products in the country; rather it was the result of the rising average import prices from various suppliers. This implies that a significant amount of foreign money was required. The investment in domestic wood based production and processing is paramount, as the price limits for importing wood based products are mounting.

Comparison of imports and export

Generally, the trend of import values for the wood based products between 2011 and 2017 were higher than the export **(Fig. 2).**

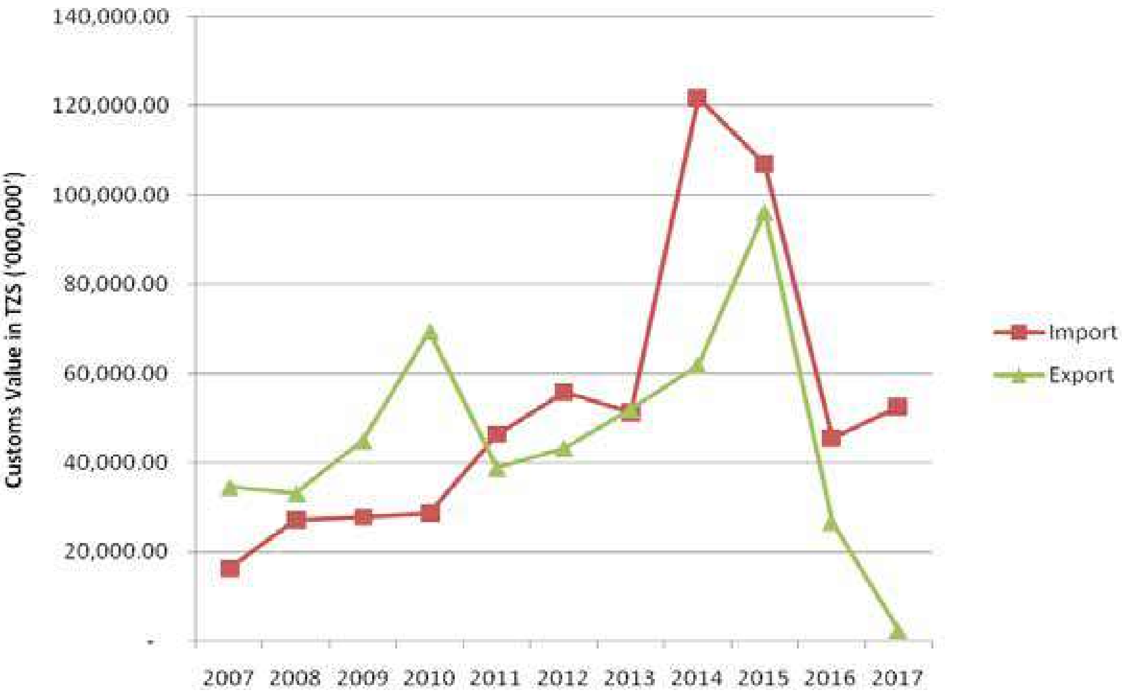


Figure 2: Trend of the Import and export values of the wood based products to Tanzania

The total value of imported wood based products was TZS 586.3 billion compared to TZS 503 billion of the exported products from 2007 to February 2018 respectively. The high values were mainly contributed by importation of poles, furniture, and paper consumption. Poles treated with paint, stains, creosote or other preservatives had the highest value (TZS 27.7 billion in 2014) compared to other products imported between 2007 and 2018. As also observed by FDT (2017), wood based furniture imports were around 20,000 tonnes annually. Tanzania was importing a range of wood furniture including chairs, windows, doors frames, shutters, and hangers.

In addition, paper was another wood based product which was being imported by the country in high volume and an increasing trend. With the exception of Kraft paper, which is produced locally, Tanzania importation has increased from 115,000 tonnes in 2011 to 136,000 tonnes in 2015.

Balance of Trade

Balance of trade deficit due to wood based products was increasing from year 2007 to 2017 **(Fig. 3).** The results show that the largest trade deficits in relation to wood based products were experienced in 2014 and 2017.

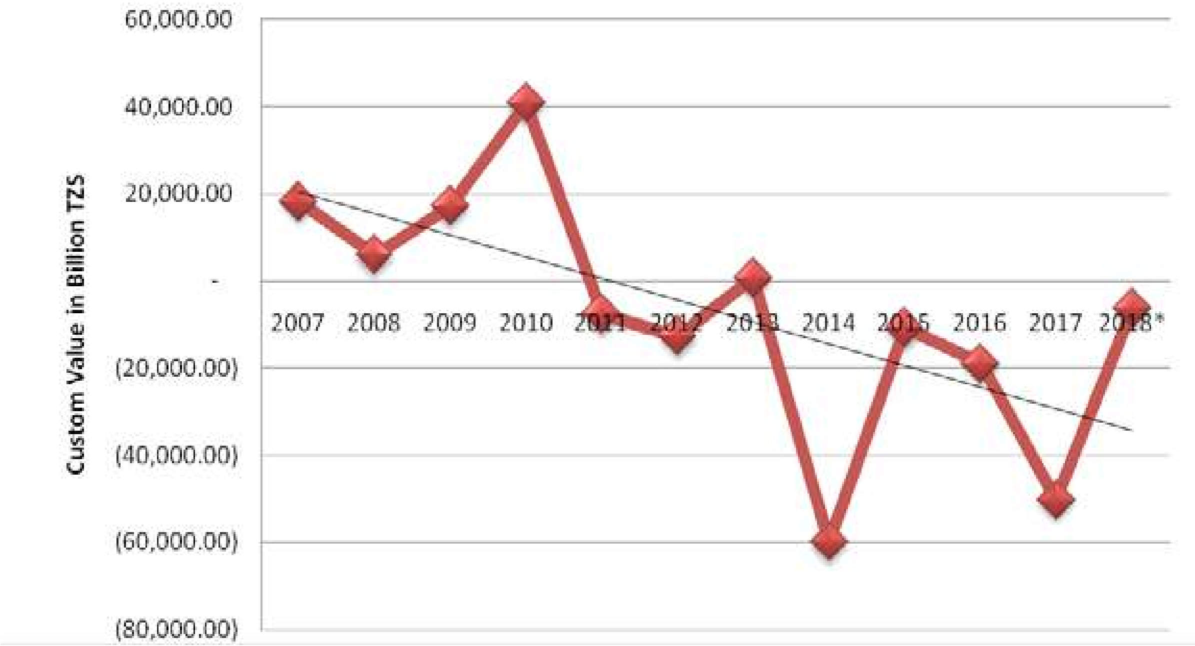


Figure 3: Trend of balance of trade for the wood based products

The lowest trade deficit for wood based products was observed in 2014 **(Fig. 3).** There is a correlation between wood based products' balance of trade deficit **(Fig. 3)** and that of all forest products of the country as shown in **Figure 4.** However, if all forest products were included, the balance of trade was positive **(Fig. 4).** This implies that the importation of wood based products had negative influence on the balance of trade in the forest sector. High economic growth in the country is 'one of the pool factors' for the demand of wood based products (e.g. as construction materials and furniture). If this trend of the balance of trade is not addressed, the deference between export and import will rise with the later having higher value. Consequently, the balance of trade will be negatively affected unless measures are taken to rescue the current situation.

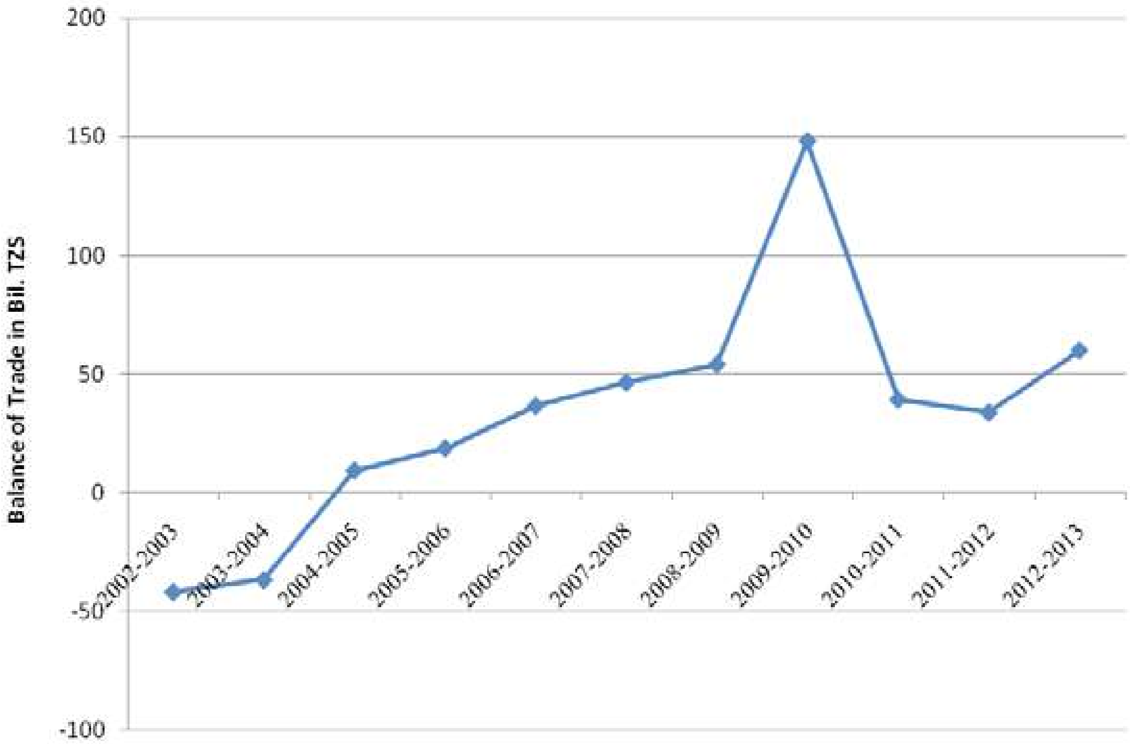


Figure 4: Trend of balance of trade for the forest products

Source: Abdallah (2014)

A trade deficit occurs when a country does not produce for her needs. A country with a balance of trade deficit also current has the account deficit. Account deficit means limited economic capabilities to ensure timely accomplishment of developmental goals for the benefit of the general public. In short term, the balance of trade deficit does not have significant negative impacts to the country's economy. Over time, trade deficit increases jobs outsource, in other words, it creates fewer jobs in the wood based industry in the country and increases job opportunities in the countries where the wood based products originate.

Products imported

The top most products that were imported to Tanzania are provided in **Table 1**. Some of the products were frequently and others were infrequently imported. Poles treated with paint, stains, creosote or other preservatives and of bamboo (plywood, veneered panels and similar laminated wood) were the main frequently imported products.

Table 1: Top most imported Wood Based Products (WBPs) from 2007 to February 2018

Description	Customs Value (TZS)	Year
Blackboard, laminboard and batter board: Plywood, veneered panels and similar.	1,409,598,935.35	2015
Coniferous: Hoopwood; split poles; piles, pickets and stakes of wood, pointed out	2,463,990,191.00	2011
Coniferous: Hoopwood; split poles; piles, pickets and stakes of wood	64,352,231,195.86	2012, 2017, 2013, 2016, 2014, 2015
Dark Red Meranti, Light Red Meranti and MerantiBakau	1,090,684,250.00	2012
Doors and their frames and thresholds	15,455,420,448.04	2008, 2009, 2011, 2016

Description	Customs Value (TZS)	Year
Non-coniferous: Hoopwood; split poles; piles, pickets and stakes of wood, pointed	27,719,609,269.78	2011, 2012, 2013, 2014 and 2015
WBPs of a density exceeding 0.8 g/cm3: Fibreboards of wood or other Ligneous matter	12,189,329,665.27	2013, 2014, 2015, 2016 and 2017
WBPs of a thickness exceeding 9mm: fibreboard of wood or other: Medium density fibreboard	1,066,544,033.00	2007 up to 2017
WBPs of bamboo: Plywood, veneered panels and similar laminated wood	16,551,818,920.35	2008, 2009, 2010, 2011, 2012, 2013, 2014 and 2015
Other WBPs (including strips and friezes for parquet flooring, not assembled) and Non conifer	1,209,919,711.64	2015
Other, coniferous	15,461,027,007.95	2014, 2017
Other WBPs, with at least one outer ply of non-coniferous wood: Plywood, veneered	13,754,423,428.90	2013, 2014, 2016 and 2017
Other WBPs: Plywood, veneered panels and similar laminated wood: Other plywood, consisting…	38,375,849,798.58	2009, 2011, 2012, 2013, 2014, 2015, 2016 and 2017
Other WBPs: Builders' joinery and carpentry of wood, including cellular wood panels	1,312,649,449.00	2007
Other WBPs: Fibreboard of wood or other ligneous materials, whether or not bonded	19,228,881,734.32	2007, 2008, 2009, 2010, 2011, 2012, 2014, 2015,
Other WBPs: Other particles of wood	12,250,560,925.52	2012, 2013, 2014, 2015, 2016 and 2017
Other WBPs: Particle board, oriented strand board (OSB) and similar board	55,557,171,933.84	2007 up to 2017
Other WBPs: Railway or tramway sleepers (crossties) of wood.	5,670,068,086.22	2008 and 2014
Other WBPs: Sheets for veneering (including those: of tropical wood specified in Subhea	1,296,878,078.00	2011
Other WBPs: Wood in the rough, whether or not stripped of bark or sapwood	38,370,610,518.89	2008 up to 2017
Particle board	4,971,924,845.83	2009, 2011, 2014, 2015 and 2017
Shuttering for concrete constructional work	5,580,028,888.32	2015
Poles treated with paint, stains, creosote or other preservatives	70,868,406,035.81	2008, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017 and 2018

Products exported

The top most products that were exported outside Tanzania are provided in **Table 2.** The frequently exported products were coniferous (sheets for veneering including those obtained by slicing laminated wood) and wood sawn or chipped lengthwise, slice: of tropical wood specified in Subhea.

Table 2: Top most exported Wood Based Products (WBPs) from 2007 to 2017

Description of the product	Customer Value (TZS)	Year
Cases, boxes, crates, drums and similar packing; cable drums	3,216,002,875.00	2013
Coniferous: Sheets for veneering (including those obtained by slicing laminated wood	32,199,505,356.00	2007, 2008, 2009, 2012, 2013, 2014, 2015, 2016 and2017
Densified wood, in blocks, plates, strips or profile shapes.	1,555,010,714.00	2007
Doors and their frames and thresholds	1,950,369,821.00	2011
Fuel wood, in logs, in billets, in twigs, in faggots or in similar forms	4,776,661,425.00	2009 and 2010
Non-coniferous: Hoopwood; split poles; piles, pickets and stakes of wood, pointed	3,914,231,211.00	2008 and 2012
Other WBPs (including strips and friezes for parquet flooring, not assembled) - Non conifer	25,096,712,108.00	2010
Other, coniferous	1,713,524,175.00	2009
Other WBPs: Other particles of wood	7,355,805,338.00	2007, 2008 and 2011
Other WBPs: Wood in the rough, whether or not straight: Other WBPs of tropical wood specified	22,407,452,020.00	2007, 2010, 2011, 2012, 2014, 2015 and 2016
Other WBPs: Wood marquetry and inlaid wood; caskets and cases for jewellery or cutlery,	1,411,225,403.00	2013
Other WBPs: Wood sawn or chipped lengthwise, slice: Of tropical wood specified in Subhea	216,328,879,566.00	2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016
Other WBPs: Wood sawn or chipped lengthwise, sliced or peeled	74,603,716,215.00	2010, 2011, 2012, 2013, 2014, 2015, 2016
Particle board	3,992,808,000.00	2010
Sapeli: Wood sawn or chipped lengthwise of tropical wood specified in subheading.	16,843,899,213.00	2014, 2015 and 2016
Statuettes and other ornaments, of wood	5,288,382,612.00	2014 and 2016
Poles treated with paint, stains, creosote or other preservatives	2,706,757,814.00	2007 and 2015
Wood wool; wood floor.	40,813,846,753.00	2007, 2008, 2009, 2010, 2011, 2012 and 2013

In addition, although the values differ, there were similarities on the types of the imported and exported products **(Fig. 5)** including the species used to make the products.

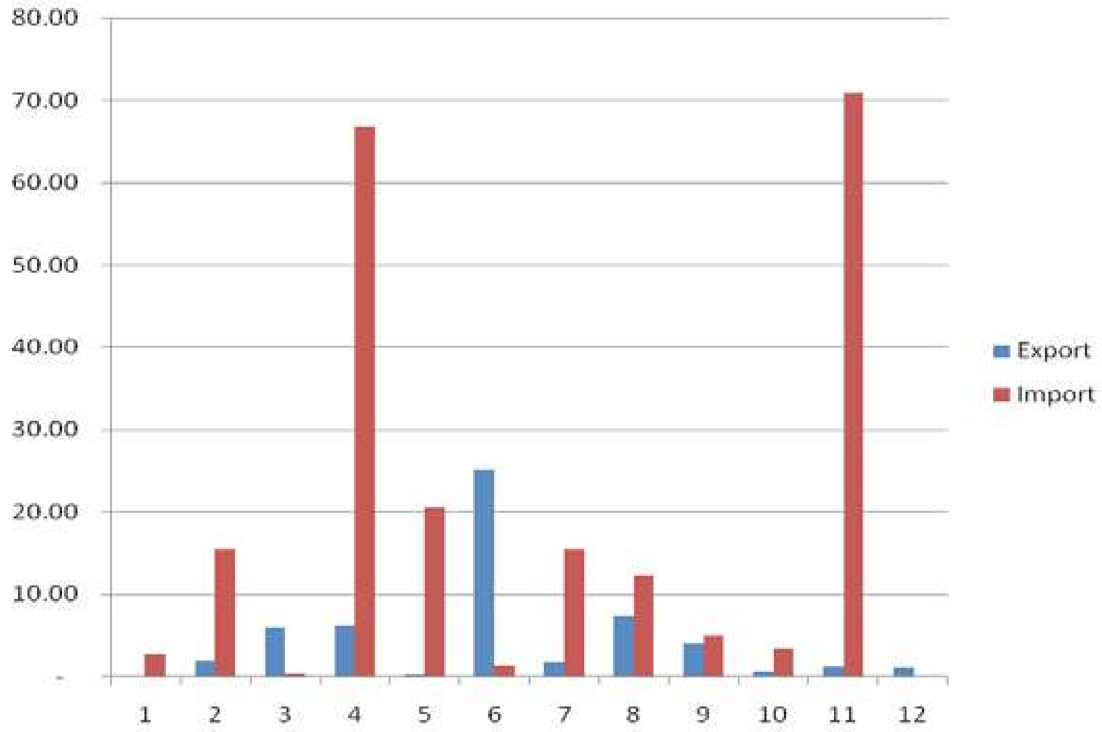


Figure 5: Comparison of the wood based products imported and exported 2007 to 2017

Key:

1. Clothes hangers
2. Doors and their frames and thresholds
3. Fuel wood, in logs, in billets, in twigs, in faggots or in similar forms
4. Non-coniferous: Hoopwood; split poles; piles, pickets and stakes of wood, pointed
5. WBPs of bamboo: Plywood, veneered panels and similar laminated wood
6. Other WBPs (including strips and friezes for parquet flooring, not assembled). Non conifer
7. Other coniferous
8. Other WBPs: Other particles of wood
9. Particle board
10. Tableware and kitchenware of wood
11. Poles, treated with paint, stains, creosote or other preservatives
12. Wood charcoal (including shell or nut charcoal), whether or not agglomerated

With the exception of coniferous species (such as *Spruces* and *Quercus* spp) which is found in temperate countries, most imported wood products (e.g. transmission poles) were reported to be produced from species that are also found in Tanzania. If same products are exported and imported it means that there is experience in the country of manufacturing the products for export to reduce deficit of the balance of trade and create jobs in Tanzania.

Countries of destinations for the forest products were the United Arab, South Africa, Kenya, the United Kingdom, China, and Germany in that serial order **(Fig. 6).** The single largest export market for sawn timber was Kenya (see also Indufor, 2011). In Tanzania, wood based products originated from a variety of countries; main suppliers being China, South Africa, Kenya, India, and Turkey (see also FDT, 2017).

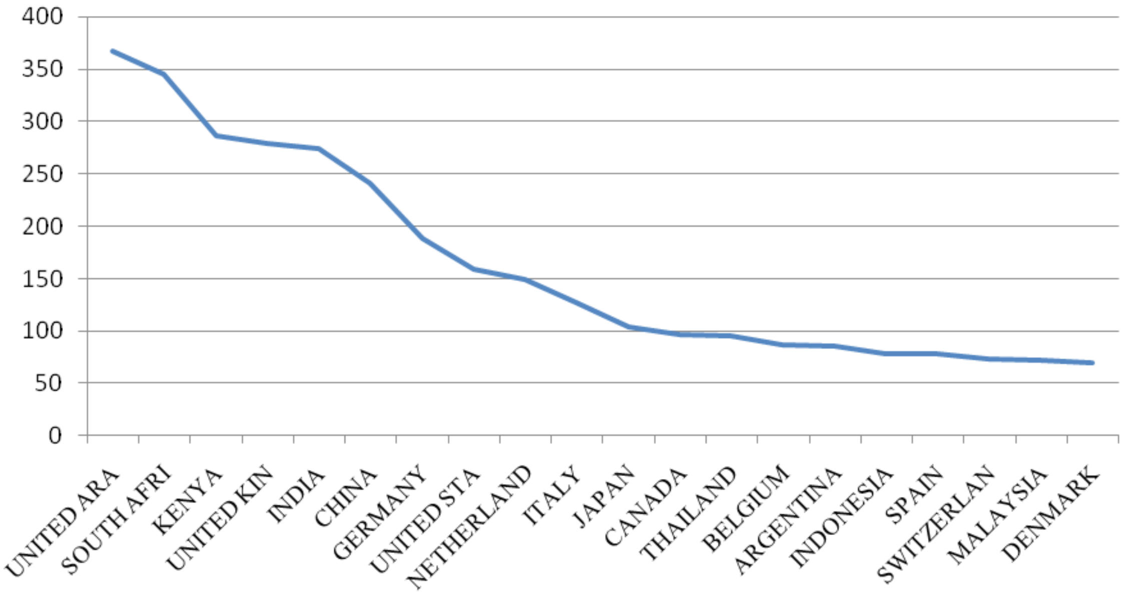


Figure 6: Top twenty countries that Tanzania exports forest products

Source: Abdallah (2014)

CONCLUSION AND RECOMMENDATIONS

There were more wood based products imported than those exported. The balance of trade deficit of wood based products has a negative dreceasing trend while that of forest products has shown a positive increasing trend. This implies that the importation of wood based products has negative influence on the balance of trade in the forest sector. There were similarities in terms of the types of products imported and those exported. The countries of destinations of the exported products were to some extent similar to those from which Tanzania imported her wood based products. This means that Tanzania has experience and the raw materials of manufacturing imported wood based products.

The paper recommends the following:

- There is a need of increasing the export of wood based products so as to improve the balance of trade. We need to export more and import less in order to stabilize our economy. More efforts are still needed in terms of the required infrastructure and logistics to support exportation of wood products from Tanzania.
- There is a need for a control on the importation of wood based products which are produced in the country (e.g. cloth hanger, tables and kitchenware made of wood, bamboo products).
- There is a need for limiting importation of low durable wood products. This can be done through tariffs, non-tariff instruments and/or avoiding free trade agreements (that waive tariffs) on wood based products.
- There is a need of increasing the production of quality wood based products by increasing industrial investment for expotation purposes.

REFERENCES

Abdallah, J.M. 2014. Contribution of the Forest Sector to the National Economy. Ministry of Natural Resources and Tourism, National Forest Programme Special Study.

Indufor. 2011. Timber Market Dynamics in Tanzania and in Key Export Markets. Forest and Beekeeping Division, Dar es Salaam, Tanzania.

URT. 2010. National Strategy for Growth and Reduction of Poverty II, Ministry Of Finance and Economic Affairs, http://www.international.gc.ca/development-developpement/assets/pdfs/countries-pays/NATIONAL-STRATEGY-FOR-GROWTH-AND-REDUCTION-OF-POVERTY-TANZANIA.PDF.

World Bank Group. 2014. Tanzania Mainland Poverty Assessment: A New Picture of Growth for Tanzania Emerges, http://www.worldbank.org/en/country/tanzania/publication/tanzania-mainland-poverty-assessment-a-new-picture-of-growth-for-tanzania-emerges.

NICOTINE CONTENTS IN HONEY FROM TOBACCO AND NON-TOBACCO GROWING AREAS IN KIGOMA REGION, TANZANIA

[*1]Balama, C., [2]Mbwambo, L., [1]Kagosi, P., [3]Tewele, C., [1]Laswai, F., [1]Msalilwa, U. and [1]Ernest, S.

[1]Tanzania Forestry Research Institute, P. O. Box 1854, Morogoro
[2]World Wildlife Fund, P.O. Box 63117, Dar es Salaam
[3]Ministry of Agriculture, P.O. Box 3047, Morogoro
[*]Corresponding author email: balamapc@gmail.com

ABSTRACT

Nicotine content in honey is currently the major issue of concern to honey quality in Tanzania. This study was carried out to determine nicotine content in honey from tobacco and non-tobacco growing areas in Kigoma Region, Tanzania. Specifically, the study determined nicotine contents in honey and bee fodder samples. Fresh honey samples were collected from beehives within tobacco and non-tobacco growing areas and from vendors for laboratory tests. Results showed that nicotine content in the fresh honey which was collected from beehives located within tobacco growing areas is significantly higher than that collected from non-tobacco growing areas (0.46µg/g vs. 0.26µg/g, $p < 0.05$). The honey samples from vendors in town and villages had nicotine contents of 0.41µg/g and 2.98µg/g, respectively. It was observed that most of the bee fodder tree species in Miombo woodland had traces of nicotine. Among the most important bee fodder tree species with the highest amount of nicotine were *Brachystegia spiciformis* (20.966µg/g), and *Julbernardia globiflora* (13.168µg/g). Meanwhile *Vernonia colata*, *Combretum collinum* and *Combretum mole* had the lowest nicotine contents of 0.836µg/g, 0.006µg/g, and 0.004µg/g, respectively. Generally, honey samples which were collected from all sources contained different amounts of nicotine. However, these contents were perceived to be tolerable for human health. The sampled bee forage tree species were also observed to have nicotine, which is associated with nicotine in the honey. The study recommends for the establishment of the national standards indicating the allowable amount of nicotine in honey for human consumption. Further research needs to be done in other areas and vegetation types in order to address this concern country- wise.

Keywords: Nicotine Contents, Honey, Tobacco Growing Areas, Non-Tobacco Growing Areas, Kigoma

INTRODUCTION

Tanzania is among the Sub-Saharan countries with the largest forest ecosystem which are covered with Miombo woodlands in more than two thirds of the total forested land (Mbuya *et al.,* 1994; URT, 1998). Miombo woodlands are normally dominated by trees of the closely related genera such as *Brachystegia*, *Julbernardia* and *Isoberlinia* (family Fabaceae, subfamily Caesalpinioideae). According to the Tanzania National Forestry Resources Monitoring and Assessment (NAFORMA) report (MNRT, 2015), the woodlands including the Miombo cover about 44,726,246 hectares out of 48.1 million hectares. Kigoma Region is among the regions in the country that has Miombo woodlands with the highest potential for honey production (Mpuya, 2003; Mwakatobe *et al*., 2016). An increase in honey production in Kigoma Region is a result of the Beekeeping Improvement Project that was implemented between August 2007 and July 2010 by the Ministry of Natural Resources and Tourism (MNRT) with the support from the Belgian Technical Cooperation (BTC), which was implemented in Uvinza, Kibondo, and Kigoma districts (BTC, 2011).

Honey is a natural sweet substance produced by honey bees from the nectar of blossomed flowers (Saba *et al.,* 2013; Waykar and Alqadhi *et al.,* 2016). The composition of honey depends on the plant species visited by the honeybees and the environmental processing and storage conditions (Sanz *et al*., 2004; Bertoncel *et al*., 2007; Guler *et al.,* 2007; Zerrouk *et al*., 2011). It is an important non-timber forest product with a very significant contribution to cash incomes for the rural communities particularly in the Miombo woodland areas. Beekeeping sector in Tanzania generates about US$ 19 million per annum, employs about 2 million people, helps in bio-diversity, and increases agricultural production through pollination (BTC, 2012). At the household level, the sector contributes up to about 33% of the household income source in the Miombo woodlands of Tanzania (Monela *et al*., 2000) as opposed to other sources such as agricultural crops and other forest products. Naturally besides honey, there are beeswax, propolis, royal jelly, and honeycomb as the by-products of beekeeping (BTC, 2012). Honey is used in four main ways; (i) direct consumption, (ii) as an ingredient in various products, (iii) for industrial use, and (iv) as a raw material for meals and drinks made from honey. Due to high value of beekeeping products in the international market, it is important to recognise beekeeping as an important provider of income to beekeeping households especially in developing economies.

Bee fodder plants which are available around the apiary are among the factors that influence the quality of the honey. Flowering plants are the sources of nectar and pollen for the honey production. For honey bees to survive, prosper, and be productive, their colonies must have a supply of both nectar and pollen in adequate quantities (FAO, 2015). Therefore, flowering plants are crucial for a colony's life cycle and survival (Castle, 2013). However, not all plants species are equally good for beekeeping, some supply both nectar and pollen abundantly when in bloom, and are often called honey plants; others yield pollen but little or no nectar, and are called pollen plants. A good beekeeping area is the one with nectar and pollen plants growing abundantly and with a relatively long blooming season (Nicolson, 2011; FAO, 2015; Stevenson, *et al.,* 2016). Moreover, depending on the type of flowering plant species, there are different types of honey. It has been established further that the quality of honey also depends on the nicotine content which is a naturally occurring alkaloid found in the plant kingdom especially of the Solanaceae family, predominantly tobacco (Asiyah *et al*., 2011; Swaileh and Abdulkhalig, 2013; Rand *et al*., 2015) and on the quality of the soil from which the flowering plant grows. In most cases, the best quality honey is that which is collected from nectar in areas free of chemicals, that is, ecologically pure areas.

Currently, major issue of concern to honey quality in Tanzania is the presence of nicotine. There has been a claim among users of honey that honey harvested within tobacco growing areas has nicotine content which affects human health (BTC, 2012; Asiyah *et al*., 2015). Nicotine is required in the human body, however according to Mishra *et al.* (2015); excess intake of nicotine is harmful to humans as it has a rapid onset of action on peripheral and central nervous systems. Similarly, Yamamoto *et al.* (1998) and Patil *et al.* (1999) cited nicotine as having side effects on human reproductive health, as it can reduce reproductive capacity causing mutagenic consequences towards the germ cell production and maturation. Such claims and scientific evidence on the negative effects of nicotine to human being have created challenges to the honey international markets (BTC, 2012). Among the sufferers from these claims are producers who seek to provide a nutritious product to local and international markets. Despite the long-time claims regarding the association of nicotine in honey and tobacco crop, there has been no study to justify the concerns. Most of the studies dealt with honey quality in terms of hydroxymethyl furfural (HMF), water content, sugar content, pH, ash content, and honey colour (Murray *et al.,* 2011; Gidamis *et al.,* 2004; Muruke, 2014). It is against this background that the current study set out to determine nicotine amounts in honey from tobacco and non-tobacco growing areas in Kigoma Region, Tanzania. Specifically, the study determined the amount of nicotine available in honey and bee fodder plants.

METHODOLOGY

Description of the Study Area

The study was conducted in Uvinza and Kibondo Districts in Kigoma Region **(Fig. 1).** The selection of the two districts among others was based on their high production of honey (BTC, 2012; Mwakatobe *et al.,* 2016) and large coverage of tobacco farms (BTC, 2011). Beekeeping practices in the two districts differ: in Uvinza District beekeeping is done in Miombo woodlands adjacent to tobacco farms and in the forest reserves, while in Kibondo District beekeeping is carried out in Moyowosi Game Reserve, which is about 50 km away from the homesteads and agricultural activities. The majority of beekeepers engage in beekeeping activities in this reserve because of having suitable conditions for apiaries.

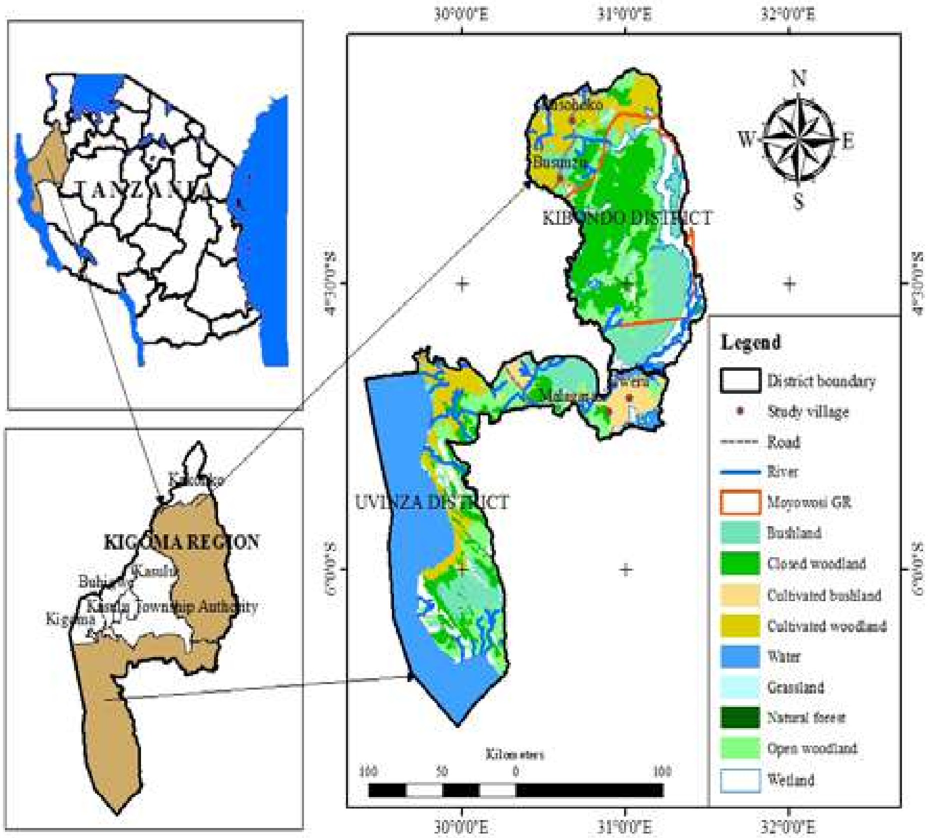


Figure 1: The map of study area

Source: NBS (2012)

Data Collection

Collection of samples for laboratory work

A total of 12 honey samples were collected from beehives and local vendors. Three beehives were sampled from tobacco growing areas (Uvinza District) and other three from non-tobacco growing areas (Kibondo District). Three samples of honey were collected from local honey vendors within the village and at the town centre (in both Uvinza and Kibondo districts) each, to make a total of six samples. These samples were collected in order to verify if there is any honey abuse along the distribution and marketing chains. Suitable bee fodder trees in the study area were identified through Focus Group Discussions (FGDs) and key informant interviews. Stakeholders involved in FGD and key informants interview were bee keepers, elders, beekeeping officers. Nine most suitable bee fodder tree species were selected where three samples from each section (bottom, middle and growing tip) from stems (of the same tree species located at different localities). The collected samples were transported to the Department of Food Science and Technology at Sokoine University of Agriculture for laboratory analysis.

Laboratory procedures for nicotine quantification

Nicotine amount was determined following a method described by Suryan *et al.* (2012). A total of 72 triplicates of honey and leaf samples were prepared for laboratory analysis. Some 1 – 5 g of homogenized samples of honey and leaves were put into 100 ml Erlenmeyer flask then 10 ml of methanol were added to it. The mixture was stirred for 30 minutes to extract the sample. Then 25 ml of distilled water was added to dilute the sample followed by the addition of 2N NaOH. The mixture was warmed in a water bath at 80°C for 6 minutes and then left to cool. The mixture was then filtered through number 41 whatman filter paper into 50 ml volumetric flask. A 1 ml of Zinc acetate was added followed by the addition of 1 ml Potassium hexacyanoferrate (II) solution and distilled water was added to complete the volume. The mixture was centrifuged at 3600 rpm for 5 minutes. The supernatant was transferred into another clean 50ml volumetric flask and the residue was discarded. Then 5 ml of 0.01 N NaOH was added and distilled water was added to complete the volume. Absorbance was read at 602 nm using spectrophotometer, where nicotine content of the sample was recorded in µg/g units.

Data Analysis

Descriptive statistics analysis was performed for laboratory data, and the results were presented indicating the level of nicotine contents in µg/g, in honey and in the leaves. Furthermore, t-test analysis was used to compare the means of nicotine contents from the honey collected from tobacco and non-tobacco growing areas. The data which were collected through FGDs and key informant interview were analysed using content analysis. The data were categorized into meaningful units and themes and summarised into meaningful information based on the study objectives.

RESULTS AND DISCUSSION

Levels of Nicotine in Honey

The results from the laboratory analysis showed that the levels of nicotine in fresh honey samples which were collected directly from beehives in Kigoma Region were 0.46 and 0.26 µg/g for the beehives within tobacco and non-tobacco growing areas, respectively. The honey samples which were collected randomly from vendors in town had nicotine content of 0.41µg/g and the samples from village vendors had nicotine content of 2.98 µg/g **(Table 1).**

Table 1: Nicotine content in honey samples from different sources in Kigoma region

Sample name	Average sample weight (g)	Nicotine contents (µg/g)
Beehives within tobacco growing areas	5.27	0.45
Beehives within non-tobacco growing areas	5.60	0.24
Honey from vendors in Town	5.43	0.41
Honey from vendors in village	5.44	2.98

Note: µg/g is equivalent to mg/Kg

The results indicate further that all honey samples contained traces of nicotine at different amounts, which were revealed to be tolerable to human health (AEMSA, 2014). However, there was a statistical significant difference ($p<0.05$) between the means for the honey which was collected from beehives located within tobacco and non-tobacco growing areas **(Table 2).** The difference in means could be attributed to nectar from tobacco flowers, as some of the beehives were not harvested during June and July blossom. The flowering of tobacco plant occurs between February and March, which is the time for nectar collection for honey to be harvested during June and July blossom.

Table 2: T-test analysis for honey samples collected in beehives from tobacco and non-tobacco growing areas

Variable	Honey sample type	
	Collected within tobacco growing areas	Collected within non-tobacco growing areas
Mean (µg/g)	0.454101972	0.243522
Variance	0.009343989	0.000576
Observations	9	9
Df	8	
P-value	0.000134009	

The nicotine content of the honey from Kigoma Region was higher than that found in other regions such as Tabora and Kilimanjaro which ranged from 0.0007 to 0.0037 mg/Kg (Ilomo *et al*., 2013). Moreover, nicotine content from the study area was higher than 0.003 to 0.005 mg/Kg which was reported by Mumbi *et al.* (2014) from Tabora, Dodoma and Kilimanjaro regions in Tanzania. This result could be attributed to factors such as the type of plants available and which bees use for forage. This study indicates that leaves from plants used by bees as fodder contained large amount of nicotine than the nicotine observed from the honey. Similar finding is reported by Mumbi *et al.* (2014) who reveal that the nicotine content in honey was also from other plant species which were found within the honey producing areas which contaminate the honey. In line to this, a study by Swaileh and Abdulkhaliq (2012) showed no statistical significant differences in nicotine concentration between honey samples from different geographic regions in Palestine. Nicotine is a natural plant product that is found in many plant species, especially tobacco. Honeybees encounter nicotine trace concentrations in the floral nectar of *Nicotiana* plant spp. Nicotine is known as a nourishing restraining owing to its bitter taste, and pollinators may encounter nicotine in both nectar and pollen. In nature, bees collect nectar from various plants, which may be mixed in the hive to reduce the concentrations of nicotine in honey.

Similarly, a study by Swaileh and Abdulkhaliq (2012), Pasquale *et al.* (2013), Muruke (2014), Ndefe *et al.* (2014), and El Sohaimy *et al.* (2015), revealed that chemical contents in honey are attributed to the type of botanical plant used. There was no established standard of the level of nicotine in honey from Tanzania Bureau of Standards. However, the American E-Liguid Manufacturing Standards Association states that the commonly allowable nicotine content in flavoured products is 36mg/ml which is equivalent to 36,000 µg/g (AEMSA, 2014). Also data bases and safety sheets consistently state that lethal dose for adult is 30 – 60 mg (Hayes, 1982). Regarding these facts, honey samples from Kigoma Region contain small amounts of nicotine that is not lethal to human being.

Nicotine content of honey found in Kigoma was not as high as nicotine content found in other foods consumed by human on every day basis. For instance, common vegetables such as tomatoes and lettuce are known to contain large amounts of nicotine and are always consumed in large quantities (Carlos *et al.,* 2011). Fresh tomatoes are reported to contain 4.1 - 4.3 mg/Kg of nicotine (Edward *et al.,* 1999). As per research findings, a human being requires a certain amount of nicotine through diet or supplements, to manage the smooth functioning of the body. In case there is a nicotine deficiency, the body may not be able to fulfil the basic as well as complex mitochondrial functions (Mumbi *et al.,* 2014).

Levels of Nicotine in Major Bee Fodder Plants

Most of the Miombo woodland trees have certain amounts of nicotine. **Table 3** shows some Miombo woodland tree species that were identified during FGD as most preferred by bees for honey production. Most of the tree fodder species in the study areas belong to Fabaceae family.

Table 3: Nicotine content in identified bee fodder trees in Kigoma

Local name	Botanical name	Family	Average sample weight (g)	Nicotine content (µg/g)
Mtundu	*Brachystegia spiciformis* Benth.	Fabaceae	1.092	20.966
Muba / Mlugwe	*Julbernardia globiflora* (Benth.) Troupin	Fabaceae	1.096	13.168
Myenzi	*Brachystegia boehmii* Taub.	Fabaceae	1.014	3.071
Mkambati /Mkurungu	*Pterocarpus chrysothrix* Taub.	Fabaceae	1.042	1.708
Mlembele	*Dalbergiella nyasae* Baker f.	Fabaceae	1.155	1.434
Mmbanga	*Pericopsis angolensis* (Baker) Meeuwen	Fabaceae	1.076	1.344
Mlulunguja	*Vernonia colata* (Willd.) Drake	Asteraceae	1.063	0.836
Mkoyoyo	*Combretum collinum* Fresen.	Combretaceae	1.036	0.006
Mlama	*Combretum molle* R.Br. ex G.Don	Combretaceae	1.031	0.004

Among the most important bee forage trees with the highest amount of nicotine were *Brachystegia spiciformis* Benth. (20.966 µg/g), and *Julbernardia globiflora* (Benth.) Troupin (13.168 µg/g) while *Vernonia colata* (Willd.) Drake, *Combretum collinum* Fresen and *Combretum molle* R.Br. ex G.Don had the lowest nicotine contents of 0.836, 0.006, 0.004 and µg/g, respectively. Mumbi *et al.* (2014) estimated nicotine level in tobacco (*Nicotiana tabacum* L.) leaves to range from 6 to 8 mg/Kg. These findings show that, apart from tobacco plants, there are also other plant species with nicotine that contaminate honey. However, most of the sampled tree species had low levels of nicotine concentration compared to the levels estimated in tobacco leaves. Similar findings were also reported by Singaravelan *et al.* (2006) and Adler *et al.* (2006) in Israel and USA, respectively.

CONCLUSION AND RECOMMENDATION

Honey samples which were collected from all sources contained some traces of nicotine at different amounts. However, such amounts of nicotine from all sources were tolerable to human health. The sampled bee forage tree species were also observed to have nicotine, which is also associated with nicotine in the honey. Much of the sampled honey from beehives which were within tobacco growing areas was not associated with nectars from tobacco plants as it was produced after the end of tobacco production season. However, some of the sampled honey was from beehives which were not harvested during June and July blossoms; therefore they could also be associated with the nicotine traces in the honey. Generally, the current traces of nicotine in honey could also be from other bee fodder plants apart from tobacco. It is important to establish the national standard that will indicate the allowable amounts of nicotine in honey and which are not harmful for human consumption. Further research needs to be done in other areas and vegetation types in order to address this concern country-wise.

ACKNOWLEDGEMENT

Authors are indebted to the Belgian Technical Cooperation (BTC) for financing this study. Much gratitude are is also extended to Messrs Juma Mkondo and Seif S. Seif, the Districts Beekeeping officers for Uvinza and Kibondo Districts, respectively for their well organised field trip, constructive ideas and the support they rendered to the research team during data collection. Special thanks go to Village Leaders, beekeepers, tobacco farmers, honey traders and customers from Kibondo and Uvinza Districts for their good cooperation during data collection.

REFERENCES

Adler, L.S., Wink, M., Distl, M. and Lentz, A.J. 2006. Leaf herbivore and nutrients increase nectar alkaloids. *Ecology Letters*, 9: 960 – 967.

AEMSA. 2014. *Creating responsible and sustainable practices and process for the safe manufacturing of "e-liquids" used in electronic cigarettes.* American E-Liguid Manufacturing Standard Association (AEMSA), Version 1.8 I 1.14. 10pp.

Asiyah, H.A., Syazana, N.S., Hashida, N.H., Sharifah, H.A.D. and Kamaruddin, M.Y. 2011. Effects of nicotine and Gelam honey on testis parameters and sperm qualities of juvenile rats. *Scientific Research and Essays*, 6(26): 5471 - 5474.

Bertoncel, J., Dobersek, U., Jamnik, M. and Golob, T. 2007. Evaluation of the phenolic content, antioxidant activity and colour of Slovenian honey. *Food Chemistry*, 105:822–828.

BTC. 2012. Kigoma Honey Subsector and Value Chain Analysis. Report Study Commissioned by Beekeeping Support Project – Kigoma Region Conducted by Match Maker Associates Limited, Final Report Submitted to Belgian Technical Cooperation, Dar es Salaam. 78pp.

BTC. 2011. *Technical and Financial File, Beekeeping Support Project in Kigoma Region Tanzania, DGCD CODE:* NN 3009890 NAVISION CODE: TAN 10 025 11, Belgian Technical Cooperation. Dar es Salaam. 89pp.

Carlos, A.V., de Paiva, S.A.A., Funai, M.N.S. 2011. Quantification of nicotine in commercial brand cigarettes. *Biochemistry and Molecular Biology Education,* 38: 330 – 334.

Castle, D. 2013. *Factors affecting global bee health",* Honey bee health and population losses in managed bee colonies, CropLife International, Brussels, Belgium. 18pp.

du Rand, E.E., Smit, S., Beukes, M., Apostolides, Z., Pirk, C.W.W. and Nicolson, S.W. 2015. Detoxification mechanisms of honey bees (*Apis mellifera*) resulting in tolerance of dietary nicotine. *Science Report,* 5:11779.

Edward, F.D., Erich, H. and Tsenge, D. 1993. The nicotine content of common vegetables. *The New England Journal of Medicine,* 329 – 437.

El Sohaimy, S.A., Masry, S.H.D. and Shehata, M.G. 2015. Physicochemical characteristics of honey from different origins. *Annals of Agricultural Science,* 60(2): 279–287.

FAO. 2015. *Chapter 3 Bee forage and floral calendars*. (United Nations, Food and Agriculture Organisation). http://www.fao.org/docrep/x0083e/x0083e04.htm.

Gidamis, A.B., Chove, B.E., Shayo, B.S., Nnko, S.A. and Bangu, N.T. 2004. Quality evaluation of honey harvested from selected areas in Tanzania with special emphasis on Hydroxymethyl Furfural (HMF) levels. *Plant Foods for Human Nutrition,* 59:129-132.

Guler, A., Bakan, A., Nisbet, C. and Yavuz, O. 2007. Determination of important biochemical properties of honey to discriminate pure and adulterated honey with sucrose (*Saccharum officinarum* L.) syrup", *Food Chemistry,* 105:1119–1125.

Hayes, W.J. (1982). *Pesticides Studied in Man*. Baltimore, MD Williams & Wilkins. 385 - 389.

Ilomo, I.I., Philip, A., Sikombe A.B. 2013. *Evaluation of honey quality in respect to nicotine content in Urambo and Same districts.* A Research Report. Tobacco Research Institute of Tanzania (TORITA). 14pp.

Mbuya, L.P., Msanga, H.P. and. Ruffo, C.K. 1994. *Useful Trees and Shrubs for Tanzania, Regional Soil Conservation Unit*, SIDA. 542pp.

Mishra, A., Chaturved, P., Datta, S. and Sinukumar, S. 2015. Harmful effects of nicotine. *Indian Journal of Medical and*

Paediatric Oncology, 36 (1): 24-31.
MNRT. 2015. *NAFORMA. National Forest Resources Monitoring and Assessment of Tanzania Mainland, Main Results.* Ministry of Natural Resources and Tourism, Tanzania Forest Service, Ministry of Natural Resources and Tourism. 105pp.
Monela, G.C., Kajembe, G.C., Kaoneka, A.R.S. and Kowero, G. 2000. Household livelihood strategies in the Miombo Woodlands of Tanzania: Emerging Trends. *Tanzania Journal of Forestry and Nature Conservation,* 73:17 – 33.
Muruke, M.H. 2014. Assessment of quality of Tanzanian honey based on physicochemical properties. *Food Science and Quality Management,* 33: 61 – 72.
Mumbi, C.T., Liseki, S.D., Silas, I.O. and Boniphace, S. 2014. Assessment of nicotine level in Tanzania honeys from tobacco growing and non-growing areas. *African Journal of Agriculture Research,* 9(44): 3258 – 3266.
NBS 2012. Shapefiles – Level one and two. National Bureau of Statistics. www.nbs.go.tz.
Ndefe, J. Abioye, L. and Dandago, M. 2014. Quality assessment of Nigerian honey sourced from different floral locations. *Nigerian Food Journal*, 32 (2): 48-55.
Mpuya, P.M. 2003. An overview of bee industry in Tanzania, In: *Production of bee products and marketing promotion workshop conducted by Heifer Internationa*l from 25th - 27th February, pp. 7 – 17.
Murray, S.S., Schoeninger, M.J., Bunn, H.T., Pickering, T.R. and Marlett, J.A. 2001. Nutritional composition of some wild plant foods and honey used by Hadza foragers of Tanzania. *Journal of Food Composition and Analysis*, 14: 3-13.
Mwakatobe, A.R., Ntalwila, J.A., and Kohi, E.M. 2016. Income generation promote the participation of youth and women in beekeeping activities in Western Tanzania", *Journal of Entomology and Zoology Studies,* 4(4): 718-721.
Nicolson, S.W. 2011. Bee food: the chemistry and nutritional value of nectar, pollen and mixtures of the two. *African Zoology,* 46(2): 197 – 204.
Patil, S., Patil, S., Bhaktaraj, B. and Patil, S.B. 1999. Effect of graded doses of nicotine on ovarian and uterine activities in albino rats. *Indian Journal of Experimental Biology*, 37:184-186.
Pasquale, G., Salignon, M., Conte, Y., Belzunces, L.P., Decourtye, A., Kretzschmar, A., Suchai, S., Brunet, J., Alaux, C. 2013. Influence of pollen nutrition on honey bee health: Do pollen quality and diversity matter? *PLoS ONE,* 8(8): e72016. doi:10.1371/journal.pone.0072016.
Saba, Z.H., Suzana, M. and Yasmin, A.M.Y. 2013. Honey: Food or Medicine? *Medicine and Health,* 8(1): 3-18.
Sanz, M.L., Gonzalez, C.M.L., Sanz, J. and Martınez-Castro, I. 2004. Carbohydrate composition and physicochemical properties of artisanal honeys from Madrid (Spain): occurrence of *Echium* sp honey" *Journal of Science, Food and Agriculture,* 84:1577–1584.
Stevenson, P.C., Nicolson, S.W. and Wright, G.A. 2016. Plant–pollinator interactions from flower to landscape Plant secondary metabolites in nectar: impacts on pollinators and ecological functions. *Functional Ecology*, 1: 1 – 10.
Singaravelan, N., Inbar, M., Ne'eman, G., Distl, M., Wink, M. and Izhaki, I. 2006. The effects of nectar–nicotine on colony fitness of caged honeybees. *Journal of Chemical Ecology*, 32 (1): 49 - 58.
Suryani, S., Izzati, T. and Noor, A.M. 2012. Analysis of nicotine content in some of the popular cigarette and tobacco brand in Malaysia. *Science International (Lahore),* 24 (2): 139 – 141.
Swaileh, K.M. and Abdulkhalig, A. 2013. Analysis of aflatoxins, caffeine, nicotine and heavy metals in Palestian multifloral honey from different geographic regions. *Journal of the Science of Food and Agriculture*, 93(9): 2073 – 2338.
Swaileh, K.M. and Abdulkhaliq, A. 2012. Analysis of aflatoxins, caffeine, nicotine and heavy metals in Palestinian multifloral honey from different geographic regions. *Journal of Science, Food and Agriculture*, 93: 2116–2120.
URT 1998. *National Forest Policy.* Ministry of Natural Resources and Tourism. United Republic of Tanzania, Dar es Salaam. 59pp.
Waykar, B. and Alqadhi, Y.A. 2016. Biological properties and uses of honey: A concise scientific review. *Indian Journal of Pharmaceutical and Biological Research,* 4(3):58-68.
Yamamoto, Y., Isoyama, E., Sofikitis, N. and Miyagawa, I. 1998. Effects of smoking on testicular function and fertilizing potential in rats. *Urological Research*, 26:45 – 48.
Zerrouk, S.H., Fallico, B.G., Arena, E.N., Ballistreri, G.F. and Boughediri, L.A. 2011. Quality evaluation of some honey from the Central Region of Algeria" *Jordan Journal of Biological Sciences,* 4(4):243 – 248.

PART B

CASE STUDIES, BEST PRACTICES AND LESSONS OF EXPERIENCE

TAFORI EXPERIENCE IN SOLVING FOREST DEFORESTATION AND DEGRADATION CHALLENGES IN TANZANIA

[*1]Maduka, M.S., [2]Laswai, F.F. and [3]Njongomi, E.E.

[1]TAFORI - Malya Lake Zone Afforestation Research Centre, P.O. Box 166, Malya, Mwanza.
[2]TAFORI - Moshi Timber Utilization Research Centre, P.O. Box 10, Moshi.
[3]TAFORI - Dodoma Arid Zone Afforestation Research Centre, P.O. Box 1576, Dodoma
[*]Corresponding author email: smaduka@hotmail.com

ABSTRACT

Deforestation and forest degradation in Tanzania are the challenges noting deforestation rate of about 500,000 ha per year. Tanzania Forestry Research Institute (TAFORI) has gained vast experiences in solving deforestation and forest degradation. Experiences gained are from enhancing natural regeneration of degraded forests and woodlands, introduction and screening and multiplication of Eucalyptus hybrid clones, artificial propagation of indigenous trees (medicinal, timber and fruit trees), including application of tissue culture technology, enhancing availability of planting materials through the establishment of seed orchards and gene conservation stands. In meeting charcoal demands and sustainable utilization of available trees resources, efficient charcoal-making kiln (Casamance) has been introduced and disseminated through outreach programme. Regeneration techniques for 10 dominant tree species in Miombo woodlands of Tabora and three tree species within the Eastern Arc Mountains have been developed. Over 500,000 ha of *Ngitilis* and 20 tree species have been restored in Mwanza and Shinyanga regions. Through Tree Biotechnology Programme, improved Eucalyptus hybrid clones have been introduced and adopted by stakeholders. Morever, the new focus towards application of tissue culture technology will widen the range of benefits including mass seedlings production. Several publications on research findings and dissemination materials in user-friendly languages have been made and distributed to stakeholders. More studies, identification of new technologies and innovations are required to meet the growing demands of wood.

Keywords: *Natural regeneration, artificial propagation, charcoal-making, dissemination*

INTRODUCTION

Deforestation and forest degradation in Tanzania are the challenges noting a deforestation rate of 500,000 ha per year (MNRT, 2015). Unsustainable anthropogenic activities such as agricultural expansion, grazing, timber extraction, charcoal making and urbanisation have been reported all over the country as threatening the existence of natural forests (Blomley and Iddi, 2009; MNRT, 2015). For instance a study by Kashaigili *et al.* (2013) indicates that between 2000 and 2007 there has been a deforestation rate ranging from 0.14 to 0.61% per year, along the coastal areas of Tanzania, and which was trigger by various uses of the forest such as timber, building poles, withies, firewood, and charcoal making. In addition, Kazimzumbwi forest has been degraded and over 20,000 hectares of the Pongwe forest were lost through human activities (Kahyarara *et al.,* 2002). Similarly according to Masanja (2013), along with energy requirements for domestic use, vegetation losses in Miombo woodlands areas of Sikonge in Tabora region are reported to have been contributed by mainly agricultural expansion for tobacco and to some extent for cereal crops.

The Miombo woodlands whose part integrate with coastal forests and surround some of the Eastern Arc Mountains are known globally for the conservation of high levels of species richness and endemism (Milledge *et al.,* 2005).

Indigenous tree species of economic and social importance (endemic and rare tree species) are threatened to near extinction. Tree species such as *Pterocarpus angolensis*, *Khaya anthotheca*, *Allanblackia stulhmannii, Ocotea usambarensis, Olea capensis, Olea welwitschii, Milicia excelsa, Osyris lanceolata* and *Dalbergia melanoxylon* are threatened while others are on the verge of extinction due to selective over-exploitation (URT, 2009). Most of the vegetation in the country due to the on-going deforestation and land degradation are facing local extinction and genetic loss. There have been remarkably negative changes of forest cover between 1990 and 2010 where the area under forests decreased from 41,495,000 ha to 33,428,000 ha with the estimated deforestation rate of 403,000 ha per year (FAO, 2011). However, with the implementation of different management initiatives following the implementation of Forest Policy of 1998 and Forest Act of 2002, there has been a slight decrease of deforestation rate down to 372,871 ha per year (MNRT, 2015). This could be due to a decrease of illegal harvesting, encroachment, fire incidences and other unregulated activities (Hamza and Kimwer, 2007) and supplemented by an increase of awareness of tree planting activities, which reduce pressure and improve regeneration of forests.

Trees can regenerate naturally in natural forests or artificially through planting. Natural regeneration is the process whereby trees and woodlands are established naturally from seeds, coppices, root suckers produced and germinated *in situ* (Mugasha *et al.,* 2004; Rocky and Mligo, 2012). Natural regeneration under reduced disturbances is much easier than tree planting as native trees are well adapted within the site. However, natural recovery in areas which are subjected to intensive anthropogenic effects might be too slow due to soil degradation, recurring disturbance and isolation from microclimate of intact forests (Shono *et al.,* 2007). Hence, the introduction of fast growing tree species and the application of artificial propagation techniques are considered as alternative solution for improving the availability of wood products and services. Artificial propagation is a process of reproducing suitable planting materials either by seed (sexually) or vegetative (asexually) to achieve various products and services.

Best planting materials (whether from seed or vegetative part) depending on the type of the tree species, must come from the best sources from plus trees in natural forests, plantations, seed stands, clonal seed orchards or mother blocks (Mbora *et al.*, 2009). This will influence efficient establishment of the materials in the field and the achievement of the desired end products. Thus, it is important to conduct experiments to determine appropriate propagation methods with optimum conditions and requirements before large-scale propagation (Hartmann *et al.,* 2011). Under Plantation Forestry and Tree Improvement Programmes, TAFORI has been carrying out experiments and researches on tree improvement, breeding and management for both local/indigenous and exotic trees by evaluating their adaptation on-farms and in the plantations. The findings from various researches - for instance Eucalyptus hybrid clones propagation, utilization and its dissemination to stakeholders have been contributing to solving deforestation and forest degradation.

Furthermore, most of the charcoal producers use inefficient technologies of charcoal-making. This has contributed to the high removal of trees regardless of sizes particularly from dry Miombo woodlands and *Acacia* to savanna woodlands (Hartmann *et al.,* 2011). For example, to produce one ton of charcoal, an estimated 3.4 m^3 of solid wood must be used (Indufor, 2011). The utilization of this source of energy will not be avoided in 10 years to come due to high price of alternative sources of energy such as electricity and solar power systems (Mbwambo *et al.,* 2005). Thus, sustainable charcoal production techniques are required to reduce the rate of forest degradation. This can be done by providing training on how to produce charcoal using improved kiln such as Casamance to communities living adjacent to the forest reserves. Unlike the Traditional Earth Mound Kiln (TEMK) methods, the improved methods of charcoal-making have an average carbonization efficiency ranging from 27% to 35%. The Casamance Earth Mound Kiln (CEMK) and Basic Earth Mound Kiln (BEMK) among others are the two varieties of the improved earth mound kiln. The CEMK that has originated from Senegal in West Africa has technically been proved to be the most efficient method of charcoal-making with a recovery rate of up to 31% (Kimaryo and Ngereza, 1989).

TAFORI EXPERIENCES

TAFORI has been carrying out research in various areas such as planting, growth, development, conservation and the use of. Research has also been carried out regarding pests and diseases associated to these local and exotic tree species. Since the Institute is mandated to do forestry research and development in the country, it has been involved in development of regulations, guidelines, policies and research master plan as tools of research, development, management and utilization of forest resources. The experiences mainly fall under six categories (i) Enhancing natural regeneration on degraded forests and woodlands (ii) Introduction of Eucalyptus hybrid clones and propagation (iii) Artificial propagation of indigenous tree species (medicinal and fruit trees) (iv) Tissue culture application technology (v) Enhancing availability of planting materials through establishment of seed orchards and gene conservation stands (vi) Dissemination of improved kilns for efficient charcoal making, and (vii) Dissemination of research findings through outreach materials.

Enhancing Natural Regeneration on Degraded Forests and Woodlands

Through trials in the Miombo woodlands in Tabora Region, the Institute has enhanced regeneration of 9 dominant Miombo tree species namely, *Afzelia quanzensis, Brachystegia boehmii, B. microphylla, B. spiciformis, Dalbergia melanoxylon, D. nitidula, Pericorpsis angolensis, Pterocarpus angolensis,* and *Swartzia madagascariensis*. Similarly, in the Eastern Arc Mountains the Institute has enhanced regeneration of *Cephalosphaera usambaransis, Newtonia buchananii* and *Ocotea usambarensis* (URT, 2011). The study of tree basal area increment using Permanent Sample Plots (PSP) which was established in the Miombo woodlands of Iringa Region, reported the mean annual basal area increment of 0.22 m^2 per ha and sustainable annual harvests of 2% of the basal area which is about 10 tree per ha after five years of its establishment. While the use of PSP in Kiteto Manyara Region reported the mean annual basal area increment of 0.12 m^2 ha^{-1} and sustainable annual harvests of 1.2% of the basal area which is about 5 – 8 tree per ha.

Furthermore, in collaboration with other stakeholders, the Institute conducted research on PFM which indicated improvement of forest quality. There has been an increase of biodiversity, regeneration, stand density, and growth (Blomley *et al.*, 2011; URT, 2011). Forests under PFM have been recovering as opposed to forests managed by the government alone, or forests under open access regimes (URT, 2008; Blomley and Iddi, 2009). In these areas, livelihood of the communities living near the forests has improved; also there has been an increase of biodiversity, which in turn, increased the area of forest reserves by 2,047,824 hectares (Hamza and Kimwer, 2007). According to a study by Piiroinen *et al.* (2008), grasses in the Miombo woodlands were found to be the major forestry regeneration factor, since when there is an intermediate suppression of grasses through intermediate grazing, tree regenerations are favoured. A similar observation was made on *Ngitili* practice in semi-arid areas of Shinyanga and Mwanza regions. Under *Ngitili* practice, there has been alternating periods of grazing and enclosures of the area, which favours regeneration of trees and grasses for household use, whereby over 500,000 ha of *Ngitilis* and 20 tree species have been revived (Pye-Smith, 2010). The *Ngitili* provides fuelwood, poles, timber as well as fodder for livestock and bee forages. However, improvement of regeneration for vegetation is reported to have increased the cost of protection for crops due to increased wild animals that damage the crops (URT, 2008, Pye-Smith, 2010; Omary, 2011; URT, 2011).

Introduction of Eucalyptus Clonal Hybrids and Propagation

According to 2012 National Population Census, approximately 75% of the country's population lives in the rural areas with 92% depending on wood fuel, which is mainly collected from natural forests, as their main source of energy. This collection is reported to have a major impact on natural regeneration. The deforestation rate is estimated at 372,871 ha per year while the total wood annual growth at the national level is estimated at 83.7 million m^3; and about 42.8 million m^3 per year is available for sustainable harvesting (MNRT, 2015). The demand for wood products, mainly for household energy, in Tanzania is estimated to be 62.3 million m^3 and loss due to land area conversions represents a deficit of about 19.5 million m^3 per year. This deficit can be met by several strategies including the use of fast growing tree species such as Eucalyptus hybrid clones (to meet the needs of fuelwood, timber and wood production on a sustainable basis) and an increase of biomass yield from farm forestry and plantations. According to Patil *et al.* (2012), the mean annual increment (Diameter at Breast Height - DBH) of eucalyptus hybrid at seven years was 2.52 cm while that of Eucalyptus local landraces was 1.78 cm. What is interesting is that, the benefits from Eucalyptus hybrid clones can be throughout the growing period depending on the management objectives **(Table 1).**

Table 1: Benefits of Eucalyptus hybrid clones under various management objectives

Management objectives	Harvesting age (Years)	Number of rotations
Building poles	2	5
Fuelwood	3 and above	4
Pulpwood	6	3 – 4
Transmission poles	6	2 - 3
Timber	12 – 15	2

Source: TAFORI (2017)

In Tanzania, Eucalyptus hybrid clones were introduced from Mondi South Africa in 2003 (TAFORI, 2017). Tanzania is among partner countries in East Africa that transfer and apply Tree Biotechnology for wood products (for home, industry) and construction (Kilimo Trust, 2011; Pima *et al.,* 2016). Through TAFORI, the transfer started by testing adaptability of the introduced hybrid clonal materials in the Tanzanian environment and this was followed by their large scale multiplication. The adoption of the clone based on the promising growth performances of the clone according to agro-ecological conditions. The introduced hybrid clones were *Eucalyptus grandis* x *E. camaldulensis* (GC), *E. grandis x E. urophylla* (GU) and *E. grandis x E. tereticornis* (GT) which has the combination of the desired traits for growth and drought tolerance, disease resistance and rooting ability (Pima *et al.,* 2016; TAFORI, 2017). The extensive trials showed that hybrid clones performed well in different agro-ecological zones of Tanzania, while others were site specific **(Table 2).** Due to their short rotation, wide adaptability, production of better wood quality and uniform stands, the species have the ability to meet various wood demands such as transmission and building poles, pulp, fuelwood and timber within the shortest period.

Table 2: Suggested Eucalyptus hybrids basing on agro-ecological growth performances

Ecological zones of Tanzania	Sites	Altitude (m.asl)	Rainfall (mm)	Eucalyptus hybrid
Lake Zone	Bukoba and Mwanza	1200 – 1600	800 – 1500	GC 15, 167, 514, 584, 785, 940 and GU 21.
Semi-arid	Dodoma and Shinyanga	200 – 1500 m	500 – 800	GC 15, 167, 522, 581 and 548,
Miombo		1000 – 1300	600 – 1200	GC 15, 584 and 940
Coastal	Kibaha and Lindi	Below 300	750 – 1200	GC 15, 167, 514, 584, 940 and GU 21
Lowlands	Korogwe and Mombo	Below 1000	800 – 1200	GC 15, 581, 584, 940 and GT 529
Highlands	Lushoto, Mafinga, Iringa, Tarime and Arusha	1000 – 2500	1000 - 2000	GC 15, 514, 522, 581, 584, 940, GU 125, 608 and GT 529

Source: Kilimo Trust (2011); Pima *et al.* (2016); TAFORI (2017).

In the mentioned ecological zones in **Table 2**, Eucalyptus clones can be planted on degraded areas which are exposed to soil erosion and with low soil fertility, water logged areas and saline soils. They can also be planted as shelter belts and wind breaks for large scale farms management. However, clones should not be planted in riparian areas (along rivers as stipulated in the Environment Management Act, No. 20 of 2004); areas around the lakes, ponds, swamps and any other bodies of standing water), irrigated farmlands and in areas with less than 400 mm of rainfall (TAFORI, 2017). These precautions are against the reported calamities of drying water sources caused by Eucalyptus. However, a strike of balances between the environment security and the demand for more wood resources should be observed (Kilimo Trust, 2011).

Eucalyptus hybrid clones have been multiplied at Kwamarukanga (Korogwe District) and Lushoto (Lushoto District) in Tanga Region, Kibaha (Pwani Region), Mufindi (in Iringa Region) and Kingolwira, Morogoro. For the growing season of between 2015 and 2017, about 920,072 of Eucalyptus hybrids were propagated by TAFORI and sold to various stakeholders. Depending on survivals in the field, these clones may have covered 575 ha at a spacing of 2.5 x 2.5 m contributing to the reduction of deforestation rate by 0.15%. For instance, Sao Hill Forest Plantation managed to plant about 300 ha of Eucalyptus hybrid clones between 2015 and 2016.

Artificial Propagation of Indigenous (Medicinal, Fruit and Timber Trees)

The on-going deforestation and forest degradation have been decreasing the availability of medicinal trees for curing various human and livestock (Dery *et al.,* 1999). Following this deficit, under the partnership with Hifadhi Ardhi Shinyanga (HASHI) or the World Agroforestry Centre (ICRAF), the study was initiated in order to identify tree species used for traditional medicine and later an ethno botanical survey was carried out to identify their availability. The study involved traditional healers, agro-pastoralists, farmers, and forestry experts. The study aimed at incorporating indigenous medicinal trees into farmlands using agroforestry systems. From the study, about 300 trees species were found to be used in traditional medicine for curing 100 human diseases. Eleven priority medicinal trees were selected and collected from areas where they are still available, especially from Miombo woodlands for propagation and silviculture studies. The priority traditional medicinal trees used included *Securidaca longipenduculata, Cassia abbreviate, Entada abyssinica, Turrea fischeri, Albizia anthelmintica, Entadaphragma bussei, Combretum zeyheri, Zanthoxylum chalybeum, Terminalia sericea, Kigelia africana* and *Harrisonia abyssinica*. After germination study, part of medicinal tree seedlings were established on-station at the Natural Forests Management and Agroforestry Centre (NAFRAC) formerly known as HASHI/ICRAF in Shinyanga Region; others were established at Igwata Forest Reserve (IFR) at Malya in Kwimba District, Mwanza Region, and the rest were provided to farmers in Shinyanga Urban. Except for *S. longipenduculata,* the growth performances of the rest have been encouraging and recommended to be planted by farmers through agroforestry practice.

Furthermore, under the partnership with ICRAF Tabora, a similar survey was conducted whereby 79 Indigenous Fruit Tree species (IFTs) in the Miombo woodlands and 131 across the country were identified. As the initial step for domestication and commercialization purposes, priority IFTs species were tested for provenance screening, propagation, suitability, marketing, and value addition (Maduka *et al.,* 2013). Priority species used were *Parinari curatellifolia, Strychnos cocculoides, Uapaka kirkiana, Vitex mombassae, Vitex doniana, Tamarindus indica* and *Vanguelia infausta* established in Tabora while *Vitex mombassae, Vitex doniana, Tamarindus indica* and *Vanguelia infausta* at Lubaga in Shinyanga. The growth performances of these IFTs have been encouraging and have been recommended to be established by farmers through agroforestry practice.

On other hand, the indigenous timber tree species from natural forests have been depleted and need to be artificially propagated due to their poor natural regeneration under natural conditions. The tree species that have been prioritized for artificial propagation included *Afzelia quanzensis*, *Pterocarpus angolensis*, *Milicia excelsa*, *Olea welwitschii* (**Plate 1**). Propagation protocols through stem cuttings have been developed for *O. welwitschii* (Maduka, 2016; Maduka *et al*., 2017). However, similar studies are required for other tree species.

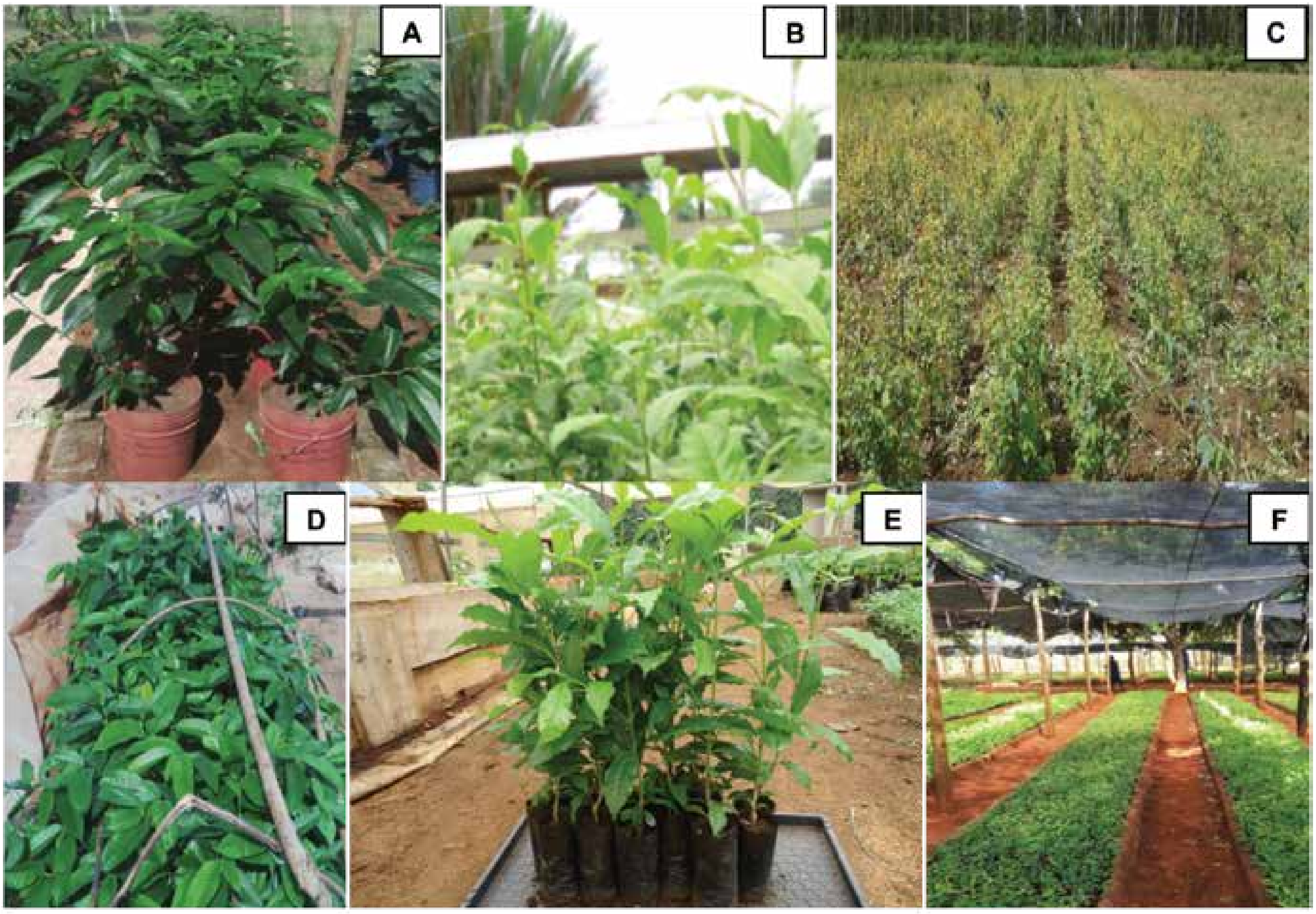


Plate 1: A, B, and C mother blocks for *M. excelsa, O. welwitschii* and Eucalyptus clone hybrids and D, E and F cuttings regenerated artificially through stem cuttings from mother blocks, respectively.

Tissue Culture Technology Application

Forestry development is still facing different challenges namely; propagation, rareness, seed dormancies and poor quality of planting materials. The priority indigenous tree species are threatened and are under both loss of genetic diversity and habitat destruction. Furthermore, the on-going deforestation due to socio-economic activities has resulted to poor natural regeneration that complicates the selection of plus trees of high value timber tree species. In this case, the use of micro-propagation or tissue culture is inevitable. In solving these challenges, TAFORI has developed propagation protocols using tissue culture technologies, namely the *in vitro* multiplication protocols for *O. welwitschii* and *Tectona grandis*. However, to improve the working condition, TAFORI is currently strengthening her laboratory by adding more infrastructure and facilities. The tree species regenerated may be useful for timber production, medicinal, resins and gums, and cosmetics.

The use of tissue culture in plant propagation is popular nowadays yet it is at an infancy stage for Tanzania forests development. Tissue culture or *in vitro* propagation is a technique which is used for mass production of plantlets or seedlings from plant tissues, cells, and somatic embryos in aseptic and artificial environment (Iliev *et al*., 2010; Hartmann *et al*., 2011). It is an important process especially where conventional seedling production rate is low. Unlike seeds, plant vegetative parts such as shoots from managed mother plants may be available all year round for collection of explants for *in-vitro* micro-propagation. The *in-vitro* has been used in massive propagation of specific species or clones of specific desirable characteristics and high economic importance, in the production of pathogen free plants, in germplasm preservation especially of endangered species and in plants that have been improved (Kane, 2000; Hussain *et al*., 2012).

Establishment of Tree Seed Orchards and Gene Conservation

The achievement of afforestation programmes, among others, also depends on sustainable supply of planting materials. TAFORI has been involved in the establishment of seed orchards and gene conservation both for priority indigenous and exotic tree species. According to FAO (1993), seed orchard is a plantation or a stand of selected clones or families which is isolated or managed to avoid or reduce pollination from outside sources, and is managed to produce frequent, abundant and easily harvested crops of seed. On the other hand, gene conservation is the collection of plant genetic resources, with the overall aim of long-term conservation and accessibility of plant germplasm to plant breeders, researchers, and other users.

TAFORI in collaboration with Tanzania Forest Services Agency (TFS) and Tanzania Tree Seed Agency (TTSA) have identified plus tree for *T. grandis* (Teak) from superior stands from Mtibwa, Longuza and Kihuhwi plantations for seed collection and establishment of seed orchard at Mtibwa Forest Plantation. Planting materials were collected from 100 plus trees (families) for the establishment of clonal seed and seed seedlings orchards. Furthermore, the Institute participated in the identification of plus trees for indigenous trees species namely, *Afzelia quanzensis, Milicia excelsa* and *Khaya anthotheca* for seed collection and seed orchards establishment at Mtibwa Forest Plantation. These orchards will save as the gene conservation stands as well as reliable seed sources improvement and production of planting materials for the establishment of plantations and woodlots.

At the same time, TAFORI - Moshi Timber Utilization Research Centre at Kilimanjaro has managed to establish seed orchards for *Pinus radiata* and *P. patula* from Zimbabwe, *Eucalyptus cloeziana, Grevillea robusta* and *P. patula* from Muguga Kenya. Likewise, Malya Afforestation Research Centre in the Lake Zone has managed to establish *ex-situ* gene conservation stands of lesser known fast growing tree species for *Melia azedarach* and *Gmelina arborea*. The tree species have the ability of growing fast in semi-arid areas of the Lake Zone and meet the demands for timber while the gene conservation stands will save as reliable seed sources and will also be used for further improvement works. At Mufindi Centre, the Institute has established seed orchards for *E. grandis* and *P. patula* with the support from TaFF, seed orchard for *E. pellita* and *E. urophylla* and gene conservation stand for *P. maximinoi* under partnership of Central American and Mexico Coniferous Research (CAMCORE). Similarly, Lushoto Silviculture Research Centre in Tanga has established clonal seed orchards of *P. patula, Cupressus lusitanica*, *ex-situ* gene conservation of *E. tereticornis*, seed stands of *G. robusta, E. saligna, E. grandis* and *C. lusitanica,* seedlings seed orchard of *P. patula* and seed orchard of *T. grandis* under CAMCORE partnership.

Dissemination of Improved Kilns for Efficient Charcoal Production

TAFORI has initiated the programme of disseminating improved charcoal production technology to charcoal producers. The introduced technologies were Casamance Earth Mound Kiln (CEMK) and Basic Earth Mound Kiln (BEMK). The technologies have a relatively higher recovery rate when compared to conventional methods. Further, TAFORI has conducted demonstrations to farmers at Kileo Forest Reserve Mwanga District in which five earth kiln designs were tested, and at Kahe village in Moshi Rural District where two earth kiln designs were tested **(Table 3).** Similarly, demonstrations were conducted at Kihangaiko villages in Bagamoyo District, Pwani Region and at Gwata and Lubungo villages in Morogoro Region **(Table 4).**

Table 3: Recovery rate for CEMK and BEMK at Kahe, Moshi Rural District, Kilimanjaro Region

Kiln type	Wood/logs weight (Kg)	Volume of logs (m^3)	Average stalk density (Kg/m^3)	Weight of charcoal (Kg)	Number of bags (Kg)	Recovery rate (%)	Duration of burn (days)
CEMK	2,457.8	4.4137	454	578.8	20	23.55	6
BEMK	2,420.7	4.4509	454	428.05	15	21.18	6

Table 4: Charcoal production using CEMK and TEMK in Bagamoyo and Morogoro sites

	Kihangaiko Village site		Kwang'andu Village site		Gwata Village site		Lubungo Village site	
Attribute	CEMK	TEMK	CEMK	TEMK	CEMK	TEMK	CEMK	TEMK
Amount of wood (m^3)	4.5	4.5	9.0	9.0	1.8	1.8	2	2
Days to complete charcoaling process	8	10	12	14	5	7	4	4
Debris and ashes (kg)	15	25	25	35	23	29	6	13
Quantity of charcoal produced (28 kg bag)	33	20	132	80	15	8	13	5
Tree species used	*Acacia nigrescens* (Mkambala) and *Xeroderris stuhlmanii* (Mnyinga)		(*Acacia xanthophloea*) Mkongowe		*Acacia nigrescens* (Mkambala)		*Acacia senegalis* (Mkongowe)	

From the above demonstrations **(Tables 3 and 4),** the Casamance Earth Mound Kiln (CEMK) has proved to be the most efficient among the three designs. This kiln is recommended to be disseminated to more charcoal-makers, technicians, Council natural resource officers and other stakeholders in order to reduce the number of trees which are used by the Tradition Earth Mound Kiln (TEMK) and contribute to the reduction of deforestation and forest degradation in Tanzania.

Enhancing Dissemination of Research Findings to Stakeholders

TAFORI has been making sure that research findings and technologies are disseminated to different stakeholders through development of outreach materials. The aim is to ensure that sufficient knowledge and technologies are available to solve deforestation and forest degradation in Tanzania. Several scientific articles have been published in newsletters, national and international journals, proceedings, books and chapters in books. Dissemination materials such as fliers, posters and booklets have been translated in user-friendly languages and distributed to stakeholders. Different directives in technical orders, guidelines and manuals have been developed as well.

CONCLUSION AND RECOMMENDATIONS

Tanzania Forestry Research Institute for many years accrued significant knowledge and experiences in tackling deforestation and forest degradation in Tanzania. The achieved experiences contributed a lot to reducing deforestation and forest degradation in the country. The available information is useful to researchers, academicians, decision makers, and the general public at large. To make sure that the efforts made are not lost, and more is done, partnerships and collaboration with other stakeholders need to be strengthened. More infrastructures, capital and human resources are required to catalyze further execution of more researches and the delivery of findings and innovations throughout the country.

REFERENCES

Blomley, T. and Iddi, S. 2009. Participatory Forest Management in Tanzania: 1993 – 2009. Lessons learned and experiences to date. [http://www.tzdpg.or.tz/fileadmin/_migrated/content_uploads/PFM_Lessons_learned_final.pdf] site visited on 21/4/2018.

Blomley, T., Lukumbuzya, K. and Brodnig, G. 2011. Participatory Forest Management and REDD+ in Tanzania. World Bank. [http://siteresources.worldbank.org/EXTSOCIALDEVELOPMENT/Resources/244362-1232059926563/5747581-1239131985528/5999762-1318623469948/TanzaniaReport.pdf] site visited on 31/5/2014.

Dery, B.B., Otsyina, R. and Ng'atigwa, C. 1999. *Indigenous knowledge of medicinal* trees *and setting priorities for their domestication in Shinyanga Region, Tanzania.* Nairobi: International Centre tor Agricultural Research. 98pp.

FAO. 1993. *Seed Orchard*. Guidelines on Establishment and Management Practices. Field Manual No. 4. [http://www.fao.org/docrep/006/ad223e/AD223E00.htm#TOC] site visited on 16/4/2018.

FAO. 2011. State of Word's Forestry, Rome. 179 pp. [www.fao.org/docrep/013/i2000e/i2000e.pdf] site visited on 15/11/2011.

Hamza, K.F.S. and Kimwer, E.O. 2007. Tanzania's Forest Policy and Its Practical Achievements with Respect to Community Based Forest Management in MITMIOMBO. *Working Papers of the Finnish Forest Research Institute,* 50: 24–33.

Hartmann, H.T., Kester, D.E., Davies, F.T. and Geneve, J.R.L. 2011. *Hartmann and Krester's Plant Propagation: Principles and Practices.* Eighth Edition. Prentice Hall. Pearson Education Inc., Upper Saddle Fine, New Jersey. 880pp.

Hussain, A., Qarshi, I.A., Nazir, H. and Ullah, I. 2012. Plant tissue culture: Current status and opportunities. INTENCH Open Science. [http://cdn.int ech open.com/pdfs-wm/40180.pdf] site visited on 6/3/2018. 28pp.

Iliev, I., Gajdoˇsov´a, A., Libiakov´a, G. and Jain, S. 2010. Plant micro-propagation. In: *Plant Cell Culture*. (Edited by Davey M. R. and Anthony P.), John Wiley & Sons, Ltd. pp. 24.

INDUFOR. 2011. *Timber market dynamics in Tanzania and in key export markets*. Private forestry and carbon trade project. 193pp.

Kahyarara, G., Mbowe, W. and Kimweri, O. 2002. *Poverty and Deforestation around the Gazetted Forests of the Coastal Belt of Tanzania*. Research on Poverty Alleviation. Research Report No. 02.3.

Kane, M.E. 2000. Propagation from pre-existing meristems. In: *Plant tissue culture concepts and laboratory exercises.*

(Edited by Trigiano, R.N. and Gray, D.J.), second edition CRC Press, New York. pp. 75 – 86.

Kashaigili, J., Mbilinyi, B., Tabor, K., Hall, J., Malugu, I., Sumbi, P., Kijazi, A. and Burgess, N.D. 2013. Tanzania is losing its biodiversity-rich Coastal Forests. Deforestation in Tanzania's Coastal Forests. *The Arc Journal,* 28:5 – 7.

Kilimo Trust. 2011. *Eucalyptus Hybrid Clones in East Africa; Meeting the Demand for Wood through Clonal Forestry Technology*. Occasional Paper No.1. 32pp.

Kimaryo, B.T., and Ngereza, K.I. 1989. *Charcoal production in Tanzania using improved traditional earth kilns*. IDRC Manuscript Report. 27pp.

Maduka, S.M., Mbwambo, L. and Swai, R.E. 2013. Review on status of research and development of edible indigenous fruits in Tanzania. *TAFORI Newsletter,* 7 (2): 32 – 38.

Maduka, S.M. 2016. Propagation and Initial Field Establishment of Elgon Olive (*Olea welwitschii* (Knobl.) Gilg & Schellenb). A Thesis for the Award of Doctor of Philosophy of Sokoine University of Agriculture, Morogoro Tanzania. 110pp.

Maduka, S.M., Msogoya, T.J. and Chamshama, S.A.O. 2017. Effect of rooting media and indole-3-butyric acid concentrations on regeneration potential of Elgon olive (*Olea welwitschii* (Knobl.) Gilg & Schellenb) stem cuttings. *Tanzania Journal of Forestry and Nature Conservation* 86(2): 1 – 12.

Masanja, G.F. 2013. Population Dynamics and the Contraction of the Miombo Woodland Ecozone: A Case Study of Sikonge District, Tabora Region, Tanzania. *Journal of Environment and Earth Science,* 3 (10) 193 – 205.

Mbora, A., Lillesø, J.P.B., Schmidt, L., Angaine, P., Meso, M., Omondi, W., Ahenda, J., Mutua, N. A., Orwa, C. and Jamnadass, R**.** 2009. *Tree Seed Source Re-classification Manual.* World Agroforestry Centre, Nairobi, Kenya. 34pp.

Mbwambo, L., Balama, C. and Mugasha, W. 2005. *The Impact of Electricity and Petroleum Tariffs on Woodfuel Consumption in Kinondoni and Morogoro Urban District of Tanzania*. TAFORI, Morogoro. 25pp.

Milledge, S.A.H. and Kaale, B.K. 2005. *Bridging the Gap - Linking timber trade with infrastructure development in Southern Tanzania: Baseline data before completion of the Mkapa Bridge*. TRAFFIC East/Southern Africa, Dar-es-Salaam, Tanzania. 120pp.

MNRT. 2015. *National Forest Resources Monitoring and Assessment of Tanzania Mainland: Main results*. Tanzania Forest Services (TFS) Agency in Collaboration with the Government of Finland and Food and Agriculture Organization (FAO) of the United Nations. Ministry of Natural Resources of Tanzania, Dar es Salaam. 106pp.

Mugasha, A. G., Chamshama, S.A.O. and Gerald V.V.K. 2004. *Indicators and Tools for Restoration and Sustainable Management of Forests in East Africa*. State of Forests and Forestry Research in Tanzania. I-TOO working paper No. 3. 56pp.

Omary, I. 2011. Role of local community on enhanced participatory forest management: The case study of Mgori Community Forest Reserve, Singida District. A Dissertation for the fulfilment of the award of the degree of Master of Art in Sociology of the University of Dodoma. 133pp.

Patil, H.Y., Patil, S.J., Mutanal, S.M. and Shahapurmath, G. 2012. Growth and productivity of different Eucalyptus species on degraded land. *Karnataka Journal of Agriculture Science,* 25 (1): 92-93.

Piiroinen, T., Roininen, H. and Valkonen, S. 2008. Regeneration of Miombo woodlands: Effects of herbivory, management and competition. *Finnish Forest Research Institute*, 98: 46–51.

Pima, N.E., Chamshama, S.A.O., Iddi, S., Maguzu J. 2016. Growth Performance of Eucalypt Clones in Tanzania. *Environment and Ecology Research,* 4(3): 146 – 154.

Pye-Smith, C. 2010. *A Rural Revival in Tanzania*: *How agroforestry is helping farmers to restore the woodlands in Shinyanga Region.* ICRAF Trees for Change No. 7. World Agroforestry Centre, Nairobi. 43pp.

Rocky, J. and Mligo, C. 2012. Regeneration pattern and size -class distribution of indigenous woody species in exotic plantation in Pugu Forest Reserve, Tanzania. *International Journal of Biodiversity and Conservation,* 4(1): 1-14.

Shono, K., Cadaweng, E.A. and Patrick, D.B. 2007. Application of Assisted Natural Regeneration to Restore Degraded Tropical Forestlands. A review. *Restoration Ecology.* 15 (4): 620–626.

TAFORI. 2017. *Guidelines for Planting Eucalyptus Clones in Tanzania.* Tanzania Forestry Research Institute. 18pp.

URT. 2008. *Participatory Forest Management in Tanzania. Facts and Figures*. United Republic of Tanzania, Dar es Salaam. 12pp.

URT. 2009. *National Framework for Reduced Emissions from Deforestation and Forest Degradation (REDD).* United Republic of Tanzania, Dar Es Salaam. 39pp.

URT. 2011. *National Forestry Research Master Plan II* (*NAFORM II) 2011-2020.* United Republic of Tanzania, Dar es Salaam. 29pp.

SOLID BIOFUELS OPTIONS AND SUSTAINABILITY: TaTEDO EXPERIENCE

Sawe, E.N. and *Swai, M.E.

Tanzania Traditional Energy Development Organization (TaTEDO), P.O. Box 32794, Dar es Salaam
*Corresponding author email: mary.swai@tatedo.org

ABSTRACT

Biomass energy (firewood and charcoal) are the main source of energy in Tanzania due to poverty, affordability and unavailability of alternatives. Biomass energy accounts for 90% of the overall energy consumption. The projections indicate that the contribution of solid biofuels will decrease, but the total use will increase during the coming decades due to population increase. Efficiencies of production and use of solid biofuels are usually low, with serious negative consequences. Charcoal demand has doubled over the past ten years as a result of rapid urbanization and high relative prices of or scarcity of energy substitutes, the projections show that the demand for charcoal, without appropriate interventions, will double by 2030, from approximately 2.3 million tons in 2012. The national biomass energy vision is to ensure that Tanzania and her people benefit from sustainable biomass energy management for sustainable development. In the efforts of enabling access to sustainable energy, TaTEDO has been promoting efficient cooking stoves and sustainable charcoal production. This paper discusses various alternative kiln technologies which were developed by TaTEDO for efficient use of biomass energy. The commonly used stoves (from the less to the most efficient) are provided. Various interventions for sustainable charcoal production are given. Among the recommendations provided for giving and maintaining biofuel options and sustainability include; improved resource management, improved regulations and governance and designing an enabling framework, enhanced affordability, and improved awareness on cooking technologies.

Keywords: Solid Biofuels, Options and Sustainability, TaTEDO Experience

Introduction

The total forested land in Mainland Tanzania is 48.1 million ha, which provides the national per capita area of 1.1ha. The forest area is equivalent to 54.4% of the total land area of 88.3 million ha (URT, 2015a). Around 28 million ha of the total forest area are protected where harvesting is not allowed; and the remaining 20.1 million ha are production forests where regulated harvesting of forest products including charcoal production is legally allowed. The average volume of wood is 37.9 m^3 per ha across all forest land cover types (URT, 2015a). Illegal and unsustainable harvesting of forest products, particularly charcoal is widespread in both productive and protective forests, leading to deforestation and environmental degradation. The estimated forest cover loss amounts to 372,816 ha per year (URT, 2015a). Tanzania is estimated to consume 62.3 million m^3 annually, which exceeds the annual allowable cut of 42.8 million m^3. The wood deficit from legal sources is around 19.5 million m^3 per year, which is met by overharvesting in the accessible forests and illegal harvesting in the protected forests.

Biomass Energy Sector

In Tanzania, wood energy demand accounts for approximately 90% of Tanzania's overall energy supply and demand. Almost 90% of that demand comes from the household sector, with the remainder coming from household enterprises (often referred to as cottage industries), commercial, institutional and industrial demand (CAMCO, 2015).

The use of firewood as the source of energy for cooking is still predominant in Tanzania Mainland as 71.2% of households use firewood as the major source of energy for cooking, followed by charcoal (37.0%) and kerosene (5.0%). The use of firewood is more dominant to rural households (92.0%) compared to urban households (28.4%). On the other hand, only 1% of households use modern sources of energy for cooking (electricity, bio and industrial gas, and solar) (URT, 2017).

In the urban areas, approximately 79% of the households use charcoal as their primary source of energy for cooking. Dar es Salaam city is the major consumer (50-70 % of the national consumption) of charcoal with 88.2% of households using it as the major source of energy. Until recently (2012), non-household demand for charcoal in Dar es Salaam was equivalent to approximately 15% of urban household consumption, and which amounted to 300,000 tons. The demand for charcoal has been driven by rapid urbanization and high relative prices or scarcity of energy substitutes, particularly kerosene, electricity, biogas, biomass briquettes, and Liquid Petroleum Gas (LPG). Projections show that the demand for charcoal, without supply- and demand-side interventions, will double by 2030, from approximately 2.3 million tons of charcoal in 2012 (URT, 2015b).

Unsustainable resource management and harvesting practices, low quality and inefficient energy technologies affect biomass energy conversion and utilization. The energy efficiency of charcoal production technology which is used is poor, with conversion efficiencies of 15% or less. In most instances, charcoal production is done using traditional earth or pit kilns, where wood is cut and stacked before being covered in earth and carbonized. This is a highly inefficient process, with a conversion efficiency of around 8% to 12% **(Fig. 1).**

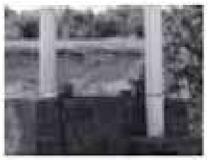
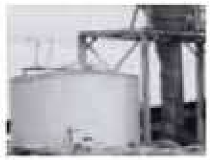
Characteristics	Traditional Kilns	Improved Kilns	Semi-industrial Kilns	Industrial Kilns
Conversion Technology				
Efficiency	8-12%	12-18%	18-24%	>24%
Emissions (in g per kg charcoal produced)	CO_2: 450 - 550 CH_4: ~700 CO: 450 - 650	→	→	CO_2: ~400 CH_4: ~50 CO: ~160

Figure 1: Efficiency of various charcoal production and Kiln Technologies

Source: World Bank, 2009.

According to World Bank (2010), charcoal production caused an annual loss of forest cover of 100,000 - 125,000 ha. For each tonne of charcoal produced in Tanzania, an estimated 9.1 tons of CO_2 are emitted (ESD, 2008) contributing to global warming and adverse climate change.

The cooking appliance which is used by the majority of rural population is a three stone stove which is estimated to have a little thermal efficiency of between 10% and 15% (TaTEDO, 2011). Of not less concern are the adverse socio-economic consequences such as indoor pollution, health hazards, and time used for fuel (firewood) gathering. This makes the lack of access to improved cooking solutions as a poverty trap and a barrier to economic development. According to World Health Organization (WHO) on a global scale, nearly 28,000 deaths occurring annually are linked to respiratory and other diseases, which are attributable to indoor air pollution from solid fuel. The same cause is believed to represent close to 5% of the burden of disease in Tanzania. Figure 2 shows chronological development of cooking stoves which is taking place in Tanzania.

Characteristics	Traditional Phase	Transition Phase	Semi-Industrial Phase	Industrial Phase
Combustion Technology	3-Stone Fire 	Improved Stove (First generation) 	Improved Stove (Second generation) 	High Efficiency Stove 
Efficiency	8-12%	20-25%	25-35%	>35%

Figure 2: Commonly used stoves for fuelwood and charcoal combustion

Source: Sepp, 2008 cited in World Bank, 2009

TaTEDO Interventions to Address Deforestation

TaTEDO promotes various technologies for sustainable charcoal production, energy efficient firewood stoves, charcoal stoves and ovens; biogas, charcoal briquettes.

Sustainable charcoal production methods

Many projects have tried to overcome the challenge of low efficiency levels by promoting more efficient kilns for charcoal production. However, the adoption rates have been disappointing as a result of an informal and often illegal nature of charcoal production. Without secure and long-term access to wood resources, investments by producers in more efficient conversion methods are likely to be limited. Additional challenges that have been encountered when promoting improved conversion technology include:

- The cost of improved kilns, which may be prohibitive for small-scale producers with limited purchasing power and very little access to credit;
- The tendency of charcoal production being highly mobile, given that most charcoal is produced in the drylands where forest cover is low. Improved kilns tend to be stationary, which puts additional costs to producers for carrying wood from the point of harvest to the kiln. This can be an arduous and time-consuming task over rough ground.

In recognition of these potential challenges, TaTEDO advocates for three types of kilns. These include Improved Basic Earth mound Kiln (IBEK), Half Orange Charcoal Kiln (HOCK), and Retort Kiln.

Figure 3: Improved Basic Earth mound Kiln (IBEK)

Improved Basic Earth mound Kiln (IBEK)

TaTEDO has undertaken simple adaptations to traditional kiln designs and achieved significant savings at a low cost. The improvement include the introduction of a chimney and ensuring that the wood used in the kiln is adequately dried and cut into approximately similar sizes. The Improved Basic Earth mound Kiln

(IBEK) **(Fig. 3)** has conversion efficiency of 20 – 25% as compared to traditional Kilns which has less than 13% (TaTEDO, 2013). IBEK has the benefit of reducing the number of logs which burn to ashes (wood wastage) in the kiln as well as reducing carbonization cycle time from 8 to 4 days. IBEK is applicable to small scale/individual charcoal producers. TaTEDO has trained more than 1000 local charcoal producers on the construction and operation of Improved Basic Earth mound Kiln.

Half Orange Kiln (HOK)

This is an improved charcoal production kiln which is constructed using burnt bricks. It has efficiency of 25 – 35 %. Half Orange Kiln has the benefit of reducing wood wastage and hence increases the quantity of charcoal. HOK is applicable in fuel wood plantations and saw mill industries that use larger amounts of raw materials (wood) for carbonization **(Fig. 4).** TaTEDO has been promoting the construction and operation technology through capacity building to technicians in sawmills industries for recycling the wood leftovers and areas of large scale trees clearing.

Figure 4: Half Orange Brick Kiln

Briquettes Production - Retort Kiln

TaTEDO promotes the production of charcoal briquettes from agro-forestry residues. The agro-forestry residues such as maize cobs, rice husks, sawmill wastes, and charcoal dusts are carbonized by using retort kiln through process which is called pyrolysis to produce carbonized residue (bio-char) **(Fig. 5).** The carbonized residues are processed into briquettes. According to Hanne (2012), the net Green House Gas (GHG) emission reduction is 78–557 kg of CO_2eq MWh−1, or 42–84%, when replacing charcoal from Miombo woodlands with these charcoal briquettes, depending on whether or not the substituted charcoal can be considered carbon neutral. High-quality non-carbonized briquettes and firewood are more eco-efficient than charcoal. This means that their carbon footprint, in other words, the amount of GHG they emit is smaller and consumer costs are low.

Figure 4: Retort Kiln

Efficient Charcoal and Firewood stoves

TaTEDO promotes energy efficient firewood and charcoal stoves for cooking and baking in households, institutions, and business centres. Through adaptive research and development (R&D) activities, TaTEDO has improved efficiency of cooking stoves through the designing and selection of proper materials. TaTEDO has developed twelve prototypes of charcoal stoves and six types of ovens including, (Straight, Bell-bottom and Sazawa), Double Plates (Stand and Box), Meat Roasting Ovens (Teksawa and Nyama Choma), and Baking Ovens (Households and SMEs) **(Figs. 6a&b).** The energy efficient firewood stoves are of three types; the improved brick made firewood stoves, the low cost made of mud stove, and Kuni-mbili stoves. All these stoves and ovens have passed through different processes of development depending upon the requirements of users and technical specifications which are considered appropriate. Improved cooking-stoves are more efficient and significantly reduce cooking time and fuel consumption compared with unimproved traditional three stone fireplaces and metal charcoal stoves.

Figure 6a: Efficient charcoal and firewood stoves

Figure 6b: Prototypes of charcoal stoves and ovenstutional firewood stoves

In addition, well performing improved cooking stoves help significantly in reducing fine particle emissions. The thermal efficiency of these stoves and ovens compared with the traditional ones has been raised from 15% to a range of 30 to 40% (TaTEDO, 2011). Through the combining efforts of different stakeholders, in Dar es Salaam more than 10,000 stoves are produced per month. The efforts of improving cooking stoves have resulted in the reduction of the quantity of the charcoal consumed as well as time and money, because the amount of charcoal and the time used in cooking have been reduced by 50%, leading to the reduction of deforestation.

Biogas

Tanzania has over 44 million of cattle units that could contribute to biogas production to intensify availability of clean energy to the community and contribute to the attainment of Sustainable development goals. Domestic biogas installations provide benefits in the fields of energy, agriculture, health, environment, natural resource, sanitation, education, gender, and the environment for enhancing the improvement of community livelihood and poverty eradication.

TaTEDO has been promoting biogas for cooking and lighting in households and institutions. Biogas is well suited for households and commercial farms where sufficient animal manure can be collected on a daily basis, or in communities that produce substantial agricultural waste. Digesters can be built on a variety of scales, from household to commercial, and is fairly efficient for use in stoves, providing instant heat upon ignition, and which can be regulated in most burners. Biogas provides a sustainable opportunity for individual households with livestock to reduce dependency on firewood and fossil fuels and benefits from modern and clean energy as well as potent organic fertilizers. Consequently, socio-economic living conditions, employment rates and environmental sustainability are considerably boosted, while reducing emissions and contributing to mitigation of climate change. With respect to biogas, some of the envisaged benefits of biogas use to the national economy include the reduction of CO_2 emissions. If biogas displaces kerosene, at least between 357 – 60,952 tons of CO_2 per annum would be avoided.

Challenges and Opportunities in Biomass Energy Sector

The National Five Year Development Plan (2016/2017 – 2020/2021) proposes the reduction in charcoal consumption in urban areas by 60% in 2020/2021 and by 30% in 2025/2026. The Biomass Energy Strategy (BEST) of 2014 suggests:-

- The implementation of an Improved Cooking Stove (ICS) programme prioritising urban households and commercial and institutional consumers, with an indicative target of reducing urban charcoal demand by 50% in 2030.
- Commercially mainstreaming of biomass alternatives (in particular biomass briquettes and biogas)

with the objective of reducing the demand for charcoal and commercial fuel wood by 5% by 2030;

- Making non-biomass charcoal and commercial fuel wood alternatives competitive on a non-subsidised basis in terms of availability and price with the target of reducing the demand for charcoal by 50% in 2020.

The Sustainable Energy for All (SE4ALL) Action Agenda (2015) projected the target of percentage of the population with access to modern cooking solutions of 75% of the population in the country by 2030. The challenges and opportunities which are associated with scaling up clean cooking solutions in the country are detailed below.

Improved Cooking Stoves

ICS sector is predominantly informal, largely donor driven and is operated between multiple development partners and networks, with weak coordination within ICS sub sector. Improved woodfuel stoves are disseminated by multi stakeholders through trained entrepreneurs, agents, and shops; and the stoves and fuels are not standardized. A GVEP study (2012) on ICS market assessment in Tanzania, estimated the penetration of improved stoves (mostly charcoal stoves) of about 1,000,000 households to urban areas. Low usage of improved cook stoves is attributed to low awareness and knowledge on the use of ICS, inadequate development of supply chain, existence of low quality stoves in the market due to inadequate quality control and failure to meet consumers' needs in some cases.

The adoption of ICS is determined by different factors such as usability, the costs involved in purchasing and maintaining the stove, the purchasing power of the people, portability, thermal efficiency, and emissions (in-door air cleanness). Consumer acceptance and preference for ICS is challenged by the prevalence of poor quality stoves due to lack of standardization and certification **(Table 1).** There is a need of demonstrating superior performance and cost savings to offer value for money for higher quality products. The introduction of subsidies or microfinance schemes may be combined with promotion initiatives to increase affordability.

Table 1: Market related barriers and opportunities – ICS

Cooking solution	Barriers	Market Opportunities
Improved Cooking Stoves	• Predominantly informal • Inadequate awareness on available quality technology options • Inadequate skilled producers for improved cook stoves • Weak coordination • Lack of high-level political buy-in. • Small scale initiatives with inadequate funding. • Existence of low quality stoves in the market	• Potential for local manufacture of stoves and local jobs creation • Growing international concerns for using ICS to alleviate respiratory health problems • Willingness of fund allocation from development partners, • Several local NGOs are willing to develop the ICS sector, • Huge potential market for ICSs and fuels in rural and urban areas

Charcoal Briquettes

Market uptake of charcoal briquettes is slow and the demand is still low. the supply of briquettes is facing challenges which are related to technical knowhow, competitive use of feedstock with other uses, low awareness and competition with firewood and charcoal **(Table 2).** Internationally, experience shows that progress often stops once international financial and technical support stops, and/or when the machinery supplied (presses, extruder, pelletizing tables) is worn out. For example, DANIDA supported the development of this technology during the 1980's, but discontinued the support in the beginning of 1990ies after several major failures.

Table 2: Market related barriers and opportunities for charcoal briquettes

Solution	Barriers	Market Opportunities
Charcoal Briquettes	• Production is still low and market is underdeveloped. • Capital intensive technology • Feedstock compete with other uses • Availability of binder is limited • Feedstock available at scattered nature. • Inadequate knowledge and skills of producing bio-char from bio-wastes • Lack of appropriate stoves, reducing in exhaust of fumes • Low investment in the briquette development • Few international success stories, particularly in comparable markets.	• Relatively simple technology • Potential of Innovation in appropriate stove production • No changes needed in people's cooking habits • Limited indoor air pollution (smokeless) compared to wood charcoal • Can be implemented at different scales • Good opportunities for women in production and sales • NGOs involved

Biogas

The biogas is used by both rural and urban households in Tanzania at an average of 0.1% and 0.4%, respectively (CAMCO, 2014). The main sources of feeding materials for biogas production in rural areas is livestock manure and human excreta (>20kg daily) (Tanzania Domestic Biogas Program, 2014). According to annual agricultural survey report by the Ministry of Agriculture Livestock and Food Security 2014/15, the number of cattle in the country was about 26 millions, where by one cattle is estimated to produce an average of 10kg of dung per day for zero grazing and 5kg for free range grazing. This is huge potential of biogas development in Tanzania. The low uptake of biogas is contributed among others by the capital intensiveness of the technology, affordability, low awareness on the potential of biogas, availability of biogas cooking appliances and close attention which is required for feeding the bio-digester (CAMCO, 2014). **Table 3** provides a list of some of the barriers and market opportunities for biogas in the country. Biogas plants represent a good synergy between energy and fertiliser, and the construction of biogas plants demands the training of new artisans and masons. Thus, despite the limited impact on wood fuel usage, the promotion of this clean, efficient, and employment creating technology is worth for further consideration.

Table 3: Market related barriers and opportunities for Biogas

Solution	Barriers	Market Opportunities
Biogas	• Inadequate awareness on biogas potential for cooking • Inadequate skilled biogas constructors/ installers • Inadequate knowledge by households to operate biogas plant • High upfront cost • The fermentation process needs a continuous supply of feedstock and water, which can be a problem in arid areas. • Feeding the digester, removing obstructions, and maintaining the mixture and equipment can be labour-intensive. • Limited availability of cooking appliances.	• Biogas if adopted can reduce use of wood fuels by households and institutions • Burns cleanly without producing smoke or ash, low emissions, clean cooking • Help to change waste into clean energy hence improve health, sanitation and the environment. • Slurry that remains after digestion is rich in nitrogen and phosphorus and can be used as a high quality organic fertilizer and increase crop productivity. • It is source of income and employment for biogas masons/ constructors • Multipurpose usage (cooking, lighting, etc.)

CONCLUSION

Several approaches may be applied to mitigate solid biofuel sustainability. This can be reached through improving regulation and sustainable management of biomass resources, promoting large scale use of efficient technologies, and encouraging people to switch to improved cooking fuels and technologies. These approaches are complementary, and a combination of all will be necessary to ensure lasting solutions to the problems.

RECOMMENDATIONS

The following recommendations are provided for sustainable use of solid biomass;

(i) Address inadequate awareness through demonstration programs, and subsidies on the available improved cooking technologies to promote behavioural change in the community;
   - Promote large scale use of improved cook stoves in rural and urban areas.

(ii) Enhance affordability - address the barrier of low purchasing power through;
   - Linking end-users with credit services providers (MFIs) to enable them to increase their income through establishing productive use of energy technologies; and
   - Developing business models, sizes and solutions that are suitable for income levels of specific market segments.

(iii) Improved resource management - Reduce deforestation and encourage afforestation to increase biomass energy sustainability through;
   - Developing harvesting plans for forest areas administered by the central or local governments;
   - Encouraging large scale development of fast growing multi-purpose tree growing;
   - Promoting fast growing Tree Woodlots and Urban Forests in high, medium, and low forest cover regions;
   - Securing tenure for rural producers by scaling up community-based forest management in the urban catchment areas;

- Promoting sustainable wood resources management models (techniques and practices for sustainable harvesting of natural forest and Miombo woodlands (CBFM, JFM and PFM);
- Promoting the use of forest by-products such as pruning's, thinning, offcuts and sawdust's for energy purposes; and
- Increasing efficiency of converting wood to charcoal.

(iv) Improve regulations and governance and the enabling framework through;
- Addressing weaknesses in formulating and enforcing appropriate regulation;
- Developing biomass energy supportive policies;
- Capacity building for regulation development and enforcement and promote good governance
- Appropriate standards on cooking technologies (fuels and appliances);
- Active enforcement framework of enacted regulations and good governance;
- Overall national policy and strategy on the use of improved cooking energy solutions; and
- Harmonisation of different biomass related policies and legislations.

(v) Collaborating with Research and Development institutions in realization of biogas technologies that could be applied in the drought areas; and

(vi) Promoting gender participation in the whole biomass value chain.

REFERENCES

CAMCO. 2014. Tanzania Biomass Energy Strategy and Action Plan (BEST)

ESD. 2007. *Situation Analysis of Charcoal Dynamics, Energy Policies and Possibilities of Switching to Alternatives.* Consultant Report. Energy for Sustainable Development, Dar es Salaam.

Hanne, K. 2012. Reducing greenhouse gas emissions from households and industry by the use of charcoal from sawmill residues in Tanzania. *Journal of Cleaner Production,* 27: 109-117.

URT. 2015a. *National Forest Resources Monitoring and Assessment of Tanzania Mainland (NAFORMA): Main Results*. Ministry of Natural Resources and Tourism, Tanzania Forest Services Agency in Collaboration with the Government of Finland and Food and Agriculture Organization. United Republic of Tanzania, Dar es Salaam. 124pp.

URT. 2015b. *National Energy Policy*. Ministry of Energy and Minerals. United Republic of Tanzania, Dar es Salaam. 88pp.

URT. 2015c. *Tanzania's SE4ALL Action Agenda*. Ministry of Energy and Minerals. United Republic of Tanzania, Dar es Salaam. 96pp.

URT. 2016. *The National Five Year Development Plan (2016/2017 – 2020/2021)*. United Republic of Tanzania, Dar es Salaam. 316pp.

URT. 2017. *Energy Access Situation Report - Mainland Tanzania Report 2016*. United Republic of Tanzania, Dar es Salaam. 377pp.

World Bank. 2009. *Environmental Crisis or Sustainable Development Opportunity? Transforming the charcoal sector in Tanzania*. A Policy Note. Dar es Salaam. 72pp.

World Bank. 2010. *Enabling Reforms: A Stakeholder-Based Analysis of the Political Economy of Tanzania's Charcoal Sector and the Poverty and Social Impacts of Proposed Reforms*. Dar es Salaam. 64pp.

CHALLENGES OF PRODUCING QUALITY TREE SEEDS TO SUPPORT AFFORESTATION IN TANZANIA

[1]Msanga, H.P., *[2]Masunga, E.W., [3]Andrew, S.M., and [2]Fandey, H.M.

[1]Sebastian Kolowa Memorial University (SEKOMU), P.O. Box 370, Lushoto
[2]Tanzania Tree Seed Agency, P.O. Box 373, Morogoro
[3]Department of Ecosystems and Conservation, Sokoine University of Agriculture, P.O. Box 3010, Morogoro
*Corresponding author email: masunga@hotmail.com

ABSTRACT

There is an increase of awareness among local communities, NGOs, the private sector and government agencies on the importance of afforestation in fostering the supply of important environmental goods and services. However, in order to sustain the afforestation initiatives and realize the anticipated impacts, quality seed production is critical. The history of tree seed production in Tanzania started as early as the 1902. In the 1970's, the Government launched the national tree planting campaigns which led to the establishment of the National Tree Seed Programme (NTSP) in 1989. Following Government reforms, NTSP was transformed to Tanzania Tree Seed Agency (TTSA) in 2003. TTSA mandate is to produce and market high quality tree seed and other propagating materials. Currently, there is an increasing demand for quality tree seed for afforestation both locally and internationally. This paper identifies the challenges facing the production of quality tree seeds such as seed quality, low investments in tree seed industry, inadequate policy, and specific law to regulate and control tree seed quality, human resource limitations, and inadequate institutional integration with related expertise, research and climate change. Others issues include, problems of seed dormancy for some species, inadequate data on individual seed protocol for storage and germination. In addressing these challenges, the paper recommends investment in establishing as many seed orchards as possible, integrating institutions with related discipline at each node to create a multiplier effect on abundance, quality, and distribution as well as financing the tree seed industry, support training and recognition of the tree seed industry through policy and legal mechanisms.

Keywords: Tanzania Tree Seed Agency, Orchard, Provenance, Policy

INTRODUCTION

The history of tree seed production and the establishment of forest plantations in Tanzania started as early as in 1902, under the German rule at the Biological and Agricultural Research Institute (Das Biologisch Land Wirtschaftlichen Institute) at Amani in Tanga Region. The sole objective of the project was to supplement the dwindling wood supplies from natural forests. This was then subsequently followed by a large scale industrial forest plantation establishment in the 1950s under the British rule.

In 1927 during the British rule in Tanganyika, the Biological and Agricultural Research Institute was renamed the "East African Agricultural Research Station (EAARS). In 1948, the Amani Station was moved to Muguga, Kenya to form the East African Agricultural and Forestry Research Organisation (EAAFRO). Besides research, the organisation catered for tree seed handling activities which were common for the three partner states under the British rule. Problems which were unique to individual countries were addressed on a national basis. This led to the establishment of the Silvicultural Research Station at Lushoto in 1951.

At Lushoto, a sub-section of handling seed activities was formed and whose objective was to supply small quantities of tree seed of mainly Pines, Cypress, and Eucalypts for research purposes and for the establishment of Government plantations.

In 1970s the Government of Tanzania launched national tree planting campaigns to rehabilitate the degraded environments. This created high demand for seed of local and exotic tree species for various end uses. The Silviculture Research Station at Lushoto was not well placed and had no capacity to handle large quantities of tree seed. The Government recognized the seriousness of the situation and this led to the establishment of the National Tree Seed Programme (NTSP) under the Ministry of Natural Resources and Tourism in 1989 to enhance sustainable supply of high quality tree seed and other propagating materials.

Following Government reforms under the Civil Service Programme, NTSP was transformed into the Tanzania Tree Seed Agency (TTSA) in 2004 with the purpose of supplying market high quality tree seed and other propagating materials.

Prevailing Conditions of forestry and tree seed

Commercial forestry is a growing industry in Tanzania. Increased domestic and international demand for wood-based products requires an ever increasing supply of quality tree seed. The demand can be met by either increasing the size of the forest area or increasing productivity of the existing forest area or both. Yields per unit area of forests land can be increased through tree improvement, which involves improving the seed quality.

The tree seed industry in Tanzania has faced many challenges including; lack of financial resources and technical expertise, weak institutional linkages and unclear mandates, inadequate collaboration among participating partners, poor oversight arrangements and inadequate resources to support public servicing agencies dealing with tree seed. The advent of climate change has also brought with it new challenges in seed production.

Quality tree seeds are a prerequisite to successful afforestation programme and constitute a major pathway for the achievement of forest conservation. Therefore, there is a great need of ensuring availability of high quality and diverse genetic material to meet the demand of its end use. Tree seed quality is a measure of potential performance of a seed under optimal conditions. The seed of the highest quality will result in trees of the highest value in the field. A high quality tree seed is a seed which has been produced from the selected good mother tree. A good mother tree is one which has gone through genetic improvement by the selection of good qualities of the desired character. For example, a timber tree should have a straight, cylindrical, non-forking and non- twisting bole, fast growth, narrow crown, thin branches with wide branch angles, high wood density and long fibre, and resistant to pest and diseases. In respect of a fruit tree, the tree should be able to produce many fruits and of the desired taste. A firewood tree should produce high biomass and wood of high calorific value. In all cases, a high quality tree seed should be free of diseases and of high physiological quality with high germination capacity (Msanga, 2007).

SPECIFIC TREE SEED INDUSTRY CHALLENGES IN TANZANIA

Seed Quality

Although TTSA has its own standards on seed sources, the collection, testing and storage to meet specific requirements in the forestry and tree seed production operations, most of the stakeholders to a large extent do not perceive it as important. As a result, common practices result in the collection of poor quality tree seeds. For instance, seeds are sometimes collected from poor quality fruits as the best fruits are sold fresh. In many cases, farmers do not maintain genetic purity through the isolation procedures and the elimination of unwanted or inferior plants. The collected seeds more often than not are those which are most accessible including those lying on the ground and vulnerable to attacks by seed eating insects and fungal pathogens. The seeds harvested from small trees which are easy to reach may result in a greater frequency of small trees in subsequent populations. It is thought that, about 90% of the non-indigenous trees in southern Tanzania woodlots came from an extremely limited genetic base. The original introduction may not have been selected for any useful characters. For indigenous species may have indeed been selected for ornamental and amenity properties, which may well not be the qualities sought for multipurpose use or timber production.

The prevailing situation calls for the need for provenance tested seed for both timber species and multipurpose trees as a means of doing away with almost exclusively from the wild, `unimproved' populations. Many of the most important species are self-incompatible thus seed characters are inherited from different parent trees, increasing the variation between individual seeds. Trees grown from the seeds collected from many trees within one area, when compared with trees from the seeds of the same species from a different area, often marked differences will be exhibited in growth rates, growth form, pod production, tolerance of environmental stresses, thorniness and the presence of ant nutritional factors. Even the seeds are collected from an individual tree; they will still produce progenies with highly variable characteristics. This variation can be exploited to allow plant breeders to develop varieties with particular desirable characteristics. Such conventional breeding programmes with multipurpose trees are rare, although the techniques have been well established for high value temperate and tropical commercial forestry species such as Eucalyptus and Pine.

A good example of the breeding of an agroforestry species was carried out at the University of Hawaii by Dr. Brewbaker (Harris, 1993). The researcher selected vigorous `giant type' varieties of *Leucaena leucocephala* from the natural population. An alternative method for rapidly isolating and exploiting useful variation between individual trees is to propagate them vegetatively by cutting. This type of work has been carried out to establish high yielding clones of commercial species such as eucalyptus. This is also not a well-developed technique for multipurpose tropical trees and is associated with more problems of storage, quality control, phytosanitary certification, transport and distribution, than is the case with the use of seeds. Hence, when a species has been selected to be tested in a particular locality, it is important to include trees from different populations (provenances) of that species in order to gain the widest genetic range possible and to determine which provenance is most suitable for that area and for the purpose of its selection.

Low Key Investments in the Seed Sector

The report on situational analyses of tree breeding and tree germplasm supply which was conducted in West and Central Africa (Avana-Tientcheu, 2016), Eastern Africa (Msanga, 2016) and Southern Africa (Marunda, 2016) showed that almost all National Tree Seed Centres in Africa are operating below capacity due to decreased levels of investment in equipment and human resource.

Tree Seed industry in Tanzania is not financially sustainable because the Government is not allocating enough funds and the low of ability of tree growers to pay for quality seed and services. TTSA was formerly supported by DANIDA, which terminated her support in 1998. TTSA inherited capital assets such as buildings, climbing gears, laboratory, and a handful of vehicles. For over 15 years, TTSA has been trying to increase its revenue by promoting the sales of seeds, seedlings and other services to make it sustainable. Due to low investment, most of the equipment and laboratory facilities are obsolete. This has resulted to low capacities in the collection, extraction and storage of seed causing delays in processing and hence resulting to poor quality seed.

Most of the seeds are often sold at cost price, therefore, self-financing through sales of seed is at present an unrealistic approach, and is probably likely to be so for many years until the farmers know the importance of using improved quality seed and seedlings. To ensure good quantity and quality tree seed, the Government support is crucial and almost all successful tree seed centres in the world are partly financed by their governments.

The assumption that trade in tree seed constitutes a viable commercial option is wrong. It is a fatal mistake to assume that seed business can generate income that can cover all the costs and generate revenue to cater for the required investments in conservation and improvement. Tree seed business can only be profitable if it specializes in some few selected species. In short, research institutions and other public sector servicing institutions dealing with tree seed such as TAFORI and TTSA are under-funded and this limits their critical roles of multiplication of quality tree seeds.

Inadequate Policy Support

Overall, policy support is also important in achieving a sustainably quality seed production. The issues of tree seed have never been addressed by the current Forest Policy. There is no law in Tanzania which provides for the promotion, regulation, and control of tree seed variety release, multiplication, conditioning, marketing, importing, quality assurance, and other propagating materials. The Seed Act of 2003 and the Plant Protection Act of 1997 which regulate the production, distribution, and marketing of seeds are categorically for agricultural seeds and are under the Ministry responsible for agriculture.

The National Forest Policy (1998) has 41 policy statements, but none of them on tree seeds. The policy only identifies management and conservation problems and opportunities. The policy states that one of the goals and objectives of the forestry sector is to ensure sustainable supply of forest products and services by maintaining sufficient forest area under effective management. Despite its strategic importance in ensuring sustainable development of forests in Tanzania, the tree seeds issue is not mentioned in the respective Policy.

The Government established Tanzania Tree Seed Agency (TTSA) in 2003 under the Executive Agencies Act, 1997 as a semi-autonomous executive agency within the ambit of the Ministry of Natural Resources and Tourism. TTSA was established for the purpose of enhancing sustainable supply of forest products and environmental conservation by producing, procuring, and marketing of high quality tree seed and other propagating materials. In the Tanzania Tree Seed Establishment Order of 2003 and its Amendment Order, 2016, the Tanzania Tree Seeds Agency is assigned some roles and functions to play through very brief statements without any legal powers.

Conclusively, there is no legal mechanism which makes provisions for the control and regulation of tree seeds and other related matters. This position impacts TTSA negatively against the performance of its roles and attainment of its objectives. It also impacts negatively the national desire and efforts of meeting the challenges in the management of forest resources on an integrated and sustainable basis. It is for this reason that the Management of Tanzania Tree Seed Agency hereby proposes for the enactment of a Tree Seed Act to provide for the promotion, regulation and control of tree seed breeding and release, multiplication, conditioning, marketing, importing, and quality assurance of tree seeds and other propagating materials and for other related matters.

This area needs to be given a national priority requiring the development of specific policies to guide and regulate the use of tree seed. Policy support requires awareness among decision makers. They must realize the important values that can be protected and generated by a specialized and well managed national tree seed programme. Many problems facing TTSA and tree seed industry in Tanzania emanate from the absence of a clear and straight forward policy, Law, and other legal guidelines. The new Forest Policy is required to consider the essence of having a new tree seed act or of having clauses on tree seeds in the legislation.

Human Resource limitations, in terms of Numbers and Skills

We live in a dynamic world where changes appear continuously, where institutions that can continue to adapt and find new ways will survive. These new ways can only be found if the institution trains its staff and motivate them at the same time. Taking on board the objectives and work load of TTSA, the quality and quantity of human resource should be seriously taken into consideration. The present situation does not allow for the maintenance of even few trained and recruited staff. For the past 10 years, TTSA has recruited 40 staff, out of these 15 left the job or asked for transfer to other institutions. The Institution is in a dare need of a Tree breeder, Plant Pathologist, Plant Entomologist and Botanist. This can only be solved through joint efforts with other stakeholders. In order to ensure long term availability of quality seeds and other propagating materials, the existing professional gap cannot be left as it is, investing in human resource in this case is inevitable.

Inadequacy of Integration between Institutions with Related Expertise

The institutional co-operation is very important in technical sustainability, in order to create a multiplier effect in line with seed production value chain. For tree seed industry to achieve this goal, all institutions in the value chain must play their role well at each node starting from the grassroots to the apex, that is, applied research in tree improvement programme, tree breeding, seed production and seed storage technology and then all the findings from each node should be integrated to generate solutions for the seed end users. The possible model for this to work might be promotion of technologies through research Institutions and Universities, while TTSA concentrates on the multiplication of seeds and other propagating materials. TFS and other private companies should finance research and multiplication of seeds and other propagating materials. In reality, the Institutional collaboration is still at a low level.

Inadequate Tree Breeding Research

The establishment of forest plantations in Tanzania started as early as in the 1900s with the objective of supplementing dwindling wood supplies from natural forests. This was then subsequently followed by large scale industrial forest plantation establishment in the 1950s. Tree improvement research is one of the key areas that support productive forest plantations and indeed, this research played a key role in the success of these early industrial plantations. For many years research services were and are being supplied by Tanzania Forestry Research Institute (TAFORI) the Ministry of Natural Resources and Tourism.

However, the level of investment in research and development related to plantation forest productivity is low due to lack of both financial resources and technical expertise. The same problem is facing collaborating institutions such as Sokoine University of Agriculture (SUA). Over time therefore, very little has been done on tree improvement research hence key constraints of the forestry sector including access to improved seed and narrow genetic base of industrial tree species in both public and private plantations could not be addressed . In summary, there is inadequate knowledge and skills among the seed value chain actors.

Climate Change

Climate change brings a change in temperatures which affects flowering phenology abundance, and seed production. Most of the exotic and indigenous tree species have been affected by climate change. Flowering studies need to be conducted and modern technologies such as vegetative propagation need to be adopted to address seeding shyness in certain species. One major seed problem in Tanzania is lack of definitive information on the phenology of flowering and maturation of fruits and seeds. Extensive phenological observations of many species have been recorded, yet predictive models for flowering are lacking (Bawa *et al.,* 1990). Flowering and fruiting of some species seem to be related to wet -dry seasons cycles (Whitmore, 1983; Wright and Cornejo, 1990) and these patterns are very difficult to predict under climate change.

Spatial Distribution

Other problems relate to spatial distribution or sizes of trees in natural stands. Low distribution frequencies of species in tropical forests are common (Gentry, 1988). If only a few fruits are available from individual trees, then the collection costs soar quickly. Plantations and/or seed orchards would have solved this problem, but they are almost non-existent for these species. In moist tropical forests, fruit-bearing limbs of the desirable trees may be as much as 35 meters above the forest floor. Unless seeds can be collected from the ground after natural seed fall, climbing is the only practical option which is very expensive for a tree seed industry.

Predators

Predators present another major problem in Tanzania. Birds, monkeys, and bats eat fruits and seeds before the natural seed fall (Howe, 1990). This problem is observed when collecting seeds of some of the species such as *Milicia excelsa,* which is eaten by bats and birds. In some cases, animals are natural seed dispersal mechanisms in tropical ecosystems, but they complicate things for seed collectors. Moreover, when seeds are dispersed on the ground, numerous birds, rodents, and insects come forth to eat them. Timely collections are needed to avoid losses, but incomplete knowledge about fruiting phenology combined with wide spatial distribution of trees make seed collection more difficult.

Seed Dormancy

In contrast to the common image of rapid germination in tropical forests, there are many species that exhibit seed dormancy. While many species germinate promptly when dispersed, others exhibit long delays in germination. Seed dormancy is most common among leguminous species and species of dry tropical forests. Numerous species (including non-legumes) have seed coats which are hard enough to survive in the litter in moist forests for at least 3 years (Whitmore, 1983). Seed coat dormancy, which is most common in the listed species, is easily overcome with scarification. However, in many cases, other more complex dormancies may be encountered.

Variation of Seed Storage Behaviour

There are three categories of seeds namely; Orthodox, recalcitrant, and intermediate seeds. Orthodox seeds survive the drying of 10 to 15%, increase longevity with drying, have predictable response to moisture and temperature and have predictable storage life. Recalcitrant seeds, on the other hand, do not survive drying to any large degree, and are thus not amenable to long term storage. The critical moisture content (MC) for survival varies among species, depending on the oil content. For example, safe moisture content for Dipterocarps (starchy seeds) is 50% and for cacao (oily) is 20%. Therefore, recalcitrant seeds cannot be dried neither can they be frozen. Intermediate seeds behave like a subset of Orthodox. They can tolerate drying of to around 40 - 50% MC. They are also often sensitive to storage of -20°C. Sugar analysis suggests that some intermediate seeds have orthodox embryos as well as mismatch between development of the fruit and the seed inside resulting to its behaviour. The well-known tree species as intermediate is Neem (*Azadirachta indica). A. indica* is often classified as intermediate but is fully desiccation tolerant if dried appropriately (remove seeds from fully-ripe fruits and dry slowly under ambient conditions). *A. indica* seeds can be stored at -20°C but are sensitive to chilling damage if imbibed at low temperatures. This can be partially overcome by imbibition at temperatures of >25 - 30°C. In general, desiccation sensitivity is recorded in 65 families with varying frequencies. In this regard, there is a big challenge in screening to determine seed storage category. How do we know if the seeds are orthodox, recalcitrant, or intermediate? Currently, TTSA use methodologies such as taxonomy, literature, laboratory experiments, predicting from seed traits, biochemical traits, ecology, and physical attributes in locating storage category.

Regardless the achievement, conservation (storage) of recalcitrant seeds is still a problem. There are no easy options for the conservation of recalcitrant seeds. Short term moist storage is the most widely used method but it has some disadvantages. The temperature must be low enough to reduce germination but high enough to avoid chilling injury. Seeds may germinate if it is too moist, and die if it is too dry. Fungal contamination is always an issue and fungicides have to be used. Alternatively, recalcitrant seeds can be stored or conserved by cryopreservation of zygotic and somatic embryos whose facilities are expensive and determination for storage needs investment in research to develop protocols. Cryopreservation of embryos rather than whole seeds is possible for some recalcitrant species. Each species requires an individual protocol for dehydration, storage, and regeneration.

CURRENT STATUS OF TREE SEED INDUSTRY

The commercial forestry sector is currently heavily reliant on poor quality planting material from a very narrow range of commercial species. The key species planted are *Pinus patula*, *Eucalyptus grandis*, *Cupressus lusitanica* and *Tectona grandis.* Lack of locally available quality planting stock affects woodlot and plantation productivity and quality, leading to reliance on the imported improved seeds. The limited species diversity in commercial use exposes the country to grave danger of the outbreak of severe pests or diseases.

In 2013 Forestry and Beekeeping Division started to support collaborative work on tree improvement in the Southern Highlands. A public- private Tree Improvement Research Working Group (TIRWG) was formed and developed a Tree Improvement Strategy for the Southern Highlands. This led to the establishment of species trials with public and private partners covering all the ecological zones in the Southern Highlands. Breeding populations have been developed for the two dominant species. The trials will yield valuable information on alternative species to be introduced.

Plans are underway to establish clonal and seed orchards of Eucalyptus and Pines in suitable locations. This year 2018, two clonal seed orchards were established at Rongai by TTSA. In order to make improved seed available on a sustainable basis, TTSA in collaboration with Tanzania Forestry Research Institute (TAFORI), Tanzania Forest Fund (TaFF), Tanzania Forest Service Agency (TFS), Private Forest Programme (PFP), and Tree Growers Associations (TGA's) have established about 50ha of seed orchard in 2018 in the Southern Highlands, Rongai and Shume forests. However, we have a long way to go if Tanzania would is to satisfy the local market and to be the leading exporter in tree seed **(Table 1).**

Table 1: A comparison between Zimbabwe and Tanzania on number of seed orchards, area and level of improvement of seed germplasm available in both countries

Species	Seed orchards in Zimbabwe			Tanzania Area (ha)		
	Number	Generation	Area (ha)	TTSA	TFS	PFP/TTSA
E. grandis	6	2nd and 4th	15	6	10	
E. maidenii				4		
E. saligna				5		5.78
E. camaldulensis	17	1st, 2nd, 3rd and 4th	33	15		
E. tereticornis	9	2nd and 3rd	10	12.5		
E. cloeziana				6.2		
E. citriodora	1	1st	0.6			
P. patula	26	1st and 2nd	46	2	10	
P. taeda	24	1st and 2nd	33			
P. radiata				1.5		
P. elliottii	28	1st and 2nd	61			
P. kesiya	17	1st and 2nd	53			
P. oocarpa	7	1st	22			3.99
P. pseudostrobus	1	1st	0.7			
P. maximinoi	4	1st	19			7.86
P. tecunumanii	14	1st	18			8.72
P. caribaea var hondurensis	1	1st	0.6			0.88
P. caribaea var bahamensis	1	1st	0.6			
P. caribaea var caribaea	1	1st	0.6			
P. palustris	1	1st	0.5			
P. chiapensis	4	1st	6			
Pinus spp hybrids	2		1.4			
Cupressus lusitanica	1		0.6			
Tectona grandis				5	52	
Grevillea robusta				0.5		
Milicia excelsa				5		
Khaya anthotheca						
Afzelia quanzensis						
Total	**165**		**321.6**	**62.5**	**72**	**27.23**

CONCLUSION

Tanzania's Tree Seed Industry has shown remarkable development over the past five years after the establishment of Private Forest Programme and Forest Development Trust. These international Non-Government Organisations (NGO's) have very much stimulated the afforestation programmes in the southern highlands, southern part, and in the Lake Zone. TFS, Local Government, many private companies (e.g. New Forest, TANWAT, Mufindi Paper Mill, Tree Growers Associations - TGA's), and farmers are ordering large quantities of quality seeds from abroad. This is an opportunity for the tree seed industry to excel by establishing seed orchards for the local and export markets. The new draft of Forest Policy for the first time contains policy statement which addresses high production of quality tree seed. There are signs of hope with Public, private companies and NGO's towards the formation of social enterprise for tree improvement programme. If the government properly coordinates tree improvement programmes through TAFORI and TTSA, the tree seed industry will experience a turn around that will make Tanzania among the prominent and leading nations in tree seed production and afforestation programme.

THE WAY FORWARD

- Seed Industry should therefore not necessarily be financially self-reliant, but rather it should obtain funding that reflects their actual contributions to the value of planted trees and environmental sustainability in the short and in the long run. The benefits/essence of TTSA should not only be assessed based on the earnings from the sales of seeds, but on the value added to the sector and to the society. Because of this reason, we recommend that since the objective is to enhance sustainable supply of forest products and carry out environmental conservation by producing, procuring, and marketing high quality tree seeds and other propagating materials, the funding must be guaranteed. Income accrued from the sales of seeds is not enough to sustain seed production due to its high cost. Due to the challenges facing budgetary allocations in the face of competing demands from other development needs, the budget for tree seed production should be met from a certain percentage of every prescribed fee payable under the forest Act.
- The Government should ensure that there is multi–stakeholder research and tree improvement research program and which is sufficiently resourced and coordinated by TAFORI for long -term sustainability. There is also a need of ensuring that there is availability of quality seeds by enabling the private sector participation in seed production and distribution and at the same time encouraging Public, Private Partnership.
- The private sector should be encouraged to invest in the sector to complement in the tree seed production, distribution, and marketing while the government carries out with tree seed production, distribution, and marketing and regulating the tree seed industry. The involvement of the private sector, donor partners, and development organizations will help to reduce the burden on government budget and the government can then channel the savings resulting from such assistance into the development of other sectors for research and development. The resurgence of the private sector and the public- private partnership arrangements will ensure that this infrastructure is used for the benefit of all players in the seed industry.

REFERENCES

Chamshama, S.A.O. and Nshubemuki, L. 2011. Plantation forestry management in Tanzania: Current situation and future focus. In: L. Nshubemuki, S.S. Madoffe, S.A.O. Chamshama, S. Bakengesa and S. Balama (editors): Proceedings of the Workshop on Insect Pests, Diseases and Soil Problems in Forest Plantations, Kibaha, pp. 45 – 75.

FAO. 2015. Global Forest Resource Assessment 2015. FAO, Rome. 244pp.

Forest Division. 1982. Management practices in conifer plantations in Tanzania. Forestry and Beekeeping Division, Ministry of Natural Resources and Tourism, Dar es Salaam. 68pp.

Madoffe, S.S. and Chamshama, S.A.O. 1989. Tree improvement activities in Tanzania. *Commonwealth Forestry Review,* 68:101-107.

Malimbwi, R.L., Zahabu, E., Katani, J. and Mwembe, U. 2010.Woodlot management guidelines for small holder farmers. Department of Forest Mensuration and Management. Sokoine University of Agriculture, Morogoro Tanzania. 18pp.

Msanga, H.P. and Poulsen, K. 1995. *Preliminary Tree Seed Handling Manual*. Tanzania National Tree Seed Programme. Technical Note. No. 5. Morogoro. 53pp.

Msanga, H.P. 1999. *Laboratory Manual for Routine Seed Testing*. National Tree Seed Programme, Technical Note No. 7. Morogoro.120pp.

Msangi, T.H., Shangali, C.F. Mugasha, W.A. Maguzu, J. and Bomani, F.A. 2009. Early growth of various Eucalyptus hybrid clones in different agro-ecosystems in Tanzania: A short communication.

Pedersen, A.P. 1994. Tree seed pricing and costs of seed procurement. Paper presented at Workshop of African Tree Seed Centres. Antananarivo, Madagascar. 9pp.

Schdmit, L. 2000. Guide to handling of tropical and sub-tropical forest seed. Danida Forest Seed Centre, Humlebaek, Denmark.510pp.

TAFORI. 2011. National Forestry Research Master Plan II (NAFORM II) 2011-2020. Tanzania Forestry Research Institute. Visions and Technologies, Dar es Salaam. 29pp.

URT. 2012. *Budget Speech for Financial Year 2012/2013, Ministry of Natural Resources and Tourism*. United Republic of Tanzania, Dar es Salaam. 40pp. (Unpublished).

COMMERCIAL FORESTRY DEVELOPMENT IN TANZANIA: PROGRESS WITH INVESTMENTS, INNOVATIONS AND INSTITUTIONS SUPPORTING TREE IMPROVEMENT, INPUT SUPPLY AND ADVISORY SERVICES

***Milledge, S., Singo, I. and Sangalali, E.**

Forestry Development Trust, P.O. Box 2, Iringa
*Corresponding author email: simon.milledge@forestry-trust.org

ABSTRACT

Commercial forestry is a growing industry in Tanzania, and is central to several major development sectors including construction and rural electrification, and is among the measures which are needed to combat forest loss and address the growing wood supply deficit. The Forestry Development Trust (FDT) is an independent, Tanzanian legal entity which was established in 2013 to help transform the commercial forestry sector by making it more competitive, inclusive and resilient. This paper draws together findings from various lines of FDT's work with partners over the past two years including: (i) an industry outlook for plantation resources and wood markets; (ii) performance measurement of tree improvement genetic trials; (iii) tree grower practices adoption surveys in the Southern Highlands; and (iv) private sector inputs to the revision of the National Forest Policy. Collectively, this work highlights three messages which are relevant to the transformation of the sector. Firstly, the private sector plays a fundamental and growing role in commercial forestry (including tree growers, investors, SMEs and service providers). This requires an enabling policy environment that recognises private roles, addresses key constraints, and stimulates investment and innovation. Secondly, the power of collaboration by public and private actors in technical innovations such as tree improvement research is immense, as it allows for leverage and sharing of technical and financial resources. Ensuring coordinated and sustainably-funded tree breeding is a key challenge to the sector. Thirdly, the sustainability of commercial forestry development and national tree planting initiatives depend on explicit recognition of economic and technical considerations including grower incentives, financial viability, site-species selection, and the quality of inputs and practices.

Keywords: Commercial forestry, innovation, tree improvement

INTRODUCTION

The Forestry Development Trust (FDT) is an independent, Tanzanian legal entity which was established in 2013 with a Memorandum of Understanding signed between the Ministry of Natural Resources and Tourism (MNRT) and Gatsby Charitable Foundation, with the formal support of an Advisory Panel consisting of key public and private forestry actors. FDT works with major public and private forestry actors to help transform the commercial forestry sector to become more competitive producers of high-value wood products, inclusive, and resilient. The Trust works in collaboration with public and private sectors to catalyse innovations and facilitate market actors in areas such as tree improvement, input supply, contractor and advisory services, wood utilisation, markets, and policy.

Economic Contribution of Commercial Forestry

Industrial growth and job creation in Tanzania is heavily reliant on, among others, wood-based products. Several key industries are dependent on a reliable supply of wood-based raw material as an input, including construction (timber, plywood), furniture, rural electrification (poles), retail (wood/paper packaging), and heat intensive industries (e.g. cement, tea and tobacco). Wood-based value chains are also significant job creators (both directly within timber value chains and indirectly in wood-dependent industries), with the potential to increase employment.

Economic opportunities from forestry are inclusive with private growers (small, medium and large) being the greatest source of future wood supply. In addition to large-scale state and private plantations, small and medium-scale private forests are an important supplier segment. In 2016, the forest plantation area in Tanzania was estimated to be 325,000 ha, with 54% (174,000 ha) owned by small/medium scale tree growers, and the balance consisting of Tanzania Forest Services (TFS) plantations (100,000 ha) and large private plantations (UNIQUE, 2017). In the Southern Highlands, some 60,000 private tree growers are a testament to the remarkable growth in the private forestry since the mid-2000s (FDT, 2016) **(Fig. 1).** The small-scale grower segment has high strong potentials of making gains in both productivity and area.

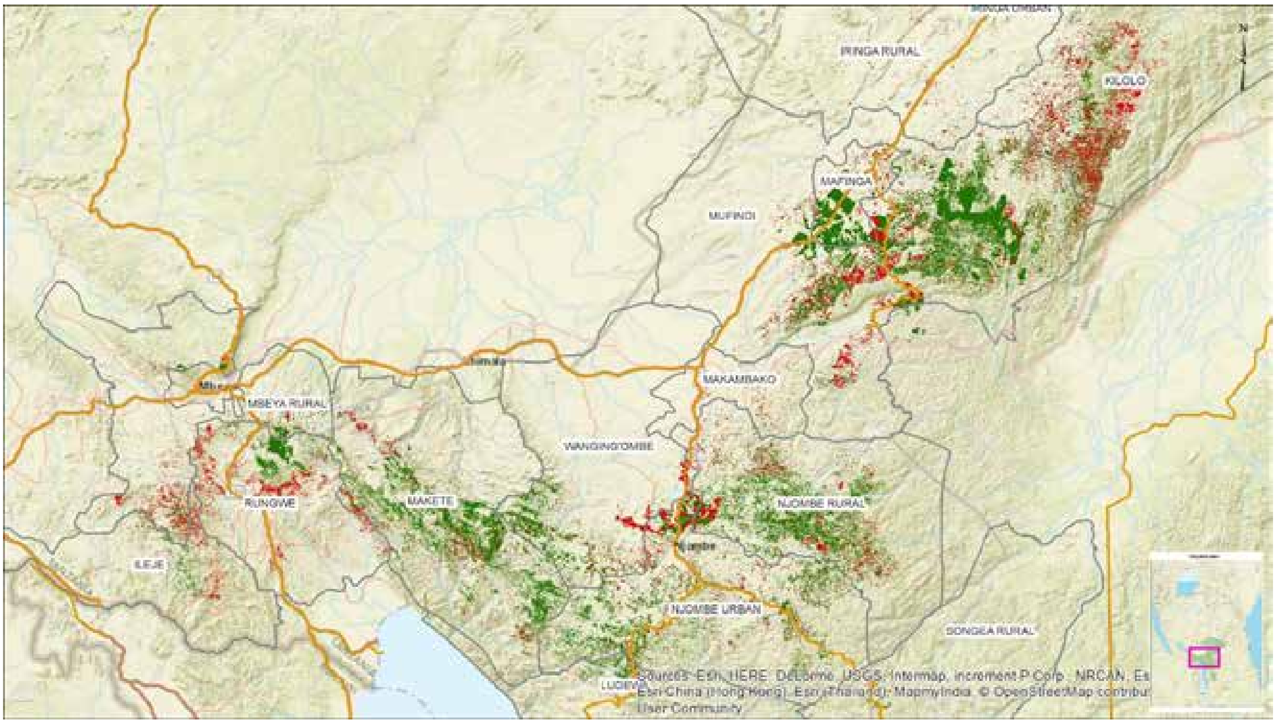


Figure 1: Distribution of pine and eucalyptus woodlots and plantations in the southern highlands

Source: FDT (2013).

Commercial plantation forestry is a growing sector, driven by economic opportunity and environmental prerogatives. Commercial forestry is one of the suites of mitigation measures which are needed to combat forest loss, climate change, and the growing deficit of wood supply. Wood demand is projected to grow substantially within the main markets, in line with population increase, urbanization, and national development priorities around infrastructure, manufacturing, and retail **(Fig. 2).** According to the latest national wood market study commissioned by FDT, timber demand (not including wood energy) is expected to more than double in round wood equivalent of between 2013 (national consumption of 2.3 million m^3) and 2035 (5.2 million m^3), driven primarily by the construction sector and paper consumption (UNIQUE, 2017).

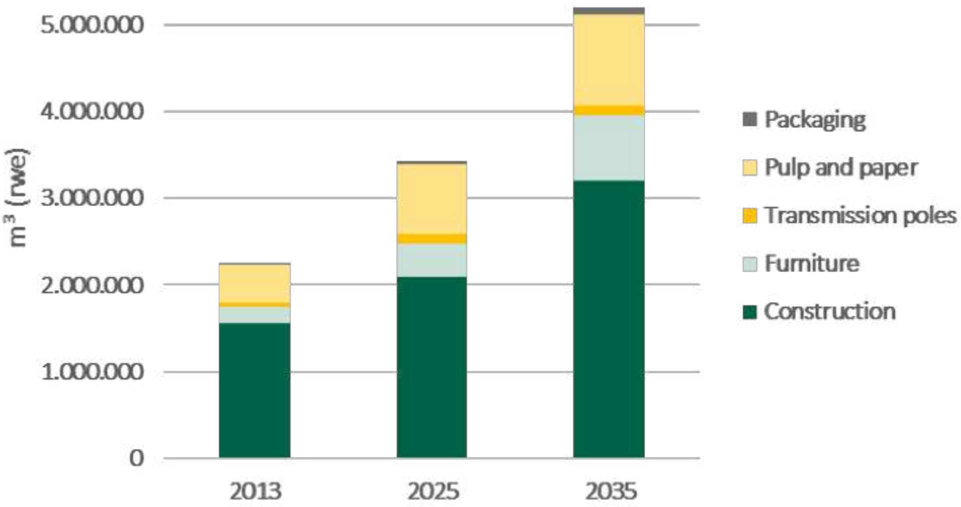


Figure 2: Consumption of wood products in Tanzania by market segments 2035
Source: UNIQUE (2017)

At the same time, a projected raw material supply deficit for most wood value chains can stimulate investments in improved tree growing and management **(Fig. 3).** Based on hectares planted and an estimation for productivity and of rotation age by each supply segment, the supply deficit in the market (not including wood energy[1]) will increase between 2025 and 2035 to a supply gap of 3 million m^3 round wood equivalent (rwe) (UNIQUE, 2017). The gap mainly consists of large diameter saw logs for sawn timber and veneer production (1.4 million m^3) and wood fibre for pulp and particle/fibre board (1 million m^3). It is expected that the national wood deficit can be reduced by increasing productivity, increasing rotation (for small tree growers) and increasing processing recovery rates. For example, lengthening small tree grower rotations from currently 12 to 18 years for sawn pine timber will reduce the saw log supply gap by 50% (UNIQUE, 2017).

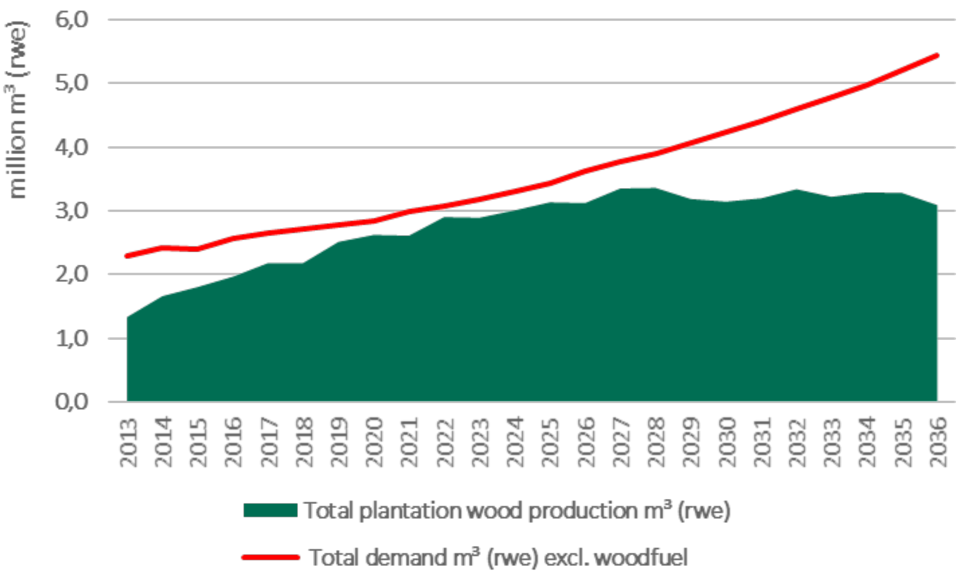


Figure 3: Summary Supply-Demand Scenario (Business As Usual scenario)
Source: UNIQUE (2017).

1 The National Forest Resources Monitoring and Assessment of Tanzania Mainland (NAFORMA) estimated an annual wood deficit of 19.5 million m^3 including wood energy supply and demand (MNRT, 2015).

.

Conditions for Improving Forestry Productivity

Tree planting helps address forest loss, climate change, and wood supply deficit, and receives political support for ambitious planting targets. In 2016, the National Tree Planting Strategy set planting targets of 185,000 ha annually for 17 years to offset more than 400,000 hectares of forest lost annually (MNRT, 2015). Naturally, there is an interest in ensuring the survival and growth of planted trees, whether be it for meeting future wood demands in commercial sectors or for reducing the net forest loss. It is critical that tree planting initiatives make three fundamental considerations for tree survival and growth **(Fig. 4).**

(i) Technical considerations vastly improve productivity and these include: (1) the selection of the right species for a particular planting site; (2) the use of quality planting material; and (3) the establishment of good land and woodlot/plantation management practices;

(ii) Sufficient economic incentives are required for actors to invest in these improved inputs and practices on a scale which is needed to reduce the net deforestation and increase wood supply. Commercial private forestry offers a blended combination of incentives for tree growing, including market demand (to pay for trees/wood) and private ownership of trees (to retain benefits); and

(iii) On the institutional front, effective sector services and an enabling environment are required to support a dynamic, competitive, and resilient commercial forestry subsector. This requires both private and public sector to play key supportive roles, with the government providing necessary incentives and regulation to drive the private sector investment and innovation at scale (e.g. tree growing, processing, retail, and service provision). The market systems approach, which recognises the diversity and interactions among actors, is required to enable sustainable sector change.

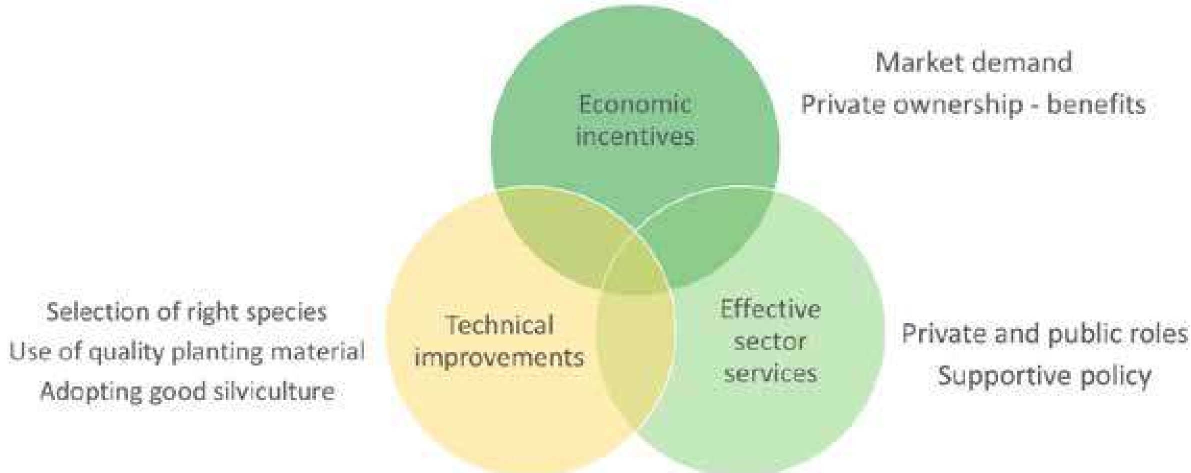


Figure 4: Key considerations to enable planted tree survival and growth

ACHIEVEMENTS IN SECTOR SERVICE DELIVERY IN SUPPORT OF COMPETITIVENESS AND RESILIENCE

Rising levels of wood demand can be met by increasing forest area, by increasing productivity of existing forest area, or both. However, while population pressure and environmental constraints may inhibit large-scale afforestation programs, methods to increase the yield potential of existing forests are often the most feasible means to meet future wood demand. The following sections outline various achievements according to the above-mentioned technical considerations to improve productivity and yield: (1) collaborative public-private tree improvement to ensure selection of the right species for a particular planting site; (2) development of private sector services to supply high quality inputs (planting material);

and (3) tree grower adoption of good land establishment and woodlot/plantation management practices.

Collaborative Public-Private Tree Improvement

Tree improvement plays a major role in commercial forestry development, with the application of high quality and diverse materials being essential to maintain competitiveness and resilience of the sector. Forestry yields and wood quality can be increased in a number of ways by breeding for increased volume, specific gravity, form, and pest & disease resistance. A scoping study carried out in the Southern Highlands revealed that sector competitiveness was hampered by reliance on poor quality and narrow genetic base of planting material (Komakech and Blakeway, 2014). The reliance on a few industrial tree species makes the whole commercial forestry sector vulnerable in the event of pest and disease outbreak. High quality planting material currently originates from other countries with established tree improvement programmes, which are not necessarily adapted to local growing conditions and come at high cost (especially for small-scale private growers).

Following sustained efforts since 2014, Tanzania now hosts an advanced commercial forestry tree improvement programme. Commercial forestry stakeholders (including public sector institutions, private companies, church organisations and individual farmers) have collaborated to develop a multi-partner, long-term tree improvement programme that benefits all scales of tree growers ultimately leading to sustained domestic production of improved planting materials. The aim is to ensure collaborative and commercially-orientated tree improvement that improves the quality, productivity, and options for market end-use of planting material, with coordinated and sustainably funded research, and information dissemination on issues such as species potential, and pest and disease risks. The benefits of collaborative tree improvement come from achieving the economies of scale, with individual actors benefitting from the collective results from all collaborators. To date, research infrastructure with FDT facilitation includes 65 genetic trials (species and clonal hybrids with known properties suited to Tanzanian wood markets), six breeding populations (*Pinus patula* and *Eucalyptus grandis*) and four seedling seed orchards (*P. patula* and *E. grandis*). The genetic trials are aimed at selecting the right genetic material for particular ecological conditions and have been established with the support from ten partners in 19 sites in different parts of the country and representing three distinct climatic zones (warm temperate, sub-tropical and tropical) **(Fig. 5).** Collectively, these genetic trials contain over 100 varieties including pine, eucalyptus, corymbia and casuarina pure species, and eucalyptus and pine clonal hybrids.

Given the recent (2017-2018) establishment of trials in drier, warmer, low-lying areas (e.g. Ruvu in Coast Region, Korogwe in Tanga Region), opportunities should emerge in the near future in terms of potential tree species and clonal hybrids for commercial planting.

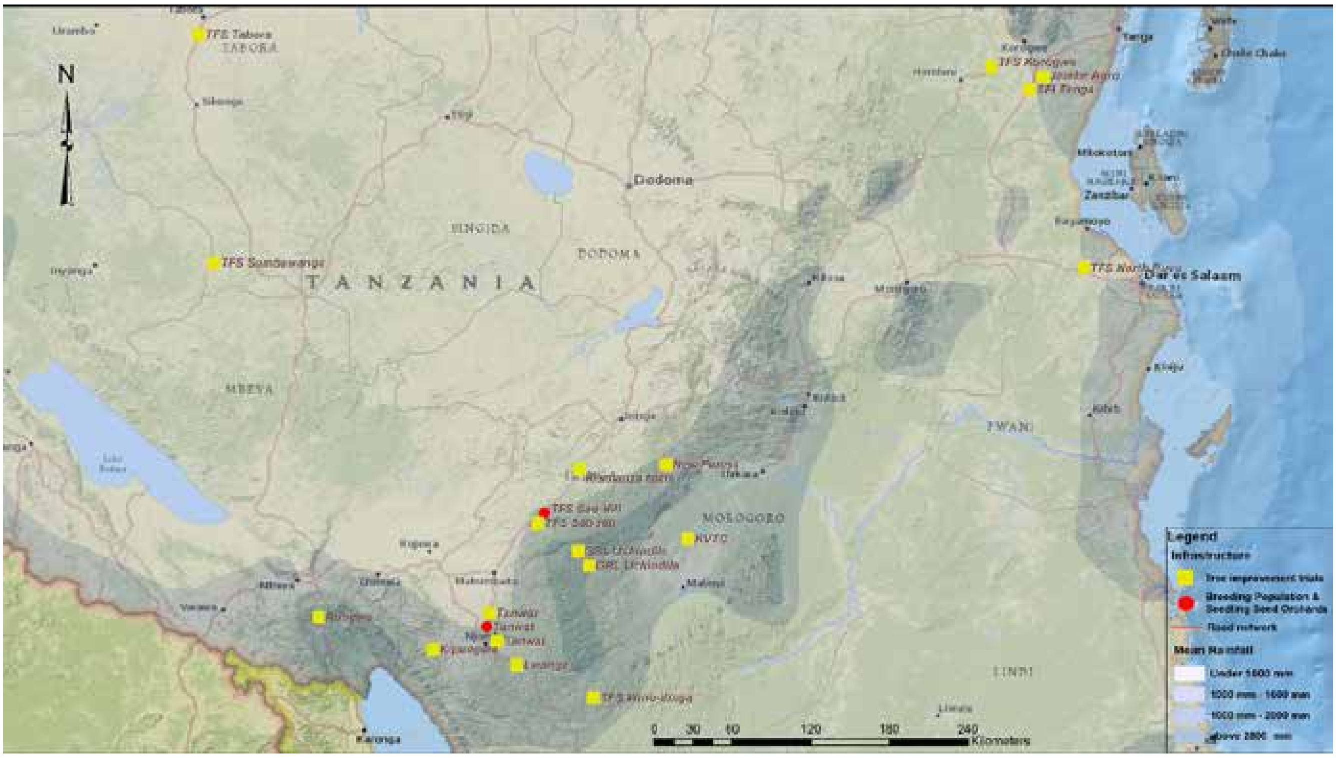


Figure 5: Map showing location of genetic trials established by FDT and partners since 2014

Source: FDT (2018)

The early results of these trials are starting to show new varieties (species and clonal hybrids) with commercial potential. Growth performance of trees in ten trials was measured in August 2017, and whose results are shared with the multi-partner Tree Improvement Research Working Group (TIRWG). As an example of the results, **Figures 6** and **8** show the strong performers after 29 months at a single trial location, Kisolanza (1730 m altitude and 600-100 mm annual rainfall), including *Eucalyptus nitens, E. badjensis, E. benthamii, E. grandis* and *E. dunnii*, *Pinus tecunumanii, P. maximinoi*, and hybrids *E. grandis* x *E. nitens* and *E. grandis* x *E. urophylla* (FDT, 2018). The early growth results demonstrate how imported genetic material is outperforming the local genetic material, while also showing the differences between sources of the same species and underlying the importance of testing through trials.

The results of genetic trials are already becoming useful to commercial forestry operations in revising the selection of planting material. For example, many GxN and GxU eucalyptus hybrids are out-performing GxC hybrids that have traditionally been planted by some commercial operations. However, observation of stem form is helpful in targeting planting material for the production of wooden transmission poles.

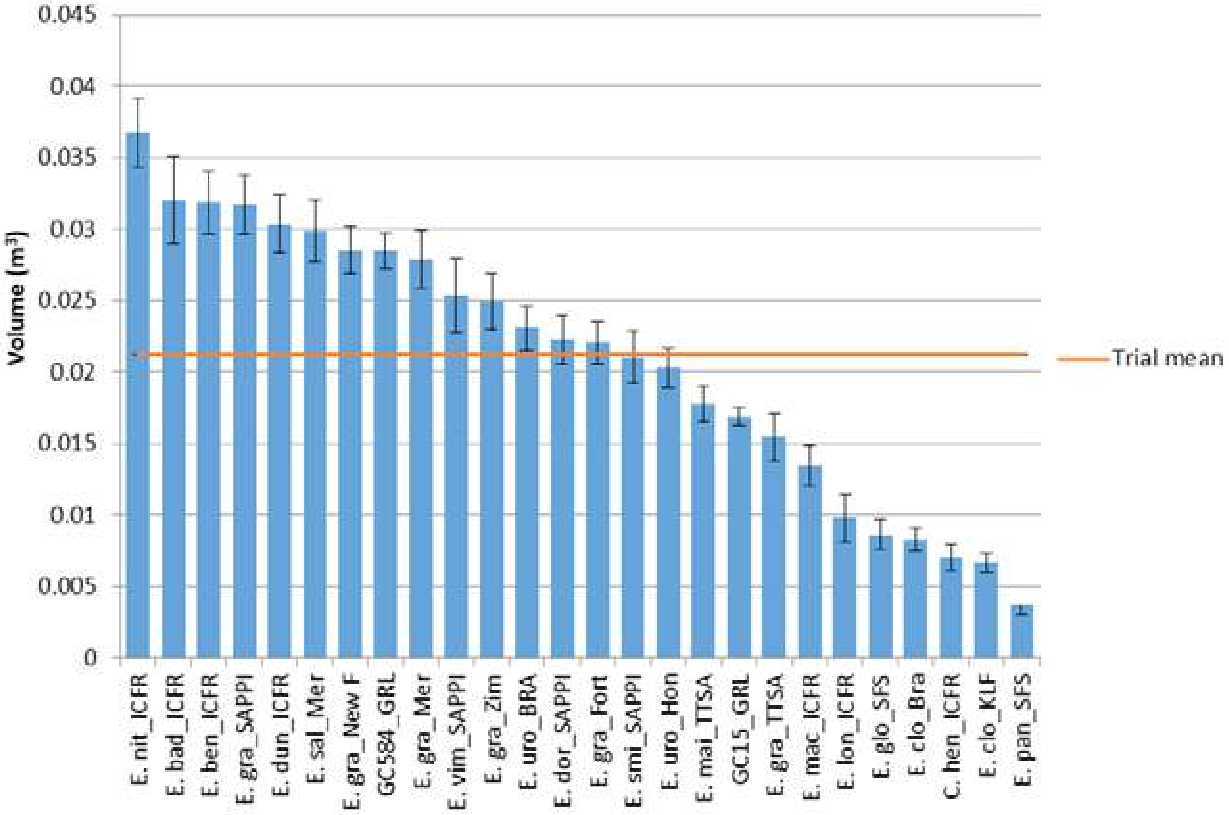


Figure 6: Mean volume of Eucalyptus pure species after 29 months, Kisolanza (established 2014/15)

Source: FDT (2018)

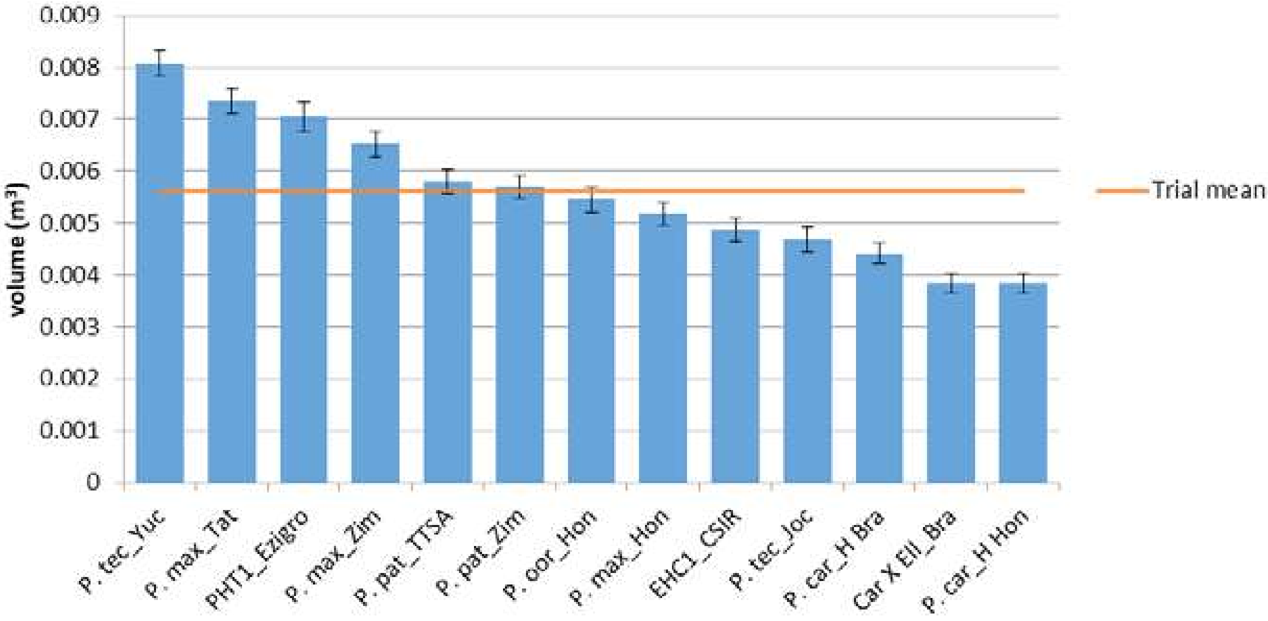


Figure 7: Mean volume of Pine pure species after 29 months, Kisolanza (established 2014/15)

Source: FDT (2018)

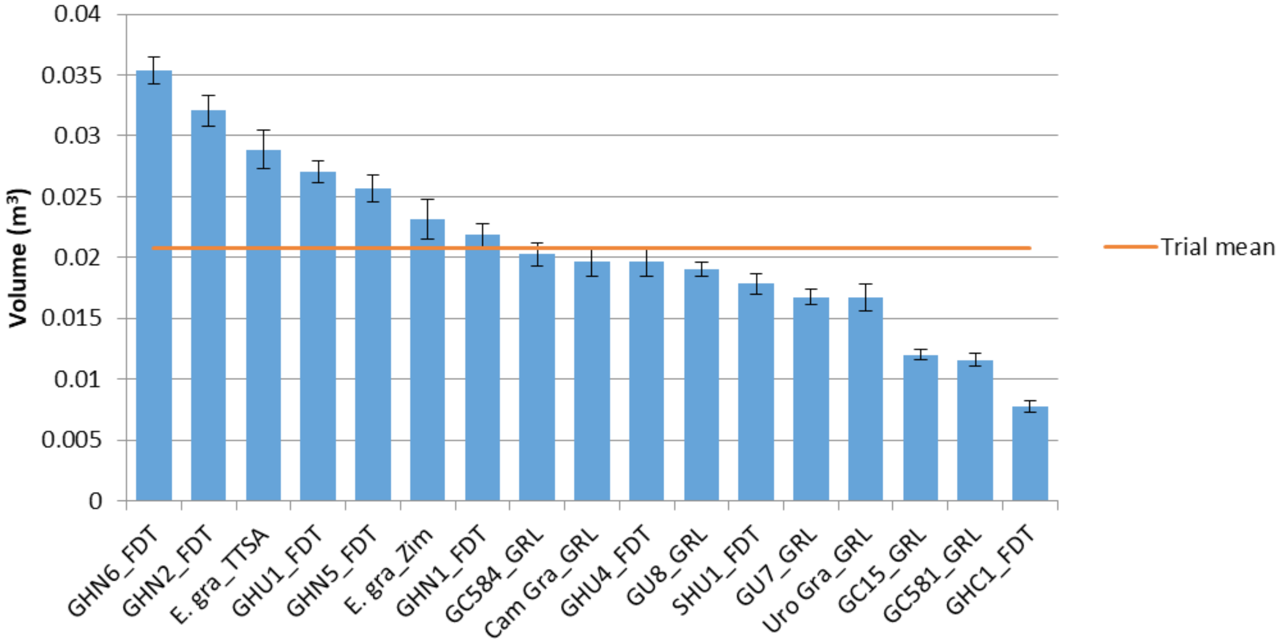


Figure 8: Mean volume of Eucalyptus clonal hybrids after 29 months, Kisolanza (established 2014/15)

Source: FDT (2018)

Growing stakeholder engagement in collaborative tree improvement is a testament to the realization of the potentially long-term benefits to commercial forestry. Central to the development of collaborative and commercially-orientated tree improvement research and development is effective coordination, sustainable resourcing, and sharing of results/benefits. To foster coordination and collaboration, a Tree Improvement Research Working Group (TIRWG) has been operational since 2015, and which was most recently chaired by the Forestry and Beekeeping Division (FBD). The TIRWG comprises interested public and private stakeholders including FBD, TAFORI, TFS, TTSA, major private forestry companies (GRL, TANWAT, NFC, KVTC, SFI) service providers (Jambe Agro) and support programmes (FDT, PFP). The number of active players continues to increase, with cost sharing also constantly rising.

Adherence to a clear strategy and the highest quality standards have been a key to ensuring relevance and quality of the collaborative tree improvement efforts to date. Key TIRWG outputs have included a Tree Improvement Strategy for the Southern Highlands (TIRWG, 2016) and Standard Operation Procedures (FBD, *in press*). The sustainability of collaborative tree improvement activities requires partnership arrangements with agreed financing modalities. Recent review by the TIRWG suggested that a social enterprise would best meet key criteria for success, and work is on-going to develop a business model.

Development of Tree Grower Services – Inputs and Advisory

In order to ensure the supply of quality wood products, plantations and woodlots should be established using genetically improved seed or vegetative propagules so as to produce fast growing trees of good form (FBD, 2017; PFP, 2016). However, the overall competitiveness of Tanzania commercial forestry is hampered by limited production and access to quality genetic material (UNIQUE, 2017).

Until recently, relatively few seed orchards were in place, including four owned by TTSA (producing seeds of *Pinus patula, Tectona grandis, Eucalyptus tereticornis* and *Grevillea robusta*) and a TAFORI-owned seed orchard of *Cupressus lusitanica,* and improved eucalyptus clones. Collectively, these seed sources cannot meet the current demand (FBD, 2017). Small/medium-scale private tree growers have traditionally lacked access to improved planting material (FBD, 2017; UNIQUE, 2017). In order to make available quality inputs to all scales of tree growers, FDT initially sourced imported improved seeds through TTSA to be used in commercial nurseries. As the demand picked up, the strategy shifted to facilitating the importation of seeds by other market players for longer-term sustainability. FDT works with commercially-driven public and private entities to source, package and distribute seeds in the short-term. One private actor, Jambe Agro, is increasingly demonstrating the ability of making available high-quality seed, including innovative 'One Acre Packs' suitable for small-scale growers.

At the same time, FDT has facilitated the establishment of high quality seed orchards to ensure local supply of genetic improved planting material over a longer term. This s included four seedling seed orchards (*E. grandis* and *P. patula*) with TFS (Sao Hill Forest Plantation) and TANWAT, each of which has the explicit intention of distributing 40% of seeds to small-holders. In collaboration with TTSA, the efforts are on-going to develop materials for grafted seed orchards. The Trust also provided technical advice to PFP and TTSA for the establishment of seed orchards for other species with Tree Grower Associations.

Apart from seed suppliers, FDT has been working with around 100 independent commercial nurseries in the Southern Highlands to adopt best practices and increase grower access to quality planting material.

Private Grower Adoption of Good Management Practices

Growers can maximise quality and productivity of their plantations and woodlots through a combined use of improved planting materials and adoption of good land and silvicultural practices. Studies have shown that rigorous site preparation such as complete cultivation results in improved survival and early growth of planted seedlings as compared to strip or cultivation (FBD, 2017; FDT, 2017). **Figure 9** shows the impact of different weeding practices on productivity of *E. grandis* from a flagship plantation demonstration site, illustrating the importance of reducing weed competition in enabling higher survival and timely canopy closure. Similarly, other establishments and silvicultural practices have a positive effect on performance (e.g. spacing, pitting, pruning and thinning).

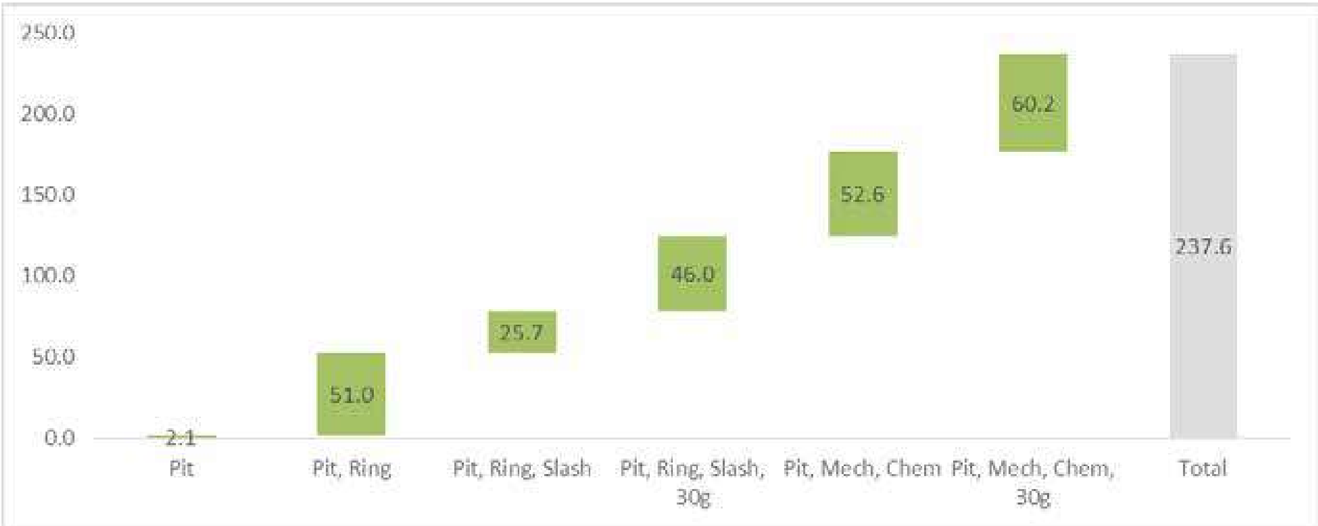


Figure 9: Incremental volume impact (m^3 per ha) of weeding practices on *E. grandis* after 43 months

Source: FDT (2018)

The establishment of effective plantation and management by growers of all scales must be supported through a range of advisory service models including inclusive out-grower arrangements, commercial providers, grower associations and government extension. The quality of silviculture employed by most small and medium tree grower woodlots is affected by low access to extension and advisory services.

Building on the *Forest Plantation and Woodlot Technical Guidelines* (FBD, 2017), FDT efforts to accelerate the adoption of good silvicultural practices have included building the business cases to deliver improved information, outreach and training, developing materials in multiple media, providing targeted training and developing industry-led standards. The focus is currently directed to: (1) government extension, a respected source of advice for tree growers with the potential of enhancing the quality of farmer-extension interactions; (2) commercial providers such as contractors, nurseries and input suppliers who provide information and advisory as part of bundled services.

A key finding is that increased adoption of improved planting material has occurred in the absence of subsidy. Commercial forestry in the Southern Highlands is dynamic, with market forces enabling growth in tree growing, enterprises and industries over the past decade. The diversity of value chains is steadily increasing (e.g. emergence of small diameter veneer peeling), which is indicative of a maturing sector with many actors ready to respond to new innovations and opportunities. FDT's approach has therefore been to facilitate sector improvements without providing direct financial subsidy. Collectively, these efforts have seen the adoption of improved planting material growing over the three years since 2014 **(Fig. 10).**

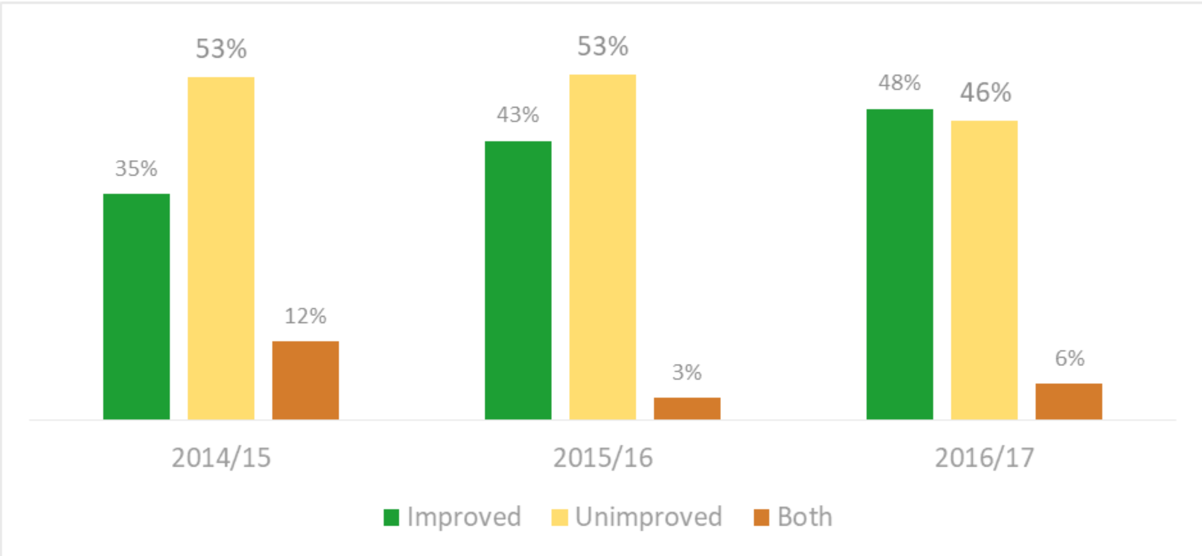


Figure 10: Improved planting material adoption trends among tree growers in the Southern Highlands

Source: FDT (2017)

CHALLENGES AND POLICY PRIORITIES FOR THE DEVELOPMENT OF COMMERCIAL FORESTRY SECTOR

Clear opportunities for growth in the commercial forestry sector are presented by favourable growing conditions, a growing national wood supply deficit, and the increasing dynamism shown by private and public actors. However, it needs to be realised that these opportunities are limited many constraints and challenges:

(i) Mostly domestic market are characterised by low value addition and limited reward of quality;
(ii) Limited competitiveness driving imports and substitution for some wood products;
(iii) Low access to quality planting material and service models for growers;
(iv) Dispersed nature of relatively low-quality wood supply, with limited aggregation;
(v) Limited investment in efficient harvesting and processing technology;
(vi) Limited coordination and preparedness around fire, pests and disease, and climate change;

(vii) Limited partnerships and financing for forestry investments (including tree improvement);
(viii) the gap between the needs of industry and commercial forestry skills and training; and
(ix) High costs due to weak road and electricity infrastructure.

During 2017, a wide spectrum of private commercial forestry actors from the Southern Highlands[2] provided their perspectives on policy issues which are needed in driving the private sector investment and innovation at scale in support of commercial forestry sector growth (Anon., 2017):

(i) *Policy recognition:* Explicit recognition of the contribution of commercial forestry sector to national development and need to promote private sector's growing role and potential.
(ii) *Forest plantation development*: Land availability, acquisition and tax; fire, pests and disease; tree improvement and planting material; information, extension and outreach.
(iii) *Forest industry development:* Raw material supply; industrial output and efficiency; trade and markets for wood products; improving business environment.
(iv) *Industry-wide enabling conditions:* Private sector coordination and dialogue; financial mechanisms and incentives; rural infrastructure; forestry research, training and education.

CONCLUSIONS

Commercial forestry is a growing industry in Tanzania with high dependence on wood from major development sectors, including construction (timber, plywood), rural electrification (poles), retail (packaging), tea and tobacco (wood energy). Commercial forestry is also a major contributor to industrial development, employment and incomes, and one of the suites of mitigation measures of combating forest loss. Opportunities for the growth of the sector are presented by favourable growing conditions, the growing national wood supply deficit, and an increase of dynamism which is shown by private and public actors. The economic opportunities are inclusive with private growers being the greatest source of future wood supply.

REFERENCES

Anon. 2017. *Synthesis of Private Commercial Forestry Stakeholder Recommendations on the Draft National Forest Policy.* Submitted by private sector commercial forestry stakeholders based in the Southern Highlands as an input to the policy review process, 28 August 2017. http://forestry-trust.org/wp-content/uploads/2018/01/2017_UNIQUE-Tanzania-Wood-Market-Study-FINAL.pdf

FBD. (in press). *Standard Operation Procedures for Implementation of Tree Breeding Activities in Southern Highlands of Tanzania.* Forestry and Beekeeping Division, Ministry of Natural Resources and Tourism.

FBD. 2017. *Forest Plantation and Woodlot Technical Guidelines*. Forestry and Beekeeping Division. Dar es Salaam, Tanzania. http://forestry-trust.org/wp-content/uploads/2015/10/Forest-Plantation-and-Woodlot-Technical-Guidelines-final-print-2017.pdf

FDT. 2017. *Tree growers' adoption survey report*. Forestry Development Trust. Iringa, Tanzania.

FDT. 2016. *Baseline tree grower survey report, July 2015.* Forestry Development Trust. Iringa, Tanzania. http://forestry-trust.org/wp-content/uploads/2015/10/FDT-Baseline-Tree-Grower-Survey-Report-Final.pdf

FDT. 2018. *Growth assessment and survival results for species and clonal hybrid trials in Southern Highlands: August 2017 measurements*. Forestry Development Trust. Iringa, Tanzania

2 Including SMEs, associations such as UWAMBA, SAFIA, NOFIA and SHIVIMITA, wooden pole enterprises, tree grower associations, medium scale tree growers, processors, service providers, timber traders and transporters.

Komakech, C. and Blakeway, F. (2014). *Tree Improvement Scoping study for Southern Highlands of Tanzania*. 15pp.

MNRT. 2015. *National Forest Resources Monitoring and Assessment of Tanzania Mainland (NAFORMA): Main Results.* Ministry of Natural Resources and Tourism, Dar es Salaam, Tanzania. http://www.fao.org/forestry/43612-09cf2f02c20b55c1c00569e679197dcde.pdf

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

TIRWG. 2016. *Tree Improvement Strategy for Southern Highlands*. Tree Improvement Research Working Group, Tanzania.http://forestry-trust.org/wp-content/uploads/2015/10/Forest-Plantation-and-Woodlot-Technical-Guidelines-final-print-2017.pdf

UNIQUE. 2017. *Tanzanian Wood Product Market study*. UNIQUE Forestry and land use GmbH. Freiburg, Germany. http://forestry-trust.org/wp-content/uploads/2018/01/2017_UNIQUE-Tanzania-Wood-Market-Study-FINAL.pdf

CONTRIBUTION OF SMALLHOLDER FARMERS TO FOREST RAW MATERIALS BASE IN TANZANIA

HAWKES, M.D. AND SUMARI, S.

Private Forest Programme, P.O. Box 2244, Iringa.
Corresponding author email: michael.hawkes@privateforestry.or.tz

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.

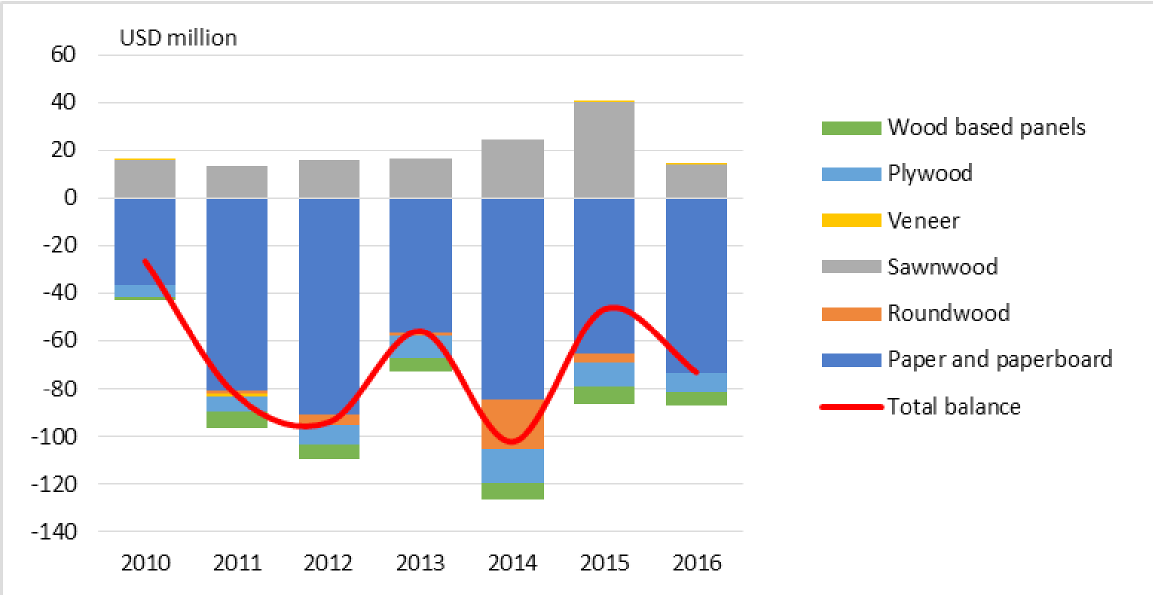


Figure 1: Forest Products Trade Balance in Tanzania between 2010 and 2016

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).

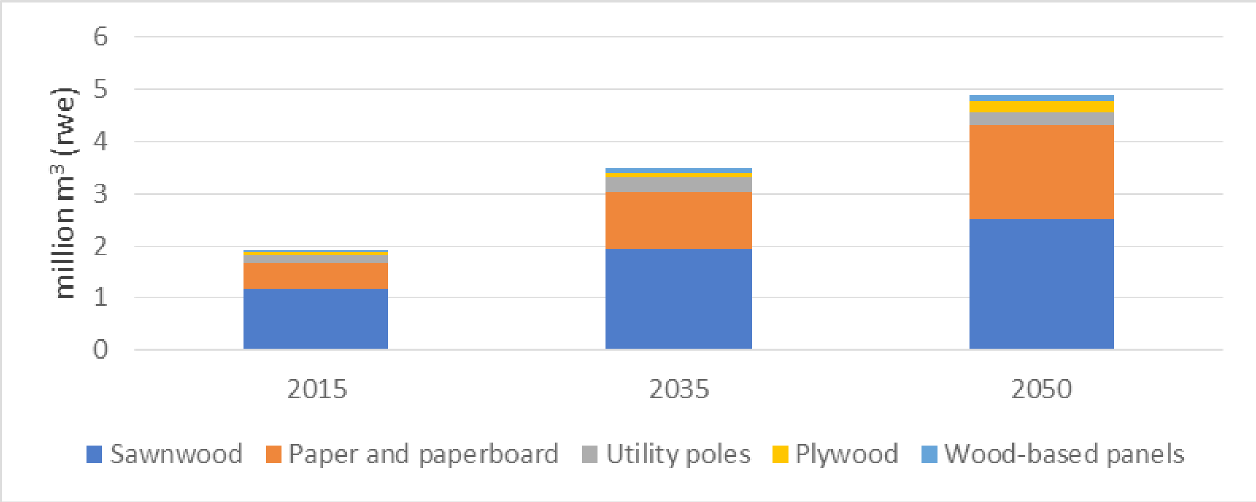


Figure 2: Projected demand for plantation wood products in Tanzania from 2015 to 2050

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.

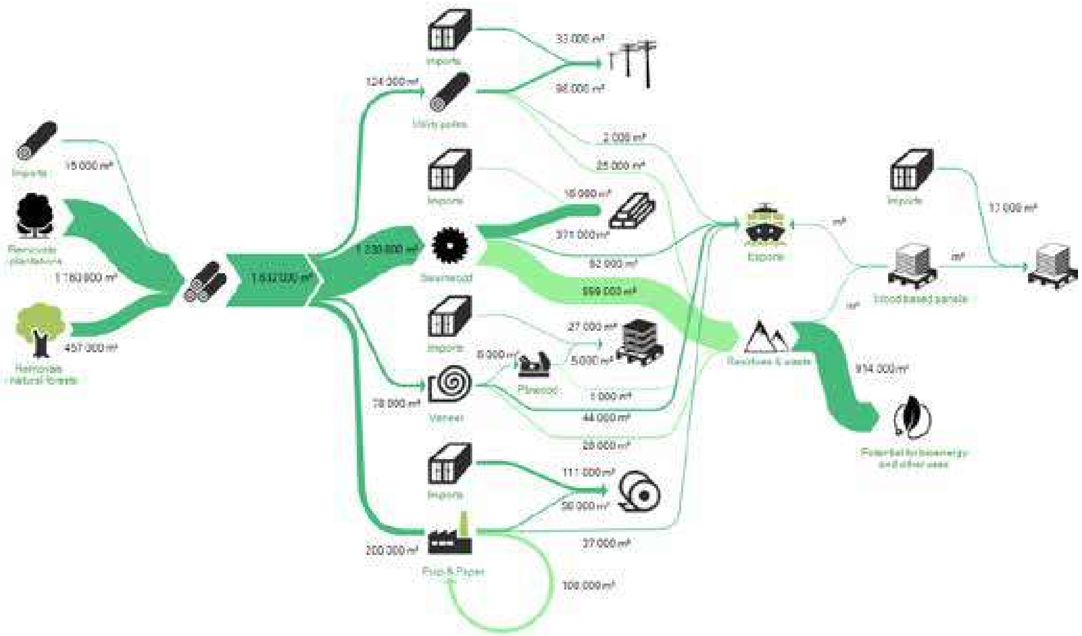


Figure 3: Wood value chain in Tanzania during 2015

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.

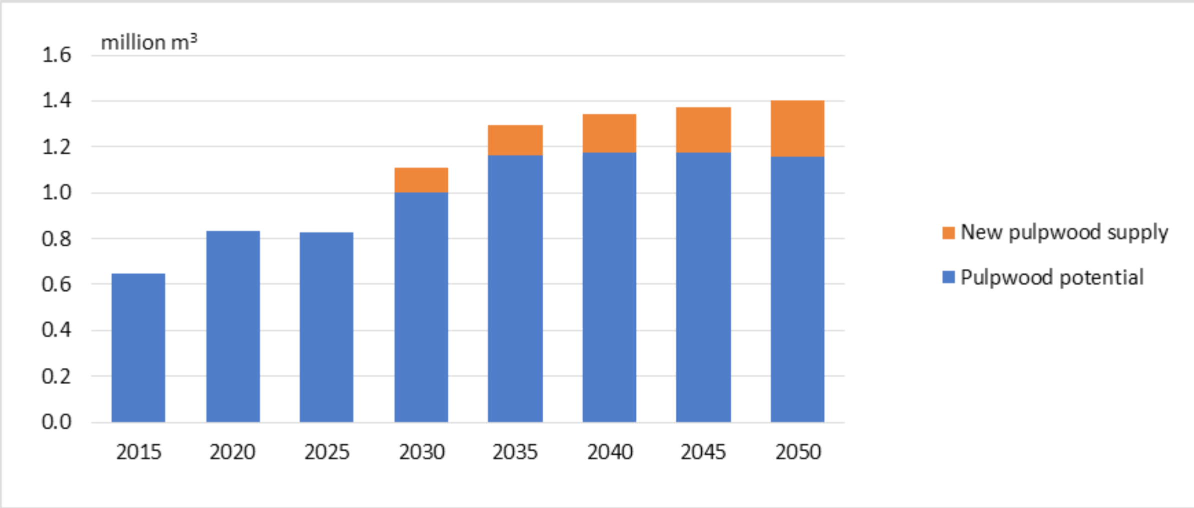


Figure 5: Pulpwood supply in Tanzania

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**.

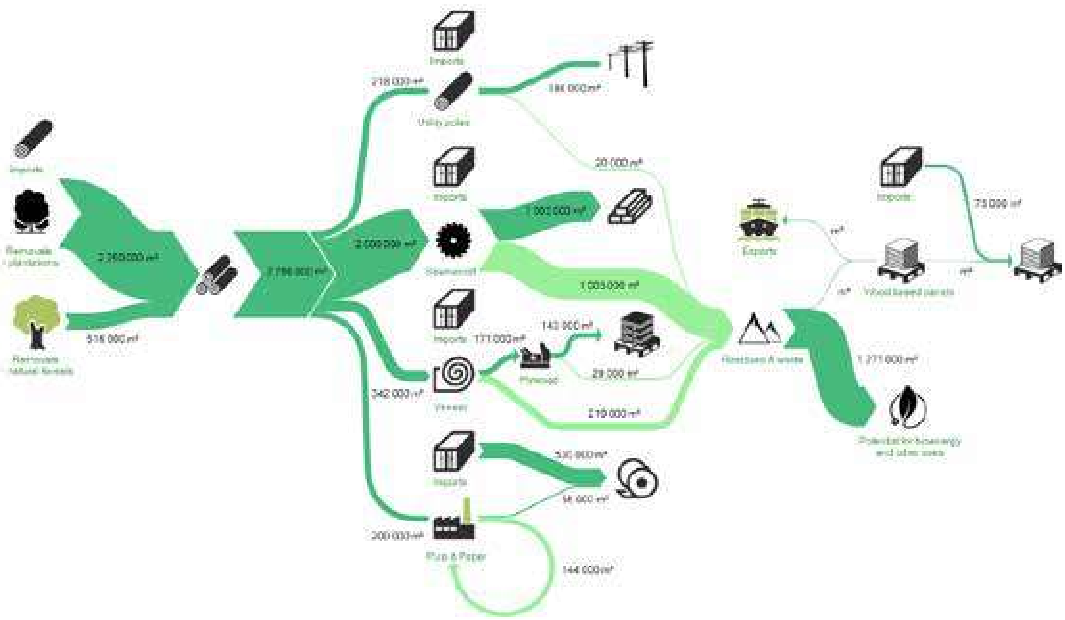


Figure 6: Wood flows in Tanzania in 2050

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.

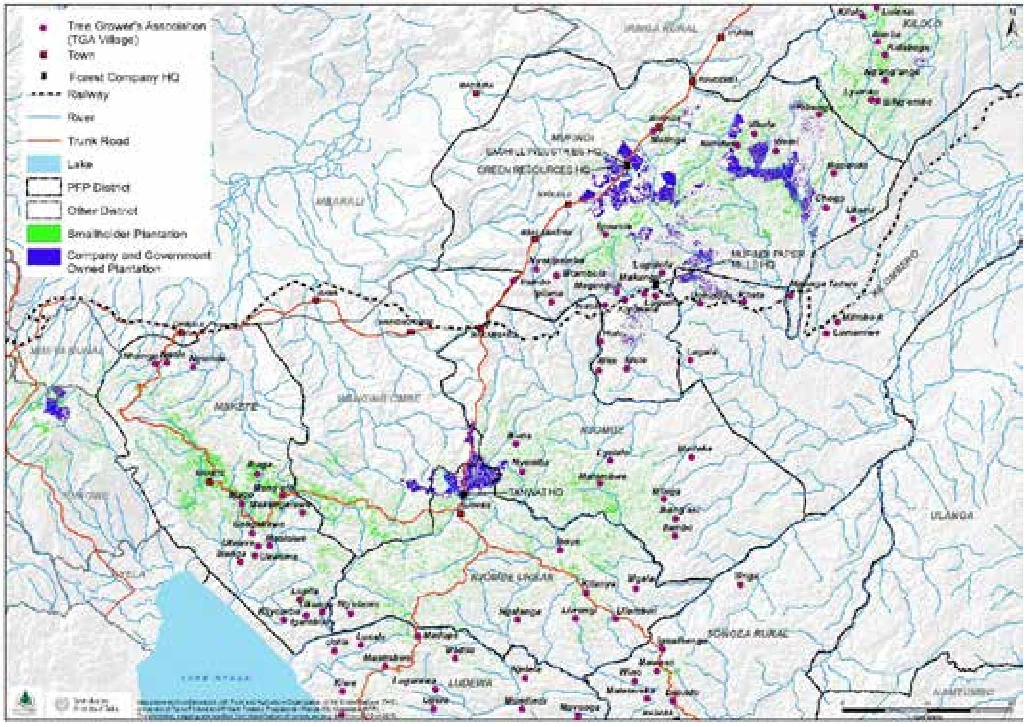


Figure 7: Forest plantations by ownership as mapped in 2016, and tree grower's associations in 2018

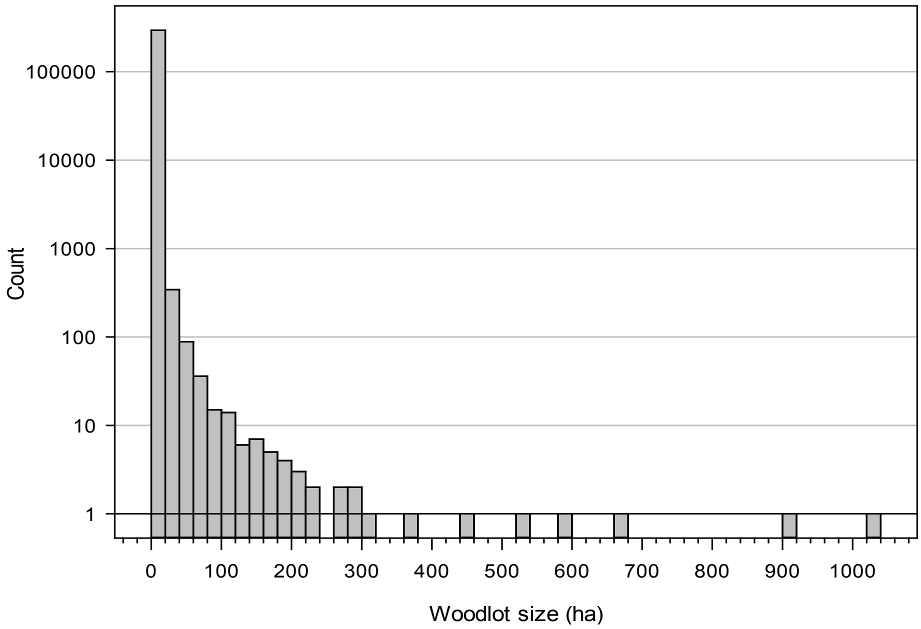


Figure 8: Mapped Smallholder Plantation Forest Polygons by Area Size Class

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.

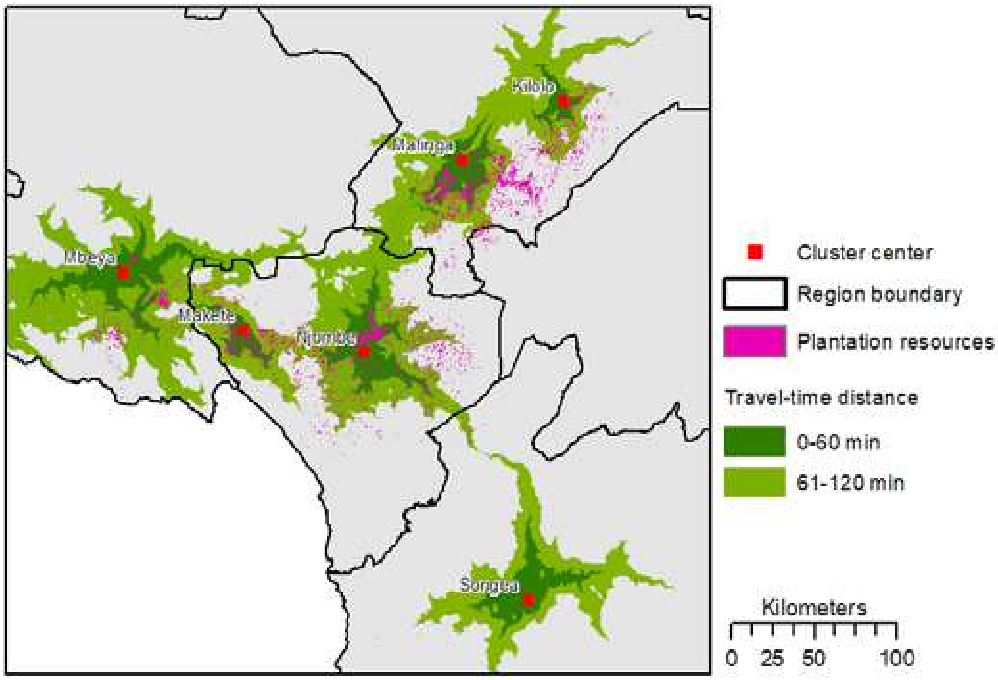


Figure 9: Forest plantations, proposed cluster centres, and travel time distances from cluster centres

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.

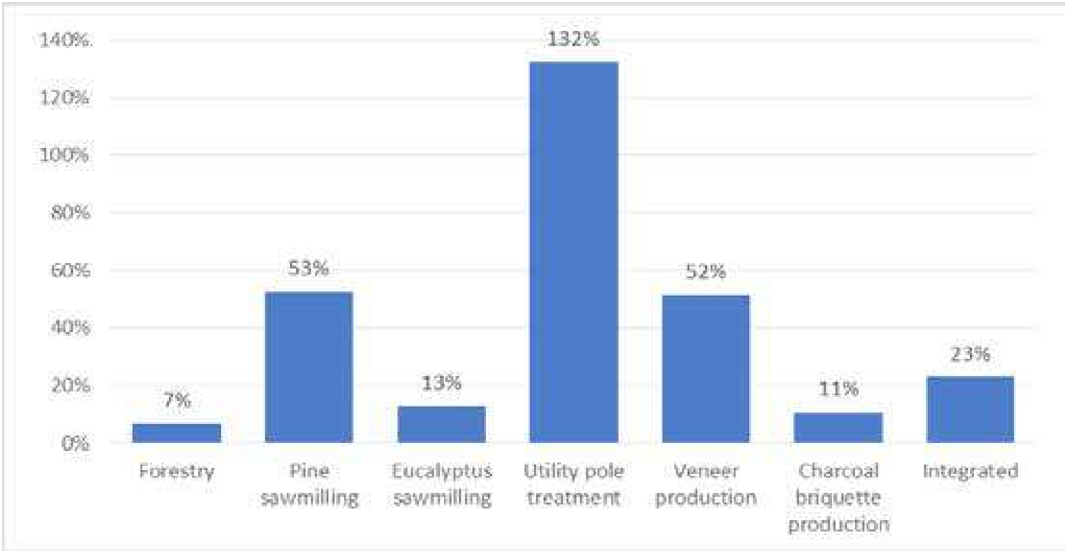


Figure 10: Comparison of Internal Rates of Return – Mafinga Cluster

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.

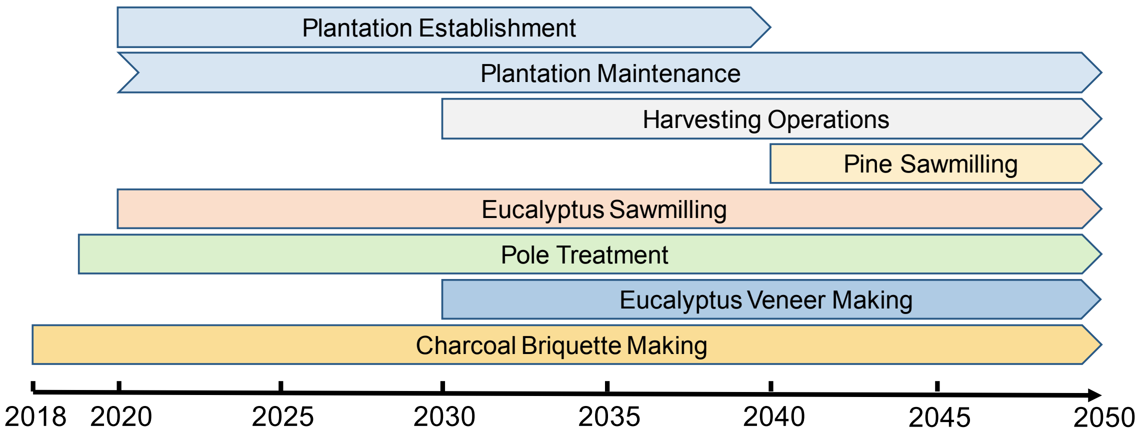


Figure 11: Phasing of investment – Mafinga cluster

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.

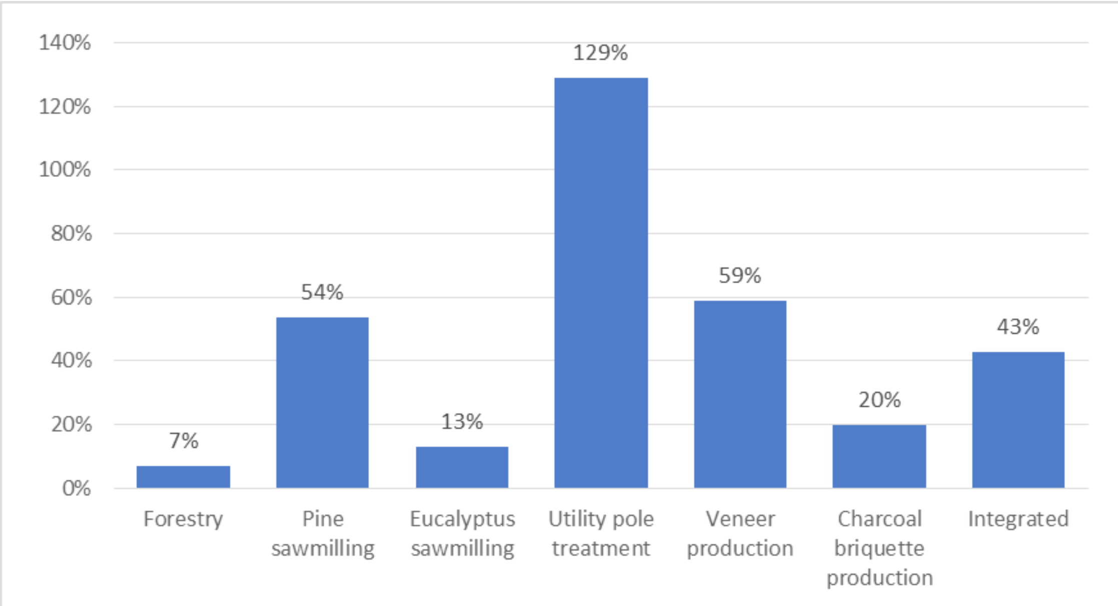


Figure 12: Comparison of Internal Rates of Return – Njombe cluster

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.

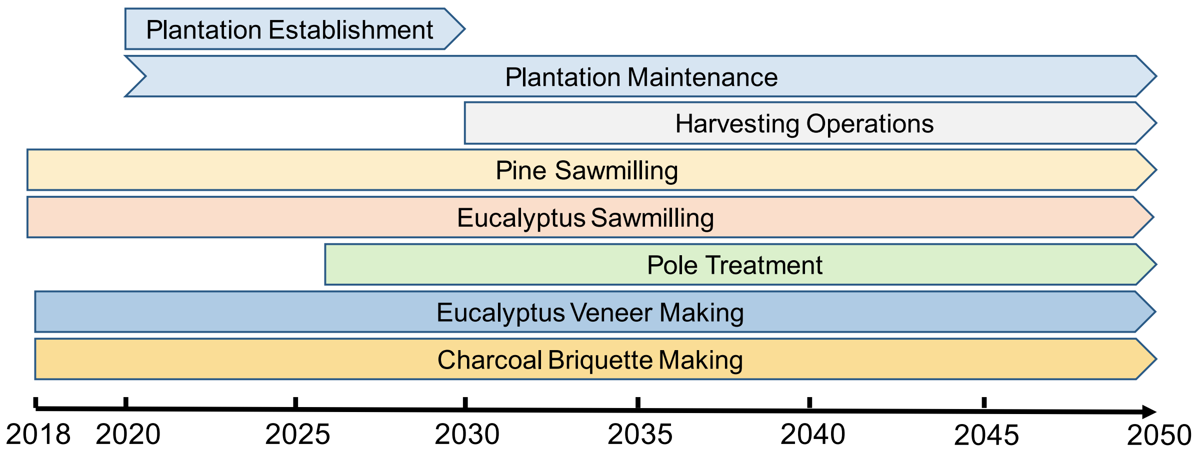


Figure 13: Phasing of investment – Njombe cluster

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.

REFERENCES

Buongiorno, J. 2015. Income and time dependence of forest product demand elasticity and implications for forecasting. *Silva Fennica,* 49(5).

PFP (Private Forestry Programme). 2018. Private Forestry Programme (2018). Investment Opportunities in the Tanzanian Forest Industry and Bioenergy Sectors. Cluster Analysis. Helsinki, Finland. http://www.privateforestry.or.tz/en/news/view/investment-opportunities-in-the-tanzanian-forest-industry.

ADDRESSING PEST AND DISEASE CHALLENGES IN THE NATIONAL FOREST PLANTATIONS: LESSONS LEARNED FROM THE NATIONAL FOREST HEALTH FORUM

[*1]Petro, R., [2]Ndomba, O.A., [1]Bakengesa, S., [3]Chamshama, S.A.O. and [2]Chidege, M.

[1]Tanzania Forestry Research Institute, Box 1854, Morogoro
[2]Tropical Pesticides Research Institute, Box 3024, Arusha
[3]Sokoine University of Agriculture, Box 3010, Morogoro
[*]Corresponding author email: revomushumbusi@gmail.com

ABSTRACT

This paper presents the results of the work carried out by the National Forest Health Forum (NFHF), which covered five National Forest Plantations: Mbizi (Sumbawanga), Meru/Usa (Kilimanjaro), Meru (Arusha), Shume (Tanga) and Sao Hill (Iringa) for the period of five years (May, 2012 - July, 2017). The problems addressed are diseases caused by pathogens and those caused by inadequacies of various requirements from the soils. Many of the diseases have been soil-borne which gave rise to foliar symptoms, with Armillaria root rot being in the lead. Occasionally, the ravage by insect pests was encountered at Sao Hill and Meru Forest Plantations. These problems threaten the productivity of the plantations against the objective for the plantations of supporting the much needed industrialization process. To a large extent, these problems which were recorded in the visited plantations were noted to be accelerated by two phenomena namely; climate change and taungya. Therefore, this paper describes the problems addressed in the plantations; the steps adopted in addressing them, key findings and recommendations for achieving better plantations.

Keywords: Forest diseases, soil-borne pathogens, insect pests, National Forest Health Forum.

INTRODUCTION

The formation of the National Forest Health Forum (NFHF) was one of the outcomes of TAFORI workshop held at Kibaha Conference Centre (KCC) in Kibaha in February, 2011. In this workshop, about 40 technical personnel from public and private institutions gathered to discuss matters hampering productivity and sustainability of the National Forest Plantations. Some of the Institutions involved were Forestry and Beekeeping Division (FBD), Tanzania Forestry Research Institute (TAFORI), Sokoine University of Agriculture (SUA), Tropical Pesticides Research Institute (TPRI), Tanzania Tree Seed Agency (TTSA), Forestry Training Institute (FTI), Kilombero Valley Teak Company (KVTC) and Green Resources. At the midst of the joint discussions was the unprecedented damage of forest plantations by pests and diseases. The goal of the workshop was to develop a national insect pest and diseases management programme. However, the soil was known to be a reservoir or nursing medium for many of the forest pests and disease problems. It was thus agreed that besides other aspects, soil studies should be an integral part of the programme. Among the several objectives of the programme, an overview of insect pests, diseases and soil problems in forest plantations in the country was found pertinent.

In order to be effective, it was deemed useful to specify plantations that needed immediate attention. After looking at the dimensions of the problems as observed in the identified priority plantations, it was immediately realized that the interventions needed to be long lived and carefully guided. On that note, it was decided that a NFHF be formed, that would attend pests, diseases and soil problems as they emerge in the national forest plantations from time to time. This paper describes the range of pest, disease and soil problems addressed by the Forum.

PESTS, DISEASE AND SOIL PROBLEMS ADDRESSED BY THE FORUM

The following are some of the problems addressed by the NFHF. They are sub-sectioned as: Nature of the problem; steps adopted in addressing it; and findings and recommendations as per individual plantation.

Death of *Acacia melanoxylon* and Crooked Growth of *Grevillea robusta*, Meru/Usa Forest Plantation, Arusha

Nature of the problem

(i) *A. melanoxylon,* trees aged 10 years at Oldonyo Sambu Range (Compartment 60) were drying from the growing tip downwards until the whole tree dries away.

(ii) *G. robusta*, trees aged 10 years at Narok Range (Compartment 294) had unusual and crooked growth.

Steps taken to look into the problem

(i) Surveys were carried out in the affected compartments to record incidence and severity of the problem.

(ii) Samples were taken for laboratory analysis. For the case of *A. melanoxylon*, composite soil samples were taken 75 cm away from the trunk and 45 cm deep. For the case of *G. robusta* soil and bark samples were taken.

(iii) Samples were prepared and analysed in the laboratory. For soil samples, the focus was on soil pH, cation exchange capacity (CEC) and exchangeable Al^{3+} and Ca^{2+}. While, for plant samples the focus was on *Botryosphaeriaceae* species of fungi, which is known to produce the recorded symptoms.

Findings and Recommendations

(i) It was found that, in *A. melanoxylon*, the problem was dieback, with incidence of the problem estimated to be 80%.

(ii) The problem was observed in a compartment where *A. melanoxylon* was planted as a pure stand.

(iii) Soil analysis results showed that pH values ranged from 11.93 (strongly basic) to 6.64 (slightly acidic) against the normal requirements for *A. melanoxylon*, which grow best at neutral to slightly acidic soils, that is, pH 6.5 and below.

(iv) The problem was more physiological than phytopathogenic, suggesting that something was wrong with the soil. On the other hand, there was a possibility of the presence of hard pan, which physically impeded root growth.

(v) In *G. robusta*, the problem was stem canker. This caused oozing of copious gum exudation, stunted growth and stem bending. In Narok, the incidence was estimated to be more than 90%;

(vi) To address the *A. melanoxylon* and *G. robusta* problems, use of resistant cultivars/varieties it was recommended.

Death of *Pinus patula* - Shume Forest Plantation, Lushoto - Tanga

Nature of the problem

Pines in the plantation were dying and dead trees showed reddish coloured needles.

Steps taken to look into the problem

(i) A survey was carried out in the affected compartments to study incidence and severity of the problems.

(ii) Needle samples were collected for laboratory analysis.

Findings and Recommendations

(i) Walking along transects of about 100 m in nine different locations, approximately 9 dead trees were encountered giving an incidence of about 5%.

(ii) The problem caused isolated death of trees in the plantation.

(iii) Laboratory results showed that the isolated death of trees was caused by Armillaria root rot.

Survey in Meru, Shume and Sao Hill and West Kilimanjaro Forest Plantation Plantations -

Nature of the problem

The survey was not a result of specific problems invading the plantations. It came forth as an integral component of a project *'Enhancing capacity of TAFORI in the management of forest pests, diseases and soil problems in national forest plantations'*. Through the project, the NFHF visited three plantations (Meru, Shume and Sao Hill). The key motive was to get first hand insight of key forest pests, disease and soil problems that need immediate intervention.

Approach adopted during the visit

(i) The Forum members held discussions with the plantation personnel in each plantation on what they considered to be the most important problems in the plantations.

(ii) The Forum visited tree nurseries in each plantation and shared working experiences with nursery working staff on pest and disease problems.

(iii) The areas with productivity problems were visited.

(iv) Where further studies on a particular aspect were required, soil and plant samples were taken.

Findings and Recommendations

(i) Nurseries – the problems observed include the damage of young seedlings by cutworms and the emergence of mutant seedlings at Shume Forest Plantation.

(ii) Within plantations - One of the most important observations was the effect of taungya farming practice. The practice was highlighted as a cause of social problems between plantation managers and the surrounding communities; of diseases (especially the soil-borne), and different sorts of damage to forest trees.

(iii) It was recommended that Taungya practice has to be improved.

(iv) Another pest/disease problem observed was gummosis, a copious exudation of gums by trees usually caused by the *Botryosphaeriaceae* fungi.

(v) In Shume Forest Plantation, an observation was noted in which mature pine trees died and toppled over. Upon uprooting, the trees were found to have Armillaria rot symptoms.

(vi) In Sao Hill Forest Plantation, two main problems were found: Needle casting in young pines aged one year in Division 4 Kitasengwa Range, Mgololo. The trees had silvery/pale patches on the needles with lower needles at the base of canopy turning yellow then casting down; in severe cases affected needles gave brown dust when shaken.

(vii) Another problem observed was infestation of Pines aged 3 years by the Pine needle aphid, *Eulachnus riley* (*Homoptera: Lachnidae*). Associated signs on the affected plants included black soot making the trees look unsightly; some needles in the affected trees turned yellow; there was a loss of the main growing tip and the proliferation of lateral shoots at the top (Witches broom). The incidence of the problem was estimated to be 85%.

Invasion of unknown Insect Pest on *Olea capensis* in Meru Forest Plantation

Nature of the problem

It was reported that this highly valuable tree species was invaded by an unknown pest that threatens to decimate the range planted with this species. The damage involved defoliation and drying of trees aged approximately 53 years covering 458 Ha.

Steps taken to look into the Problem

(i) The first intervention was to visit the affected range to study the incidence and severity.

(ii) The next step was to identify the pest responsible for defoliation.

Findings and Recommendations

(i) From vantage points near the affected trees, the incidence of the problem was estimated to be over 90%. The trees looked like they were burnt all over!

(ii) Closer to the trees, severely affected trees were found. The leaves were chewed from the margins to the extent that in some, only midribs had remained. One tree was felled to reveal the topmost part of the canopy**.**

(iii) The other sign associated with the infestation was the appearance of webbing on the trunks and branches of the affected trees. The webbing was thought to protect larvae from predation. There was also a mat of shed leaves on the ground and lots of frass, suggesting the extent of damage. Samples of the insect stages including the webbing were collected, were briefly reared at TPRI and were then sent to the experts for identification**.**

(iv) The pest was new in the country's plantations and thus proper identification had to be done to pave way for its management. Many efforts were made, involving taxonomy experts (Smithsonian Institution, USA and University of Auckland, New Zealand). Through intensive molecular characterization, it is only in recent months that the defoliating insect was identified as larvae of the moth *Palpita sp* (*Lepidoptera*: *Crambidae*). Two other species were found to be associated with *Palpita sp*, namely *Cryptoblabes gnidiella* (*Lepidoptera: Pyralidae*) and *Problepsis sp*. (*Lepidoptera: Geometridae*) but their roles in the damage was not clearly known.

(v) Upon revisiting the site (Sakila Range), three months later the trees were found to be recovering from the infestation.

Death of young *Pinus patula* in Mbizi Forest Plantation, Sumbawanga

Nature of the problem

It was reported that 1 – 2 year-old pines in the newly established Mbizi Forest Plantation in Sumbawanga were dying, both in the field and in the nursery. The problem reportedly started in mid-November 2015, about two weeks following a heavy downpour in the area.

Steps taken to look into the problem

(i) A discussion was held with the Plantation Manager in order to get more information on the nature of the observed tree death.

(ii) The next step was to visit part of the plantation having the problem to study the incidence and severity.

Findings and Recommendations

(i) On-site observations revealed that the trees were not dying as such but had altered growth. Characteristic features of the observed (altered) growth included suppressed growth of the leading bud in both apical and lateral branches; tip death of the leading bud in apical parts and in lateral branches in some trees; emergence of light blue multiple leaders (split leader), which seemed to replace the suppressed leading buds; and shortened internodes, which made the whole tree look stunted. In some of the trees, death of growing tips was accompanied by an exudation of resin.

(ii) As observed, death of the tips was just one of the symptoms of the problem but it did not seem to lead to the death of the whole tree. Alongside these observations, there was no sign of any insect being involved in the problem – no bore holes, no chewing, no insect life stage found, and no frass that could be linked to the problem. The incidence of the problem was estimated to range from 36 to 80%. The severity on individual trees was variable, from moderate to severe. In every tree that had the defect, 30% of the crown looked normal.

(iii) Three hypotheses (perceptions) were advanced to describe the probable cause of the problem;
- The infection of the plant by phytoplasma, typical feature of which is the appearance of multiple branches, a condition which is referred to as a witches' broom.
- The infection of the plant by *Diplodia pinea* (syn. *Sphaeropsis sapinea*), typical symptoms of which are brown, stunted new shoots with short, brown needles, the presence of resin droplets and one or a few very short needles.
- Micronutrient deficiency, especially that of Boron, typical deficiency symptoms which include reduced growth rate (stunting), followed by cessation of and sometimes death of the growing point. The cessation of apical growth is accompanied by swelling of the stem apex followed by multiple branching.

(iv) Boron deficiency was considered as the most convincing cause of the problem. *Phytoplasma* are transmitted by insect vectors, and during the survey, no insect was encountered in the poorly growing pines. The infection by *Diplodia* was also discarded because symptoms of their infection in pines first appear on older branches while in the present case, altered growth appeared on the apical and younger lateral branches.

(v) Boron is known to influence the physiology of the plant, particularly growth. It is involved in cell division and influences apical dominance. The micronutrient is immobile within the plant and therefore, its deficiency symptoms are likely to start on younger tissues. Deficiency of Boron in pines suppresses apical dominance causing the formation of multiple branches; sometimes, critical deficiency of the micronutrient leads to death of the apical shoot. Some chemical and physical properties of soils and chemical properties of Boron minerals influence boron mobility within the soil and its availability to plants.

(vi) Soil samples around root zones of the affected plants and the analysis thereof revealed critical deficiency of Boron in the soils. The findings in this study showed the available Boron to be ranging from 0.05 – 0.17mg/kg. This was a critical deficiency as normal soils have Boron of the range of 3 – 6mg/kg.

(vii) As a way forward, it was suggested that Boron spray be applied along a narrow strip in areas where boron deficiency symptoms were detected. The use of the traditional fast release Boron fertilizer such as Borax (Sodium tetraborate) and slow release fertilizers such as Colemanite (Calcium borate) was recommended.

Death of *Pinus patula* in West Kilimanjaro Forest Plantation, Siha District - kilimanjaro

Nature of the problem

(i) It was reported that Pines aged 3 – 4 years in compartments 57 and 77B were dying of unknown cause and affected the areas previously planted with *Acacia melanoxylon* (*Fabaceae*) which could attribute to the problem.

(ii) The dying reportedly started in 2015, with the trees dying consecutively in patches; and that the dying usually started with yellowing of needles followed by dying of whole tree.

(iii) In addition, *Dovyalis caffra* (*Flacourtiaceae*) trees which were used for fencing in the nursery were also dying in patches.

Steps taken to look into the problem

(i) The Team visited the affected trees, both in the plantation and in the nursery. Some of the on-field observations were made, including soil sampling. Also samples of the bark in the butt of the affected trees were taken to generate further information about the problem.

(ii) The samples were taken to the laboratory for further investigation and analysis.

Findings and Recommendations

(i) In the nursery when the affected trees were uprooted, the root system was found to be dead and rotten. The basal part of the root system was black but further from the base, the affected stem had a whitish covering.

(ii) In the plantation, it was also found that the trees (Pines) were indeed dying in patches as reported, with the foliage turning yellow before dying. The incidence of the problem was estimated to be 15%.

(iii) Taungya was the dominating practice in the plantation. The plantation was cultivated all over, with crops (potato, carrot and garden peas) at different stages of growth.

(iv) After critical integration of field observations and laboratory findings; and after considering different possible hypotheses about the observed problem, it was concluded that the trees were killed by Armillaria root rot, a disease caused by a fungus *Armillaria sp*. (formerly *Agaricus melleus*).

(v) The pathogen is a facultative necrotroph. It colonizes living roots, kills root tissue and then utilizes the dead tissue as source of nutrition. The pathogen may infect roots of healthy trees by basidiospores and through rhizomorph contact (from diseased tissue). The disease (Armillaria root rot) is favoured partly by closer spacing, which enhances contact of healthy trees with rhizomorphs. A wider spacing is recommended.

Death of Cypress, (*Cupressus lusitanica*) in West Kilimanjaro Forest Plantation, Siha District - Kilimanjaro

Nature of the problem

(i) It was informed that Cypress trees aged 15 years in a 9 Ha Compartment 104, were dying. The problem was first observed in 2016.

(ii) The death of trees was isolated and gradual.

Steps taken to look into the problem

(i) A visit accompanied by some forest managers was made to the forest compartment where the trees were reported to have died, first viewed from a vantage point.

(ii) The researchers and managers then walked into the compartment, to capture the nature of the problem on individual trees – the parts affected and the extent of the effect, that is, the severity.

(iii) Some of the affected trees were uprooted to determine what was happening in the root system**.**

(iv) Using a machete, the bark of the affected trees was scratched at the basal parts to expose the appearance of the inner tissues.

(v) Bark samples from the basal parts of the affected trees were taken for further investigation in the laboratory to identify the disease.

Findings and Recommendations

(i) From vantage points in the field, trees were seen to be dying at different stages – some showing yellow canopies, others brown, and others typically dead.

(ii) Upon uprooting, it was found that the root system was infected, with some parts having the bark falling loose.

(iii) It was also found that some whitish substance typical of fungal mycelia was dispersed in the soil and around the infected root parts.

(iv) Scratching the bark at the soil level using machete also revealed a white parchment just beneath the cork, suggesting that *Armillaria* infection could be one of the causes of rotting.

(v) Subcultures from the ten (10) samples submitted to the laboratory gave rise to whitish and to slightly yellow fluffy mycelia.

(vi) Upon keeping the cultures for prolonged periods, structures typical of *Armillaria* rhizomorphs formed. The structures are typically black and root like, suggesting that the pathogen involved was likely to be *Armillaria* species.

(vii) It was strongly advised that trees in the affected compartment be harvested and put into whatever use, to avoid further loss.

CONCLUSION AND RECOMMENDATIONS

Managing soil borne diseases in the national forest plantations is a key to maintaining and enhancing productivity. Just as it requires systems approach to maintain resilience between forests and their native diseases, addressing challenges of the diseases at landscape scale requires concerted efforts by multistakeholders – researchers, plantation managers, and policy makers. When a researcher suggests an approach to managing a freshly identified disease, for example, plantation managers should look for the means of implementing the recommended practice instead of just forwarding the reports to higher management level or simply shelving them in the office.

ACKNOWLEDGEMENTS

The members of the team are grateful to the forest professionals gathered in Kibaha in 2011 who had confidence on the forum thereby blessing them to undertake these research roles. We are grateful to the Tanzania Forest Fund, which has been supporting the accomplishment of these research roles. Special thanks to Messrs Joshua Maguzu and Aloyce Mpiri for their support during the accomplishment of this work in Shume and Mbizi plantation forests, respectively. Last but not least, we thank the forest managers in the forest plantations we visited for providing good background information to the problems we explored and for providing other types of assistance as it deemed necessary.

REFERENCES

Bryce, J.M. 1967. *The Commercial Timbers of Tanzania*. 2nd Edition Revised by A.W. Chihongo. Tanzania Forestry Research Institute, Morogoro, Tanzania. 293pp.

Ennos, R.A. 2015. Resilience of forests to pathogens: an evolutionary ecology perspective. *Forestry* 88: 41–52.

Katan, J. 2017. Diseases caused by soil borne pathogens: Biology, management and challenges. *Journal of Plant Pathology,* 99 (2): 305-315.

Keenan, R.J. 2015. Climate change impacts and adaptation in forest management: a review. *Annals of Forest Science,* 72 (2): 145-167.

Matunda, B., Chaha, O., Peregrin, M., Peter, M. and Lukumay, R. 2010. *The status of Compartments 62, 63, 64, 65 and 69*. Brief report. 2pp.

Muchiri, M., Pukkala, T., Miina, J. 2002. Modeling trees' effect on maize in the *Grevillea robusta* and maize system in Central Kenya. *Agroforestry Systems,* 55: 113 – 123.

Nshubemuki, L. 1998. Selection of Exotic Tree Species and provenances for afforestation in Tanzania. Unpublished Thesis for award of D.Sc. Degree, University of Joensuu, Faculty of Forestry. 138pp.

Petro, R. 2011. *The invasion and control of Grasshoppers (Zonocerus variegatus) in Ukaguru forest plantation, Morogoro, Tanzania*. Report submitted to Ministry of Natural Resources and Tourism, Dar es salaam, Tanzania. 18pp.

Ramsfield, T.D., Bentz, B.J., Faccoli, M., Jactel, H. and Brockerhoff, E.G. 2016. Forest health in a changing world: effects of globalization and climate change on forest insect and pathogen impacts. *Forestry*, 89: 245–252

Randhir, T.O. and Erol, A. 2013. Emerging Threats to Forests: Resilience and Strategies at System Scale. *American Journal of Plant Sciences,* 4: 739-748

Sturrock, R.N., Frankel, S.J., Brown, A.V., Hennon, P.E., Kliejunas, J.T., Lewis, K.J., Worrall, J.J. and Woods, A.J. 2011. Climate change and forest diseases. *Plant Pathology*, 60: 133-149.

Veena, D.R., Priya, H.R., Khatib, R.M. and Divya, J. 2014. Soilborne Diseases in Crop Plants and Their Management. *Research and Reviews: Journal of Agriculture and Allied Sciences*, 3 (2): 12 – 18.

FINANCING FORESTRY RESEARCH MECHANISM: TANZANIA COMMISSION FOR SCIENCE AND TECHNOLOGY EXPERIENCE

Kindeketa, W.J.

Tanzania Commission for Science and Technology,
P.O. Box 4302, Dar es Salaam, Tanzania,
Corresponding author emails: wkindeketa@costech.or.tz; william.kindeketa@gmail.com

ABSTRACT

Tanzania is one of the highest biodiversity in the world, containing a significant number of endemic and threatened plant, mammal, bird, reptile, frog, butterfly, snail, and millipede species. Tanzania has set aside about 40% of her area for conservation, including total land mass and marine area, hence categorized as a 'mega-diversity' nation. There are about four identified financing sources of forestry research sector in Tanzania, including Government budgetary allocations, retained income from forest revenues, grants from Tanzania Government and development partners, and private financing. The Tanzania Commission for Science and Technology (COSTECH) as one of the financing sources for Research and Development is an apex body for the coordination, promotion, and popularization of Science and Technology in Tanzania. COSTECH supports Research and Development activities through the National Fund for the Advancement of Science and Technology (NFAST) in terms of grants and awards. The funding from the NFAST specifically aims at: supporting research with special emphasis in the national priority areas; supporting development and transfer of appropriate technologies; supporting capacity building in Research and Development and Science and Technology Institution's (STIs) activities; supporting organization of and/or attendance to scientific fora and information dissemination through publications; promoting innovativeness and inventiveness through the provision of awards; commissioning individuals, groups of individuals, institutions or groups of institutions to undertake research or studies in special areas identified by the Commission; and supporting any other activities whose objectives would be the promotion of STIs for national development.

Key words: Forestry, Financing, NFAST, Commission, COSTECH, National Research Priority.

INTRODUCTION

Forest finance refers to all forms of financing for sustainable forest management and has been described and emphasized in Addis Ababa Action Agenda (2015), Sustainable Development Goals (2015), National Forest Policy (1998), and the Forest Act of Tanzania (2002). Financing of the forestry research sector in Tanzania occurs mainly through Government budgetary allocations, retained income from forest revenues, grants from development partners, and private financing (United Nations Forum on Forests, 2016). In Tanzania, there has been a significant change towards facilitating forest research financing such as the establishment of the Tanzania Forest Fund under the Forest Act (2002) which aims at among others establishing a sound domestic financing base for forestry research. Besides, the reforms have brought in the private-sector as a new stakeholder in the forestry research. The Tanzania Commission for Science and Technology (COSTECH), which was established in 1986 by the Act of Parliament No.7 as a successor to the Tanzania National Scientific Research Council, is an apex body for the coordination, promotion, and popularization of Science and Technology in Tanzania. Part V of the Act No. 7 of 1986 provides for the establishment of the Fund which shall be known as the National Fund for the Advancement of Science and Technology (NFAST), which is managed and administered by the Commission (COSTECH Act, 1986). The Fund is basically intended to provide support in terms of grants and awards to Science, Technology and Innovation (STI), Research and Development (RD) activities carried out by Tanzanian scientists within the National Research Priorities.

In order to operationalise the Fund, COSTECH has developed a Grants Manual that provides guidelines and procedures for the provision of various grants and awards. The grants may be given in full or in collaboration with other agencies. The Manual is intended to inform the potential grantees and the general public on the existence of the Fund, how they can access it and the processes used in reaching a funding decision.

OBJECTIVES OF THE FUND

The objectives of the Fund among others include:

i. Supporting forestry research with a special emphasis in the national priority areas;
ii. Supporting development and transfer of appropriate technologies;
iii. Supporting capacity building in RD and STI activities in terms of research, human resources and facilities;
iv. Supporting organization of or attendance to scientific fora and information dissemination through publications;
v. Promoting innovativeness and inventiveness through the provision of awards; and
vi. Commission individuals, groups of individuals, institutions or groups of institutions to undertake research or studies in special areas identified by the Commission to be of the national interest.

TYPES OF GRANTS AND AWARDS

The Tanzania Commission for Science and Technology supports various awards and STI activities, including attending STI events and hosting scientific events. This paper will only deal with research, innovation, fellowships and infrastructure improvement. The following are the categories of grant types:

i. **Open Research Grants**: These grants are given to researchers on a competitive basis either basing on calls that have a specific theme responding to specific national priorities or a broad in nature theme allowing researchers to explore diverse areas of scientific inquiry. In this category, there are small or minor, standard, medium, long term and partial subcategories, depending on the amount of the grant award and project lifespan.
ii. **Commissioned Research Grants**: Refers to the grants commissioned through its RD Advisory Committees to individual researchers/institutions in order to solve specific problems of national interest. They may also support the promotion of new and emerging technologies, technology incubation and transfer, as well as documentation and dissemination of scientific information. The value of the grant awarded depends on the nature of the project.
iii. **Fellowships Grants**: The grants support Postgraduate studies, short courses and the establishment of research chairs.
iv. **Capacity Building Grants:** The grants apply to support research facilities (infrastructure), supporting scientific publication, dissemination of scientific and technological information, the writing of scientific text books and monographs, supporting scientific expeditions within the country and

abroad, supporting the development and strengthening of national, regional and international linkages, and supporting the creation and maintenance of databases on STI for R&D and Higher learning Institutions.

PROCEDURES AND PROCESSES FOR OBTAINING GRANTS

Research and Innovation Grants

Research or innovation calls are carried out twice a year, depending on the availability of funds. Normally research calls should address the National Research Priority Areas and are open to Tanzania's citizens attached / working in a Research and / or Higher learning institution (public and private institutions). There are two kinds of research calls, namely open and commissioned calls. Open research calls entail submission of concept note prior to the development of full proposals while commissioned researches require the submissions of full proposals based on the identified problem. Once a call is issued, the applicant is expected to submit a concept note within two weeks from the date of advertisement.

Concept notes are either submitted online using COSTECH Research website form or via emails. The received concept notes are screened in-house by a screening committee before being sent to external reviewers. The reviewers are required to declare conflict of interest and fill forms and adhere to the principles of integrity and non-disclosure. The review process is based on the assessment criteria. The successful concept notes are published on COSTECH website for development of full proposals.

Again, the submitted proposals go through an in-house screening process to ensure that all the proposals are complete and conform to the stipulated rules and regulations of the research grant before being sent out for external review. All research proposals are subjected to a systematic external review processes for evaluation of scientific and technical merits. Generally, at least three scientific reviewers review each submitted proposals. External reviewers are selected based on their qualification, sound experience in the field of study as well as in evaluating projects in their specialty. Reviewers are required to sign a Conflict of Interest.

The reviewers' grades are submitted to COSTECH management for recommendation based on evaluation and availability of resources prior to approval by the NFAST Committee, and forwarded for endorsement by the Board of Commissioners. The successful applicants are notified four months after the submission of the research proposals. On the other hand, unsuccessful applicants are notified upon request.

Once a funding decision has been made, a due diligence is performed to the host institution. It is important that the process is complete prior to the signing of the contract. Key areas to be addressed in the due diligence process are (i) to ascertain whether the applicant's institution has the capacity to manage disbursed funds (ii) to determine whether the commission will obtain value for money outcomes, (iii) to establish the legality of the applicants in their respective institutions and (iv) to determine whether the institution has the required infrastructure to perform the proposed research.

Awarding and contract signing is only done on the basis of a satisfactory due diligence report. A contract agreement is signed between COSTECH, the host institution and the applicant. Issues of ownership of equipment, research results, copyright and patent are addressed in the contract.

Funds are disbursed through the applicant's institution and the request for disbursement should bear an institutional emblem and seal. Funds for subsequent phases are released within four weeks after the receipt of a satisfactory progress report of the previous phase based on technical and financial aspects and together with the agreement as per the contract. Being public funds, the grants must be used for the purpose for which they are budgeted for and properly accounted for. In case the grantee cannot proceed with the work for whatever reason, the unspent funds must be returned to the Commission.

Fellowship Grants

Fellowships are advertised in the print and electronic media for easy access by the potential applicants. The fellowships must be tenable within the country or outside the country as may be recommended by the Commission and as per the availability of resources. The applicant must have evidence of admission. Fellowships may also be advertised tenable at the national or regional universities that have entered into partnership with the Commission for specific programmes of interest to the nation. The selection of students bases on academic and scientific qualifications as well as gender consideration. Fellowships can be subcategorized into Masters Fellowships, PhD Fellowships, Post-doctoral Fellowships, and Short Courses Fellowships. Successful applicants for all post-graduate studies are notified accordingly and required to sign a contract agreement, before the funds are released. The contract agreement is between the Commission, the grantee, the training institution and the grantee's employer.

All funds related to the fellowship are disbursed directly to the university/ institute where the successful applicant pursues the fellowship programme. The university/ institute use its existing internal procedures to disburse the money to the students/ study fellows. The Commission will not entertain direct communication with the students/study fellows regarding the grants.

Accountability and Reporting: Grantees must furnish the Commission with regular progress reports of their studies as agreed in the Fellowship Grants Contract. The university/institute is responsible for making sure that the intermediate reports and the final thesis are prepared by the grantees and copies sent to the Commission. Grantees of Post-doctoral and short course fellowships are required to furnish the Commission with the course report within two weeks of completing the course.

Support Research and Development and S&T Institutions

The key focus of this grant category is building capacity of Research and Development, and Higher Learning Institutions in terms of infrastructure/facilities and human resource development. Applications for a grant to support RD and STI institutions are received throughout the year. Applicants are notified of the receipt of their applications within two weeks of the receipt of the application at the Commission. The status of the decision on the application is made known by the end of each quarter that is, September, December, March and June. Applicants are normally from public and private universities, RD and STI institutions as well as Non-Government Organisations (NGOs) and professional associations. Applicants for any grant category may only submit one application per year.

CONCLUSION AND RECOMMENDATION

Research and Development activities are necessary in order to inform, lead, and guide all which needs to be done to achieve the desired transformation of the socio-economic status of a nation. COSTECH supports all sectors as indicated in the National Research Priorities including forestry research. However, the payback for investment or funding in Research and Development by way of tangible achievements will be realized only if the research is demand driven, and in that regard, the outcomes are utilized to solve fundamental as well as pressing societal and development challenges.

REFERENCE

Tanzania Commission for Science and Technology (2015): National Research Priorities for Tanzania 2015 – 2020.

The Republic of Tanzania (1986): Tanzania Commission for Science and Technology Act, Number 7 of 1986 (revised).

The Republic of Tanzania (1998): National Forest Policy of Tanzania. Retrieved from: *http://www.forestfund.go.tz/uploads/tanzania_forest_policy_1998.pdf*

The Republic of Tanzania (2002): The Forest Act. Retrieved from: *http://theredddesk.org/sites/default/files/forest_act_tanzania.pdf.*

United Nations (2015): The Sustainable Development Goals and Agenda 2030. Retrieved: *https://sustainabledevelopment.un.org/content/documents/15806Brazil_English.pdf*

United Nations (2015): Addis Ababa Action Agenda of the Third International Conference on Financing for Development. Retrieved from: *http://www.un.org/esa/ffd/wp-content/uploads/2015/08/AAAA_Outcome.pdf.*

United Nations Forum on Forests (2016): Forest Finance. Retrieved from: *http://www.un.org/esa/ffd/wp-content/uploads/2016/01/Forest-Finance_UNFF_IATF-Issue-Brief.pdf.*

FINANCING FORESTRY RESEARCH MECHANISM: TANZANIA FOREST FUND

[*]Msuya, T., Paulo, T. and Mwakilla, E.

Tanzania Forest Fund, P.O. Box 11004, Dar es Salaam
[*]Corresponding author email: tuli.msuya@mnrt.go.tz

ABSTRACT

Tanzania Forest Fund (TaFF) is a Public Conservation Trust Fund which was established under sections 79 to 83 of the Forest Act No. 14 of 2002. It is a mechanism of providing long term, reliable, and sustainable financial support to enhance sustainable forest management in Tanzania mainland. The Fund is an important instrument for financing forestry research particularly the National Forestry Research Master plan II (NAFORM II) of 2011 to 2020. TaFF has seven functions two functions of which provide a window for financing forestry research namely; (i) promotion and funding of research into forestry, and (ii) the promotion of such other activities of a similar nature to those set out in Section 80 of the Forest Act No. 14 of 2002. TaFF is obliged to fund forestry research through her Strategic Objective titled "Applied and adaptive research on management of forest resources supported". From July 2011 to March 2018, TaFF spent Tanzania Shillings (TZS) 720.9 million to support 36 research projects of which 69% are still being implemented. The research projects supported by TaFF have been/are being implemented by research and training institutions, government agencies and non-governmental organizations. In addition, TaFF has spent TZS 500 million for supporting special projects which are being implemented by government institutions including Tanzania Forestry Research Institute (TAFORI). The Fund has also spent TZS 136.2 million to support the dissemination of forestry research findings. The support to infrastructure development, equipment and facilities, is another window of supporting and promoting forestry research in Tanzania mainland. It can be concluded that, TaFF has spent substantial amount of money for financing forestry research. TaFF will continue financing forestry research; and finally, the commitment for spending research funds for the intended purposes is paramount.

Keywords: Financing, Forestry Research, Tanzania Forest Fund

INTRODUCTION

Sustainable forest management (SFM) can best be realized if proper backstopping is provided by forestry research. Forestry research has a role in providing appropriate knowledge and technology for sustaining management of forest resources. Furthermore, it supports making informed decisions on socio-economic and social issues. Priority areas of forestry research are covered in the current National Forestry Research Master plan II (NAFORM II-from 2011 to 2020). Financial support is paramount for successful implementation of NAFORM II of which Tanzania Forest Fund (TaFF) is an important instrument.

Tanzania Forest Fund is a Public Conservation Trust Fund established under sections 79 to 83 of the Forest Act No.14 of 2002, as a mechanism of providing long term, reliable, and sustainable financial support to sustain management of forest resources in Tanzania mainland. The Fund is governed by a Board of Trustees and was made operational in July 2010 through Treasury Circular No. 4 of 2009 and embarked in full implementation of its functions in July 2011.

The Fund's mission is to mobilize financial resources for supporting, among others, forestry research in Tanzania mainland.

The sources of income for the Fund are as follows:

i. A levy of 2% of every fee payable under the Forest Act;
ii. A levy of 3% of any royalty payable under the Forest Act;
iii. Penalty and sales of any forest produce confiscated under any of the provisions of the Forest Act;
iv. Grants, Donations and Bequests contributed by any private individuals;
v. Corporate bodies, foundations, international organizations or Funds within or outside the country; and
vi. Income generated by projects financed by the Fund.

According to section 80 of the Forest Act No.14 of 2002, Tanzania Forest Fund has the following functions:

(i) Promote awareness of the importance of the protection, development and sustainable use of forest resources through public education and training;
(ii) Promote and assist in the development of community forestry directed towards the conservation and protection of forest resources through making of grants and providing advice and assistance to groups of persons;
(iii) Promote and fund research into forestry;
(iv) Assist in enabling Tanzania to benefit from international initiatives and international funds directed towards the conservation and protection of biological diversity and the promotion of sustainable development of forest resources;
(v) Assist groups of persons and individuals to participate in any public debates and discussions on forestry and in particular to participate in the processes connected with the making of an environmental impact assessment;
(vi) Assist groups of persons and individuals to ensure compliance with the Forest Act; and
(vii) Promote such other activities of a like nature to those set out in the objects and purposes of establishing Tanzania Forest Fund as will advance the purposes of the Forest Act.

Potential beneficiaries of TaFF include individuals: local communities, researchers, training institutions, research institutions, non-academic institutions, and environmentalists. Others include government institutions such as ministries, agencies, independent departments/authorities, regional administration and local government authorities (LGAs); non-governmental organizations (NGOs); civil society organizations (CSOs); faith based organizations; private sectors; and community based organizations.

FINANCING FORESTRY RESEARCH

Tanzania Forest Fund has two functions which provide a window for financing forestry research. These functions are (i) promoting and funding research into forestry, and (ii) promoting such other similar activities that advance the purposes of this Act. On the other hand, other functions of TaFF can also provide a window for financing forestry research.

As mentioned above, TaFF is obliged to promote and fund forestry research. This obligation is translated into the Fund Second Strategic Plan (2016/2017 – 2020/2021) whose one of the Fund Strategic Objective is "To support applied and adaptive research on the management of forest resources".

The strategies to achieve this strategic objective include: (i) supporting applied and adaptive research based on identified sector priority areas; (ii) Facilitating dissemination of forestry research findings; and (iii) Supporting evaluation of impacts of forestry research on Sustainable Forest Management (SFM). In the five years of the implementation of its second Strategic Plan (2016/2017 – 2020/2021), the Fund plans to support the implementation of 50 projects on applied and adaptive forestry research to inform SFM and support dissemination of research findings. TaFF finances forestry research in different ways as elaborated in subsequent sections.

Support Research Project Proposals through Offering Grants

According to the Guidelines for Preparation of Project Proposals and Procedures for Grants Making, Tanzania Forest Fund offers grants to project proposals focusing on three priority areas as illustrated hereunder:

(i) Forest resources protection, conservation and management;
(ii) Improvement of livelihood of communities living adjacent to the forest resource base; and
(iii) Applied and adaptive research in forestry.

Tanzania Forest Fund offers three types of assistance to grantees as follows:

(i) Monetary assistance - Tanzania Forest Fund could provide financial assistance to support implementation of approved interventions/project activities.
(ii) Material assistance - Tanzania Forest Fund could provide required materials, facilities and equipment.
(iii) Technical assistance - Tanzania Forest Fund could provide technical assistance to grantees by hiring professionals to offer the requested services.

As for grant types, the Fund offers three types of grants as follows:

(i) Small Grants – amounts not exceeding Tanzanian Shillings (TZS) 5 million.
(ii) Medium Grants – amounts exceeding TZS 5 million, but not exceeding TZS 20 million.
(iii) Large Grants – amounts exceeding TZS 20 million, but not exceeding TZS 50 million.

Modalities for Supporting Forest Based Research Projects

Currently, the method used to support forest based research projects is through submission of project proposals in response to TaFF's call for proposals which is made once per year. Individuals and research institutions interested in submitting project proposals under the priority area of applied and adaptive research are obliged to compete to the themes and sub-themes shown under the priority area. From the financial year 2017/2018 to 2019/2020, research project proposals to be supported by TaFF should focus on the following themes and sub-themes:

Theme 1: Plantation forestry and tree improvement

Sub-themes under this theme are as follows:

i) Search for new plantation tree species with emphasis on indigenous species.
ii) Assess effects of forest plantations on water resources, biodiversity and soil health.

Theme 2: Forest resource assessment

Sub-theme under this theme is as follows:

i) Develop simple forest resource assessment methods for local communities.

Theme 3: Community and farm forestry

Sub-themes under this theme are as follows:

i) Undertake biological evaluation of various Agro forestry technologies for various end uses in sets of ecological zones and farming systems.

ii) Assess and provide/develop management techniques/guidelines for woodlots and tree outside the forests (ToF).

Forest Research Projects Supported by Tanzania Forest Fund

From July 2011 to March 2018, Tanzania Forest Fund has supported 494 projects as shown in **Figure 1**. Normally, the projects supported by TaFF are categorized into two broad categories: community based projects abbreviated as "CDs" and research based projects abbreviated as "RPs".

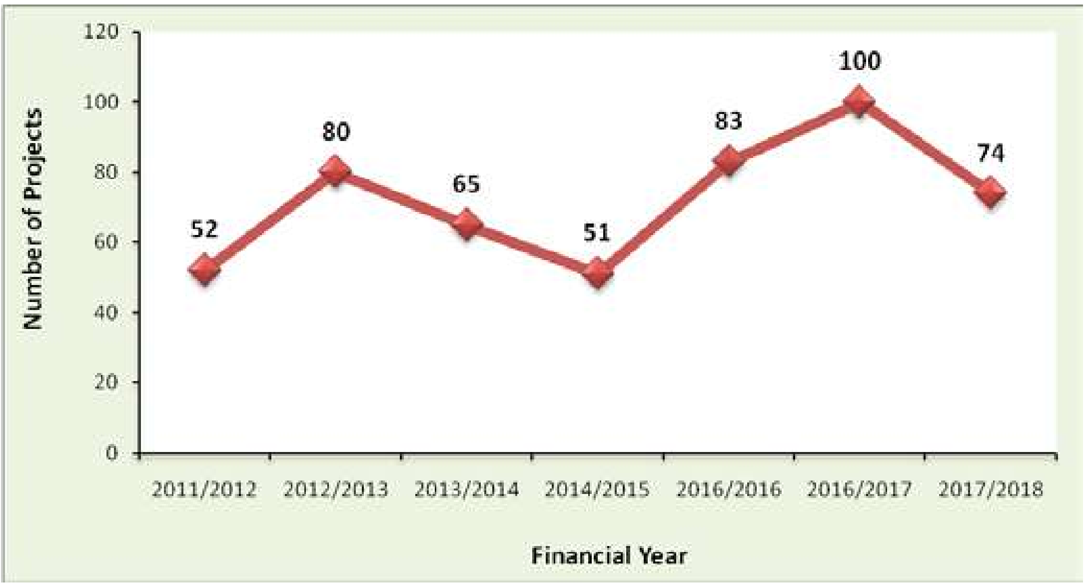


Figure 1: Number of projects supported by TaFF from the year 2011/2012 to March 2018.

Out of 494 projects supported by TaFF from 2011/2012 to March 2018, 36 are research based projects and 458 are community based projects. Community based projects (CDs) supported by TaFF show an increasing trend from 2011/2012 to March 2018, unlike research based projects (RPs) in the same period **(Fig 2).** The Amount of money spent for supporting 36 research projects is TZS 720.9 million. The 36 TaFF supported research projects were implemented in 28 districts, 4 Municipalities and two cities in 17 regions of Tanzania mainland.

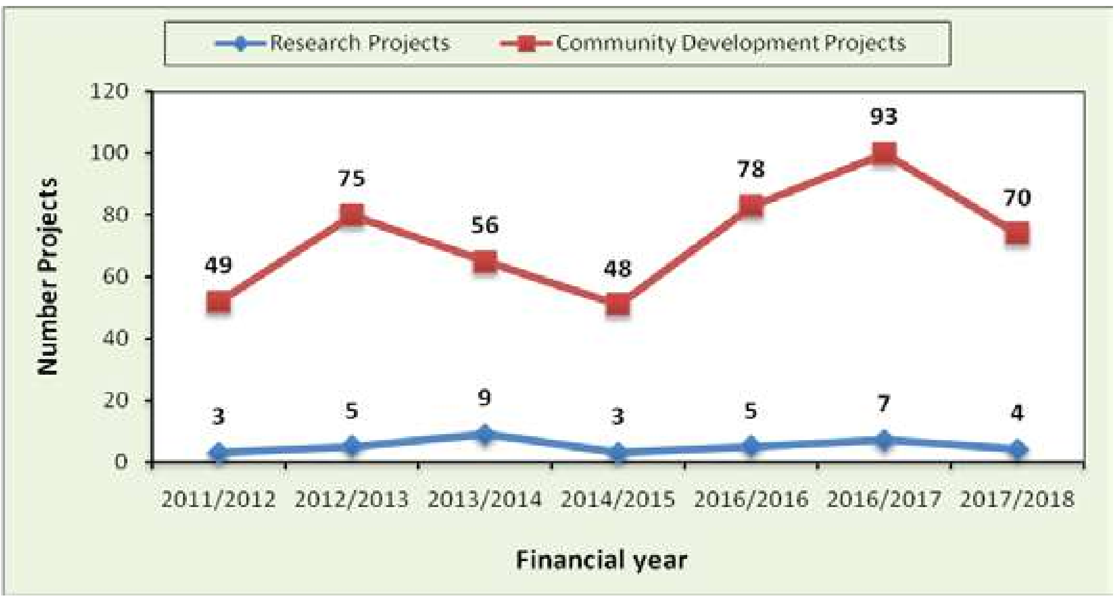


Figure 2: Illustration of Commiunity Development Projects and Research Projects Supported by TaFF from the year 2011/2012 to March 2018

Implementers of the 36 research projects supported by TaFF are individual researchers affiliated with: research institutions, training institutions, and others (including Tanzania Forest Services Agency - TFS and non-governmental organizations - NGOs). **Figure 3** shows that a large proportion (59%) of research projects were implemented by research institutions, followed by training institutions while very few research projects were implemented by other beneficiaries including TFS and NGOs.

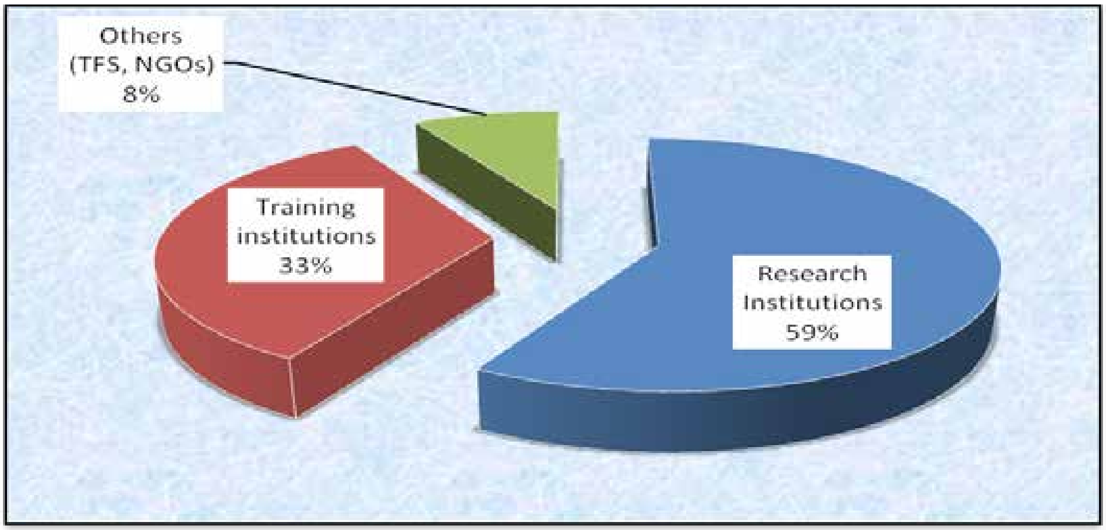


Figure 3: Illustration of proportional of implementers of 36 research projects supported by TaFF

Out of 36 research projects supported by TaFF, 13 projects (36%) fall under small grants, 10 (28%) under medium grants, and 13 (36%) under large grants category. Large amount of money (TZS 475.8 million) was disbursed to support projects under large grants category, followed by medium grants category (TZS 180.8 million) with the small grants category (TZS 64.4) **(Fig. 4).**

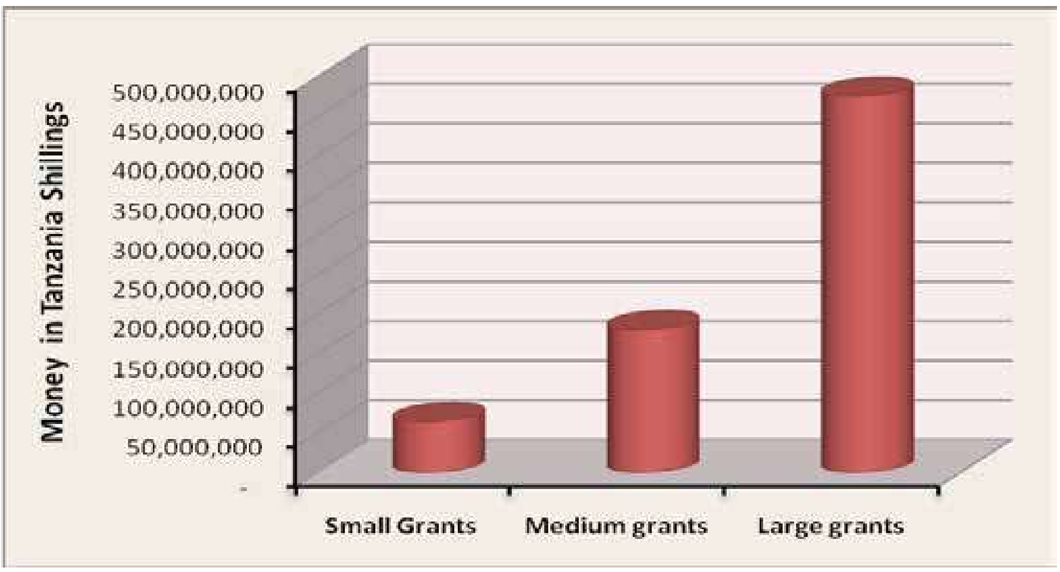


Figure 4: Illustration of proportional amounts of money spent for supporting small, medium and large grants categories of the 36 research projects supported by TaFF

Supporting Special Projects

Based on the Fund Second Strategic Plan (2016/2017 – 2020/2021), TaFF has started to support special projects of more than TZS 50 million for one project from the financial year 2016/2017.The decision regarding who should be given special grants' project, and the amount of money to be offered as special grants per project, is vested under the TaFF Board of Trustees. As a starter up, in the financial year 2016/2017 TaFF spent more than TZS 500 million for supporting special projects, of which TZS 180 million was granted to TAFORI for supporting revival of research trial plots located in her seven Research Centres and at Headquarters. **Table 1** shows the number and sizes of research trial plots established in each of the seven Research Centres, and at the Headquarters as well as the amount of money spent for establishing.

Table 1: Number and size of research trial plots established in each of the seven Research Centres and at Headquarters and respective amount of money spent

TAFORI Research Centres	Number of Research Trial Plots	Area Planted Trees (Ha)	Amount of money spent (TZS)
Malya Lake Zone Afforestation Research Centre	3	16	43,443,200.00
Dodoma Arid Zone Afforestation Research Centre	3	11	26,387,400.00
Kibaha Lowland Afforestation Research Centre	6	26	46,013,400.00
Tabora Miombo Woodland Research Centre	3	21	20,250,000.00
Lushoto Silviculture Research Centre	1	6	3,540,000.00
Moshi Timber Utilisation Research Centre	2	5	6,030,000.00
Mufindi Pulpwood Research Centre	1	4	7,336,000.00
TAFORI Headquarters	3	11	27,000,000.00
TOTAL	22	100	180,000,000.00

Support Dissemination of Forestry Research Findings

One of the mandates of TAFORI is to ensure that research findings and recommendations are disseminated to the general public using various fora. TaFF in its Second Strategic Plan (2016/2017 – 2020/2021) planned to support two scientific conferences aiming at facilitating dissemination of forestry research findings. The dissemination of forest research information/findings is important as contributes to decision making particularly on issues related to forest protection, conservation, management, and sustainable use of forest resources. In this regard, TZS 57 million were spent to support the first scientific conference on forestry research, which was organized by TAFORI. TaFF has also supported a workshop for disseminating research projects findings, and a workshop for identifying research priority areas was included in TaFF call for project proposals of which TZS 79 million were spent.

Other Forestry Research related activities supported by TaFF

Tanzania Forest Fund has supported equipment and facilities for carrying out forestry research. The Fund has spent TZS 500 million for purchasing laboratory equipment and facilities for Tanzania Tree Seed Agency (TTSA) laboratory. The Fund has also spent TZS 69 million for supporting construction of laboratory for testing quality of honey and other beekeeping products. In addition, TaFF has spent TZS 170 million for purchasing vehicle to be used by TAFORI for carrying out and coordinating forestry research.

LESSONS LEARNT AND FUTURE PROSPECTS

In the past five years of supporting forestry research, many lessons have been learnt:

Delay in Project Implementation

There is a delay in the implementation of most of the research projects supported by TaFF. Of the 36 research projects supported by TaFF, 23 projects were supposed to have been completed. However, only two out of 23 research projects have been completed in time implying that 91% of the research projects have been delayed. Delays in project implementation is a challenge to most of the projects including community development projects.

Inadequate Adherence to Stipuated Instructions

Some researchers do submit research proposals requesting medium and large grants as a team of researchers instead of institutions. This is contratry to the TaFF guidelines for the preparation of project proposals and procedures for making grants and the TaFF call for project proposals. As a result, such proposals are not considered for funding. In addition, some instructions stipulated in the TaFF call for project proposals, particularly on themes and sub-themes for applied and adaptive research are sometimes not addhered to by some researchers. For example, TaFF set funds for offering grants for five research projects in March 2017, it offered grants to four research projects because all other research proposals received at TaFF office did not adhere to some instructions stipulated in the 2017 call for project proposls, particularly themes and sub-themes for applied and adaptive research. According to TaFF guidelines on the preparation of project proposals and the procedures for making grants, the research projects should be 10% of the total projects supported by TaFF. However, from July 2011 to March 2018, only 7% of research projects have been supported.

Small Grants are not Attractive to Some Researchers

It has been observed that, small grants are not attractive to some researchers. This is because very few research proposals requesting for small grants have been received at TaFF office compared to the total number of proposals from 2014 to 2017 **(Table 2).** Six research proposals requesting for small grants were received at TaFF in June and December 2014 compared to the number of proposals received in the same period. In June 2015 and December 2015, no applications requesting for small grants research projects were received at TaFF office. The research proposals requesting for small grants were also few compared to the total number received in June and December of the year 2016 and 2017.

Table 2: Number of research proposals (received at TaFF office in June and December) requesting small grants fron 2014 to 2017 compared to total number of proposals received in the same period.

Year	June		December	
	Total number of proposals Received	Number of Research proposals received	Total number of proposals Received	Number of Research proposals received
2014	142	2	118	4
2015	571	0	139	0
2016	146	2	172	4
2017	223	1	192	2
TOTAL	1,082	5	621	10

Few Applications for Research Projects

The research proposals received at TaFF office are normally few compared to the proposals received in a particular time. For instance, from July 2013 to December 2017 the proposals received at TaFF office were 2,786 out of which the research proposals were only 104, which is 4%. **Figure 5** shows the research proposals received at TaFF office compared to the total number of proposals received from July 2013 to December 2017.

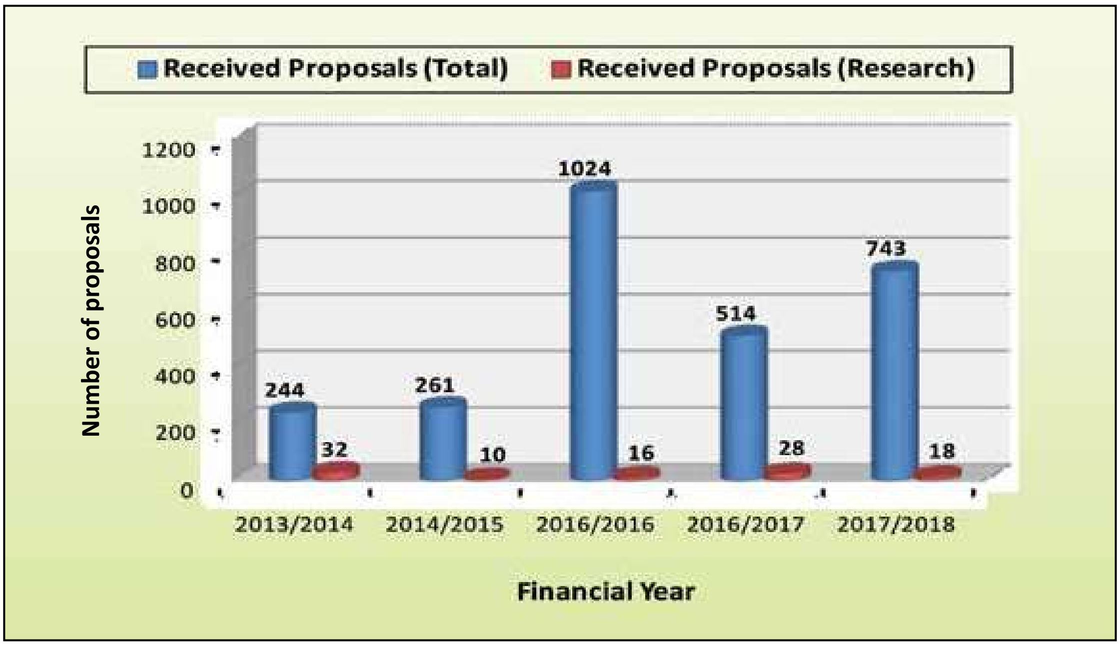


Figure 5: Number of research proposals received at TaFF office compared to total number of proposals received from July 2013 to December 2017.

CONCLUSIONS

Tanzania Forest Fund has spent substantial amount of money (more than 10% of her annual budget) for financing forestry research in Tanzania mainland. The Fund will continue to finance forestry research, but the commitment in spending forestry research funds for the intended purposes is paramount.

COORDINATING FORESTRY RESEARCH IN TANZANIA: THE NEED OF FOREST RESEARCH GUIDELINE

Bakengesa, S.

Tanzania Forestry Research Institute, P.O. Box 1854, Morogoro
*Corresponding author email: siima.bakengesa@tafori.or.tz

ABSTRACT

Forestry research in Tanzania has been carried out for a long time since 19th century. Carrying out research for forest development has been the responsibility of the Government. Recently, however several stakeholders have shown increased interest in carrying out forestry research. Documentation of forestry research in Tanzania has been poor and fragmented. Granting of research permit / research clearance with respect to forestry research is done by COSTECH, TAFORI, and to some extent higher learning institutions. There is however knowledge gap in extrapolating future research needs and trends in terms of what are the salient characteristics of forestry research undertaken to address the National Research Master Plan in term of themes, titles, types of collaboration, conformity of research in the national agenda, and their contribution to socio-economic development. In order for forestry research to be coordinated, it needs a guideline which is vested within the Directorate of Forest and Beekeeping within the Ministry of Natural Resources and Tourism. It is in this context therefore that the need of forest research guidelines is presented. The guidelines will guide current and future forestry researches from different stakeholders including private sectors. Forestry research now strives to meet the National Vision of 2025 on sustainable socio-economic development through applied research. Such guideline will provide guidance for research on sustainable conservation, utilization, and management of forests and ultimately develop the forestry industry.

Key words: Forestry Research, Guidelines, Coordination,

INTRODUCTION

Forestry research in Tanzania dates back to the 19th Century. The main goal of forestry research is to make it as the basis for sustainable development and management of forest sector. Forest and tree resources have immense potentials to contribute to social and economic development of the country through a range of economic, environmental, ecological and social services. Based on the fact that different stakeholders have significant contribution to advancement of the forest sector; and since, the contributions in addressing national development agenda is pertinent a coordination mechanism is needed. In Forestry, the National development agenda is drawn from the National Forest Programme (NFP), which is an instrument of (i) putting the National Forest Policy and related legislation into practice taking all relevant macro-economic and sectoral reforms/policy changes in the country into account; and (ii) operationalizing the commitments and obligations derived from international agreements and intergovernmental processes. It is from the NFP that the National Research Master plan (NAFORM) is drawn. The success of the national forest programme depends much on the active participation of all stakeholders both local and international. At the national level, the Forestry and Beekeeping Division (FBD) is responsible for policy management functions, and for legal and regulatory framework. At the local level, the coordination of the sector is undertaken by

Local Government Authorities (LGA), while Tanzania Forest Services Agency (TFS) is mandated to manage national forest reserves and forests on general lands. The success of LGAs and TFS in the management of forests is strongly linked to the works done by Tanzania Forestry Research Institute (TAFORI) which is mandated to carry out, coordinate, and regulate Forestry Research in the country.

It is evidenced that economic and social transformation calls for the engagement of human and financial resources from research institutions, academia, the private sector and other partners in innovative solutions that promote economic and social development. In order to do so, TAFORI proposes operation research guidelines. These guidelines will provide a framework for the implementation and operationalization of NAFORM II.

THE PROPOSED FOREST RESEARCH GUIDELINES

The guidelines should contain guidance on the procedures of acquiring permit for conducting forestry research in Tanzania. This guideline should be housed within the Directorate of Forest and Beekeeping Division of the Ministry of Natural Resources and Tourism or TAFORI. It is proposed that TAFORI facilitate the processing of entry permits for forestry research purposes and making recommendations on the proposed research work for final approval by the Tanzania Commission for Science and Technology (COSTECH) from which permits for all research in the United Republic of Tanzania are issued. The guideline should provide requirement to foreign researchers who may be required to submit application letter with:

(i) A detailed research proposal with the following format:-
- Title, Names of collaborating Scientists and affiliated institutions
- Background information
- Problem statement and justification
- Literature review
- Objectives
- Hypotheses/Research questions
- Methodology
- Outputs
- Inputs – Financial and Human
- CVs of principal investigator(s) and collaborators
- Three recent passport size photographs for each participant
- Letters of intent from relevant organisations
- Source and mechanisms of funding
- Monitoring and Evaluation
- Bibliographies/References

(ii) Completed TAFORI application form (Form I)
(iii) Completed and signed declaration of compliance by the researcher to TAFORI (Form II)
(iv) Completed Commission for Science and Technology (COSTECH) application form (Form III)

Time for submission of research project proposal is proposed to be 3 months prior to the commencement of the work. This would enable scrutinization of the research projects for relevance and alignment with the National Forestry Research Agenda. This will be done collaboratively by TAFORI and COSTECH before clearance/ Permit is issued. In this guidance, all foreign researchers should obtain a Residence Permit class C and promise to abide by the national laws and regulations during their stay.

For the case of the on-going projects, progress report should be submitted and renewal of the resident permit sought. The guideline will establish the time for submission. Final project reports should be submitted to TAFORI and COSTECH as per guided format.

The guidelines will also set requirements for foreign scientists attached to local or higher learning institutions. Tanzanian scientists / researchers will be obliged to register their research projects with TAFORI by submitting an introductory letter from respective affiliated organization/ institution. The guideline should provide for academic conversant persons to be contacted by foreign researchers. The guideline will provide the ways of managing reports and samples. It will also provide the set of clearance fees payable to both TAFORI and COSTECH and other relevant placements. Monitoring and evaluation of the project will be done by members from COSTECH, TAFORI, and FBD.

CONCLUSION AND RECOMMENDATIONS

The research guideline if in place will help in identifying salient characteristics of forestry research undertaken to address the National Research Master Plan. It is therefore recommended that the Director of Forest and Beekeeping division give the guidelines due consideration to make them operational.

REFERENCES

TAFORI. 2011. National Forest Research Master plan (NAFORM).
COSTECH. 2015. Research Priorities for Tanzania.
URT. 1998. *National Forest Policy.* Ministry of Natural Resources and Tourism. United Republic of Tanzania, Dar es Salaam. 59pp.
URT. 2010. National Forest Programme.

VARIOUS APPLICATION FORMS

Form No. I: TAFORI Application Form for Conducting Forestry Research in Tanzania

TANZANIA FORESTRY RESEARCH INSTITUTE (TAFORI)
P. O. Box 1854, MOROGORO TANZANIA
Tel. +255 23 2604498/2603725; Fax +255 23 2603725
E-mail: tafori@tafori.or.tz

(Please type or print)

1. I .... from .... am applying for a permit to undertake forestry research in Tanzania beginning ....year.
2. The proposed research site will be .... Forest Reserve/District
3. My research area of interest is ....
4. This is a new/on-going forestry research project titled .... and it is a short/long term project of .... years
5. Project collaborators in Tanzania are ....
6. This project with total budget of .... (Currency) will be funded by ....of .... and the budget includes costs for local collaborators and TAFORI monitoring and evaluation costs
7. If it is a long term research project; have you provided budget for training a local scientist to M.Sc. or Ph. D? Yes/No
8. Reference names and addresses
9. 1. ....
10. 2 ....
11. I have enclosed my project proposal, curriculum vitae and copy of passport for your reference
12. Signature of the applicant .... Date ....

Form No. II: Declaration of Compliance by the Researcher to Tanzania Forestry Research Institute

TANZANIA FORESTRY RESEARCH INSTITUTE (TAFORI)
P. O. Box 1854, MOROGORO TANZANIA
Tel. +255 23 2614498/2613725; Fax +255 23 2613725
E-mail: tafori@tafori.or.tz

After being allowed to carry out forestry research in Tanzania and to use the facilities provided by TAFORI,

I hereby abide to:

1. Strictly undertake research activities approved by TAFORI and not otherwise unless some amendments are made and approved by both TAFORI and COSTECH
2. Provide TAFORI with copies of my research and residence permits upon arrival to Tanzania
3. Observe and adhere to disciplinary and administrative instructions provided by TAFORI Director General.
4. Prepare and submit research reports to TAFORI Director General as required by the research permit for further actions.
5. Submit to TAFORI copies of all documentation records for retention in the Institute and the copyrights will remain to TAFORI
6. Make sure that all scientific papers from my research work to be published in journals are approved by TAFORI before submission
7. Work with local scientist(s) as stipulated in the research permit and have included budget line for such a scientist
8. Adhere to any agreements regarding donation of research equipment after a specified period of time as indicated in my budget and application forms
9. Write a notice of absence to the Director General, while away from my working station
10. Attend workshops/seminars arranged by TAFORI and present my work
11. Observe rules laid down by the Director General of Tanzania Commission for Science and Technology for conducting scientific work in Tanzania as required by the law

In case any of the above is violated my contract shall be revoked and my research clearance withdrawn and shall leave the country immediately

Surname: .... Other names: ....

Signature: .... Date: ....

Form No. III: COSTECH Application Form for Research Clearance

TANZANIA COMMISSION FOR SCIENCE AND TECHNOLOGY (COSTECH)

P. O. BOX 4302, DAR ES SALAAM
TEL. +255 22 21175311/2/3/4, 21175315 - FAX: +255 22 21175313
TELEX: 41177 UTAFITI: E-MAIL: rclearance@costech.or.tz

(Please type or print)

1. Applicant personal particulars
   Surname ....
   First name ....
   Title (Mr./Mrs./Ms./Miss./Prof./Dr.) (Delete the inapplicable)
   Nationality .... Date of birth ....
   Highest academic qualification ....
   Institutional Affiliation ....
   Mailing Address ....
   Town/City ....
   Region/Province/State ....
   Permanent address ....
2. Title of proposed research project ....
3. Purpose of research: Ph.D./M.Sc./B.Sc./B.A./Other (specify) .... (Delete inapplicable)
4. Research methodology (brief description)...
5. Research objectives ....
   ....
6. Regions in Tanzania where research will be conducted ....
   ....
7. Date of commencement ....
8. Estimated period for research .... (months)
9. Sponsor/Funding agent ....
10. Contact address while in Tanzania ....
    ....
11. References (provide names and addresses of two referees preferably one of whom should be based in Tanzania)
    ....
    ....
12. Names of other applicants ....
13. Signature of applicant ....Date.......................................

Form No. VI: COSTECH Application Form for Extension of Research Clearance

TANZANIA COMMISSION FOR SCIENCE AND TECHNOLOGY (COSTECH)

P. O. BOX 4302, DAR ES SALAAM

TEL. +255 22 21175311/2/3/4, 21175315 - FAX: +255 22 21175313

TELEX: 41177 UTAFITI: E-MAIL: rclearance@costech.or.tz

1. Name ....
2. Nationality ....
3. Title of research project:..
4. Mailing:..
5. Previous clearance file no: .... 6. Permit no: ....
7. Date issued: ....8. Date expired: ....
9. Requested Extension period from: ....to:......................................
10. Original location of research: ....
11. Extension research location: ....
12. Reasons for extension: ....
13. Name and address of local contact: ....
14. Applicant signature: ....

NOTES

This application form must be submitted together with the following:

a) A progress research report

b) Letter of recommendation from local contact

c) Applicant's three passport –size photographs (4 x 5 cm)

PART C

SPEECHES

WELCOMING REMARKS BY CHAIRMAN OF THE BOARD OF DIRECTORS OF TAFORI DR. FELICIAN KILAHAMA IN T HE OPENING CEREMONY OF THE FIRST TAFORI SCIENTIFIC CONFERENCE ON FORESTRY RESEARCH FOR SUSTAINABLE INDUSTRIAL ECONOMY IN TANZANIA, HELD AT TAFORI HEADQUARTERS, MOROGORO, ON 24TH APRIL 2018

The Guest of Honour, Honourable Dr. Hamisi Kigwangalla (MP), Minister of Natural Resources and Tourism
Director of Forestry and Beekeeping, Dr. Ezekiel Edward Mwakalukwa
Acting Director General TAFORI, Dr. Revocatus Petro Mushumbusi
Media people
Invited guests
Ladies and Gentlemen

First of all I have a great honour of taking this opportunity to welcome you in the First Scientific Conference on Forestry Research for Sustainable Industrial Economy in Tanzania organised by TAFORI. Thank you very much for accepting our invitation as the Guest of Honour and officiate the opening ceremony of the conference. As a Minister of Natural Resources and Tourism, you have huge and many national responsibilities; but you have given this event its due weight and have made time to be with us in this event. On behalf of TAFORI Board, the Management, all TAFORI staff, and other stakeholders, I wish to express our sincere thanks for accepting our invitation. You are most welcome Honourable Guest of Honour**.**

Also, on behalf of the Board and the entire TAFORI Community, our sincere thanks go to the Tanzania Forest Fund (TaFF) for their financial support and for their cooperation with TAFORI, in organising this First TAFORI Scientific Conference on Forestry Research for Sustainable Industrial Economy in Tanzania. I wish to thank TAFORI Management in a special way for giving me the honour of attending and welcoming the Guest of Honour and his delegation. We often have a saying, 'an event is never successful without having enough people in attendance.' in that respect, I wish to express my gratitude to stakeholders/delegates and invited guests and the newsmen and women for putting aside their important national building commitments and other personal matters and joined us in this conference. I wish to say to all of you, thank you so much and God Bless you. In these two coming days, I would request all of you to work together so as to realise the goal of this conference, through detail discussions on how forest research contributes to Sustainable Industrial Economy of this country, taking into account that forest is an important resource in this country.

Honourable Guest of Honour,
TAFORI has a legal mandate of carrying out, monitoring, and coordinating all forest research in the country. I believe that the findings of the studies carried out by TAFORI have been a stimulant in forest development in the country especially in tree plantations. Through research activities, TAFORI is able to provide advisory service to the government and to the general public.

Honourable Guest of Honour,
Among the research activities carried out by TAFORI include:

(i) establishing experiments in various areas in Tanzania mainland;
(ii) forest research on the right age of harvesting pine (*Pinus* spp) and teak (*Tectona grandis)* trees to

enable forest industries obtain good raw materials without having to wait for a long time;
(iii) forest research on forest pest and diseases as well as how climate change influence tree growth;
(iv) forest research on water uses for various types of trees such as eucalyptus trees;
(v) forest research on sustainable production and use of charcoal energy;
(vi) forest research on rate of growth of various types of natural trees, marketing and the quality of forest products; and
(vii) TAFORI is also carrying out research on improved natural and exotic tree seedlings for various uses in the country.

Honourable Guest of Honour, experiments are being started countrywide for various purposes including:
(i) to determine the types of trees which are resistant against pests and diseases;
(ii) to determine drought resistant types of trees; and
(iii) to determine the types of trees which are suitable for planting in different areas of the country; growth rate of trees especially indigenous trees which are suitable for planting in the plantations.

Honourable Guest of Honour, through these forest researches, the Government and other Stakeholders can be able to establish large tree plantations which are important in realising national goals through the national Policy on Sustainable Industrial Economy**.**

Honourable Guest of Honour, besides the good work performed by TAFORI, the Institute is facing various challenges in executing its day to day duties. Among the challenges include:
(i) budget constraints which make it very difficult for researchers to meet their objectives;
(ii) poor state of infrastructure, especially office buildings in the centres and laboratories; and transportation and research working facilities are highly inadequate and qualified staff are so inadequate that in some areas there are none, for example there is only one Entomologist, and in some areas Pathologists, Taxonomists/Botanists have long retired in March 2018, there are no Soil Scientists and Tree Breeders.

These problems pose big challenges to TAFORI Management Board. We are doing our best to build capacity of the existing researchers to enable them draft many research projects using funds from donors and development partners. However, Honourable Guest of Honour, besides these efforts by the Board, further financial assistance from the government is still needed to enable TAFORI fulfils its intended national goals.

We recognise the huge contribution of the Ministry of Natural Resources and Tourism, especially the efforts made by the Ministry in ensuring that the debt of the contractor engaged in the construction of the infrastructure in our current venue is settled. Besides these encouraging efforts, I would still request your Ministry to assist TAFORI in securing research funds to enable it fulfil its objectives. As the saying goes, 'where there is a will; there is a way', therefore, the Ministry through Tanzania Forest Fund and Tanzania Forest Services Agency, can set aside five (5%) percent to enable it carryout forest research in the country for the benefit of our nation. It is also ideal if this matter is incorporated in the Forest Act and its regulations to simplify its implementation.

The Guest of Honour
Lastly, I would like to take this opportunity to welcome you here at TAFORI, and speak to this gathering before you.

HONOURABLE GUEST OF HONOUR WELCOME

A SPEECH BY THE MINISTER OF NATURAL RESOURCES AND TOURISM HON. DR. HAMISI A. KIGWANGALLA (MP) IN THE OPENING CEREMONY OF THE FIRST TAFORI SCIENTIFIC CONFERENCE ON FORESTRY RESEARCH FOR SUSTAINABLE INDUSTRIAL ECONOMY IN TANZANIA, HELD AT TAFORI HEADQUARTERS, MOROGORO, ON 24TH APRIL 2018

Chairperson, Board of Directors of TAFORI, Dr. Felician Kilahama,
Director of Forestry and Beekeeping, Dr. Ezekiel Edward Mwakalukwa
Acting Director General TAFORI, Dr. Revocatus Petro Mushumbusi
Invited Guests
Media people
Ladies and Gentlemen

First of all, I should like to thank Almighty God for granting us life and making it possible for us to congregate at this place today. I should like to thank the Permanent Secretary of the Ministry of Natural Resources and Tourism, Major General Gaudence Milanzi for approving the Tanzania Forest Fund to sponsor this conference.

I should also like to take this opportunity to congratulate you the Chairman of the Board of Directors and all officials of the Tanzania Forestry Research Institute for conceiving this idea of making time of coming together and share experience in matters related to forest research and its contribution to Sustainable Industrial Economy of this country. This is a noble idea and has come at the right time taking into account that the vision of the Fifth Phase Government under the leadership of Dr. John Pombe Joseph Magufuli is it to see our country becomes part of the middle industrial economies through Sustainable Industrial Economy by year 2025.

Our Ministry of Natural Resources and Tourism, which this Institute is a part, is supposed to play a major role in ensuring that this vision is realised. Therefore, I congratulate you for organising this conference. It is my expectation that you would properly utilise these two days of the conference in discussing findings of various researches which you conducted and those carried out by other stakeholders and other institutions so that together you can generate resolutions of what need to be done to improve the contribution of forest to Sustainable Industrial Economy in this country.

Mr. Board of Directors' Chairman and Invited Guests,
I know that forestry research has a big contribution in the development of forests in the country. We all know that large part of forest vegetation especially of planted forests is a good product of research which has been carried out since the colonial period from the 1890s to date. On the part of the Central Government, statistics show that Tanzania Forest Services Agency (TFS) is managing 18 forest plantations with a total of 300,000 hectares (with 110,000 tree planted area and the remaining is Catchment forests). Furthermore, the Agency has continued to establish five (5) new forest plantations with an estimated 170,000 hectares, and bringing the total of 23 forest plantations with a combined total area of nearly 470,000 hectares. These are great achievements in the forest sector which are basically the results of the forestry research which have been carried out and continue to be carried out in the country.

Mr. Board of Directors' Chairman and Invited Guests,

I also know that there are many achievements through research conducted by this Institute and which have been clearly specified in the National Forestry Research Master Plan II, 2011-2020. For example, through your five years research, you have discovered that Miombo woodlands in arid/semi-arid areas (in Iringa) grow at an average rate of 0.22 m^3 / hectare per year; whereas in Kiteto these trees grow at an average rate of 0.12 m^3 / hectare per year. This implies that if you want to harvest these trees sustainably and without affecting vegetation (Sustainable annual harvests), you need to harvest between 8 and 10 stems per hectare. You will thus realise that, the on-going environmental damage in the country is an outcome of our failure of utilising these research results in designing concrete plans of using our own resources. Therefore, I wish to encourage everyone here to nurture the habit of providing advisory services on how best to utilise research results in developing sustainable forest management and utilisation so as to enable the general public to benefit from the available resources sustainably.

Mr. Board of Directors' Chairman and Invited Guests,

Besides these good achievements which have been obtained through your research activities. I still realise that there are several challenges in the forestry sector which you need to make concerted efforts in addressing them. Recently, I celebrated the national tree planting day held in Kishapu District, Shinyanga region on 5th April 2018. This year's anniversary had a motto: GREEN TANZANIA IS POSSIBLE, PLANT TREES FOR SUSTAINABLE INDUSTRIAL ECONOMY. Now a million dolour questions which I keep asking myself is, Why do we as a government have good plans like these of encouraging the public to plant trees with very good intentions such as ensuring that our industries flourish, but the outcomes have always been unsatisfactory?

Therefore, you will realise that the issue here is not planting tree, rather is to make sure that the planted trees are properly managed for them to grow. However when you walk in the streets, you will never see the trees. Then, you ask yourself, where these planted trees are and why they cannot be seen? I think an Institute like this should help us find an alternative strategy of making sure that this tree planting activity is not a smokescreen. There is a possibility that something is not right somewhere. Now, think about this critically and advise us to enable these government efforts bear the desired fruits. As a Ministry, we need to make sure that the people have good living environment as well as getting the resources they need in their industries. But these people fail to keep what we give them, what do we do? I would be very grateful if you would help us find a simple mechanism of addressing this problem.

Mr. Board of Directors' Chairman and Invited Guests,

Another issue is that this sector has a small contribution to the GDP. Statistics show that this sector contributes almost 3.7 - 4 percent to the GDP. As a Ministry, we are not satisfied with this contribution; we still feel that the figures are way too low to be believed. We feel that this is an area that needs to be addressed as a matter of urgency. I once made this advice in the past in one of the National Forestry Advisory Committee – NAFAC meetings and requested them to work on the matter. Today however, I have realised that this is the right forum for this task. Thus, you need to look into this matter and advise us scientifically as to how we might use this forest sector to increase its contribution to the GDP?

We believe that there are many opportunities in this sector, but they have never been properly utilised yet. Therefore, Mr. Chairman, you need to look into this matter more closely. For example, when you look at the water which drives our electric power machines, the water which is used in our homes and in the industries, carbon dioxide from industrial emission and absorbed by the forests, the wood used in construction, power transmission poles; I have also been told that there are almost 630 Primary wood industries and on average each industry employs not less than 10 people, and many other products, is it true that all these contributions accounts for only 4 percent? You need to reflect on this matter.

Mr. Board of Directors' Chairman and Invited Guests,
Another matter relates to technologies we are using in processing our forest products. Given the many available industries (more than 630), if all these industries use inefficient technologies, then we may not be doing justice to our investment efforts which are expended in establishing and conserving our forests. I once again would like to ask you Mr. Board Chairman to work on this matter. Make sure you carry out research on the extent to which these technologies help us in conservation and in environmental protection. We should not have destructive technologies.

This matter should also be looked at in tandem with the appropriate technology of charcoal production and use. We all know that almost 90 percent of our people use this energy for cooking. The issue now is to what extent they will continue using this energy without causing deforestation in our country. I also believe that this is an important matter and you need to research about it. And for a start, you need to look into the currently used technologies. For instance, we need to know how many charcoal producing technologies are available. How many are suitable for cooking that saves charcoal, and which ones are suitable for increasing the resource to make it sustainable. This entails the types of trees which take a short time to mature for charcoal production, instead of cutting trees in and around water sources. All these things are under the mandate of this Institute. Thus, Mr. Chairman please help us on this matter as well.

Mr Board Chairman and Invited Guests,
Before concluding my speech, may I now highlight a few things which I think are important to be mentioned here?

- ***i)*** ***First***, my congratulations to all the people living in these southern highland regions (Iringa, Mbeya, Njombe etc.) for your positive response of planting many trees. I am told there are currently almost 150,000 hectares of planted trees by the people. This is exemplary. However, scientists have told us that these efforts are contributed by good quality of the soil and the rains available in these parts. My plea is that make sure this is replicated in semi-arid/arid regions. This is where we need to do research to give us answers as to what needs to be done so that these other areas can also have large investment like this, and which helps our people combat poverty. Also, to what extent we have invested in knowing the growth rate of our indigenous trees and how they can be used to establish large plantation investments. I think that these trees would have been more suitable in semi-arid areas because of being familiar with such climate. I request that you to also look at this through scientific research.
- ***ii)*** ***Second,*** is about protection of these forests or these planted trees against fire hazards and pests. As you know, this is a big investment. And the protection of these trees is costly in terms of forest wardens or keeping of security guards in the plantations. Now, how are we prepared against these fire hazards and pests? This also must be looked at seriously;
- ***iii)*** ***Third,*** is about the effects of climate change. How are we prepared as a country to adapt to this variability especially in growth and development of our forests in the country. Are there any researches which have been carried to find out what will happen to our forests in case of too much or too little rains? I am told that our Itigi thickets may possibly disappear due to climate change. Now, what is the situation in other forests and what needs to be done? Also, to what extent do we know the resilience of our trees to withstand climate change variability? Also, as an Institute, to what extent do we benefit from international resolutions on efforts of adapting to the effects of climate change? This is another area, which I leave to you as a challenge;
- ***iv)*** ***Fourth,*** is about Non-Timber/Wood Forest Products, which we have, for example, honey, mushroom, wild fruits, herbal trees, vegetables and so on. If we get a big investor in these areas can we give him/

her any statistics on these such that we can say what type of herbal trees and how many there are in the forest? How did they grow, how much do they produce so that he/she can start an industry? This is an area I want to see it being worked on. We should not stop at saying this is a good tree; we should also say where it is found, how much, and what is the growth rate when planted, how does it produce and what are its benefits? And;

v) ***Fifth,*** is about trees suitable for planting in our houses (Urban forestry). I have seen different types of trees planted in our towns and cities. And when you take a closer look, you realise that some of these have not been planted in the right places, to the extent of damaging roads, drainage systems, and so on. Now, what are the right types of trees for planting in such areas and at the same time become ornamental? Are there any researches which have been carried out to find out weather conditions of our towns and cities and the types of trees which are suitable for planting in these towns and cities? We also need to look at more utilities of these trees in terms of other ecological benefits such as the absorption of carbon dioxide, and even other chemicals produced in our industries so as to make our cities have clean air and safe environment. Now, I am not sure if this has been worked on in detail in Tanzania. I would also like to see this matter taken aboard accordingly, so as to come up with a guide on how to plant trees in our towns/cities.

Mr. Board of Directors' Chairman and Invited Guests,
Let me conclude by saying I thank you so much for inviting me and I believe that I haven't bored you with much short speech. It is my hope that everything I have shared with you will be looked at through scientific research so as to enable the Ministry get solutions for the benefit of all Tanzanians. Lastly, I wish you a fruitful conference, and I would like now to declare that The First Conference on Forestry Research for Sustainable Industrial Economy has now been officially opened. May Almighty God Bless you

THANK YOU FOR LISTENING

A KEYNOTE SPEECH BY THE DIRECTOR OF FORESTRY AND BEEKEEPING DR. EZEKIEL E. MWAKALUKWA FOR THE 1ST TAFORI SCIENTIFIC CONFERENCE ON FORESTRY RESEARCH FOR SUSTAINABLE INDUSTRIAL ECONOMY IN TANZANIA HELD AT TAFORI HEADQUARTERS, MOROGORO, ON 24TH APRIL 2018

Honourable Dr. Hamisi A. Kigwangalla (MP), the Minister for Natural Resources and Tourism,
Chairman, TAFORI Board of Directors, Dr. Felician Kilahama,
Acting Director General, TAFORI, Dr. Revocatus Mushumbusi
Representatives from Development Partners,
Representatives from Mass Media,
Distinguished Guests,
Ladies and Gentlemen,

GOOD MORNING

Dear participants,
On the outset, I would like to take this opportunity to thank Almighty God for enabling all of us to be here today. It is indeed through the will of God that many of you have managed to travel from distant places to Morogoro to attend this important Conference. Much appreciation should go to you Mr. Chairman, and TAFORI management for allowing me to give this keynote speech to participants of this important conference. I am told that this is the first TAFORI forestry research conference organized in this year, and which mainly focuses on one theme of Industrial development. I believe that all participants are aware of the objective of this conference and that they are well prepared not only to share their knowledge but also to learn from others.

Dear participants
I understand that most of you know very well the current data of forested land we have in Tanzania. What we know is that, the total forested land in Mainland Tanzania is 48.1 million hectares, which is equivalent to 54.4% of the total land area of 88.3 million hectares. The production forests cover 20 million ha, which is 41.6% of all forests. The growing stock is estimated to be 3.3 billion m^3, whose closed forests account for 11.3% while woodlands account for 73.9%. The remaining 14.8% comes from Trees on farm. The total annual supply of wood at the national level is estimated at 83.7 million m^3. For sustainable utilization, Tanzania may harvest up to 42.8 million m^3 of wood per year, which is the allowable cut. However, the wood volume cut in 2010 was 62.3 million $m^{3,\text{ which}}$ is 19.5 million m^3 above the allowable cut. While the above data are very useful at the level of national planning, they are not sufficiently detailed to be used for forest management planning at local levels or for individual forests. This means that more research is needed in order to generate facts that will guide us in making informed decisions on how these resources can be sustainably utilized.

Dear participants
There is a famous quote by a Chinese Marxist theorist, Mr. Mao Tse-tung which says "No investigation no right to speak"...... and "To investigate a problem is, indeed, to solve it". This quote has a lot to say about the importance of doing research, and on the mandate which TAFORI has been given particularly on Forestry related issues. So, in order for someone to have the confidence of speaking, he/she must do investigations on the issues at hand. Otherwise, he/she has no right to speak about a given issue.

Mr. Mao further stressed that "Everyone engaged in practical work must investigate conditions at the lower levels. Such investigation is especially necessary for those who know theory but do not know the actual conditions, for otherwise they will not be able to link theory with practice". This means that for someone to reach a point where he/she sees the opportunity of investing in something, detailed information about particular issues/ideas needs to be made available to him/her. This will be possible only through research. Therefore, staying with theory alone is not enough to make significant changes in industrial development. This is because innovation is a key to industrial development and its sustainability. There is no innovation without Research. Furthermore, our investigation should not focus on what looks to be big and fancy ideas, but rather on small details which are also very important. In general, Mr. Mao insisted on the importance of doing research. Through research someone can be able to establish facts which would help in arriving to new conclusions which would then help someone to make informed decisions. I am told, fifteen papers will be presented during the conference. I am sure these papers are based on good founded research and I hope that the findings will have significant contribution to the main objective of this conference, which is the contribution of forestry research in addressing the existing challenges in the wood industries and the establishment of new industries so as to realize sustainable industrial development in Tanzania. The papers to be presented in this conference are the tools of ensuring that both conservation and industrial development challenges are fully addressed.

Dear participants,
In order to be able to accomplish whatever investigation you wish to carry out, the following three key things are needed; 1. To know the existing problem, 2. Resources available (human and financial), and 3. Time. In terms of resources you need to have people with knowledge and skills of doing research. So, I believe those who are going to share their findings have undergone these three important elements in research. In that case, I would argue all the participants to be attentive when your colleagues are presenting because the facts that will be shared might be of great value to you in making informed decisions.

Dear participants,
As clearly said by the Guest of Honour, the contribution of the forest sector to the GDP is very low (3.7 - 4%) despite the immense potential it has in sustaining the industrial economy in the country. Because of this, the sub-themes of this conference touch areas of great importance, and if they are well addressed they will help to put the forest sector into a bigger picture of its importance to the development of the industrial economy in the country.

Just to recite the five proposed sub-themes for this conference are:

(i) Forestry research on solving deforestation and forest degradation;
(ii) Forestry research for propelling industrial economy;
(iii) Forestry research under climate change scenario;
(iv) Financing forestry research for achievable industrial economy; and
(v) Coordination and regulation of forestry research in Tanzania.

The sub-themes are structured in a way that all issues of industrial concerns are critically analyzed so that the conclusions are made very clear for the decision makers to use them in making the necessary changes in the sector. For example, deforestation and degradation have become matters of great concerned in recent years simply because, if the forest is gone, we will surely suffer from many consequences including shortage of water as catchment areas which are used to store rain water and discharge it slowly for us to use will also be gone, this effect will also directly hamper development and sustainability of our industrial sector as water is one of the key components in any industrial endeavour. Likewise, climate change is among the crucial matters as negative effects are always disastrous. Since research is a continuous process and financial resources are not always available, finding different sources to finance research work is also important as research brings new technology (innovations) which improves efficiency and hence sustainability of industries and the economy at large. Coordination and regulation of forestry research in Tanzania are also very important. Regulations help to guide people on what they are supposed to do correctly. Therefore, all of these issues will be covered in detailed in this conference. It is my hope that the resolutions which will be made after this conference will set the stage for further advancement in the sector.

Dear participants,
Since more will be shared under these themes, I would like now to emphasize one important concept that if well addressed can assure the sustainability of our industries hence the economy of the country. This is nothing but rather the concept of Eco-efficiency. This concept has emerged as an innovative business strategy combining both environmental and economic efficiency to create more value with less environmental impact. Any investment which has less environmental impact means that sustainability will be assured. And when we talk about sustainability we mean that there will be endless production of the produce simply because the environment will continue to sustain the available services which are needed by the industries (the raw materials). This is where the sustainable industrial economy can be achieved. Environmental protection, economic development and social development are thus the three pillars of sustainable development. The achievement of sustainable development requires a balanced integration of environment, economic and social objectives, taking into account the needs and concerns of both the present and future generations, and more importantly the protection of the environment. Now, the question is how do you protect the environment in order to ensure sustainability of the industrial economy? The answer to this question resides on the use of modern technology which guarantees higher efficiency in using the available raw materials.

Dear participants,
Achieving sustainable industrial development means that business and industry will have to adjust production structures and its product mix. In other words, the technology to be used needs to match with the output or the products to be produced. However, this is not the case here in Tanzania. Most of the technologies we have (the production structures) are not up to date which leads to wastage of the little raw materials we have at the moment. We all know that we have limited resources in terms of raw materials to meets the current demands of wood in the country. We need to use whatever we have very efficiently in order to have something left for the future generations. Now, switching to these new technologies which are more efficiency has been a challenge due to lack of incentives to most investors in the forest sector. Lack of incentives is a result of lack of price differentiation of the products, which are brought to the market. More often those who are using modern technologies which guarantee high efficiency produce products of higher prices, and thus no one likes to buy from them. The only way of getting rid of this problem is to introduce sets of standards that every producer and a buyer must adhere to. This approach rather shifts the awareness of costs upstream, in other ways, away from future generations and the society as a whole towards the current generation and the polluters themselves thus making the economy more efficient.

Moreover, since prices play an important role in the decisions of both business and consumers, in order to make the right choices, it is necessary that the appropriate framework is established by Governments, including price signals that reflect a full range of costs and environmental externalities. We all know that here in Tanzania, the forest sector faces some big challenges for selling most of products without giving much weight to the quality of these products. This means the price tags do not reflect the reality. This leads to disincentives to those who have invested in the production of products of good quality. Those who adhered to the principles of efficiency find themselves in a more difficult situation than those who do not. Because of this reason, the Ministry through FBD is now preparing specifications for different standards starting with the Log and timber grading specifications, seeds production (tree breeding trials) specifications, nurseries/contractors specifications and the like. The aim is to set price tags based on efficiency of production structures and hence the quality of the said products. What is required here is awareness creation among our communities on the importance of using wood products of high quality. And this is the obligation of all of us who are here.

Dear participants,
The integration of environmental quality in productive investment will ensure a rational use of resources and enhance economic performance and competitiveness. Specific action combining environmental improvement and investment in the industry and services should include the following elements:

i) Preventive approach: support the investments which are characterized by a preventive approach, including priorities such as the efficient and sustainable use of natural resources, waste minimization and reuse, reduction of air pollution and the implementation of a sustainable product policy;
ii) Clean technologies*:* favour measures that accelerate the shift from old, polluting technologies to new clean technologies;
iii) Environmental management*:* financial support provided, in particular to Small and Medium Enterprises, to make use of environmental services such as Eco-audits;
iv) Industrial sites: priority to the rehabilitation of derelict industrial sites over the development of greenfield sites; and
v) Training: improving skills in environment-related issues within the business sector and promoting new employment (or conversion).

Dear participants,
Education, training and information dissemination are also important factors as knowledge and its use have become key to competitiveness in the market. It follows that the objective of ensuring sustainable industrial development cannot be fully addressed without addressing issues of competencies, skills and knowledge, information and human resource generally. In this respect, the improvement of education and lifelong learning and competencies for the worker and producer, and the extension of accessibility of information to the citizens and consumers must be important and indispensable ingredients in ensuring that sustainability is achieved. The Ministry through the Private Forestry Programme (PFP) is trying to secure competence based technologies and impart skills to lower cadre professionals in forest operations, harvesting, and processing**.** Currently, a total of 40 students are undergoing training at Forestry Training Institute (FTI), Arusha and Forest Industries Training Institute (FITI) in Moshi implementing the new curriculum which was developed to suite those who work in Small and Medium Enterprises. This development has to be emulated by others so that at the end of the day we all have a pool of well-trained workforce to ensure quality and hence justification for price differentiation of our products.

Dear participants,
Finally, I would like to conclude my presentation by reciting some key points which I have shared with you today;

i) Research is a key for any development. There is no innovation without research;
ii) Research is a continuous process, thus sustainable financing is unavoidable. All stakeholders must be involved in supporting research activities;
iii) Striving for efficiency is a key for industrial sustainability. Thus, investing on clean technologies is necessary;
iv) Setting the price based on the quality of the wood products produced from our industries is also necessary. This will encourage more investment in wood industries hence more jobs and higher

revenue to the government. Thus, the use of standards/specifications to guide the market of wood products is unavoidable;

v) Having a society which attaches great value on using products of high quality is something we should strive to achieve. Thus, awareness creation is also necessary and should be the duty of all of us; and

vi) Well trained work force will ensure higher efficiency, and quality products, thus justifies for having price differentiation on our products which is key of sustainability of our industries. All stakeholders in the sector should strive to make sure this target is achieved.

Dear participants, I once again thank you for your attention and wishing you a very fruitful and successful conference.

MAY GOD BLESS YOU ALL

A SPEECH BY THE DIRECTOR OF FOREST AND BEEKEEPING DR. EZEKIEL E. MWAKALUKWA IN THE CLOSING CEREMONY OF THE FIRST TAFORI SCIENTIFIC CONFERENCE ON FORESTRY RESEARCH FOR SUSTAINABLE INDUSTRIAL ECONOMY IN TANZANIA, HELD AT TAFORI HEADQUARTERS, MOROGORO, ON 25TH APRIL 2018

Chairman, Board of Directors of TAFORI Dr. Felician Kilahama,
Acting Director General TAFORI, Dr. Revocatus Petro Mushumbusi
Secretary Forest Fund of Tanzania – Dr. Tuli Msuya
Chairman, Conference Organising Committee - Dr. Chelestino Peter Balama,
Invited Guests
Ladies and Gentlemen

I am very happy to officially close The First TAFORI Scientific Conference on Forestry Research for Sustainable Industrial Economy. On behalf of the Organiser- Tanzania Forestry Research Institute (TAFORI) and Tanzania Forest Fund (TaFF); I thank all of you who have made this conference a success.

Mr Chairman,
This two day conference has brought together private participants and participants from 18 institutions, Tanzania Forestry Research Institute (TAFORI) and Tanzania Forest Fund (TaFF), Tanzania Forest Development (FDT), Tanzanian Traditional Energy Development, (TATEDO), Sokoine University of Agriculture, (SUA), Forest Industrial Training Institute(FITI), Nelson Mandela University, Sebastian Kulowa University, World Wildlife Fund, (WWF) Tanzania Forest Conservation Group (TFCG), Tanzania Commission for Science and Technology, (COSTECH), Tanzania Tree Seeds Agency (TTSA), World Agroforestry Centre (ICRAF), Tanzania Forest Fund (TaFF), and Tanzania Forest Industries Federation (SHIMIWITA).

Mr Chairman,
In this conference, 15 publications have been presented in 5 topics:
(i) Forestry Research on Solving Deforestation and Forest Degradation
(ii) Forestry Research for Propelling Industrial Economy
(iii) Forestry Research under Climate Change Scenario
(iv) Financing Forestry Research for Achievable Industrial Economy
(v) Coordination and Regulation of Forestry Research In Tanzania

I thank all of those who spared some time for preparing and presenting these publications.

Mr Chairman,
Forestry research on participatory forest Management, natural growth of Miombo trees, good charcoal making using improved ovens, production of tree seedlings using cloning technology, improving stoves, production of alternative charcoal (briquette) - the use of alternative energy, establishment and development of planted forests to ease pressure in natural forests, and development of agroforestry have contributed in reducing damage and disappearance of forests. Sustainable research fund is required to mitigate the damage and disappearance of forests in the country.

Mr Chairman,
Forestry Research for Sustainable Industrial Economy has also been done. Although much of this research focused on the production of forest products to meet current needs. It is now time to devote more efforts in

designing improved technologies for processing of forest products, research of value chain and marketing of forest products; setting of quality standards in forest products so attract investment in technology and industries, plus increasing the export of products. Through these researches, we will have enough understanding in enhancing Sustainable Industrial Economy.

Mr Chairman,
Climate change is a reality, and research results have indicated that the change has stimulated an increase of diseases and tree attacking pests in tree plantations in the country. More research is required so as to know the challenges and opportunities of tree growth and biodiversity conservation in this climate change situations. This would help in various planning and direct policy towards adapting to the effects of climate change.

Mr Chairman,
As I said in my key note speech, research is crucial for development. In realising this, the Tanzania Government set aside a budget for forestry research, provides loans for forestry research in priority areas through the Tanzania Commission for Science and Technology and has established Tanzania Forest Fund (TaFF), which among other responsibilities is sponsoring forestry research. Besides the Government, Development stakeholders and the private sector also provide loans and sponsor forestry research. In order for these researches to have a contribution in attracting more funding, it is pertinent to link these researches with the Vision of the Fifth phase Government for the country to be middle income economy by 2025. Also, the Government needs to increase TAFORI budget for training of forestry researchers to enable them write winning research project proposals, and for carrying out more research for directing policy towards sustainable Industrial Economy.

Mr Chairman,
Coordination of forestry research is important in National Forestry Research Master Plan II, 2011-2020 (NAFORM II). For Tanzania, there has been weak coordination leading to haphazard forestry research, and making NAFORM II difficult. I agree with this idea and I will form a team of preparing a system of coordinating and regulating forestry research in the country; in order to have a database of the forestry research which have already been done, carrying out forestry research in line with national priorities, to identity areas which have not been adequately researched, and improving cooperation among forestry research stakeholders.

Mr Chairman,
In addition I know that there is a National Strategy for Tree Planting which is coordinated by the Vice Present's Office. However, the Ministry of Natural Resources and Tourism has a role of providing guidance on how tree planting ought to be done so as to make the strategy produce good results. Currently, there is haphazard tree planting leading to death of many planted trees. I urge forest plantation managers of the Ministry of Natural Resources and Tourism to implement this role of providing guidance on how tree planting ought to be done to make tree planting exercise have desired results.

Mr Chairman,
The conference hall we are using belongs to the Tanzania Forestry Institute. I wish to extend my sincere thanks to the Management of TAFORI and conference Hall attendants for receiving us and serve us well. Also, I thank the media people for having our events reaching many Tanzanians through News Bulletins.

Mr Chairman, Invited Guests, Ladies and Gentlemen,
After saying these words, I declare that The First TAFORI Scientific Conference on Forestry Research for Sustainable Industrial Economy is now officially closed.

THANK YOU VERY MUCH AND MAY ALMIGHTY GOD BLESS YOU

PART D

ANNEXES

ANNEX I: CONFERENCE DELIBERATIONS

The conference deliberated about 22 issues of which had several actions to be taken by different stakeholders as seen in **Table 1.**

Table 1: Conference deliberations

SN	Issue	Action to be taken	Coordinator	Main Actor(s)	Collaborators	Time Frame
1	Insufficient funding for Forestry Research	1. Establishment of legal framework to ensure a fixed percentage of forest revenues is set aside for research	FBD	TFS	TAFORI	2019/2020
		2. Revise funding regulations to allow setting aside at least 10% of TaFF funds to support forestry research in TAFORI	TaFF	TaFF	TAFORI	2018/2019
		3. TAFORI should develop strong proposals to attract funding from different development partners to sustain forestry development and research in the Country	TAFORI	TAFORI	TAFORI	Continuous activity
2	Poor dissemination of research findings	1. TAFORI should develop dissemination strategies and mobilize funds for regular dissemination of research findings	TAFORI	TAFORI	SUA, PRIVATE SECTOR	2019/2020
		2. Translate available research findings in user friendly languages for wider public use.	TAFORI	TAFORI	TAFORI, PRIVATE SECTOR	2018/2019
3	Poor performance of trees planted during National tree planting campaigns	1. Provide tree planting training just before National tree planting day	FBD	TAFORI, LGAs	NGOs, PRIVATE SECTOR	2018/2019
		2. Establish mechanisms to manage and monitor survival of trees planted during National Tree Planting Campaigns	FBD	TFS, TAFORI, LGAs	NGOs	2018/2019
		3. Establish database of planted and surviving trees (showing species planted, acreage and location)	FBD	TFS	NGOs	2018/2019

4	Low recognition of the contribution of forest sector in the GDP	1.	Need for research on actual contribution of Forest Sector to the GDP	FDB	TAFORI, SUA,	TFS, TFCG, WWF, PFP and TaFF	2018/2019
		2.	Emphasize proper collection and documentation of forest revenues	TFS	TFS	TFS, TRA, TAMISEMI/LGAs	2018/2019
5	Insufficiency of data on existing NTFP resources to attract industrial investment	1.	Quantify the amount of highly demanded NTFP available in the country for promoting investment	TFS, TAFORI and FBD	TAFORI, TFS	NGOs, Private Sector	2018/2019
6	Use of poor and inefficient charcoal production technologies	1.	Develop and create awareness on efficient charcoal production technologies	FBD	TAFORI	SUA, KVTC, WWF	2018/2019
		2.	Develop Biomass Utilisation Energy Strategy	FBD/MNRT, MEM	TFS, TATEDO	NGOs	2019/2020
7	Use of unsuitable tree species for urban forestry	1.	Develop Guidelines for Tree Planting in Urban Areas	FBD	TAFORI, TTSA	TFS	2019/2020
		2.	Create awareness on problems caused by using unsuitable trees in urban areas	FBD	TAFORI, TTSA	TFS, TFCG,	2018/2019
8	Uprooting of *Terminalia* species due to religious controversial beliefs	1.	Prepare a Press release on *Terminalia catappa* and *T. mantaly* and government position on the uprooting	TAFORI	TAFORI	TAFORI	2017/2018
		2.	Provide alternative benefits that can offset the misconceptions				2017/2018
9	Impact of climate change on distribution of forest tree species	1.	Provide current status of climate change impacts on forestry	NCMC	TAFORI, SUA, IRA, ARDHI UNIVERSITY	TFS, LGAs	2018/2019
		2.	Study the impact of climate change on species shift gradient, phenology and tree growing behaviour				2018/2019
		3.	Study the adaptation strategies by different tree taxa				2018/2019

10	Inefficient wood processing and utilization technologies	1.	Set standards to ensure efficient processing of Wood products by reviewing and enforcing forest laws and regulations	FBD	TFS	TAFORI, SHIMIVITA, TBS, FDT	2018/2019
		2.	Identify and promote incentives for adopting improved wood processing technologies.				2018/2019
11	Lack of market differentiation based on quality of wood products	1.	Set quality standards for wood products and certify forestry production practices	FBD	TAFORI, TFS	KVTC, PFP, FDT	2018/2019
		2.	Create awareness to the public on the use of quality wood products				2018/2019
12	Unauthorized production, importation and exportation of tree seeds.	1.	Develop Tree Seed Act to regulate seed production and supply	TTSA	TFS, TPRI, TAFORI	PFP, FDT, PRIVATE SECTOR SEED PRODUCERS AND DISTRIBUTORS	2019/2020
		2.	Establish and maintain seed orchards as seed sources	TTSA	TTSA	PFP, FDT, TFS, KVTC, TAFORI, PRIVATE SECTOR, SEED PRODUCERS	2019/2020
13	Inadequate experts in some forestry research areas	1.	Create windows for funding training programs in Tree Breeding, Pathology, Entomology and Soil science	FBD	COSTECH, TAFORI, SUA	TAFORI, Private Sector	2018/2019
		2.	Develop a coordinated training program to increase human resources	FBD	TAFORI, SUA	PFP, FDT, TFS, KVTC, PRIVATE SECTOR, SEED PRODUCERS	2018/2019
14	Uncoordinated research activities in the country	1.	Prepare research guidelines and circulate to stakeholders and ensure they strictly adhere to guidelines	FBD	TAFORI	FDT, PFP, TFCG, SUA, COSTECH, Private Sector Forestry Companies and NGOs Working in Forest Sector	2018/2019
15	Honey quality in tobacco growing areas claimed to have high amount of nicotine and hence affecting its market	1.	Inform stakeholders on the amount of nicotine in honey after further research	TAFORI	TAFORI, TBS	TFDA, TOBACCO DEALERS/ COMPANIES	2018/2019
		2.	Expand the research on nicotine contents to include other honey producing areas	TAFORI	TAFORI	TOBACCO DEALERS/ COMPANIES TFDA, TBS	2018/2019

16	Adoption of new technical orders on rotation ages	1.	Develop Technical Orders to address reduced rotation age for Pines and Teak tree species, once research is concluded	FBD	TAFORI, TFS	FDT, KVTC, PFP	2019/2020
17	Limiting use of fuel wood as source of energy to industries	1.	Create awareness of existing laws and regulations that allows market of fuel wood from legal sources	FBD	FBD	TAFORI, SUA, TFS, TATEDO, TFCG	2019/2020
18	Stimulate wood based industries	1.	Create awareness on different forest products available in the forests.	FBD	TFS	TAFORI, SUA, TIC, FDT	2019/2020
		2.	Emphasis planting more trees growing	FBD	TFS	TAFORI, FDT, WOOD INDUSTRIES	2018/2019
19	Wood products trade deficit	1.	Regulate importation and exportation of wood products to reduce trade imbalance deficit	FBD	TRA	TANESCO, TFS, WOOD INDUSTRIES	2018/2019
20	Declining capacity for Agroforestry research and development in Tanzania	1.	Give priority to Agroforestry, revive coordination, dissemination and create research theme(s)	FBD	TAFORI, ICRAF, SUA	MINISTRY OF AGRICULTURE, PRIVATE SECTOR	2018/2019
		2.	Review Agroforestry strategy for Tanzania	FBD	TAFORI, ICRAF	MINISTRY OF AGRICULTURE, SUA	2018/2019
21	Low rate of using indigenous tree species in woodlots/plantations and tree planting campaign	1.	Conduct more researches on Improvement, Tree Breeding and Silviculture methods for indigenous tree species	TAFORI	TAFORI	NGOs, TaFF, EAMCEF	2018/2019
		2.	Promote establishment of plantations of native tree species	FBD	TFS, LGAs, VPO	NGOs, TaFF, EAMCEF	2018/2019
		3.	Develop regulations that will enforce the use of indigenous tree species during tree planting campaigns (for example in every 100 trees, at least 40 should be indigenous)	FBD	TFS, LGAs, VPO	TAFORI, NGOs	2018/2019
22	Low Public Private Partnership in Forestry Sector	1.	Create a forum for Private Public Partnership involvement in research and decisions on the use and promotion of forestry products	FBD	PFP, TAFORI, FDT	PFP, KVTC, MPINGO PROJECT	2018/2019

ANNEX II: PROGRAMME FOR THE 1ST TAFORI SCIENTIFIC CONFERENCE ON FORESTRY RESEARCH, 24TH AND 25TH APRIL 2018, TAFORI HEADQUARTERS, MOROGORO

SN	TIME	TITLE / THEME	RESPONSIBLE	AUTHOR / RESPONSIBLE
		DAY ONE		
1	8:00 – 8:30	Registration	All	Secretariat
		Opening Session Chairperson: Facilitator *Rapporteurs: Dr. Nancy Pima and Mr. Siwa Ernest*		
2	8:30 – 8:50	Introduction	All	Facilitator
3	8:50 – 9:00	Welcoming note	TAFORI Acting Director General	Dr. Revocatus Petro
4	9:00 – 9:10	Welcoming remarks	TAFORI Board of Directors Chairman	Dr. Felician Kilahama
5	9:10 – 10:00	Opening address	Minister: Ministry of Natural Resources and Tourism (MNRT)	Hon. Dr. Hamisi Kigwangalla (MP)
6	10:00 – 10:10	Vote of thanks	TAFORI Acting Director General	Dr. Revocatus Petro
7	10:10 – 10:40	Group photo and Health Break	ALL	Secretariat
8	10:40 – 11:00	Key note address	Session Chair	Dr. Ezekiel Mwakalukwa
		Presentation Session One Chairperson: Prof. Salim Maliondo *Rapporteurs: Dr. Pilly Kagosi and Mr. Joshua Maguzu*		
		Sub-Theme One: Forestry research on solving deforestation and forest degradation		
9	11:00 – 11:15	Experience of TAFORI in solving forest deforestation and degradation in Tanzania	Session Chair	Dr. Stephen Maduka TAFORI
10	11:15 – 11:30	Solid biofuels options and sustainability: TaTEDO experience	Session Chair	Ms. Mary Lema TATEDO
11	11:30 – 11:45	Challenges of producing quality tree seeds to support afforestation in Tanzania	Session Chair	Mr. Edgar Masunga TTSA
12	11:45 – 12:00	Experiences of FDT on commercial forestry development: Achievement, Challenges and Opportunities	Session Chair	Mr. Simon Milledge FDT

13	12:00 – 12:15	Experience of agroforestry research in Tanzania	Session Chair	Dr. Anthony Kimaro ICRAF
14	12:15 – 12:45	Discussion	All	Paper presenters
15	12:45 – 14:00	Health break	All	Secretariat
		Session Two Chairperson: Dr. Suzana Augustino *Rapporteurs: Dr. John Richard and Ms. Jacqueline Kajembe*		
		Sub-Theme Two: Forestry research for propelling industrial economy		
16	14:00 – 14:15	Rotation Age and Fibre Length of *Pinus Patula* at Sao Hill Forest Plantation, Tanzania	Session Chair	Mr. Francis Laswai TAFORI
17	14:15 – 14:30	Availability of forest products to support industries: challenges and opportunities	Session Chair	TFS
18	14:30 – 14:45	Contribution of smallholder farmers to forest raw materials base in Tanzania	Session Chair	PFP
19	14:45– 15:00	Economic value of imported wood based products streaming to Tanzania	Session Chair	Prof. Jumanne Abdallah SUA
20	15:00 – 15:15	Nicotine contents in honey from tobacco and non-tobacco growing areas in Kigoma Region, Tanzania	Session Chair	Dr. Chelestino Balama TAFORI
21	15:15 – 15:45	Discussion	All	Paper presenters
		Presentation Session Three Chairperson: Dr. Emma Liwenga *Rapporteurs: Dr. Stephen Maduka and Mr. Aloyce Mpiri*		
		Sub-Theme Three: Forestry research under climate change scenario		
22	15:45 – 16:00	Addressing pest and disease challenges in the national forest plantations: lessons learned from the National Forest Health Forum	Session Chair	Dr. Revocatus Petro TAFORI
23	16:00 – 16:15	Emerging industries to respond to climate change scenario	Session Chair	Dr. Freddy Manyika VPO
24	16:15 – 16:45	Discussion	All	Paper presenters
25	16:45 –	Health break and End of Day One	All	Secretariat

DAY TWO				
26	8:00 – 8:30	Registration	All	Secretariat
Presentation Session One Chairperson: Dr. Lemayon Melyoki *Rapporteurs: Mr. James Lyamuya and Mr. Pray Solomon*				
Sub-Theme Four: Financing forestry research for achievable industrial economy				
27	8:30 – 8:45	Financing forestry research mechanism: COSTECH	Session Chair	Dr. William Kindeketa COSTECH
28	8:45 – 9:00	Financing forestry research mechanism: Tanzania Forest Fund	Session Chair	Dr. Tuli Msuya TaFF
29	9:00 – 9:30	Discussion	All	Paper presenters
30	9:30 – 10:00	Health break	All	Secretariat
Presentation Session Two Chairperson: COSTECH Director *Rapporteurs: Dr. Chelestino Balama and Mr. Francis Laswai*				
Sub-Theme Five: Coordination and regulation of forestry research in Tanzania				
31	10:00 – 10:30	Coordinating Forestry Research in Tanzania: The need of Forest Research Guideline	Session Chair	Dr. Siima Bakengesa -TAFORI
32	10:30 – 11:00	Discussion	All	Paper presenter
Plenary Session Chairperson: Dr. Tuli Msuya *Rapporteurs: Mr. Siwa Ernest and Representative from Lushoto*				
33	11:00 – 12:00	Conference Deliberations	Session Chair	Facilitator
Closing Session Chairperson: Facilitator *Rapporteurs: Dr. Siima Bakengesa*				
34	12:00 – 12:10	Invite guest of honour for closing remarks	TAFORI Acting Director	Dr. Revocatus Petro
35	12:10 – 13:00	Closing address	DFoB	Dr. Ezekiel Mwakalukwa
36	13:00	Lunch and Departure	All	

ANNEX III: LIST OF CONFERENCE PARTICIPANTS

NO	NAME	DESIGNATION	ORGANISATION	TEL. NO.	E MAIL ADDRESS
1	ABEL R. KIKO	DRIVER	FITI - MOSHI	0718 016397	
2	ADAM I. RAMADHANI	DRIVER	RC - MOROGORO	0788 271698	
3	AGNESS B. HAULE	REPORTER	TANZANIA STANADARD NEWS (TSN)	0656 597840	agneshaule27@yahoo.com
4	ALLY J. MKUDE	RESEARCH ASSISTANT	TAFORI - MAFINGA	0757 704741	mkude46@yahoo.com
5	ANTHONY A. KIMARO	ICRAF REPRESENTATIVE	ICRAF- DSM	0684 223889	akimaro@cgion.org
6	ASHA B. RAFFY	PERSONAL SECRETARY	TAFORI - MOROGORO	0713 333389	asha.raffy@tafori.or.tz
7	ASHTON BALAIGWA	JOURNALIST	THE GUARDIAN / NIPASHE - MOROGORO	0713 811110	ashtonbally@yahoo.com
8	BEN M. SULUS	FEDERATION PRESIDENT	SHIVIMITA - DSM	0759 291261	bensulus@gmail.com
9	BRUNO J. MGAIWA	DRIVER	MNRT - DODOMA	0767 654463	
10	CHELESTINO P. BALAMA	ACTING DIRECTOR, FOREST UTILISATION RESEARCH	TAFORI - MOROGORO	0767 404873	balamapc@gmail.com
11	CHRISPINE S. NJAU	RESEARCH OFFICER	TAFORI - MOROGORO	0754 301524	chrisirito@gmail.com
12	DAMAS A. MWAIJONGA	DRIVER	TAFORI - MOROGORO	0784 658810	
13	DANIEL S. LUKUMAY	DRIVER	SUA - MOROGORO	0753 049992	stevebdaniel640@gnauk,cin
14	EDGAR W. MASUNGA	CHIEF EXECUTIVE OFFICER (CEO)	TANZANIA TREE SEED AGENCY (TTSA) - MOROGORO	0754 826823	ce@ttsa.go.tz
15	EDWARD KIMWERY	DISTRICT FOREST OFFICER	MOROGORO DISTRICT COUNCIL	0713 843131	ekimwery@yahoo.com
16	ELIEZA MWAKILLA	ACCOUNTANT	TANZANIA FOREST FUND (TaFF)	0754 388392	emwakilla@gmail.com
17	ELINIPA M. SEKIETE	PRINCIPAL	FOREST INDUSTRIES TRAINING INSTITUTE (FITI) - MOSHI	0767 968680	elinipa.sekiete@gmail.com
18	EMMANUEL I. SANGALALI	BMF	FOREST DEVELOPMENT TRUST (FDT) - IRINGA	0766 210066	emmanuel.sangalali@forestry-trust .org
19	EMMANUEL R. LYIMO	PROJECT MANAGER/ADG	TANZANIA FOREST CONSERVATION GROUP (TFCG)	0754 433311	elyimo@tfcg.or.tz
20	ESSAU M. MASONDA	DRIVER	PRIVATE FOREST PROGRAMME (PFP)	0764 431141	masondaesau@gmail.com

21	EVARIST NASHANDA	PRINCIPAL FOREST OFFICER	TANZANIA FOREST SERVICES AGENCY (TFS)	0789 965656	evarist.nashanda@gmail.com
22	FANDEY H. MASHIMBA	SEED BIOLOGIST	TTSA - MOROGORO	0768 600071	fandeys@yahoo.co.uk
23	FELICIAN KILAHAMA	CHAIRMAN, TAFORI BOARD OF DIRECTORS	DSM	0756 007400	fkilahama@gmail.com
24	FRANCIS F. LASWAI	CENTRE DIRECTOR	TAFORI - MOSHI	0784 698140	francis.laswai@tafori.or.tz
25	FRANCIS S. MOYO	LECTURER	NELSON MANDELA INSTITUTE	0675 609130	francismoyo@nm-inst.ac.tz
26	FREDY K. MANYIKA	PRINCIPAL FOREST OFFICER	VICE PRESIDENT'S OFFICE	0765 664260	kanizio.manyika@vpo.go.tz
27	GEOFREY KESSY	SILVICULTURE MANAGER	KILOMBERO VALLEY TEAK COMPANY (KVTC) - IFAKARA	0684 293625	gkessy@kvtc-tz.com
28	GEOFREY NJOVANGWA	INFORMATION AND DOCUMENTATION OFFICER (IDO)	TAFORI - MOROGORO	0753 097047	geofreyn@tafori.or.tz
29	GOODLUCK G. MOSHI	DRIVER	SUA - MOROGORO	0752 049254	
30	HANTA RWEGOSHORA	COMMERCIAL MANAGER	KVTC - IFAKARA	0764 789900	hrwegoshora@kvtc-tz.com
31	HERIEL E. MDEE	DRIVER	TBC - MOROGORO	0719 338160	
32	HERIEL P. MSANGA	LECTURER	SEBASTIAN KOLOWA LUSHOTO	0719 185604	agroimplements@gmail.com
33	IJUMAA K. SINGO	TREE IMPROVEMENT RESEARCH MANAGER	FDT - IRINGA	0715 718990	ijumaa.singo@forestry-trust.org
34	ISSA SINGANO	DRIVER	TAFORI - LUSHOTO	0784 661054	
35	JACOB MLULA	DRIVER	WWF - TANZANIA	0717 606318	
36	JACQUELINE G. KAJEMBE	RESEARCH OFFICER	TAFORI - MOROGORO	0657 654179	jgkajembe@gmail.com
37	JAMES V. LYAMUYA	RESEARCH OFFICER	TAFORI - TABORA	0762 770491	lyamuya.james@yahoo.co.uk
38	JIMMY S. MATEMU	DRIVER	ICRAF - DSM	0713 686486	jsianga@cgiar.org
39	JOHN KESSY	COLLEGE PRINCIPAL	COLLEGE OF FORESTRY, WILDLIFE & TOURISM, SUA	0754 948708	jfkessy2012@gmail.com
40	JOHN R. MBWAMBO	CENTRE DIRECTOR	TAFORI - LUSHOTO	0715 811618	jorijomb@yahoo.com
41	JOSEPH J. CHUWA	REGIONAL NATURAL RESOURCES OFFICER (RNRO)	RC - MOROGORO	0787 858803	chuwaj@yahoo.com
42	JOSHUA S. MAGUZU	RESEARCH OFFICER	TAFORI - MOROGORO	0755 342634	joshuamaguzu@yahoo.com

43	JULLIET HAMZA	CASHIER	TAFORI -MOROGORO	0783 668888	juliethhamza@tafori.tz.or
44	JUMA R. MWANGI	FOREST OFFICER	TANZANIA FOREST SERVICES	0787 889977	Mwangijr2003@gmail.com
45	JUMANNE M. ABDALLAH	HEAD OF DEPARTMENT OF FOREST AND ENVIRONMENTAL ECONOMICS	SUA - MOROGORO	0655 255301	abdallah@suanet.ac.tz
46	KOMBO S. KATAMBO	DRIVER	TAFORI - MOROGORO	0685 656031	
47	LAWRENCE R. MBWAMBO	POLICY ADVISOR	WWF - DSM	0754 439576	lmbwambo@wwftz.org
48	MAFUNDA DUGUSHILU	FACILITATOR	COSTECH - DSM	0655 364068	djmafunda@gmail.com
49	MARRY E. SWAI	PROGRAM MANAGER	TaTEDO -DSM	0713 549862	mary.swai@tatedo.org
50	MICHAEL D. HAWKES	TEAM LEADER	PRIVATE FORESTRY PROGRAMME	0786 365173	michael.hawkes@privateforestry.or.tz
51	MOHAMED KILONGO	DIRECTOR OF PLANNING AND RESOURCES UTILIZATION	TFS – DSM	0754 692391	makilongo@yahoo.com
52	MSAKAA J. VICENT	DRIVER	SUA -MOROGORO	0714 188114	
53	MWANAHAWA A. OTTO	PERSONAL SECRETARY	TAFORI - MOROGORO	0719 708150	mwanahawa-ahmed@yahoo.com
54	NAIMAN SARAKIKYA	DRIVER	TFS - DSM	0785 854954	
55	NANCY E. PIMA	CENTRE DIRECTOR	TAFORI – KIBAHA	754820793	nancypima@yahoo.com
56	NOBUKO T. NZULLUNGE	FARMER	FOREST AND FARM PRODUCTS PROCESSING AND PROMOTION	0752 363943	egajidom@yahooo.com
57	NOEL D. MAEDA	PRINCIPAL FOREST OFFICER	TFS - DSM	0767 465443	noelmaeda@yahoo.com
58	OSMUD A. NDOMBA	PRINCIPAL RESEARCH OFFICER	TROPICAL PESTICIDES RESEARCH INSTITUTE (TPRI) - ARUSHA	0762 529155	ondomba@tpri.or.tz
59	PETER E. ZYAMBO	DRIVER	TaFF - DSM	0713 811010	
60	PILLY J. KAGOSI	SENIOR RESEARCH OFFICER	TAFORI - MOROGORO	0784 479904	pjkagosi@yahoo.com
61	PRAXEDA L. MTANI	HEAD OF EASTERN ZONE	TBC - MOROGORO	0784 813888	praxedamtani2016@gmail.com
62	PRAY S. KWEKA	RESEARCH ASSISTANT	TAFORI – KIBAHA	0758 410627	praykweka@yahoo.com
63	RAMA H. MOHAMED	DRIVER	TTSA - MOROGORO	0715 947258	
64	REMMY YASINT	CAMERAMAN	TBC - MOROGORO	0654 171762	remmyyasinto2015@gmail.com
65	REVOCATUS P. MUSHUMBUSI	ADG TAFORI	TAFORI - MOROGORO	0754 819623	revomushumbusi@gmail.com

66	RODA M. LYANGA	JOURNALISM	TBC - MOROGORO	0717 321873	
67	SALLIM M. MALIONDO	PROFESSOR AND MEMBER OF TAFORI BOARD OF DIRECTORS	SUA - MOROGORO	0652 659697	salimmaliondo@gmail.com
68	SAMUEL L. MSUVA	EXECUTIVE OFFICER	TANZANIA ASSOCIATION OF FORESTERS (TAF)	0769 571001	samuelmsuva@gmail.com
69	SAMY DAVID	CAMERAMAN	ITV & RADIO ONE	0919 009914	
70	SANGITO SUMARI	NATIONAL PRIVATE FOREST ADVISOR	PRIVATE FORESTRY PROGRAMME	0757 406755	sangito.sumari@privateforestry.or.tz
71	SEVERIN K. KALONGA	PARTNERSHIP DEVELOPMENT	WWF - TANZANIA	0715 432375	skalonga@wwftz.org
72	SHABAN M. MPUTA	RESEARCH ASSISTANT	TAFORI - MAFINGA	0652 309421	mputashabani@gmail.com
73	SIIMA S. BAKENGESA	DIRECTOR, FOREST PRODUCTION RESEARCH	TAFORI - MOROGORO	0754 784545	siima.bakengesa@tafori.or.tz
74	SIMON MILLEDGE	TRUST DIRECTOR	FDT - IRINGA	0788 102580	simon.milledge@forestry-trust.org
75	SIWA E. NKYA	RESEARCH OFFICER	TAFORI - MOROGORO	0713 414589	siwa.ernest@tafori.or.tz
76	STEPHEN M. MADUKA	FOREST RESEARCH OFFICER	TAFORI - MALLYA	754448851	smaduka@hotmail.com
77	SUZAN AUGUSTINO	LECTURER AND MEMBER OF TAFORI BOARD OF DIRECTORS	SUA - MOROGORO	0686 499999	
78	TULI S. MSUYA	ADMINISTRATIVE SECRETARY; AND MEMBER OF TAFORI BOARD OF DIRECTORS	TANZANIA FOREST FUND (TaFF)	0784 393 414	tuli.msuya@mnrt.go.tz
79	TULLOH SHUNDA	DRIVER	TAFORI - MOROGORO	0713 967113	
80	VEDASTO MSUNGU	REPORTER	ITV & RADIO ONE	0784 640700	vmsungu@yahoo.com
81	VEDASTUS I. GEORGE	SUA TV	SUA TV - MOROGORO	0718 760883	vedastugeorge@gmail.com
82	VLADISLAV VEONOVIC	PLANNING MANAGER	KVTC - IFAKARA	0684 4297658	vvejnovic@kvtc-tz.com
83	WILLIAM J. KINDEKETA	NATURAL RESOURCES PRINCIPAL OFFICER	COSTECH - DSM	0766 922447	william.kindeketa@gmail.com
84	YOHANA J. MAGANGALI	RESEARCH ASSISTANT	TAFORI - LUSHOTO	0742 267933	yohanaj24@gmail.com
85	YOUNG ZENI	FOREST OFFICER	TFS - DSM	0688 427441	young.zeni@tfs.go.tz
86	ZUBERI A. MFAUME	DRIVER	SUA - MOROGORO	0756 110288	