

**DETERMINATION OF QUANTITY OF WOOD USED FOR CURING FLUE-
CURED TOBACCO**

MSc (Environmental Science) Thesis

By

FELIX KALEBE

BSc. (Environ. Sc.)-University of Malawi

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University of Malawi

Chancellor College

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DECLARATION

I, the undersigned hereby declare that this thesis/dissertation is my own original work, which has not been submitted to any other institution for similar purposes. Where other people's work has been used, acknowledgements have been made.

Felix Kalebe

Signature

Date

CERTIFICATE OF APPROVAL

The undersigned certify that this thesis represents the student's own work and effort and has been submitted with our approval.

Signature: _____ Date: _____

Marlene Chikuni, PhD (Senior Lecture)

Main Supervisor

Signature: _____ Date: _____

Tembo Chanyenga, PhD (Director, FRIM)

Co-Supervisor

Signature: _____ Date: _____

Ephraim Vunain, PhD (Senior Lecture)

Coordinator, Masters in Environmental Science Program

DEDICATION

This work is dedicated to my parents late Mr Matthews Banda Kalebe & Mrs Rose Kalebe, my wife Loney, Children Luso and Lisa and the whole Kalebe family. I also dedicate this work to God the Almighty for everything was possible through him – Thank You!

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ABSTRACT

The importance of tobacco to Malawi cannot be overemphasised. It contributes about 60 % of foreign exchange earnings and 13 % of GDP to the country. However, certain activities within the industry have a negative effect on the environment; nearly 25% of total deforestation is attributed to the curing of Flue cured Tobacco. With the shift of balance from Burley to Flue cured Tobacco, no studies have been undertaken to identify the actual species and quantities of wood used in curing Flue cured Tobacco. This study was therefore conducted to characterise and quantify the wood species used in curing Flue cured Tobacco as well as to determine mitigation measures that are undertaken. Results showed that estates preferred exotic species mainly due to convenience and quality end product while clubs preferred indigenous tree species due to its economic advantage. Findings showed no significant difference in the amount of wood used between clubs and estates to cure a tonne of tobacco. The Rocket Barn used the highest quantity of wood (14.8 cubic meters per tonne) while Tunnel was the most economic barn (5.5 cubic per tonne). Despite allocating part of their hectarage to forest as stipulated in the Land Act (2004), smallholder farmers did not own forests and were outsourcing their curing wood from forestry reserves. High cost of raising seedlings is one of the reasons mentioned to hinder forest establishment by smallholder farmers. Based on the findings of this study, it can be concluded that tobacco related deforestation needs to be tackled with seriousness and the current mitigation measures are not addressing the problem.

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LIST OF ABBREVIATIONS AND ACRONYMS

AHL:	Auction Holdings Limited
AOINTL:	Alliance One International Tobacco Limited
ARET:	Agricultural Research and Extension Trust
ECAMA:	Economics Association of Malawi
EPA:	Environmental Protection Agency
FAO:	Food and Agriculture Organisation
FCTC:	Framework Convention on Tobacco Control
FCV:	Flue Cured Variety
FRIM:	Forestry Research Institute of Malawi
GDP:	Gross Domestic Product
IFSC:	Indian Financial System Code
IPS:	Integrated Production System
LLTC:	Limbe Leaf Tobacco Company
NDDF:	Northern Division Dark Fired
NFP:	National Forestry Policy
NEAP:	National Environmental Action Plan
NHBG:	National Herbarium and Botanical Gardens
SDF:	Southern Division Fire cured
SFC:	Specific Fuelwood Consumption
SPSS:	Scientific Package for Social Scientists
TCC:	Tobacco Control Commission
WHO:	World Health Organisation

CHAPTER 1: INTRODUCTION

1.1 Introduction and background

1.1.1 What is tobacco

Tobacco (*Nicotiana tabacum*) is an annual leafy crop of the family Solanaceae. The genus *Nicotiana* has about 45 accepted species (Plant list, 2013), information from literature suggest that only *Nicotiana tabacum* is of economic importance. *Nicotiana rustica*, sometimes referred to Wild Tobacco is also cultivated.

The tobacco crop is grown from seeds, which are raised in a nursery to prevent attacks from insects and seedlings are then transplanted to the field (ARET, 2012). Reaping (harvesting of tobacco) is usually done mechanically or by hand. After reaping, tobacco is immediately taken for curing, a process which allows the slow oxidation and degradation of Carotenoids.

As a tropical crop, tobacco requires a warm climate, temperature of about 28 °C (degrees Celsius) to germinate (Apiado *etal*,2012), and the optimum daily temperature range of 20-30 °C for its growth (FAO, 2011). However, the crop cannot withstand temperatures above 35 °C. Tobacco needs rich, well-drained soils and is sensitive to water logging. The crop is susceptible to numerous bacterial, fungal as well as viral diseases (ARET, 2012).

Tobacco is widely grown for its leaf, which contains stimulant alkaloid nicotine. The final product is mainly used for smoking. Reports have also indicated that tobacco can also be used as a pest repellent. When mixed with Garlic and compost, tobacco can control Garden Aphids; sprinkling tobacco dust around Peach tree deters tree borers. Tobacco is also used for medicinal purposes, for example, a poultice of tobacco is used for treating skin inflammations to soothe and relieve pain, when placed in a mouth it can also be used to

alleviate pain from toothaches. Research has shown that chewed tobacco can be used to treat Rattlesnake and insect bites when applied directly to the wound (Pennington, 2017). When mixed with either Lime or Chalk, tobacco has been used for whitening or cleaning teeth. Tobacco leaf stems are used as manure while tobacco stems are also used as firewood.

1.1.2 Types of tobacco grown in Malawi

Tobacco plays an important role to Malawi, it contributes about 60 % of foreign exchange earnings and 13% of the Gross Domestic Product (GDP) (TCC, 2014). As an industry, tobacco employs a large number of people, with total figures for farmers and workers averaging 2,000,000 (FAO, 2003). The tobacco industry in Malawi dates back to 1890's when about 3,000 kilograms of tobacco was produced on approximately 3 hectares of land (Institution Government and Business, 2004). It has been reported that the unstable economic state of the country made it favourable for the intensification of tobacco production so as to boost its financial viability. Ever since, land under tobacco cultivation has steadily increased over the years, approximately 200,000 hectares of land was under tobacco cultivation at the peak of tobacco cultivation in the year 2011, This however declined to around 50,000 hectares in 2012 following tumbling down of tobacco prices on the auction floors (TCC, 2014).

Presently, Malawi produces three types of tobacco that legally are sold in the designated markets: Burley Tobacco, Flue cured Tobacco and Western Tobacco (TCC, 2014). Oriental Tobacco which is sun air cured, was being grown in Mzimba district from 1954 when it was first introduced, but in 1973 R.J. Reynolds had their expert in Malawi to assess the potential of the crop, until then the country was unable to produce large volumes to suffice the market (LLTC, 2008). *Nicotiana rustica*, also known locally as Labu Tobacco is cultivated on a small scale and not for commercial purposes. This tobacco is sundried before powdered into a fine snuff.

Burley Tobacco generally appears light brown in colour after curing, and is the most predominant type grown in Malawi. It is grown in all the three regions of the country (LLTC, 2008) and makes up over three quarter of the tobacco market (TCC, 2012). Burley Tobacco is mostly grown by small-holder farmers whose average hectarage is

0.405 (1 acre) and small to medium estates, Curing of Burley Tobacco is done in open barns where natural air is used to remove excess water (ARET, 2012). Currently, Malawi is ranked as the highest producer of Burley Tobacco in the world (Jomo, 2009). However, market of the crop is presently under threat from World Health Organisation (WHO) through a treaty called Framework Convention on Tobacco Control (FCTC). This treaty was adopted by the 56th World Health Assembly on 21st May, 2003, and it seeks to protect the present and future generation from consequences of consumption and exposure to tobacco. It condemns the use of additives such as Burley in tobacco manufacturing.

Western Tobacco which is locally referred to as ‘wa chikopa’ is categorized into two groups, depending on the region of production (TCC, 2004). Northern Division Dark Fired (NDDF) from central and northern parts of Malawi and Southern Division Fire-cured (SDF) from the southern region of the country. These two groups of tobacco are generally the same, but SDF tends to be lighter brown when compared to the NDDF. NDDF is dark brown after curing, the colour difference between the two has come about due to scarcity of wood for curing in southern Malawi (LLTC, 2008). Western Tobacco has always had the least hectareage when compared to other two types tobacco, it accounts for at most 5 percent of the total crop annually (TCC, 2013). Curing of Western Tobacco relies on the direct contact of leaves with smoke. The leaves are hung in an enclosed barn with smoke-tight to remove excess moisture, hence the dark brown appearance of a finished product.

Flue cured variety (FCV) Tobacco which is the focus of the study is locally recognized as ‘Kampopi’ and internationally as Virginia Tobacco. It is predominantly grown in Kasungu district in the central region and Namwera area in Mangochi in the southern regions, the northern region produces FCV Tobacco but on a small scale (LLTC, 2008). It takes 6 to 8 days to cure FCV Tobacco depending on the type of barn and wood used to provide heat energy. Curing of FCV Tobacco is done under an enclosed barn, a process whereby heat is supplied into flues (metallic pipes) or channels from an outside furnace, and is varied depending on the stage of curing (Bernard, 1989). Normally, the final product of FCV Tobacco has two colours after curing, orange and lemon, though at times

leaves are mahogany (TCC, 2010). Orange coloured leaves usually originate from upper position of the plant while lemon coloured leaves are normally associated with the lower position of the plant, (TCC, 2004).

FCV Tobacco on average contributes about 15 – 20 % of Malawi’s total tobacco production annually, (Otanez, 2003), and is normally associated with well-established commercial farmers and estates. In terms of price (gross) comparisons, FCV attracts higher prices on the selling floors than Burley and Western Tobacco. Trend from the year 2000 has seen average prices of FCV soaring from US\$1.35 per kg to above US\$ 3.00 per kg in the year 2013 and 2015 selling seasons (Figure 1). The steady increase in the prices of FCV has pushed production volumes high. From year 2000 to present, production volumes of FCV has tripled from about 10,000 metric tons to 31,000 metric tons annually (TCC, 2017).

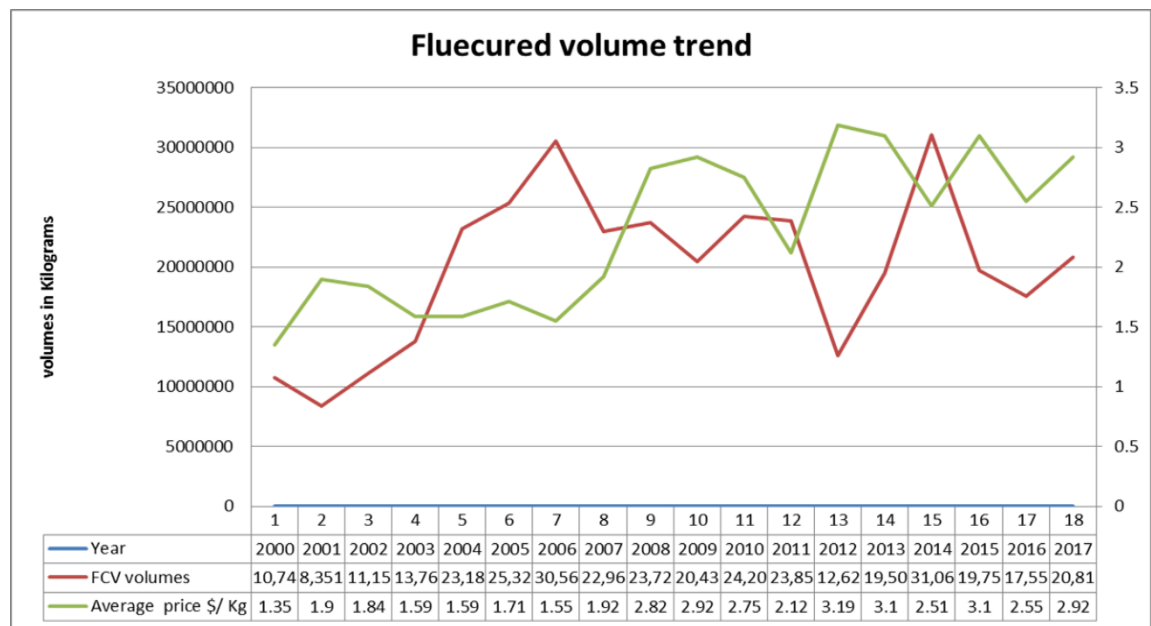


Figure 1: Flue-cured volumes and average prices 2000 – 2017

Source: Tobacco Control Commission, 2017

Unpublished reports indicate that some farmers in Nkhamenya and Mzimba have been growing FCV and side selling in Zambia, these volumes are unaccounted for in the annual output. The farmers are illegally sponsored with inputs by vendors from Zambia

who later buy the crop at a prearranged price. This then entails that the annual production of FCV in the country is higher than what crosses through the designated selling Floors (Phiri, 2012).

Unlike Burley tobacco, FCV crop has not been directly affected by the WHO FCTC treaty on anti-smoking lobby as it is not used as an additive. As a result, the government of Malawi through the Tobacco Control Commission (TCC) has been emphasizing on growing more FCV tobacco compared to other types of tobacco. Its demand is very high on the international market (Phiri, 2012).

1.2 Problem Statement

Several scholars have reported on the quantities of wood used in curing tobacco, among them include Campbell, 1996, Geist, 1999, Otanez, 2003, Nijenhuis, 2008. However, they have all reported on a broad-spectrum without specifying the condition under which the volume is achieved. This general approach overlooks tree species and curing barns used in the tobacco curing and little is known on the actual tree species and quantities of wood used in curing FCV Tobacco. No studies have been undertaken before pertaining to the actual tree species and the curing barns with their proportions used in curing FCV Tobacco, especially presently when the balance is shifting from Burley Tobacco. The current research, therefore, seeks to address the gap in the literature relating to the actual tree species and its quantities used as fuel wood (as with regard to barn types and their proportional use) in the process of curing FCV Tobacco in the country, specifically the central region of Malawi which has the highest concentration of FCV Estates.

1.3 Goal and objectives of the study

1.3.1 General Objective

The main objective of the study was to determine tree species and quantity of wood used for curing FCV Tobacco, in selected estates & clubs

1.3.2 Specific Objectives

Specifically, the study intended to:

1. Document the most used tree species in curing FCV Tobacco
2. Quantify wood used to cure a unit weight of FCV Tobacco
3. Establish the most used barn
4. Establish the most efficient barn
5. Determine mitigation measures undertaken to address deforestation.

CHAPTER 2: LITERATURE REVIEW

2.1 Background Literature

Malawi's vegetative cover is mainly dominated by Miombo woodlands one of the major dry forest Savanna biomes of the world. Miombo woodlands covers much of southern Africa, stretching from mid Tanzania across Angola through Malawi and down to the northern edge of South Africa as shown in Figure 2 below. The word Miombo meaning *Brachystegia* species, is vernacular to Zambia and Tanzania.



Figure 2: Miombo woodlands stretch

Source: <https://en.wikipedia.org/wiki/Miombo>

Miombo woodlands are mainly associated with competition for water during the dry season, this consequently result in widely spaced canopies. Grasses take up water in the upper horizons of the soil while trees take up the water that infiltrates deeper. Miombo woodlands are characterized by trees in the sub family Caesalpinoideae, especially species in the genera *Brachystegia* and *Julbernardia*. Typically, trees are semi-deciduous meaning that they lose some or all of their leaves in the dry season depending on severity (Campbell, 1996).

Tobacco curing is the second biggest factor contributing to deforestation of Miombo woodlands, and deforestation is regarded as the second biggest threat to the country's biodiversity (Malawi, Country Strategy Paper, 2012-16). Wood is mainly used as a source of fuel, barn construction as well as source of poles for hanging harvested tobacco leaves in the curing process. For example, Burley Tobacco requires wood for construction of barns and for hanging sticks whilst FCV and Western Tobacco require firewood mainly for the curing process. It has been reported that 69 % of total wood used in the curing process is in the form of fuel (Clay, 2001). Several reports indicate that the tobacco industry in Malawi is one of the major drivers of deforestation.

For example, Geist in 1999 reported through the Global Assessment of Reforestation Related to Tobacco curing that Malawi clears 55 hectares of woodland annually to cure tobacco representing 26.1 percent or a quarter of all the deforestation that takes place in the country (Geist, 1999; Otanez, 2003). This was in agreement with Campbell (1986) who reported that the tobacco industry alone contributed to 23 percent of the total wood demand in Malawi.

It has been estimated that more than 90 percent of the total wood for curing FCV tobacco comes from indigenous tree species (ARET, 2003). Nijenhuis (2008) reported that Malawi has an estimated 10,000 small holder tobacco growers, 65 percent of whom use wood to cure tobacco, with a single farmer dedicating 13.5 kilograms of wood to cure 1 kg of tobacco. In comparison, Friedel (1989) reported that a study by IFSC found an average of 13.3 kilograms of wood to cure 1 Kilogram of FCV tobacco. Food and Agriculture Organization (2003) also reported that tobacco has the highest specific fuel wood consumption ranging from 5.0 to 12.0 kilograms per 1.0 kilogram of tobacco.

Several reports have highlighted amount of wood used to cure tobacco in weight, Klein has however expressed contrary views, in his article 'Forestry inventory', he accentuated that wood measurement is best expressed in Volumes than mass.

Different tree species and curing barns are used in the process of curing of FCV tobacco, no scientific studies have been conducted to determine wood consumption rate of all barns in comparison. Furthermore, there is uncertainty on the preferred barns and their frequency of use thereby compounding the problem of ascertaining annual fuel wood consumption for tobacco

In an effort to address the tobacco related deforestation problem, the government of Malawi through the National Forestry Policy (NFP, 2016) is promoting the use of wood fuel saving devices, among them Rocket barns. Little has been said about tobacco related afforestation. The NFP has emphasized on the importance and good managerial practices on the sustainability of forests. Integrated Production System (IPS) in tobacco industry which is being initiated by the tobacco customers and merchants has also placed much emphasis on tobacco reforestation, the system strives to come up with models in tree planting depending on wood usage (LLTC, 2013). In relation to that, Alliance One International Tobacco Limited (AOINTL) at some point threatened to pull out of the Malawi unless issues of environment were adequately addressed (Daily Times, 2011). It was further reported that, only contractual farmers, that are less than 40 percent of all tobacco adhere and comply with environmental and social principles in their production process. Limbe Leaf Tobacco Company every year supports its contract FCV tobacco growers. In 2008 for instance, it supported the non-traditional tobacco growing communities in their reforestation efforts. The Company partnered with communities together with the department of forestry and Total Land Care to replant trees in the degraded areas (LLTC, 2011). The TCC has in their strategic plan focused on massive reforestation programs to accommodate maximization of FCV tobacco production. This is in response to the fact that Malawi is in the course of moving away from Burley Tobacco as its mainstay in preference for FCV because the manufactures are also moving from Burley blended to Virginia blended tobacco.

The tobacco industry forestry model is almost finalised. Among the issues proposed include transferring the forestry levies that are deducted from farmers from government coffers (Account number One) to the set up committee by the tobacco industry (ARET, 2017). The funds are to be used in driving the tobacco industry afforestation program. It may be seen if government is ready to let go the management of the funds.

2.2 Curing Barns

Contrary to previous studies, this study attempts to establish the most used and the most efficient FCV barn in Malawi. Four different types of barns were recorded to be correctly in use. They are called by different names, some according to their structural make-up; they include Convention type of barn, Chongoloro Barn, Rocket Barn as well as Tunnel type of Barns. All these barns have different capacities as with regard to wood consumption in relation to quantity of tobacco cured.

2.2.1 Convention Barn

They are the commonest type of barn used especially by ordinary small scale growers. Convention barns are mostly built in a rectangular shape, usually they do have a Ventuli furnace, which is V shaped. This barn has round shaped flues (Figure 3) inside from where heat is produced.



Figure 3: External and internal view of Convention Barn

Source: Researcher

2.2.2 Cascade/ Chongoloro Barns

Chongoloro Barn originated from Zimbabwe, the name was derived from Bongoloro owing to its structural make up. Chongoloro or Cascade Barns as shown in Figure 4 are more or less like a chain of Convention Barns, these barns are made in such a manner that radiant heat that cures the leaf originates from a single furnace and passes through a series of barns. Heat in other barns is then controlled by vents that are put in between. These barns are normally used by well-established estates as they are costly to construct.



Figure 4: Outside the Chongoloro Barn

Source: Researcher

2.2.3 Rocket Barn

Rocket Barn are similar to Convention Barn in its outside structural make up, except for a protruding external metal chimney (Figure 5) that assist in pulling inside the air for its efficiency. The flues inside are also made from common bricks and flat iron sheets. Rocket Barns do have a snake like structure system (Figure 6) which gives a greater than two-fold increase in surface area as compared to the Malawi traditional barn. Rocket Barns came from Zimbabwe in 2005-2006 seasons under a project, Development of

Improved Tobacco Curing Barn for Smallholder Farmer in Southern Africa., These type of barn have undergone some modifications of late due to their inefficiency.



Figure 5: Outlook of a Rocket Barn

Source: Researcher

Literature from a study conducted by Peter Scott in 2006 showed that Rocket barns are more efficient, and consume half amount the quantity of wood as compared to convention type of barns. In Kasungu, Rocket Barns are mainly found in the northern part around Nkhamenya. Alliance One International Tobacco Limited (AOINTL) was the one championing the project. The company constructs these barns for its contract growers. For a Rocket Barn to be built, it costed a farmer approximately Mk100, 000.00.



Figure 6: Internal view of Rocket Barn showing bricks and iron sheets

Source: Researcher

2.2.4 Tunnel Barn

As the name implies, Tunnel Barns are similar to a tunnel made in one single continuous channel without demarcations, and have one furnace as shown in Figure 7 and 8. Tobacco leaves are packed on trolleys and moved forward at intervals against the direction of air flow, this movement may either be manual or mechanical (Bernard, 1989). Growers using this type of barn prefer using coal as its heat energy. However, coal has proved to be costly and also difficult to control adjustments on barn temperature hence compromising leaf quality.



Figure 7: Internal view of a tunnel barn and trolleys in their rails ready to hang the leaves



Figure 8: External view Tunnel Barn with the furnace,

Source: Researcher

CHAPTER 3: METHODOLOGY

In the study, both quantitative and qualitative approaches were used to determine tree species, quantity of fuel wood used and mitigation measures taken in the curing of FCV Tobacco. A Questionnaire was administered to FCV Tobacco club members and estates to determine the trees species used and determine the mitigation methods that were taken. Experiments were also conducted to measure quantities of wood used in curing a specific volume of tobacco.

3.1 Study Site

The study was conducted in Kasungu District (13°0'00" south, 33°25'0" east) at 64 curing sites from six EPAs (Figure 9). Kasungu District is found in the central region of Malawi and has an estimated population of about 60,000. It lies at a height of 1,342 meters and has a warm tropical climate and a rainy season that lasts from November/ December to March/ April, its dry season lasts from May to October. The District annually receives rainfall ranging from 500-1,200 millimeters, and the soils are mostly sand veld. Kasungu, especially the National Park is mostly dominated by Miombo woodlands. Kasungu District was chosen because it has the highest number of estates growing FCV Tobacco in Malawi, hence the most affected by tobacco related deforestation.

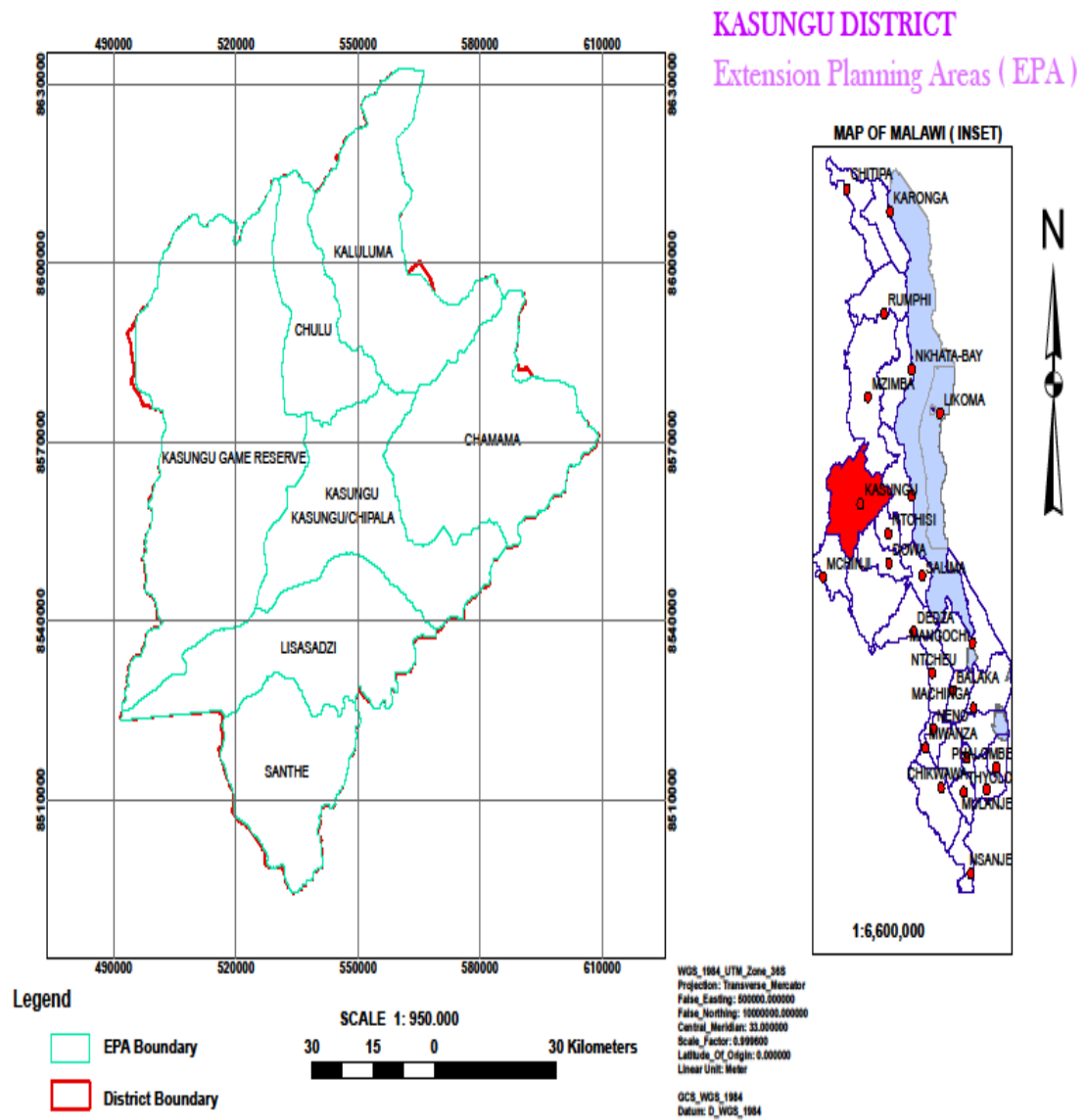


Figure 9: Map of Kasungu district and EPAs

Source: researcher

3.2 Sampling Method

A simple random sampling approach was used in the study. From a population of 298 FCV estates and 520 FCV clubs in Kasungu that had already registered in the 2009/2010

growing season, a sample was drawn for both categories based on the formula by Edriss, 2003.

$$n = \frac{z^2 (1 - p) p}{e^2}$$

Where **n** = sample size

p = *estimated population proportion*

e = *absolute size of the error in estimating p that one is willing to permit*

z = *confidence limit of survey*

The formula is deployed when: the population size is not known, when resources either/ both financial and time are limited. In this study, the formula was used since the club and estate registration by Tobacco Control Commission the tobacco regulatory body in the country was still ongoing. Furthermore, the formula was deployed due to limited time and financial resources.

Hence, the sample size was

$$\begin{aligned} n &= \frac{1.96^2 (1 - 0.021) 0.021}{(0.05)^2} \\ &= 31.59 \\ &= 32 \end{aligned}$$

3.3 Data Collection

A questionnaire was administered to estates owners and smallholder FCV tobacco growers in order to establish the most used and the most preferred tree species used in curing FCV. It also focused on afforestation programs in comparison to total tobacco hectareage of FCV grown. (Appendix 3)

3.3.1 Volume measurement

Wood volume measurements were taken in cubic meters to determine the quantity of wood used in the curing process of a specific amount of FCV tobacco at both clubs and estates. Measurements were taken using a Diameter tape and a Tape measure (Figure 10), and this was during the actual process of tobacco curing.



Figure 10: Picture depicting measurements of wood species

Source: researcher

Due to irregularities in cross-section and the longitudinal profile of tree trunks, a section-wise wood volume calculation formula called *Huber's* (Philip, 1994) was employed to calculate the volume of wood. In the formula, Log volume is not measured directly but is calculated using log mid-diameter and log length.

Huber's formula: Wood volume $V = (\pi * dm^2) / 40000 * L$ (Philip, 1994)

Where

V = wood volume

π = 3.1416

dm = mid diameter (diameter of a log at exactly half its length) in centimeters

L = length of section

Measurements were also taken from Chords of wood that were heaped before the actual curing process as a control.

3.3.2 Experimental design

From the sampled 32 estates and 32 club sites, wood measurements were taken per log of wood from a stacked pile and then the cubic meters were added to come up with total wood volume per stack to be used in curing tobacco. Control of the experiment was done prior to the actual experiment in relation the average estimated volume of wood used by both estate and a club. Total wood volume measured was then compared with the actual stack volume and an average conversion factor of 0.6 to crosscheck (not necessarily to compare) if the measured volume was in line with the stacked volume as depicted in figure 14. In some estates where furnaces were more than one, a simple random sampling was conducted to come up with two experiments and the average was calculated in the end to come up average fuelwood consumption for that particular estate.

Tree species, number of workers and size of barn in terms of number of sticks a barn accommodated and type of furnace were also recorded as independent variables.

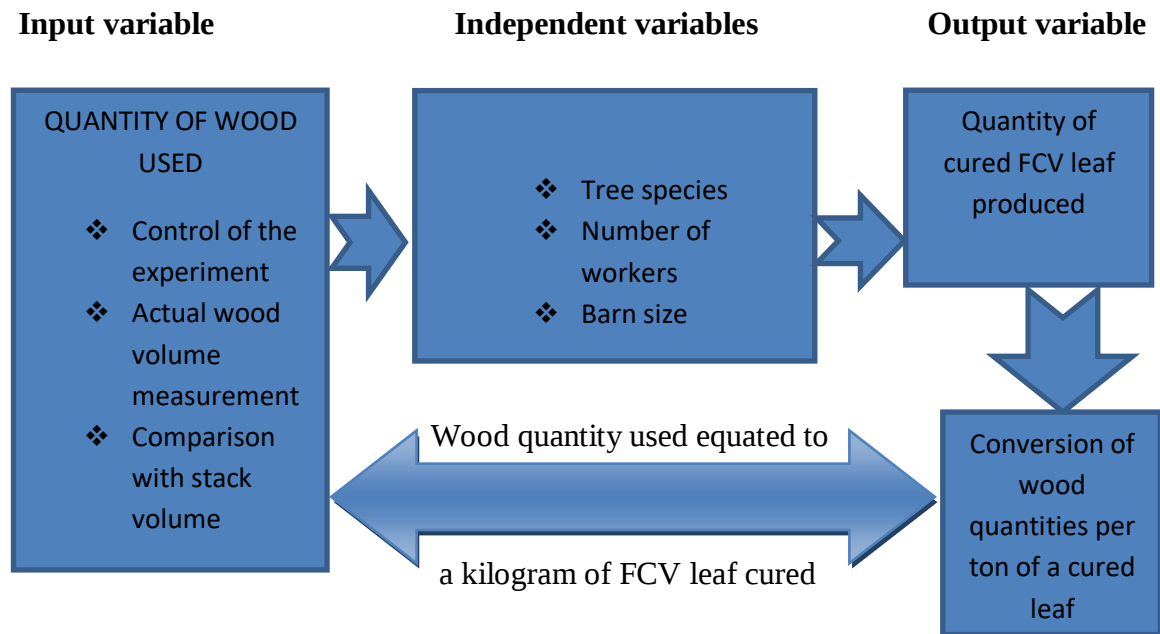


Figure 11: Conceptual framework of experimental design

Source: Researcher

3.4 Data Analysis

The data collected was analysed using the Statistical Package for Social sciences (SPSS) Version 12.0 and the Excel package. In SPSS, t-test was run to compare means of wood quantities used by estates and clubs, Pearson Correlation was also run to show measures of association between number of workers and quantities of wood used. Box plots were also plotted in SPSS to show variations in means between the two samples estates and clubs. Descriptive statistics was deployed using Excel package to show measures of central tendencies and measures of dispersion. Means, medians and modes on quantities of wood used were then located, frequency graphs on trees species used, quantities of wood and comparison between tobacco hectareage and areas afforested were also plotted in excel package. In Measures of dispersion, standard deviations, ranges on quantities of wood were all calculated, Pie Charts and Bar Graphs were also plotted in Excel Package to show frequencies and comparison among different categories

CHAPTER 4: RESULTS AND DISCUSSION

4.1 Tree Species Used

4.1.1 Tree Species used in curing FCV Tobacco in Malawi

Table 1: Tree species used in curing flue cured tobacco

Name of species	English/Local name	Tree type	User
<i>Eucalyptus globulus</i> , <i>tereticornis</i> , <i>maidenii</i>	Blue gum	Exotic	Estates & few clubs
<i>Gmelina arborea</i>	Gmelina or Malaina	Exotic	Estates
<i>Pinus patula</i>	Pine	Exotic	Estates
<i>Pericopsis angolensis</i>	“Muwanga”	Indigenous	Clubs
<i>Pterocarpus angolensis</i>	“Mlombwa”	Indigenous	Clubs
<i>Dalbergia melanoxylon</i>	“Phingo”	Indigenous	Clubs
<i>Afzelia quanzensis</i>	“Msambafumu”	Indigenous	Clubs
<i>Acacia polyacantha</i>	“Mthethe”	Indigenous	Clubs
<i>Cordyla African</i>	Bean-pod /“Mtondo”	Indigenous	Clubs
<i>Brachystegia longifolia</i>	Mombo/ Bovu	Indigenous	Clubs
<i>Brachystegia allenii</i>	Msenga	Indigenous	Clubs
-	Kanung’unung’u	Indigenous	Clubs
<i>Brachystegia bussei</i>	Mseza	Indigenous	Clubs
<i>Faidherbia albida</i>	Nsangu	Indigenous	Clubs
<i>Brachystegia utilis</i>	Mkuti	Indigenous	Clubs

Source: Researcher

Results from the study revealed that both exotic and indigenous tree species are used for the curing process of FCV Tobacco. *Eucalyptus globulus*, *Eucalyptus tereticornis*, *Eucalyptus maidenii*, *Pinus patula* and *Gmelina arborea* were the exotic species that

were being used, mainly by estates, whilst majority of smallholder /scale farmers were mostly opting for indigenous species such as *Pericopsis angolensis*, *Acacia polyacantha*, *Brachystegia bussei* and *Cordyla africana* among them as listed in Table 1 above. However, it was noted that not all wood used came from Kasungu, some growers sourced firewood from as far as Chikangawa Forest in Mzimba District and also Dzalanyama Forest.

4.1.2 Frequency of use of indigenous and exotic tree species

Indigenous species were the highly used trees in as far as the curing FCV Tobacco is concerned. The popular species were *Cordyla Africana*, *Acacia polyacantha*, *Brachystegia bussei*, *Pericopsis angolensis* and *Brachystegia longifolia*. Figure 12 depicts the indigenous species that were reported to be used in curing tobacco with their frequencies.

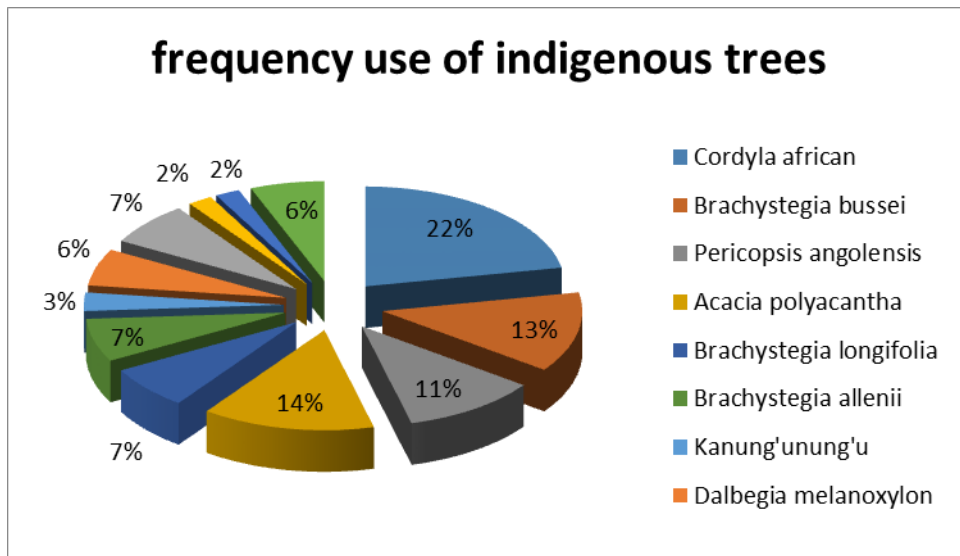


Figure 12: Pie chart on frequency of use of indigenous trees for both estates and clubs

Use of indigenous species was more prevalent among smallholder farmers whereas estates mainly used exotic tree species. Among exotic trees, *Eucalyptus* species such as *Eucalyptus tereticornis*, *Eucalyptus maidenii* and *Eucalyptus globulus* were mostly used species in curing flue cured tobacco (77%), seconded by *Pinus patula* (16%) and *Gmelina arborea* (7%) (Figure13).

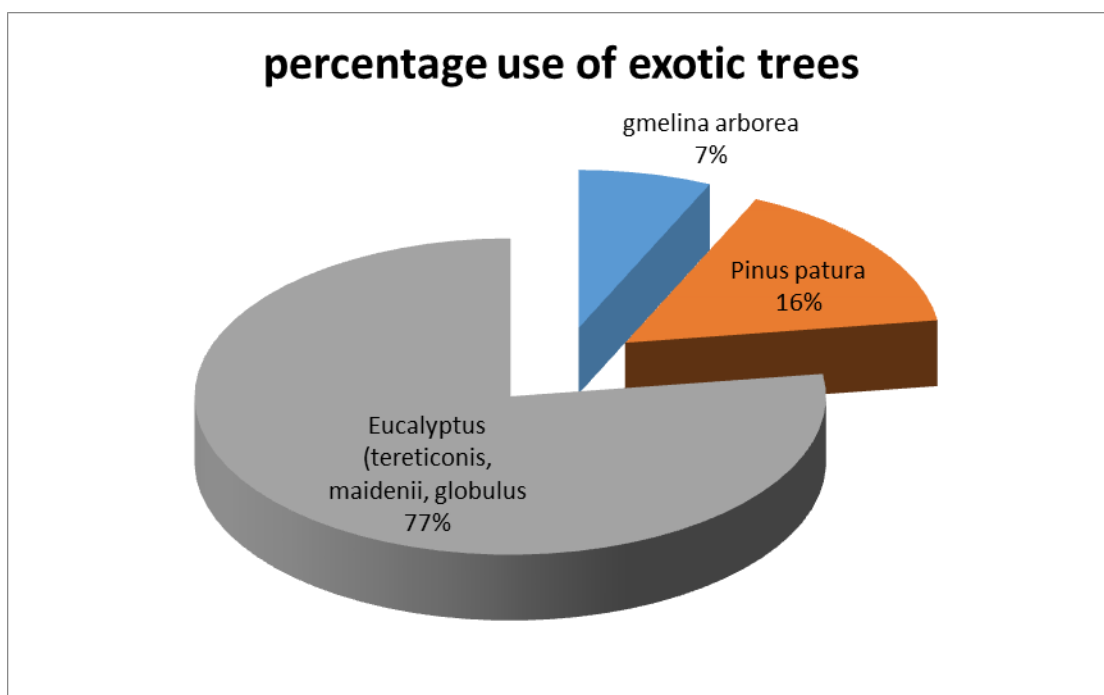


Figure 13: Pie chart on frequency use of exotic trees for both estates and clubs

4.1.3 Frequency of use of species by estates and clubs

Results indicate that out of a total of 32 FCV estates, 47% were using exotic species mainly Eucalyptus in curing their crop, 31% were using the indigenous trees, whilst 22% were combining both types of trees species (Table 2). The pattern of tree use was different among farmer clubs where 53 % were using indigenous species, 25 % were using exotic species, mainly blue gum whilst the remaining 22% were combining both exotic and indigenous trees. In comparison, estates were using more of exotic species than clubs while clubs were using more of indigenous trees. Overall, 42 % of the total growers used indigenous tree species, 36 % were using exotic species while 22 % were combining both indigenous and exotic species.

Table 2: Frequency of use of tree species by estates and clubs

TREE SPECIES USED	ESTATES	CLUBS	TOTAL	PERCENTAGE
Indigenous	10	17	27	42
Exotic	15	8	23	36
Both (Exotic & indigenous)	7	7	14	22
Total	32	32	64	100

Comparison between indigenous and exotic species, it was established that indigenous tree species were high in use, 54 % of FCV Tobacco growers are using indigenous tree species while the 46 % are using exotic trees. Study findings showed over half of the FCV Tobacco growers are still procuring their curing wood.

Several reasons were cited as to why FCV growers preferred particular species of trees in curing their tobacco. *Eucalyptus* species for instance, were preferred due to the fact that barn temperature could easily be adjusted, unlike when using indigenous trees, *Eucalyptus* could also burn when wet. Furthermore, logs of most *Eucalyptus* species are mostly straight in shape which makes them easily fit into a furnace, availability was also attributed as to preference, there are more *Eucalyptus* plantations in Kasungu making it easy for users to access.

Responses from the farmers indicated that Indigenous tree species were preferred due to their efficiency. It was indicated that Indigenous trees are persistence when burning, when put into a furnace, they take time to last when compared to exotic species. Secondly, indigenous species were reported to be cheap, a chord of indigenous species of trees was costing Mk1, 500.00 as compared to that of eucalyptus at Mk 2,500.00.

Farmers who were using more than one type of species in curing their tobacco had their own explanations: to supplement shortfalls, they could not see the difference among species hence combining while others attributed this to the availability of a particular trees type, hence they had no choice but to use the wood that was accessible at that particular time.

4.2 Quantities of wood used to cure tobacco in different barns

During the study, FCV Tobacco growers expressed quantities of wood used in terms of chord, a normal chord of wood refers to a gross stack of wood that measures 1meter by 1.5meters by 2.4meters which equal to ± 3.6 cubic meters (Figure 14). Measurement of a chord embraces the whole stack of wood including space in between the logs.



Figure 14: Picture showing a chord, as stalked at an estate ready for use

Results from the study showed that on average, the Convention Barn used 13.6 cubic meters of wood to produce one ton of FCV Tobacco (0.014 cubic meters per kilogram). Chongoloro/ Cascade Barn was found to be consuming 8.8 cubic meters of wood per ton of a cured leaf (0.009 cubic meters of wood per one kilogram). Among estates and smallholder farmers visited, only Mwimba Research Estate and Estate 88 were found using Chongoloro Barns. Rocket Barns was consuming an average of 14.8 cubic meters of wood to produce a ton of cured FCV Tobacco (0.015 cubic meters per kilogram). This is contrary to the claims by Mr. Scott, who in his findings indicated that Rocket Barn was using half amount of wood as compared to convention barn to cure equal amount tobacco. Tunnel Barns on average were consuming 5.5cubic meters of wood to produce one ton of cured leaf (0.006 cubic meters per kilogram) (Figure 15). Among the sample,

only two estates Lisandwa 1 and Chamwavi were using Tunnel Barn, representing 3 percent of sampled growers visited.

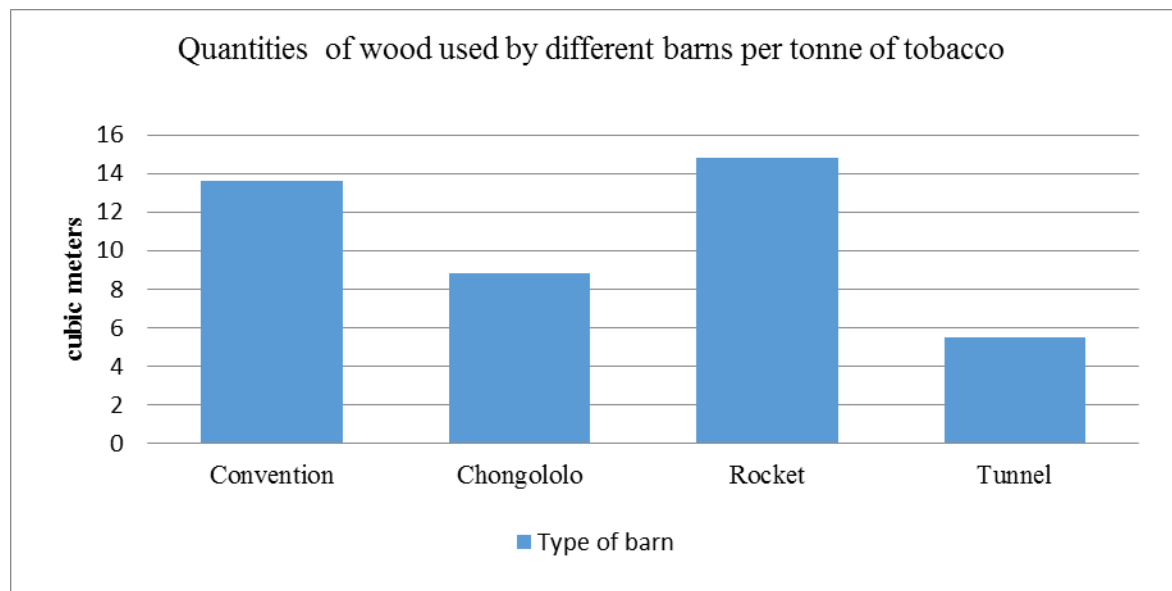


Figure 15: Average quantities of wood used by different barns to cure a ton of tobacco

Result for Convention, Cascade and Tunnel Barn are not far from the expectations. However, results from Rocket barn contradicts earlier reports that use of the Rocket Barn led to savings in the amount of wood used in curing tobacco (Scott, 2008). In the study, Rocket Barns were found to be consuming highest amount of wood than any other barn studied. Earlier claims by Mr. Scott could be lacking credibility since they came from the scholar who brought the Rocket Barn concept into the country hence there could be an element of biasness. Further consultation with Key Informers from ARET a leading institution in tobacco research and extension has also shown that Rocket barns consume higher volumes of wood than it was earlier claimed.

4.2.1 Frequency of barn type use

Among the visited estates, 82% were using Convention type of barn, 9% Chongoloro Barn, 3% Rocket Barns and 6% Tunnel Barns as indicated in table 3. Clubs on the other hand were found to be using only two types of barns, with 69% using Convention type

and the remaining 31% using Rocket (Table 3). In total, 75.5 % were using Convention Barn, 17% Rocket Barn, 4.5% Chongoloro and only 3% Tunnel barn. This consequently means that more wood is being used because of the frequency and type of barn in use. The commonly used Convention barn uses twice the amount of wood than the tunnel barn. This would imply that if all FCV Tobacco growers using Convention Barns were to use Tunnel Barns, they would probably reduce tobacco related deforestation by over half assuming other factors stay constant.

Table 3: Frequency of barn type use

TYPE OF BARN	PERCENTAGE USE		
	ESTATES	CLUBS	AVERAGE
Convention	82	69	75.5
Chongoloro	9	0	4.5
Rocket	3	31	17
Tunnel	6	0	3

Chongoloro and Tunnel Barn were exclusive to estates as they are costly to construct even though they are economic in their wood usage. Some estates operate on a small scale, hence still opt for Convention type of barn. In such cases the cost is passed over to environment, as farmers prefer using cheap but high wood consuming barns to costly but low wood consuming barns.

4.2.2 Comparison between estates and clubs on wood quantities

On average, clubs consumed 15.54 cubic meters of wood to cure one ton of flue-cured tobacco as compared to estates that consumed an average of 12.20 cubic meters of wood to cure one ton of leaf. The study found weighted mean to be 13.87 cubic meters of wood per curing one ton FCV tobacco. Wilcoxon nonparametric test (for two related samples) was used to compare means for estates and clubs, at 95 percent confidence interval, P-value 0.007, rejecting the null hypothesis that the means between estates and clubs are significantly different. This therefore entails that the two means for estates and clubs were not significantly difference at 5 % significant level. This is really valid as the total

average may have been skewed by some few estates that used economic barns (refer to table 6: frequency on barn use). Figure 17 below shows quantities of wood used by Estates in comparison to smallholder Clubs.

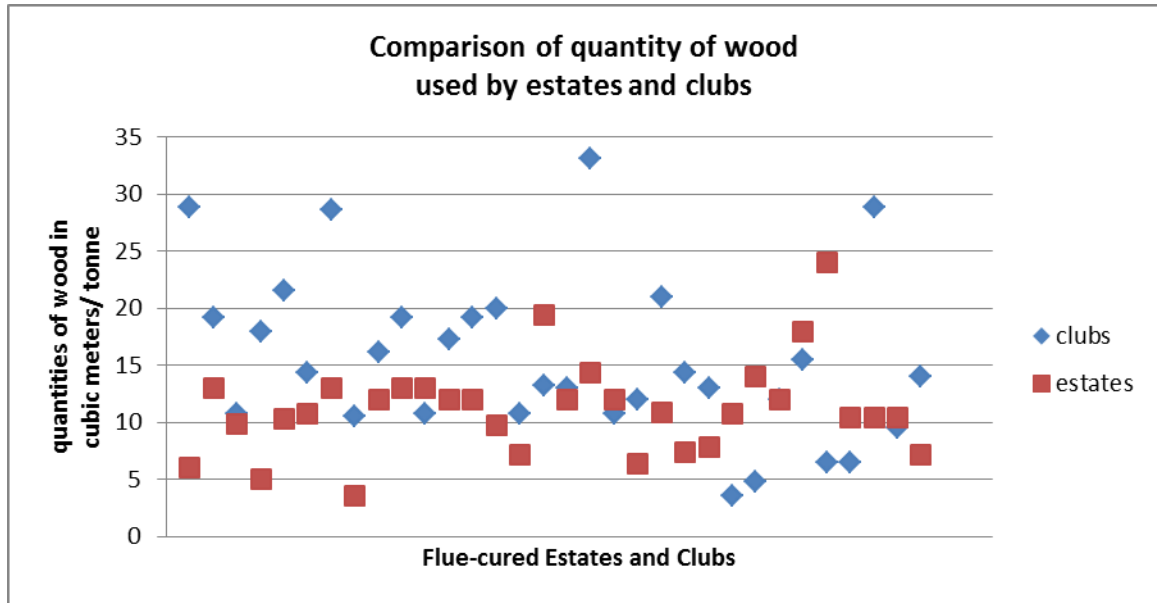


Figure 17: Average quantities of wood used by estates and clubs

Graph for Clubs shows higher average quantities of wood used as compared to Estates. This is the case because most Estates other than being adept in using wood, they are using economic barns like Tunnel and Chongoloro. Unlike smallholder farmers, majority of Estates also do have a well-planned schedule pertaining to the quantities of wood they use annually.

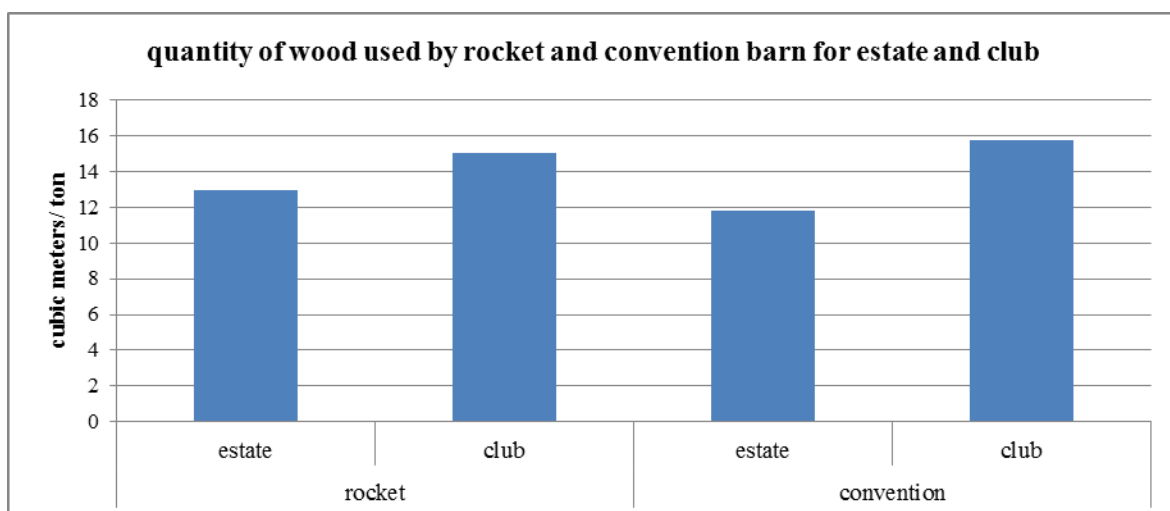


Figure 18: Comparison of wood usage by estates and clubs for rocket and convention barns.

During the study, it was found that only two type of barns were common to both estates and clubs. Figure 18 above, illustrates the average quantities of wood used by both estates and clubs for Rocket and Convention Barn for curing on ton of FCV Tobacco. Results are showing that in both type of barns, estates had lower average volumes of wood to cure a ton of FCV Tobacco as compared to clubs. The above results could be attributed to the experience that estates have in curing tobacco.

4.3 Other factors affecting quantities of wood used

4.3.1 Tree species

Results obtained from our measurements, showed no much difference in the quantities of wood usage when compared among different species. As already reported, both indigenous and exotic trees were found to be in use, some growers were using a combination of both indigenous and exotic species.

Table 4: Tree species and quantities of wood used in curing flue-cured tobacco

Tree type	Tree species	Quantity of wood used (SFC)	Percentage
Exotic	<i>Eucalyptus</i>	14.07	22
	<i>Pinus patula</i>	12.66	3
	<i>Gmelina arborea</i> (with <i>eucalyptus</i>)	6	1
Indigenous		14.37	48
Exotic and Indigenous		13.44	26

Results from Table 4 above to a larger extent could have been influence by corresponding type of barns than the actual species, this is so because on both exotic and indigenous type of trees all type of barns were involved, this factor might have led to overshadowing the influence of tree types to consequently conclude that the type of barn has had much influence than any other factor.

4.3.2 Number of workers

Number of workers per club or estate varied much periodically, depending on an activity and quantity of work taking place at a particular time. However, the study managed to come up with average estimates for each particular estate and club. In the end, results showed negative relationship between number of workers and quantity of wood used to cure specific quantity of tobacco (figure 19). Pearson Correlation found P value to be - 0.42, rejecting the null hypothesis that there was no relationship between number of workers and quantity of wood used to cure specific quantity of tobacco. The explanation could be that estates that had a high average number of workers per period time and were also adept in wood usage hence efficient contrary to clubs that had a few number workers and varied much in wood usage.

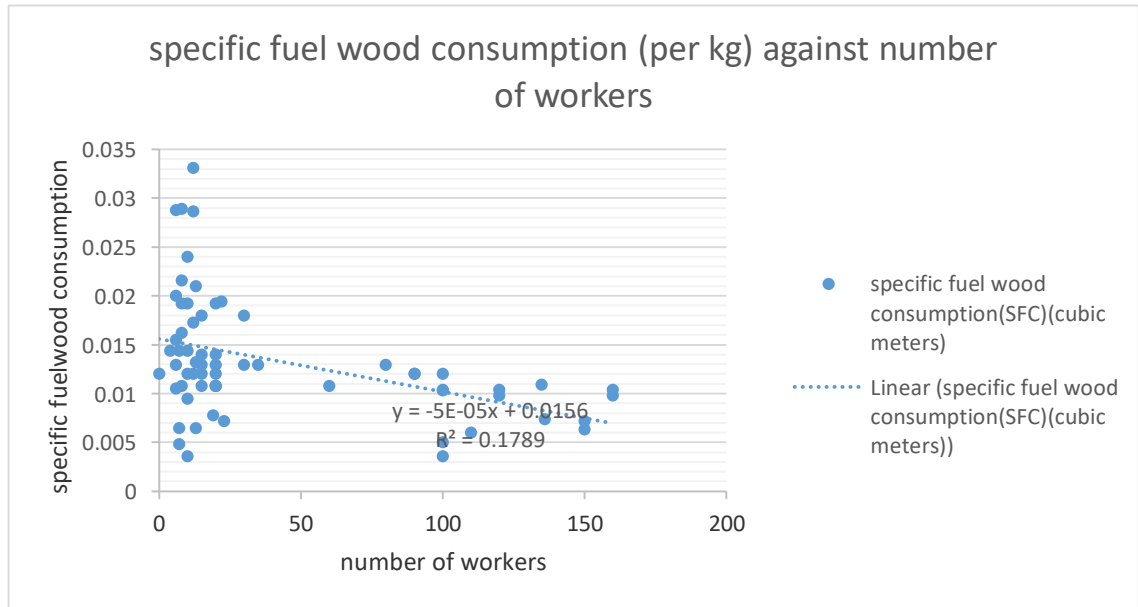


Figure 19: Comparison between number of workers and quantity of wood consumed.

Pearson correlation test was also run to assess the level of relationship between number of workers per farm against estimated volume of FCV tobacco to be produced. The correlation found P value to be 0.68 meaning there was a very strong relationship between number of workers and volume of tobacco produced. This therefore rejected the null hypothesis that there was no relationship between number of workers and quantity of tobacco produced.

4.3.3 Barn size

The study did not necessarily measure the actual size of barns, instead it came up with number of sticks that were being put into the barn. Using the Pearson correlation, the study found coefficient value to be -0.15 meaning there was a negative relationship between number of sticks entered and Specific Fuelwood Consumption (SFC).

4.4 Mitigation Measures in addressing Deforestation

In this study, mitigation measures refer to the actions undertaken by FCV Tobacco growers in order to lessen or alleviate the problem of deforestation, arising from tobacco curing. Out of all FCV Tobacco clubs and estates visited, 64% planted trees as a

mitigation measure to deforestation, while the remaining 36 % did not, 40 percent of all that planted admitted that monitoring has been a challenge.

In terms of hectarage, 42 % of the total tobacco hectarage (grown by FCV Tobacco) was planted with trees (figure 20). This is far much better than the stipulated 10 percent (GoM, 2004). Clubs alone had afforested 49 % of their total tobacco area while estates planted 42 % of their total hectarage. Despite the significance hectarage devoted to afforestation, the growers were still outsourcing wood since most of their plantations were still at a tender stage. It was again pointed out that it was cheaper for clubs and estates to buy wood. Others were of the opinion that, it was hard to wait for a tree in their plantations to grow to its full size, hence buying was the alternative. Almost all the smallholder farmers were buying their wood from areas like Chikangawa, Mpasadzi, Lunyangwa, Manyani and also Dzalanyama. This is in line with what Ng'ongola, (1993) reported, that despite a legal requirement, to set aside 10 % of estate land for tree planting, most clubs/estates ignore it and rather opt to procure firewood from government plantations, because it is a cheaper alternative. Estates on the contrary were utilizing their tree plantations though some have increased their tobacco growing hectarage than they have done with their plantations.

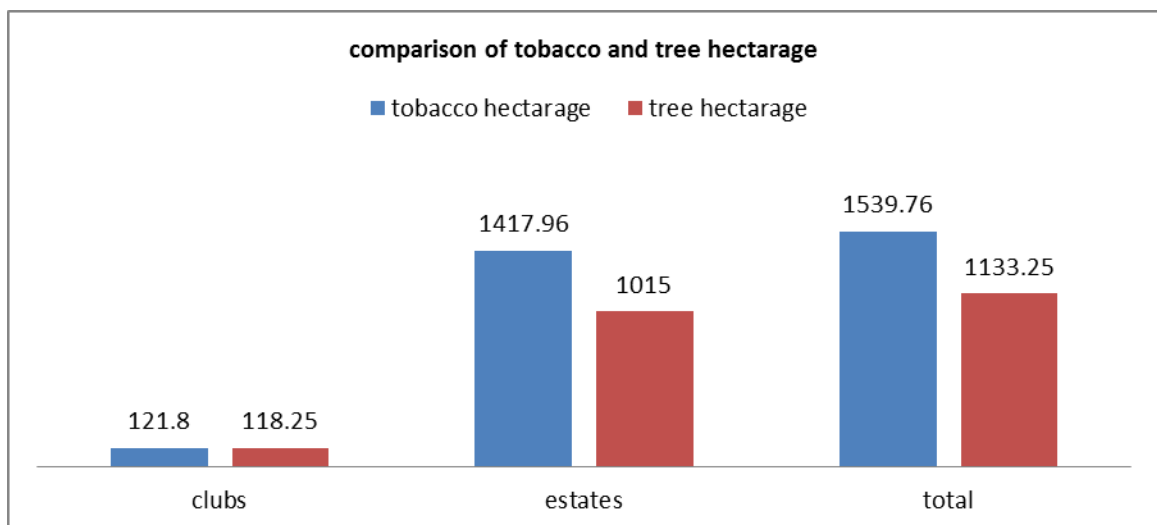


Figure 20: Comparison of tobacco and tree hectarage between Estates and clubs

In terms of replacing barns as a mitigation measure, none of the FCV Tobacco growers opted nor had immediate intentions to switch to alternative wood saving barn as a mitigation measure as per recommended by the National Forest Policy (NFP). All admitted that it was expensive to switch to an alternative barn than to consequently pass over the cost to deforestation whose impact could not be instantly felt.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

The study found that both indigenous and exotic trees are used in the curing process of FCV Tobacco. Clubs prefer using indigenous type of trees because it is economic while estates prefer using exotic species because they do not compromise on quality of the tobacco as they are well manageable, in terms of temperature adjustments. In general, there are no specific species preferred, FCV growers are mainly interested in the heat produced rather than the type of wood.

It was also found that different types of barns consume different quantities of wood to cure equal amount of tobacco. Rocket Barns are not as efficient as they are claimed, findings showed they use highest volume of wood. Type of barn has much influence on quantity of wood used than other factors considered in the study. Tunnel and Chongoloro Barns are exclusive to estates, due to the cost associated with them.

Most FCV tobacco growers, especially smallholder clubs do not fully adopt mitigation measures to address the problem of deforestation. Both estates and clubs devote ten percent or more of their total land area under forest plantations as stipulated in the Land act, however they still procure their curing wood from other areas.

The tobacco regulatory body in the country, TCC deducts forestry levy from growers proceeds for the rehabilitation of the environment, so that it assists in afforestation programs as stipulated in the National Forest Policy (NFP), however the money is not put into its proper use. The national tobacco industry forest model is still in the formulation stages forcing only farmers that are contracted to buyers adhere to their respective buyer models.

Government should find means of increasing the cost of wood sold to FCV tobacco growers for curing purposes, so that part of proceeds collected should be ploughed back to afforestation programs as stipulated in section 2.3.12.4 of the NFP.

Tobacco industry stakeholders should take an initiative in sensitizing small sector FCV growers on the importance of using the barns that are economic in their wood consumption capacity as a mandatory by the NFP section 2.3.11.

TCC, as a tobacco regulatory body should ensure that forestry levy deducted from FCV tobacco growers is put into appropriate use i.e. developing and promoting the use of wood saving barns so as to reduce the amount of deforestation.

The study findings shall be presented to the TCC as a tobacco regulatory body and Agricultural Research and Extension Trust (ARET) as a leading tobacco research and extension institution in the country so that recommendations are mainstreamed in the tobacco publications i.e. Forest Model, the Tobacco Act, Tobacco Industry Strategic Plan and other tobacco agronomy publications. This will consequently assist policy makers in coming up with well informed decisions regarding to coming up with policies that will comprehensively address the tobacco curing deforestation. Furthermore, the study shall also give an insight not only to tobacco farmers and service providers but also to tobacco merchants who are currently facing pressure from their customers to achieve a higher level of compliance, thus addressing the threat to environment through afforestation.

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APPENDICES

Appendix 1: LIST OF ESTATES AND QUANTITIES OF WOOD (CUBIC METERS) USED PER CURING ONE TONNE OF FLUE-CURED TOBACCO

	NAME OF ESTATE	QUANTITY OF WOOD IN CUBIC METERS USED PER ONE TONNE OF CURED LEAF
1	CHAMWAVI 1	6
2	CHILANGA	12.96
3	ESTATE 35	9.82
4	LISANDWA 1	5
5	LISANDWA 2	10.3
6	ESTATE 15	10.8
7	CHIMBUNDE	12.96
8	CHAMWAVI 2	3.6
9	ESTATE 14	12
10	MWATITHA	12.96
11	KADWA	12.96
12	MWIMBA RESEARCH	12
13	MWIMBA RESEARCH CONVENTION	12
14	ESTATE 43	9.8
15	ESTATE 29	7.2
16	DESIDERATA	19.44
17	MIKUYU	12
18	KUKADAKUMACHA	14.4
19	BWANTHI	12
20	ESTATE 47	6.35

21	ESTATE 88	10.9
22	ESTATE 33	7.4
23	YANKHO	7.8
24	MTAPOWADOTHI	10.8
25	KAZIPUTA	14
26	MTUWA	12
27	TITAUKE	18
28	MATAWALE	24
29	KAWERAWERA	10.4
30	CHIMWEMWE	10.4
31	ESTATE 40	10.4
32	MADONDOLO	7.2
	AVERAGE	12.20
	MAXIMUM	19.4
	MINIMUM	3.6
	RANGE	15.8
	STANDARD DEVIATION	5.84

**Appendix 2: LIST OF CLUBS AND QUANTITIES OF WOOD (CUBIC METERS)
USED PER CURING ONE TONNE OF FLUE-CURED TOBACCO**

	NAME OF CLUB	QUANTITY OF WOOD IN CUBIC METERS USED PER ONE TONNE OF CURED LEAF
1	CHITSIME	28.8
2	DZIWAZAKO	19.2
3	KULIMA	10.8
4	MDYELAMO	18
5	TAKOMANA	21.6
6	ELIA GOMANI	14.4
7	MCHEU	28.66
8	MALEPERA	10.5
9	TAKOMANA	16.2
10	KAKONKAKO	19.2
11	SANKHANI	10.8
12	TCHESA	17.28
13	TOKHA	19.2
14	MWAZISIYA	20
15	CHITUKUKO	10.8
16	MPHAPA	13.2
17	CHILIPANZAKO	12.96
18	KANJOKA	33.12
19	KADAMSANA	10.8
20	MNENENJI	12
21	MJEDAMBUTO	21
22	CHIDZENJE	14.4

23	MSAUKA	12.96
24	MKHWELA	3.6
25	FUKAFUKA	4.8
26	CHALENDEWERA	12
27	MCHOMBO	15.52
28	NANGANTANI	6.48
29	KAKWELA	6.48
30	TABWERA	28.9
31	TAWINA	9.5
32	CHANDUWA	14
	AVERAGE	15.54
	MAXIMUM	33.12
	MINIMUM	3.6
	RANGE	29.52
	STANDARD DEVIATION	7.17

Appendix : QUESTIONNAIRE

DETERMINATION OF TREE SPECIES AND QUANTITY OF WOOD USED FOR CURING FLUE-CURED TOBACCO

(Case study of Kasungu estates)

This study attempts to establish the most preferred and mostly used tree types and their quantities of wood used as fuel based on proportion of farmers using different types of barn for the process of curing flue-cured tobacco. The study shall also attempt to establish mitigation measures that are being taken to address the situation, so that in the end it should recommend for appropriate a forestation programs with respect species choice.

DATE

NUMBER

INTERVIEWER

A. ESTATE DETAILS

1. Name of estate.....
2. Location.....
3. Hectarage.....
4. Number of workers.....

B. BARN SPECIFICATIONS

5. Type of barn
6. Size of barn

7. Number of sticks accommodated.....
8. Type of energy used: Electricity..... Coal..... Wood.....
9. Type of furnace.....
10. Number of furnaces.....

C. TREE SPECIES USED

Tree species used

Percentages

Blue gum....

Indigenous wood.....

Other types.....

Unknown.....

11. Mostly preferred.....
12. Reason.....
13. Where do you source the wood.....?
14. How much do you buy (per chord/any quantities)
15. Size of barn
16. Number of sticks
accommodated.....
17. Type of energy used: Electricity.... Coal..... Wood.....
18. Type of furnace.....
19. Number of furnaces.....

C. TREE SPECIES USED

Tree species used

Percentages

Blue gum....

Indigenous wood...

Other types....

Unknown...

- 20. Mostly preferred.....
- 21. Reason.....
- 22. Where do you source the wood.....?
- 23. How much do you buy (per chord/any quantities)