IMPACT OF TOBACCO GROWING AND CURING ON INDIGENOUS WOODY VEGETATION: THE CASE OF CHOMA DISTRICT, ZAMBIA.

BY

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DECLARATION

I, Mirriam Beene Chonya, declare that this dissertation represents my own work. It has not previously been submitted for a degree at this or any other university. All published work or material from other sources incorporated in the dissertation has been specifically acknowledged and adequate reference thereby given.

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DATE : 19th April, 2001

APPROVAL

THIS DISSERTATION BY MIRRIAM BEENE CHONYA **IS APPROVED AS FULFILLING THE REQUIREMENT FOR THE AWARD OF THE DEGREE OF MASTER OF** SCIENCE, GEOGRAPHY **BY UNIVERSITY OF ZAMBIA.**

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DEDICATION

To my deceased parents and sister Harriet, whose inspiration still compels me to go on.

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ABSTRACT

Deforestation in Zambia is a source of concern to various stakeholders. Agriculture, which includes tobacco growing and its curing, is cited as a major factor, among others, contributing to woodland clearance. Tobacco production is associated with deforestation because it requires large quantities of fuelwood in the curing process without any legal requirement for the growers to replace the woody vegetation that is consumed.

The study therefore, was an assessment of the impact of tobacco growing and curing on indigenous woody vegetation in Choma district, Zambia. The impact was ascertained by examining the size of tobacco fields and the quantities of wood used in the curing process.

Quantitative and qualitative types of data were used in the study. These were obtained from questionnaires, unstructured interviews and field surveys. Woodland clearance was determined using black and white panchromatic aerial photographs for 1960, 1980 and 1990. District tobacco production figures were used to approximate woodland clearance which was directly as a result of tobacco production.

Data was analysed to establish the relationship between the quantity of cured tobacco and the amount of land cleared annually. The study revealed that the growing of flue-cured virginia tobacco contributes to deforestation in the area by more than fifty percent. At this rate, tobacco production poses a serious environmental problem. The study, therefore, suggests the introduction of central curing facilities and well-planned reforestation programmes where there will be full community involvement as well as collaboration among other stakeholders in trying to avert further woodland loss.

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AGRIPLAN	- Agricultural Planning
CIDA	- Canadian International Development Agency
CSO	- Central Statistical Office
ECZ	- Environmental Council of Zambia
eds	- Editors
EIU	- Economic Intelligence Unit
FAO	- Food and Agricultural Organisation
GRZ	- Government of the Republic of Zambia
GTZ	- Germany Technical aid to Zambia
Ha	- Hectares
ICRAF	- International Centre for Research in Agroforestry
IFRI	- International Forestry Resources and Institutions
IFSC	- International Forest Sciences Consultancy
ITGA	- International Tobacco Growers Association
ITTO	- International Tropical Timber Organisation
IUCN	- International Union for the Conservation of Nature
K	- Kwacha
Kgs	- Kilogrammes
Ltd	- Limited
M	- Metres
MAB	- Man And the Biosphere
MAWD	- Ministry of Agriculture and Water Development
MENR	- Ministry of Environment and Natural Resources
NECZAM	- National Education Company of Zambia
NORAD	- Norwegian Agency for Development
PFAP	- Provincial Forestry Action Programme
SADC	- Southern Africa Development Community
SARDC	- Southern African Research and Documentation Centre

SCAFE	- Soil Conservation and Agroforestry Extension
SFC	- Specific Fuel Consumption
TAZ	- Tobacco Association of Zambia
TBZ	- Tobacco Board of Zambia
WHO	- World Health Organisation
US	- United States
USAID	- United States Agency for International Development
UNDP	- United Nations Development Programme
UNZA	- University of Zambia
ZACCI	- Zambia Association of Chambers of Commerce and Industry
ZGA	- Zambia Geographical Association

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Chipungu and Kunda (1994) state that the extent of coverage of vegetation in Zambia is on the decline and agricultural practices have been cited as a major contributing factor to deforestation together with the exploitation of woodland and forestland for woodfuel. Among the farming activities, tobacco growing and its curing have been observed to contribute greatly to this scenario. Chenje and Johnson (1994) observe that in Malawi, Mozambique, Tanzania and Zimbabwe where tobacco was grown significantly on both subsistence and commercial farms, there was an estimated loss of about 1400km^2 of indigenous woodland annually, in the entire region. Zambia is a tobacco-producing nation and experiences similar woodland losses. The study, therefore, was an attempt to determine deforestation that results from tobacco production in Choma district, the main producer of the flue-cured virginia tobacco in Zambia. Temu (1981) suggests that the quantity of fuelwood used in the curing of tobacco is so large that it should be regarded as industrial usage and should, therefore, be given consideration in tobacco production plans. In other words, the extent of wood usage in this regard requires more attention owing to the volumes of fuelwood involved.

1.2 Statement of the problem

Tobacco production consumes large quantities of fuelwood in the curing process although there is no legal requirement for tobacco producers to replace the woody vegetation that is consumed by equivalent amounts of newly planted trees (Cheatle and Cheatle, 1979). This, therefore, means that these areas are deforested, leading to huge losses of valuable woodland. The gravity of the problem of woodland loss due to tobacco growing and curing revealed in other areas is anticipated (or expected) in Choma if measures are not put in place to mitigate these losses. Fraser (1986) also asserts that the area of all types of woodland in most African and Asian countries is now below the level at which it is capable of meeting current and future fuelwood on a sustainable basis. This means that accelerating deforestation can be expected with potentially serious ecological effects.

1.3 Purpose of the study

The aim of the study was to assess the impact of tobacco growing and curing on woody vegetation in selected parts of Choma district in the Southern Province of Zambia. To achieve this aim, the study focussed on the following objectives;

(i) To identify the size of tobacco holdings in the area.

(ii) To determine the different methods of curing tobacco.

(iii) To determine the quantity of wood required in the different methods of curing tobacco.

(iv) To determine the extent of deforestation resulting from tobacco growing and curing.

In this regard, the study attempted to answer the following research questions;

(i) Is there any relationship between the quantity of tobacco produced and cured and the amount of land cleared for tobacco cultivation?

(ii) Is tobacco growing and processing in Choma being carried out on a sustainable basis?

1.4 Significance and relevance of the study

Man and the Biosphere (1997) suggests that quantification and monitoring of deforestation is one area requiring research. The National Conservation Strategy for Zambia also states that there is no reliable measurement of the extent of deforestation and therefore recommends research in such areas so that priority action can be designed and anticipatory measures taken at local level to avert further environmental degradation (GRZ/IUCN, 1985). The study, therefore, provides information that is of practical value to policy makers and planners in development plans.

Furthermore, the study was worth undertaking because it comes when there is need to re-emphasise the sustainable use of natural resources in the wake of declining supply and increasing demand for the natural resources. The study will also add to the increased awareness of deforestation and be used as a reference on deforestation in general and particularly to that emanating from tobacco growing and curing.

1.5 Operational definitions

Deforestation - This refers to the permanent removal or change of forest with depletion of tree crown cover to less than ten percent.

Woody plant biomass -This is the above ground wood of a plant expressed as oven dry or green mass in tonnes per hectare.

Cord - This is a measure of a stacked volume of wood. One cord is equivalent to $3m^3$ (3m x 1m x 1m).

Specific Fuel Consumption - This is the standard way of expressing the number of kilogrammes of wood required to cure one kilogramme of tobacco.

Landcover – refers to the landuse pattern in an area. This study considers only two landcover classes; cleared and wooded areas.

Fuelwood – This is wood harvested for use as firewood, in this case for curing tobacco.

Woodfuel – This is an aggregate term incorporating firewood and charcoal.

Reforestation – The establishment of a tree crop on forestland.

Side- marketing – This is a practice where farmers avoid deductions for inputs obtained on credit by selling their produce to buyers other than those who supplied them with inputs.

1.6 Organisation of the dissertation

This dissertation comprises six chapters. Chapter one is the introduction to the study. Chapter two reviews the relevant literature on deforestation in general and particularly that resulting from tobacco production. The third chapter presents a description of the study area and the factors that influenced its selection. Chapter four describes the methodology used in the study. Research results and discussion of the findings are presented in the fifth chapter. The sixth chapter provides a conclusion to the study and makes recommendations arising from the findings. An area which would be of interest for further research is spelt out at the end of the chapter.

CHAPTER TWO

LITERATURE REVIEW

In this chapter, deforestation in general is discussed and some of its causes and effects are outlined. The chapter further considers tobacco-related deforestation and gives an overview of tobacco production in Zambia.

2.1 Deforestation : an overview

Deforestation is among the world's pressing problems today. The rate at which forests are being cleared locally, regionally and globally has raised concern among various sectors of society concerned with the environment. The State of the World's Forest Reports (FAO, 1997 and 1999) state that between 1980 and 1995, the extent of the world's forests decreased by some 180 million hectares, which represents an annual loss of 12 million hectares. Myers and Norman (1989) cite higher rates of forest depletion of up to 31.5 million hectares of forest being claimed per year. This translates into a loss of about 60 hectares of forest per minute. The ITTO report brings out an even gloomier picture with its estimates of forest depletion at the rate of 200 hectares per minute! (Times of Zambia, 2000). Barney (1980) projected that by the year 2000, the world forest area will have shrunk to 2.1 or 2.2 billion hectares.

In Zambia, Chipungu and Kunda (1994) state that about 200,000 hectares of land is being cleared of vegetation every year through various activities. Among these is arable agriculture which accounts for a large portion of woodland losses and more so under the chitemene system, a type of shifting cultivation where an estimated 9000km^2 of woodland is lost annually (Chidumayo, 1979). Chibbamulilo and Phiri (2000) report that more than 50% of the farmers in Zambia clear all the fields (leaving no shrubs of trees) as they prepare their land for agricultural operations. Shifting cultivation poses even a greater threat to vegetation as it involves the cutting of trees from time to time so that the burnt ash is used to fertilize the fields. This system of agriculture which was described as a "rotation of fields" rather than a rotation of crops (Mulenga, 1982) is said to be responsible for about 70% of the permanent destruction of forests in Africa (Leach and Mearns, 1988).

Another major cause of deforestation is the exploitation of wood resources for industrial and domestic energy supply. Chenje and Johnson (1994) observed that most urban areas in Southern Africa are surrounded by cleared land, the result of intensive woodcutting to meet urban demand for woodfuel. Reporting on energy use in Zambia, the ZACCI Business Line Bulletin of 2001reveals that in 1999, fuelwood accounted for over 80% of the total energy consumed by the agricultural sector. Coal and electricity, each, only accounted for about 8% of the energy applied in the sector. In Zambia, as in most developing countries, the underlying cause is poverty, which has resulted in uncontrolled exploitation of forest resources for survival, coupled with poor land use policies and weak institutional capacity to ensure good use of these vital resources. According to Chipungu and Kunda (1994) all these factors have been exacerbated by a rapid growing population, which entails added pressure on the resources. Given this scenario, the next section considers tobacco-related deforestation.

2.2 Tobacco production and deforestation

de Montalembert and Clement (1983) observe that in addition to its main role in satisfying domestic energy requirements, woodfuel is also an important fuel for many rural industries; drying tea and tobacco, smoking fish, brick making, lime kilns, smithies, potteries and various village handicrafts. The EIU (1983) in a report ***Tobacco and Food Crops Production in the Third World*** also states that one of the major consequences of tobacco production in the third world results from the considerable energy requirements of the flue-curing and fire-curing processes. Temu and Phillips (1981) note that processing agricultural cash crops such as tobacco has created a heavy drain on rural wood supplies. Geist (1994) also observes that while the annual forest depletion rate for Africa in general had been 0.7% and 0.6% for the countries of the miombo region, the major tobacco producers showed an overall average annual depletion rate of 1.1% (see Appendix II). This was found to be nearly 60% higher than the overall annual depletion rate for Africa. Fraser (1986) states that it is important to note that a high proportion of the tobacco growing areas in the developing countries lie within the parts of the world identified by FAO as being in the wood-deficit or prospective wood-deficit situations. As such, tobacco is a contributing factor in some countries to the problems of deforestation now being encountered. Taylor (1984) notes that in Brazil, which is one of the largest world producers, the 100,000 tobacco farmers need the wood of sixty million trees a year for curing.

In Malawi, the total demand for wood by the tobacco industry in 1986 was estimated to be 23% of the estimated national demand of 9.4million cubic metres. The industry was reported to be responsible for a clearance of about 10 000 hectares of forest per year and significantly contributing to the serious problems of deforestation in Malawi (Geist, 1994). Similarly in Zimbabwe, 70 000 hectares of woodland loss is attributed to tobacco production (Grainger, 1990). Moss and Morgan (1981) found that five hectares of tobacco require one hectare of indigenous standing timber as fuel for flue curing. They also observed that land had been indiscriminately stumped to provide wood for curing one season's tobacco and land for growing the next season's crop so that some estates have expanded rapidly in their search for fuel and fresh land for cultivation.

In Tanzania, Boesen and Mohele (1979) estimate that for every one hectare of tobacco, which yielded an average of 675 kilogrammes of cured tobacco, there was an additional clearing of about 1.35 hectares of woodland to meet woodfuel requirements for curing tobacco. Hammond (1997) also notes that the cutting down of trees to cure tobacco accounts for about 4% of annual deforestation in Tanzania, a figure which does not include the amount of forest that is being cleared for new tobacco farms. Temu (1979) asserts that due to three interrelated problems namely fuelwood scarcity, nematode attack and low soil fertility, tobacco production cannot be sustained without endangering the environment through shifting cultivation and deforestation. Akehurst (1970) notes that for most countries in the south, wood is the obvious source of heat. Therefore, the supplies of indigenous wood can quickly become exhausted with the intensive development of flue-cured tobacco. This is because heat has to be supplied continuously for six days and six nights (Brokensha and Rilley, 1978).

In Zambia, the PFAP (1998) rightly observes that the tobacco and fisheries sectors are some of the consumers of wood. A large percentage of tobacco farmers depend on fuelwood for curing tobacco as is discussed in section 5.2 on page 32. However, presently there seems a dearth of data on the quantity of fuelwood that goes towards tobacco curing and hence the justification for this study.

2.3 Types of tobacco and methods of curing

According to Campbell (1994), there are four main types of tobacco, which are identified by their method of curing. One type of tobacco which is air cured includes burley, cigar and light tobacco. This type of tobacco is cured in ambient air with minimal artificial control of humidity. Another type of tobacco is fire-cured. This is similar to flue-cured tobacco except that heat is supplied by open smouldering fires, usually of fresh wood such as *Gmelina arborea* in mud barns to give the product its characteristic smoked aroma and flavour. Dry wood is used in the later stage of the curing process. Oriental tobacco belongs to the sun-cured type whose strong flavour and taste are developed in the first phase of curing and then retained by drying leaves outside in the sun. The tobacco is cured in tents or tunnel- like structures with special plastic tents to develop the desired aroma. Flue-cured virginia tobacco, named after the US state where the method was first used, is cured using artificial heat radiating from flue pipes as hot air passes through the barn from a furnace, to the outside. The production of flue-cured tobacco is associated with deforestation in areas where wood is the source of energy. The energy requirements are reflected in the stages involved in the flue-curing process.

Flue-curing requires a lot of experience in order for the tobacco to be successfully cured. It is done under strictly controlled temperature regimes to ensure correct chemical and physiological changes in the leaf at the various stages in the curing process. Although there are some variations in the procedures, Collins (1951) identifies three main stages. Firstly, the cells of the leaf must be kept alive so that the chlorophyllase enzyme destroys the chlorophyll and induce the colour to change from green to yellow. This is enabled by the low temperature and high humidity requirement at the time of filling the barn. Thereafter, the temperature is raised to about 32^0 C in three to six hours.

This temperature is maintained until the leaf starts to yellow at the tips and round the edges. This normally occurs in about twenty-four to seventy-two hours depending on the time of the season. When the weather is hot and rain falls frequently, the leaves will change colour more quickly but later in the season when temperatures are low, colouring takes a longer period of time. The temperature is then raised successively until it reaches 46^0 C where a proper yellow colour is achieved. This yellowing stage is followed by the fixing stage which involves the gradual killing of cells by slowly drying them out in order to prevent the loss of the required yellow colour to brown or black. The yellow colour gives the tobacco a high market value.

During the fixing stage, the temperature is raised and maintained at 48^0 C until the edges begin to curl in towards the stem. The temperature is raised further and is maintained until the leaf appears to be dry. This process lasts between fifteen to eighteen hours. The final stage is the drying stage where temperatures are maintained for about four hours at 54^0 C. By this time, the web should be thoroughly dry. Thereafter, the temperatures are raised by 15^0 C at one-hour intervals until a final temperature of 71^0 C is reached and the stems are completely dry and brittle. In all the stages, humidity is ascertained by a wet and dry bulb thermometer. The opening and closing of ventilators helps to maintain the required humidity levels. This prevents incidences of sponging, the discolouration of the leaf from yellow to brown or pale orange which comes as a result of excess moisture in the fixing stage.

At the completion of the curing, the leaf will be dry and brittle, and has to be conditioned to render it sufficiently pliable for handling before it can be removed from the barn otherwise considerable breakage will occur. During the period of damp weather, this can be achieved by leaving the door open and allowing the leaf to absorb moisture from the air. However, Carr (1950) says the usual way is by introducing a low-pressure steam in the barn or allowing it to soften by liberally watering the barn floors. Alternatively, growers can spread hessian sacks on the floor and sprinkle water on them in order to increase the barn humidity. This whole process takes an average of between 5-8 days during which the heat energy requirements are supplied mainly by fuelwood.

2.4 The importance of forests and effects of deforestation

Hardcastle *et al.* (1995) estimate that once clear felled, some woodlands require as much as 50 to 80 years to regain full stocking. Leach and Mearns (1988) also state that consumption of wood resources often exceeds the annual growth rates of trees. This may mean utilising trees before they mature and that woodfuel has to be fetched far beyond the perimeters of the human settlements. The EIU (1983) carries the WHO's argument that increased distances in the search for fuelwood, in addition to the already intense labour that is required in tobacco production might impact more negatively on food production, which should be a priority, especially for developing nations. Temu (1979) also observes that the current trend suggests that the tobacco farmers will be forced out of production through lack of new land and fuelwood.

Furthermore, forests play an important role in various aspects. Socially, forests provide a variety of non-timber products like fruits, bush meat, medicines and shades. Their usual economic benefits include those of provision of timber for the building and construction industry; they are used in chemical industries, for recreation which can promote tourism, industrial energy supply and so forth (Poore, 1989 ; Musokotwane 1979). Curry-Lindahl (1972) rightly points out that in evaluating forest resources, one must count much more than just the timber value. Instead, the total ecological roles of forests must be taken into account. He notes that the wholesale clearing of trees can cause changes in hydrological cycles and water regimes resulting in erosion of river banks, sedimentation in rivers, lakes and seas; adverse flooding, drying up of rivers and streams; decline in water, soil and air quality, collapse or adverse changes of aquatic ecosystems in rivers and marshes as well as the decline in wild terrestrial animals. Micro and macro climatic changes may occur depending on whether deforestation takes place on a small or large extent. Pearce and Jeremy (1993) observe that at a global level, forest degradation causes an accumulation of carbon dioxide in the atmosphere leading to global warming.

According to Beaumont (1979), tobacco growing has been going on in Choma since the 1930's, making it obvious that there has been some amount of deforestation directly as a result of tobacco growing and processing. Therefore, this and other aspects revealed in the literature offer the challenge for the study.

2.5 Tobacco production in Zambia

The land under tobacco cultivation in Choma falls under two main categories, as it is for the rest of the country. The big commercial farmers in the area are on private land under leasehold. Most of the small-scale growers occupy communal land under the control of traditional chiefs except some who have obtained title to the land that was formerly under TBZ.

Tobacco growing in Zambia dates back to the colonial period where production, especially of flue-cured virginia, was in the hands of expatriate large scale commercial farmers (Harvey, 1973). Lombard and Tweedie (1972) say that at the time of Independence, tobacco vied with maize as Zambia's major agricultural commodity having been an important export and also a major employer of farm labour. However, it has been noted that production declined from a marketed 11, 000 metric tonnes in 1964 to 4,700 tonnes in the 1970s. This was due to the departure of most expatriate farmers and other difficulties such as high production costs and price fluctuations.

The Tobacco Board of Zambia was later set up to control processing and marketing, and in 1968 entered the production field. It started several schemes to encourage production and to introduce the crop to indigenous Zambian producers. The aim was to establish units of about one thousand farmers to produce about 450,000 kilogrammes (450 tonnes) of virginia tobacco in a concentrated area, (Lombard and Tweedie, 1972). This aim was linked to other government policies namely; to reduce reliance on copper, to earn more foreign exchange, to lessen dependence on non- Zambian producers and to reduce rural-urban income differences, (GRZ, 1980a).

CHAPTER THREE

DESCRIPTION AND SELECTION OF THE STUDY AREA

This chapter provides a description of the study area, focusing on the physical as well as socio-economic characteristics of the study area. The chapter also considers the factors that influenced the selection of the study area.

3.1 Physical characteristics of the study area

3.1.1 Location and Size

Choma district, with an area of 7, 296 km^2 is centrally located in the Southern Province of Zambia between latitudes 16^0 10′ and 17^0 30′ south and longitudes 26^0 45′ and 27^0 35′ east. It is bordered by five other districts namely Kalomo to the west, Sinazongwe to the south-east, Namwala to the north-west, Monze to the north-east and Gwembe to the east (Figure 3.1). The area is served by the main railway line and the Great North Road from Livingstone to Nakonde.

3.1.2 Relief and Drainage

Choma district lies on the Tonga Plateau, which is part of the Central Africa Plateau. The large part of the area has an altitude ranging between 900 – 1200 metres above sea level, with some areas having a higher elevation. The area is characterised by gently undulating land with a series of low ridges separated by streams especially to the north of the district. The main seasonal streams include Muzuma, Mahumba, Chilala, Ngonga and Semahwa. Other smaller streams such

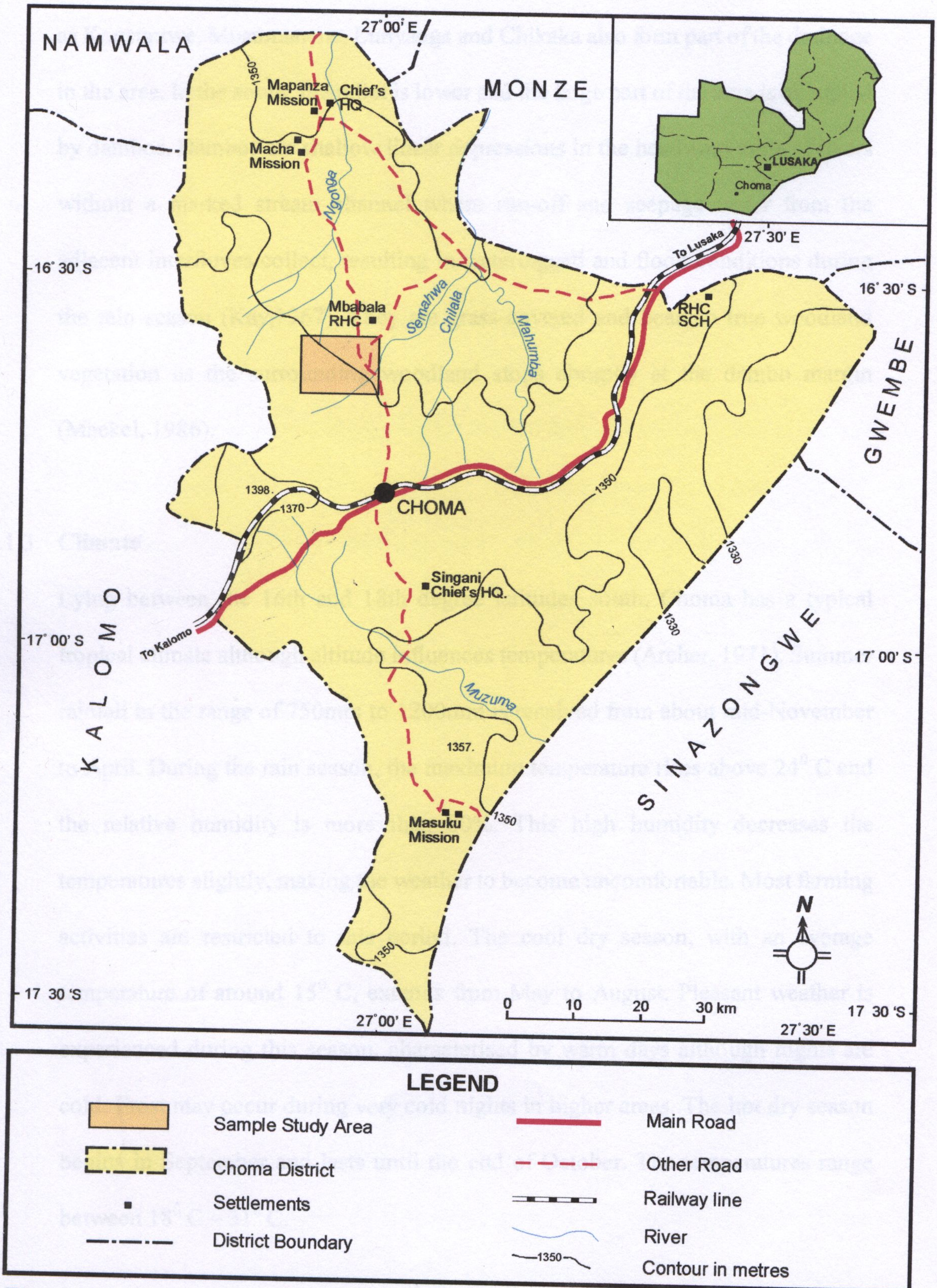


Figure 3.1: Location of the study area.

as Koosuntwe, Musumanene, Lunyanga and Chikaka also form part of the drainage in the area. In the south, the relief is lower and the large part of the area is occupied by dambos. Dambos are shallow linear depressions in the headward zone of rivers without a marked stream channel where run-off and seepage water from the adjacent interfluves collect, resulting in waterlogged and flood conditions during the rain season (Kay,1967). They are grass-covered and bear no true woodland vegetation as the surrounding woodland stops abruptly at the dambo margin (Mackel, 1986).

3.1.3 Climate

Lying between the 16th and 18th degree latitudes south, Choma has a typical tropical climate although altitude influences temperatures (Archer, 1971). Summer rainfall in the range of 750mm to 1200mm is received from about mid-November to April. During the rain season, the maximum temperature rises above 24^0 C and the relative humidity is more than 80%. This high humidity decreases the temperatures slightly, making the weather to become uncomfortable. Most farming activities are restricted to this period. The cool dry season, with an average temperature of around 15^0 C, extends from May to August. Pleasant weather is experienced during this season, characterised by warm days although nights are cold. Frost may occur during very cold nights in higher areas. The hot dry season begins in September and lasts until the end of October. The temperatures range between 18^0 C – 31^0 C.

3.1.4 Vegetation and Soils

The district is characterised by savanna woodland, which is a mixture of various broad umbrella-shaped trees interspersed with tall grass and herbs. Other woodlands, mainly of the deciduous type are found on the plateau. Miombo woodland is the most dominant. Huckabay (1975) observes that the miombo is best developed around the Choma-Kalomo plateau. It is generally open woodland with grass, which occurs all across the plateau (Mackel and Pullan, 1972). Unlike the luxuriant miombo woodland of the high-rainfall belt of the north, the miombo in the southern part of Zambia is described as floristically poor and less luxuriant. The characteristic miombo species present in the district are the *Brachystegia* and *Julbernardia* and these seldom exceed 15 metres in height (Huckabay, 1975).

Fanshawe (1969) describes the miombo as secondary vegetation in a disturbed and dynamic state as it is re-growth after fire, cultivation or exploitation. Other species found in the district include the *Uapaca kirkiana (masuku), Burkana african* (*musesi*), *Periocopsis angolensis* (*mubanga*) and *Parinari bequertii* (*mubula*). Beneath the lower storey of woody plants are found grass species like the *hyparrhenia* especially in the south where dambos are a common feature.

The main soil types found in Choma are *ferrallitic*, varying from sandy loams to loamy sands. According to Veldkamp (1984) Choma has moderately leached reddish to brownish soils derived from acid rocks, which give rise to the characteristic miombo vegetation in the area. Mackel (1971) notes that these soils are suitable for cultivation of a wide range of climatically adapted crops.

3.2 Socio- economic aspects

In 1990, Choma district had a population of 164 387, making it the most densely populated in Southern province with 22.5 persons per square kilometre. Eighty percent of the population in the district was recorded as rural and the sex ratio in 1990 was about 95 from about 93 in 1980 (GRZ, 1990).

Most of the people are engaged in small-scale agricultural activities for their livelihoods except for a few commercial farmers who grow crops on a large scale. The commercial crops grown include maize, tobacco, sunflower and groundnuts. Both commercial and small-scale farmers also keep cattle. In the urban centre, people are largely engaged in the provision of services such as education and banking.

3.3 Factors which influenced the choice of the study area

Tobacco was prominent among export agricultural commodities at independence. According to Lombard and Tweedie (1972) it was Zambia's second most important cash crop and foreign exchange earner after copper. Although its production has now declined, the growing of the crop has a long history in Choma district. This is why the study focuses on this particular area.

Choma encompasses a number of now defunct TBZ tenant schemes. Under these schemes, experienced farm foremen and others with practical experience received five years of training, at the end of which a trainee was given an opportunity to grow eight hectares of virginia tobacco on a portion of land. TBZ provided infrastructure such as grading sheds, equipment, transport and other inputs. They also provided a management service to support production.

Today, production has continued both on large and small-scale farms. According to the existing Tobacco Board of Zambia data, Choma district has been the largest tobacco-producing district, contributing on average about a third of the total national production. In the 1998/99 season, the national production was about 3,900 metric tonnes of tobacco out of which 1,300 tonnes came from Choma district representing, about 34% of the country's total production (TBZ, 1999). This background strongly influenced the choice of this study area.

Other factors included the researcher's familiarity with the study area, which helped reduce the time necessary for reconnaissance work. The researcher's home village is within the study area and so the researcher's ability to speak the major local language (Chitonga) facilitated communication.

CHAPTER FOUR

METHODOLOGY

4.1 Research design

4.1.1 Types and sources of data

The study used a combination of primary and secondary data. Primary data included information on the size of tobacco fields, the quantity of wood used in curing, types of tobacco grown and their methods of curing. This was obtained by;

(i) **Questionnaires**: - The questionnaire (see Appendix I) was administered to 51 respondents after a pilot study of six farmers. The researcher filled in the responses for the questionnaire since some farmers could not read English.

(ii) **Unstructured interviews**:- Interviews were held with officers from the District Forest Office and the extension department of TAZ to determine the efforts that were being made to ensure sustained yields of forest resources and to consolidate information obtained from farmers on tobacco growing and curing.

(iii) **Field surveys**:- These were undertaken to verify the size of tobacco fields for some selected small scale growers. Field measurements were taken using an agricultural chain. This is a chain with a length of thirty meters. The sources of wood were also established during field surveys and dimensions of cords of wood were measured using a measuring tape.

Secondary data obtained mainly from archival sources were in form of aerial photographs, books, articles and reports. Aerial photographs at a scale of 1: 30 000 for 1960, 1980 and 1990 were used to help delineate wooded and cleared areas so that the changes in land cover between the periods could be determined in the sample study area. Reports from the TBZ and its affiliates were also used to determine the trend of tobacco production.

4.1.2 Sampling procedure

The population for the study comprised tobacco farmers in TAZ and Zambia Leaf Tobacco registers, which were used as sampling frames. Individual farmers were the sampling units for the study. At the time of the study in the 1998/99 season, there were 153 registered tobacco farmers who were considered in various strata. Of these 18 were commercial farmers on private land, 87 occupied communal land under traditional chiefs and 48 were farmers on former TBZ tenant schemes.

In order to come up with a proportional sample, a third of each category of farmers was included in the sample, which was initially selected through stratified sampling. The respondents were further selected by random sampling from each stratum. A proportional sample was preferred to ensure equal representation of the different classes of farmers. Probability sampling was used to avoid bias in the result and initial selection of respondents. Thus, a proportional sample of 51 tobacco farmers (see Appendix III) in different categories was captured all around the district. This sample was felt to be adequately representative of the study area both in terms of the number and the sampling sites from which the farmers involved in the study were picked. The time and financial resources available to the researcher could not allow for a larger sample to be involved.

4.1.3 Data analysis

Data were coded and summarised. Descriptive statistics in the form of percentages and means were used to analyse the data. Graphical representations of these data were made where necessary using pie charts, tables and graphs.

Quantitative data was analysed using inferential statistics. Non-parametric tests like the Kruskal Wallis H-test (see Appendix IV) and the Mann- Whitney U-test (see Appendices V, VI and VII) were used to determine the difference in the quantity of wood used per tonne of cured tobacco by the different categories of farmers. Non-parametric tests were used because by using such tests, data can be analysed without necessarily satisfying assumptions of homogeneity of variances or normality about the distribution of a population (Bless and Kathuria, 1993). In this study, Non-parametric tests were more appropriate than parametric tests because tobacco growers, especially those on former TBZ land are clustered and hence their distribution cannot be treated as normal. Moreover, they are easier to apply and can deal with small samples. Non-Parametric tests can also be used on data from a variety of measurement scales.

Pearson's product-moment correlation co-efficient was used to find out if there was any relationship between the quantity of wood used to cure a tonne of tobacco and the number of years one has been in tobacco production (see Appendix VIII). This was done in trying to establish some factors that bring about differences in the quantities of wood used to cure tobacco. The relationship between field size (hectarage) and yield (production) was also established through correlation analysis (see Appendix IX).

The land cover between 1960 and 1990 was determined from a sample study area shown in Figure 3.1. This was a selected portion in the study area where all the categories of tobacco farmers were represented. This helped to approximate the total annual woodland loss, which was useful in determining tobacco-related deforestation.

4.2 Data limitations

a) District tobacco production figures

Production figures were only available for the period after 1990. Production figures before this period, for which aerial photographs are available, would have facilitated a better estimation of deforestation as a result of tobacco production.

b) Non- availability of aerial photographs

The absence of up-to-date aerial photographs hampered the estimation of deforestation from the date of the last photograph (1990) to the present. This could result in underestimation or overestimation of the deforestation rates which were determined by use of production figures from the 1990/91 to 1998/99 season. The 1970 aerial photographs were also not available and this could have masked the changes in landcover between 1960 and 1980.

CHAPTER FIVE

PRESENTATION OF FINDINGS, ANALYSIS AND DISCUSSION

This chapter presents the findings and analysis of the results from the study. The size of tobacco holdings and factors determining their sizes are discussed. The chapter also presents the quantity of wood used by farmers and further discusses some factors that bring about differences in the quantity of wood used by different categories of farmers. An attempt to give the extent of deforestation as a result of tobacco production is also made.

5.1 The size of tobacco holdings

The size of tobacco fields found in the study area are presented in Table 5.1 below which shows the percentages of different categories of farmers according to their field sizes.

Table 5.1: **Size of tobacco holdings in the study area – 1998/99 season**

Field Size (ha)	Farmers on communal land (%)	Former TBZ tenant farmers (%)	Commercial farmers on private land (%)	Total percent
Less than 5	56.86	25.49	0	82.35
Between 5-10	0	5.88	0	5.88
More than 10	0	0	11.76	11.76
Total	56.86	31.37	11.76	99.99

Source : Field data

The study revealed that tobacco fields ranged in size from 0.2 hectares to 60 hectares. The largest part of the sample constituted farmers growing less than five hectares of tobacco. These were all the 29 (56.86%) traditional farmers in the sample and the 13 (25.49%) farmers occupying formerly TBZ land. Only three farmers (5.88%) on former TBZ land grew between 6 and 10 hectares of tobacco while all the six (11.76%) farmers on private land grew over 10 hectares. However, although the number of farmers growing less than 10 hectares is larger than that of farmers growing more than 10 hectares, their total hectarage and production is far less than that for the latter group of farmers.

The hectarage of tobacco and ultimately the yield are dependent on several factors, some of which are discussed in the next section. In the study area, a high correlation of .983 was obtained between field size and production (see Appendix IX). This correlation was found to be significant at the 0.01 level. This strong association between yield and field size agrees with other studies such as those conducted by Leach and Mearns (1988) which have shown that crop yields are mostly dependent on area under cultivation in the developing nations. This means that the larger the fields, the more tobacco is produced and so more woodland is cleared to supply fuelwood for curing.

5.1.1 Field size changes

The situation regarding field size changes during the last five seasons is presented in Figure 5.1 below:

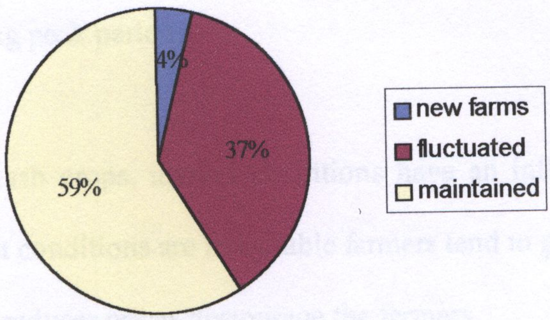


Figure 5.1: Changes in tobacco field sizes in Choma district,1995-1999

The study revealed that a large group of farmers maintained the size of their tobacco fields over the last five seasons. These constituted 58.82% of the sample. Two farmers (4%) grew tobacco for the first time while nineteen others (37.25%) indicated that they fluctuated the hectarage of their tobacco fields. These included all the categories of farmers. The fluctuation in hectarage varied between 0.5 and 3 hectares per season among individual farmers due to various factors.

Labour is one of the factors that have an influence on hectarage. This is a crucial factor because tobacco is a labour-intensive crop. Lombard and Tweedie (1972) note that nearly 50% of all agricultural labourers at independence were employed on virginia tobacco farms as shown in Appendix XI. The intense labour requirements for tobacco production, as compared to other crops, are also reflected in Appendix XIII. Adequate labour is required at various stages, starting from nursery work, reaping, curing and grading up to the packing stage. In the study area, the large commercial farmers employed farm workers while the small-scale farmers largely depended on family labour, both male and female, but both classes hired extra labour force during peak periods.

As is the case with other cash crops, market conditions have an influence on production. When the market conditions are favourable farmers tend to grow more in order to earn more. Low producer prices discourage the farmers.

Tobacco needs to be cured on the same day that it is reaped and so barn facilities are also a determining factor. A lot of wastage occurs if more tobacco than can be cured, is reaped on any particular day. Meanwhile if the leaves become overripe in the field, they do not cure well.

Accessibility to and the quantity of loaned inputs such as seed and chemicals also determine hectarage of tobacco. Other factors playing a significant role in determining field sizes include availability of draught power and farm implements. A large number of small-scale farmers depend on draught power and implements to cultivate their fields and these have an effect on hectarage when they are not sufficiently owned, or cannot be hired due to financial constraints. When these factors are favourable, hectarage will increase and this calls for a further demand on the energy resources, which means more woodland clearing.

On a long-term basis, hectarage of tobacco has generally declined in the study area, and elsewhere, and this has ultimately affected tobacco production at national level. The trend of national virginia tobacco production is shown in Appendix X.

The decline soon after independence was attributed to nationalisation of the tobacco marketing body (TBZ) and to the departure of some commercial white settlers. TBZ is said to have offered tobacco growers unattractive prices which drove many farmers away from tobacco growing while others reduced their hectarage (Harvey, 1973 and Times of Zambia, 2/11/2000). This is evident among the former TBZ tenant farmers whose hectarage has reduced from the initial eight hectares that was being cultivated under TBZ schemes to less than five hectares in most cases as shown in Table 5.1. Other factors had to do with government policy such as the removal of subsidies on agriculture, lack of equipment and well-trained personnel to run tobacco schemes (GRZ, 1985).

In the last four seasons however, there has been a steady increase of tobacco production in the study area despite an indication that many farmers maintained the size of their fields as shown in Figure 5.2 below:

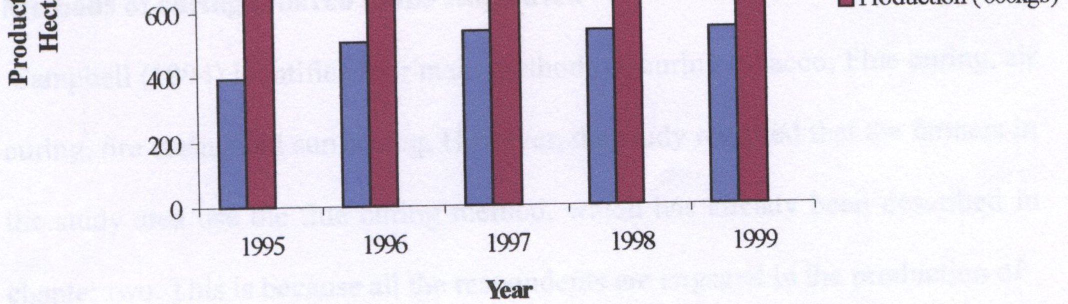


Figure 5.2 : Trends in the production and hectarage of tobacco in Choma district, 1995 - 1999

The increase in production could be accounted for by the farmers who were undertaking tobacco production for the first time. Intensification of farming and better curing techniques could be other reasons for the increase in the production levels since hectarage has been almost constant. These could in turn be attributed to the reversion of tobacco production management to private hands. The Zambia Leaf Tobacco and TAZ offer quality extension services by well-qualified personnel. One of the reasons that is said to have affected tobacco production during nationalisation was lack of skilled personnel to manage the tobacco schemes (GRZ, 1985). However, in 1996, production was lower compared to the other years with similar hectarage. This is because there were more small-scale farmers whose yield per hectare is lower than that of large-scale commercial farmers. This is partly so because small-scale farmers have constraints in acquiring inputs such as fertilizers and other chemicals necessary to ensure high yields. The general increase in production entails more woodfuel requirements for curing and ultimately more woodland clearance. This will be discussed in detail in section 5.4 on page 47 when considering the extent of deforestation as a result of curing tobacco.

5.2 Methods of curing tobacco in the study area

Campbell (1994) identifies four main methods of curing tobacco; Flue curing, air curing, fire curing and sun curing. However, the study revealed that the farmers in the study area use the flue curing method, which has already been described in chapter two. This is because all the respondents are engaged in the production of flue-cured virginia tobacco. Fraser (1986) states that flue curing is by far the major culprit in the industry's exploitation of wood, consuming about 3 million hectares of forest annually. Of this quantity, 69% goes to fuelwood used in curing and 15% to poles and sticks used in barn construction (Plate 5.1).

Flue- cured virginia tobacco is preferred because the weather conditions that characterise the Southern Province during the curing period do not favour the growing of other varieties such as burley tobacco, which is air cured. A humid atmosphere cures tobacco slowly while a dry atmosphere will dry tobacco too quickly. These atmospheric conditions make the tobacco leaves result in an undesirable colour, which reduces its market value (Emslie, 1962). However, two farmers (4%) in the sample had grown burley tobacco before and the returns were not good enough to justify further production.

In the study area, the main source of energy for curing tobacco is fuelwood as shown in Plate 5.2. Only two respondents (4%), who are commercial farmers, were using energy supplied by coal alongside with wood. The other 96% of the farmers solely depended on fuelwood, which is used in varying quantities to cure a given quantity of tobacco as presented in section 5.3 on page 36.

Most of the flue curing is done in the tall conventional barns (Plate 5.3). The barns are made of brick wall with several flue pipes fitted inside. Small-scale farmers, however, often use a different type of barn known as the pepperpot (Plate 5.4).

Plate 5.1: A tobacco barn under construction in Choma

Plate 5.2 : Fuelwood used for curing tobacco

Plate 5.3: Conventional barn used for curing tobacco by commercial farmers

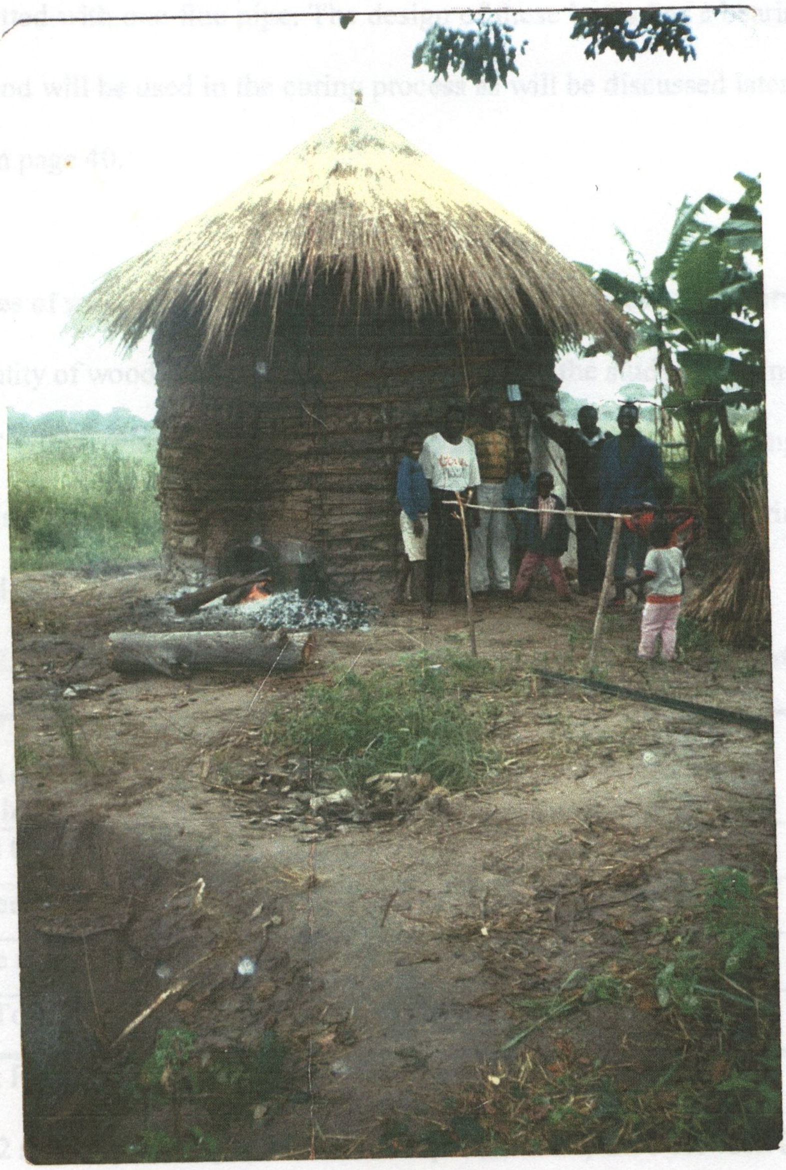


Plate 5.4 : Pepperpot barn used for curing tobacco by small-scale farmers

A typical pepperpot barn is round with a diameter of about 360 centimetres and usually fitted with one flue pipe. The design of these barns has a bearing on how much wood will be used in the curing process as will be discussed later in section 5.3.1.2 on page 40.

5.3 Quantities of wood required in tobacco flue-curing tobacco in the study area

The quantity of wood used for flue-curing tobacco in the study area is measured in terms of cords (Plate 5.5). The actual quantities used vary among different categories of farmers. Table 5.2 below shows fuelwood used for curing tobacco harvested from one hectare for the different classes of farmers.

Table 5.2: **Cords of wood used for curing a hectare of tobacco in the study area**

Cords of wood per hectare	Farmers on communal land (%)	Former TBZ tenant farmers (%)	Commercial farmers on private land (%)	Total percent
Less than 20	0	7.85	11.76	19.61
Between 20-30	47.06	23.52	0	70.58
More than 30	9.8	0	0	9.8
Total	56.86	31.37	11.76	99.99

Source: Field data

Table 5.2 shows that a large part of the sample (70.58%) used between 20-30 cords (60 m^3-90m^3) of wood to cure tobacco from one hectare of land. These are small-scale growers on traditional and former TBZ land. These two classes of farmers do not differ significantly in terms of fuelwood usage for curing tobacco as will be shown in the next section. However, there is still a difference, albeit insignificant, between these two classes of farmers in that a few of those on former TBZ land (7.85%) use less than twenty cords while some of those on traditional land

Plate 5.5: A cord of wood in the bush

constitute part of the sample that uses more than thirty cords of wood. On the other hand, commercial farmers on private land use the least quantity of wood for curing tobacco from a hectare. This is evident from Table 5.2, as all of them fall in the category using less than twenty cords of wood for a hectare of tobacco. The next section considers some factors behind the differences in the quantities of fuelwood used for flue curing tobacco.

5.3.1 Factors determining the quantity of fuelwood used for curing tobacco

The average quantities of wood used for curing a tonne of tobacco by each of the three categories of farmers in the study area are presented in the Table 5.3 below.

Table 5.3: **Average volume of wood used per tonne of cured tobacco in the study area**

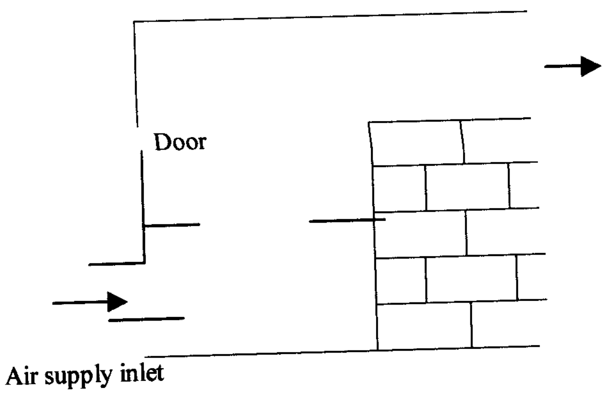
Volume of wood	Farmers on communal land	Former TBZ tenant farmers	Commercial farmers on private land
(m^3/tonne)	110.10	92.31	11.33
Cords(m^3)	37	31	4

A comparison of the quantities of wood used per tonne of tobacco as given in Table 5.3 shows that there are differences among the different groups of farmers. Commercial farmers on private land use about $11.33m^3$ of wood per tonne of tobacco. This quantity is very close to Fraser's (1986) findings with commercial farmers in Malawi who used between $12m^3$ and $19m^3$ of wood per tonne of tobacco for improved and ordinary barns respectively. The farmers on the traditional and TBZ land also used wood quantities similar to the small-scale tobacco growers in Tanzania. Boesen and Mohele's (1979) study of tobacco farmers in Tanzania's

Tabora region revealed that a tonne of tobacco was cured by between 45 – 120 m^3 of wood. The small-scale farmers in the study area, as seen from Table 5.3 use quantities of wood within this range. The fuelwood consumption patterns reflect the similar curing techniques employed by the respective groups of farmers. This further entails that even Choma is headed for a similar problem of severe woodland clearance that the other regions such as Tabora in Tanzania are now facing. The differences in the quantities of wood used to cure a given quantity of tobacco are as a result of a number of factors, which include the following;

5.3.1.1 Furnace design

An efficient furnace is one that is designed to give the highest output in energy and is a product of many design techniques. One such type, commonly used by big commercial farmers in the study area is the slot or ventura type. The characteristic features contributing towards fuel efficiency include the size and construction of the furnace itself. A large enough furnace made in such a way that wood is placed above the ground and allows air to enter the furnace and blow through the fire bed is desirable. The door should be kept closed, and only opened when stocking wood. This allows in sufficient air supply in the inlet (with oxygen) which in turn facilitates complete combustion and more heat energy is given out. When wood is placed on the ground and air blows above, as is the case with most small-scale farmers in the study area (Plate 5.4) not as much heat is obtained as combustion is seldom complete. Brooker and Sinclair (1989) assert that incomplete combustion can cause a loss of up to 70% of the heat value of the fuel. This calls for more fuelwood and hence the difference in the quantity used. A desirable set-up for an ideal furnace, to which conventional barns used by commercial farmers in the study area conform, is illustrated in Figure 5.3.



Source : Brooker and Sinclair (1989: P117)

Figure 5.3 : Arrangement of an ideal furnace

5.3.1.2 Barn Design

As is the case with furnaces, barn efficiency is enhanced through various design techniques. The arrangement and number of flue pipes in the barn also counts towards the quantity of wood that is used. Two pipes at different elevations in the barn will help to supply heat energy quickly in the barn. When distribution of heat is aided by the use of a fan, as is the case with commercial farmers, there will be an almost uniform drying rate of the leaves hanging from the tiers at different heights. This helps to shorten the curing time unlike in the case of small-scale farmers whose pepperpot barns are fitted with one flue pipe in most cases. In addition, the use of fans helps to recycle the heat so that maximum utilisation is made before it is expelled to the outside through the chimney. With the absence of such techniques among small-scale growers, it means more wood is used.

Some barns among commercial farmers are constructed in such a way that one furnace supplies heat to several barns. In this way, a large quantity of tobacco is cured at once and this has been found to be economical as excess heat, which would otherwise be wasted, is used up.

The arrangement and state of the equipment used plays a role in determining the quantity of wood used. The point at which the furnace connects to the flue pipe should be air tight to prevent heat from escaping to the outside. In principle, hot air rises and when the flue pipes are connected to the furnace at a higher elevation more heat enters the barn. When the flue pipe is at the same level as the furnace, only part of the heat enters the barn as some of it is reflected back and lost to the outside. However, in the study area, it was found that small-scale growers used more fuelwood because in most cases they had old and broken flue pipes where a lot of energy losses were experienced.

Ideally, barns are supposed to have ventilators that can be closed or opened to prevent heat loss and to let humid air escape respectively. On the contrary, some barns especially among small-scale growers had permanently open outlets where heat was lost. Cracked walls on dilapidated barns were also contributing to the loss of heat energy among small-scale farmers who could not renovate their structures due to financial constraints.

The design of barns and furnaces has been found to have an effect on the SFC. Barnard (1994), for instance, observes that the wood- tobacco ratio may be reduced from 7.7 kilogrammes of wood to 1kilogramme of cured tobacco to 5 kilogrammes of wood to 1kilogramme of cured tobacco due to improved designs of furnaces. However, some of these new and improved wood-burning techniques are found to be expensive among small-scale growers in the study area especially when it means breaking down the old barns in order to redesign them. As such, some farmers have adhered to the old designs which are not fuel efficient and hence the differences in wood usage.

5.3.1.3 Moisture content in the wood

During the study, it was found that some farmers preferred using wet wood because it is believed to last longer and cure tobacco more efficiently. However, from a technical angle, wet wood has been found to use up its own energy to dry itself before it can burn. In addition, wet wood reduces furnace temperature, thereby affecting the energy of the fuel; high temperature in the furnace is one of the factors that support combustion. Panshin *et al.* (1962) observe that high moisture content reduced the calorific value of wood because heat is lost as latent heat of vaporisation of water. This observation was made after a study whose findings are as presented in Table 5.4. Temu (1979), therefore, recommends the need of educating farmers on the need for splitting, drying and storing fuelwood properly before use. de Montelambert and Clement (1983) also point out the importance of using dry wood as an energy saving measure.

Table 5.4 : **Effect of moisture content on the calorific value of wood**

Moisture content oven dry basis, %	Heat lost, based on that available at 10% moisture content, %
20	10
50	32
100	54
200	76

Source: Panshin *et al.* (1962: P 281)

5.3.1.4 **Experience**

Tobacco production involves a lot of stages from the time of planting through to curing. The different stages require a lot of expertise in order to achieve successful results. Similarly, the quantities of wood used per given quantity of tobacco depend on the farmers` experience with curing. This experience is acquired over time and so the number of years in tobacco production was assumed to have an effect on the quantities of wood used. To verify this, the number of years a farmer had been in tobacco production was correlated with the quantity of wood per tonne of tobacco using Pearson's product-moment correlation. A correlation co-efficient of -0.431 was obtained (see Appendix VIII). The result is presented in Figure 5.4.

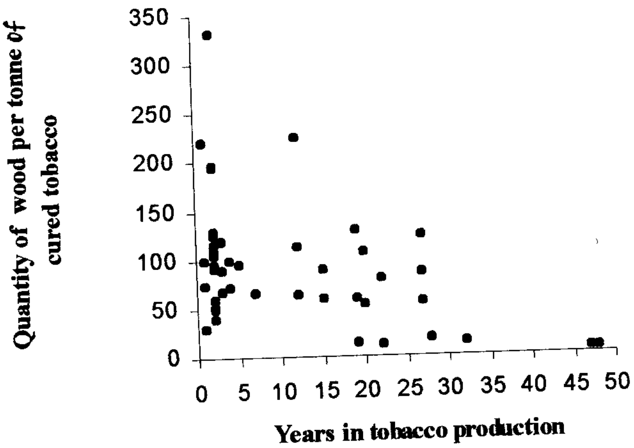


Figure 5.4: Time in tobacco production and quantity of wood used for curing tobacco in the study area

A one-tailed test of significance at 0.01 percent shows that there is a moderate, significant inverse relationship between the variables. This means that with more years in tobacco production, the quantity of wood used per tonne of tobacco is likely to be reduced. The co-efficient of determination, r^2, is 0.185 meaning that only about 19% of the quantity of wood used for curing is accounted for by the number of years in tobacco production. In other words, the extent to which the number of years in production has a bearing on fuel consumption is minimal unless other factors earlier discussed in section 5.3.1 on page 38 are taken care of. This is evident among former TBZ tenants who have grown tobacco for a longer time than those on traditional land, yet the quantities of wood used per tonne of tobacco do not differ significantly between the two groups of farmers. On the other hand, the quantity of wood used per tonne of tobacco by the big commercial farmers who have been on private land much longer and also use improved barns differs significantly from the other two classes of farmers.

The differences in the quantities of wood used for curing tobacco by the different categories of farmers were confirmed with the Kruskal-Wallis H test (see Appendix IV). The differences were significant at the 0.05 level.

Since the H-Test gave a general conclusion for the three categories of farmers in the sample, further Mann Whitney U-Tests (see Appendices V, VI and VII) were further conducted at 0.05 percent level of significance to verify the differences in wood usage between paired samples of farmers. The differences were still found to be significant between commercial farmers on private land and those on traditional land, as well as between commercial farmers on private land and those on former TBZ land.

However, the U-test between farmers on traditional land and those on former TBZ land at the 0.05 percent significance level showed that there was no significant difference in the quantities of wood used for curing a tonne of tobacco. This is evident through the relatively small difference between the quantities of wood (110.10 m^3 and 92.31 m^3) used by the two groups of farmers respectively. The similarity in fuelwood usage between these two groups, which are predominantly small-scale, has been attributed to the curing techniques employed. Meanwhile the quantity of wood used by the large-scale farmers (11.33 m^3) who use improved methods is far less.

On the whole, it could be argued that the major factor that brings about differences in wood quantities used between large-scale farmers on private land and small-scale farmers on traditional and former TBZ land is the amount of capital and knowledge invested into achieving fuel efficiency. While the former put in a lot in terms of these attributes, the latter face financial constraints and hence the difficulty in taking up measures to reduce the quantity of wood used. To some extent, as Akehurst (1970) observes, this is because wood is considered cheap and is in most cases still readily available. Fraser (1986) however, points out that as long as wood is treated as a 'free good' and its price does not reflect its replacement cost, the destruction of the forest will continue. This has far reaching implications and may impact negatively both on the environment and the farmers themselves. In the study area for instance, farmers travel long distances to fetch their wood for curing tobacco as will be seen when considering the situation regarding wood resources within the study area. The scarcity of fuelwood was in fact cited as one of the constraints contributing to a decline in tobacco production in several tobacco schemes in the study area (GRZ, 1985).

From an environmental perspective, the situation in the study area is similar to that in Kabile scheme in Chibombo district where Lungu (1996) observes that vegetation altered from open bush and tree grassland to mere shrubs and grasslands due to agricultural production of virginia tobacco.

5.4 Tobacco production and the related deforestation in the sample study area

This section attempts to determine the extent of deforestation that was as a result of tobacco production in the study area.

5.4.1 Woodland clearance between 1960 and 1990

Land cover in the sample study area in 1960, 1980 and 1990 is shown in Figures 5.5, 5.6 and 5.7 which are based on the interpretation of aerial photographs for the respective periods. The extents of the land cover types are given in Table 5.5.

Table 5. 5: **Land cover in the sample study area, 1960-1990.**

LAND COVER TYPE	CLEARANCE (%)		
	1960	1980	1990
CLEARED AREA	15	16.6	41.9
WOODED AREA	85	83.4	58.1
TOTAL	100	100	100

Source: Aerial photographs of Choma -1960,1980 and 1990.

Table: 5.5 above shows that there was not much clearance or loss of woodland between 1960 and 1980. There was only a loss of 1.6% of woodland cover. The low rate of clearance could be attributed to the relatively low population density, which was at an average of 15.5 persons per square kilometre (GRZ, 1980b). There were also fewer tobacco farmers in the district before this period as only a few white settlers dominated the tobacco production industry until later when the crop was introduced to the Zambian farmers under TBZ (Harvey, 1973). This means that there was less pressure or demand on the land resources before then and this facilitated for woodland re-growth. Huckabay (1975) notes that in Choma, one occasionally encountered remnant species of the old vegetation cover, in various stages of re- growth after disturbance due to human factors.

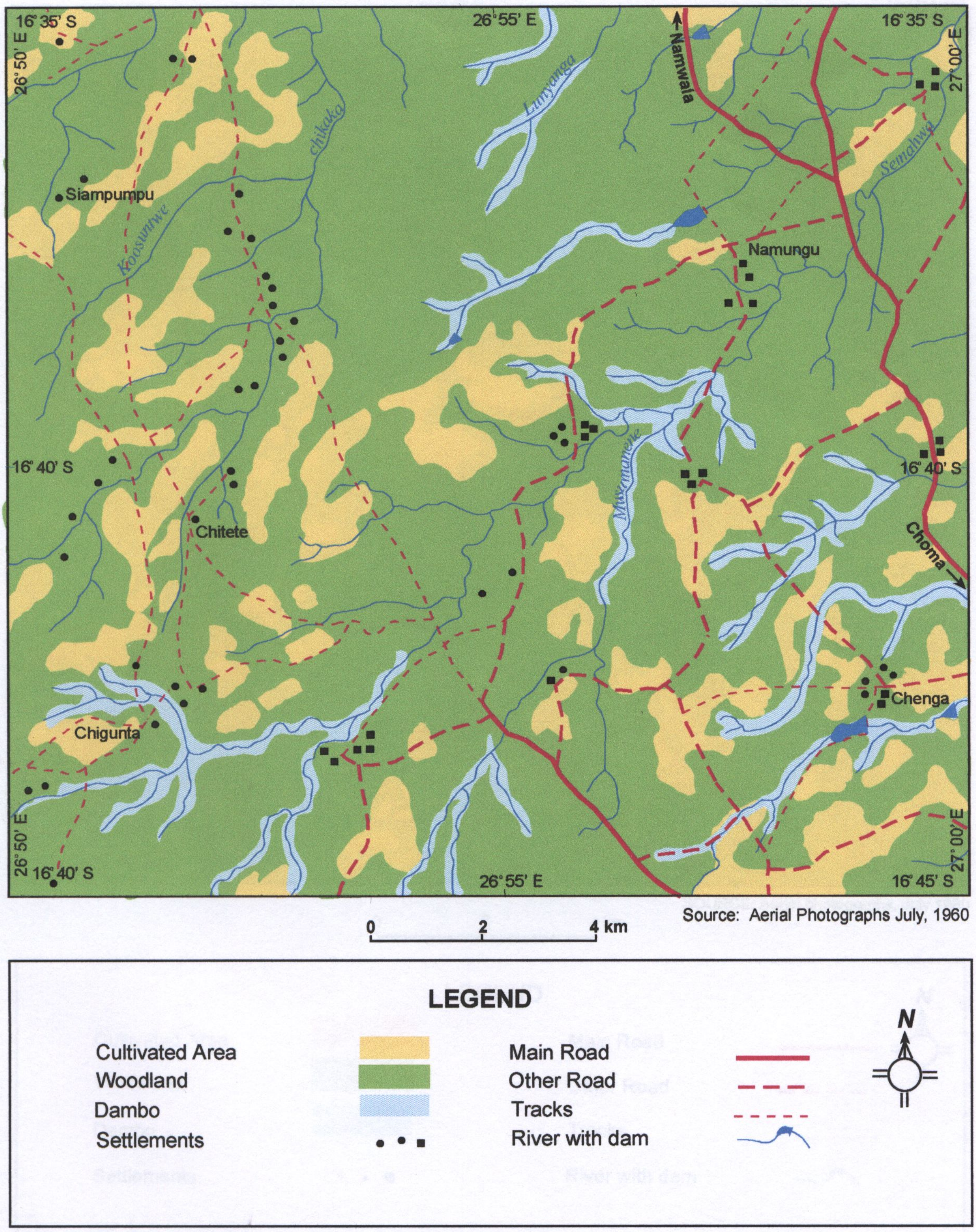


Figure 5.5: Landcover map of the sample study area in Choma, 1960.

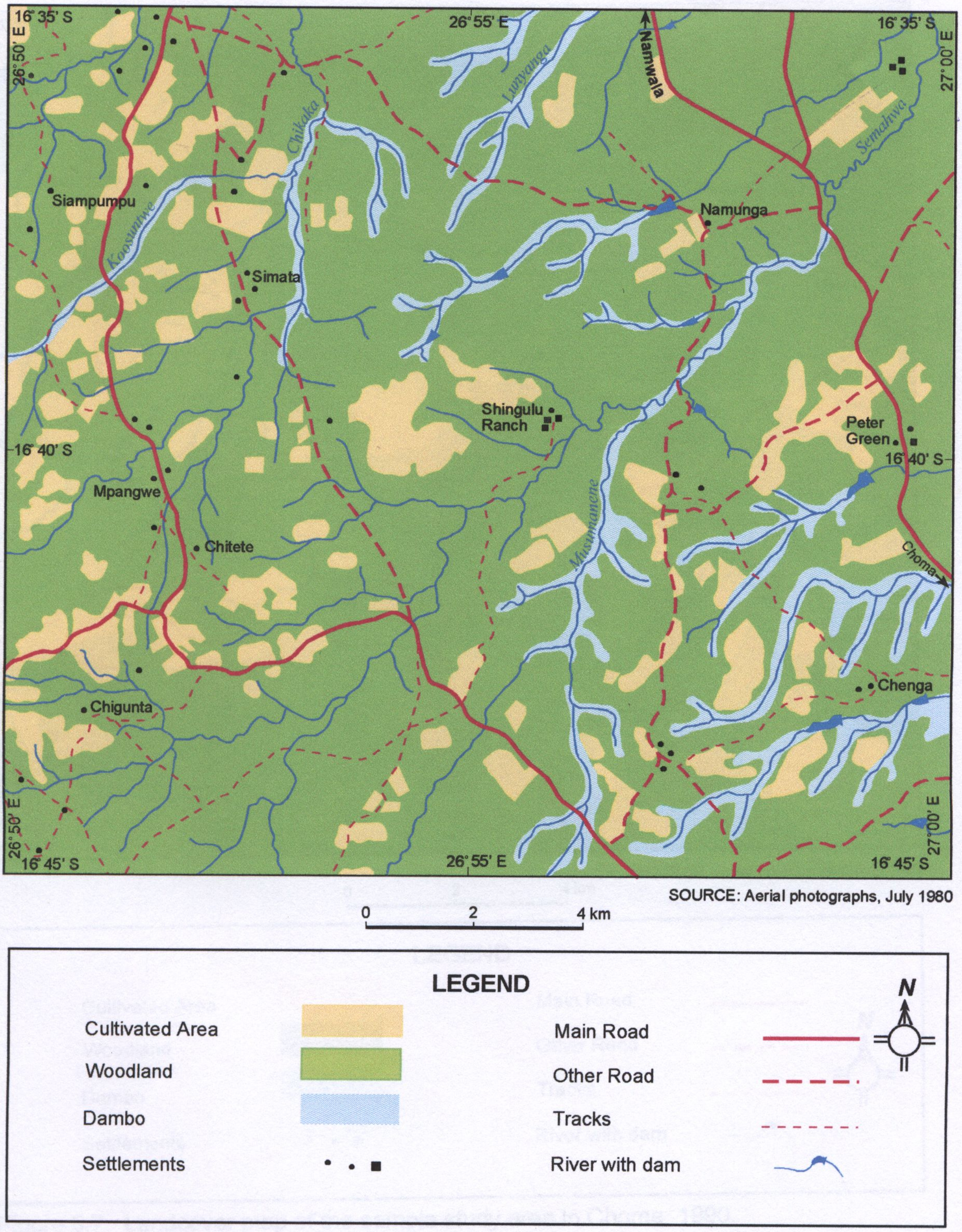


Figure 5.6: Landcover map of the sample study area in Choma, 1980.

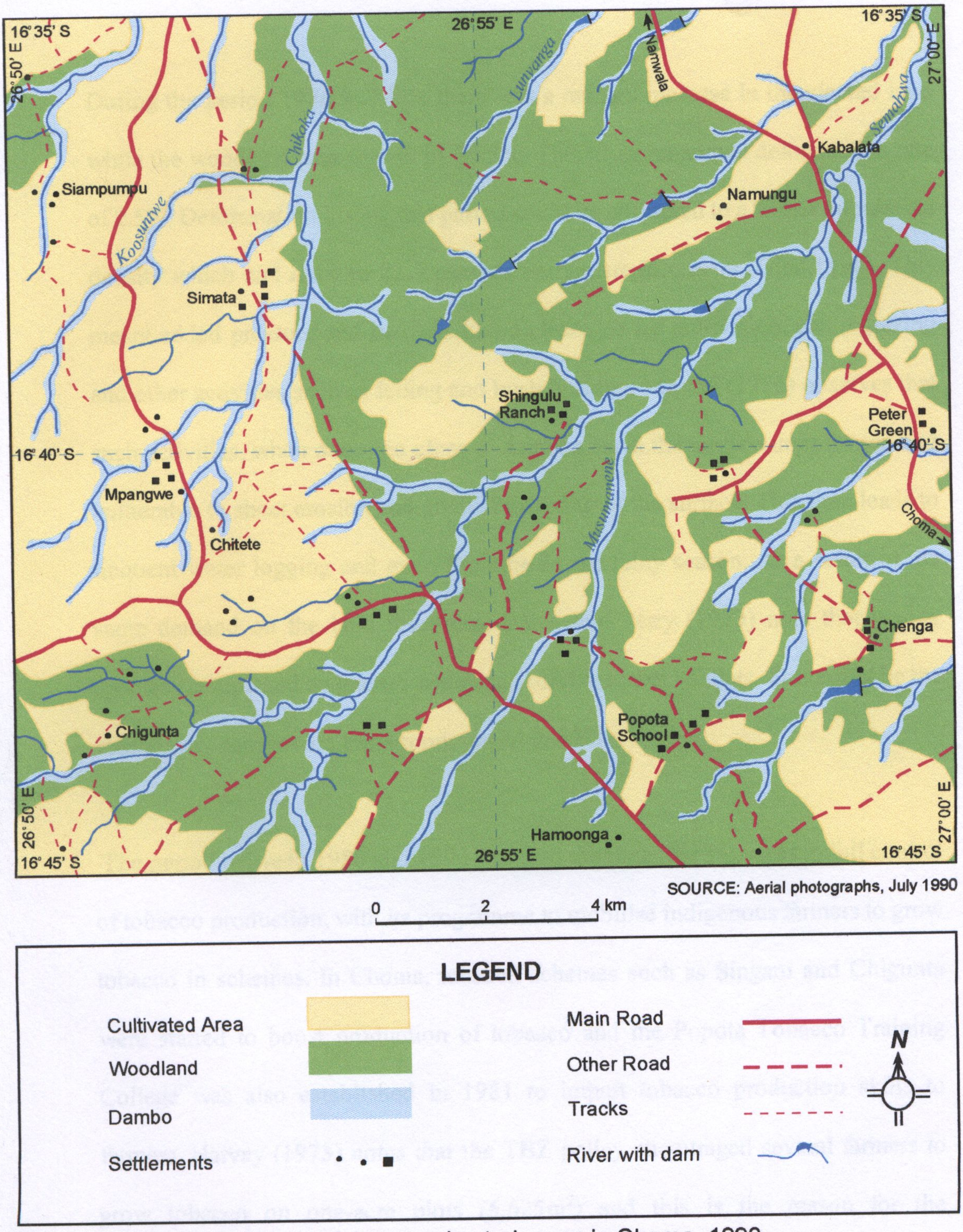


Figure 5.7 Landcover map of the sample study area in Choma, 1990.

During the period 1980 to 1990, there was a marked increase in the cleared land while the woodland area shrunk by 25.3%. This gives an annual deforestation rate of 2.5%. Deforestation during this period could be attributed to a higher population density which had risen to 22.5 persons per square kilometre (GRZ,1990). This meant added pressure and increased land clearance for cultivation, cattle grazing and other activities such as felling and bush burning. Mackel (1986) observes that such activities, when done too close to dambos leave the surface unprotected and vulnerable to sheet erosion and gradual lowering of the surface. This then leads to frequent water logging and even flooding in the rainy season. As a result of the same demand on the land resources, Balek and Perry (1973) note that woody species are replaced by grasses which can survive in wet habitats. This could be the reason why dambos are more pronounced in 1990.

The period between 1980 and 1990 was also the time that TBZ was in full control of tobacco production, with its programme to mobilise indigenous farmers to grow tobacco in schemes. In Choma, tobacco schemes such as Singani and Chigunta were started to boost production of tobacco and the Popota Tobacco Training College was also established in 1981 to impart tobacco production skills to farmers. Harvey (1973) notes that the TBZ policy encouraged several farmers to grow tobacco on one-acre plots ($6,625m^2$) and this is the reason for the fragmentation of cleared areas in 1980 as shown in Figure 5.6. This scenario is in contrast to the situation in 1960 (Figure 5.5) where huge extents of cleared land prevailed in one estate, typical of monocropping regimes.

Generally speaking, there is more woodland clearance on the western part of the maps (Figures 5.5 and 5.6) and this is more pronounced on the 1990 map (Figure 5.7). *This is the area which mainly constitutes communal land. Under communal* ownership of land, resources belong to the community and so activities such as tree *cutting are not restricted. This is unlike the case of commercial farmers on private* land where felling is controlled. In fact, during the study it was revealed that commercial farmers preserved the wood stocks on their farms and opted to meet their fuelwood requirements by cutting trees from communal land where there was no restriction. Banana and Gombya (1994) observe that the tendency to regard forests as 'open access' accelerates the reduction of forest resources and so if people had some kind of individual ownership to land in the community, sustainable ways of harvesting resources would be employed.

At the 2.5% annual rate of deforestation for the period between 1980 and 1990, the woodland in the area faced depletion in about twenty-three years from 1990. Assuming that this rate had been constant in the last ten years, the woodland would now (in 2002) face depletion in about twelve years. Some farmers interviewed during the study in 1999 indicated that they would experience wood acquiring problems in about five years' time and so this projection is in line with the farmers' current experiences regarding the wood situation in the area as is discussed later in section 5.4.3 on page 55.

5.4.2 **Woodland clearance after 1990**

Deforestation associated with tobacco production after 1990 was determined by estimating how much woodland clearance resulted from the curing of tobacco annually. The study considered production from the 1990/91 season to the 1998/99 season in the district, the period for which district production figures were available (see Appendix XII). Hectarage of tobacco was determined on the basis of an average of 2000 kilogrammes per hectare while the hectarage of woodland cleared was based on estimates of woody plant biomass of the region.

Chidumayo (1997) estimates that one cubic metre of solid volume of wood is equivalent to 355kgs and that western dry miombo woodlands, in which Choma lies, yield 51 000 kgs of wood per hectare. Therefore, one hectare yields approximately 143.66m^3 of wood and so the volumes of wood (shown in Appendix XII) required for the nine- seasons' curing meant subsequent clearing of hectares of woodland, shown with the crop hectarage, in the compound line graph in figure 5.8 on page 54.

Figure 5.8 shows almost equal hectares of land put under cultivation and those cleared to provide wood for curing tobacco. Eckholm *et al.* (1984) and ITGA (1997) also make this observation that one hectare of tobacco required one hectare of adjacent woodland for curing tobacco. However, this is not necessarily so because of the different factors involved such as the plant biomass of the wood (which differs in various ecological zones), the combustion characteristics of the species used for curing as well as the other factors pertaining to the designs of the

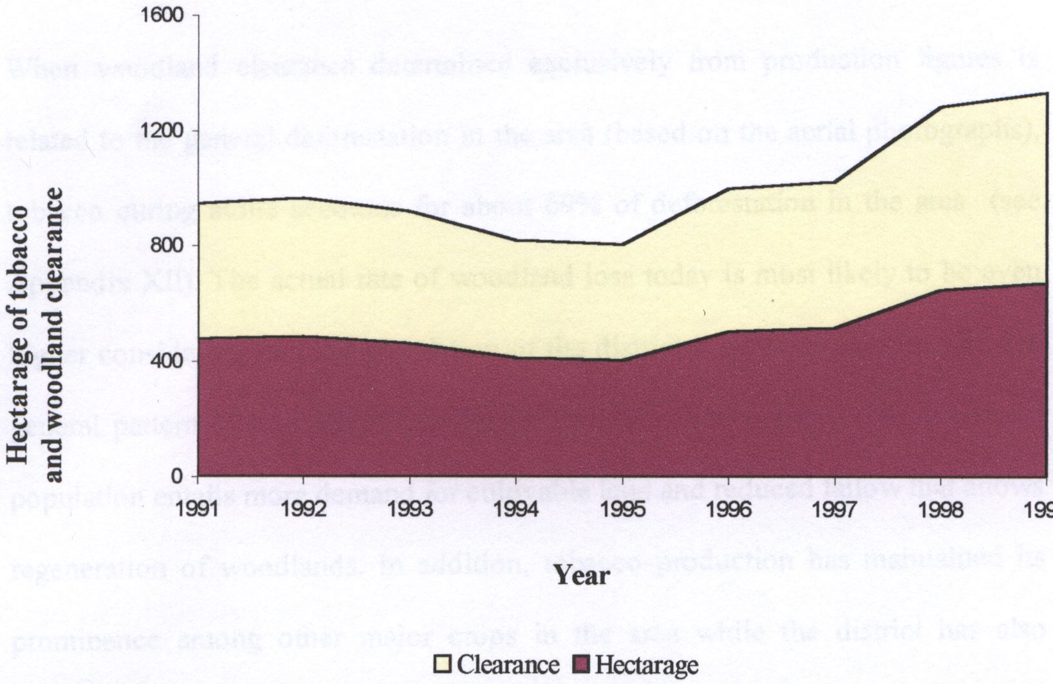


Figure 5.8: Tobacco hectarage and associated woodland clearance in Choma district, 1991-1999

furnaces and barns as discussed earlier in sections 5.3.1.1 and 5.3.1.2 on pages 39 and 40 respectively.

From the trend shown in Figure 5.8, the average clearance annually for tobacco curing in the district is 472.65 hectares while the annual deforestation rate obtained from the interpretation of aerial photographs was 688.8 hectares up to 1990 (see Appendix XII). Both figures show a high deforestation rate per annum. The figure derived from production figures shows a lower rate than what could actually be the case. This is because the figures representing production only stand for the tobacco successfully cured and sold on the auction floors, meaning that there is still more wood wasted for tobacco that is rejected or that which is not brought to the market due to side- marketing or other logistical problems.

Table 5.6: **Farmers' experiences in acquiring wood for curing tobacco in the study area - 1998/99 season**

Experiences	Farmers on communal land (%)	Former TBZ tenant farmers (%)	Commercial farmers on private land (%)	Total percent
Problem Faced	25.49	15.69	0.0	41.18
Problem not Faced	31.37	15.69	11.76	58.82
TOTAL	56.86	31.38	11.76	100.00

Source: Field data

Table 5.6 above shows that there is a problem of wood in the study area although those who experienced the problem are fewer (41.18%) than those who said they did not face any problem (58.82%). Among the farmers who responded that they did not face any problem, 47% indicated that they would face the problem in about five years' time.

Table 5.6 also shows that all the farmers on private land had no problem with acquiring wood. With this class of farmers, acquiring wood was not considered a problem because they have the means of bringing the resource by way of tractors, (Plate 5.6). However, the long distances covered, beyond twenty kilometers in most cases, to ferry the wood between the felling and curing points entail that in essence, the problem of diminishing wood resources is also faced by this category of farmers. The use of tractors to 'overcome' the problem of distance means an increase in the production cost. Some commercial farmers also considered wood not to be a problem because neighbouring farmers were cattle ranchers and so permitted them to cut trees to boost the growth of pasture for the animals.

Plate 5.6 : Wood being transported from distant places

Similarly, the small-scale growers travel an average distance of four kilometers in the open bush to cut their wood and transport it to the curing point by ox-carts. The long distances covered to acquire wood shows that wood resources are diminishing and that the problem of wood is imminent in the study area. Choma is one area facing deforestation at a local level although this is not yet a problem at national level (GRZ/IUCN, 1985). This confirms Fraser's (1986) assertion that a high proportion of the tobacco growing areas in the developing countries lie within parts of the world identified by the FAO as being in wood-deficit or prospective wood-deficit situations. Geist (1994) also reports that countries with miombo woodlands that are tobacco producers show an overall average annual forest depletion rate higher than those that are not producers (see Appendix II).

In view of these woodland losses arising from continued tobacco production, TAZ initiated a programme of planting trees in the study area. This was in an effort to abate deforestation and to ensure continued wood supply for future curing. The tree-planting programme is discussed in detail in the next section.

5.4.4 Tree-planting in the study area

The Tobacco Association of Zambia is fully aware of the environmental effects of deforestation with the continued production of flue-cured tobacco. As such, they initiated a tree- planting programme of eucalyptus and blue gums in the study area. The responses to this initiative are presented in Table 5.7.

Table 5.7: **Tree-planting in the study area**

RESPONSES	Farmers on communal land (%)	Former TBZ tenant farmers (%)	Commercial farmers on private land (%)	Total percent
Planted	0	3.92	11.76	15.68
Did not plant	56.86	27.45	0	84.31
Total	56.86	31.37	11.76	99.99

Source: Field data

The study revealed that a large number of the tobacco growers (84%) are not involved in any kind of tree-planting. These are mostly the farmers on communal land who constitute the biggest proportion of the sample (56.86%). Only 3.92% of those on former TBZ land planted some trees while the other 27.45% did not plant any trees. However, all the commercial farmers on private land, constituting only about 16% of the sample have tree plantations on their farms and have continued planting trees from individual efforts.

The tree-planting programme has not been successful and various reasons were put forward for its failure. Within the 84% of farmers who did not plant, 25 % cited lack of seedlings. However, although this was given as an inhibiting factor, a good number of farmers were supplied with seedlings from TAZ at a fee of US $20 (ZK39,000) which was deducted from the farmers' tobacco income.

Thirty-eight percent of the farmers indicated that they did not know how to plant trees. Among those who tried only a few or none of the trees survived. The poor survival rates could be attributed to poor silvicultural techniques and management.

A further 23% of the farmers felt that trees were still plentiful and therefore saw no need to replant while 5% said they only had limited portions of land and so could not plant woodlots. Another 9% stated that they simply did not think about it. One crucial factor that was stated alongside the others was pressure of work from other farming activities. On the whole, the failure of this programme was mainly due to poor implementation. The farmers were not prepared for the task and so there was no commitment on their part.

This state of affairs in the study area qualifies WHO's statement that where tobacco companies engage in reforestation efforts, the promises seldom match the results (ITGA, 1983). ITGA (1997), for instance, claims that tobacco farmers in Zambia had 5% of their farmland devoted to tree plantations to ensure sustained yields of fuelwood for future curing. This is not the case in the study area especially among small-scale growers as shown in Table 5.7. Only commercial farmers are closer to this claim on average basis, as presented in Table 5.8.

Table 5.8: **Actual percentages of farmland devoted to tree planting in the study area –1999**

Farm serial no.	Farm size (ha)	Area under tree plantation (ha)	Plantation area as % of total farm area
1	1860	40	2.15
2	1650	60	3.64
3	2024	100	4.94
4	3500	15	0.43
5	890	3	0.34
6	1700	100	5.88
Total	11 624	318	2.90

Source : Field data

It was clear from the study that reforestation in the study area is only undertaken by a few big commercial farmers and almost none among the small-scale tobacco farmers. Economic and social benefits were the reasons behind the planting of trees. The plantations were of exotic species meant for sale as poles in future. Only one out of the six commercial farmers on private land stated that the tree plantation was, among other farm uses, for future curing. FAO (2000) observes that sustainable forest management is a broad concept seeking to bring better balance between the environmental, economic, cultural and social dimensions of managing forests. The use of woodfuel without much regard for the environmental aspect implies that tobacco production in the study area is not sustainable.

From the foregoing, the aspect of land tenure seems to play a crucial role in determining the choices made concerning the use of forest resources and ultimately their sustainability. It was noted that rampant deforestation occurs on communal land where everybody has free access and can exploit resources at will because the land is owned collectively. Southgate (1988) rightly observes that the general failure of poor farmers to participate in land and forest conservation programmes emanate from insecure tenure regimes. He argues that because they do not hold any title, they are unlikely to consider making long-term investment required for tree-planting. To some extent this is also true of the study area and if organisations like SCAFE and GTZ who are working to promote the planting of indigenous tree species in the study area do not consider the issue of land tenure, their efforts are bound to fail and woodland degradation will continue.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

The study has shown that tobacco production has had and still continues to impact negatively on the indigenous woody vegetation in Choma district. This was evident from the rate of vegetation clearance directly associated with tobacco production in the period after 1990. It was established that tobacco curing alone accounts for about 69% of deforestation in Choma district.

The impact was assessed by examining several objectives to establish their relationship or contribution to woodland clearance. The sizes of tobacco fields were established and it was found that the majority of the growers were small-scale farmers growing less than five hectares of tobacco. The few big commercial farmers had more hectarage and produced much more tobacco than the small-scale farmers. However, despite the less hectarage and yield by the small-scale farmers, the study revealed that this category of farmers used more woodfuel to cure a unit of tobacco compared to the large scale farmers. It was found that farmers on traditional land used the largest quantity of wood (110.10 m^3) to cure a tonne of tobacco. Those on TBZ land used a little less wood (92.31 m^3) than the former group while farmers on private land used the least quantity of wood (11.33 m^3) per tonne. These disparities were as a result of the type of wood used, the expertise of individual farmers at the curing process and the design of barns and furnaces.

The study also revealed that in the recent years, tobacco production has been on a steady increase. The increase in tobacco production will be accompanied by further deforestation in order to meet the corresponding increase in curing requirements. According to the study findings nearly 500 hectares of land are cleared annually for the purpose of curing virginia tobacco in Choma. However, with respect to land use, it is appears that little new land is cleared in order to open up fields for tobacco as most farmers have maintained their field sizes. The increase has been attributed to enhanced management of tobacco through extension services.

Virginia tobacco is the type of tobacco grown in the study area. It is flue-cured in individual barns and the major source of energy for nearly all the farmers is fuelwood. However, woodfuel resources are diminishing and these have to be obtained over increasingly long distances. Despite efforts by some farmers to embark on tree-planting activities, there exists net deforestation arising from tobacco curing as the amount of land being planted with tree is relatively smaller to that being cleared and only a few farmers are engaged in tree-planting. In the overall sample, only 15.68 % comprising mostly large scale farmers planted trees. These planting efforts cannot counteract what is reaped from the forests through tobacco curing.

The situation regarding woodland clearance in Choma is most likely similar to that obtaining in other tobacco producing districts like Kaoma, Mkushi, Mazabuka and Katete. This means that the entire country is faced with a problem of woodland clearance not only through tobacco production but also through other land uses. If unabated, this would become more severe in the near future and affect not only the environment but also tobacco production itself.

6.2 Recommendations

Having determined the impact that tobacco production has had on the woodland in Choma district, the study suggests some ways of abating further deforestation to make tobacco production more sustainable, as well as averting serious environmental consequences.

6.2.1 Central curing facilities

Tobacco organisations like TAZ should consider putting up central curing facilities in areas where the small-scale farmers are clustered so that transportation costs are minimal. The farmer would bring their raw tobacco for curing to these common facilities that would be appropriately designed. They would also have the advantage of being managed by personnel who would be trained to use fuelwood efficiently. In this way, there would be less wastage of fuelwood. Further, a processing industry of this kind could easily be monitored by bodies like ECZ to ensure that the curing process conforms to guidelines, which would be formulated in line with environmental principles. With such a facility, indiscriminate cutting of trees for curing tobacco would also be regulated while proper harvesting techniques would also be employed. Temu (1979) also suggests that co-operative central curing facilities would create some employment for the personnel managing the barns and at the same time enabling farmers to undertake other activities like tree-planting. Alternatively, investment funds, currently available to TAZ through the Enterprise Development Fund of the European Union, could be availed to tobacco farmers to specifically help them adopt fuel-efficient technologies. This would be by way of constructing barns and furnaces that will use less wood (or indeed use other sources of energy altogether, other than wood) for tobacco curing.

6.2.2 Reforestation

The tree-planting programme initiated by TAZ should be resumed. To ensure that it is successfully carried out, the people concerned should be given adequate information and be educated on the importance of the programme. The education programme should include silvicultural techniques as well as information on the types of wood of higher calorific value or better combustion characteristics.

Once the programme is embarked on, the local people should fully be involved from initiation to implementation stage. Most of the programmes that do not involve the community have proved a failure from past experience.

Apart from community participation, there should be commitment on the part of government. Temu and Philips (1981) noted that forestry development programmes are usually long term and so would require sustained encouragement by government at all levels. In addition, all the other stakeholders should work in collaboration and endeavour to sustain the community's interest in natural resource management programmes in general and particularly those concerned with forestry such as those initiated by SCAFE and GTZ in the area. The government can also come up with a vigorous campaign to encourage private land ownership as well as easing the procedures of obtaining title to land if forestry management programmes are to be sustainable. This would in turn promote the planting of individual woodlots and controlled harvesting.

6.2.3. Planning for forestry development programmes

Planning is very crucial for the success of any programme. The failure of the tree-planting programme by TAZ in the study area hinges on poor planning and ill-timing. The programme did not consider other activities that the farmers were committed to when the saplings were brought in for planting and hence the saplings were wasted. In future if the programme is to be successfully executed, other important activities for the people involved should be considered.

6.3 Further work

One common feature among small- scale growers is dependence on borrowed inputs such as seed. The cost of these is usually recovered after the sale of the crop by the lending institutions, which also market the produce on behalf of the farmers. In Kenya, Kweyuh (1994) observed that farmers consider tobacco production a 'necessary evil' because even if it may not be so profitable in relation to other crops, the farmers are lured into production because of the inputs that are offered on loan basis. Similarly, in Zambia, the ratio of returns (income) to production costs for tobacco was found to be the lowest (2.20) compared to other crops in a study conducted by FAO [GRZ, 1980a, (Appendix XIII)]. In other words, the net returns compared to production costs are low. Morever, at the time of the study, the ratio of returns (revenue) to production costs was found to have further been eroded to 1.76 (Appendix XIV), which entails reduced profit margins per hectare. The growers sometimes get a poor market price and coupled with the fact that sales have to be made through third parties, the profits are further reduced.

Despite this, people have continued growing tobacco because of the same credit facilities for inputs (which are 'appreciated' because cash is rarely available). The real gain is therefore questionable, especially where food (which otherwise would be grown) has to be purchased from the same minimal returns. There is need, therefore, to research into the profitability of undertaking tobacco production, as opposed to other crops, by the small-scale growers under the current conditions.

However, as a way of addressing the problem of woodland loss resulting from tobacco production, the possibilities of using coal as an alternative energy source in the near future from the neighbouring Gwembe district should seriously be considered by the government, in conjunction with other organisations that are stakeholders in the tobacco industry such as TAZ. Coal has a higher calorific value and although it is expensive, its use might even offset the heavier cost arising from environmental degradation.

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APPENDIX 1

Questionnaire

The following questionnaire is to help the research student gather data on tobacco growing and curing. The information is strictly for academic purposes.

Tick in the spaces provided or fill in information as appropriate.

FARM NAME;____________________

Location /Type of farmer: ____ Commercial ____Former TBZ tenant ____Communal

1. What types of tobacco do you produce on your farm?

2. What is the size of the area under tobacco cultivation? _______________

3. How much tobacco did you produce in:

   (i) 1997/1998 season _________kgs

   (ii) 1998/1999 season _______ kgs

4. For how long have you been growing tobacco?_______________

5. For how long do you use the same field for tobacco production?________

5. Do you increase the size of your field every year?

   Yes______ No _______

7. If yes, by how many hectares every year? __________ha

8. Why do you expand your farm? Explain

   ____

   ____

   ____

9. If your answer to question 5 is No, why?

____

10. Do you cure the tobacco on your farm?

Yes _____ No _____

11. If Yes, what method of curing do you use?

Sun-curing _____ Flue curing _____ Air curing _______

12. If No, what do you do with it? Explain

____

____

13. If your answer to question 9 was Yes, what type of barn do you use for curing?

____

14. How many days does it take to cure tobacco in a barn?________ Days

15. What factors have an influence on the number of days spent on curing tobacco?

____

____

16. Can you give an estimate of the quantity of wood you used to cure tobacco in;

1997/1998 ____________ha Amount of wood _________cords

1998/1999 ____________ha Amount of wood _________cords

17. Where do you sell your tobacco?________________________________

18. Where do you find your supplies of wood for curing?

____

19 How many kilometres do you travel to obtain your wood for curing tobacco?

____

20. Do you have any problems in acquiring this wood? Explain

____

____

21. What type of wood do you use for curing?

Wet______ Dry _______

22. What other uses do you make of the wood you collect?

____

23. If you have problems, how do you intend to overcome them?

____

____

24. Have you planted any trees on your farm?

Yes _____ No ______

25. If Yes, why? _______________________________________

26. If No , why? _______________________________________

27. If a reforestation programme was initiated would you be willing to participate? Give reasons for your answer;

____

____

THE END
THANK YOU VERY MUCH

APPENDIX II

Miombo woodlands, forest cover change and tobacco development in continental Africa, 1990- 95

Country	Miombo			Forest cover change* 1990-95		Tobacco production			Tobacco area		
	Surface (1986)		As % of country			1989/91 (1000 ton)	1995 (1000 ton)	As % of Africa	1989/91 (1000)	1995 (1000)	Total change (%)
	(km^2)	(% of total)		(1000)	(% of total)						
Zimbabwe	100 858	3.0	25.3	-50	-0.6	146	198	42.0	63	82	+30
Malawi	54 119	1.6	41.9	-55	-1.6	100	129	27.4	102	130	+28
Tanzania	443 484	13.2	48.0	-323	-1.0	13	28	5.9	25	32	+28
South Africa	77 407	2.3	6.3	-15	-0.2	32	22	4.7	24	14	-42
Kenya	5 164	0.2	0.9	-3	-0.3	10	10	2.1	4	4	0
Uganda	16 282	0.5	6.8	-59	-0.9	4	7	1.5	5	8	+60
Angola	600 304	17.9	49.5	-237	-1.0	4	4	0.9	8	8	0
Rwanda	4 427	0.1	22.9	-2	-0.2	3	4	0.9	3	3	0
Zambia	447 858	13.3	59.9	-264	-0.8	5	3	0.6	4	3	-25
Congo/ Zaire	1 035 936	30.9	45.9	-740	-0.7	3	3	0.6	6	6	0
Mozambique	463 507	13.8	60.4	-116	-0.7	3	3	0.6	3	3	0
Burundi	12 699	0.4	47.4	-1	-0.4	4	1	0.2	4	1	-75
Congo	66 185	2.0	19.5	-42	-0.2	2	1	0.2	n.d.	n.d	n.d
Botswana	1 528	0.1	0.3	-71	-0.5	0	0	_	0	0	_
Namibia	1 581	0.1	0.2	-42	-0.3	0	0	_	0	0	_
Swaziland	4 690	0.1	26.1	0	0	0	0	_	0	0	_
Gabon	20 864	0.6	8.0	-91	-0.5	0	0	_	0	0	_
TOTAL	3 356 895	100.1	27.6	-2 111	-0.6	326	413	87.6	247	291	+18

Source: Geist, H in Abedian, I *et al.* (eds) (1994) p.245

* Represents annual forest change

APPENDIX 111

Sampling plan

Type of farmer (strata)	Total population	Number sampled
Commercial farmers on private land	18	6
Former TBZ tenant farmers	48	16
Farmers on communal land	87	29
TOTAL	**153**	**51**

Total Sample (N) = 51

Commercial Farmers on private land $\frac{1}{3} \times 18 = 6$

Farmers on former TBZ land $\frac{1}{3} \times 48 = 16$

Farmers on communal land $\frac{1}{3} \times 87 = 29$

APPENDIX 1V

The Kruskal-Wallis H-test

HYPOTHESES

H_o: There is no significant difference in the quantity of wood used by commercial farmers on private land, those on former TBZ land and farmers on communal land in the study area.

H_i : There is a significant difference in the quantity of wood used by commercial farmers on private land, those on former TBZ land and farmers on communal land in the study area.

H- test computation formula

$$H = \left[\frac{12}{N(N+1)}\right]\left[\sum \frac{R_i^2}{n_i}\right] - 3(N+1)$$

where:

N = Sample size
H = Test statistic
3 and 12 are constants
R_i is the sum of ranks in the ith group
n_i is total number of scores in the ith group
i is the number of the group from 1to k

Ebdon's Correction Factor (for correcting ties)

$$1 - \frac{\sum (t^3 - t)}{n^3 - n}$$

Where n = Sample size

t = number of tied ranks

Results of the Kruskal-Wallis H-test

N	51
Significance level of testing	0.05
H- Observed	16.55
H- Critical	5.99
Degrees of freedom	2
Decision	H_o rejected

CONCLUSION

Since the critical value is less than the observed value, the null hypothesis is rejected and hence the conclusion that there is a significant difference in the quantities of wood used by the different categories of farmers.

APPENDIX V

The Mann-Whitney U-Test (A)

HYPOTHESES

H_o: There is no significant difference in the quantity of wood used by commercial farmers on private land and those on former TBZ land in the study area.

H_i : There is a significant difference in the quantity of wood used by commercial farmers on private land and those on former TBZ land in the study area.

U-Test Computation Formula

$$U = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

where U = Test statistic

n_1 is total number of scores in group 1
n_2 is total number of scores in group 2
R_1 is the sum of ranks in group1

Results For Mann- Whitney U-Test

n_1 (Commercial farmers on private land)	6
n_2 (Farmers on former TBZ land)	16
Significance level of testing	0.05
Observed U-value	96
Confidence interval	16-80
Decision	H_o rejected

CONCLUSION

The observed value between commercial farmers on private land and those on former TBZ land lies outside the confidence interval and hence the rejection of the null hypothesis at 0.05 significance level. This means that there is a significant difference in wood usage between these groups of farmers.

APPENDIX VI

The Mann-Whitney U-Test (B)

HYPOTHESES

H_o: There is no significant difference in the quantity of wood used by small-scale farmers on former TBZ land and those on communal land in the study area.

H_i : There is a significant difference in the quantity of wood used by small-scale farmers on former TBZ land and those on communal land in the study area.

U-Test Computation Formula

$$U = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

Z_u formula for large samples

(Used for transforming U to Z values for samples greater than twenty)

$$Z_u = \frac{U - \frac{1}{2}(n_1 n_2)}{\sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}}}$$

Results For Mann- Whitney U-Test

n_1 (Farmers on former TBZ land)	16
n_2 (Farmers on communal land)	29
Significance level of testing	0.05
Observed U-value	1.091
Confidence interval	$-1.96 < Z_u < +1.96$
Decision	H_o not rejected

CONCLUSION

The observed value between small-scale farmers on former TBZ land and those on communal land lies within the confidence interval, meaning that the null hypothesis is not rejected at 0.05 significance level. Therefore, there is no significant difference in wood usage between these groups of farmers.

APPENDIX VII

The Mann-Whitney U-Test (C)

HYPOTHESES

H_o: There is no significant difference in the quantity of wood used by commercial farmers on private land and those on communal land in the study area.

H_i : There is a significant difference in the quantity of wood used by commercial farmers on private land and those on communal land in the study area.

U-Test Computation Formula

$$U = n_1 n_2 + \frac{n_1(n_1+1)}{2} - R_1$$

Z_u formula for large samples

(Used for transforming U to Z values for samples greater than twenty)

$$Z_u = \frac{U - \frac{1}{2}(n_1 n_2)}{\sqrt{\frac{n_1 n_2 (n_1 + n_2 + 1)}{12}}}$$

Results For Mann- Whitney U-Test

n_1 (Commercial farmers on private land)	6
n_2 (Farmers on communal land)	29
Significance level of testing	0.05
Observed U-value	3.81
Confidence interval	$Z_u \geq + 1.96$
Decision	H_o rejected

CONCLUSION

The observed value between commercial farmers on private land and those on communal land lies outside the confidence interval and hence the rejection of the null hypothesis at 0.05 significance level. This means that there is a significant difference in wood usage between these groups of farmers.

APPENDIX V1II

Pearson's Product – Moment Correlation (A)

Correlation between years in tobacco production and quantity of wood to cure a tonne of tobacco

HYPOTHESES

H_o: There is no significant likelihood that with more years in tobacco production, the quantity of wood to cure a tonne of tobacco will be reduced.

H_i : There is a significant likelihood that with more years in tobacco production, the quantity of wood to cure a tonne of tobacco will be reduced.

Correlation Results

Years	Pearso Correlation	1.000	-.431
	Sig. (1-tailed)	.	.001
	N	51	51
Wood	Pearson Correlation	-.431	1.000
	Sig. (1-tailed)	.001	.
	N	51	51

** Correlation is significant at the 0.01 level (1-tailed).

CONCLUSION

The inverse correlation of -.431 between the number of years one has been in tobacco production and the quantity of wood used to cure a tonne of tobacco is significant. The null hypothesis has been rejected. Therefore, there is likelihood that with more years in tobacco production, the quantity of wood to cure a tonne of tobacco will be reduced.

APPENDIX IX

Pearson's Product – Moment Correlation (B)

Correlation between field size and yield

HYPOTHESES

H_o : There is no significant relationship between field size and yield of tobacco.

H_i : There is a significant relationship between field size and yield of tobacco.

Correlation results

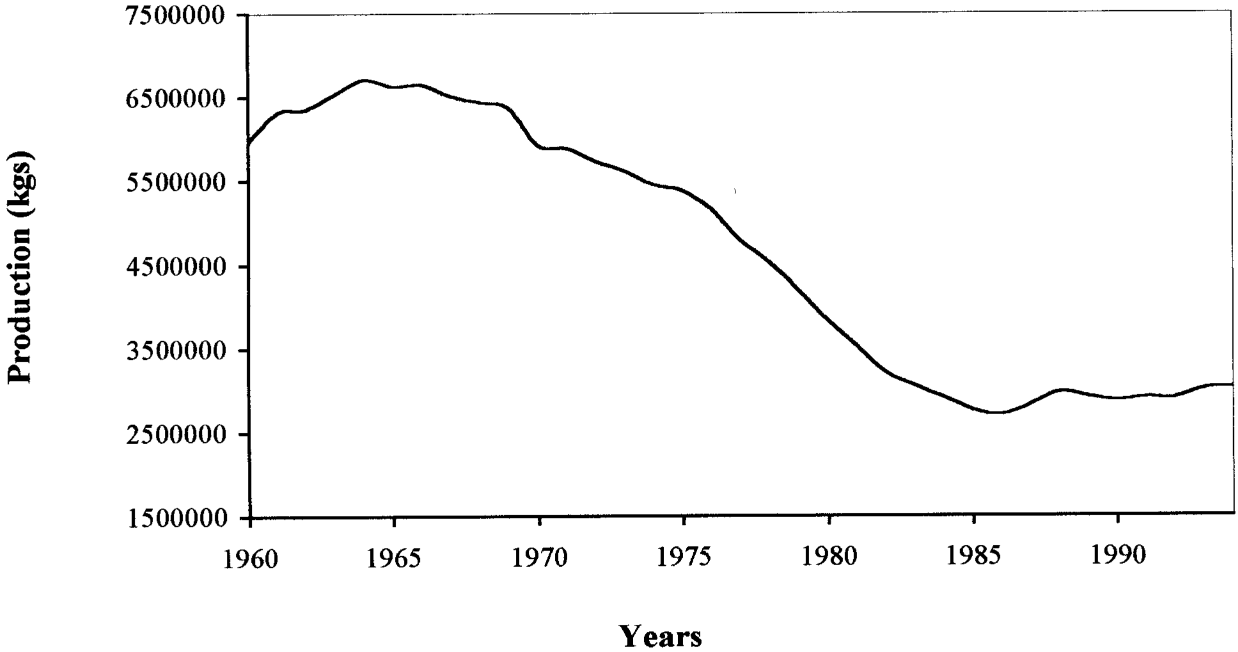
Hectarage	Pearson Correlation	1.000	.983
	Sig. (2-tailed)	.	.000
	N	51	51
Production	Pearson Correlation	.983	1.000
	Sig. (2-tailed)	.000	.
	N	51	51

** Correlation is significant at the 0.01 level (2-tailed).

CONCLUSION:

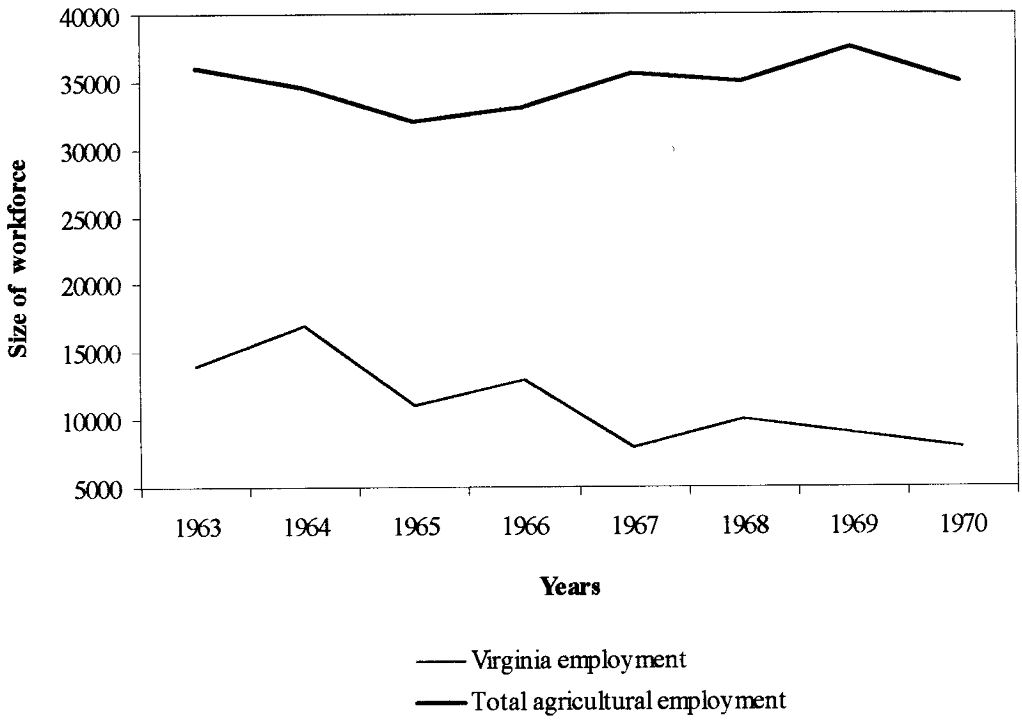
The correlation co-efficient of .983 entails a very strong positive correlation between field size and yield of tobacco. The null hypothesis has been rejected. This means that the larger the field, the more the yields.

APPENDIX X



11-Year moving average trend of national virginia tobacco production, 1955-99

APPENDIX XI



Employment in the agricultural sector, 1964- 1970

APPENDIX XII

Tobacco hectarage, yield and cleared area in Choma district, 1990-1999

	YIELD (kgs) A	PLANTED AREA (ha) B	CLEARED AREA (ha) C	WOOD VOLUME (m^3) D
1990/91	952 914	476.46	470.95	67656.89
1991/92	971 761	485.88	480.27	68995.03
1992/93	924 599	462.30	456.96	65646.53
1993/94	824 403	412.20	407.44	58532.61
1994/95	808 590	404.30	399.62	57409.89
1995/96	1 006 719	503.36	497.54	71477.05
1996/97	1 032 000	516.04	510.04	73272.00
1997/98	1 291 182	645.59	638.13	91673.92
1998/99	1 341 296	670.65	662.90	95232.02

Source: TBZ and TAZ tobacco production data, computation from field data

Calculation of the rate of deforestation

Deforestation rate between 1980 – 1990[1] (A) = 688.8 hectares

Average annual rate of wood clearance for curing tobacco (B) = 472.65 hectares

∴ B/A x 100 = 69% of deforestation attributed to tobacco production.

Calculation of the volume of wood (D)

Average volume of wood per tonne = 71m^3 (110.10 m^3 + 92.31 m^3 +11.33 m^3 /3)
(per tonne of cured tobacco for all classes)

∴ If 1000kg = 71m^3
Then A kgs = Dm^3 (volume of wood)

Where ;
A = tobacco production in a particular year (column A).
D = estimated wood requirement for tobacco produced in the same year (column D).
∴ To obtain the required quantity of wood (D) corresponding hectarage of land shown in column C has to be cleared, (Based on Chidumayo's (1997) estimates of one hectare = 143.66 m^3)

Note: The hectarage of the cleared area (column C) is almost equal to the tobacco planted area (B) and hence the conclusion that a given hectarage of tobacco requires clearing an equivalent hectarage of land to obtain fuelwood for curing.

[1] The calculation is based on the annual deforestation rate established for this period and the same is used to estimate tobacco-related deforestation for the period after 1990 due to data limitations cited in b (p.24)

APPENDIX XIII

Cost, cash returns and labour inputs of a number of crops (1980)

	V/ TOBACCO	MAIZE	COTTON	S/FLOWER	G/NUTS
Yields Kg/ha	1050	2250	700	400	960
Return (K)	1207.50	292.50	316.50	108.00	336.00
Production costs	549.20	90.40	120.50	14 .30	66. 40
Net returns (K)	658.30	202.10	196.00	93.70	269.60
Person-days of labour required/ha/season	778[a]	135	137	84	234
Net return / person-day of labour (K)	0.80[b]	1.50	1.40	1.10	1.20
Return / production costs (K)	2.20[c]	3.24	2.63	7.55	5.06

Source: Ministry of Agriculture, 1980, FAO AGRIPLAN.

a Number of days of labour per person per hectare required for tobacco production in one season.

b The ratio between Net Return to Labour (K658.30 : 778days).This means one day of labour per person yields a Net Return of K 0.8. This is lower compared to other crops.

c The ratio between Return to Production Costs (K1207.50 : K549.20). This means one unit of production cost yields 2.20 units of the production cost, which is the Return. This is also lower compared to other crops.

APPENDIX XIV

Approximate cost to grow one hectare of virginia tobacco

(Small- scale growers)

Yield	1500kg/ha	
Estimated Price (1998)	US$ 1.75	K3,448
Revenue	US$ 2,625	K5,151,250
Direct input cost	US$ 1,487.70	K2,930,772
Gross margin/ha	US$ 1,137.30	K2,240,478
Conversion Rate (Dollar : Kwacha)	US$ 1	K 1,970

Source: Tombwe Extension Services Ltd, 1998,TAZ.

Ratio of Return (Revenue) to Production Cost (Direct input cost) = K5,151,250 : K2,930,772 = 1.76

This means that one unit of production costs gives a return of 1.76 units of the input (production cost). This shows a reduction in the profit margins from 1980 where the Return/Production ratio was at 2.20.