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TROPICAL
FORESTRY
PAPERS

27

Patterns of Farmer Tree Growing in Eastern Africa: A Socioeconomic Analysis

by
Katherine Warner



OXFORD FORESTRY INSTITUTE
DEPARTMENT OF PLANT SCIENCES
UNIVERSITY OF OXFORD

INTERNATIONAL CENTRE FOR
RESEARCH IN AGROFORESTRY
NAIROBI

1993

Cover illustration (photo: P.A. Dewees)

Trees in a farm landscape in Central Province, Kenya

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South Parks Road,
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International Centre for
Research in Agroforestry,
Nairobi,
Kenya.

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The study design was developed in collaboration with the project leader at the OFI, Mr J.E.M. Arnold, who also reviewed and commented on drafts of the component and overall reports as they were developed. Additional advice and review comments were provided by Dr P.A. Dewees of the OFI.

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An earlier version of the regional paper was presented at a Workshop on Socio-economic Aspects of Treegrowing by Farmers organised by the OFI and the Institute of Rural Management in Anand, India, and held at the latter. This revision has tried to incorporate the suggestions made at that meeting, and by my collaborators from OFI and ICRAF, but any inaccuracies which appear in the paper are mine.

FOREWORD

The science of agroforestry was born from empirical observations of how rural households and farmers integrate, manage and utilize a wide array of tree types in their farming systems. Preliminary descriptive studies of agroforestry systems around the world have identified about 70 different uses households make of such trees, to satisfy their basic needs for food, health, shelter, income, security and welfare.

In an effort to further our knowledge, this study presents the results of a major attempt by two international institutions, the Oxford Forestry Institute and the International Centre for Research in Agroforestry, to collect, organize and synthesize secondary and primary data in Eastern Africa which shed light on the key socio-economic factors affecting farmers' decisions about the growing of trees. The study identified important explanatory variables in this respect, such as tenure rights, crop and livestock management, availability of tree based products, market opportunity, as well as factor supply and costs, cultural attitudes, sustainability concerns and governmental interventions. The information was obtained from eight countries in the region: Burundi, Kenya, Malawi, Rwanda, Tanzania, Uganda, Zambia and Zimbabwe. Since these countries represent a wide diversity of natural environments, cultures, population density, land use systems and development potentials, these results have strategic value not only in the study region but also in other parts of the world.

We hope that this publication, together with others on the topic, would substantially enhance the science and practice of agroforestry. This study in particular will assist a wide range of professional users. Institutional policy makers and leaders will find that it improves understanding of the effect of their policies on village and household behaviour; educators and trainers will have a richer, up-to-date source of qualitative and quantitative information; extension and rural development specialists will be able to draw on it to establish a better picture of local knowledge and skills about people and trees, relevant to making new recommendations about management of trees in farming systems.

Most importantly, we hope that this publication will contribute in ways that enable rural households and farmers to enjoy in full the socio-economic benefits of multipurpose trees and agroforestry on their lands.

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Research in Agroforestry

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INTRODUCTION

The primary objective of the project was to investigate the factors affecting farmers decisions about the growing (planting and retaining) of trees as part of their farming systems. This was accomplished through the examination of patterns of tree growing in eight east African countries: Burundi, Kenya, Malawi, Rwanda, Tanzania, Uganda, Zambia and Zimbabwe.

1. Methodology

Information was obtained from the literature, from unpublished records from research and projects, and by discussion with researchers working in this and related areas in each of the eight countries. The information was assembled and analyzed within a framework which distinguished major agroecological zones, and within each zone major land use systems. The classification used was based wherever possible on that developed by ICRAF and its national collaborators, in the course of the AFRENA country studies to define agroforestry potentials and research needs. Country visits and contacts with in-country researchers were organized through the AFRENA network.

The framework for the analysis and information search was based on a hypothesis, developed during an earlier and broader literature survey, that in addition to agroecological and land use characteristics, tree growing by farmers is related to the following factors:

- Tenure and rights
- Agriculture and livestock management practices
- Rural dependence on forest products and availability of supplies from existing tree stocks
- Commoditization of tree products, size of markets, access markets, etc.
- Factor availability and cost to the farmer
- Cultural and attitudinal factors
- Sustainability, stability and risk management
- Government and other outside interventions

Considerably less relevant information was available than had been expected. Moreover, only a small part of it provided quantitative measures of these factors; most of the data are of a descriptive, localized, and qualitative nature. Within the agroecological zones, the diversity of land use systems localized the data still further. Initial attempts to organize the information using a computerized data base foundered on these limitations to the quantity and quality of the data available. The database, developed from the ISIS system, required a level of precise information that was rare in the literature.

A basically descriptive approach was therefore adopted. The patterns of tree growing were first assembled and analyzed at the country level. For each country, a report based on the agroecological zones was prepared which provided both general background information of the country, and detailed information of the above factors for one or more case studies. An attempt was made to identify existing patterns of tree growing, the factors that motivate and support tree planting by small farmers, and the impact of outside interventions. Within each country the reports assemble information designed

to answer the following questions for each agroecological zone:

1. Where are farmers planting or not planting trees?
2. How does tree planting relate to agroecological zone, cultural traditions and values?
3. What incentives are there for tree planting?
4. How does tree planting by farmers relate to government promotional and extension efforts?

The findings of these reports were then integrated and aggregated to the eight-country regional level. This regional report focuses on patterns of tree growing which are found more widely than in just one land-use system, agroecological zone or country; and attempts to identify broader relationships between farmer use of trees and the various factors explored in the study.

2. Definition of zones, agroecological zones and land use systems

The study region is divided by AFRENA into two major zones: the Bimodal Highlands and the Unimodal Plateau. The Bimodal Highland Zone includes the countries of Kenya, Uganda, Burundi and Rwanda, while the Unimodal Plateau includes the countries of Tanzania, Malawi, Zambia, and Zimbabwe (see Figures 1.1 and 1.2). The Humid Tropics zone also occurs in the study area, but it is relatively minor zone in the region and only includes sections of the Tanzanian and Kenya coast and some lakeside areas.

Each zone was further delineated into agroecological zones (see Figure 1.2) based on altitude, rainfall, and in some instances soils. In contrast to the zones, which span the whole region, the agroecological zones are delineated country by country and reflect specific in-country zonal specifications. The agroecological zones are linked to land use systems (LUS) - resource management systems which display a distinctive combination of environment, technology and user characteristics. Both within country and cross nationally there was great variation in the land use systems in each agroecological, especially those based on microenvironmental adaptation, cultural factors and historical experience.

Delineation of Land Use Systems

Region-->Zones-->Countries-->Agroecological Zones-->Land Use Systems

Since Zimbabwe was not included in the AFRENA country documents, decisions had to be made as to the zone, agroecological zone, and land use classification. The rainfall pattern and altitude of Zimbabwe placed it within the Unimodal zone. A classification system that is widely accepted in Zimbabwe by both government ministries and researchers was utilized for the agroecological zone delineation. This system is primarily concerned with the amount of rainfall and agricultural potential. Delineation of land use systems was based on case study sites within the agroecological zones.

Limitations were imposed on the study by the lack of in-depth data, the large number of agroecological zones and land use systems, and the time constraints of the project. Decisions were made on a country by country basis as to which agroecological zones and land use systems to include in the analysis. The decision to include a land use system was based on the importance of the land use system to the country (focus area for projects, economic importance, size of population, etc.) and the quality of the data. In Tanzania, for example, only two out of a possible seven land use systems were included. The two land use systems chosen were (1) the major livestock area which has undergone extreme deforestation and is now the focus of the largest afforestation efforts in Tanzania, and (2) the extremely productive coffee banana garden land use system of the Bimodal Highland zone.

The **Bimodal Highland Zone** is defined as follows:

Altitude range of 1000-2500 m above sea level

Rainfall of at least 1000 mm per year

Crop growing period of 90-270 days

In some areas of the zone (eg. Burundi and Rwanda) very little natural vegetation remains. Where natural vegetation does occur it is usually forest, although the particular species composition varies.

For the purposes of this study the Bimodal Highland zone has been expanded to include the Tanzanian Bimodal North Highlands. The area of a country in the zone varies from 85 percent (Burundi) to less than 5 percent (Tanzania) (see Table 1.1).

Table 1.1 Countries and land area in the Bimodal Highland zone

Country	Land area (Km ²)	% of country's land area
Kenya	72,000	15
Uganda	96,000	40
Rwanda	16,000	62
Burundi	23,000	85
Tanzania	2,000	<5

Source: Hoekstra 1988:2

It should be noted that certain areas of the Bimodal Highland zone, such as those around Lake Victoria in Uganda and Kenya, experience rainfall throughout the year rather than in a marked bimodal pattern. However, these land use systems meet the other criteria for the Bimodal zone, and are included in the AFRENA papers, and therefore they have been placed in the Bimodal Zone. Also, within the Bimodal zone there are large areas with less than 1000 mm of rainfall per year. These areas do not meet the criteria for the AFRENA Bimodal zone since they are not regarded as having high agricultural potential. One land use system, the Sub-Humid/Semi-Arid land use system in Kenya, was included so as to provide information on the lower rainfall areas.

The **Unimodal Plateau Zone** is defined as follows:

Altitude 600 - 1500/1600 m

Rainfall is in a unimodal pattern 600 mm - 1500 mm

Crop growing period of 90-270 days. The 180 day growing day Isoline was used to further delineate the wetter and drier drought prone areas.

Vegetation mainly consists of miombo (*Brachystegia*, *Julbernardia* and *Isoberlinia* are the major species) or Acacia woodlands (*Acacia*, *Piliostigma* and *Combretum*).

The proportion of each country falling within the Unimodal Plateau zone ranges from 36 percent (Zimbabwe) to 86 (Zambia) percent (see Table 2).

Table 1.2 Countries and land area in the Unimodal Plateau zone

Country	% of country's land area
Malawi	43
Tanzania	41
Zambia	86
Zimbabwe	36

Source: MATF and ICRAF 1986, NATF and ICRAF 1988, ZATF and ICRAF 1989, Campbell, 1987

As can be seen from Tables 1.1 and 1.2, only a part of each country actually falls within either the Bimodal Highland or Unimodal Plateau zone. However, the areas in these zones are the high potential parts of each country, and generally support the highest population densities. In Kenya, for example, 50 percent of the country's population live in the Bimodal Highlands, which comprise only 15 percent of the land area.

Since the objective of the country reports was to analyze the entire country, the present study included certain areas (for which data were available) which had been excluded from the AFRENA classification because they exhibited lower or higher altitude and rainfall than the parameters of the AFRENA zones. Rwanda, for example, is included within the AFRENA Bimodal Highland zone. However, a large portion of Rwanda, the Kagera Piedmont, is not within the parameters of the Bimodal Highlands and was therefore excluded from the AFRENA analysis. Although the Kagera Piedmont lies outside the highlands, it is an important target area for internal migration in the country and for development interest. The Kagera Piedmont was, therefore, delineated into an agroecological zone, linked to a land use system, and became one of the two land use systems analyzed in the Rwanda country report.

As a result of the expansion of the criteria the chosen land use systems are placed within a framework based primarily on the distinction between bimodal and unimodal rainfall patterns. This is an extremely broad division and both of these zones contain a wide range of natural environments. The Bimodal Highland zone, for example, has an altitude range of 1500 m which, when combined with over 1000 mm of rainfall a year,

allows for a very large number of possible land use systems.

The agroecological zones/land use systems presented in Tables 2.4 and 2.5 are the major land use systems for which data were available. For the purpose of this paper, land use systems were chosen for which there were data not only on the farming system, but also on the household, environment, and local economy. The data of sixteen out of over seventy delineated land use systems in the region are presented in the tables (see also Figure 1.2). These sixteen land use systems contain over twenty-five per cent of the entire population in the region. With the exception of Rwanda and Burundi, both of which are included in the High Plateau land use system, each country in the region is represented in the tables by at least two land use systems. In the individual country reports, data concerning smallholder management of trees were also included from land use systems for which the data were too anecdotal or incomplete for an in-depth analysis. As the focus of the project was on smallholder farmers and trees, pastoralist land use systems were not included in the country reports.

Figure 1.1
AFRENA ZONES

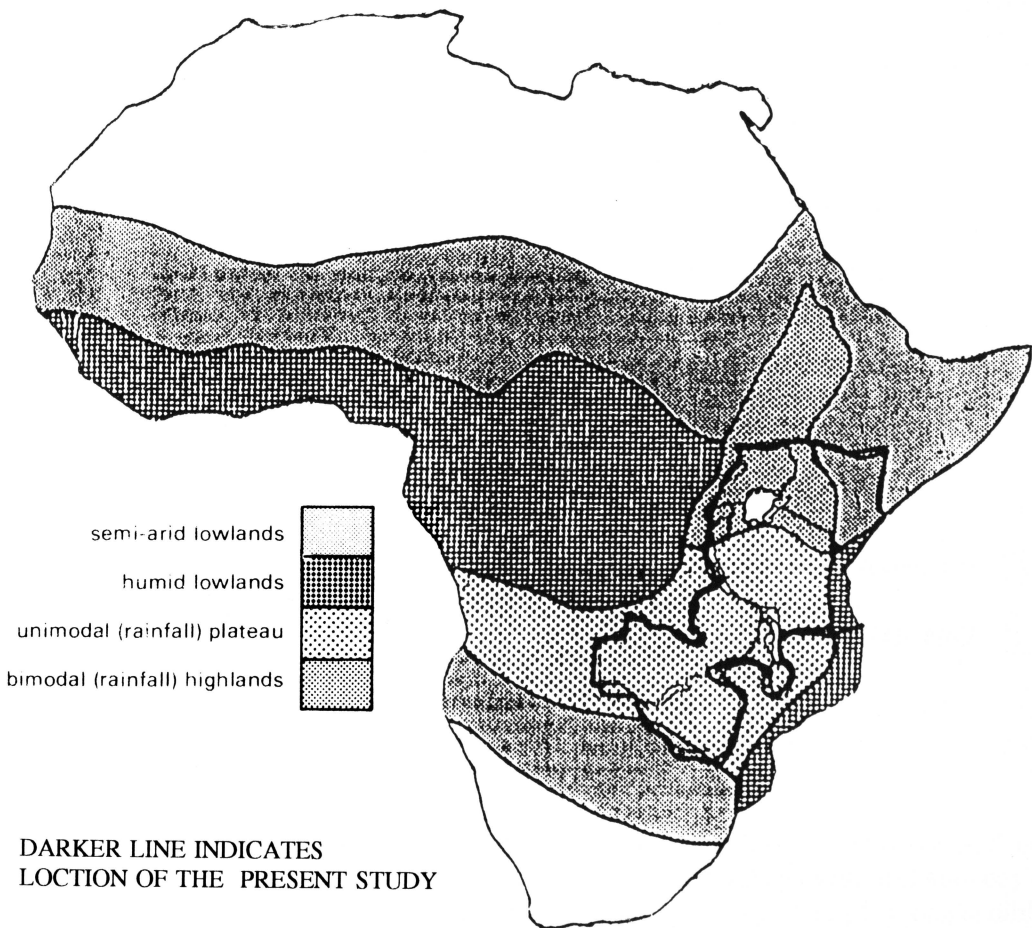


Figure 1.2
LAND USE SYSTEMS IN THE STUDY AREA

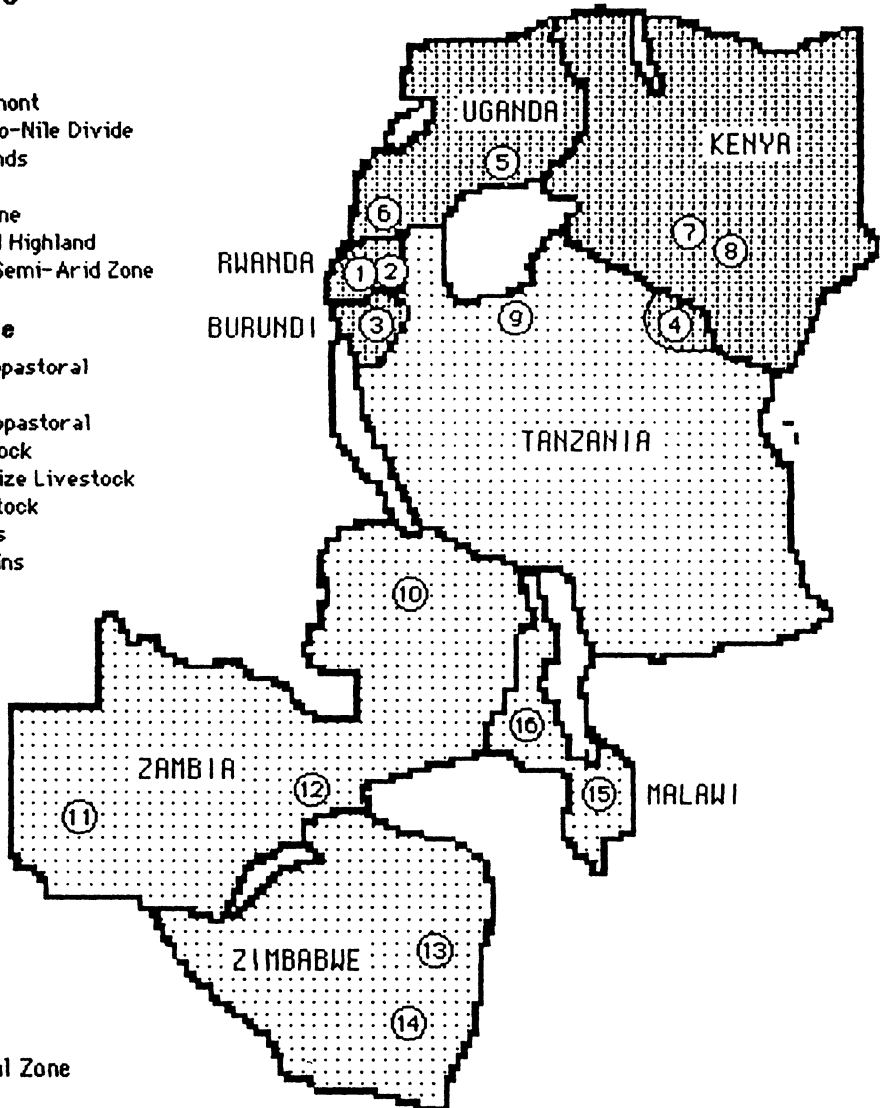
Land Use Systems

Bi-modal Zone

1. High Plateau
2. Kagera Piedmont
3. Central Congo-Nile Divide
4. North Highlands
5. Lakeshore
6. Kigezi Montane
7. Coffee-based Highland
8. Sub-Humid/Semi-Arid Zone

Unimodal Zone

9. Sukuma Agropastoral
10. Chitemene
11. Barotse Agropastoral
12. Maize Livestock
13. Region III Maize Livestock
14. Cereal Livestock
15. Maize/Pulses
16. Lilongwe Plains



REGIONAL PATTERNS

1. Introduction

This eight country region contains a diversity of natural environments, culture, and land use systems. It is an economically poor region which is not self-sufficient in food, and has the highest population growth rates (Table 2.1) and deforestation rates in the world (RWEDP, 1990). The role of trees in the response of rural households to the decline of forest, fragmentation of land holdings, degradation of grazing land, and falling crop yields was regarded as a critical concern which needed to be explored.

Table 2.1 Population, density, growth and per capita income

Country	Population*	Population Density (Km ²)	Population Growth	Per Capita Income (US\$)**
Burundi	5,000,000	180	3.0	241
Kenya	23,000,000	20	3.9	330
Malawi	8,000,000	65	2.9	164
Rwanda	7,000,000	250	3.8	301
Tanzania	22,000,000	30	3.4	180
Uganda	17,000,000	70	3.0	260
Zambia	7,500,000	10	3.3	248
Zimbabwe	9,000,000	23	3.1	585
TOTAL	98,500,000			

* 1990 estimates

** 1987 Source: World Resources Institute/UNEP/UNDP 1990

This paper reports the findings at the level of the eight-country region. In the first section there is a detailed presentation of the findings concerning land use systems and the pattern of tree growing that exists within the context of the country and zone. Within the context of the household's evaluation of resource availability, analysis of the findings based on the hypothetical factors is conducted. This is in turn followed by a summary of the findings which provides an overview of the main patterns of tree growing that have emerged.

As was discussed in the Introduction, the study region comprises two major zones, the Bimodal Highland and the Unimodal Plateau -which constitute the high potential areas within each country, and the areas of highest population concentration. These two zones are defined primarily on the basis of altitude, rainfall and crop growing period. The Bimodal Highland zone includes the countries of Kenya, Uganda, Burundi and Rwanda, while the Unimodal Plateau includes the countries of Tanzania, Malawi, Zambia, and Zimbabwe (see Figures 1.1 and 1.2). Each zone is then subdivided into agroecological zones, and each agroecological zone into land use systems.

Tables 2.4 and 2.5 present data on thirty five variables for each of the chosen land use systems concerning the agroecological zone, household, farming system, and sources of income. The differences within and between the major zones are readily discernible. The land use systems in the Bimodal zone reflect the inherent potential of higher

rainfall: more people are able to be supported in an area because families are able to subsist on a small field; there is less reliance on livestock despite the growing importance of dairy cattle; and there is increased involvement in export crops such as coffee and tea. In the drier Unimodal areas there is a greater emphasis on livestock, especially with the availability of a sufficient grazing area.

Bimodal	Unimodal
Higher population densities	Heavier reliance on gathering wood and cow dung for fuel
Smaller farms	land preparation by plough or hoe and plough
Greater preparation of fields	More emphasis on (value) on livestock component
Land preparation usually by hoe	Areas for community grazing
Export orientated cash crops	
High proportion of stall fed livestock	
Hedges or fences	

There are also similarities which occur in the land use systems of both zones:

Both Zones
Outmigration of males
Security of tenure (although no rights of exclusion)
Seasonal labour shortages
Dependency on off-farm labour income and remittances
Beer brewing (with heavy fuel demands)
Increasing reliance on new world crops: maize, cassava, potatoes, sweet potatoes, beans

These similarities reflect the declining condition of the rural household throughout east Africa which is experiencing both labour shortages and a growing dependency on off-farm income. The rural household is changing the 'traditional' crop repertoire in response to the negative change in household labour availability and the increasing demand for income.

Despite these similarities, it is important to recognise that both these zones contain a wide range of natural environments. For all the diversity, certain multicountry land use patterns did emerge to some extent in the highlands of the Bimodal Highland zone. However, in the Unimodal Plateau zone there were wide differences in the amount of rainfall, altitude, and soils, and when these factors were combined with government policy, and economic and cultural differences, multicountry land use patterns did not

emerge. Nevertheless, within the eight country project area a number of broad patterns did emerge regarding farmers and tree management.

2. Patterns of Trees Growing by Land Use System

The data for the tree component in each of the land use systems are presented in Tables 2.6- 2.24. The varying formats of the tables reflect the variation in the data. Given the differences in the tree growing practices in the land use systems, as well as the variation in the data itself, uniformly comparable data were not available for each of the land use systems.

Table 2.2 Land use systems

Bimodal	Unimodal
High Plateau	Sukama Agropastoral
Kagera Piedemont	Chitemene
Central Congo-Nile Divide	Barotse Agropastoral
North Highlands	Maize Livestock
Lakeshore	Region III Maize Livestock
Kigezi Montane	Cereal Livestock
Coffee-based Highland	Maize/Pulses
Sub-Humid/Semi-arid	Lilongwe Plains

Bimodal Highland Zone

In the High Plateau of Rwanda trees are planted "on farm boundaries, around homesteads and in the fields. Woodlots are planted on hillsides and some planting takes place on agricultural land lying fallow" (Gibson and Mueller, 1987:12). Fruit trees are almost universal, especially avocado, but non-fruit trees are planted as well, with *Eucalyptus* spp., *Euphorbia tirucalli*, *Ficus* spp., *Markhamia platycalyx*, and *Grevillea robusta* equally common. In Burundi the same species of trees are found, but are dispersed in the fields as well as planted on the boundaries.

A very large number (52) of indigenous species are retained in the fields and near the home in the CARE site of Gituza. The primary use of the most common species is fuelwood. This is an interesting finding, because in the land use systems in the Unimodal zone (see below) the trees most frequently left in the fields are for fruit, not fuelwood.

Sector nurseries provided seedlings for the majority of exotic fruits and *Eucalyptus* spp., *Cupressus lusitanica*, and *Grevillea robusta*, but farmers also collected seedlings from natural regeneration in the fields. *Eucalyptus* spp. woodlots are planted by farmers who have to cut on-farm trees to obtain fuelwood for the household.

This pattern of trees in the High Plateau is similar to that found in the Kagera Piedmont of Rwanda, the Northern Highlands of Tanzania and the Lakeshore banana-coffee gardens of Uganda. This may be reflective of the cropping system of intensive banana gardens that these land-use systems share. In the High Plateau and Kagera Piedmont systems coffee is monocropped, a mandatory regulation of the governments, but in the Northern Highlands of Tanzania and the Ugandan Lakeshore, coffee is integrated into the banana gardens. The composition of tree species may vary; for example, more fruit trees appear in the Lakeshore system than in the High Plateau, but the general pattern of where trees are planted and the density of trees on the farming landscape appear to be similar.

This pattern is also found to a large extent in the Central Congo-Nile Divide in Burundi, but with a marked difference in species. The trees which so often appear in eastern and southern Africa, mango, *Markhamia* spp., and *Euphorbia tirucalli*, are absent in the Divide. The Divide's extremely poor soils, its high elevation and low temperatures, etc. have resulted in a different choice of trees. *Eucalyptus* spp. with their high tolerance of the soil conditions found in the Divide is the tree genus of most importance and popularity. Fruit trees are less prevalent, and *Euphorbia tirucalli*, almost universally used elsewhere as hedges, is absent.

In the Kigezi Montane land use system trees are mostly found around homesteads, boundaries or in small household woodlots rather than integrated into the cropland. The percentage of households with trees is far smaller than in the Divide, but the location and species are similar. Although absent in the Divide, in the Kigezi Montane two tree species are commonly found, *Euphorbia tirucalli* used as hedges and *Markhamia* spp. in fields and homesteads.

This pattern of trees on boundaries is found in the Coffee Based Highland land use system as well, but there is a much higher proportion of fruit trees in the Kenyan system, and the non-fruit species planted are similar to the species found in the High Plateau.

Unimodal Plateau Zone

In the agropastoral land use systems of the Sukuma and the Barotse, planted trees, especially fruit trees, are found around the homesteads and, in the Barotse system, sometimes in the permanent fields. There are no trees reported planted outside of these areas. Both of these land use systems, it should be noted, report shortages of fuelwood and rely heavily on cow dung and agricultural residue for fuel.

In the Chitemene, Maize Livestock, Region III Maize Livestock, and Cereal Livestock land use systems, exotic fruit trees are found in the homestead and a large number of indigenous tree species are retained in the fields and homestead. The number of exotic fruit trees varies as does the species and number of the trees retained in the fields. In addition to exotic fruit trees, *Eucalyptus* spp. was reportedly planted in the Zambian Maize Livestock system.

In the Lilongwe land use system this pattern of planted fruit trees in the homestead and retained trees in the fields, has been expanded to include a larger number of planted species of non-fruit trees which are found within the homestead: *Eucalyptus* spp., *Cassia*

siamea; *Gmelina* spp., *Toona ciliata* and *Melia azedarach*.

The trees retained in the fields in these land use systems appear to be primarily for food, usually fruit trees, although trees which can be used for animal fodder are also retained. The miombo woodland, the common vegetation cover in much of this zone, is rich in indigenous wild fruits. The fruit trees are protected when the fields are cleared and it is recognized that the trees will bear fruit during the dry season when other foods may be scarce. In Zambia it was found that fruit was a significant part of the diet and was eaten by all family members (Kwesiga and Chisumpa, 1990). Not all indigenous fruit trees are equally valued, and highly favoured trees are more likely to be retained. Over time, this results in the woodlands surrounding the settlements gradually having a higher proportion of preferred fruit trees.

Unlike other agricultural land use systems in the Unimodal Plateau zone, the Shire Highlands Maize/Pulses system's pattern of tree utilization does not include trees retained in the fields, although exotic fruit trees and *Eucalyptus* spp., *Cassia* spp. and *Gmelina* spp. appear around the homestead. This is an interesting feature and at first glance makes the land use system appear to be more similar to the agropastoral systems than to the other agricultural systems in the zone. However, unlike an agropastoral system, livestock plays a minor role in the Shire Highlands. The Maize/Pulses Land Use System has relatively high population density, with the smallest farms in the study area (0.4 ha) fragmented into several fields, on which a series of crops are grown in an intensive system of relay cropping. The relay cropping system shares many characteristics with the land use systems in the Bimodal Highland zone. Current agricultural practices utilize the entire field for annuals with no space allotted for perennials such as trees (see below).

Zonal patterns of trees in farming systems

Environmental factors such as two rainy seasons and higher total rainfall aids farmers in the Bimodal Highland zone in establishing and maintaining trees both on-and off-farm. Farmers in the Unimodal Plateau zone, especially in the drier areas, have to expend both more time and energy in tree establishment and care. In the Unimodal Plateau zone the timing of seedling planting is especially crucial, a factor that is reflected in the lower seedling survival rates in the zone.

General patterns do emerge in each of the zones. In the Bimodal Highland zone, trees are planted on boundaries and homesteads. Trees also found in most of the land use systems at varying densities in crop fields. Exotic fruits are the universally planted trees in the homestead area, but *Markhamia* spp., *Ficus* spp., *Euphorbia* spp., *Cassia* spp., and *Grevillea* spp. are common as well. Indigenous trees are also retained in the landscape, and/or planted. It was unclear in some instances whether the indigenous trees were planted or retained. Planting of indigenous trees does occur, but as in the Coffee-based Highlands system, the farmers in some systems believe that indigenous trees just appear, or are God's work, and hence there is no need to plant them. This lack of planting of indigenous trees could result in their gradual replacement by exotics.

There is a pattern of planted exotic fruit trees in the homestead, and indigenous trees are retained in the homestead and fields throughout the Unimodal Plateau zone. Unlike

in the Bimodal Highland zone, planted trees outside the homestead are rare. Indigenous fruit trees appear of far more importance in the Unimodal Plateau zone than in the Bimodal Highland zone. This may be because of the many fruit trees which are found in the miombo woodlands. This type of woodland is common in much of the Unimodal Plateau zone.

There also appears to be a relationship between livestock and trees; in those land use systems in which the livestock component is important, planted trees outside the homestead area appear to be few in number.

Table 2.3 Zonal Patterns: Location and Uses of Trees

	Bimodal Highland Zone	Unimodal Plateau Zone
Location of trees-		
Retained:	Homesteads	fields and homesteads
Planted:	Boundaries, fields, homesteads	homesteads
Uses of trees-		
Retained:	Fuel	indigenous fruit
Planted:	Exotic fruits, indigenous/exotic trees (esp. <i>Markhamia</i> spp., <i>Ficus</i> spp., <i>Euphorbia</i> spp., <i>Cassia</i> spp., <i>Grevillea</i> spp.)	exotic fruits
Special concerns	Competition between crops and trees	Competition between livestock and trees

There are also similarities within the entire eight country study area. Farmers are planting trees, although perhaps not in the number, location and species that governments in the area might prefer. The farmers' first choice appears to be for fruit trees, a preference that was expressed throughout the area except in the Central Congo-Nile Divide land use system in Burundi where farmers wanted more trees for construction, fuel, and timber. Even in the Chitemene land use system where wild fruits were available and forest cover at some sites was over 70 per cent, farmers planted exotic fruit trees even if they retained indigenous fruit trees in the fields.

Similarities between the Bimodal Highland and Unimodal Plateau zones

Preference:	Exotic fruit trees Multipurpose trees
Location:	Homesteads for exotic fruit trees

There is relatively little information on the sources of the exotic fruit seedlings, yet they are ubiquitous in the farming system, especially the mango in the Unimodal zone and

the avocado in the higher altitudes of the Bimodal zone. Farmers appear to get seedlings from their own fields, neighbours, and non-governmental organizations (NGOs). Fruit trees were not usually included in forestry extension, which focused on 'forestry' species, nor in agricultural extension which in most instances focused on export crops. Yet with little government support farmers throughout the study area have established fruit trees on their farms, and they are interested in increasing the number and improving the quality of their trees.

The farmers also favour multipurpose trees. In the land use systems where livestock is an important component, there is interest in trees that can be used for fodder and other purposes such as poles and timber. In land use systems of high population density, there is interest in trees for poles and construction and those that can be used for fuel or soil improvement. Despite being the major goal of government forestry projects, trees were seldom planted for fuel alone (see below).

3. Analysis

The hypothesis of the study was that tree growing by farmers in eastern and southern Africa was related not only to agroecological and land use systems, but also to certain socioeconomic factors. Each of these factors is considered below in relation to the patterns of tree growing found in the study area.

3.1 Tenure and rights

It has often been suggested that farmers will not plant trees if there are uncertainties as to whether they will continue to have rights of access to their holdings. The implication is that farmers will not make long term investments in their holdings unless there is security of tenure (Migot-Adholla *et al.*, 1990). However, security of tenure does not necessarily mean freehold or individual private tenure. In the study area, except for Kenya, land is held under customary law, and the great majority of farmers appear to feel secure about their landholdings (see Tables 2.4 and 2.5). This is true whether the land is held under customary law or as in Kenya individual private tenure. The current laws vest ultimate ownership of the land in the state. In Kenya, once a title is obtained, all customary rights are "extinguished," but it appears that some degree of administrative control is maintained by the County Councils (Deweese, 1991a; NTF and ICRAF, 1988; Glazier, 1985).

The general pattern of customary land tenure is for a farmer to be given the land by a local authority, such as a village headman or council, in charge of land distribution. The farmer has "rights of avail"; he has land for cultivation, grazing, house site and use of natural resources. These rights may be inherited and the particular kinship system determines if the land will be inherited from mother to daughters, father to sons, or parents to child. In areas of high population density, inheritance may be limited to one rather than all of the offspring. It is a usufruct system, because if the land is not farmed, the rights to it are ended and the land becomes available for redistribution. In some of the land use systems, land can also be acquired through the purchasing or leasing of another person's land.

This land tenure system shows little sign of ending, in fact it may be extending, as indicated by recent changes in Zimbabwe where commercial freehold areas are being transformed into areas for resettlement. In Tanzania, Sukuma farmers did express some uneasiness about their tenure. However, this uneasiness was the result of the Tanzanian villagization program that had moved entire communities from one area to another, and was not due to the customary land distribution system.

The large number of trees found in areas of customary tenure does not support the argument that freehold tenure is necessary for tree planting to occur. What appears to be more important for tree planting is not the right to farm, but the rights of exclusion, specifically, the rights of a farmer to exclude livestock from grazing on the household's fallow fields. If the farmer cannot protect seedlings from livestock grazing in the crop land, trees will only be planted where the farmer has clear rights of exclusion, *eg.* the homestead area.

In land use systems where the livestock component is culturally and economically important, the community leaders are reluctant to allow individuals to assume exclusionary rights. Fencing of cropland, for example, may be prohibited without the permission of the elders. This conflict over grazing areas probably will continue, especially since the community leaders are often the owners of the larger herds. The difference in location of tree planting in the Unimodal and the Bimodal zones may be, at least partially, explained by the communal grazing rights and the importance of livestock found in the Unimodal zone.

Farmers in the Bimodal zone plant trees on the boundaries of fields, claiming the land and, importantly, rights of exclusion. These rights of exclusion have been increasing as the resources in the area decline. As a response to (or coevolving with) this increase, community rights to grazing, fuelwood collection, fruit collection, *etc.*, on individuals' land are declining. Communal areas of woodlands and grazing are also disappearing.

In Kenya, the impact of the new individual private tenure system on tree planting appears to be positive. There is more tree planting on farms which have been adjudicated than on those which are not, but the primary motivation for planting trees may not be security of tenure (Brokensha and Riley, 1987; Shepherd, 1989). Initially individual tenure does encourage tree planting since farmers plant trees to establish the boundaries needed for adjudication of the land holding under the new tenure system. As in other areas of the Bimodal Highlands, these boundaries then serve to establish rights of exclusion. Shepherd (1989), for example, found adjudicated farms had far more trees planted on the boundaries than unadjudicated farms which planted trees in the fields.

However, is this due to the security of tenure under the individual private tenure system? Or is it also due to the change in resource access and the diminishing resources in the area which elicits an increase in tree planting? An argument can be made that it is not just the system of tenure, because farmers perceive their landholdings as secure under both systems. What also appears to motivate farmers to plant trees is the decline of off-farm resources. Brokensha and Riley (1987), for example, noted that among the Mbeere (sub-humid zone) after individual land title was received, tree planting immediately increased, but the authors went on to note that with the communal bush disappearing,

farmers were becoming aware of the need to plant trees to replace those to which they no longer had access. As in the Bimodal Highlands, if the construction material, fuel and fruit were not available off-farm, on-farm sources were being developed.

In the study region, rights to trees are becoming increasingly intertwined with rights to the land on which the trees stand. The planter of the tree is recognized as having rights to the tree, but in the case study land use systems these trees are usually only planted on land to which the planter has pre-existing rights or for which rights will be established once trees are planted. The rights to the trees may become attenuated if the planter of the tree no longer farms the land on which the tree stands. However, in the Unimodal Plateau zone if the trees are planted on crop land to which the community has access for grazing, the landholder usually does not have rights to exclude livestock to protect the seedlings, although this is changing in some communities. Recognized rights to trees retained in crop fields are also common, as are the rights to trees in communal areas when they are given special care, such as weeding, or if they are utilized for a specific purpose, such as hanging beehives.

Since under customary tenure landholdings are increasingly becoming recognized as 'belonging' to individuals (Migot-Adholla, 1990), distinctions between tree tenure and land tenure will probably decline. Currently, in the Bimodal Highland zone, tree and land tenure are becoming synonymous, while in the Unimodal Plateau zone when fields are cleared from bush, recognized rights to trees retained in the crop fields continue to be important.

It has also been argued that lack of individual or freehold tenure will limit access to credit, and therefore discourage tree planting as well as other investments. This has not proven to be a very important factor since farmers are extremely reluctant to use land as collateral for loans. Also, there is little credit available to the small farmer in the region, and what credit does exist is usually tied to cash crop inputs. In order to obtain credit for cash crops, the farmer does not have to use his land as collateral, although he may have to be a large enough producer to qualify for a loan.

3.2 Agricultural and livestock management practices

Agricultural practices

Field preparation/cultivation.

Depending on the particular land use system, fields are prepared by clearing and burning bush, and cultivated by hoe, ox plough, or tractor. The method of field preparation does have some impact on the number of trees retained or planted in the fields. In the chitemene system, such as is found in the Zambia, trees are lopped and topped, the branches carried to another site and then burned. The cutting in one area and burning in another is an adaptation to the slow growing miombo, and allows the tree to resprout and the forest to regenerate quickly. Trees which are highly valued are not felled or burned. Such a system retains trees while transferring the nutrients locked in the vegetation to the acidic leached soils of the fields.

The hoe is more commonly used in the Bimodal Highland zone (in seven out of eight

of the land use systems), while the plough is frequently used in the Unimodal plateau zone (in six out of eight of the land use systems). Ploughing is considered to have a negative impact on tree growing since trees have to be cleared from the field to allow the plough to be used effectively. However, given the retention of trees in the fields in the Unimodal Plateau zone, this might be an overstatement of what actually occurs. Even with ploughing, trees are retained for shade, fruit, fertility, *etc.*

Cultivation by tractors encourages the removal of all trees in the fields, but within the land use systems studied, tractors were used in only the Northern Highlands in Tanzania. The fields which were ploughed by tractor were not the intensively worked banana-coffee homegardens, but the maize fields in the lowlands. Although trees were removed from the crop field, they were still retained and/or planted at the boundaries.

Competition/complementarity

Competition between crops and trees does occur with varying intensity in the land use systems. The farmer weighs the potential gains from the tree with the possible losses from shade, water/nutrient competition, harbouring of pests, *etc.* If the negative consequences of having trees in the fields outweigh the positive ones, the trees are relocated out of the fields and into the boundaries and homestead area.

In the Unimodal Plateau zone, trees are retained in the field because the farmer perceives potential gains from the trees. A tree is retained because it produces fruit, is a good construction wood, has religious significance, or is simply too large to remove. *Acacia albida* is valued and retained throughout eastern Africa in order to improve the yield of crops and providing shade. In the Cereal Livestock land use system in Zimbabwe, crops growing under indigenous fruit trees (*Ficus capensis*, *Ficus burkai*, and *Paranaria curatellifolia*) are recognized as having higher yields than crops elsewhere in the field.

In the Malawi Maize/Pulses Land Use System, trees are found in the homegarden areas, but not in the fields, nor on the boundaries. Farm size is so small (0.4 ha) and fields are so fragmented that trees are perceived as providing too much competition for the annual crops.

The crops grown in a land use system must also be considered as a factor in the inclusion of trees. In the land use systems in the Bimodal Highland zone in which bananas are the dominant crop, trees are well integrated into the fields. The banana does well under shade, and when combined with coffee, produces the mulch for coffee that is often lacking when bananas are not an integral part of the cropping system. Trees complement rather than compete in the banana-coffee garden, and have helped to create a sustainable land use system.

Livestock management

"Trees" could well be substituted for "women" in the anthropological aphorism "cattle are the enemy of women". Where free grazing is prevalent, farmers usually do not have the right to keep cattle out of harvested fields. This discourages the planting of trees in crop fields, and tree growing becomes restricted to the homesteads and other protected areas, such as the fenced fields in the seasonal wetlands.

The result is the pattern found in the Unimodal plateau zone (Sukuma Agropastoral, Barotse Agropastoral, Zambian Maize Livestock, Zimbabwean Maize Livestock, Cereal Livestock land use systems) where trees are not planted outside protected areas. However, trees are retained and may be used for fodder.

In the Bimodal Highland zone, livestock are either far from the fields in communal grazing areas (Gituza site in the High Plateau), individual herds are small in number (Kagera Plateau) and/or are stall fed (North Highlands, Lakeshore, Kigezi Montane, and Coffee based Highlands), and hedges are common. In this agroecological zone, trees can be planted outside of the homegarden areas without a large loss to livestock grazing. The exception to this is the Sub-humid/Semi-arid land use system in Kenya, an agropastoral system similar to those in the Unimodal Plateau zone in which herd size is relatively large, and livestock grazing has inhibited the planting (although not the retention) of trees outside the homestead or protected areas.

Rather than for fodder alone, trees are planted or retained which can also provide fruit, timber, poles, *etc.* Fodder from trees retained in fields or found in the forest can be seasonally important in the Unimodal Plateau zone, while planted trees are of growing importance in the Bimodal Highland zone for stall fed livestock. Farmers in the Unimodal Plateau zone will probably not plant trees in crop fields for fodder, or as noted above for other purposes, unless they have the right to exclude livestock from their fields.

3.3 Rural dependence on forest products and availability of supplies from existing tree stocks

Access to forest resources appears to have a direct bearing on tree planting practices throughout the study area. The amount of forest cover is dependent on the ecozone, population density and land use systems in a zone, and there is a general correlation between forest cover and population density in the study area. The household has basic needs for fuel and construction material which must be met, if not by forest, then by tree planting and/or management. A relationship between the amount of forest cover, household needs, and tree planting is supported by the data.

In the Unimodal Plateau land use systems with low population density and large areas of forest cover (Chitemene, Maize Livestock, resettlement areas in Zimbabwean Maize Livestock), there is not much incentive to plant trees other than exotic fruit trees, because the required building materials, poles, and fuel can be met by the existing stocks.

In Bimodal Highland land use systems in areas of high population density where forests are degraded or nearly absent (High Plateau, North Highlands, Kigezi Montane, Coffee-based Highland land use systems) farmers have to plant trees to meet their tree product needs, have the income to purchase tree products, or be able to shift to substitutes (cow dung and agricultural residues for fuel, bricks for housing, *etc.*). It is not surprising that tree planting increases as population density increases, and access to forest and community reserves declines.

Tree planting appears to be stimulated by the decline in access to especially valued or

needed tree products, for which there is not a readily available substitute. Fruit trees, for example, are usually the first trees to be planted, and although this may have initially been in response to the decline of indigenous fruit trees, exotic fruit such as mango, papaya, guava, and in the highlands, avocado trees are popular and highly valued throughout the region. Diminishing supplies of fuelwood are unlikely to be met by the planting of trees since substitutes often can be found at a lower cost. Even in treeless areas such as Barotse, biomass fuels such as dung and crop residue will be used, or fuelwood will be purchased, rather than trees planted specifically for fuelwood.

Planting trees with fuelwood production as one of the purposes, is more likely to occur when the responsibility for fuelwood starts being shared by men, as in the High Plateau, Kagera Piedmont, and North Highlands land use systems of the Bimodal Highland zone. Even so, it will not be the first priority when compared to other tree products.

Substitutes for other wood needs cannot be made as readily as that of fuelwood. The need for poles and construction materials, for example, are less easily met and more likely to result in tree planting. In addition poles and construction material have a higher potential income value than fuelwood, and this encourages the planting of trees for more products than just fuelwood.

Trees which provide fodder are commonly retained in fields. Planting of trees for fodder alone is not common, since, as with fuelwood, trees which are multipurpose and provide fruit, fuel, timber, and fodder are preferred by farmers. Trees which are planted as a source of mulch and green manure have been the focus of some major projects in the region: In Rwanda, the well documented PAP project in Nyabisindu included *Sesbania spp.* as a source of green manure (Sands 1987). Labour shortages, however, proved to be a limitation in the utilization of green manure in the fields. A similar labour constraint has been found to be a problem in introducing cut and carry fodder for stall fed livestock.

3.4 Commoditization of tree products, size of markets, and access to markets

In the study area, the driving force for tree planting has been household self-sufficiency. Nevertheless, market demand has been a subsidiary factor favouring the growing of trees, especially for fruit and poles. Although the amount of income generated by the sale of fruit, fuelwood, *etc.*, may not be large, it can play an important role in helping with the day-to-day household expenses and can encourage the planting of more trees. Given the poor condition of the infrastructure and the high cost of transport it is to be expected that households are concerned with first satisfying their needs for wood products, and only then looking for possible markets. The impact of market demand should increase as infrastructure improves and farmers become more aware of income possibilities. Government policy is increasingly focusing on the small farmer as the producer of wood products for the nation, as an alternative to large commercial plantations or national forest reserves.

However, the existence of markets and a government policy favouring small farmer tree growing does not automatically result in more trees being planted on farms. In the Unimodal Plateau zone, charcoal production for the urban market, for example, occurs

in woodlands rather than on farms and has contributed to the deforestation of large areas in the zone. Although there are legal restrictions on charcoal production in the forest areas throughout the region, enforcement is difficult and usually ineffectual.

Farm level tree growing may be stimulated by the processing needs of a cash crop such as tobacco. Producers of tobacco are encouraged (or required) to grow trees to provide fuel for processing the tobacco. However, it is common for farmers to sell the trees grown on-farm for poles and construction material and gather or buy fuel off-farm for drying the tobacco.

In the Bimodal Highlands of Kenya there is a long history of marketing tree products. The commonly found *Acacia mearnsii*, for example, was originally planted for the sale of the wattle bark to the tannin industry. Despite the decline in the wattle bark market, woodlots are maintained by many households for wood products (subsistence/market demand for charcoal and fuelwood) and as a way to keep land productive when there is a shortage of agricultural labour (Deweese, 1990).

3.5 Factor availability and cost to the farmer

Labour appears to be the major limiting factor in production in the region. Although farm sizes are extremely small in the Malawian Maize/Pulses system and the Bimodal Highlands, households, especially during seasonal labour peaks, still need more labour than the household can provide. In both the Unimodal Plateau and Bimodal Highland zones, the shortage of labour reduces the likelihood that agricultural residues and dung will be worked into the soil. The agricultural residues and dung which cannot be used for soil improvement increase the fuel supplies that are available to the household.

The outmigration of young males throughout the study area will probably continue as a labour constraint hindering the intensification of the existing land use systems. Tree growing can be one response to labour constraints where markets for trees products exist, such as in Kenya, because trees require low inputs and provide high returns to labour.

Although there is land security in the region, the high population growth rate and the relatively small amount of arable land, may result in land becoming a constraint in the future. However, the projected decline in farm size does not necessarily mean a decline in tree planting; in the Unimodal Plateau zone, the Maize/pulses system of Malawi has the smallest farm size of the LUS in the study, but trees are planted on the boundaries and in the homestead to provide fruits, poles, construction, and fuel. In the western highlands of Kenya the proportion of trees in the landscape increased with population density, with more productive exotic trees replacing indigenous species (Kerkhof, 1990).

The Chagga of the Northern Highland Land Use System of Tanzania have small homegardens and large families (see Table 2.4), but some communities have managed to maintain the stability of the system by expanding the resource base. During villagisation, when the residents of the nearby plains were relocated, these communities were able to acquire access to land on the plains. Currently, these communities with banana-coffee homegarden in the highlands and maize fields in the plains are the most prosperous in Tanzania.

Capital is also a limiting constraint in production. Credit is difficult for small farmers to obtain since it is usually linked to cash crops, production quotas, or the size of a landholding. Livestock generally constitutes the main form of capital accumulation by households. This, plus the prestige of ownership, encourage a household to expend labour and land (in fodder crops, grazing) to maintain livestock. However, money from the sale of animals is usually not invested in agricultural improvement but in food, school fees, medical expenses, *etc.*, Remittances are, in much of the study area, the most common source of investment. However, there is competition within the household for this income between the capital needed for agricultural inputs and household expenses. In Zimbabwe (Region IV/V) it was found that remittance money was spent on capital improvements (carts, inputs) for the farm, but it is unclear whether this is true of the entire study area.

Although the amount of capital needed for tree planting and maintenance is dependent on the country, tree species, and the number of trees to be planted, it does not have to be a large sum. During national tree planting days, tree seedlings are usually free, even if the species selection and the number available may be limited. The success of farmers in obtaining tree seedlings has been generally unrecognized. Throughout the region farmers are establishing their own nurseries for seedlings, and even in the past, they were able to obtain seedlings for highly desired fruit trees which were not available in government nurseries. A lack of capital does not, therefore, prevent a farmer from planting trees, although it may hinder a farmer in obtaining a preferred species or a large number of seedlings. In just a few years after the trees are planted and maintained, they can become a source of both capital and income (Scherr and Alitsi, 1990).

3.6 Cultural and attitudinal factors

Regionally, cultural attitudes toward trees range from the positive, even sacred, to the negative. When trees are held as sacred they are seen as harbouring guardian spirits or as being a gift from god. Religious traditions for example, prohibited the Shona of Zimbabwe from cutting certain species (primarily fruit trees) which were associated with the guardian spirits of the land (Wilson, 1989). Such beliefs foster "indigenous conservation" and reluctance to cut trees. While such beliefs can help to conserve indigenous trees, other beliefs can create a reluctance to plant indigenous trees. In Zambia, the planting of indigenous trees is culturally discouraged because it is perceived that "only God can plant forest trees" (Kwesiga and Chisumpa, 1990:54). In Kenya, it appears that indigenous trees are viewed as "something already there, to be used or managed" rather than to be planted (Feldstein *et al.*, 1990). However, since this constraint is only on the planting of indigenous species, farmers are still free to plant exotic trees, and they do.

Cultures in which trees are regarded as negative, may take an adversarial stance towards trees. The Sukuma are reported to have such an attitude and stance (Wood, 1966), combining a stated dislike for bush in distant fields (an attitude surviving from the anti-tsetse campaigns), with the felling of trees near the fields to stop the nesting of grain-eating birds. Since trees are also viewed as interfering with pasture, it might be competition with livestock production rather than diseases or birds that is the real basis of the antipathy. Even so, the Sukuma plant trees, especially exotic fruit trees, in their

homegardens.

Cultural norms and expectations concerning male-female division of labour, ownership, and decision-making have an impact of tree planting. Women assume primary responsibility for fuelwood in much of the region and men become more involved in fuelwood collection when the fuelwood is distant and there are ox carts for transportation. Commonly, women are responsible for fuel and men are responsible for construction materials and certain cash needs of the household, hence, a higher priority is given by men to trees which can be used for construction and income. Men become more involved in fuelwood collection when the fuelwood is distant and there are ox carts for transportation. When men share in the responsibility for fuelwood gathering, there is more interest in planting trees that can be used for fuel as well as for other tree products.

Why don't women plant trees for fuel? Planting trees implies ownership of a resource (the tree and its products and sometimes the land on which it is planted). Except for the matrilineal societies in Malawi and Zambia (and even in these societies men are given control of the land), women in the study area are usually recognized as users, not owners, of resources. Permission to use a resource is determined by a woman's relationship to a male in the community, usually a father or husband. Therefore, it is the man who holds the right to make decisions about planting trees since this is an affirmation of his right to control resources in the community.

Even so, women do plant trees, although where and what species they plant may be limited. Fruit trees on the homestead, for example, are found throughout the study area, and both women and men plant them. Since women are given the responsibility for providing food for their household, a fruit tree planted in the homestead or homegarden affirms a woman's rights and responsibilities.

The outmigration of males and the high proportion of female headed households in the rural areas has been cited as one of the reasons that tree planting in some households or communities has lagged behind others. If men have to give permission or make a decision, as in some communities in western Kenya, their absence may hinder tree planting (Scherr and Alitsi, 1990).

3.7 Sustainability, stability and risk management

In the Unimodal plateau zone, the trees retained in the fields and growing in the nearby woodland are utilized for fruit and fodder. During the dry season these trees assume a vital role; wild fruit provides important nutrients for the household during a time of food scarcity, and tree fodder is used for maintaining livestock. The retained trees also benefit the soil, by improving or maintaining fertility and inhibiting erosion (Young, 1989).

As wild resources diminish and tree planting increases, the process of incorporating trees into the farming systems concentrates resources that had been spread throughout the landscape on to the farm. Trees planted, rather than retained, on the farm and in the homestead have a positive impact on both off- and on-farm resources. If trees are available on-farm, the time (and energy) spent by family members collecting fuelwood,

fruit, *etc.*, declines and more time is available for other activities. As a result, off-farm resources in the area are conserved. The configuration and niche of tree plantings can have a positive impact on the sustainability of the system: boundary plantings, for example, help protect the crop field not only from livestock, but also from wind and soil erosion; trees planted in the crop field provide shade, retain moisture, and, depending on the species, may improve soil fertility through nitrogen fixation or leaf litter.

In the Bimodal Highland zone, the multistoried banana-coffee garden is the most pronounced of the integrated crop/tree systems; vertical layering increases overall productivity, and the diversity of the garden spreads labour inputs throughout the year. The high productivity of these gardens and the maintenance of soil fertility through mulching and composting has created a sustainable system. However, even if the well developed gardens continue to produce at a sustainable level, the household component of the system will not.

The large size of current and projected households in eastern Africa will demand the intensification or expansion of existing land use systems. Trees should play an increasing role both in providing products and income, and in maintaining soil fertility and stability in land use systems in the region.

3.8 Government and NGO interventions

Governments in the study area share certain agricultural policy objectives:

Self-sufficiency in food.

Mixed farming (the integration of animals and crops)

Increased production of fuelwood by farmers (in the Bimodal Highland zone, trees for fodder and soil conservation are an additional objective.)

These objectives shape current government programmes and extension services. However, current programmes are still being affected by the policies of the past: the former English colonies, for example, inherited not only the programmes but also the attitudes of the colonial era. The cultural attitudes of the colonial governments were against trees in the fields and people in the forests. Although during colonial times trees planted in woodlots were in some cases encouraged for income (wattle in Kenya and *Eucalyptus* spp. in Rwanda), farmers were told to clear all the trees out of their fields, while forest reserves expropriated land which formed part of the grazing and fallow systems. These attitudes lingered after independence. Farmers in Zambia continued to be told to clear all the trees from their fields and "this tended to paint a picture of trees as something rather nasty to be removed in 'modern agriculture'. Only the planting of fruit trees was given some attention" (Gossage, 1989:1).

This division between forestry (trees) and agriculture (fields and, occasionally, horticultural trees) is still reflected in the government ministries and services focused on farmers and trees. In the study area, only Rwanda has created a truly integrated program for agroforestry, *i.e.* trees integrated into the farming system. The more common pattern is for agroforestry programs to be either placed in agriculture, where there is a lack of expertise relating to trees or forestry, where there is generally a lack of extension

services.

Since agricultural programmes in the past focused primarily on export crops, there are institutional problems in creating the incentives for tree planting: infrastructure may be poor, access to markets difficult and credit facilities nonexistent. Lack of long term support for a tree product also creates a problem of credibility for the governments in the region. Black wattle, for example, was successfully introduced in the past, but current market instability has created difficulties for producers.

The low income of farmers in the region limits the amount of capital available for agricultural inputs, especially for trees. Among the crops of the Bimodal Highlands zone of Kenya, trees are given the lowest priority in terms of resource allocation and management inputs (Minae, 1988).

Increased agricultural productivity is an objective of both governments and farmers. The strategy of the rural household is to be self-sufficient in food and to grow enough of a cash crop, and/or earn enough off-farm, to fulfil its cash needs. On the national level there is concern about falling crop yields because of soil erosion, over-grazing, and fertility decline. On the farm level, programmes focused on interventions concerned with soil improvement have not been successful. Farmers do recognize that soil fertility is important, but they have other pressing needs which are given higher priority. In Burundi, farmers were less concerned with using trees for soil improvement/conservation and fodder than what they perceive as their more critical need for building materials and fuel.

The same lack of mesh between the farmers' needs and government policy has occurred in the fuelwood projects. Throughout the region tremendous concern has been generated about the "fuelwood crisis" (Munslow *et al.*, 1988; Leach and Mearns, 1988). Government fuelwood programmes, some quite massive in scope, were created and implemented, and most have not succeeded in their goals. The major problems with the programmes were implementation, species choice, and farmer disinterest.

Implementation of tree planting programmes focusing on household level tree planting was hindered by the traditional orientation of the forestry and agricultural ministries. Forest ministries produce seedlings of forest species and usually do not have extension services and personnel skilled in providing services to farmers, while agricultural ministries have the extension services, but not the personnel skilled in non-fruit tree species. The result was a lack of coordination between ministries, and the lack of skilled personnel at the community level.

The logistical problem of providing a large number of seedlings at a specific time to multiple sites was difficult given the level of funding and the difficulty of coordination between various ministries. Poor choices of days to plant were made: in Zambia the initial date of national tree planting (World Forest Day) was at the end, not the beginning, of the rains. Hence, most of the seedlings died. Species choice was limited (sometimes only *Eucalyptus* spp.) and did not reflect the ecozone differences in the country or the tree species that farmers were interested in planting.

The tree species distributed reflected reflected the goals of the government rather than the needs of the household. The government provided fuelwood oriented tree species which were perceived as being necessary to stave off the impending fuelwood crisis. However, fuelwood trees are not the first choice of farmers. Farmers want fruit and/or multipurpose trees, so the programmes were focusing on what government policy identified as being needed, not what the farmer wanted. Farmers were not interested in planting and caring for trees primarily for fuelwood, and the projects by failing to engage the farmers failed in meeting their goals.

This inability to persuade the farmer has also been characteristic of community forestry projects. Communal woodlots were the focus of many of the programmes, yet household support was weak because it was unclear who would benefit from these programmes (Skutsch, 1983). In Tanzania, for example, community forestry programmes had far lower survival rates of seedlings when compared to farm plantings.

Subsidies do not appear to be a necessary component of government programmes, and certainly they are not the primary motivation for farmers to plant trees. Government subsidies may actually have a long term negative impact on seedling production. When seedlings are made available below cost by government nurseries, it depresses prices and discourages the creation of private nurseries. Governments will have to continue to shoulder the cost of seedling production and distribution if private nurseries are not encouraged.

Although tree planting programmes have not been successful in meeting their goals, there has been notable success in disseminating information about tree planting to the villages. Although the survival rate of trees planted on the annual tree planting day in the countries in the region is felt to be low, such programmes have been effective in getting schools, communities, and individuals involved in tree planting.

In some of the countries in the region, NGOs (non-governmental organizations) have been very active in tree planting. The role of the NGOs is sometimes overlooked since many lack the staff, time, funds, or inclination to produce documents. Yet in the rural areas their impact is readily apparent. Many churches in the region, for example, have tree nurseries, conduct training, and actively encourage tree planting (Brokensha and Riley, 1987).

Some of the larger international NGO's working in the region are not only designing and implementing innovative agroforestry projects, but are also producing documentation. In Rwanda the CARE Gituza project has produced an excellent series of papers concerning agroforestry project design and evaluation. Kenya has a large number of NGO agroforestry projects and one of the most effective is the CARE Siaya project which is regarded as being one of the more successful projects in the region (Scherr and Alitsi, 1990).

NGO projects are in many instances more responsive to the needs of the community than government projects, and usually can be more flexible in their approach. The participatory approach of the CARE projects in the region, for example, has encouraged farmer interaction and flexibility in project objectives.

How could programmes be improved? Government policies should recognize the role of trees and tree products in land use systems. Each country in the study area has a diversity of agroecozones and land use systems and programmes should reflect this diversity and not attempt to impose a single strategy (or a single tree species) on the nation as a whole.

There is a need for programmes which:

- 1) Are based on an understanding of the role of trees in the land use system in question. The constraints on tree planting should be identified and alleviated through intervention. It should also be recognized that in some land use systems there might not be a felt need for increasing tree planting.
- 2) Produce seedlings of species which farmers want and may be difficult to propagate on farm, have a low survival rate, or for which seed stock is not available (Deweese, 1986).
- 3) Conduct research on how fruit trees are managed by farmers. Farmers in the study areas perceive fruit trees as being multipurpose and manage them to obtain a variety of products such as fuel, fodder, fruit and timber.
- 4) Help farmers to link tree growing to market possibilities.
- 5) Provide support over a long enough period to allow sustainable practices to develop. Trees require more of a time commitment than do annual crops. Agencies have to be willing to follow a tree from seedling to maturity.

4. Discussion and conclusions

A tree is not just any tree to farmers in the study area. Farmers know what trees they want and they have specific purposes for trees within their farming system. Fuelwood trees are not the first choice of farmers. Farmers want fruit and/or a multipurpose tree which can produce poles, construction material, and perhaps fodder. Knowledge of tree planting and maintenance does not appear to be a constraint for the planting of trees for which farmers are familiar. However, training may be needed for new trees which are introduced into an area and nurseries may need to be established for seedlings of tree species which are hard to propagate.

The planting of trees by farmers appears to be dependent on the wood resources available to the household. When population density is low and there is access to forest or woodland, there is not a strong incentive for the planting of trees. Yet even when tree resources are readily available, some trees are planted, although usually in small numbers, usually for fruit, and near the homestead.

Trees are planted in the homestead or homegarden in all of the land use systems. Where

population densities are low, farmers plant fruit trees in the homegarden in response to either concern about livestock grazing or, as in the Chitemene system, fear of fire in the fallow fields.

In order to satisfy the needs of the household for tree products, as population densities increase and access to resources off-farm decline, there is an increase not only in the number of trees, but also in the number of tree species and planting locations in the farming system. A point may be reached, as in the Shire Highlands, where farm size becomes so small that tree planting is again limited to the homegarden.

When rights to off-farm resources decline, and rights of exclusion are strengthened, more boundary planting occurs. Living fences can be used to protect areas from livestock, and establish boundaries. Ploughing may also encourage the relocation of trees from fields to boundaries.

Farm woodlots appear, as in Rwanda and Burundi, when wood resources have to be totally met by on-farm production. These woodlots are usually on marginal land and hence competition with crops is minimal. Woodlots also occur when there is a strong market for wood products and/or outmigration of males, as they make relatively little demand on household labour and do not require large amounts of capital.

In summary, farmers in the region are planting trees, although perhaps not with the species and number, or in the locations that the governments would prefer. Tree planting is motivated by the needs of the household, with certain demands, such as poles and fruit, being given a higher priority than others, such as fuelwood. Tree planting will continue to expand in the region as a response to the decline of resources off-farm, an increase in the market for wood products and the decline of available on-farm labour. In support of the projected increase in tree planting, there is a need for: easier access to preferred species; an improved infrastructure to aid in marketing tree products; better information on markets; and a government policy which supports the integration of more trees on farms.

Table 2.4 Land Use Systems in the Bimodal Zone

Agroecological zone and Land Use System (LUS)	High Plateau*	Kagera Plateau	Central Congo Nile Divide	North Highlands	Lakeshore
Country	Rwanda/Burundi	Rwanda	Burundi	Tanzania	Uganda
Rainfall (mm)	1000-1200	850-1000	1400-2000	750-2000	1000-2250
Altitude (m)	1550-1800	1400-1550	> 1800	1000- > 2000	1000-2000
Vegetation	little forest	some forest	grasslands, 7% woodlands	some forest	forests and grass savanna mosaic
Soils	shallow, acidic	generally poor, lower slopes and valley bottoms soil good	acidic, aluminum toxicity	fertile volcanic	deep, leached
Population (LUS) (1990 est.)	3,720,000	2,423,000	788,100	1,200,000 ¹	3,000,000 ⁽¹⁹⁸⁸⁾
Population density	300-500	150	155	up to 500	140
Settlement pattern	dispersed	dispersed	dispersed	densely scattered	densely scattered
Household size	5-6	6	6	10	5-10
% Female headed households	21 ^a , 7 ^b	n.d.	11	n.d.	n.d., but male outmigration area
Tenure	secure	secure	secure	secure	secure
Farm size (ha)	.77/2	2.3	.81	homegarden .68	1-1.5
Number of fields	2-11	2-3	14	2	homegarden may have several plots
Types of fields:					
Homegarden	all	all	all	major field: banana coffee	major field: banana coffee
Upland (dry)	all	all	all	majority- lowland for maize	no
Wetlands	majority	rarely	majority	no	no
Land preparation	hoe	hoe	how	how in homegarden; tractor/plough for maize	hoe
% Households hired labour	25 ^a , 36 ^b	n.d.	56	n.d.	large % hire migrant labour
Crops:					
Food	bananas, beans, sweet potatoes, sorghum, maize	banana, beans, maize, sorghum, groundnut	peas/beans, maize, millet, sweet potato	banana, beans, taro, maize	banana, taro, yams, beans, manioc
Export/Cash	coffee	coffee, banana	tea	coffee, maize	coffee, fruit (minor)
Fuelwood:					
Sources	on-farm, gather	on-farm, Agr. residues, purchase	on-farm, purchase	¼-½ homegarden, forest reserve, lowland fields, purchase	on-farm, swamp vegetation
Responsibility	both hus/wife	both hus/wife	n.d.	primarily husband	n.d.
Expressed shortages	28% ^a	54-90% ^{bgm}	n.d.	minor	n.d.

Agroecological zone and Land Use System (LUS)	High Plateau*	Kagera Plateau	Central Congo Nile Divide	North Highlands	Lakeshore
Country	Rwanda/Burundi	Rwanda	Burundi	Tanzania	Uganda
Other sources of income:					
Processed food/beer	yes	yes	no	yes	yes
Wood/tree products	no	no	no	minor	minor
Off-farm income	1/5 of household income ^a	almost 1/3 of household income	remittances	remittances	remittances, fishing
Livestock component:					
% households: cattle	> 15	n.d.	68	n.d.	n.d.
sheep/goats	> 50	n.d.	43	n.d.	n.d.
No. owned: cattle	2	2	4	3	2-5
sheep/goats	6	4	4	2	3-5
Livestock management:					
Communal grazing land	yes	yes	43% only use 32% com/private	no	yes, cattle
Private field grazing	yes	fallow	16% only use	no	no
Wet land grazing	yes	no	no	no	no
Stall fed	no	40% cattle 82% goats	no	all	yes, esp. goats
Agricultural residue	fallow	yes, stall	yes, minor	yes	yes
Tree fodder	negligible	yes, stall	negligible	yes	Ficus spp.
Fencing/hedges	yes	some sites	yes	yes	n.d.

* This is the predominant land use system in the agroecological zone. The data utilized for the land use system of the High Plateau is from several sites which are used to describe the prevalent land use system: ^a site of Gituza, Rwanda (Gibson and Mueller 1987) and ^b site of Bugenyuzi, Burundi (Moussie and Muhitira 1989).

¹ This is an estimate for all of Kilimanjaro; the population in the Chagga LUS is probably less, but specific data is not available.

Sources:

Rwanda: ISAR and ICRAF 1988a, 1988b; Hoekstra 1988.

High Plateau: Sands 1987, Neumann and Pietrowicz 1985, Gibson and Mueller 1987, Wanjama et al. 1988, Jones and Egli 1984.

Kagera Piedmonts: Balasubramanian and Egli 1986, Pinners and Balasubramanian 1990, Hummel 1985, Jones and Egli 1984.

Burundi: ISABU and ICRAF 1988, Hoekstra 1988, Jones and Egli 1984.

High Plateau: Moussie and Muhitira 1989, Lamfalussy and Delince 1987, ISABU and ICRAF 1988, Jones and Egli 1984.

Central Congo-Nile Divide: Depommier and Kaboneka 1988, Ntagunama 1989, Jones and Egli 1984.

Tanzania: ICRAF 1979, Fernandes et al. 1984, O'king'ati et al. 1984, O'king'ati and Mongi 1986.

Table 2.4 Land Use Systems in the Bimodal Zone (continued)

<u>Agroecological zone and Land Use System (LUS)</u>	<u>Kigezi Montane</u>	<u>Coffee based Highland</u>	<u>Bimodal Sub-humid/semi arid</u>
<u>Country</u>	Uganda	Kenya	Kenya
<u>Rainfall (mm)</u>	1000-1500	1200-1500	850 (mean annual)
<u>Altitude (m)</u>	> 1800	1280-1820	1200-1300
<u>Vegetation</u>	savanna, forests, swamps	bushlands, grasslands	cleared acacia combretum woodland
<u>Soils</u>	volcanic, fertile	moderate to high fertility	predominantly alfisols with some ultisols; erosion
<u>Population (LUS) (1990 est.)</u>	450,000 ⁽¹⁹⁸⁸⁾	3,887,200	1,356,000
<u>Population density</u>	620	450-700	172
<u>Settlement pattern</u>	clustered	densely scattered	densely scattered
<u>Household size</u>	5	9	7
<u>% Female headed households</u>	n.d. - but male outmigration area	n.d. - but 60% of farmers are female	n.d. - but male outmigration area
<u>Tenure</u>	secure	secure	secure
<u>Farm size (ha)</u>	< 1	1.5	1.08 cropland 2.1 grazing land
<u>Number of fields</u>	7	1 divided into 2 or 3 plots	cropland may be divided into plots
<u>Types of fields:</u>			
<u>Homegarden</u>	all	all	all
<u>Upland (dry)</u>	all	all	all
<u>Wetlands</u>	62%	n.d.	n.d.
<u>Land preparation</u>	hoe	hoe	plough
<u>% Households hired labour</u>	n.d. but common	80 (coffee)	n.d. but common
<u>Crops:</u>			
<u>Food</u>	sorghum, potatoes, sweet potatoes, beans, peas	maize, beans, potatoes, bananas, arrowroot	maize, beans, cow peas, pigeon peas, sweet potatoes, manioc
<u>Export/Cash</u>	sorghum, potatoes, wheat, tobacco	coffee, tea	cotton, sunflower (minor)
<u>Fuelwood:</u>			
<u>Sources</u>	on-farm	on-farm, purchase	on-farm, gather; forest, mountain, neighbour's landholding
<u>Responsibility</u>	n.d.	female	female
<u>Expressed shortages</u>	64% fuel or poles	yes, by majority	yes

Agroecological zone and Land Use System (LUS)	Kigezi Montane	Coffee based Highland	Bimodal Sub-humid/semi arid
Country	Uganda	Kenya	Kenya
Other sources of income:			
Processed food/beer	n.d.	n.d.	n.d.
Wood/tree products	11% solid fuelwood	minor	minor
Off-farm income	remittances	remittances	82% receive income from off-farm employment/ remittances
Livestock component:			
% households: cattle	31	83	"most"
sheep/goats	45	77	"most"
No. owned: cattle	few	2-3	7.6 (average)
sheep/goats	few	2	10
Livestock management:			
Communal grazing land	yes, all	no	no
Private field grazing	27%	no	yes
Wet land grazing	yes	no	no
Stall fed	12% goats	all	few
Agricultural residue	n.d.	yes	oxen
Tree fodder	n.d.	minor	minor
Fencing/hedges	yes	yes	yes

Sources:

Kigezi Montane, Uganda: UNT and ICRAF 1988.

Coffee Based Highland, Kenya: ICRAF 1988, NTF and ICRAF 1988, Scherr and Alitsi 1990.

Bimodal Sub-humid/Semi-arid, Kenya: Rocheleau and Hoek 1984, Vank 1983, Rocheleau 1984, Hoekstra 1984.

Table 2.5 Land Use Systems in the Unimodal Zone

<u>Agroecological zone and Land Use System (LUS)</u>	<u>Sukuma Agropastoral</u>	<u>Chitemene</u>	<u>Barotse Agropastoral</u>	<u>Maize Livestock</u>	<u>Region III Maize Livestock</u>
<u>Country</u>	Tanzania	Zambia	Zambia	Zambia	Zimbabwe
<u>Rainfall (mm)</u>	600-700	1000-1500	600-1000	800-1000	600-700
<u>Altitude (m)</u>	100-1500	1200 (av)	800-1200	800-1400	900-1200
<u>Vegetation</u>	almost treeless	wetter miombo	miombo/grasslands	miombo/acacia	dry miombo
<u>Soils</u>	varies, mostly clayish	sandy loam, leached, acidic	infertile sand, alluvial valleys	relatively fertile	shallow, moderately leached, low fertility
<u>Population (LUS) (1990 est.)</u>	3,427,100	400,000 (est.)	610,000 (est.)	1,500,000	2000 ¹
<u>Population density</u>	35-50	2-4	4	11	35
<u>Settlement pattern</u>	village	dispersed	densely scattered	villages	villages
<u>Household Size</u>	6	5-9	5-9	5-9	5
<u>% Female headed households</u>	some outmigration of males	30-40	large numbers of males migrate	large numbers of males migrate	outmigration of males is not allowed
<u>Tenure</u>	land secure; tree to planter	land secure; tree to planter	land secure; community grazing rights	usufruct, must ask permission to fence	site of resettlement community, secure
<u>Farm size (ha)</u>	3	1	1-5	1.5-3	5 plus grazing rights
<u>Number of fields</u>	several fields and/or plots	several fields in crop sequence	several fields	several fields	several fields
<u>Types of fields:</u>					
<u>Homegarden</u>	yes, all	yes, all	yes	yes	yes
<u>Upland, dry</u>	yes	yes	yes	yes	yes
<u>Wetlands</u>	minority/rice	no	yes, most	yes	yes
<u>Land preparation</u>	plough	slash/burn	hoe/plough	plough	plough/hoe
<u>% Households hired labour</u>	n.d.	hire for male tasks if have funds	n.d.	n.d.	n.d.
<u>Crops:</u>					
<u>Food</u>	maize, sorghum, millet, cassava	millet, beans, cassava, groundnuts	maize, cassava, sorghum, millet	maize, groundnuts	maize
<u>Export/Cash</u>	cotton, maize, rice	maize	maize	maize, cotton, sunflower, tobacco	maize
<u>Fuelwood:</u>					
<u>Sources</u>	gather, purchase, agr. residue, cow dung	gather, purchase	cow dung agr. residue gather, purchase	gather, cut live trees	gather
<u>Responsibility</u>	female	male if distant female if closer	men - 28% men cut trees	men - 40%	primarily female
<u>Expressed shortages</u>	yes	no	yes	yes	no

Agroecological zone and Land Use System (LUS)	Sukuma Agropastoral	Chitemene	Barotse Agropastoral	Maize Livestock	Region III Maize Livestock
Country	Tanzania	Zambia	Zambia	Zambia	Zimbabwe
Other sources of income:					
Processed food/beer	yes	yes	yes	yes	yes
Wood/tree products	no	no	no	minor	no
Off-farm income	remittance	remittance	remittance	remittance	n.d.
Livestock component:					
% households: cattle	70	Bemba do not keep livestock, other groups to the south keep small numbers	50	30	have livestock, but data as to % not presented
sheep/goats	n.d.		n.d.	> 35	
No. owned cattle	10-50	n.a.	10-15	4-8	n.d.
sheep/goats	n.d.		n.d.	n.d.	n.d.
Livestock management:					
Communal grazing land	yes	n.a.	yes	yes	yes
Private field grazing	fallow	n.a.	yes, fallow	yes, fallow	fallow
Wet land grazing	fallow	n.a.	yes, fallow	yes, fallow	none
Stall fed	no	n.a.	no	no	no
Agricultural residue	fallow	n.a.	fallow	fallow	fallow
Tree fodder	minor	n.a.	minor	minor	n.d.
Fencing/hedges	homestead	n.a.	no	yes, wetlands	yes, thorny fences

¹ Site specific population data of resettlement community (see Table 2.20).

Sources

Tanzania: TAFT and ICRAF 1988a and 1988b; Barrow et al. 1988, Mascarenhas et al. 1989, Kikula et al. 1983, Wood 1966.

Chitemene, Zambia: ZATF and ICRAF 1988 and 1989, Mansfield 1976, Chidumayo 1987 and 1988b, Holden 1988, Schultz 1976, Stolen 1983, Vedeld 1983.

Barotse Agropastoral, Zambia: ZATF and ICRAF 1989, Chidumayo 1988b, Schultz 1976.

Maize-Livestock, Zambia: ZATF and ICRAF 1989, Schultz 1976, Kwesiga and Chisumpa 1990, Gossage 1989, Bohlin and Larsson 1983.

Region II, Maize Livestock, Zimbabwe: Grundy et al. n.d.

Table 2.5 Land Use Systems in the Unimodal Zone (continued)

Agroecological zone and Land Use System (LUS)	Region IV Maize Livestock	Shire Highlands Maize/pulses System	Lilongwe
Country	Zimbabwe	Malawi	Malawi
Rainfall (mm)	200-1100 (av.559)	800-1300	800-1200
Altitude (m)	550-750	800-1300	1000-1200
Vegetation	mopane, miombo uapaca woodlands	grasslands, isolated trees	acacia woodland
Soils	variable- shallow/heavy	moderate to high soil fertility	fairly fertile
Population (LUS) (1990 est.)	143,450 ¹	1,460,000	788,000
Population density	55	>150 up to 250	114
Settlement pattern	dispersed clusters	villages	villages
Household size	5	5	5
% Female headed households	18 50% of males 20-29 absent	seasonal outmigration of males	seasonal outmigration of males
Tenure	secure	secure if not on estate; if on estate, usufruct only	secure
Farm size (ha)	2.8	.4	1.5
Number of fields	several	upland field divided into 2 or 3 plots	several fields, plots
Types of fields:			
Homegarden	yes	yes	yes, usually vegetable
Upland (dry)	yes	yes	yes, all
Wetlands	26% maize field 44% vegetables	yes	yes, all
Land preparation	plough	hoe	hoe 5% use plough
% Households hired labour	n.d.	few households can afford	hired during peak labour demand periods
Crops:			
Food	maize, millet sorghum, groundnut	maize, cassava banana, cowpeas, pigeon peas, sorghum, rice	maize, groundnuts beans, cassava, sweet potatoes
Export/Cash	maize, vegetables	tobacco, chickpeas	tobacco, maize, groundnuts
Fuelwood:			
Sources	gather	agr. residue	gather, purchase, agr. residue
Responsibility	primarily female	primarily female	primarily female
Expressed shortages	yes	yes	yes

Agroecological zone and Land Use System (LUS)	Region IV Maize Livestock	Shire Highlands Maize/pulses System	Lilongwe
Country	Zimbabwe	Malawi	Malawi
Other sources of income:			
Processed food/beer	yes	yes	yes
Wood/tree products	no	no	no
Off-farm income	remittances and off-farm income provide 60.5% of income	remittances	seasonal remittances
Livestock component:			
% households: cattle	75	4.5	16
sheep/goats	> 65	small number of households keep goats for rituals	42
No. owned: cattle	65% of households own less than 8	n.d.	n.d.
sheep/goats	n.d.	n.d.	n.d.
Livestock management:			
Communal grazing land	yes	yes, wetlands	yes, wetlands
Private field grazing	fallow	fallow	fallow
Wet land grazing	fallow	yes	yes
Stall fed	no	goats	no
Agricultural residue	fallow	cattle, fallow goats, stall fed	yes
Tree fodder	yes, 41% of cut tree foliage in dry season	minor	yes, browse
Fencing/hedges	no	n.d.	sisal

¹ Population data based on one site, total population of LUS is considerably higher.

Sources:

Region IV, Cereal Livestock, Zimbabwe: Balderrama et al. 1988, Wilson 1989.

Shire Highlands, Maize/pulses system, Malawi: MATF and ICRAF 1986, FAO 1984, ESU 1981, McCall and Skutsch 1989, Chisimba 1987, Chandelet et al. 1987, Manda et al. 1985.

Lilongwe, Malawi: MAT and ICRAF 1988, MATF and ICRAF 1986.

Bimodal Zone Tree Component

Table 2.6 Trees in the Land Use System of the High Plateau

Location: Rwanda/Burundi

<u>Site</u>	<u>% Households</u>	<u>Trees Planted</u>		<u>Number</u>	<u>Use</u>	<u>Source of Seedlings</u>
		<u>Species</u>	<u>Location</u>			
Gituza (Rwanda)	94.6	24, common; Eucalyptus spp.	location on farm; boundaries, woodlots	314	fuel construction	nursery nat. regener.
		Euphorbia spp. Persea amer.	hedges homestead	5	hedge, fuel fruit, fuel	other farms nursery nat. regener.
		Ficus spp.	enclosure, windbreak		tools, fuel	other farms nat. regener.
		Markhamia spp.	n.d.		tools, construction	other farms nat. regener.

Preferred species: Persea amer., eucalyptus, papaya, grevillea, guava

Source: Gibson and Mueller 1987

<u>Site</u>	<u>% Households</u>	<u>Species</u>	<u>Location</u>	<u>Number</u>	<u>Use</u>	<u>Source of Seedlings</u>
Nyabisindu (Rwanda)	80	various fruit	homestead, nearby	1 or more	fruit	n.d.

Source: Neumann and Pietrowicz 1987

<u>Site</u>	<u>% Households</u>	<u>Species</u>	<u>Location</u>
Northwest area of High Plateau (Burundi)	n.d.	Dracaenan spp.	boundaries
		Euphorbia tir	boundaries, hedges,
		Albizia spp.	coffee fields
		Cassia spect	coffee fields
		Eucalyptus spp.	woodlots

Source: ISABU and ICRAF 1988

<u>Site</u>	<u>% Households</u>	<u>Species</u>	<u>Location</u>	<u>Number</u>	<u>Use</u>	<u>Source of Seedlings</u>
Muyinga (Burundi)	80	Ficus ingens	dispersed fields	4	fuel construction	cuttings
	77	Persea amer.	fields, homesteads	4	fruit, fuel	plant seed
	69	Euphorbia tir.	hedges	41	construction, fuel	cuttings
	65	Eucalyptus sal.	woodlots	28	construction, fuel	nursery
	57	Markhamia cut.	dispersed fields	8	construction, fuel	nat. regener.
	56	Grevillea robu.	dispersed fields	6	cottage craft, fuel	nat. regener.
	36	Mangifera ind.	dispersed fields	2	fruit, fuel	plant seed
	30	Dracaena afro.	hedges	12	construction, fuel	cuttings
	28	Erythrina abys.	dispersed fields	3	fuel, cottage craft	cuttings
	27	Vernonia amyg.	dispersed fields	3	fuel, medicinal	nat. regener.

Source: Lamfalussy and Delince 1987

<u>Trees Retained</u>			
<u>Site</u>	<u>% Households</u>	<u>Species</u>	<u>Location</u>
Gituza	78	52, most common;	fields, home
		Erythrina abys.	
		Veronia amyg.	
		Acacia sieberiana	
		Rhizinus spp.	
		Ficus spp.	
			fuel, tools fuel, medicine fuel, construction fuel, stakes fuel, tools

Source: Gibson and Mueller 1987

Bimodal Zone Tree Component

Table 2.7 Trees Planted in the Kagera Piedmont

Location: Rwanda

<u>Site</u>	<u>% Households</u>	<u>Species</u>	<u>Location</u>	<u>Number</u>	<u>Use</u>	<u>Source of Seedlings</u>
Bugsera-Gisake-Migongo (BGM)	> 86	Fruit: Persea amer., papaya, guava, jackfruit, mango, passion fruit	homestead	total: 16-21	fruit	portion from nurseries
	n.d.	other species; Eucalyptus spp. Grevillea rob.	woodlots (infertile land) woodlots (infertile land) roadside	n.d.		nurseries nurseries
		Ficus spp.	homestead			n.d.
		Sesbania spp.	homestead			n.d.
		Cedrela serr.	roadside			n.d.
		Cassia spect.	roadside			n.d.
		Euphorbia tir.	boundaries		hedges	n.d.

Source: Balasubramanian and Egli 1986, Pinners and Balasubramanian 1990

<u>Site</u>	<u>% Households</u>	<u>Species</u>	<u>Location</u>	<u>Number</u>	<u>Use</u>
Muyaga	100	Grevillea rob.	roadside, boundaries, fields	22	fuel, construction anti-erosion
	100	Persea amer.	fields	6	fruit, fuel
	86	Carica papaya	fields	6	fruit
	83	Ficus thon.	fields, boundaries	2	fuel, construction, tools, fodder
	55	Eucalyptus spp.	fields	7	fuel, construction, tools
	48	Senecio man.	roadside, fences, boundaries	17	fuel, construction, stakes

Source: Hummel 1985

Bimodal Zone Tree Component

Table 2.8 Trees in the Central Congo-Nile Divide Agroecological zone/Land Use System

Location: Burundi

<u>Site</u>	<u>% Households</u>	<u>Species</u>	<u>Location</u>	<u>Use</u>
Gisozi	98	Eucalyptus spp.	woodlots	construction, poles, fuel
	79	Arundinaria alp.	homestead, fields	construction, cottage craft, fuel
	77	Erythrina aby.	hedges, fields	hedge
	76	Acacia mearnsii	woodlots, fields	construction, fuel
	57	Ficus spp.	fields, hedges	construction, hedges
	43	Cupressus lus.	woodlots	construction, cottage craft
	41	Persea amer.	fields, homestead	fruit, fuel
	37	Solanum acul.	boundaries, hedges	construction, fuel, hedges
	25	Iboza riparia	hedges	hedges
	24	Dracaena afro.	hedges	hedges, fodder

Source: Depomier and Kaboneka 1988: 24-49

Species Wanted

Site: CVHA Project, Burundi

Farmers stated that the three most important roles of trees were for construction, heating (fuelwood), and timber. Of less importance was income, soils conservation, or soil improvement

Source: Ntagunama 1989

Bimodal Zone Tree Component

Table 2.9 Trees in the Northern Highlands Land Use System

Location: Tanzania

<u>Site</u>	<u>Species</u>	<u>Location</u>	<u>Use</u>	<u>Source of Seedlings</u>
Kilimanjaro	39	homegarden	fuelwood, fruit, fruit, timber, fodder, hedges	National regeneration, wildings, Govt. nursery, NGO nurseries, neighbours

Source: Fernandes et al. 1984

Table 2.10 Trees Found in the Lakeshore Banana Coffee Garden Land Use System

Location: Uganda

<u>Site</u>	<u>Species</u>	<u>Location</u>	<u>Use</u>
Southeastern Uganda	Ficus	homegarden	fodder, barkcloth, windbreak, stakes, shade construction, income
	Chlorophora excelsa		fruit, income
	Artocarpus heterophy.		fruit, income
	Mangifera indica		construction, income
	Maesopsis eminii		fruit, income
	Psidium guajava		fruit, income
	Persea americana		fruit, income
	Carica papaya		construction, income
	Entandrophragma ang.		shade, poles
	Markhamia spp.		windbreaks
	Albizia spp.		fruit, income
	Passiflora edulis		n.d.
	Canarium schwenfurthii		n.d.
	Lantana camara		fruit, income
	Citrus sinensis		fruit, income
	Citrus limon		medicinal
	Ricinus communis		construction, fuel, poles
	Eucalyptus spp.	swamps	
Ornamental trees are also planted and there is a demand for improved varieties			

Source: Oduol and Aluma 1990, UNT and ICRAF 1988

Bimodal Zone Tree Component

Table 2.11 Trees in the Kigezi Montane Land Use System

Location: Uganda

<u>Site</u>	<u>% Households</u>	<u>Species</u>	<u>Location</u>	<u>Use</u>	<u>Source of Seedlings</u>
Kabale	70	Eucalyptus spp.	woodlots, homestead	fuel, poles, timber	*
	33	Erythrina aby.	boundaries	boundary marker, live fences, poles, cottage craft	
	30	Acacia mearnsii	woodlots	fuel, charcoal, poles	
	24	Cupressus lus.	homestead	fuel, fencing, windbreaks, timber	
	22	Euphorbia spp.	boundaries, homestead	poles, cottage crafts, fencing, boundary marker,	
	10	Sesbania sesban	boundaries	fuel	
	8	Ficus natalensis	homestead, boundaries	cottage craft, poles, shade, timber	
	4	Markhamia plat.	cropland, homestead	fuel, poles, timber, tools, construction	

* NT and ICRAF 1988: 27 note of this site "Seventy-three percent of the farmers indicated that they raised their own seedlings, especially Eucalyptus or they relied on natural regeneration in the case of the other species ... Others (37%) bought or acquired seedlings from the Forest Department".

Also note: "... most farmers were opposed to the idea of mixing trees and crops because their experience with Eucalyptus and Acacia mearnsii has shown considerable competition (NT and ICRAF 1988: 29)."

Source: NT and ICRAF 1988

Bimodal Zone Tree Component

Table 2.12 Trees in the Coffee Based Highland Land Use System

Location: Highlands, Kenya

<u>Site</u>	<u>% Households</u>	<u>Species</u>	<u>Location</u>	<u>Use</u>	<u>Source of Seedlings</u>
Runyenjes, Embu	nearly all: 60 30 47 27 n.d. n.d. n.d. n.d.	Grevillea rob. Croton megalo Markhamia lutea Ficus spp. Euphorbia spp.	 external boundaries internal boundaries food crop plots coffee plots external boundaries external boundaries external boundaries external boundaries	fuel, timber, poles	*
	nearly all: a few	fruit trees: citrus, passion, Persea amer., loquat, mango, papaya macadamia	food crop plot, homestead	fruit, timber, shade	
	<u>General data:</u> common common common common common common	Spathodea nil. Eucalyptus sal. Cupressus lus. Acacia mearnsii Cordia abyssinica Albizia coriaria			

Trees in high demand: Grevillea, fruit, and cypress.

* "According to farmers, one of their most serious problems is ... in obtaining planting material (Minae 1988: 21)."

Source: Minae 1988, NTF and ICRAF 1988: 24, 21

Table 2.13 Location of trees in the Coffee Based highland Land Use System

Location: Highlands, Kenya

<u>Site</u>	<u>% Households</u>	<u>Location</u>
Murang'a	97 93 26 43 97	cropland house compound woodlots windrows hedges

Source: Bradley and Ngugi 1986

Bimodal Zone Tree Component

Table 2.14 Trees in the Food Crop Land Use System

Location: Highlands, Kenya Site: Siaya, CARE Project area

<u>Trees</u>	<u>Location</u>	<u>Method of Establishment</u>
539 trees individually growing; 56% after CARE contact Total trees (including hedges) 924		42% seedling 8% direct seed 20% cuttings 7% transplanted wildings 23% natural growing
Of 178 species: (retained/planted)	17% homesteads 41% croplands 25% grazing area 10% blocks 7% paths/boundaries	
<u>Tree Species</u>		<u>Uses</u>
5 species account for 57% of all free-growing trees on farm:	Eucalyptus spp Markhamia lutea Leucaena leucocephala Cassia siamea Agave silansis	
4 species account for 40%:	Euphorbia terucalli Agave sisalensis Dracaena spp. Lantana camara	hedges/boundaries
3 species account for 19%:	Eucalyptus spp. Cupressus lucitanica Cassia siamea	"forestry"
2 account for 14%:	Markhamia lutea Leucaena leucocephala	"agroforestry"
22 tree species account for 19% of trees on farm:		
4	Psidium guajava Citrus spp. Carica papaya Mangitera indica	fruit
3	Delonix regia Jacaranda mimoseaefolia Terminalia mentalis	shade and ornamentals
3	Aberia caffra Dracaena studnerii Parkinsonia aculeata	fencing/boundary
8	Calliandra spp. Callistris spp. Cassia spectabilis Grevillea robusta Melia azadirach Sesbania sesban Terminalia brownii	wood/leaf products
4	Acacia spp. Albizia coriaria Euphorbia candelabrum Sesbania bispinosa	natural/fallow

Source of Fuelwood	
<u>% Households</u>	<u>Source</u>
95	On-farm - naturally growing
89	On-farm - planted trees
65	Off-farm - collected
36	Off-farm - purchased
<u>% Households</u>	<u>Primary Source</u>
41	Free growing trees
36	Planted
20	Off-farm collection
3	Purchased
Source: Scherr and Alitsi 1990, revised 1992	

Bimodal Zone Tree Component

Table 2.15 Trees in the Sub-humid/Semi-arid Land Use System

Location: Kathama, Machakos District, Kenya

Agroecological zone: Sub-humid/Semi-arid

<u>Traditional Agroforestry Practices</u>		
<u>Location</u>	<u>Tree Species</u>	<u>Uses</u>
Crop field/pasture (primarily retained)	Terminalia brownii Acacia spp. Tamarindus indica Thespesia dania Kigelia african Erythrina abyssinica	fodder, fuelwood, timber
Pasture (retained)	Acacia spp. Balanites spp. (shrubs and other bushes)	shade, forage, fruits (also food, medicine, fuel, construction)
Crop field (intercropped, planted)	Mango, orange, pawpaw, guava	fruit, income
Terraces/slopes (primarily planted)	Guava, oranges Phyllanthus spp. Eucalyptus spp.	fruit, income fodder timber, fuel
Boundaries (primarily planted)	Euphorbia spp. Combretum spp. Acacia spp.	fencing, living fences
Homestead compound (primarily planted)	Mango, organge, papaya, guava Rhus tenuinervis Zanthoxylum spp. Acacia spp. Eucalyptus spp.	fruit fruit medicine fuel construction
Woodlots	Cassia siamea Kigelia africana Eucalyptus spp. Terminalia brownii Acacia albida Ficus spp. Gliricidia sepium Acacia tortilis	multipurpose
Source: Wanjohi 1987		

Unimodal Zone Tree Component

Table 2.16 Common trees in the Sukuma Agropastoral Land Use System

Location: Tanzania

<u>Tree Species</u>	<u>Location</u>	<u>Density</u>	<u>Use</u>	<u>Frequency</u>
Cassia siamea	homesteads, roadsides	woodlot, single	fuel, shade, windbreak	very common
Delonix regia	homestead	single trees	fuel, poles, shade, windbreak	very common
Albizia lebbek	homestead	single tree	fuel, shade, windbreak	very common
Acacia arabica/nilotica	homestead, garden	woodlot, single	fuel, shade, windbreak	very common
Melia azedarach	homestead	woodlot, single	fuel, poles, shade, windbreak, ornamental	very common
Parkinsonia aculeata	homestead	single, scattered	shade, ornamental	common
Leucaena leucocephala	homestead	single, scattered	fuel, poles, browse	becoming common
Eucalyptus cam., citri.	homestead	single, woodlot	fuel, poles	very common
Euphorbia tir.	homestead, bomas (kraals)	live fencing	fencing	very common
Tamarindus ind.	homestead	single, scattered	fruit, shade	common
Mfausiku (Mimosoideae)	homestead, bomas (kraals), cattle paths	live fencing	fencing	very common
Sisal	homestead, bomas (kraals), boundaries	live fencing	fencing, poles, sisal fibre	very common
Fruit trees: mangoes, papaya, guava, lemon, oranges	homesteads	single, clustered	fruit	very common

Source: TATF and ICRAF 1988, Barrow et al. 1988

Table 2.17 Trees in the Chitemene Land Use System

Location: Zambia

Agroecological zone: Western Semi-arid Plains

<u>Tree Species</u>	<u>Location</u>	<u>Use</u>
Over 30 species of wild fruit	woodland, left standing in fields	fruit
Pterocarpus angolensis	left standing in fields	planks
Other indigenous trees	left in homegarden or around homestead	shade, live fencing, food, oil, medicine, fish poison

<u>Exotic Fruit Trees</u>			
<u>Site</u>	<u>% Households</u>	<u>Location</u>	<u>Use</u>
Kasama	almost all	homegarden	fruit, income
Mpika	80	homegarden, fields close to home	fruit, income

Preferred species: fruit, not interested in tree species which only provide fuelwood

Source: Hans 1978, Hans 1985, Mudenda 1981, Holden 1988

Unimodal Zone Tree Component

Table 2.18 Trees in the Barotse Agropastoral Land Use System

Location: Zambia
Agroecological zone: Western Semi-arid Plains

<u>Trees</u>	<u>Location</u>	<u>Uses</u>
Fruit and nut trees: mango, citrus and cashew	in the permanent fields around homestead and homegarden	fruit
Preferred species: fruit and multipurpose, not just fuelwood		
Source: ZATF and ICRAF 1989, Schultz 1976		

Table 2.19 Trees in the Maize Livestock Land Use System

Location: Zambia
Agroecological zone: Central, Southern and Eastern Plateau

<u>Trees</u>		<u>Location</u>	<u>Uses</u>	
Acacia, fig, wild fruits, and Pterocarpus angolensis		left standing in the field	fruit, fuel, timber	
<u>Site</u>	<u>% Households</u>	<u>Tree Species</u>	<u>Location</u>	<u>Uses</u>
Eastern Province	60	exotic fruit	homesteads and fenced permanent fields	fruit, fuel
Katete project		Eucalyptus grandis	homesteads and permanent fields	projected: 100% respondents: poles, furniture 14% respondents: income 14% respondents: fuel
Preferred species: 86% in Eastern Province responded that they would like to plant fruit trees				
Sources: ZATF and ICRAF 1989, Kwesiga and Chisumpa 1990, Gossage 1989, Bohlin and Larsson 1983, Chidumayo 1988b				

Unimodal Zone Tree Component

Table 2.20 Trees Found in the Region III Maize Livestock Land Use System

Country: Zimbabwe

Site: Mutanda Resettlement Area

Trees Planted				
<u>Tree Species</u>	<u>% of Respondents</u>	<u>Location</u>	<u>Purposes reported planting trees</u>	<u>% of Respondents</u>
Mangifera indica	32	all trees planted near homestead	fruit	74
Carica papaya	22		shade	29
Morus alba	11		hedge	6
Citrus sinensis	8		ornamental	6
Prunus persica	4		fuelwood	0
Musa sapientinum	3		other	0
Uapaca kirkiana	3			
Persea americana	2			
Ricinus communis	1			

Source: Grundy et al. n.d.:48-49

Trees Retained				
<u>Tree Species</u>	<u>% of Respondents</u>	<u>Location</u>	<u>Purpose or reason to retain</u>	
General	94	in cultivated fields	fruit, shade, construction, religious significance, or were difficult to remove	
Fruit trees**	60	in cultivated fields	fruit	

** Not all fruit trees were conserved. Conservation was more likely to occur with large trees of favoured species.

Source: Grundy et al. n.d.: 25-26

Table 2.21 Trees in the Cereal Livestock Land Use System

Location: Zimbabwe

Agroecological zone: Region IV/V

Trees Retained				
----------------	--	--	--	--

Trees, especially fruit trees, are left standing in the fields after clearing.

Crops growing under fruit trees, such as Muvonde (*Ficus capensis*), Mushavi (*Ficus burkai*) and Muchakata (*Paranria curatellifolia*) are recognized as having higher yields than crops elsewhere in the field. Over 30 indigenous tree species were reported by farmers to be used for feeding animals.

Trees Planted, Preferred Species

Fruit trees, planted near home.

A large proportion of the farmers have great enthusiasm for tree planting with a multipurpose approach to the livestock feed storage.

Source: Balderrama et al. 1988

Trees Retained				
Site: Region IV				
36% of households reported growing fruit trees.				
The preferred fruit tree is mango, followed by citrus and guava.				
Source: UNDP/FAO 1989				

Unimodal Zone Tree Component

Table 2.22 Tree Planting in Region III and IV

Country: Zimbabwe

Site: Rural Afforestation Project area in central Zimbabwe primarily in Regions III and IV

Trees

61% of households reported having planted a tree(s).

Of those who had planted a tree in the last 5 years:

<u>Tree</u>	<u>% of Households</u>
fruit	98
shade or ornamental	34
Eucalyptus spp.	11

Source: Du Toit et al. 1984

Table 2.23 Trees in Shire Highlands Maize/Pulses Land Use System

Country: Malawi

Land Use System: Maize/Pulses system

<u>Trees</u>	<u>Location</u>	<u>Uses</u>	<u>Source of Seedlings</u>
Exotic fruit trees: mangoes, citrus "and other fruits"	around homesteads	fruit, shade, fuel	Poulsen (1981) notes that many smallholders have their own nurseries to meet their needs
Eucalyptus spp.	around homesteads	poles, construction, fuel	government nurseries** and/or own nursery
Gmelina arborea	around homesteads	poles, construction, fuel	government nurseries** and/or own nursery
Cassia siamea	around homesteads	poles, construction, fuel	government nurseries** and/or own nursery

** Provided by national tree planting program

Source: MATF and ICRAF 1988, Chisumba 1987

Table 2.24 Trees in the Lilongwe Land Use System

Country: Malawi

Agroecological zone: Lilongwe Land Use System

<u>Trees Retained</u>	<u>Trees Commonly Planted</u>	<u>Location</u>
Acacia albida	Mangifera indica	"Mango dominates the landscape. Nearly every field is dotted with mango trees. The other trees ... are commonly found on the fields, in the homesteads and woodlots ..."
Acacia polyacantha	Eucalyptus spp.	
Albizia spp.	Cassia siamea	
Bauhonia thonningli	Gmelina arborea	
Markhamia obtusifolia	Toona ciliata	
Parinari curatifolia	Melia azedarach	
Percopsis angolensi		
Pterocarpus angolensi		
Piliostigma thonningli		
Faurea saligna		

Source: MAF and ICRAF 1988b; 19, 1988a

3. COUNTRY REPORT: KENYA

1. General information

1.1 Background

Population

Kenya is in equatorial East Africa, bordering on Somalia, Ethiopia, Sudan, Uganda, Tanzania and the Indian Ocean. The country is over 580,000 km² in area and the population is estimated to be around 24 million people. With an annual growth rate of approximately 3.9 percent, its population is among the fastest growing in the world. The population density is unevenly distributed, with areas of good agricultural potential being heavily populated. In some areas density exceeds 900 person/km². These high potential agricultural areas support the majority of the population, but comprise less than 15 percent of the land area. The areas of high population densities are in the Central province on the eastern slopes of the Aberdare Mountains and Mount Kenya, and in western Kenya in the Kisii and Kakamega areas (NTF and ICRAF, 1988).

Arid and semi-arid areas are generally of more recent agricultural settlement than the high potential areas. The drier areas have long supported pastoral populations and large, widely disbursed populations of livestock and wildlife. Population densities in these areas range from fewer than 1 person/km² to more than 50 person/km².

Topography

Kenya has a diversified topography, ranging from coastal flatlands and upland plateau to the steep slopes and high peaks of the mountain ranges. The altitude ranges from sea level to over 5,000 m.

Climate

The pattern and amount of rainfall varies and "is highly correlated with altitude except where it is influenced by other features such as lakes" (NTF and ICRAF, 1988). There is a bimodal rainfall pattern in the areas east of the Rift valley, and a unimodal rainfall pattern in the Lake Basin and the highlands west of the Rift Valley. Seasonal rains can be extremely erratic in the arid and semi-arid areas. In the case of the bimodal pattern, the "long rains" fall from March to May and the "short rains" from October to December. On the coast, the main period of precipitation is from April to October. The Lake Basin, including the Western Highlands, has a longer rainy season which is usually between March and November (NTF and ICRAF, 1988:3).

The amount of rainfall ranges spatially from less than 200 mm to over 2 m per year. The area of lowest rainfall is the northeast, while the area of highest is on the slopes of Mt. Kenya and the highlands of Kisii and Kericho. "There is a relative wet belt along the coastline and the Lake Victoria basin. Dry areas are found in the great valleys and basins"(NTF and ICRAF, 1988:4).

Vegetation

Vegetation ranges from near treeless savanna to forested areas. The latter comprise only 2 percent of the total land area of Kenya. However, most of the forested areas are in the high potential zones and comprise up to 20 percent of the high potential land in some

areas. Hence, the forested areas are under increasing pressure to be cleared for agriculture.

Soils

Although there is extreme variation in the soils of Kenya, a few generalizations can be made. The soils of the highlands are usually deep, well drained, easily workable and with moderate to high fertility. There is variation within the highlands: the soils of the central highlands are volcanic, deep and fertile; those of the Rift Valley highlands are more fragile and of moderate to poor fertility; and the soils in the western highlands are less fertile than the central highlands and have been heavily depleted by intensive cultivation (NTF and ICRAF, 1988).

Soils in the drier areas tend to have a sandy-loam texture with moderate to low fertility. In the Lake Basin the soils are often vertisols which have a high clay content (black cotton soils) and are especially subject to heavy flooding. Soils along the coast are sandy and of exceptionally low fertility (NTF and ICRAF, 1988).

1.2 Agroecological zones

Six broad agroecological zones have been identified in Kenya (see Figure 3.1), and these reflect the wide range of differences in rainfall, temperature, altitude, topography and soils. The zones have been delineated primarily on the amount of rainfall received. Rainfall is crucial for agriculture, yet Kenya receives a reliable 750 mm per annum in only 15 percent of the country (Lundgren, 1975).

Table 3.1 Description of Zones

Zone	Description	Agricultural potential
I Afro-Alpine	High altitude montane	Low
II Highlands (Humid zone)	Central, Western, Taita, <i>etc.</i> about 9% of Kenya	High
III Sub-humid/ Semi-Arid	Fringes of the humid highlands coastal strip, about 9% of Kenya	Medium/High
IV Semi-arid	Inland coastal areas, Lake Victoria, foothills	Medium
V Arid	Most extensive zone in the country, 52% of Kenya	Low
VI Very Arid	Drier with less reliable rainfall, occupies 22% of Kenya	Low

Source: Based on Odingo, 1988; NTF and ICRAF, 1988; ICRAF, 1988; Lundgren 1975.

This country report is concerned with farmers in areas of high and medium agricultural potential. The discussion of these areas is based on two agroecological zones: the bimodal highlands and the sub-humid/semi-arid zone. The greater portion of Zone II and some areas of Zone I and Zone II in Table 3.1 are included in the zone identified

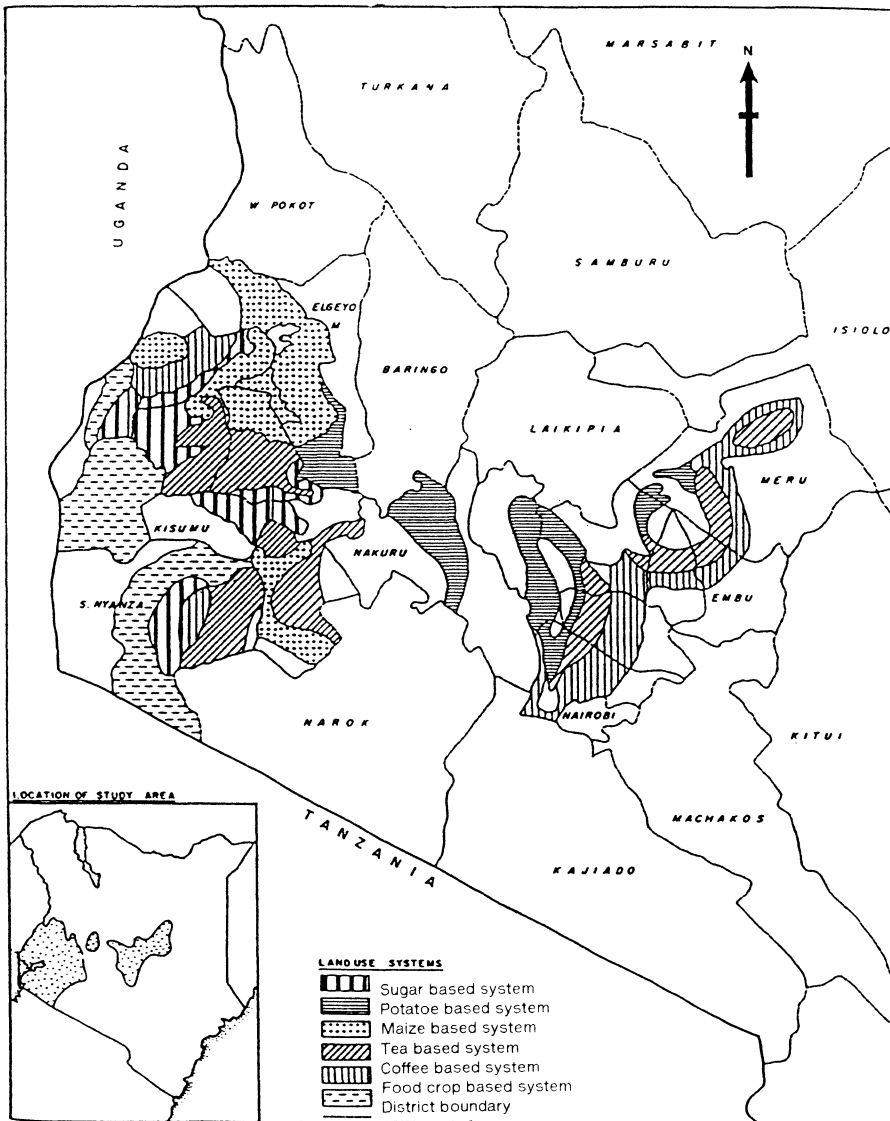
by AFRENA (Agroforestry Research Networks for Africa) as the bimodal highlands. The sub-humid/semi-arid agroecological zone is in the medium potential area of Zone III and IV.

Bimodal Highlands land use systems

The Bimodal Highlands zone constitutes 80 percent of the high potential area of Kenya, with the remainder being on the coast and the Lake Basin. Although it comprises only 15 percent of the total land area, it supports over 50 percent of the population. Six land use systems have been identified in the Bimodal Highlands by AFRENA (see Figure 3.1). The delineation of the land use systems is based on biophysical factors (altitude, rainfall, soil and tree cover) and socioeconomic factors (population density, markets, government policy, farming practices, and tenure). The forestry systems found on government land and the large scale commercial farms are excluded (NTF and ICRAF, 1988; ICRAF, 1988).

1. Coffee based system. Coffee is the most important cash crop and the main staples are maize and beans. Dairying is important although it is still relatively undeveloped. The terrain is characterised by steep slopes and consequently, soil erosion is a problem. There are four subsystems of this land use system, delineated on the basis of inputs, intercropping, and food crops.
2. Tea based system. This land use system is characterised by the importance of tea and dairying and the relative unimportance of the food crop component. The high altitudes allow only one growing season and temperate fruit and vegetables grow well. The soils are volcanic and have high inherent fertility. There are four subsystems of this land use system, delineated on the basis of crops, degree of dairying, and inclusion of coffee.
3. Maize system. Maize is cultivated in all six of the land use systems in the Bimodal Highlands, but only in the maize system land use system is it the sole cash and food crop. Maize and dairying are the two main components of this system, and they are well integrated. This system is found almost entirely in the Rift valley province. There are two subsystems of this land use system, delineated on the basis of farm size and livestock management.
4. Sugar based system. Sugarcane is the most important crop and replaces maize as the main cash crop. Dairying is poorly developed. Sugarcane production is managed under contract with the factories. This system is found in the Lake Basin Plateau and there are two subsystems of the land use system, delineated on the basis of farm size.
5. Potato-based system. This system is found in the Central and Western Highlands, and potato is the main crop.
6. Food crops based system. This is a mixed crop/livestock system, although there is not a cash/export crop of importance. The basis of the system is food crops and livestock (not dairy animals) and it is found in the South Nyanza-Kisumu area.

Figure 3.1
BIMODAL HIGHLANDS: LAND USE SYSTEMS



Source: NTF and ICRAF, 1988:35

Sub-humid/Semi-arid Land Use Systems

This zone has a bimodal rainfall pattern, but the amount of rainfall is less than that in the bimodal highlands. In much of this zone there is a subtle shift from sub-humid to semi-arid. The distinction is usually based on rainfall; above 750 mm it is subhumid, and below it is semi-arid. The areas which are the concern of this report are the medium-potential areas where rainfall is usually above 750 mm.

The land use systems follow the same gradient as rainfall. They are usually agropastoral, with the emphasis on livestock in a particular site depending on the amount of rainfall; the greater the rainfall the more likely that the agriculture component is of more importance in the land use system, and, conversely, the lower the rainfall the more likely that the livestock component is of greater importance.

1.3 Tenure

Land tenure

There are three recognized systems of land tenure in Kenya: land is held by the government (Government lands); by the County Council in trust for the government (Trust lands); and by private individuals under freehold (Freehold lands) (see Figure 3.2).

Government lands

Unlike other countries in the region, the Kenyan national government does not hold all the land in trust for the people. The lands which the government controls are primarily reserves and parks (which generate income for the government), and lands which have been set aside for institutions, military uses *etc.*

Trust lands

Trust lands include lands which were under customary law during the colonial period, and reserves, parks and game reserves which are under the jurisdiction of the County Councils. The County Councils may request the government to manage the reserves, but the revenues are retained by the Council.

At independence in 1963, the land which was within the African Native Reserve automatically became part of the Trust lands. Customary tenure was the only tenure recognized by the colonial government for an African until the Native Lands Registration Ordinance of 1959. This ordinance started the process of land adjudication, registration and titling, it was supported by the Registered Land Act of 1963, and it continues today.

In order to obtain a title, the land must be demarcated (adjudication) and registered. Once titles are registered, all customary rights to the land are said to be extinguished. Although there is regional variation, customary rights usually included activities such as gathering deadwood and grazing rights in fallow fields. Under the new tenure system, the registered owner has, even if community pressure discourages its use, the right of exclusion over the landholding.

Customary tenure, however, continues to play an important role, even in areas where there is registration of titles. Once a landholding is registered, it is regarded as being under the control of an individual, but customary tenure continues to control how land is inherited and subdivided and, increasingly, any disputes concerning it. Although the Registered Land Act has technically abolished all customary rights to land which had been titled, the Magistrates's Jurisdiction (Amendment) Act of 1981 empowered panels of elders, agreed upon by the disputants, to settle land disputes. These panels have increasingly relied on customary tenure to settle land disputes. Registered landholdings, therefore, still fall within the sphere of customary practices and rights.

Table 3.2 Tenure: by area

Type of Tenure	Area km²	Percent of total
Government lands		
Forest reserves	9,116	1.6
National parks	24,067	4.1
Other Government land (reserves, townships, lands, unalienated lands, open water)	82, 905	14.2
Subtotal, Government land	116,088	19.9
Trust lands		
Forest reserves	7,084	1.2
National parks	3,149	0.5
Game reserves	13,691	2.4
Other Trust lands (reserves, towships, alienated	35,701	6.1
Subtotal, Trust land	59,625	10.2
Other Trust lands, reserved for smallholders		
Registered	27,729	4.8
Not yet registered	370,087	63.6
Subtotal, Other Trust Lands	397,816	68.3
Freehold lands		
Titled to smallholders	6,615	1.1
Other freehold	2,116	0.4
Subtotal, Freehold lands	8,731	1.5
TOTAL	582,260	100.0

Source: Republic of Kenya (1989)

The term "freehold" has also been used to describe the individual private tenure which occurs in the Trust Lands (NTF and ICRAF, 1988). In terms of the rights of the individual who holds title there is little difference, for although the County Council has jurisdiction over titled land, the individual has the same rights of transfer (sell, rent, *etc.*) over the landholding as an individual in the Freehold Lands (see below). The primary difference is that a land dispute under freehold tenure (Freehold Lands) is taken to court, whereas under individual private tenure (Trust Lands) a dispute is settled by the panel of elders (Deweese, 1991a). The reliance on elders maintains customary law, especially concerning inheritance, and serves to reinforce regional differences rather than supporting the development of a national tenure system. A dispute settled by the panel of elders is also less costly to the disputants than the court system and allows more access to mediation.

Private ownership of land by women has been projected as one of the potential benefits of land registration. However, it is difficult for women to both obtain land to register, and maintain control of land after registration. Under the customary law of many of the

ethnic communities of Kenya, a married woman cannot own property in her own right. All the wife's property, whether acquired before or after marriage, falls under the control of her husband (Muigai, 1989). On the death of her husband, a woman is not necessarily the heir, nor will a daughter in most communities inherit land from her father unless she is unmarried.

The only way a woman can own property is if she purchases it or is specifically willed it and is living in a community that recognizes her as an owner, *ie.* one in which her husband would not automatically gain control of her property. Or, as appears to be a trend, she obtains property through purchase or will and does not marry.

What the gender-land issue illustrates is the difference between control (inheritable and recognized) and right of use and access of land. Under customary law women had rights of access through either clan, lineage, father, spouse, or brother, while under registered land her access to land has been narrowed, usually to her husband, or perhaps son. After her spouse's death, the landholding may be inherited by his brothers or son, not her, and access may then be denied (Okoth-Ogendo, 1981; Haugerud, 1984; Hunt 1984; Rocheleau 1989). Access to land, therefore, is very different from having control of it.

In summary, the policy is for individual private tenure land and for the abolishment of customary rights of access to land. Registration does appear to provide security of tenure, but at the loss of customary rights of access to other landholdings.

Freehold Lands

Freehold lands are the lands which were originally set aside for European settlement. It is the intention of the Government to eventually convert ownership of all land currently in freehold status and regulated by the Indian Transfer of Property Act of 1882, so that it falls under the jurisdiction of the Registered Land Acts (Wanjala, 1990).

Tree tenure

Although there is regional variation, in general there is a very strong link between land tenure and trees under customary law, which could be expressed as "whomever plants trees owns them and their products." However, as with the distinction between control and access of land, there is under customary law a distinction in some communities between owning trees, and usufruct concerning trees. A customary right, for example, is to be able to gather deadwood for domestic use from another's land.

Under the Registered Land Act all such customary rights to trees were abolished. In terms of owning trees, the Land Act reaffirmed previously held customary rights, for in most areas planted trees always belonged to whomever planted them, although usually for only as long as they had cultivation rights on the land. The Registered Land Act increased the period of cultivation rights, and therefore reaffirmed the ownership of trees planted on the land.

Given the diversity of Kenya's ethnic communities, it is to be expected that in some communities there is a distinction between tree tenure and land tenure. On the Kenya coast, for example, Fortmann (1985) notes that Muslim women can inherit trees that are located on the property of male relatives and men's use of the land must not interfere

with the proper management of the trees.

What of trees which were not planted? Traditionally, if trees were on land which was not allotted or being cultivated, there was open access to all members of the community to use the trees for building materials, fuelwood, fruit, *etc.* There could be specific restrictions placed on certain trees. Among the Kamba, for example, if a bee hive was placed on a tree which was on communal land, the tree could not be cut or tampered with and cattle grazing was restricted so as not to disturb the hive (Penwill, 1951 as cited in Fortmann and Riddell, 1985).

In some communities gender has an impact on access; trees may be conceived as being owned by men, and access to them by women for fuelwood may be limited. In most communities if trees are planted for commercial purposes, their use is likely to be controlled by men (NTF and ICRAF, 1988).

Government interventions

Government policy has been to convert landholdings from customary to private tenure. The belief is that if land is held under individual private tenure it will be better managed and have higher production than if it is held under customary law (Migot-Adholla, 1990). As noted above, the inheritance of land after registration is still governed by customary law. There have been several attempts to have a Marriage Bill passed by the Parliament which would grant some inheritance rights to widows of not only land but other assets. So far none of the bills have been passed, and the current projection is that none will pass in the near future.

1.4 Economy

Kenya has a per capita income of \$330 and this is the second highest of the countries in the study area (World Resources Institute/UNEP/UNDP, 1990). The economy of Kenya is heavily dependent on agriculture which accounts for around a third of the domestic product and provides employment for nearly 70 percent of the predominantly rural population (World Bank, 1990; World Resource Institute/UNEP/UNDP, 1990). Agriculture produces nearly all of Kenya's food supplies and is a source of raw material for a substantial and expanding agro-industrial sector. Agriculture also provides over 50 percent of Kenya's export earnings, principally from coffee and tea (World Bank, 1990).

Although other countries in the region have reported declines in production in recent years, there has been a growth in the agricultural sector in Kenya. However, the rate of growth has not kept pace with the growth of the population. Agricultural production grew 4.9 percent annually between 1965 and 1980, but since 1980 the average annual rate of growth has been about 3.3 percent. In real terms this has represented a decline in per capita production because during this same period the population grew at almost 4 percent a year.

The industrial sector of the economy has been growing, but again it has not been able to pull ahead of the rapid population growth. Since 1980 the industrial sector has been growing at about 3 percent a year, and contributes about 19 percent of the GNP. The services sector has had the most steady rate of growth, and since 1965 had, until the

current slump, been growing at an annual rate of between 5.5 and 6.5 percent. In 1987, tourism was the most important source of foreign exchange, followed by tea and coffee exports (World Resources Institute/UNEP/UNDP, 1990; World Bank, 1990).

In summary, the economy of Kenya, especially when compared to the other countries in the study area classified as having a "low income economy", is a growing one. However, the population is growing at such a high rate that per capita growth is not occurring.

1.5 Rural Sector

The household is the unit of agricultural production. Although polygyny still occurs, the majority of rural households are monogamous. Household size varies, but it usually ranges from 5 to 8 members.

Rather than nucleated villages, the settlement pattern is usually of households located on their landholdings. Female headed households are quite common, reaching over 30 percent in many communities, as a result of the outmigration of males to urban areas.

Although the structure of agricultural production has changed considerably since Independence, there is still a degree of dualism. Large farms, over 20 ha. in size, still account for a quarter of the total farmed area. Smallholdings of less than 20 ha. account for 60 percent of the total farmed area, while group ranches account for the remaining 15 percent. Over three-quarters of smallholdings are under 2 ha. in area.

Households will always grow a food crop, and in many of the areas an export crop as well. Maize is produced for household consumption, but some of the harvest may be sold for cash. It has been estimated that 90 percent of total maize production comes from farms which are smaller than 5 ha.

Exports crops are an important source of income to smallholders. About 60 percent of the marketed production of coffee and around half of the tea is produced by smallholders (ICRAF, 1988).

Labour

There appears in many households to be a labour shortage, especially during the periods of peak agricultural labour demand. Although households are relatively large, many of the households members are either too young, in school, or absent to provide the amount of labour needed. Traditionally, women were the primary agricultural producers; after the land was cleared by her spouse, a woman was responsible for producing enough food for herself and her children. The situation today is not dissimilar except that the children provide less labour than they would have done in the past.

Although the household provides most of the labour, hired labour is used if possible during the peak labour demands of export crops, especially coffee and tea. However, a household has to be able to obtain enough capital to pay for the costs of hired labour, which given the lack of credit available for labour costs, usually means a source of off-farm income.

Credit

In order to qualify for credit, a smallholder usually has to grow an export crop. Short term loans are provided by farmer organizations, cooperatives and special development programmes (NTF and ICRAF, 1988). Currently, credit is primarily used to purchase inputs for export crops, especially fertilizer. Between 1971 and 1988, the use of fertilizer per ha. of arable land increased by 77 percent (World Bank, 1990). Credit for expenses such as hiring labour at the peak demand periods is generally not available.

There is relatively little credit available for a smallholder who is not growing export crops. A farmer growing maize, for example, would have to have more than 2 ha. (>5 acres) to qualify for credit in the form of GMR (Guaranteed Minimum Returns), a provision which eliminates the great majority of farmers (NTF and ICRAF, 1988). Given the high cost of inputs such as fertilizer and the lack of credit, smallholders tend to concentrate their use of inputs on high value crops and not food crops for domestic consumption (NTF and ICRAF, 1988).

Fuelwood

In the central highlands it was estimated that of the total fuelwood supplies "80 percent comes from private farms, 13 percent from natural forests and 7 percent from county council forests" (NTF and ICRAF, 1988:23). Even though farmers plant and retain trees, the demand for fuelwood in the highlands is still higher than the on-farm supply. In the semi-arid areas fewer trees are planted and there is still reliance on wood gathered off-farm.

In the urban areas of Kenya charcoal is widely used as the fuel for cooking. Most of the charcoal on the urban markets is a by-product of the clearing of land for agriculture. Although wattle may be used for charcoal, in the highlands relatively little land remains to be cleared. The semi-arid lands are increasingly becoming the areas of new settlement, and consequently, have provided an increasing proportion of charcoal for the urban market.

Other supplies of charcoal come from producers who burn charcoal specifically to generate income. This is particularly the case in dryland areas where yields are poor and growing seasons short; charcoal burning provides an important source of income before crops have been harvested. In these circumstances, woodland is not really cleared, but is greatly modified by the process of felling trees for charcoal production.

1.6 Government policy on land use, crops and trees

Kenyan policy on land use is based on the goal of increased production of both food and export crops and increased rural income. In order to fulfill the goal of increased production, the current agricultural policies "aim at developing the whole agricultural sector by putting efforts in both the high and medium potential areas and the arid and semi-arid lands" (NTF and ICRAF, 1988: 27). In the medium and high potential areas, the main goals are for intensification of production and "the introduction of high value products and improved land sustainability technologies" (NTF and ICRAF, 1988:27).

The policy calls for the expansion and intensification of crops, such as coffee, tea and

maize, which are already well established in Kenya. *Coffee robusta*, a new crop in the areas, is to be established in western Kenya and the Coast province.

Government policy strongly supports agroforestry and one of the priorities of rural development is to establish agroforestry systems on 3 million ha. in the high potential highlands for soil conservation, tree products and soil improvement. Since agroforestry is "multi-disciplinary and multi-institutional" it was recognized that for agroforestry development and policy making to be successful, it would be necessary to include the following government departments in the planning and implementation of policy: the Ministry of Environment and Natural Resources; the Ministry of Energy and Regional Development; the Ministry of Agriculture; the Ministry of Livestock Development; and the Ministry of Research, Science and Technology (NTF and ICRAF 1988).

Government interventions

Although agroforestry *per se* is a relatively new concept, government support of tree growing by farmers began before independence. Through the agricultural sector, programmes encouraged farmers to plant trees for fruit, shade, windbreaks and soil conservation. Under the taungya system, the forestry department also introduced crops during the establishment of forests as early as 1910 (Oduol, 1986; NTF and ICRAF, 1988).

Primary responsibilities for encouraging rural afforestation lie with the Rural Afforestation Extension Service (RAES) of the Forest Department which was created in 1971. Its mandate was to promote tree planting outside of the Forest Reserves. The primary aim of RAES was to establish a nursery in each administrative division (220 in total). By late 1987, about 170 of these nurseries had been established. Although the major purpose of these nurseries was to provide seedlings of trees for fruit, fodder, fuelwood and building materials for smallholders, the species in the nurseries, primarily *Pinus* spp., cypress, and *Eucalyptus* spp., were more suited to plantations.

The RAES produced seedlings but did not establish and operate an effective extension service. This emphasis on seedling production was further strengthened by the 1984-88 National Development Plan which incorporated a 1983 policy statement to the effect that the country should be producing 200 million seedlings annually (Wamagunda, 1989). By late 1986, RAES was producing about 60 million seedlings for sale or free distribution. Seedlings were being sold for around US\$ 0.50 per hundred, compared to estimated production costs of US\$ 3.50 per hundred (Deweese, 1986). It has been argued that the subsidized seedlings production of the Forestry Department has promoted a dependence on the Department and has duplicated (and hindered) smallholder tree nursery efforts. The needs of the farmer are not so much seedlings, but rather for the introduction of better tree management practices, improved farmer nursery practices, and new tree species (Deweese, 1986).

There is a continuous pro-tree media campaign by the government. The campaign includes an official annual tree planting day on which the President ceremoniously plants a tree and seedlings are planted by institutions and individuals throughout the country. Throughout the year the President plants trees to commemorate numerous public occasions and in his speeches he encourages the planting of trees.

While there is currently strong government support for tree planting by farmers, agricultural regulations in some areas still discourage retaining or planting trees in cropland, and modern agriculture is perceived as one in which trees are removed from the fields. Also, a farmer may find that in order to fell a tree, even if it had been planted on his cropland, a permit is required from the district officer. In neither of these cases would a farmer be encouraged to continue planting or retaining trees on his fields (Deweese, 1990).

Small farmers and trees

Government policy while encouraging farmers to grow trees, has not fully accepted that farmers know how to grow trees and are already growing trees on their landholdings. Tree retention, protection, planting, and management are found in agricultural communities throughout Kenya. In the highlands, for example, traditional agroforestry systems exist based on retaining trees in crop lands for shade, fuelwood and soil fertility. Near the homestead, fruit trees are planted where they can be maintained as part of a home garden. Boundary planting around the farm for demarcation and fencing out (or in) of animals is quite common as well.

2. Agroecological Zone Analysis

2.1 Bimodal Highlands

Definition of zone

Crop growing period ranges from 270-365 days per year.

Rainfall is bimodal and ranges from an annual average of 1000 mm to 2500 mm. The amount of rain is positively correlated with altitude. In the central highlands the seasonal variation is more pronounced than in the western highlands. In the latter, rain falls throughout the year, but peaks in April and December, while in the central highlands there are two distinct rainy seasons, the "long" rains between March and May and the "short" rains between October and December (ICRAF, 1988).

Altitude ranges from 1000 m to about 2500 m above sea level. The highlands areas are divided by the Rift valley.

Vegetation has been greatly modified by the agricultural activities and livestock grazing in the zone. The natural vegetation of forest and woodlands has been transformed into a landscape of fields, bush, and grasslands with scattered or small groups of trees.

In the highlands six soil groups have been identified (NTF and ICRAF, 1988; ICRAF, 1988):

Nitosols - derived from basic volcanic rocks, which are of moderate fertility, moderately to strongly acid, with a capacity to support more or less continuous cultivation.

Ferralsols and Acrisols - derived from felsic rocks, well drained, acid to strongly acid, fertility is moderate to low.

Luvissols and Cambisols - derived from felsic rocks, well drained, only moderately acid, with variable though generally moderate fertility.

Andosols - derived from volcanic rocks, well drained with humic topsoil with high inherent fertility.

Vertisols - derived from volcanic rocks, imperfectly to poorly drained, stiff and sticky when wet, and develops cracks when dry.

Gleysols and Fluvisols - derived from alluvium and colluvium, and generally poorly drained.

Case study: coffee based system

The case study of the bimodal zone is the coffee based system of the central and western highlands. Included in the discussion is survey information from two agroforestry projects in the western highlands, one in the maize and the other in the food crop land use systems.

Location

Within the coffee based system two major subsystems have been identified: the high-input subsystem and the low-input subsystem. The high input subsystem of this land use system is found in the central highlands on the slopes of Mt. Kenya and the Aberdare Range, mainly in the Central and Eastern Provinces. It is characterized by relatively high inputs dairy cattle, maize, beans, and even some tea. The low input subsystem is found in the Kericho and Kisii highlands. It is characterized by low inputs without dairy cattle. A small scale food crops subsystem (without coffee) is found in these areas as well, especially in the Kisii and Kakamega district. The total area under the land use system is about 4000 km² (NTF and ICRAF, 1988).

Population

There are over 2 million people in the coffee land use system. The highlands are believed to have been the earliest agriculturally settled area in Kenya. The population density in the land use system ranges from 450 to 700 persons/km², with an average of about 500 persons/km², making it the most highly populated region of Kenya (NTF and ICRAF, 1988).

Outmigration from this area began before independence, but owing to the high population growth rates, this has not had a significant impact on reducing population pressure on the land. Outmigration has been to urban areas and new agricultural settlements. The pattern of male migration to the urban areas has gradually been replaced by outmigration of both males and females from the land use system.

Land tenure

Land is currently registered under an individual private tenure system. Since in the past land was held and cultivated on an individual basis (although the clan was the recognized

owner), the new system does not impose a land tenure concept entirely foreign to the residents of the area. However, land registration does give more management control to the landholder and abolishes customary rights of access to members of the clan, such as the collection of fuelwood and fruit.

Landholdings are being subdivided, usually when inherited by sons or unmarried daughters. In a survey of farmers in Embu in the central highlands, 28 percent of the respondents reported that their land had been subdivided since adjudication (boundary demarcation), and two thirds stated that further subdivision would take place during the next ten years (ICRA 1986; ICRAF, 1988).

Tree tenure

In this zone there are ethnic group differences in tree tenure. In the Bimodal Highlands among the Kikuyu, trees which are planted or retained on a landholding belong to the owner of the land. During land consolidation, if a land-user was forced to give up land with trees, the new landowner had to pay compensation for the trees. Prior to adjudication, trees could be used by land rights holders to reinforce their claims to land which had been cultivated by tenants. Land right holders had been granted the land by their sub-clan, but could only continue to hold the land if it was cultivated. The use rights could be lent to other farmers who would cultivate the land, but the land grant would be retained by the original right holders. The tenancy rights could be inherited, so the relationship of land holder-tenant could remain for generations (Deweese 1991a; also for the Mbeere see Glazier, 1985).

During the colonial period, in order to retain their rights, land holders canceled the inheritable tenancy arrangements and planted the land in wattle (*Acacia mearnsii*). The land was then considered to be cultivated and the land holder retained the rights granted by the clan (Deweese, 1991a). In this instance planting trees under the guise of cultivation reaffirmed rights to the land.

In the western highlands only the owner of the land can plant trees, hence trees can be used to establish a claim to land ownership. Land disputes have traditionally been resolved in favour of the party claiming ancestral ownership to the most mature trees on a piece of land.

There are gender differences in the rights to trees. In southern Kakamega in the western highlands, men own the land and trees, while women are responsible for fuelwood collection. Women are not allowed to plant trees, especially Cypress spp. and *Eucalyptus* spp. which produce construction poles, a product perceived as belonging to men. Women, however, can grow and harvest *Sesbania* spp., which are regarded as being more a shrub than a tree, and are used for domestic cooking and not for construction. The control of tree resources by men is supported by cultural beliefs such as "if a woman plants a tree, she will become barren", which at least in the past, discouraged women from planting trees (Chavangi, 1984; Kerkhof 1990).

Land use system

This system is based on small landholdings intensively worked with most of the labour provided by family members. The farm sizes range from between 0.5 ha. to 3 ha. The

average farm size in the Central Highlands is 1.5 ha. with a household size of 9 members. Not all of the household members reside all year round on the farm (ICRAF, 1988).

Homesteads are usually at the top of a hill, or near a road or pathway, with the fields running from the top to the bottom of the slope. The farms are in most cases fenced, live fencing being common. There may also be an area around the homestead which is live fenced and contains a homegarden or a grazing area (ICRAF, 1988).

There is competition between the export, food, and livestock components for land. Although the system is basically cash oriented with coffee being regarded as the most important component, households also produce food, keep livestock, and grow trees for fuel and fruit. The strategy of the household is firstly to be self-sufficient in food and fuel, and then to have enough income to meet its other expenses. As a result of this strategy there is a positive correlation between the size of the farms and the area allocated to coffee, since once the subsistence needs of the household are met any additional land is then placed under coffee. In the central highlands about 70 percent of the total area is under crops, with the coffee plot occupying 20-45 percent of the crop land, and the rest is under food crops. In the western highlands the area under coffee is smaller, about 15-25 percent of the land (ICRAF, 1988; NTF and ICRAF, 1988).

In the central highlands coffee is usually grown as a monocrop, whereas in the west intercropping coffee with trees is quite common. The trees provide shade and some protection from the not infrequent hail storms in the western highlands. Food crops are generally intercropped throughout the land use system. Maize and beans are the most important food crops, with bananas also important in the western highlands. Homegardens are intensively cropped with vegetables, fruits, bananas, maize, *etc.* (ICRAF, 1988).

Except for the larger farms, the area under pasture is usually very small. Fodder, usually Napier grass (*Pennisetum purpureum*) is planted in small plots and grass strips within the fields of the food crops, and along the river banks.

This land use system requires heavy inputs of fertilizers and fungicides to be productive. Coffee societies provide such inputs against future crop payments. However, many farmers are wary of holding heavy debts for inputs, and are using smaller amounts than are needed for optimal production. In the past few years payment to small producers for their coffee has been sporadic and delayed, and the price for coffee has been relatively low and fluctuating. Smallholders may be forced to keep coffee in the fields (a permit, not readily obtainable, is necessary to cut down coffee and tea) and hence some smallholders have responded by minimizing inputs.

Off-farm income is an important component of this system. The majority of households in this system are not able to meet the goal of self-sufficiency in food and an adequate cash income. It is common for households to sell food crops and buy the same food crops later. Cash, therefore, is necessary to buy food, as well as for the other household expenses. Not surprisingly, given the large number of children in the household (7 of the 9 household members), the highest demand for cash is to pay for school fees (Minae,

1988: 23). The cash received from the sale of coffee, food crops, and milk is often insufficient for many households. Hence, off-farm employment, such as male employment in the urban areas, and agricultural wage labour by members of the household, are needed to supplement farm incomes.

Tree component

Trees are an important component of the land use system. One of the consequences of land adjudication and registration was that households lost customary rights of access to trees on land held by others, and had to develop an adequate supply of tree products on their own landholdings. In the highlands this need for self-sufficiency in wood products has resulted in a landscape where between five and ten percent of the agricultural land and about twenty percent of the total land area is under tree cover (Deweese, 1990; NTF and ICRAF, 1988). Tree cover consists of trees that are both planted and retained.

In the western highlands the proportion of land with planted trees correlates with population density, *ie.* the higher the population density the higher the proportion of trees. The increase in tree cover is accompanied by a shift from indigenous to exotic species as trees are planted or retained by farmers which are more productive than the indigenous species, or fill a particular niche, such as providing fruit (Kerkhof, 1990). With an estimated 60 trees per ha., Meru in the central highlands is where the highest population of trees is found (NTF and ICRAF, 1988:41). In Siaya in the western highlands in the food crop land use system, there were an estimated 237 trees on the average landholding before an agroforestry project began in the area (Scherr and Alitsi, 1990).

Trees are planted and retained in cropland, near the homestead, in woodlots, and on boundaries. Traditionally, some trees were left in the cropland. Shepherd (1989) observed, in parts of Meru and Embu districts, that adjudication had an impact on where trees were planted. Trees were more commonly saved in fields which were held and cultivated under customary tenure. Adjudication tended to lead to a smaller number of species of trees on the farm, but more individual trees from each species, and an increase in tree planting on field boundaries.

Tree planting on field boundaries, however, was done prior to the current tenure system. In the Kikuyu areas, the planting of trees to demarcate the holding was recognized in the customary tenure system. The practice was recognized by colonial authorities whilst trying to settle tribal land claims in the early 1930s. Boundary planting gained importance during the land reform programme of the 1950s and 1960s as a critical part of the consolidation and registration process. Hedges were the administratively accepted means of boundary demarcation and were planted immediately after a plot had been consolidated (Deweese, 1990; Deweese, 1991a; NTF and ICRAF, 1988).

In Siaya it has been noted that a recent increase in dense hedging is due to current or projected land sub-division. When a new household is established a hedge is "established around the homestead, and the boundaries must be demarcated" (Scherr, 1991:31).

Fruit trees are found on nearly every farm, especially near the homestead, but are also scattered in the crop field. The most common fruit are citrus, mangoes, pawpaw and

avocados. Avocadoes can readily be sold by farmers near Nairobi. Some macadamia appears, but it is difficult for a small producer to find a market. Fruit is an important part of the diet, especially for children.

In the central highlands there are woodlots of black wattle (*Acacia mearnsii*), while in the western highlands small *Eucalyptus* spp. woodlots are common along the road and valley bottoms. Both wattle and *Eucalyptus* spp. have a long history in these areas. *Eucalyptus* spp. planting was encouraged from 1935 in what was then the Kakamega District, and black wattle was introduced into Murang'a District in 1898 (Deweese, 1991 citing Kitching, 1980). *Eucalyptus* spp. are used by farmers for cash and building materials. In the past wattle was sold to the tannin industry, but currently very little is sold, and instead it is used to meet household fuel demands and to enhance soil stability.

Livestock component

In the western highlands the dairy component is minor and local Zebu cattle are still common. In the central highlands, dairying is important and the cattle are exotics and crosses. In a survey of farmers in the central highlands "83 percent kept cattle, 77 percent goats and 10 percent sheep" (ICRAF, 1988:18). Herd size is small, usually consisting of one adult cow, one heifer, and a calf. The animals are kept under a zero and semi-zero grazing management. The purchase of fodder is common, and the lack of fodder serves as a constraint on the expansion of the dairy component in the system.

Labour

In the household the female adult member provides most of the labour used for agricultural activities. A survey in the central highlands found that "of the adult labour ... 60 percent are women working full time and 14 percent working part time" (ICRAF, 1988:9). Children do help occasionally (77 percent of the households), but because of educational demands they cannot provide the level of labour which might be needed. Although family labour provides most of the labour, it is common to hire labour to help with specific activities, such as coffee picking and weeding. In the central highlands 80 percent of farmers surveyed reported "hiring labour for picking coffee, 30 percent for weeding, 17 percent for pruning and 10 percent for spraying" (ICRAF, 1988:9). Casual labour appears to be provided by older adults, since young people, presumably having some schooling, do not appear to be interested in agricultural wage labour. Group exchange labour is common, with 50 percent of the farmers interviewed in the central highlands having participated in it.

The labour shortage in the coffee based land use system is especially acute during the rainy season when both food crop and coffee activities have to be undertaken. In response to the competition for labour by the different components, the strategy of the farm household is firstly to do what is considered to be critical, such as planting a crop at the appropriate time or picking coffee, and secondly to carry out the other tasks.

Perception of trees

Trees are recognized as an integral part of the land use system. Farmers purposefully replace indigenous trees species with more productive exotic species, produce their own seedlings, and manage their trees for fruit, fuel, building materials, and income. However, the tree component of the system is "given the lowest priority in terms of

resource allocation and management inputs" when compared to export, food, and livestock (ICRAF, 1988: 26).

Certain species are recognized by the farmer as having a positive or negative effect on crops. In Siaya, farmers identified nine tree species which most felt grew well with crops: *Calliandra calothyrsus*; pawpaw; *Croton megalocarpus*; *Leucaena leucocephala*; *Markhamia lutea*; *Sesbania sesban*; *Samanea saman*; avocado and *Grevillea robusta*. Four tree species were identified as having a negative effect: *Eucalyptus* spp.; *Cassia siamea*; *Lantana camara*; and *Thevetia peruviana* (Scherr and Alitsi, 1990).

Use of tree products

Fruit trees can be an important source of food, especially for children. In Siaya, 88 percent of the households interviewed obtained fruits on-farm from planted trees and 72 percent from free-growing trees. Although the primary source of fruit was on-farm (74%), there appears to be a local market for fruit, since 81 percent of the households purchased 22 percent of the fruit they consumed. Over half (57%) of the households reported gathering fruits off-farm, but gathered fruit was only a small percentage (4%) of the total fruit obtained (Scherr and Alitsi, 1990). Fruit can also generate income: in Siaya, 47 percent of the households reported selling some fruit (Scherr and Alitsi, 1990).

Although trees are used for fuelwood, it does not appear that they are planted only for fuelwood. *Grevillea robusta*, for example, is lopped for fuelwood, but is also used for shade, boundaries, and when the need arises, timber.

Fuelwood is primarily from on-farm trees and shrubs. There is variation between households and areas as to the sufficiency of the fuelwood supply. Difficulties in fuelwood collection have been analyzed in terms of the time needed for gathering fuel for daily or weekly needs. Households with enough fuelwood on-farm have to expend far less time gathering, than do households where the women have to travel to reserves, roadsides, etc. to gather. In some areas of Kisii District, for example, all fuelwood supplies were on-farm and the relative time spent collecting was small (Orvis, 1985).

In other areas, trees on-farm do not provide enough wood for domestic fuelwood consumption. In Siaya, on-farm planted and free-growing trees provided 77 percent of the fuelwood, 20 percent was gathered off-farm, and 3 percent was purchased. On the household level, 65 percent of the households reported gathering fuelwood off-farm and 36 percent reported purchasing fuelwood (Scherr and Alitsi, 1990). It appears that even with the large number of trees on the farm, not all households are self-sufficient in fuelwood. However, since purchased fuelwood only contributes a very small share of the total fuelwood, households by a combination of growing and gathering can obtain almost all of their fuelwood (Scherr and Alitsi, 1990).

Farmers are interested in trees for pole and timber production. In the central highlands farm trees have provided an important source of sawn timber in rural areas. Cypress spp. and *Grevillea robusta* trees are the most common pit sawn on-farm timber species. The bulk of the timber cut is sold locally, with the profits split equally between the sawyers and the owner of the trees (Deweese, 1991a).

In Siaya in the western highlands, few farms can provide enough poles for domestic construction needs. Although only a fifth (21%) of the farmers surveyed, reported using mainly purchased poles for the last structure built on the farm, the majority (56%) had to purchase at least some poles (Scherr and Alitsi, 1990).

Selling a tree to a pitsawyer can be quite lucrative. A single cypress tree, for example, 20 years old and half a metre in diameter, can generate nearly KSH 20,000 in total revenue if it is carefully sawn and marketed. *Grevillea robusta* timber is generally 30% less valuable than cypress (Deweese, 1991a). Prunings of trees are also in high demand, and if not used by the household, they can be sold for fuelwood or for the construction of fences and furniture.

In Kakamega in the western Kenya, *Eucalyptus* spp. woodlots are an important source of income among smallholders. A very high rate of male outmigration has created serious labour constraints on the household. A tree crop such as *Eucalyptus* spp., which is fast growing and needs relatively little maintenance, is emerging as a cash crop of the poor. "On even the smallest holdings, up to a third of the land area may be used for growing trees" (Deweese, 1991a:28).

Interventions in support of tree growing

Although the government has seedling production as one of its major goals, farmers in the central highlands still identify planting material as one of the serious constraints in tree production. In a survey area in the central highlands, for example, the Rural Afforestation Extension Service (RAES) operated 2 nurseries and the soil conservation unit also supplied seedlings, but the supply was still not adequate. Seedlings were produced, but there was a shortage of seedlings of those species which were in demand. In the survey area the demand was for *Grevillea robusta*, cypress, and fruit trees (ICRAF 1988).

External agencies only provide a relatively small portion of the seedlings planted. Many studies have made it clear that on-farm nurseries are the primary source of seedling supplies in the highlands (Bradley and Kuyper, 1985; Bradley and Ngugi, 1986; Kuyper and Bradley, 1985). In the western highlands in the Kisii district, for example, farmers reported that 65 percent of their seedling stock came from either their own tree nurseries or from their neighbours, 10 percent from the local markets, and only 25 percent from Forest Department nurseries (Kuyper and Bradley, 1985).

Another intervention is the shift in government policy concerning *Eucalyptus* spp. Government policy, based on concern of a possible negative impact of *Eucalyptus* spp. on the environment, has in recent years discouraged the planting of *Eucalyptus* spp. In 1985 a ban on the planting of gum trees was very nearly introduced in Parliament. While this ban was not introduced, current policy is to encourage the cutting down of *Eucalyptus* spp. within 20 m of a river, especially in areas such as Kisii where such planting are common, and replacing them with indigenous trees (NTF and ICRAF, 1988: 42).

In terms of non-governmental organizations, one of the best documented programmes in the highlands of Kenya is the Kenya Woodfuel Development Programme (KWDP)

which began in 1983 under the direction of the Beijer Institute and the ETC Foundation (Kerkhof, 1990). The two districts of the project area, Kakamega and Kisii, are in the high potential area of Kenya, however coffee is only one of the land use systems. Other land use systems in the project area are the relatively minor tea based system and the greater portion of the area in the maize based system.

The purpose of the programme was to develop effective methods of promoting tree growing for fuelwood. The KWDP project, which operates in the western highlands of Kenya, conducted three different baseline surveys as a first phase in deciding which techniques were to be used to promote tree growing: an air and satellite analysis of on- and off-farm vegetation; an agroforestry survey; and a survey concerned with cultural constraints on increased woodfuel production (Gelder and Kerkhof, 1984; Kuyper and Bradley, 1985; and Chavangi, 1984).

Among the major findings was the involvement of large numbers of farmers in on-farm nurseries. In the Kakamega district, for example, 43 percent of households operated their own backyard nurseries on a regular basis (Bradley and Kuyper, 1985). On-farm nurseries were often used to provide seedlings of the common exotic trees - *Eucalyptus* spp., cypress, and *Grevillea robusta* - in the area.

Before the surveys "it had been assumed that farmers got their seedlings from the Forest Department and the absence of a nearby nursery would prevent them from planting trees" (Kerkhof, 1990:52). As a result of the agroforestry survey the focus of the programme shifted to on-farm nurseries, and later, as the programme progressed, to providing seeds for fast growing exotics that the farmers could not otherwise obtain, as well as improving on-farm nurseries (Kerkhof, 1990).

The underlying assumption of the programme, that fuelwood was a major tree growing priority of the households, has been questioned and there is "increasing recognition that men and women want to plant trees for a variety of reasons" (Kerkhof, 1990:61). The programme has undergone a name change, it is now called the Kenya Woodfuel and Agroforestry Project (KWAP) and appears to have broadened its focus to include trees for other than fuelwood (Kerkhof, 1990).

Another well-documented project in the western highlands is the CARE/Agroforestry Extension Project which began in 1984 in Siaya District and was later expanded to include South Nyanza. The objective of the project was to improve rural welfare through tree planting. The extension component of the project was to promote rapid expansion of agroforestry practices in the area. The strategy was to use "participatory" extension and to tailor the project to the household's needs. There is a tradition of tree growing in the project area and considerable indigenous knowledge about tree growing (Scherr, 1991).

Although the main purpose of the project is development, there is a research component. The project area was purposefully chosen to include a number of agroecozones in order to learn more about agroforestry under varying agroclimatic conditions. Although the four ecozones range from <800 - 1600 mm of rainfall and 1000 to 1500 m in altitude, most of the project area is within the Bimodal Highlands zone. The land use system in

the project area is primary food crop with no dominant cash crop (Scherr, 1988; Scherr, 1991; Vonk, 1986; NTF and ICRAF, 1988). The project used ICRAF's Diagnosis and Design methodology to establish a priority of problems, assess the current uses of indigenous trees and traditional agroforestry systems, and to identify the potential contribution of agroforestry. The project works primarily with community groups, mostly women, "in establishing small, private tree nurseries and use(ing) them as intermediaries to introduce new agroforestry practices" (Cook and Grut, 1989:22).

A 1989 impact survey found that the number of trees planted by farmers involved with the project had increased sharply: the average farmer had 237 individual growing trees before CARE contact and 539 after, an increase of 56%. There was also a substantial change in the tree planting configurations, with the proportion of trees growing in lines increasing, especially as linear intercropping such as alley-cropping and lines of trees for poles (Scherr and Alitsi, 1990:2-3). Counting trees is easy but evaluating the project's success in fulfilling its objective of improving rural welfare is more difficult. In addition, five years (1984-1989) is a relatively short time for the impact of more trees to be felt in a community. However, farmers report benefits from the trees that have been planted and interest to continue planting trees appears high. The project is regarded as having been extremely successful and is being used as a model for CARE agroforestry projects in other countries (Scherr, 1991).

Preferred species for tree planting

Exotic species such as *Grevillea robusta*, *Eucalyptus saligna*, *Acacia mearnsii* and *Cupressus lusitanica* predominate in the highlands, although indigenous species such as *Markhamia lutea*, *Croton megalocarpus*, *Cordia abyssinica* and *Sesbania sesban* are also common. *Grevillea robusta* was originally introduced as a shade tree for coffee and tea, *Eucalyptus* spp. were initially planted by the forestry service as a fuel for the railway, *Cupressus lusitanica* was established by the forestry service for timber, and *Acacia mearnsii* for tanning bark (Gelder and Poulsen, 1982; NTF and ICRAF, 1988).

Grevillea robusta is now used on farms for external and internal boundaries, often for shade in coffee plots. In a survey in the central highlands, seventy-seven percent of the farmers interviewed were planning on growing more *Grevillea robusta* for timber and fuelwood. *Eucalyptus* spp. is still, even with government pressure to limit, very common in the western highlands (ICRAF, 1988; Kerkhof, 1990). The prevalence of these exotics is to some degree dependent on their qualities, such as being fast growing and marketable, and the availability of seedlings initially from government nurseries and currently from on-farm nurseries.

In the western highlands certain tree species are planted in different locations. *Eucalyptus* spp., for example, are favoured for woodlots, but windrows are most frequently *Cupressus lusitanica*, although *Eucalyptus* spp., *Pinus patula*, or *Acacia mearnsii* may also be used. Hedges on small farms in southern Kakamega are dominated by *Euphorbia tirucalli*, which forms a thin hedge, while the hedges of the larger farms in the north, where there is more livestock and a thicker hedge is needed, are usually *Tithonia diversifolia* or *Caesalpinia decapetata* (Bradley and Kuyper, 1985).

Although a few trees species may dominate, households have traditionally had a variety

of trees on-farm. In Siaya, for example, nine tree species: *Euphorbia tirucalli*; sisal; *Dracaena*; *Lantana camara*; *Eucalyptus* spp.; *Cupressus lucitanica*; *Cassia siamea*; *Markhamia lutea*; and the recently introduced *Leucaena leucocephala* account for 73 percent of all trees found on farm. The remainder of the trees on-farm consist of over 170 tree species used for fruit, shade, fencing, wood and leaf products (Scherr and Alitsi, 1990).

The trees which are favoured appear in on-farm nurseries. In Kakamega, for example, it was found that about a third of all farms had nurseries and were producing their own seedlings. The majority trees were of the predominate species such as *Eucalyptus* spp. and cypress, which are used for both household construction and income (Kerkhof, 1990).

Future tree-growing

When questioned as to what trees they would like to plant, farmers in the central highlands cite fruit trees, as well as species such as *Grevillea robusta*. Although farmers do have on-farm nurseries, there is still the expressed need for high quality seedlings, especially of fruit trees and other exotics (NTF and ICRAF, 1988; ICRAF, 1988).

In Siaya, when farmers were asked which five tree species they would like to plant that year, the most frequently mentioned use preference were poles (24%), fruit (23%), timber (14%), green manure (12%), shade (9%), fuelwood (5%), fencing (5%), ornamental uses (4%), fodder (2%), and windbreaks (2%) (Scherr and Alitsi, 1990:6). A total of 46 different tree species were mentioned; the most preferred species for poles were *Eucalyptus* spp.; for poles/timber *Markhamia lutea*; for fruit tree Citrus, and for fencing/ timber *Cupressus lusitanica*.

Conclusions: Bimodal Highlands

Where are farmers planting or not planting trees?

In the Bimodal Highlands, farmers are planting trees along external boundaries, internal boundaries, in woodlots and windrows, and near or around the homestead. In the western highlands, trees, especially *Eucalyptus* spp., are planted along rivers and streams. Although exotic trees such as *Eucalyptus* spp., cypress, and *Grevillea robusta* are quite common, a variety of tree species are planted for fruit, shade, poles, income, etc.

How does tree planting relate to ecozone, and to cultural traditions and values?

There are patterns of tree planting which occur throughout the coffee land use system in the bimodal highlands, for example, trees are planted in similar niches on the landholdings. However, the trees species may vary since they reflect past policy and interventions.

Cultural traditions, especially the prescribed relationship between men and women, appear to have an impact on tree planting. If women do not have the right to plant trees, but are the resident farmers in areas of male outmigration, fewer trees might be planted on the landholding. Scherr and Alitsi (1990), for example, found that female-headed households in Siaya and South Nyanza Districts were slower to adopt tree planting practices because the women had to wait for the permission of their husbands who lived and worked elsewhere.

What incentives are there for tree planting?

The incentives for tree planting are based on the household having to produce on-farm wood products to meet its needs. In highland zone where there is high population density, little communal woodland and restricted access to forest reserves, individual private tenure encouraged an increase in on-farm tree production. This is not to imply that households do not request and are not granted permission by other households to gather fuelwood, fruit, *etc.*, rather it suggests that recognized rights of access are different from favours granted and that households prefer to be self-sufficient rather than dependent.

How does tree planting by farmers relate to government efforts and extension attempts to promote tree planting?

In this zone, farmers were planting trees prior to recent attempts by the government to encourage tree planting. However, the most common trees, such as *Eucalyptus* spp., *Grevillea robusta*, and cypress, are those for which there has been a history of extension and availability through the Forest Department or forest reserves. Current interventions, especially programmes such as KWDP, have been focused on introducing new species or new niches for tree planting. Farmers appear to have readily accepted some of the new species, especially improved fruit.

2.2 Sub-humid/Semi-arid Zone

Definition of zone

Crop growing period is greater than 90 days.

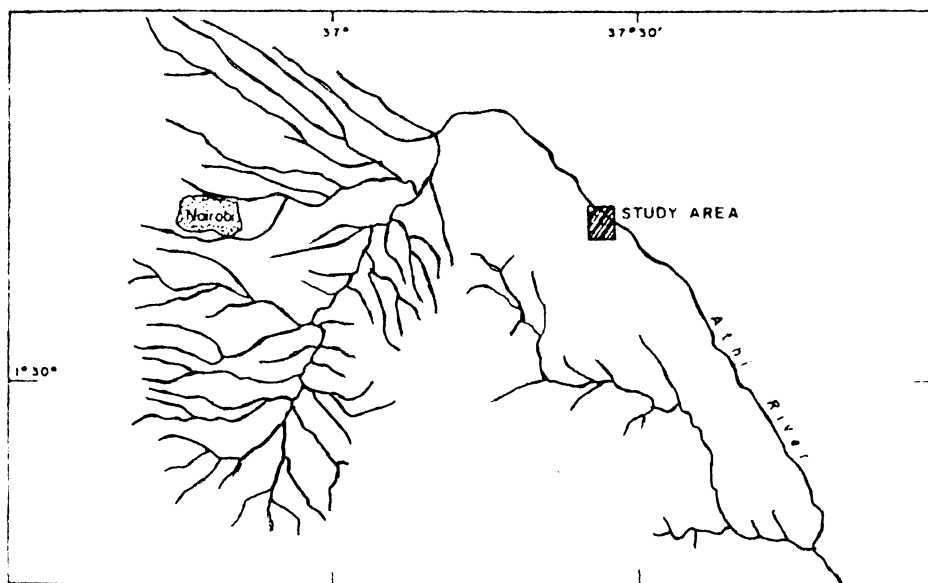
The climate of the case study area is transitional from sub-humid to semi-arid. The rainfall is bimodal with a mean annual of 850 mm. Rainfall is extremely unpredictable both within and between years (Vonk, 1983).

Altitude ranges from 1750 m at the top of the Kanzalu Range down to 1200 m at the Athi river. Most of the agricultural land is between 1200 - 1300 m (Vonk, 1983:13).

The natural vegetation is *Acacia-combretum* woodland. The main species of the natural vegetation are *Acacia tortilis*, *Combretum Zeyheri*, *Terminalia brownii* and *Lantana camara*. Currently, large trees are rare. Large *Acacia tortilis* trees, once common, have been extensively cleared for charcoal-making (Rocheleau and Hoek, 1984; Vonk 1983).

According to Rocheleau and Hoek (1984:18) the soils are predominately alfisols, with some ultisols "along the upper footslopes of the Kanzalu Range, and along the Athi River . . . a strip of pellic vertisols run through the center of the area" (citing Collinson, 1979; and Vonk, 1983). The soils in the area show some signs of erosion. The gully erosion of the midslopes can be quite severe, and sheet erosion occurs in the upper-mid-lower slopes.

Figure 3.2
KATHAMA CASE STUDY AREA



Source: Rocheleau and Hoek 1984:17

Case study: Mixed farming system

The land use system for this zone is a mixed farming system based on livestock and food crops. There is no major cash crop, and income is obtained from the sale of food crops, livestock, and off-farm earnings.

The case study is Kathama, an area in the Machakos District (see Figure 3.2). The description of the zone is based on the ecozone of Kathama.

Location

Kathama is in Machakos District, approximately 100 km east of Nairobi between the Kanzalu Range and the Yatta Plateau. The area is part of the Athi River basin. The slopes on the plateau are gentle, but become steeper in the upper footslopes of the escarpment. Approximately 25 percent of Kathama is in the sub-humid zone near the Kanzalu Range, while 75 percent is in the drier zone closer to the Athi River.

Population

The population of Kathama is Akamba. The Akamba were in the past primarily pastoralist with some agriculture, but in Kathama they are making a transition to permanent cultivation with some livestock. Population density in Kathama in 1983 was about 172 persons/km², much higher than the 72 person/km² for the district. Access to water (Athi river) has served to concentrate the population in the area. Although the population rate of increase is comparable to the national average (about 4%), because of outmigration the actual population growth rate is only 3 percent a year. Outmigration is primarily male, creating a high proportion of female headed households in the area.

The average household size is 7 persons. Outmigration increases when rainfall is low and harvests are poor (Vonk, 1983).

Land Tenure

Land in Kathama was adjudicated between 1960 and 1970, and all land within Kathama is now registered. Usufruct rights of fuelwood and grazing are still being granted to grazing land by some owners to members of the community, but exclusive rights are being applied to cropland, homesteads and small grazing plots (Rocheleau and Hoek, 1984).

Under Akamba customary law the father's landholding is divided by all the sons at his death. This inheritance pattern is creating progressively smaller farms. Households which do not have enough on-farm fodder can through kin ties, exchange of services, or fees, obtain rights to grazing on other household's lands. Gathering rights for fuelwood can also be granted, usually without fees, as "borrowing", but the understanding is that the borrower will "take deadwood, small stickwood, and the least desirable species" (Rocheleau and Hoek, 1984:30). Payment is expected if trees are felled for charcoal or fuelwood. Land available for "borrowing" fuelwood or grazing is decreasing as new generations inherit, and grazing land is converted to cropland.

Tree Tenure

With adjudication and registration, trees became the property of the holder of the land. Since all land is now under individual tenure, all trees are owned within the area. However, as mentioned above, gathering rights can be sought on another's land. These gathering rights are usually without charge for fuelwood and fodder only, but a fee usually must be paid for trees used for products such as fencing, timber, poles and charcoal (Rocheleau and Hoek, 1984).

Land use system

In the past the Akamba land use system was agropastoralist with livestock the dominant and fields crops the subsidiary component. In the last fifty years the land use system has been transformed into a mixed farming system based on food crops as the dominant and livestock as the subsidiary component. The current system gradually evolved as the population grew (fifty years ago the population in the area was 10 percent of its present size), as the ox plough was adopted for land preparation, as terracing became common, as maize replaced millet, and as fruit trees were planted around the homestead (Vonk, 1983).

The average household is 7 persons. Landholdings include both crop and grazing land. There is household and locational variation in the size of the landholding. On average there are larger landholdings in the semi-arid areas, and smaller more intensively managed landholdings in the sub-humid areas in the foothills. The overall average size is 1.08 ha. of cropland and 2.1 ha. of grazing land per household (Vonk, 1983).

Households attempt to grow two crops a year, one in the short rains and one in the long rains. The main food crops are maize, beans, cow peas and pigeon peas. Intercropping of food crops is the usual pattern. Some sweet potato and cassava are also grown but Vonk (1983) reported problems with cassava mosaic in the area.

The only crops grown for cash are cotton and sunflower, both on a small scale. Cotton was encouraged by the agriculture extension service in the area but the number of farmers involved in cotton production was declining during the period of Vonk's research (early 1980s) partly due to its high labour requirements and poor returns. The farmers also had problems with debt incurred for cotton inputs which discouraged further production. Farmers had obtained loans from the cotton society to purchase inputs, but the prices they received from the society for their cotton was not enough to completely repay the debt.

This debt continued from one season to the next so that any further cotton production, when sold to the society, went to service the debt and the farmer did not receive any income. At the time of Vonk's study, there was still a relatively large debt outstanding to the cotton society by farmers in the area. Sunflower is a minor crop which is only grown by a few farmers (Vonk, 1983).

Almost all of the cropland is terraced. Fields are prepared by ox and plow and it is possible for a household to get access to one or both through sharing or renting arrangements. Most farmers plough at the onset of the rains and planting is done at the same time as ploughing. Fields are manured (although not enough to maintain soil fertility), and very little purchased fertilizer is used. Weeding is done by hand and by plough. Harvesting is done by hand, but because of multiple intercropping, different crops are ready to be harvested at different times, so harvest labour is staggered (Rocheleau, 1984; Vonk, 1983).

At harvest it is common for households that need cash or do not have sufficient storage facilities to sell a portion of the crop. This does not mean that there is a surplus, for the same household may have to purchase food later in the year (Vonk, 1983).

The great majority of households (82%) receive income from off-farm employment. Since employment possibilities are few in the district, 59 percent of the households receive money as remittances from outside the area. The money is primarily from male household members who are working in urban areas such as Nairobi. This outmigration pattern creates a disproportionate number of female headed households in Kathama. The money sent back to Kathama is of an irregular nature and is mostly used for daily needs rather than for savings or investments. However, because of it being irregular the household must still pursue a strategy of food self-sufficiency (Vonk, 1983).

Tree component

Paralleling the shift from agropastoralism to mixed farming, tree management has changed from a passive to a more active approach. In the past, as is the case today, trees were left standing in the fields after clearing with more trees being retained on land designated as grazing than in cropland. Trees commonly found in Akamba fields therefore reflect the natural vegetation in the area: *Acacia tortilis*, *Acacia polyacantha*, *Balanites aegyptiaca*, *Terminalia brownii*, and *Combretum zeyheri*. These trees also regenerate themselves in the fields.

On a lesser scale, trees were planted as farmers began to assume a more active role in establishing trees. As a result exotics such as *Jacaranda mimosaefolia*, an ornamental,

or *Eucalyptus* spp. and *Cassia simeia*, which have been planted for poles and timber, are found (Wachiira, 1987).

Trees continue to be retained, especially in other landscape niches. In gullies, for example, certain tree species recognized as beneficial are protected. *Vangueria* spp. help in holding the soil, and *Ficus* spp. are "reputed to have roots with high soil holding capacity as well as providing fruits and medicine" (Wanjohi, 1987:67). Trees and shrubs are also protected as "volunteers" in hedgerows.

Exotic fruit trees, such as citrus, pawpaw, guava and mango, were among the first trees to be planted on the landholdings. Trees which were planted twenty or more years ago are found scattered in the homestead or in the fields. Fruit trees which were "volunteers", such as the ubiquitous mango, were protected to maturity. It is common to find mango and guava "dotting the landscape" in what appears to be a random pattern. More recent plantings of fruit trees, since adjudication, have been not only around the homestead, but also on terraces and trenches where the fruit trees (with other trees, such as *Phyllanthus* spp. and *Eucalyptus* spp. and shrubs) help stabilize the soil (Wachiira, 1987).

The adjudication and registration process encouraged the enclosure of the landholdings, tree planting for living fences and, more recently, for soil conservation purposes. Although in the past retained trees served as boundaries, with the new tenure the planting of live fences is occurring. Sisal and *Euphorbia tirucalli* are most commonly used as fencing, but volunteers of *Lantana camara* and *Gnidia* spp. are also found intermingled with indigenous trees, such as *Terminalia* spp. and *Acacia* spp., which have been retained and/or protected (Wachiira, 1987). In the homestead trees are found which are both retained and planted as well as indigenous and exotic (Wanjohi, 1987).

The retained trees on grazing land provide most of the fuelwood for the household. With the gradual conversion of grazing land to crop land, the amount of wood available to households has been declining (Vonk, 1983; Hoekstra, 1984).

Tree establishment in this area has been hindered by two major factors: low rainfall and livestock grazing. Rainfall in the area is low and erratic. Natural establishment may be virtually nil in years of low rainfall. Maintaining seedlings during the dry season may require the woman of the household to carry water from a stream, river, or well, a time and labour commitment which might not be maintained. It has been estimated that trees currently established experienced a survival rate of 15-20 percent in a moderate year, and a much lower rate in a drier year (Wachiira, 1987). Dry season livestock grazing on fields after harvest damages seedlings either from browsing or trampling. Although this is a recognized problem, farmers are more willing to lose seedlings than give up scarce dry season fodder (Wachiira, 1987).

Livestock component

Small Zebu cattle, sheep and goats are kept by households in Kathama. The average number of livestock per household is 7.6 cattle, and 10 sheep and goats. There is household and locational variation. Households that have larger landholdings usually have more animals, and households in the drier areas of Kathama usually have more land and animals than in the subhumid areas. Livestock are sold to provide income.

Vonk (1983) reports that 54 percent of the household reported selling livestock during a 12 month period. Livestock are also used for manure, milk, meat, and energy.

Although all land in Kathama is held under individual tenure, relatively few households graze their livestock only on their land; 33 percent of the households graze their own livestock exclusively on their own landholding and do not have livestock from other households sharing the grazing. Sharing arrangements are reported by 44 percent of the households, and hiring or renting arrangements by 44 percent as well (Vonk, 1983). Off-farm fodder sources play an especially important role during the dry season. Livestock graze and browse on grass, shrubs, and pods found along the roadside and in gullies. Management of livestock during grazing varies with households "from tethering to careful herding to almost free range" (Rocheleau and Hoek, 1984:29). Oxen during the ploughing season may be given crop residues to supplement grazing. During the dry season, after harvest, livestock usually graze on the crop fields.

Both cattle and goats are kept in a kraal at night and taken to grazing during the day. Manure is collected from the kraal and taken to the fields. Manure is highly valued and used by the majority (63 percent in 1982) of households; households which do not use manure lack either livestock or transport. The cattle of some households have to be driven to and from the water source relatively far away (Vonk, 1983; Rocheleau and Hoek, 1984).

In 1983 Vonk noted that 48 percent of the farms had degraded grazing areas (Vonk, 1983:43). Goats are gradually increasing in ratio to sheep and both sheep and goats are increasing in relation to cattle. This is projected to have a further negative impact on the grazing areas since goats "tend to pull out the grass instead of biting it off and thus have a bad effect on the grass cover" (Vonk, 1983:43).

With the decrease in grazing areas, the pattern that appears to be emerging is for fewer animals to be kept by a household with more intensive management, *eg.* there is an increase in cut and carrying fodder rather than grazing.

Labour

Collection and spreading of manure, ploughing, planting, weeding, harvesting, herding, water collection, and fuelwood gathering are all tasks for which the household must supply labour. Although some hiring of labour occurs, the great majority of households rely on family labour. Exchange labour based upon friendships and kinship is also utilized by households. Shortage of labour does occur, especially in female headed households. Weeding is a crucial task with a direct impact on yields, yet in many households it is not done as thoroughly as it should be because of labour conflicts with other tasks (Vonk, 1983).

Herding, for example, is usually done by children and old men. The labour requirements can be quite high since cattle have to be prevented from entering the crop areas during the rainy season and herded to water sources during the dry season (Hoekstra, 1984).

Men engage in outside employment, keep bees, carve wood, make charcoal, and perform the heavier agricultural tasks such as ploughing. As owners of the land, men assume the

role of decision makers for agricultural activities (Hoekstra, 1984). Women provide the labour for most of the agricultural tasks and are responsible for collecting water and gathering fuelwood.

Perception of trees

The traditional view of trees is that they are "naturally occurring 'God-given' events of nature" (Wachiira, 1987:16). This view supports a passive rather than an active approach in tree management within a belief system that views trees (God given) as a positive component of the land use system.

Farmers perceptions as to the difficulty of establishing trees in grazing areas and crop fields appear to be accurate. Survival of seedlings is low, especially in grazing areas, and seedlings require time spent on protection and watering. Nevertheless, trees are being increasingly planted by households rather than just retained.

Use of tree products

Fuelwood is gathered both on-and off-farm by the majority of smallholders. Vonk (1983) reports that 47 percent of the households collected fuelwood exclusively from their own lands, while the other households also made use of forest, a society reserve, the Kanzalu range, a nearby island in the river, and neighbours.

Fruit was traditionally gathered from trees retained in the fields and from trees in the woodlands. Wild fruit is still collected and sometimes sold; it is especially important in the children's diet (Wachiira, 1987). Fruit trees were among the first trees planted by the Akamba and are among the most favoured trees planted today.

Although there is emphasis placed on fuelwood, fodder, and soil conservation in the projects in the area, farmers express the need for building materials such as poles. Houses in Kathama are made of burnt brick, and there are problems in finding fuel for the brick making. Local preference for fuel is for large logs, still partially green, that will burn for a long time (Raintree pers. comm.). Such logs are difficult to find. The interest by farmers in *Leucaena* spp. is not for alley cropping for soil conservation as the project suggested, but rather as a fast growing tree which is not pruned but is allowed to grow and to be used eventually for poles.

Interventions in support of tree growing

Kathama is regarded as being one of the poorer areas of Kenya. In approximately one year out of five the harvest fails (in the early 1980s there were two bad years in succession) and famine relief is sent by the government to the area. The Machakos Integrated Development Project is a government project which is attempting to make extension services more available to the farmers in the district. In the Machakos District research in agroforestry is being conducted by the Kenya Agricultural Research Institute.

Kathama was chosen in 1981 as a site for a collaborative project between ICRAF and Wageningen Agricultural University. Students from Wageningen were to conduct research on the farming system and on-farm research of agroforestry innovations, the potential role of women's groups in agroforestry, the demand for fuelwood in the area, the volume of fuelwood on pasture, and the landscape. ICRAF's role was to provide

information and guidance to the students. The Ford Foundation later funded nurseries and extension activities with women's groups in the area.

The on-farm trials served to illustrate the problems farmers encounter in tree establishment. In first two seasons the rains failed and this led to a very high mortality rate of the initial seedlings. Labour, especially for watering the seedlings, became an issue, for although men were the main participants in the trials, women were responsible for collecting and transporting the water for the seedlings. During the drought women were unwilling to continue to collect water when they had to walk 3 - 5 kilometers to the river. All the farms in the trials had problems with termites and/or other insect pests, and browsing. Mortality rates up to 100 percent were experienced by seedlings in grazing area, however those established in croplands showed much high survival rates of 70 to 80 percent (Rocheleau, 1984).

The research in Kathama revealed the reliance of the majority of smallholders on off-farm water, grazing, and wood resources. This led to the design of an agroforestry project that was based on a landscape analysis of the area and focused on the watershed as the unit for development. Extension support was provided to women's self-help groups for nurseries which provided seedlings to members and initially for public works (gully rehabilitation, *etc.*) in the community. The favoured tree species were fruit trees and a mixture of fodder, fuelwood and timber trees (Rocheleau, 1984; Rocheleau and Hoek, 1984).

Farmer-researcher interactions changed the emphasis of on-farm trials of alley cropping. Initially alley cropping was for mulch. Farmers, however, prefer traditional mulch from the kraals and dispersed trees in the cropland. The alley cropping extension activities now emphasize fodder and fruit with wider spacing between the hedgerows (Rocheleau, 1984).

Preferred species for tree planting

In the past trees were retained in the fields and exotic fruit trees were planted. Currently farmers have been choosing trees that can be commercially exploited, especially fruits, or those that are quick growing (Wanjohi, 1987).

Conclusions: Sub-humid/Semi-arid Zone

Where are farmers planting or not planting trees?

Historically, Akamba agropastoralists have retained trees, especially fruit and medicinal trees, in the fields. Among the first trees to be planted were exotic fruits usually in the cropland or around the homestead. Currently, the Akamba are planting an increasing number of trees in more niches in the landscape, especially boundaries, croplands, and homesteads. Trees are still being retained and there is growing awareness about the positive impact of maintaining trees in gullies and in the watershed.

How does tree planting relate to ecozone, and to cultural traditions and values?

The unpredictable rainfall and prolonged droughts combined with the lack of easily accessible water sources, makes tree establishment far more difficult than in the Bimodal Highlands. The cultural traditions of the Akamba did not foster depth of knowledge

on tree planting and growing. Trees were retained in the past, but tree planting was limited. Currently, farmers are having to learn the skills of tree propagation and maintenance, in an environment not favourable for tree growing. Trees are valued and recognized as being a necessary component of the land use system, but when competition occurs, as in the grazing areas, livestock appear to be valued more.

What incentives are there for tree planting?

The incentives for tree planting are primarily household derived, the need for fruit, fuelwood, construction wood, *etc.* With land privatization, households are having to provide more of the wood products on-farm. However, as with fuelwood, there are still other sources, although these are being quickly degraded. There appears to be some incentive for tree planting for soil conservation on off-farm sites, but group organization is fragile and it is uncertain how successful these organizations will be in dealing with gullies and eroded areas.

How does tree planting by farmers relate to government efforts and extension attempts to promote tree planting?

Although there has been a large integrated government project in Machakos district, in Kathama itself there has been little contact with government agencies. The Kathama Agroforestry Project by ICRAF and Wageningen appears to have had some positive impact on tree planting. Although agroforestry techniques such as alley cropping did not meet with much success, households appear to be planting more trees, in more niches, for more purposes than occurred in the past.

3. Kenya Summary

1. In both zones, the combination of individual private tenure and rapid population growth has created a situation in which households have had to increasingly rely on on-farm wood resources.
2. The Sub-humid/Semi-arid zone is a more difficult environment for tree establishment than the Bimodal highlands. Lack of rainfall and accessible water serve as a constraint for farmers trying to establish more trees on their farms.
3. In the Bimodal Highlands there was a tradition of tree planting and management and farmers had the necessary skills for tree propagation and care. This was not the case in Kathama in the semi-arid zone where lack of skill appears to serve as a constraint in tree propagation. Extension activities in training are needed to aid farmers in establishing trees on their landholdings.
4. The competition between grazing livestock and seedlings for land, is another constraint for tree establishment in the semi-arid areas. In the Bimodal Highlands livestock are usually kept on-farm with zero grazing, but in areas such as Kathama, livestock are taken off-farm for watering and grazing. Dry season grazing on crop land is especially destructive to seedlings and young trees.
5. Government extension services have been more accessible to farmers in the Bimodal Highlands. In Kathama government extension services were too far for most farmers to use.
6. Non-government interventions have had a real impact in both the western highlands and the Kathama area. The major projects cited in this report (CARE Agroforestry Project, KWDP, and the Kathama Agroforestry Project) all attempted to fit the project outputs to the needs of the community. The KWDP project, for example, was initially focused on fuelwood, but gradually broadened to become an agroforestry project. Their responsiveness to local needs has made these projects more effective in their extension activities.
7. In both of the case studies households were dependent on off-farm income for both subsistence and cash needs. As inheritance subdivides landholdings still further, the dependence on off-farm income will increase. If this pattern continues, landlessness will become increasingly common in Kenya as rural households are forced to sell their landholdings and rely totally on off-farm income.

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4. COUNTRY REPORT: UGANDA

1. General information

1.1 Background

Population

Uganda is a landlocked country lying about 700 km from the Indian Ocean with a total land area of approximately 240,000 km². The population in 1988 was estimated to be about 16 million, with an annual growth rate of over 3 percent per year.

With only about 9 percent of the population living in towns, Ugandan society is overwhelmingly rural. The areas of higher population identify the areas of agricultural potential; the distribution of the population is uneven with the drier areas having far fewer people than the moist highlands. The density generally decreases when moving northward away from Lake Victoria. The average nationwide population density was estimated in 1982 to be 66 persons/km², ranging from fewer than 10 persons/km² in the dry zone to nearly 750 persons/km² in several non-urban locales.

The population is ethnically diverse, with forty distinct ethnolinguistic tribes of four major language groups (UNT and ICRAF, 1988; EIU, 1988; Muwanga, 1987; Adupa *et al.*, 1988).

Topography

Uganda lies atop the east-central African plateau between the western rift and the eastern rift systems and north of the Lake Victoria basin (UNT and ICRAF, 1988). The plateau slopes gradually downward towards the Sudanese border. Where the plateau meets the two rift systems there are mountain ranges with elevated peaks. The topography of the plateau is of gently rolling ridges interspersed with shallow swamp valleys. One sixth of Uganda is composed of lakes, the largest of which is Lake Victoria.

Climate

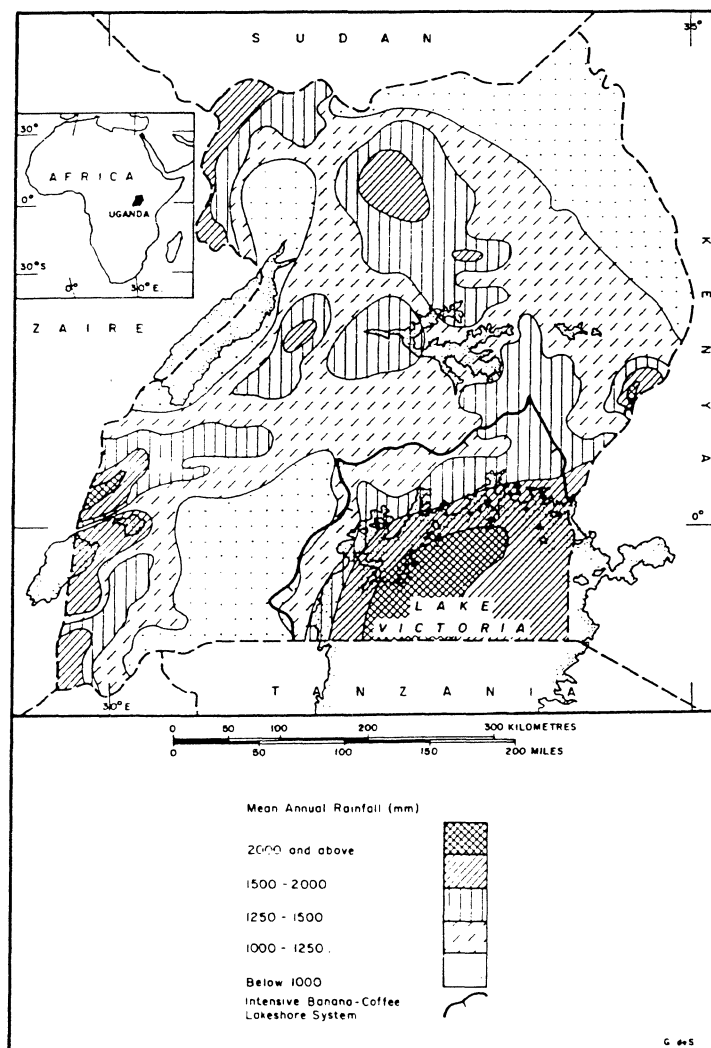
The annual rainfall varies from an average of about 500 mm in the north in the Karamoja area to 2000 mm near Lake Victoria and the mountains. The rainfall pattern is bimodal in the south around Lake Victoria and in the highlands, becoming unimodal moving north toward the Sudan and the northeast border with Kenya, and southwest between Lake Victoria and the highlands of the western rift (see Figure 4.1). In the bimodal areas there are two distinct rainy seasons separated by two dry spells usually occurring in June and July and in December and January. These dry periods can be broken by occasional thunderstorms, especially the areas near Lake Victoria.

In the unimodal areas there is one long rainy season (usually from April to October) and farmers in these areas usually have one cropping season a year. The amount and reliability of the rainfall declines toward the north.

Altitude

Most of the Ugandan plateau lies between 900 and 1400 m in altitude with the mountainous area reaching well over 2000 m.(UNT and ICRAF 1988).

Figure 4.1
UGANDA: RAINFALL



Source: Oduol and Aluma 1990:214

Vegetation

Reflecting the diversity of altitude and climate, the natural vegetation of Uganda is extremely varied and characterized by both savanna and forests, grasslands and swamps, steppes and thickets, palm, bamboo and AfroAlpine with Acacia savanna, grass steppe and thickets predominating in the dry (semi-arid) area of Uganda. Much of the natural vegetation has been cleared in the areas of higher population density for cultivation, and in areas of pastoralism it has been modified for grazing.

Currently, it is estimated that about a quarter of Uganda is under moist forest. All of the moist forest occurs in the bimodal highlands, *ie.* Kigezi and western Ankole, the southwest and the Buganda region (UNT and ICRAF 1988).

Soils

There is great variation in the soils of Uganda. In the Bimodal Highlands most of the soils are Acrisols and Ferralsols. Ferric Acrisols are found mostly in the southwestern parts of Uganda. Highly weathered and leached orthic and humic Ferralsols are the most common soils and lie under savanna and forest cover. The high volcanic regions are covered with Andosols and Nitosols (UNT and ICRAF 1988).

1.2 Agroecological zones

Uganda can be divided into two major agroecological zones, each with its own distinct climate, vegetation, soil, *etc.*,

Bimodal Highlands. This is agriculturally the high potential area of Uganda. Currently this zone covers about 40 percent of the total land area and supports 60-65 percent of the country's population. It includes most of the high population density areas (UNT and ICRAF, 1988).

Semi-Arid Plateau. This is the area of Uganda with lower population densities and greater reliance on livestock in the land use systems. The growing period (<180 days), rainfall (mean annual rainfall of about 750 mm), unimodal rainfall pattern, and altitude (1000 - 1300 m) places much of this area in the drier subzone of Unimodal Upland Plateau as identified by AFRENA (Agroforestry Research Networks for Africa). The plateau area in southwest/central and northeast Uganda appear to have much in common with the unimodal plateau areas in the neighbouring countries (Adupa *et al.* 1988; UNT and ICRAF, 1988).

Bimodal Highlands land use systems

UNT and ICRAF (1988) have identified nine land use systems in the Bimodal Highland zone (see Figure 4.2):

1. **Intensive banana-coffee lakeshore system.** This system is most common in southern Uganda, mainly on the northern shore of Lake Victoria and surrounding areas, most of Busoga and Mpigi, as well as the high density urban localities of Kampala and Jinja. The system consists largely of banana-coffee-annuals gardens. Trees and crops are highly integrated in this land use system. Livestock is not held in large numbers.
2. **Western banana-coffee-cattle system.** This system is located in southwest Uganda. The population density varies with the highest densities in the Rukungiri, Bushenyi and Kabarole areas. This system is based on the production of banana as the main food crop and coffee (robusta) as the cash earning export crop. Most farmers cultivate both the valleys and hill slopes. Unlike the intensive banana-coffee lake shore system, there is greater integration of livestock and crop sub-systems. Trees also form an important component of the farming system.
3. **Forest-savanna mosaic banana-coffee system.** This system is similar to the western banana-coffee-cattle system. It differs in having lower population

densities and an "abundance of unsettled areas, covered by savanna and forest and the small number of cattle due to tsetse infestation" (UNT and ICRAF, 1988: 37). Other export crops are tobacco and cotton.

4. Medium altitude intensive banana-coffee system. This system covers parts of Okoro county, Mount Elgon slope, Bugisu, the higher altitude part of Tingey county in Sebei, Rukiga county in Kigezi, and some part of the Ruwenzori range. Population densities are high while landholdings are small and fragmented. The main export crop is coffee (arabica) and banana is the main food crop. Households also keep cattle, usually one or two head, and smallstock. Trees are found in fields, in farm compounds, and in small woodlots (*Eucalyptus* spp.).

5. Sebei annual food crops montane. This system is located in the Mount Elgon region in the high altitude zones above 1800 m. It is not heavily populated. Maize, not banana, is the commonly grown crop, both for food and as a cash crop. Ox-ploughing is commonly practised in some areas, with cattle and smallstock present throughout the land use system. Wood shortage is a recognized constraint, encroachment of the forest is common and there are few woodlots.

6. Kigezi annual food crops montane system. This system is located on the northern slopes of the Mufumbiro mountains above 1800 m in altitude. Farm sizes are very small. Sorghum is the main cash crop. Although smallstock are common, only a few households keep cattle, and grazing land is scarce. Trees are not found in fields, but around the homestead and in small household woodlots.

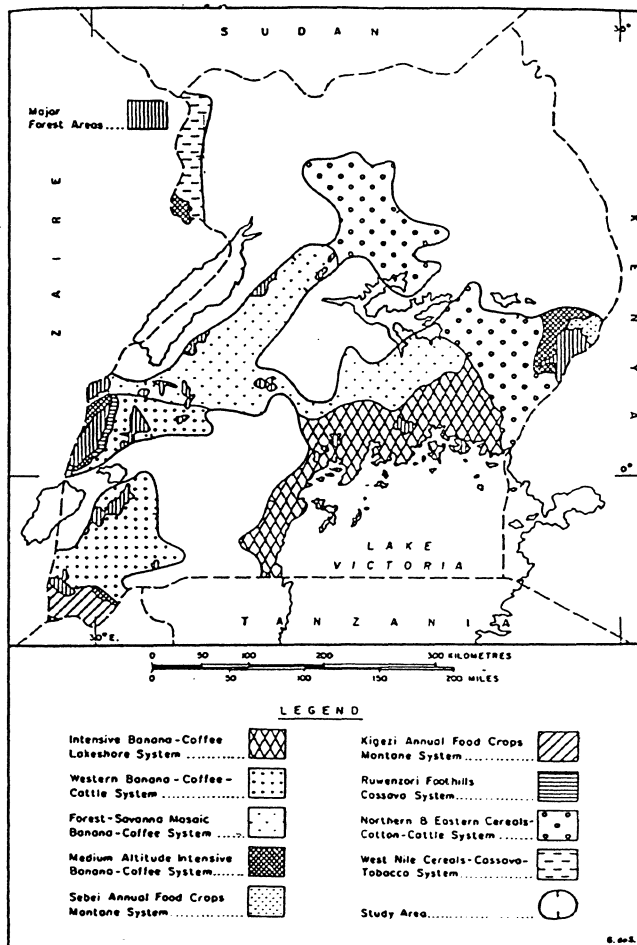
7. Ruwenzori foothills cassava system. This system covers only a very small area of the Ruwenzori mountains. The staple crops are cassava and beans, with sorghum an important crop as well. Livestock is an insignificant component of the system. Fuelwood has been recognized as a serious constraint.

8. Northern and eastern cereal-cotton-cattle system. This system covers part of Apach, Gulu, Kumi, Mbale, Soroti and all of the Tororo district. In the northern areas the climate is hotter with a longer dry season than in the southeast. Population density decreases from the southeast to the north. The predominant food crop is millet, while cotton is the major export crop. Livestock is an important component of the land use system, with more cattle being kept in the north and east than in the southeast. Fruit trees are found around households. The natural vegetation has been modified by the clearing of land.

9. West Nile cereals-cassava-tobacco system. This is a system found in the northwestern area of Uganda along the Zaire border. Population density is for the resources fairly high and households experience land shortage. Intensive, mixed, and double cropping is common. Tobacco is the major export crop, with cassava, millet, sorghum and maize grown as staples. Livestock herd size is small, but are highly valued. Trees have been cleared for land cultivation, but trees are planted, although not in the fields. Fruit trees such as oranges, lemons, grapefruits, pawpaws, and mangoes are planted in the homestead. Non-fruit trees

such as *Cassia siamea*, *Cassia agnes*, *Cassia spectabilis* are also planted in the homestead, while small *Eucalyptus* spp. woodlots have also been planted by smallholders to provide poles and fuelwood. However, although there has been plantations established by the Forest Department and tobacco societies to provide fuelwood for tobacco curing, wood scarcity is being experienced (source for this section UNT and ICRAF, 1988; Muwanga, 1987).

Figure 4.2
BIMODAL HIGHLANDS: LAND USE SYSTEMS



Source: UNT and ICRAF 1988: 41

Unimodal Plateau land use systems

The long period of war and its disruption prevented research in Ugandan land use systems and tree use comparable to that which has occurred in other countries in the study areas. The analysis for AFRENA of land use systems in Uganda was primarily concerned with the high potential areas, so the focus of the UNT and ICRAF (1988) study was on the bimodal highlands, not the lower potential semi-arid areas. Unfortunately, this has resulted in a lack of comparable case studies of smallholders and trees for this semi-arid zone.

The data which is available, is in some instances contradictory because of the variation in land use systems, ethnic group, and time period of the studies. Therefore this the semi-arid plateau in the Unimodal Plateau zone has not been delineated into a land use system, nor is a case study presented.

A few generalization, however, can be made about this zone. As can be seen in Figures 4.1 and 4.2, the semi-arid zone occurs in areas in the south, between the mountains and the lake region, and in the northeast. The population densities in this zone range from 14 persons/km² in the Karamoja (northeast) region to over 50 persons/km² in the Ankole/Masaka area to the south.

Land use systems can be identified very broadly as pastoral or agropastoral systems. In the pastoralist land use system livestock is the dominant component. Pastoralists are being encouraged to become "settled", but livestock management in the very dry areas in which they live requires mobility. The agropastoralists depend heavily on both the agricultural and livestock components of the land use system. In the agropastoralist areas rains are uncertain and crop failure is not uncommon. The income/products from livestock provide some stability to these systems (Adupa *et al.* 1988).

As to tree planting, Pyatt (pers. comm.) reports *Eucalyptus* spp. woodlots in Bushenyi, and Mujuni (pers. comm.) notes that there have been tree planting projects in Karamoja since 1981. Communal woodlots have been introduced in Karamajo, but there have been problems in management.

1.3 Tenure

Land tenure

In the belief that it was the main path to economic development, Uganda was one of the countries that opted at the time of independence for a policy of individual tenure. However, in the years following independence it was found that such a policy was difficult to implement, and currently both customary (traditional) law and private individual tenure are recognized. While in principle, through the 1969 land and the 1975 land reform decree, all land belongs to the public (state), in practice there are discernible categories in the tenure system. These are:

Freehold and leasehold land

This mainly comprises land held by individuals, companies and public bodies. The freehold land locally known as "mailo" is particularly common in the Buganda region (central Uganda). In the Kigezi (southwest) and Bugisu (eastern Uganda) areas customary freehold also exists.

The mailo freehold land arose from a shift in power in the Buganda kingdom. In the past land rights were held by the clan. As the power of the king increased, these rights declined and were finally abolished in 1900 when freehold land (over 23000 km²), known as "mailo", was conferred to the chiefs, leaving only a little over 2000 km² as public land. This mailo land has created a large number of landholders in central Uganda.

There is also a freehold-like tenure "Kibanja" for which the government issues certificates

of occupancy. However, while the mailo land can be sold, the Kibanja can not under law be sold, transferred or sub-let. However, Mujuni (pers. comm.) notes that although the land could not be sold in Kibanja, landholdings the developments and improvements on the land could be sold. Notwithstanding the prohibitions, under the guise of the sale of improvements, sale of land does take place (UNT and ICRAF, 1988).

Land held in freehold by the government

This includes national parks and forest reserves.

Public land

All remaining land is, by law, public land. This land is held under customary tenure and constitutes most of the land held by smallholder farmers. Reflecting the historical background and particular ethnic group, there are regional differences in customary tenure rights, but some generalizations can still be made. In this form of tenure emphasis is on rights of access, *ie.*, rights of cultivation, grazing, wood gathering, disposal and inheritance, rather than ownership of the land parcel *per se*. In this system land is allocated to villagers, by clan elders or chiefs, or even in some situations by occupation, particularly if the land is far from a village. A household has the right of the use of the land as long as it continues to cultivate it. Continuation of cultivation is the basis of tenure, if the land is not utilized and/or the household moves away, rights end, although the length of time that the land must be vacated before it can be redistributed, varies.

What is referred to as "land tenancy" does occur in Uganda, although in some areas tenants appear to have the same rights as other occupants in the area. Among the Lugbara of the West Nile cereals-cassava-tobacco land use system, for example, land tenancy has been practised since at least early colonial times. The tenant, usually related through a man's sister or daughter, requested the use of land for farming. Once the tenant was established on the land it was his (and his wives) to use until he decided to break the tie by moving elsewhere. If he stayed, the rights to cultivate the land was inherited by his descendants. No discernible distinction existed between those who were tenants (although they were of a different lineage) and those who were not. Since groups from one community were not allowed by the colonial government to resettle within another community's boundaries, this form of tenancy allowed the movement of individuals via kin ties to areas where land was still available (Middleton, 1965).

Tree Tenure

It can be inferred from Opio-Odongo (1985) that under customary law the individual who planted the tree(s) becomes the recognized owner of the tree(s), and no one else can cut the tree(s) down. However, tree and land tenure are not necessarily one and the same. Among the Iteso (semi-arid area), trees remain the property of the individual who planted them, even if the land on which they grow has, by his absence, ceased to belong to him. If the owner has left the area and wishes to maintain his rights, he has to appoint someone to look after the trees. Such trees can be bought and sold, but the sale does not include similar rights to the land (Lawrence, 1970).

Rights to fuelwood are generally granted to deadwood on communal forest and lands, but permission may have to be granted for collection on another's farm (Gayer, 1970). In other areas any person may gather deadwood on any land (Lawrence, 1970).

Throughout Uganda, although cutting a tree may only be done by the owner on allotted land, any person may cut a tree on unallotted land. Beattie (1970) noted that under the Kibanja freehold system among the Bunyoro the holder had the right to all the timber on his land.

However, certain trees may be regarded as belonging to the community and may not be cut, even on allotted land. Among the Iteso these are usually trees which produce food or have other valued uses (Lawrence, 1970). Pyatt (pers. comm.) notes that the government ownership of mvule trees (*Milicia excelsa*) deters smallholders from growing it, even though it is a tree of recognized value as a hardwood for timber.

Government interventions

Although there was in previous governments some unease concerning freehold tenure, the current government policy regarding tenure appears to be one of accepting the status quo and not initiating any new tenure programmes (Musisi, 1986).

1.4 Economy

With 76 percent of the Gross National Product based on agriculture, the economy of Uganda is the most dependent on agriculture in the study area. This is more than double the percentage for neighboring Kenya (31%) and Rwanda (37%) and higher than Tanzania (61%) (World Resources Institute/UNEP/UNDP 1990). Virtually all (99%) of the country's export earnings are from agricultural products. The relative lack of industry and services as components of the GNP has been influenced by the severe domestic problems of Uganda.

It should be noted that Uganda experienced a decade of damaging war which created tremendous hardship in the country. Existing capital assets in agriculture, manufacturing and transportation were seriously rundown due to lack of maintenance or investment, and little new investment was made during this period. Manufacturing plants were operating at only 5 percent of capacity and infrastructure deteriorated. Agricultural production was disrupted in areas of conflict, but agriculture was the only sector that was operating at some level of production (EIU, 1988-89; FARCES, 1989; UNT and ICRAF, 1988).

The agricultural sector has been resilient since the cessation of major conflicts. Current government agricultural policies are aimed at increasing agricultural production for self-sufficiency in food production and export earnings (UNT and ICRAF 1988).

1.5 Rural Sector

Population density in the rural areas varies in response to natural resource availability (rainfall, soils, etc.) and the absence of tsetse fly, as well as being influenced by historic events and infrastructure facilities (UNT and ICRAF, 1988). The most prevalent resident pattern is one of scattered households. Households may be more scattered in some areas than in others depending on the population density, farm sizes, and cultural traditions. Polygyny is valued and for many it is a goal, but monogamy is the common marriage pattern for the majority of men.

The average rural household varies in size depending on the region and ethnic group. The overall mean is between 5 and 7 people per household. It is unknown how many female headed households there are in the rural areas. Prior to the war period, there were regions of outmigration, such as the northwest, from which males went to find work in towns and in the south as agricultural labourers (Middleton 1965). These migration patterns appear to have continued. Oduol and Aluma (1990) note that the banana-coffee system in Buganda and parts of Busoga is dependent on hired labour from other regions in Uganda and neighbouring countries.

The rural household is the basic unit of production. Generally, households produce staple foods for domestic consumption and often for sale; in some areas virtually all households will grow a major export crop as well. The staple food varies in response to rainfall and altitude. In the south the staple food crop is bananas (plantains), while finger millet (eleusine) is the staple in the north and east. Maize growing is increasing in the finger millet areas. Other common food crops are cassava (especially in the northwest), sweet potatoes, sorghum, maize, peanuts, simsim, beans and peas (UNT and ICRAF, 1988).

Export crops, such as coffee and cotton, have been grown since the beginning of the century. Tea is primarily grown by large-scale plantations (UNT and ICRAF, 1988). The planting of coffee and cotton has been declining because of the lack of infrastructure. Tobacco is grown by smallholders in the northwest. The government is encouraging regional export crops such as maize, beans, soybeans, and sunflower. Bananas (plantains) are a very important cash earner in areas in which they are grown.

Livestock production is important in much of Uganda. "While distribution of cattle is partly influenced by the tsetse fly [infestation], other major contributory factors are the ethnic differences and the production of cash crops in certain areas resulting in lesser emphasis on livestock" (UNT and ICRAF, 1988:27). Cattle raising is, of course, most important in the drier regions in the pastoral land use system and it is an important component of the agropastoral systems. Small stock is kept everywhere, although the number and distribution varies (UNT and ICRAF 1988).

Labour

Households depend on familial labour for most, if not all, of the agricultural activities. Seasonal exchange labour accompanied by feasting and beer is common, and seasonal hiring may occur, especially if the labour is needed for cash crops. Labour migration to the banana-coffee areas has been occurring for over a generation (Middleton, 1965; UNT and ICRAF, 1988).

Credit

There is little credit available to the smallholder. Shortage of credit has been identified as a major constraint to increased agricultural production. Small farmers lack the required assets and/or land title securities to qualify for loans, while the government has little foreign exchange to use to import the necessary farm inputs which the farmer would use if he could get the necessary funds (UNT and ICRAF, 1988).

Fuelwood

It is unclear whether smallholders share the government perception of a fuelwood

shortage as being a crisis and whether subsequently they are responding by planting trees. It does appear that households in some areas recognize a fuelwood shortage. However, a fuelwood shortage is usually accompanied by shortages of other wood products, especially building materials, which may be perceived by households as more of a problem than a shortage of fuel. It is the shortages of wood products other than fuel which may motivate tree planting. This view is supported by a study which found that even if fuelwood was identified as a problem, the motivation to plant trees was based not on fuelwood but rather on the need for construction materials or the desire for more fruit (Pyatt, 1990).

1.6 Government policy on land use, crops and trees

One of the government's primary policies is to increase agricultural production. In order to fulfill this goal, arable areas which are currently not being cultivated are going to be progressively used for agriculture and the intensification of use of existing fields will have to occur. The objectives of the government are to:

- Ensure self-sufficiency in food production
- Conserve natural resources through good management practices
- Improve the quality and diversity of export crops
- Develop appropriate farming systems
- Provide fuelwood and timber

These objectives have led to policies that could potentially have some impact, positive as well as negative, on tree growing by smallholders. Current government policy, for example, not only encourages tree crop production for fruit, oils, *etc.*, and extension services by the Forestry Department to help farmers and organizations grow and protect their own trees, but it also encourages the mechanisation for the cultivation of large areas, which usually results in all the trees being cleared from the fields.

Government interventions

Up to the 1950's forests formed a major part of the country's landscape. However, both colonial policy and government policy following independence appears to have emphasised increased agricultural production at the expense of forest reserves. In particular the policy statement that stressed ". . . because of Uganda's dependence on agriculture, the rapid development of the country, and the continuing increase of its population, it is necessary to limit the size of forest estate to the minimum area" had far reaching consequence) (Hamilton, 1984).

Besides causing massive (condoned) destruction of the forest, this policy fostered a negative attitude towards trees. Forests were perceived as being something to be exploited rather than managed, and agriculture and forests were viewed as being competitive rather than complementary (Odongo, 1984). Thus all forest resources experienced a serious reduction in size, including a decline in the number of trees outside the forest reserves such as communal woodlands (Odongo, 1984).

There has been increasing government and donor encouragement of tree planting. Current forestry policy strongly supports aiding "farmers, organisations and individuals

to grow and protect their own trees for timber, fuel and poles and to encourage agroforestry practices" (Eckerberg and Frykman, 1990:45). Much of the activity in support of this policy has been concentrated in social forestry programmes, the goals of which are to expand tree planting outside the forest reserves and into the villages. These activities are sponsored by the Forestry Department often with additional funding and training provided by a donor organisation (Opio-Odongo, 1985; Eckerberg and Frykman, 1990). CARE has been very active in projects encouraging tree planting.

Until the late 1980's the emphasis of tree planting programmes was on timber, fuel and poles rather than trees that would fulfill nutritional or fodder needs. The UDF/CARE Tree Planting Project (1986-1988), for example, was based on giving away *Eucalyptus* spp. seedlings to grow in woodlots for building poles, timber and fuelwood. Near the end of the project changes were recommended to shift the focus to the needs of the poorest people and efforts were made to provide a wider variety of trees for the additional purposes of soil conservation, soil fertility, fruit, shade, boundary plantings, fodder and wind breaks. Following the shift in project goals, seedling distribution declined dramatically, and the extra technical demands of providing more varieties of trees, especially fruit trees, lowered the output of seedlings below demand (Pyatt, 1991).

Currently there is the Forestry Rehabilitation Project which is co-funded by a number of agencies: World Bank, EEC, DANIDA, CARE, UNDP, NORAD, and the Ugandan government. The project's objectives are to improve the technical capacity of the Forest Department, to promote social/community forestry and to create forest conservation awareness, and to identify future training requirements. The farm forestry (social/community) component of the project is being implemented by CARE (Eckerberg and Frykman 1990).

The organization of government ministries has hindered the effective implementation of government policy that encourages tree planting by farmers. Eckerberg and Frykman (1990:45) found that "coordination of efforts involving both forestry and agriculture is very difficult, since agriculture in Uganda is under 4-5 different ministries." There is competition between ministries and programmes for seedlings, funds, and transport facilities.

Small farmers and trees

Farmers in Uganda generally know how to plant and manage trees. One study indicated that fruit trees were the most common tree planted, but other trees were grown on farmland for use as building poles and fuel (Opio-Odongo, 1985).

Traditional agroforestry systems have been developed in Uganda, although few of these practices have been documented. In the banana-coffee growing areas it is common to find trees such as *Ficus natalensis*, *Markhamia platycalyx*, *Maesopsis eminii* and *Ricinus communis* growing in the fields with the perennial crops. In West Nile and northern Uganda, *Cajanus cajan* is commonly intercropped with millet and simsim, while in Soroti and Kumi Districts of the northeast, *Tamarindus indica*, *Mangifera indica* and *Butyrospermum parkii* are commonly retained or planted on farmlands (UNT and ICRAF 1988: 31).

Generally, both government and NGO-sponsored programmes have promoted tree planting in Uganda, although mainly for fuelwood rather than for other purpose. Experience in other eastern and southern African countries has often shown that there was greater likelihood that substantial number of households who planted trees have done so for building poles and fruit rather than for fuelwood (Shepherd, 1989). Fuelwood is perceived more as a byproduct of trees planted for other purposes, rather than a need for which a tree would be specifically planted. This is supported in a survey of southern Uganda which showed that respondents regarded all of the thirty-four trees species, including eight fruit trees, as providing fuelwood (Pyatt, 1991).

Again, as in other countries in the study area, when a project, such as the UDF/CARE Tree Planting Project, encouraged woodlot planting, households preferred planting trees in their own woodlots, rather than in communal woodlots (Opio-Odongo 1985). Households seem to want control over the trees they have planted.

2. Agroecological Zone Analysis

Bimodal Highlands

Definition of zone

Crop growing period ranges from 180-270 days.

Rainfall is more than 1000 mm per year. Rainfall is in a bimodal pattern with the rainy peaks in March-May and October-November.

Altitude ranges from 1000 m to 2500 m above sea level.

Vegetation in the bimodal highlands is "characterised by a mosaic of forest, savanna, marshes, and grassland" (UNT and ICRAF 1988:16).

Most of the soils in the zone are acrisols and ferralsols. The high volcanic regions of the western rift are andosols and nitosols. Nitosols are "good soils for coffee, tea and food crops, and can also support ranching and dairy farming" (UNT and ICRAF 1988:14).

Case study: Intensive Banana-Coffee-Lakeshore land use system

Location

Most of the area lies between 1000 m and 1200 m above sea level. It is centered mostly in the southern area of the country, around the shores of Lake Victoria. It surrounds the two largest cities in Uganda: Kampala and Jinja. There are also several big "towns" within the system (Oduol and Aluma, 1990; UNT and ICRAF, 1988).

Population

This is over 3 million, with population density varying between 41-276 km², with an average of 140 km² and an annual population growth rate of about 3 percent. The household size averages 6-10. Land holdings per family varies between 1-1.5 ha. The average size of the homegarden is 1 ha with a range of 0.4-1.5 ha. The major tribes

living in the land use system are the Baganda and Basoga (Oduol and Aluma, 1990).

Land tenure

Most of the land in this system is held under the "mailo" freehold tenure system. The land has become highly fragmented since a father's land is divided among his offspring, usually just his sons, but occasionally his daughters. A farmer will usually have several small, usually irregularly shaped fields. Land is allowed to be sold, so some farmers sell their land and become traders or move to other areas. Although hill top grazing is owned by individuals, the community has the right to use it (Oduol and Aluma, 1990; UNT and ICRAF, 1988).

Tree tenure

Under this freehold system farmers have the right to the trees they have planted and maintained on their property.

Land use system

This system is characterised by intensive production of both subsistence and export crops. Banana is the main food crop and coffee (robusta) is the main export crop. A household will usually have "a banana-coffee-annuals garden with a few scattered plots of annuals" (UNT and ICRAF 1988:47).

Banana is the traditional staple, but other important crops are maize, sweet potatoes, beans, groundnuts, cassava, sorghum and yams. Cotton was the major export crop until it was replaced by coffee after World War II. Coffee robusta is now the main export-oriented cash crop grown in the region and "accounts for 89 percent of the total coffee production in the country, and generates a considerable percentage of the foreign cash earnings for the country" (Oduol and Aluma 1990:222 citing Anon 1984). The cropping pattern is a mixed one with coffee intercropped in the homegarden with banana and annuals and biennials grown between. As with the Tanzanian Chagga homegardens (Fernandes *et al.* 1984), there are several distinct vertical zones which can be identified in the homegarden (see table 4.1).

Table 4.1 Homegarden Composition

Level (m)	Description
> 5	trees for various uses such as shade for coffee/banana, fuelwood, poles, timber and fodder
2.5 - 5	banana canopy, with fruit and fodder, shade trees
1.5 - 3	coffee, cassava and sometimes maize and young tree
0 - 1.5	food crops such as pumpkins, doodo (<i>Amaranthus candatus</i>), beans, taro, grasses and regenerating tree/shrubs

For most households the homegarden supplies more than enough food. The homegarden provides not only food throughout the year, but also a cash income from the sale of coffee and perhaps plantains or beer bananas (Oduol and Aluma, 1990; UNT and

ICRAF, 1988).

This land use system is currently maintained without much capital. There is little capital investment made in tools, since no mechanized equipment is used in this system.

The tools used by the farmers are the basic hoe, axe, and panga (machete). There is also little off-farm inputs purchased since seeds and banana suckers are usually taken from the previous harvest (although trading among neighbours is probably common), and inorganic fertilizer is not generally used. Inorganic fertilizer has been difficult to obtain and too expensive for smallholders without access to credit when available (Oduol and Aluma, 1990).

Although the system appears to be stable and self-sustaining, there is increasing pressure being placed upon it. The population is growing, landholding size is diminishing with each generation, and outmigration of young adults (and restriction on migrant labour) is causing seasonal labour shortages. There is also concern that with the young migrating to the cities the knowledge of how to maintain such an intricate management system will be lost to the next generation (Oduol and Aluma, 1990).

Tree component

Most farmers retain, manage and plant several tree species and shrubs in the homegardens. Trees fulfill the high soil fertility and moisture needs of the banana garden since they aid in water retention and recycle deeply leached nutrients. Management practices by farmers reflect their knowledge of how to open up the canopy via pruning and lopping to increase the flowering and fruiting of coffee. Different trees be planted or maintained for different purposes. A homegarden will include trees for timber, food and fruit, fodder, shade, and fuelwood (Oduol and Aluma, 1990).

UNT and ICRAF (1988) noted that there had been a tremendous increase of fruit trees in the area. Fruit trees such as avocados, jack fruits, guavas, and mangoes were assuming greater commercial value for the smallholder as urban demand for fruit increased. Other income from the trees in the homegarden is generated from the harvesting of trees at maturity for poles and timber. A large Mvule (*Milicia excelsa*) was estimated in 1987 to be worth "US\$300-\$500 for timber and another US\$100-200 for charcoal from the wastes" (Oduol and Aluma, 1990:222 citing Aluma, 1987).

Eucalyptus spp. have been planted in many swamps. This is a controversial practice, since it is believed that *Eucalyptus* spp. will lead to a loss of soil water. It is unclear from the source (UNT and ICRAF, 1988:48) who planted the *Eucalyptus* spp., *ie.* farmers, communities, forestry programmes, or the forestry department.

Livestock component

On the average each household has about 2-5 cows, 3-5 goats, 10 chickens. Some households also have pigs. The animals are usually tethered and feed mostly on grass. Goats may occasionally be fed tree/shrub leaves (e.g. *Ficus* spp.) and banana plants. Cattle are used for milk, meat, cash, and social needs such as marriage. Goats and pigs are sold and domestically consumed (Oduol and Aluma, 1990:230).

Although manure is applied to the banana fields, the use of dung is not widespread.

Whereas animals are tethered, they are usually not stall fed, and the labour demands of taking the manure from grazing areas to the homestead may be more than most households can manage on a regular basis (Oduol and Aluma, 1990; UNT and ICRAF, 1988).

Labour

The banana-coffee system is based on the work traditionally done by women in cultivation of the banana garden. Robusta coffee was integrated into the existing banana garden and the care of the coffee was incorporated into the agricultural labour responsibilities of women. Labour is needed for bananas, taro and yams throughout the year. The peak labour demand for coffee is for harvesting in June and July. The coffee harvesting overlaps with the period of land preparation and planting of the annual crops and therefore labour shortages occur during this time. This shortage is intensified with the outmigration of young adults from the area to off-farm employment, especially the urban areas (Oduol and Aluma, 1990).

Hired labour has been a component of this land use system for some time. In Buganda and part of Busoga there appears to be sizeable numbers of labourers who come from other areas of Uganda and neighbouring countries. Wages are regarded as being low, and it is common for workers to shift from one employer to another in response to higher wage offers (Oduol and Aluma, 1990; UNT and ICRAF, 1988).

Perception of trees

The people in this land use system appear to have a very positive attitude towards trees. Trees are planted, wildlings retained and protected, *etc.*, so that homegardens and homesteads contain a complex mix of trees for different purposes.

Use of tree products

Trees are planted and maintained in the homegarden and homesite for food, bark cloth, timber and poles, shade, beauty, income, and fuelwood. Fishing is a major economic activity, especially by households very close to the lakeshore, and wood fuel is required for smoking fish. This has been identified as one of the contributory reasons for increased deforestation in the area (Oduol and Aluma, 1988).

Interventions in support of tree growing

This system has developed and operated without much government support. There appears to be little government intervention concerned with tree planting in area.

Oduol and Aluma (1990:225) do note that farmers are not receptive to agricultural extension agents who are "normally single crop oriented" since the traditional form of management is based on crop diversity and intercropping.

Preferred species for tree planting

Trees commonly found in the homegarden are: *Ficus* spp., mvule (*Milicia excelsa*) [*Chlorophora excelsa*], jackfruit (*Artocarpus heterophyllus*), mango, *Maesopsis eminii*, guava, avocado, papaya, *Entandrophragma angolense*, *Markhamia* spp., *Albizia* spp., passion fruit, *Canarium schwenfurchii*, *Lantana camara*, *Citrus sinensis*, *Citrus limon*, and castor (*Ricinus communis*). Ornamental trees are also planted. In Buganda a number of *Ficus natalensis*

are usually planted in the homegarden to provide not only bark cloth, but also to serve as a windbreak and support for vines (Oduol and Aluma, 1990).

Case study: Kigezi annual food crops montane system

Location

This land use system is in Kabale District in the Mufumbiro mountainous region near the border with Rwanda and Zaire. It is above 1800 m and covers about 1,800 km². Rainfall is bimodal but the amount is variable ranging from 1000 to 1500 mm. The lower temperatures of the high altitude mediate the effects of the dry season, and evapotranspiration is much lower in the areas of the LUS than in the lower altitude zones. The terrain is one of steep hills and valleys (UNT and ICRAF, 1988).

Population

The population was estimated to be about 450,000 in 1987, with a population density of 620 persons/ km². The government is encouraging outmigration from this area to Bunyoro or urban areas with "processing industries" (UNT and ICRAF, 1988: 59). Even before government encouragement this was an outmigration area.

Household size averages 6 to 10 family members. It is not surprising that given the high population density and the terrain, that homesteads are closer to one another and less scattered than is found in other areas of Uganda. Homesteads are usually found in the valleys, and the slopes are cultivated up to the hilltops. Although the percentage is not known, as a consequence of the outmigration of males the proportion of female headed households must be significant.

The main tribal group is the Bakiga, but other tribes are also found (UNT and ICRAF, 1988).

Land tenure

There is private land ownership, supported by customary law. Land sales, especially from smallholders to relatively large farmers, is common. Hill tops and wetlands (swamps) are also privately owned, but will be communally grazed if not fenced.

Tree tenure

As in the Banana-Coffee land use system, trees go with the land. However, in this land use system trees are not planted or maintained in the croplands, but are planted around the homestead and in woodlots.

Land use system

Households have landholdings which are very small, on the average less than 1 ha. The landholding is fragmented into several plots "scattered on the slopes" and valley bottoms (UNT and ICRAF, 1988:61). It is a system based on permanent field cultivation (with short rotation period) of small dispersed plots cultivated by hoes.

In Rwanda, farmers in similar terrain plant anti-erosion bunds with improved grasses. In Uganda, farmers plant anti-erosion bunds as well, but with local, rather than improved grasses. Inorganic fertilizer is not used, and manuring usually only occurs around the

homestead.

The most important crops are sweet potatoes, beans, sorghum, potatoes, peas, maize, vegetables and wheat. Sorghum, consumed as beer, is the main cereal crop and cash crop. Crops are usually intercropped and grown in a sequence on the slopes and valleys. Potatoes for example are grown on the slopes during the rains, but in the valleys during the dry season. Some crops, such as beans and peas, are grown twice a year. Other crops, such as maize and sorghum, are usually grown once a year. Sweet potatoes is the crop which covers the most acreage in the area, and because of its long maturity, is only grown once a year.

Tree component

Trees are found around the homesteads and in small household woodlots, but the "integration of trees with crop production is not practised" (UNT and ICRAF, 1988: 61). Fruit trees, highland pawpaw and passion fruit, *Markhamia platycalyx*, *Erythrina abyssinica*, *Cupressus lusitanica*, *Pinus patula*, and *Ficus natalensis* are common species found around the homestead. *Acacia mearnsii* is found in marginal lands, and *Mitragyna* spp. in swamps.

The small woodlots are generally *Eucalyptus* spp. which provide wood products for household needs and cash earnings. There is a strong demand for wood products in the highlands, and within the community a household can receive higher amounts than the government prices for *Eucalyptus* spp. products. The local price (1987) for poles from 3-4 year old *Eucalyptus* spp., for example, "is around 100 Ushs compared to 20-30 Ushs, the government price" (UNT and ICRAF, 1988: 61). The wood products purchased locally are used by households in the community and by local brickmaking factories.

Livestock component

Almost all smallholder households keep smallstock, but only a few households keep large stock. Livestock are kept to provide cash, food, and "social function." Stock are not stall fed, but are grazed on marginal hilly areas, valley bottoms, roadsides and interseasonal fallow during the day and kraaled at night (UNT and ICRAF, 1988:61).

Labour

The main source of labour is the family, or perhaps more accurately, the female household members. It is recognized that women are the ones responsible for farming, while men are mostly engaged in off-farm employment. Large numbers of men appear to migrate outside the area, although this can only be inferred since there is little data and no quantification of female household heads. Hired labour may also be used to supplement household labour, especially for planting and harvesting.

Perception of trees

The presence of trees in the land use system implies a positive perception of trees. Trees are planted around the homestead and in woodlots. However, trees are not planted, nor do they appear retained, in the crop fields. This pattern also occurs in the high density areas of the Shire Highlands of Malawi, where field size is small and farmers are concerned about the impact of shade and nutrient competition of trees on crops. However, unlike Malawi, livestock in this land use system graze on fallow fields,

which may inhibit the planting of tree seedlings where they could be browsed.

Use of tree products

Trees are used for food, timber, fuelwood, barkcloth, *etc.* Trees do not appear to be used for boundaries or hedgerows, or on anti-erosion bunds.

Interventions in support of tree growing

The woodlots of *Eucalyptus* spp. are probably the result of government efforts in the area. There have been projects in the past, and currently "there are 28 nurseries in the Kabale districts with a capacity of approximately 10,000 seedling/nursery (mostly *Eucalyptus* spp.)" (UNT and ICRAF 1988:61). There are large plantations of *Cupressus lusitanica* and *Pinus patula* in the highlands, which have probably served as a source of seedlings and/or extension since both species are common around homesteads.

Preferred species for tree planting

Fruit trees are popular around the homesteads as are trees for timber, shade, barkcloth, *etc.*

Conclusions: Bimodal Highlands

Where are farmers planting or not planting trees?

Trees feature in the land use systems of Uganda. In the Banana-Coffee Lakeshore land use system trees are planted and retained in the homegarden and the homestead, a pattern that appears in the other banana-coffee land use system as well. However, in the Kigezi Montane, trees are not found in the fields, but in the homesteads and small woodlots. Small field size, the dependence on annuals rather perennial crops, and the grazing of smallstock in the fallow fields appear to encourage tree planting in the homesite or in woodlots, rather than in the fields.

How does tree planting relate to ecozone, cultural traditions and values?

There is considerable diversity across the agroecozones of Uganda. Staple crops, export crops, farm size, ethnicity, *etc.*, all vary depending on the agroecozone and land use system. What appears to be similar is the substantial number of trees which are retained and planted if not in fields then in homesteads for their contribution of food, shade, timber, medicines, *etc.*

As in the case of the Kigezi Montane when the size of the landholding gets extremely small, trees disappear from the fields, although they are retained around the homesteads, woodlots, and marginal lands. Communal grazing of smallstock may also have an impact on tree planting, since farmers are wary of planting seedlings where they can be browsed.

What incentives are there for tree planting?

The incentives for tree planting are generated by household needs rather than government programmes. The strongest incentives appear to be for poles and timber, fruit, shade, and income. Fuelwood does not appear to be an incentive for tree planting, since it is perceived as a by-product of trees planted for other purposes.

How does tree planting by farmers relate to government promotional and extension efforts?

Government interventions have encouraged the planting of certain species, especially *Eucalyptus* spp. The incentives were free seedlings (as in the CARE Tree Planting Programme) and government set prices for the wood products (although local prices appear to be higher).

Woodlots also appear to be the result of government interventions. Farmers are planting woodlots, especially of *Eucalyptus* spp., in some of the land use systems. Communal woodlots (for which there were little data) do not appear to be as successful as household woodlots, at least in the case study areas.

3. Uganda summary

1. Uganda's turbulent past has made research difficult and the longitudinal in-depth background data that exists for other countries in the study area was not available. The recent information that is available is primarily from the high potential bimodal highlands, rather than the unimodal plateau. Data from the bimodal highlands show that farmers are planting and retaining trees to satisfy their perceived household needs.
2. Knowledge of tree planting and care does not appear to be a constraint in tree planting. Ugandan farmers, at least in the bimodal highlands, know how to manage trees on their landholdings. New tree species may require some training, but basic tree husbandry knowledge is present.
3. The government's emphasis on planting trees for fuelwood was too narrowly focused and did not fit the farmer's perception of which wood products were critically scarce. Rural households appear to be motivated to plant/retain tree by the need for poles, timber, and fruit, rather than fuelwood.
4. Government/donor programmes are moving away from providing a single species, usually *Eucalyptus* spp., to farmers. This is a positive step to broaden both the number of species and the goals of the programme, *ie.*, to include trees for fruit, fodder, *etc.* rather than just fuelwood.

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5. COUNTRY REPORT: RWANDA

1. General information

1.1 Background

Population

The population of Rwanda was estimated to be 6.5 million in 1987, and based on a population growth rate of about 3.5 percent a year (a conservative rate, some sources suggest a growth rate of 3.8 percent, see World Bank, 1984), the population is projected to reach over 10 million by the year 2000. Over 50 percent of the population is under the age of 15.

Unlike some countries in the region, large scale migration into the urban areas has not yet occurred. Over 90 percent of the population still resides in the rural areas, although seasonal migration between town and farm does occur. Countrywide, the population density is estimated to be over 250 km², the highest in Africa. However, within Rwanda, population distribution is uneven, with the population densities of the high plateau and volcanic highlands being more than double that of the drier lower areas.

Until this century the population was concentrated in the High Plateau (see below), the prime agricultural area of the Great Lakes Highlands. As a result of the introduction of New World crops and population growth there has been outmigration into the previously uncultivated forested areas above 1800 m and the drier warmer Piedmont.

Ethnically Rwanda and Burundi are the most homogeneous countries in the region. In Rwanda 88% of the population is Hutu, with the remainder of the indigenous population being Tutsi or Twa.

(Sources: Gillespie, 1989; EIU, 1988; Isaie, 1989; ISAR and ICRAF, 1988.)

Topography

Rwanda is a mountainous country, the "land of a thousand hills" (Kleinart, 1985:p. 93). The Congo-Nile watershed runs north to south with peaks reaching 3000 m. On the east "the plateau slopes gently to 1400 m at the Tanzanian frontier" (Gillespie, 1989: 303). Altitude has a critical impact on the land use system; above 1800 m food crops such as sorghum and beans are replaced by maize and peas, and coffee is replaced by the other export crops of tea and pyrethrum.

Climate

Rwanda is fairly temperate with areas above 2500 m experiencing frost. The rainfall pattern is bimodal; rainfall peaks in April and the driest period occurs during June to July. The short rainy season, from September to December, is more variable and less certain than the long rainy season of February to May.

Vegetation

The intensity of land use has created a landscape of annual crops and tree crops in the areas below 2300 m and degraded forest above. Only about 8 percent of Rwanda is still under forest, and much of this has been degraded by grazing, mining, and fuelwood

collection (Kleinert, 1985).

Soils

The volcanic soils of the Volcanic Highlands (see Figure 5.1) are Rwanda’s best "with excellent physical properties and chemically rich" (Jones and Egli, 1984: 18). The Volcanic Highlands are, however, only a small portion of Rwanda. Although there is a great deal of local variation, most of the soils of the remainder of Rwanda are well drained, but prone to acidity and aluminium toxicity. In the areas of high population density between the altitudes of 1800-2500 m the soils are degraded and pasture is poor.

At the valley floors in the seasonally flooded areas, there are alluvial soils that are nutrient rich which are used for dry season crops. As in Zimbabwe and Zambia, these seasonal wetlands play an important role in the local farming systems (Jones and Egli, 1984).

1.2 Agroecological zones

For the purposes of this paper a World Bank study, supplemented by ICRAF’s work on the highlands of central Africa, is used as the basis for the discussion of Rwandan agroecological zones (see Figure 5.1 and Table 5.1).

Table 5.1 Description of zones

Zone	Rainfall (mm) (bimodal)	Altitude range (m)	Population density (km²)
A. High Plateau	1000-1200	1550-1800	261
B. Kagera piedmont	850-1000	1400-1550	124
C. Kivu lakeshore	1000-1200	1400-1800	259
D. Central Congo-Nile Divide	1400-2000	> 1800	200
E. Volcanic highlands	>2000	1800-2800	303

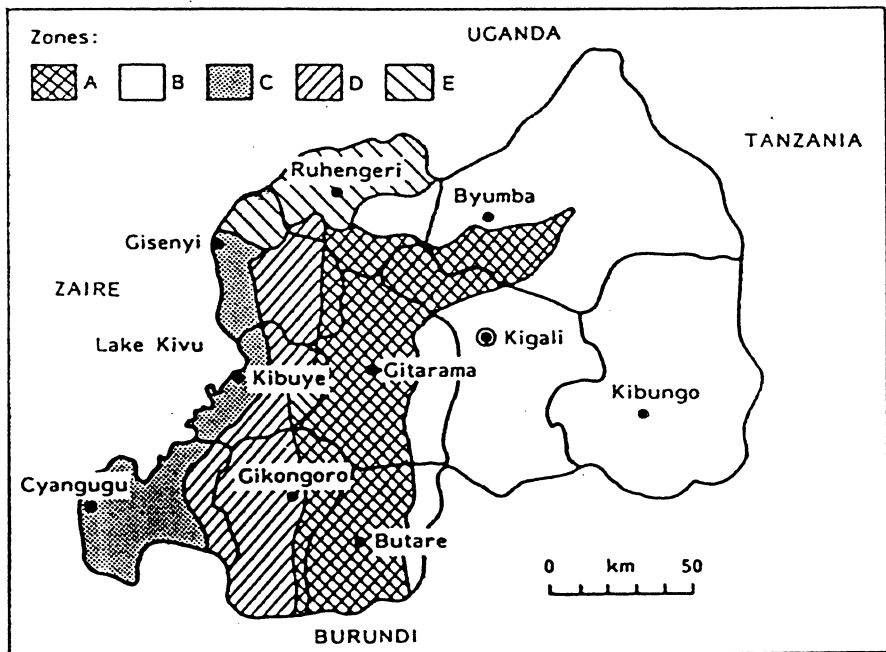
Source: Gillespie, 1989 based on Jones and Egli, 1984

There are major differences between the population density figures presented above (Jones and Egli, 1984) and a more recent AFRENA report (ISAR and ICRAF, 1988a). The AFRENA report shows population density figures for areas included in Zones A,C,E ranging from 300-400/km², and in Zone D as being about 150/km². Part of the discrepancy lies in the utilization of different criteria in defining the zones. The AFRENA report focuses on the high potential highlands, *ie.* those areas with over 1000 mm of rainfall and over 1500 m altitude, thereby excluding the Kagera Piedmont agroecological zone and the lower areas of zones A, C and E. Since the higher altitudes are more densely settled than the lower, this results in higher population density figures.

However, part of the discrepancy is also the result of the high growth rate, and the

reliance on different data sets collected at different localities and time periods. Given the high population growth rate of Rwanda, it can be assumed that the population densities are currently higher than reported by Jones and Egli (1984), and will continue to increase.

Figure 5.1
AGROECOLOGICAL ZONES



Source: Gillespie, 1989 (This figure was first published in *Land Use Policy*, Vol 6, No 4, pp 306, and is reproduced here with the permission of Butterworth-Heinemann, Oxford, UK.)

Since population densities are high, land is intensively worked. There is a general pattern of crops corresponding to altitude, but crops are grown above and below the optimal altitude. The major land use patterns of the agroecosystems are shown in table 5.2.

1.3 Tenure

Land tenure

After the successful uprising of the Hutu against the Tutsi feudal system, a new Constitution in 1962 created a new land tenure system. According to the Constitution and subsequent legislation, all land is state owned, but it is held and administered by the Communes (a unit that includes a number of villages, each with an elected headman who reports to the Commune's mayor, an appointed official). The Communes allocate land to individuals who have "exclusive usufruct rights rather than outright ownership" (Gibson and Muller, 1987:3). Farmers appear to feel secure in their landholdings and have been referred to as holding "title" to their land (Gibson and Muller, 1987; see also ISAR and ICRAF, 1988a and 1988b).

Table 5.2 Agroecosystems and land use patterns

Zone	Land use
A. High plateau	Land is intensively used; wet valley bottoms have been developed for dry season fields. Only fallow for uplands is dry season, only fallow for wet lands is during rains. Crops: beans, sorghum, sweet potatoes, cassava, banana, coffee.
B. Kagera piedmont	Cropping intensity less than Plateau; little wetland developed. More than seasonal fallow occurs. Crops: beans, groundnuts, sorghum, maize, cassava, banana, coffee.
C. Kivu lakeshore	As in High Plateau, except no wetlands to develop. Crops: beans, sorghum, sweet potatoes, banana, cassava.
D. Central Congo-Nile Divide	Cropping intensity is low and fallow is used to slow the further nutrient decline of the poor soils. Crops: peas or pole beans, maize, millet, wheat, sweet potato.
E. Volcanic highlands	Intensive land use with no fallow, smaller farms than Zone A. Crops: peas or pole beans, maize, millet, wheat, potato, pyrethrum.

Source: Jones and Egli, 1984; Gillespie, 1989

Agricultural use of the seasonally flooded valley bottoms in the High Plateau ecozone is relatively recent and reflects the growing pressure on the hillside farming areas. Land tenure of the swampland in the valleys is not as clearly delineated as the hillside areas. As more pressure is being exerted on upland fields, the flooded lowland areas are also being allocated to individual households by the Commune, but for more "temporary" use than the upland fields (Egger and Martens, 1987).

It is expected that individual households' rights to particular plots will become similar to land use rights on hillside plots. Although the flooded fields are small and seasonal, the soils are usually good (see above) and the amount of food harvested is important to the household (Jones and Egli, 1984).

Within the household, land tenure is based on the premise of equal shares in the family properties for each son. This leads to each generation having smaller farms than the previous one. As a result of this inheritance pattern a projected decline of almost 30 percent in the size of holdings is expected between 1987 and 2000 (Balasubramanian and Egli, 1986).

The Commune not only allocates land to individuals, but it is also empowered to allocate land for communal grazing areas and woodlots. There is an incentive for the Commune to allocate all the land under its jurisdiction, since land unassigned to either individuals

or communal use reverts back to the national government. Such land, however, can "be ceded to the Commune or individuals upon request" (Gibson and Mueller, 1987:3).

Legislation in 1987 required each Commune to produce a forestry management plan for all woodlots over 2 hectares in size. Permits are now required for cutting these woodlots, regardless of whether they are owned by the community, individuals or groups. Permits are only issued if the cut areas are scheduled to be replanted (Leach and Mearns, 1988). By giving more control and responsibility to the communes, the assumption is that management of existing forest and woodlots reserves will improve.

There appears to be no customary constraints on tree planting, although specific types of trees in particular places may be forbidden. Security in land tenure allows the farmer to plant trees; indeed, planting trees strengthens the claim on the land. Gibson and Mueller (1987:9) note that "Farmers have traditionally planted trees on their land and seem to recognize tree planting as a productive land-use function which strengthens title to land." The impact of legislation which requires a permit to cut down trees on woodlots over 2 hectares will have little impact on tree planting by farmers, since farm landholdings are well under 2 hectares, and woodlots are measured in square metres rather than hectares.

In summary, Rwandan farmers appear to have land security for their fields. Swampland is also coming under the control of individuals and is being integrated into a seasonal land use pattern. Communes have been given more control over local woodlots, but they must be used within the objectives of the national policy on woodlot management.

1.4 Economy

The economy of Rwanda is primarily agricultural, with little industrial production that is not related to agricultural processing and relatively small urban centres. Of the eight countries in the study area, Rwanda is grouped as one of the seven having a "low income economy" (see Table 5.3). Compared to the other seven countries, Rwanda ranks second to Kenya in per capita GNP.

Rwanda is dependent on the production of coffee and tea as its two principal exports for its foreign earnings. Rwanda is at a severe disadvantage in producing agricultural exports that are competitive on the world market: Rwanda is landlocked and it is 1800 km from the nearest port. Hence, it is dependent on the infrastructure of Kenya, Uganda, and Tanzania for most of its exports and imports. The roads in Tanzania are in extremely poor condition and impassable for days at a time. Kenya roads are in good repair, but the port of Mombasa is underequipped to meet current demands, so delays are common and port fees are expensive. Uganda is currently experiencing both petrol shortages and roads in need of repair (Sands, 1987).

As a result of these constraints, imported agricultural inputs such as fertilizer and pesticides are far more expensive in Rwanda than on the world market. Sands (1987) notes that a metric ton of fertilizer in Rwanda costs three times the world market price. This places Rwanda at a disadvantage in coffee and tea production, since other countries in the region are producing the same crops with lower transportation and input costs.

Table 5.3 Distribution of Gross National Product (1987)

Country	Agriculture (%)	Industry (%)	Services (%)	Per capita GNP (US\$)
Rwanda	37	23	40	301
Kenya	31	19	50	330
Uganda	76	5	19	260
Zambia	12	36	52	248
Burundi	59	14	27	241
Tanzania	61	8	31	180
Malawi	37	18	45	164

Source: World Resources Institute/UNEP/UNDP 1990

Transport costs also inflate the costs of food imports. Rwanda has to import food, primarily wheat, rice, sugar and dairy products (Isaie, 1989). The economy is not keeping pace with the population growth rate. Inflation is generally higher than GDP growth, and imports are at twice the level of exports (EIU, 1988).

1.5 Rural Sector

Rwanda is overwhelmingly a nation of rural dwellers. The settlement pattern is dispersed, with families living on their farms. Although in the past households could be quite isolated, currently, as a result of high population density and small farm size, dwellings may be quite close to one another. Informal networks exist within the community and these are reinforced by the exchange of banana beer. Banana beer is constantly traded between households, with payments being made in cash, kind, or just maintenance of friendship (Jones and Egli, 1984).

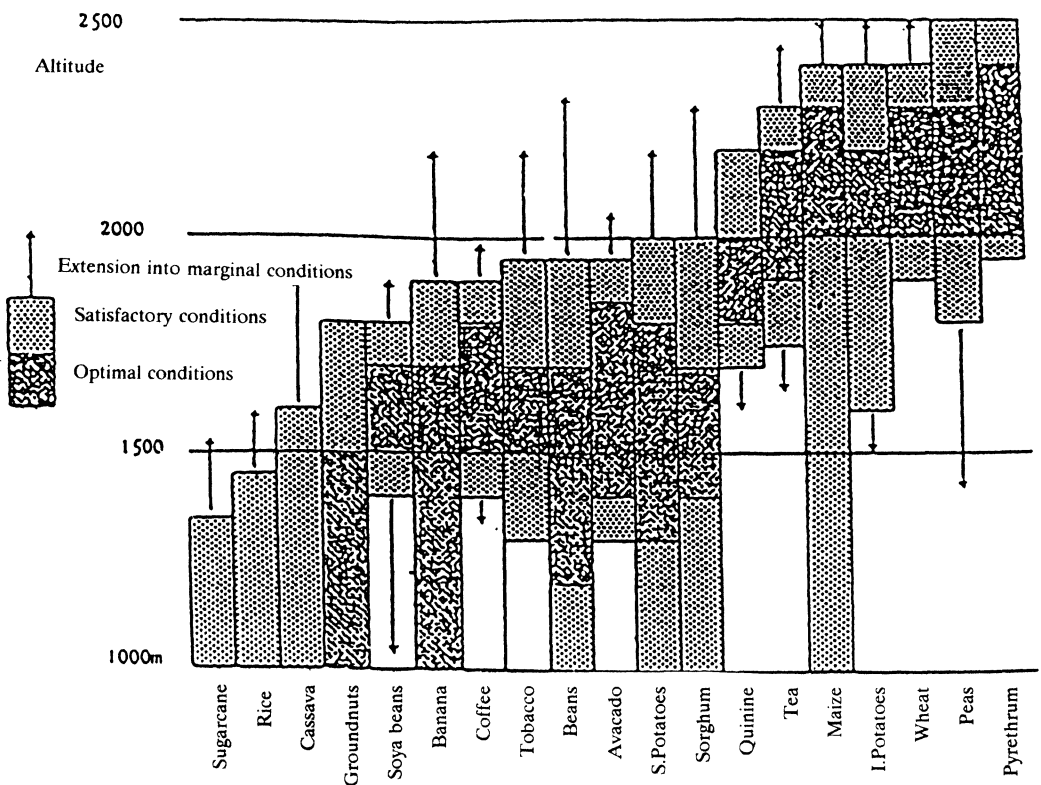
In 1982 the mean rural household size was estimated to be 4.5 persons (Balasubramanian and Egli, 1986 citing Delepierre, 1985). Women are head of 21.7 percent of the households. The majority of these women are widows, the remainder are wives of absent spouses (Gibson and Mueller, 1987 citing Service des Statistiques Agricoles, 1985). Educational levels in Rwanda are low; more than half of the household heads in one survey were reported as being illiterate (Gibson and Mueller, 1987). Land holdings are small and the current (1989) size of a household farm area is estimated to be about a little under 1 ha. (Isaie, 1989; see also projections of Delepierre, 1985 cited in Balasubramanian and Egli, 1986). As a result of the very high rate of population growth and an inheritance pattern that divides the farm equally between all the sons, farm size is expected to continue to decline.

Farm holdings usually consist of several plots. In areas where marshlands are used, households attempt to have access to "owned" plots on the hillside and "usufruct" rights to land on the valley bottoms. This, combined with the homestead land, will give a

household at least three plots of land, each with a different sequence of crops and activities.

Local adaptations to altitude and rainfall have resulted in variation both in the number and proportion of crops grown by farmers in Rwanda. Throughout the agroecozones, however, a farmer will usually plant a combination of crops which includes a legume, grain(s), root crop(s), and below 1800 m altitude, bananas in the fields. When farmers migrate from the High Plateau into higher altitudes or into the Piedmont and savanna, the crops which accompany them are commonly extended below and above the satisfactory and optimal attitudinal conditions into marginal areas (see Figure 5.1). Maize, for example, is widely grown in areas for which it is not really suited, and when planted at very high altitudes may take 6-9 months to mature (Hoekstra, 1988; ISAR and ICRAF, 1988a).

Figure 5.2
ALTITUDE RANGE OF CROPS IN RWANDA



Source: Hoekstra 1988 based on Delepierre 1982

Since farmers are encouraged to grow crops which can be exported, cash crops, such as coffee and tea, have also been extended into marginal areas. Export crops were introduced by the Belgians during the colonial period. The primary export crops of coffee, tea, cinchona, and pyrethrum currently make up less than 5 percent of all Rwandan crop area (Jones and Egli, 1984). Coffee, the major export crop, was (and is) a smallholder-oriented rather than an estate-oriented crop.

Although they are not export crops, food crops or processed food crops such as banana beer are sold by the majority of the households. Since banana beer is made in large batches and does not store well, most households both brew and purchase beer. The cash from banana beer may be greater than that from other cash crops, but, as with the various beers in this region of Africa, money earned in the household from the sale of banana beer may be equal to the same household's purchase of banana beer (Jones and Egli, 1984). However, since women are the brewers and men the purchasers, sale of beers in east and southern Africa appears to serve as a mechanism to redistribute money within the household and between the sexes.

Labour

The small intensively worked farms place heavy labour burdens on the household. The great majority of Rwandan households are nuclear families. Given the age structure of Rwanda, about half of the household is under the age of 15. This high percentage of the young combined with the relatively small percentage of aged creates a high dependency ratio, with each active adult supporting at least one other person. The average Rwandan household of 4.5 members will, therefore, only have a labour force of 2.25 members for all of the household activities, both agricultural and domestic.

Women are responsible for food crops and food processing, and spend more time in agricultural and domestic work than men. Cash crops and livestock are the responsibility of men, although women will provide labour for cash crops (weeding coffee, picking berries, *etc.*) and children may assume primary responsibility for livestock, especially goats. Men do the plowing, while women do the seeding, weeding and harvesting. Children share the responsibility for collecting fuelwood and water.

There are agroecological zone differences in both the amount of gender-assigned labour and total household labour inputs. The greatest labour gender gap (difference in male-female labour) is found in the Volcanic Highlands. Since bananas and coffee are not grown in this zone the male workload is light while the female workload remains high. The gender gap in the Kagera Piedmont agroecological zone is much less, since both banana and coffee, "male" crops, are grown, therefore male labour inputs are correspondingly higher.

Unlike households in the other agroecozones, households in the High Plateau with wetland cultivation during the dry season, do not have an "off-season" since labour demands are high throughout the year.

Labour also has to be provided to the commune or sector. Every man and woman is required to provide 4 hours a week of voluntary labour ("umuganda"). Although voluntary in concept and implying community spirit fervor, participation is enforced

albeit not terribly effectively, by the Commune authorities.

(Sources: Gillespie, 1989; Jones and Egli, 1984; Mueller, 1988; Balasubramanian and Egli, 1986)

Credit

Credit is available from the Banque populaire which has 61 branches dispersed through the country. Cooperatives also provide credit to their members. The credit needs of the small farmer are perceived as being "weak", and it is unclear what portion of farmers makes use of the credit facilities, and how credit is utilized (ISAR and ICRAF, 1988a).

Fuelwood

Fuelwood is perceived by the government and agencies as being a major problem in Rwanda. The clearing of forest for more farms and resettlement projects, the fuelwood needs for Kigali, and the ever growing number of rural households have resulted in a sharp decline in total forest area and the degradation of existing forest (see case studies below). Reforestation programmes have not been notably successful. The Forestry Service has a very small staff which traditionally has been involved in forest protection rather than reforestation.

1.6 Government policy on land use, crops and trees

The government has recognized the constraints imposed by high population densities, small farm sizes, poor infrastructure, and the financial inability of the government to underwrite major technological changes that would require imported inputs in the farming system, and hence government policy has focused on the objective of food self-sufficiency within the context of the smallholder producer. To obtain this objective, it is recognized that the smallholder will have to modify current farming methods, and certain inputs will have to be made available to the farmer. Specifically these include:

- Interventions to help prevent soil erosion.

- Utilization of manure, compost and chemical fertilizer.

- Utilization of improved seeds.

- Development of the marshlands (lowland areas which are seasonally flooded, similar to the dambo's of Zimbabwe and Zambia).

- Increase agriculture production so that imports of food will not be necessary.

In order to accomplish these goals the Ministry of Agriculture, Livestock and Forests has developed an integrated and focused approach (Isaie, 1989). Forestry has, for example, gone beyond National Arbor Day (when everyone is supposed to plant at least one tree) and forest conservation, and now provides support for the government's objective of food self-sufficiency. Forest policy promotes agroforestry and expands the role of reforestation to include both the production of wood and soil conservation (Isaie, 1989).

Increased tree planting on farms is strongly linked by the government and development agencies to soil conservation. Soil erosion is regarded as being one of the primary problems in crop production and the sustainability of the farming system. The government, since 1982, has attempted to increase national awareness of the soil

degradation problem and has increased efforts to encourage farmers to adopt techniques which would improve "erosion control, soil improvement, production of compost and tree planting" (Wanjama *et al.*, 1988:4).

Trees are promoted as a major means of reducing water run-off, recycling leached nutrients, contributing to humus/compost, and providing food and fodder. The goal of the forestry policy is to integrate trees into a sustainable farming systems based on intensively worked fields and livestock, which would not need expensive imported inputs (Isaie, 1989).

With the inclusion of agroforestry in forestry policy, there has been an expansion in the number of tree species offered so as to include not just the usual forest species (essences forestieres classiques), but also agroforestry species (species chosen for forage and fuelwood) as well as fruit trees. The current goal is to have a seedling nursery for every 5000 people. Prior to the shift in policy the number of tree species offered by government nurseries (which are dependent on voluntary labour, umuganda) was very limited. *Eucalyptus* spp., cypress, *Grevillea robusta*, and perhaps avocado and guava, were the primary species available (Gibson and Mueller, 1987). Although the number of available species was small, seedlings from the sector nurseries were, and are, free.

On-farm research focusing on the problems of the farmer is the new approach advocated by the government. The "ecofarming" approach and extension activities developed by GTZ in Nyabisindu appear to be serving as a model for encouraging farmer involvement in the development of new methods and the adoption of new crops, trees, and farming techniques.

If the government's objectives are met and farmers plant more trees for different purposes in different sites on their farms, it is projected that there will be improvements in soil conservation, increased fodder to sustain livestock production, more fuelwood will be collected from village woodlots and on farm trees rather than forests, and a more varied and nutritious diet for the smallholder will evolve.

Government policy in the past has been to discourage the integration of other crops, including tree crops, with coffee. Unlike the highlands of Tanzania, where banana and coffee are integrated into the Chagga fields (Fernandes *et al.*, 1984), the Rwandan policy has been to have monocrop coffee fields. The current policy has not expanded to include a shift to multicrop coffee fields. Even if food crop yields were increased, Rwanda is too dependent on coffee earnings to risk a decline in yields.

Government interventions

Interventions have primarily been through programmes of international agencies, usually in collaboration with ISAR or under the sponsorship of government ministries. The small number of personnel in the ministries (Kleinart, 1985:97, notes that the Forestry Service in 1981 consisted of "nine forestry engineers and eleven technicians for the whole of the country") has encouraged the Rwandan government to invite agencies to assist in developmental projects. The ISAR/IITA FSR Program in the BGM region and the CARE project which works closely with the Ministry of Agriculture in Gituza are examples of such programmes.

The government encourages the planting of community forests for fuelwood and timber throughout the country. National Arbor Day, an annual event when each Rwandan is expected to plant at least one tree, has also been successful in increasing awareness of trees and their benefits. Unfortunately, survival rates of the trees planted on Arbor day is estimated to be less than twenty percent (Gibson and Mueller, 1987).

In the past, reflecting the few tree species available from government nurseries, *Eucalyptus* spp., cypress, and *Grevillea robusta* were planted in reforestation areas and woodlots, and on National Arbor Day.

Current programmes are expanding the number of tree species which are available to Rwandan farmers. Many of the programmes are engaged in on-farm testing of new trees, shrubs, and grasses. There has been a marked increase in the diversity of trees which are being integrated into Rwandan farming systems. The training of personnel by the development agencies has strengthened the government's capacity to provide better extension services.

Small farmers and trees

Small farmers in Rwanda are planting trees. Fruit trees are the most common planted trees, but trees are also planted for shade, poles, and fuelwood. Farmers favour multipurpose trees, even if the purposes for which they utilize the trees are not the ones originally envisioned by the designers of the projects. The Farming Systems Research Program (FSRP), for example, promoted agroforestry species such as *Sesbania* spp, for erosion control and soil improvement. The majority (95%) of the farmers in the project, however, utilized the trees for stakes for beans (Yamoah, Eylands, Ndiaye and Thomas, 1990; Yamoah n.d.).

Farmers also manage and protect trees which regenerate naturally on the land. *Markhamia platycalyx*, for example, is grown by farmers in the banana fields. It grows well under partial shade and is not perceived as having a negative effect on the growth of the banana plants. *Markhamia platycalyx* "coppices readily and provides firewood, as well as construction and carpentry wood" (Mueller, 1988:4). The Planting of *Markhamia* in banana fields is culturally prohibited, but protection and utilization is encouraged.

2. Agroecological zone analysis

2.1 Kagera Piedmont

Definition of zone

Rainfall is between 750 - 1000 mm with a pronounced dry season of 4 months or more (June to September). There is a bimodal rainfall pattern with the short rains from October to November and the long rains from February to May.

Altitude is between 1200 m and 1800 m. This includes areas in BGM which are outside the altitude range (1400-1550 m) used by Jones and Egli (1984) for the Kagera Piedmont, but most of area of the case studies is within the altitude range and the land

use system is similar throughout.

In the BGM region there are four main soil types, each of which is associated with a specific terrain (see Table 5.4).

The natural vegetation of the agroecozone is natural savanna woodlands. Variation in species and density of trees stands is "mainly a function of different soil types" (Balasubramanian and Egli, 1986: 274).

Table 5.4 Soil types in the BGM region

Soil type	Location	% site	Quality
Raw mineral soil (Entisols)	Hill-tops, eroded steep slopes, exposed hard-pans	30	Too shallow for cultivation
Tropical black clays (Vertisols properties)	Valley bottoms, low lying areas	5	Chemically rich but poor physically
Tropical brown soils (Inceptisols)	Four hills and lower slopes	5	Excellent potential for agriculture
Ferruginous and ferrallitic soils (Oxisols, Ultisols, Alfisols)	Plateau and mid and lower slopes	60	Fair to medium agricultural; highly variable

Source: Balasubramanian and Egli, 1986

Case studies: BGM region and Muyaga commune

Location

There are two case studies for this agroecozone. The primary case study is the Bugesera-Gisaka-Migongo (BGM) region in the southeastern Rwanda, the site of the ISAR/IITA FSR Program. The other site, for which the data is less comprehensive, is the commune of Muyaga to the southwest of the BGM region (see Figure 5.2).

(Primary Sources: Balasubramanian and Egli, 1986; Pinners and Balasubramanian, 1990; Hummel, 1985.)

Population

The population of the case studies is about 95 percent rural and lives in nuclear family households. Settlement pattern is of homesteads "scattered over the plateaux and hills" (Balasubramanian and Egli, 1986:274). The family size in the BGM region was 6.2 members in 1983, larger than the national average family size of 4.5 persons. It is interesting to note that in 1989 a study of two sites in the BGM showed a larger family size of 7.4 and 8.6 for the respective sites (Pinners and Balasubramanian, 1990).

Whatever the size of the family, the age structure is young with only 50 percent of the population between the ages of 15-59. A family of 6.2 members will, therefore, only have

3.1 active workers.

The Piedmont agroecozone is an in-migration area. The Muyaga commune, for example, was a resettlement community started in 1950 which included coffee farming as part of the project.

Land and tree tenure

Male farmers have permanent land use rights. Although all Rwandan land is officially "owned" by the state, farmers regard themselves as owning their land, especially since the land is inherited by their sons with no interference by the state. Tree planting, since it is done on land recognized as theirs, reinforces these rights.

It is unclear what rights would be given to either the tree or the land if a tree was planted at a place in which the farmer had no recognized rights. Community woodlot and reforestation projects are on commune land, not individual farmer's landholdings, and labour is provided by umuganda; voluntary labour which is provided by each adult.

Land use system

The Kagera Piedmont is a target area for migration. Migrants entering the BGM region and Muyaga commune find more land available for farms than in their natal areas. The average farm size is almost twice the national average and commune areas are still available for grazing.

Each household has 2-3 parcels or plots of land. The ideal is for a family to have plots both on the plateau and the valley bottoms. "About a third of the land is in the homestead and its close vicinity"(Balasubramanian and Egli, 1986:283). In the BGM different crops are grown in the different plots. In the homestead the important crops are coffee, banana, beans, groundnut, maize and sorghum. In the more distant plots crops such as cassava, sweet potato, sorghum and fodder grass are grown which require less intensive care.

In the BGM region banana is the principal crop. Bananas are sold as well as processed into beer for home consumption and neighbourhood sale. Several types of banana (beer, cooking and fruit) are planted in mixed stands. Reflecting their importance as a staple, banana is planted on the better watered areas with the deeper soils, mulched, and given preferential application of manure and compost. Since bananas are usually intercropped, those crops planted in the banana plots also benefit.

A common pattern is to intercrop banana with beans, groundnuts and maize for both rainy seasons, and sorghum during the long rains. Other crops such as sweet potato, cassava, colocasia, pineapple, vegetables, etc., may also be planted under banana. Banana plants are pruned so as to open up the canopy for the crops planted below.

The result of maintaining trees and intercropping, is a form of vertical stratification in the banana fields. The highest level (greater than 6 m) is composed of tall trees (*Acacia* spp., *Maesopsis eminii*, *Ricinus communis*), then banana (3-4 m), cassava and sorghum (2-3 m), and low-growing food crops (0-1 m).

Coffee is the important crop produced only for sale. Unlike other plots, coffee plots are monocropped; the Rwandan government, concerned that intercropping will result in interspecies competition and reduced coffee yields, prohibits coffee intercropping.

Income and expenditures

Cash is earned through the sale of food crops, processed food (banana beer), salary and wages, coffee, livestock, and off-farm income (see Table 5.5).

In the BGM region it is estimated that 45 percent of food products produced and 100 percent of the coffee are sold. The high percentage of food products sold implies an agricultural system that is providing far in excess of a household's subsistence needs.

Table 5.5 Bugersera-Gisaka-Migongo (BGM) Region Household Income

Source of income	Percentage of total income
Banana	38.3
Other food crops and products	13.9
Salary and wages	28.4
Coffee	11.7
Livestock	5.2
Other off-farm income	2.5

Source: Balasubramanian and Price, 1983 cited in Balasubramanian and Egli, 1986: 280

Comparable data on expenditures is not available. Little expenditure is made on farm inputs, since farmers use locally available inputs (manure, crop residue, compost, own seed *etc.*). Farmers in the BGM area "neither apply chemical fertilizers nor use tractors for food crop farming" (Balasubramanian and Egli, 1986: 283). If farmers did want to invest more in agricultural inputs, the small amount of cash available and the limited credit facilities serve as a constraint.

Tree component

The indigenous forest in the area has "almost disappeared due to conversion to agricultural land by the increasing population and charcoal production for the country's capital" (Balasubramanian and Egli, 1986: 275). Trees have been integrated into the farming system, but the trees planted on the homesteads and cultivated areas are primarily fruit and fodder trees, rather than fuelwood and timber.

In a study of trees on small farms in the BGM region in 1983, it was found that about 86 percent of the households had fruit trees. The most important were papaya (*Carica papaya*) and avocado (*Persea americana*), with guava (*Psidium guajava*), jack fruit (*Artocarpus heterophyllus*), citrus (*Citrus* spp.), mango (*Mangifera indica*), and passion fruit (*Passiflora* spp.) also being planted. An average of nine fruit trees were planted by each household. In 1988 the number of fruit trees per household had more than doubled (see

Table 5.6) (Pinner and Balasubramanian, 1990).

Table 5.6 Trees planted per household

Site	Fruit			Non-fruit		
	% Household	No. of species	No. of trees	% Household	No. of species	No. of trees
BGM(1983)	85.7	7	9	n.d.	n.d.	n.d.
BGM(1988)	n.d.	7	16-21	n.d.	n.d.	n.d.
Muyaga	100.00	9	16	100.00	19	6

Sources: Balasubramanian and Egli, 1986; Pinner and Balasubramanian, 1990; Hummel, 1985

In Muyaga 100 percent of the households had planted avocado. Avocado was available in the past in some of the government nurseries. Avocado is a favourite tree since its fruit can be sold and pruned branches can be used for fuelwood (Hummel, 1985).

Other than fruit trees, farmers plant or maintain trees for shade around the homestead. In the BGM region castor bean trees are planted in banana fields and used to support heavy bunches of banana; the large leaves of the castor are used as a cover for sorghum fermentation.

Some farmers plant *Eucalyptus* spp. and *Grevillea robusta* on the areas of their landholding that are not suitable for crops. The species planted reflect what is available in the nurseries. In Muyaga 100 percent of the households have planted *Grevillea robusta* probably because seedlings are distributed before National Arbor Day (Hummel 1985). Even though the specific site may not be suitable for intensive cropping, when trees are planted they are initially intercropped with food crops. This intercropping is maintained for the first 2-4 years of the woodlot. The trees are lopped to allow food crops to receive light and water. The loppings are used for mulch and/or fuel. In 1983 in the Gisaka-Migongo area of the BGM region 16 percent of the farmers were reported to have planted woodlots with an area of 200m² (Balasubramanian and Egli, 1986).

Euphorbia tirucalli is used by most farmers in boundary plantings. It is fast growing and "highly resistant to drought and termites" (Balasubramanian and Egli, 1986: 288). In summary, households are planting trees and managing trees left standing on their fields. In the BGM region trees are planted in the homestead (fruit and *Ficus* spp., *Sesbania* spp.) along the roadside (*Cedrela serrulata*, *Cassia spectabilis*, *Grevillea robusta*), planted or managed in the banana fields (*Acacia* spp., *Maesopsis eminii*, *Ricinus communis*), or other fields (*Albizia* spp., *Erythrina abyssinica*, *Markhamia lutea*, *Solanum* spp., *Vernonia* sp.) and/or planted on property boundaries (*Euphorbia tirucalli*) (Balasubramanian and Egli, 1986:278).

Livestock component

Livestock, especially cattle, are highly valued. In the BGM region the average number of livestock per household is relatively high (see Table 5.7) given the size of farms. The communal grazing area and household fallow plots support 60 percent of the cattle and

a much smaller percentage of goats and sheep.

Table 5.7 Livestock

Type of animal	BGM Region		Muyaga Commune	
	Mean (per household)	% Stall fed	Mean (per household)	% Stall fed
Cattle	1.9	40	0.74	36
Goats	3.5	82	0.70	36
Sheep	0.4	67	n.d.	n.d.

Source: Balasubramanian and Egli, 1986: 281; Hummel, 1985

Although the amount of land available for farming in the BGM area is by Rwandan standards relatively plentiful, the area under pasture is declining and will continue to decline as more migrants enter the area and current residents form new families. Stall feeding is dependent on the availability of cut fodder and crop residues, which is in turn dependent on the farmers ability to increase his production of fodder and make effective use of crop residues.

The utilization of manure on agricultural fields varies in the region. Muyaga households, for example, have such a small number of animals that there is not sufficient manure for the fields.

Labour

As mentioned above, only about half of the household members can be classified as "active adults". Although cash income in BGM is cited as being used for hiring labour, it is unclear from the data how many households hire labour nor the activities for which hired labour is used.

As throughout Rwanda, women take care of the food crops and bananas and coffee are the responsibility of men. Gillespie (1989) presents data that suggests that in the Kagera Piedmont agroecological zone male contribution to household labour is higher than in the other regions, primarily because of the labour expended on banana, coffee, and livestock.

Perception of trees

Although little data is available that is specifically concerned with farmer's perception of trees, it can be inferred from their planting practices that tree planting/maintenance is valued. While fruit trees are, perhaps, the more favoured tree, other types of trees are planted or left standing in the fields. Pinner and Balasubramanian (1990) report that "all the farmers realize the need to plant other trees in their farms for the production of wood and/or fodder".

The study of Muyaga suggests that rather than perceiving the trees as a negative competitor with crops, the farmer is willing to accept a small decline in crop yields if

he gains increased wood and fruit production (Hummel 1985). The farmer also prefers multipurpose trees, which are perceived as more useful than trees only for construction or fuelwood.

Use of tree products

Trees are used for food, fodder, building materials and fuelwood. The objective of the ISAR/IITA programme was to improve soil fertility through mulch and green manure production. Although soil fertility is recognized as declining by the great majority of farmers, there is a preference to use the foliage of multipurpose trees for fodder and/or fuelwood.

Fodder is recognized by the farmer to be a problem, especially during the dry season. Community grazing land is shrinking in size, and farm size does not allow much land to be in fallow in any one year. In the semi-arid areas the lack of fallow and pasture (see Table 5.8) has resulted in fewer animals per household than in the sub-humid areas. Throughout the region households have had to take a more active role in the production of fodder. Farmers are planting not only fodder grasses, but also trees and shrubs on bunds and borders which can be used for fodder.

Table 5.8 Farm land use

Site	Rainfall(mm)	Percentage of farm area under:					
		Crops	Fodder	Pasture	Fallow	Woodlot	Fruit trees
Subhumid	> 1000	65.3	5.8	7.2	9.3	12.4	21
Semiarid	700-900	84.3	1.9	4.2	5.9	2.7	16

Source: Pinners and Balasubramanian, 1990

Fuelwood is also recognized as a problem by households in the BGM region. The semi-arid areas of the region have the more severe problems since a larger percentage of the landholdings are under crops and less than 3 percent of the available land is devoted to woodlots. In the semi-arid areas fewer fruit trees are grown, and the households have less pasture for livestock (see Table 5.8). Although the subhumid areas can provide more fuelwood on-farm, throughout the region other sources of fuel must be found. A combination of farm residues and collected and/or bought off-farm fuelwood is the energy strategy of households in the region.

A higher percentage of households in the semi-arid areas report fuelwood problems (see Table 5.9), but fewer households buy fuelwood and substitute crop residues than their counterparts in the subhumid zone.

In Muyaga although women and children collect most of the fuelwood, men also help. Hummel notes that the consumption of fuelwood does not equal the actual family requirement (estimated as 15 kg. per family per day). If a family cannot gather enough from the farm or surrounding area, then fuelwood is bought or, more commonly, crop

residues are used.

Table 5.9 Fuelwood

Site	Woodlot area (ha.)	% households reporting problems	% farms buying fuelwood	% farms searching fuelwood	Search time hours/week
Subhumid	0.124	54	21	21	8.9
Semiarid	0.027	90	7	28	10.6

Source: Pinnars and Balasubramanian 1990

The substitution of crop residues for fuelwood is regarded as having a negative impact on soil fertility, the improvement of which is one of the major, if not the major, goals of the programmes in the region. The programmes in the region expect the competition for crop residues for compost, mulch and energy to decline as more trees are integrated into the farming system.

Stakes for bananas are among the most important other wood uses in the region. Stakes are made from *Cassia* spp., *Eucalyptus* spp., castor, *markhamia lutea*, *grevillea robusta* and *Ricinus communis* (Balasubramanian and Egli, 1986; Hummel, 1985).

Interventions in support of tree growing

The ISAR/IITA FSR Programme is operating under the premise that although the current land use system based on intensively worked fields, intercropping, and mulching is basically sound, a new improved system must be developed to meet the challenges of the future. The new system that is being developed is based on the current intensive organic farming methods, and research on alley cropping, planted fallow, improved livestock, community forestry and woodlots, and boundary planting.

In 1983 in the BGM seedlings were available to farmers from "10 to 15 nurseries per 60,000 inhabitants funded by the Government and development projects" and considered adequate for the demand (Balasubramanian and Egli, 1986: 275). However, in 1990 it was reported that the community nurseries were "not able to meet the demand of all the farmers" (Pinnars and Balasubramanian, 1990). This implies that the nurseries were not operating as well as expected, and/or that nursery production could not keep up with increased demand.

Preferred species for tree planting

Pinnars and Balasubramanian (1990) report not only an increase of fruit trees on BGM farms, but also an increase in the number of households planting multipurpose trees. Preferred species, reflecting the increase in the number of tree species available, currently include *Leucaena leucocephala* and *Cassia spectabilis*. In the drier areas of the BGM region farmers are planting "more *Cassia spectabilis* than other species, because it resists the termite attack common in the drier areas"(Pinnars and Balasubramanian, 1990: 8).

The great majority (87%) of the respondents in the Pinner and Balasubramanian survey had been involved in on-farm testing of the FSR project technologies. Since the respondents were actively involved with the project, the survey results reflect the impact of project intervention rather than changes which have occurred throughout the region.

The survey does show, however, that the farmers who had been involved in on-farm testing were interested in planting multipurpose trees, but for fodder and fuelwood, rather than for soil fertility. Although soil fertility improvement was one of the main objectives of the project and current government policy, the farmer, while recognizing declining soil fertility, utilized the trees to provide fodder and fuelwood.

2.2 High Plateau

Definition of zone

Rainfall is between 1000 - 1250 mm and is in a bimodal pattern with a dry season during June, July, and August.

Altitude is between 1500-1900 m in Nyabisindu and 1450-1890 m in Gituza Commune. In Gituza there is a pattern similar to the BGM region of specific soil types being found in association with location in the terrain.

In Gituza the pattern of soils is vertisols on the bottomlands, ultisols on the sideslopes, and inceptisols and entisols on the steeper slopes (Gibson and Mueller, 1987). A more general description of the soils in the Nyabisindu area stresses the shallowness and acidity of the soil (Neumann, 1983; Sands, 1987).

In Gituza the off-farm vegetation is degraded forests and grasslands. This higher population densities of the Nyabisindu area has resulted in the natural forest being replaced by grassland (savane herbeuse anthropique).

Case studies: Nyabisindu project, Gituza and Mugusa communes.

There are three case studies for this agroecozone. The two major case studies are Nyabisindu in the center of the Plateau, and the Gituza commune in the northeast near the Ugandan border. Nyabisindu is the site of the very well documented GTZ 'Project Agro Pastoral de Nyabisindu'(PAP) which began in 1965. Initially the PAP project focused on livestock and dairy production, but in 1975 the PAP objectives were redirected to "ecofarming" (ecologically sound small-farm production systems), reducing deforestation in the area, reducing soil erosion, and improving extension activities and information. Data are also presented from Mugusa, a commune near Nyabisindu, and the site of an agro-silvo-pastoral project (PIASP) which began in 1983 as an extension of the ecofarming strategy developed in the PAP project.

Gituza is the site of an innovative CARE project which began in 1985. A survey based on the conceptual framework of ICRAF Diagnosis and Design (D&D) provided baseline data which was used in the design of interventions for agroforestry extension.

(Primary sources: Sands, 1987; Zeuner, 1981; Neumann and Pietrowicz, 1985; Gibson and Mueller, 1987; Wanjama *et al.*, 1988.)

Population

Although within the same agroecozone, Nyabisindu and Gituza are very different communities. Nyabisindu is a long settled community in the most heavily populated area in Rwanda. It had a population density estimated to be 386 persons/km² in 1983. The surrounding communes also involved in the PAP project have population densities ranging from 236-342 persons/km² (MINAGRI/GTZ, 1983). Household size is about 5.7 members and is supported by an estimated household labour force of 2.7 members.

The Gituza commune is a migration target area which has one of the lowest population densities in Rwanda. As a target area, the population is increasing at a faster rate than the national average, but it is still one of Rwanda's least populated areas. The mean family size is about 6 persons, comparable to the household size of Nyabisindu, with a similar household labour force (Gibson and Mueller, 1987).

Land tenure

As throughout Rwanda, farmers have usufruct rights to their land holdings and these rights are passed from father to son(s). According to Gibson and Mueller (1987) "the majority of the [Gituza] farmers (83%) hold title to their land while most of the remaining 17 percent have customary use rights" (p.9). It is unclear what "title" is since only permanent usufruct is granted to the Rwandan farmer. Whatever the term used, usufruct rights appear to be secure, and farmers feel they "own" their land.

Tree tenure

See above in country description.

Land use system

There are differences in farm size between the two sites. In Nyabisindu farm size is smaller than the national average with 47.6 percent of the farms under 0.5 ha. (see Table 5.10).

In Gituza, household farm size is about 2.1 ha., twice the national average. Gituza is a newly settled area and there is more land available. However, farm size is already declining as new families are formed and more migrants arrive.

There is also a difference between Nyabisindu and Gituza in the number of farm plots (fields) per household. In the PAP project area about 50 percent of the households had 5 or more fields, in Gituza only 6.7 percent of the households had that many fields, the average being about two fields per household (Neumann and Pietrowicz, 1985; Gibson and Mueller, 1987).

The Rwandan ideal is to have more than one field, usually a homestead field and a "further" field and, when there are wetlands, a dry season field as well. Dispersed fields, perhaps with different crops, allow the farmer to make effective use of microenvironments and minimize risk. But five or more fields, as in the PAP area, create the pragmatic problem of how to manage the logistics of agricultural activities in widely

separate fields.

Table 5.10 Farm size

Farm size (hectares)	Nyabisindu (percent)	Gituza (percent)
< 0.5	47.6	n.d.
0.6 - 1.0	22.4	n.d.
Total: < 1.0 or less	70.2	32.1
Total: > 1.0	29.9	67.9
1.1 - 2.0	n.d.	28.3
2.1 - 3.0	n.d.	17.5
3.1 - 5.0	n.d.	14.6
> 5.0	n.d.	7.5

Sources: Sands, 1987; Neumann and Pietrowicz, 1985; Gibson and Mueller, 1987

Major crops in the High Plateau are bananas, beans, sweet potatoes, manioc and sorghum. In Gituza, maize is also an important crop, both for home consumption and sale. Coffee is grown by virtually all the farmers in the PAP area and occupies about an 1/8 of the farm holdings (MINAGRI/GTZ, 1983). In Gituza only 43 percent of the households were growing coffee, but the percentage will probably increase as settlers become more established.

The larger farm size in Gituza permits a more extensive land use system than in the PAP area. There is still land to fallow and the possibility of new land to clear. In the PAP area the small farm size has eliminated fallow fields, although the PAP has promoted the adoption of a year fallow with green manuring for a portion of the farm each year (increased yields more than offset the loss of the fallow area).

In Gituza, as throughout Rwanda, the age of farmer was associated with labour availability, more cashcrops, and more livestock. Since it is a migrant area, older farmers who had spent more time in the commune also had larger landholdings and their fields were in the more fertile areas.

Income and Expenditures

Gibson and Mueller (1987) note that in Gituza "pure subsistence farming hardly exists as 95 percent of the farmers sell at least one product" (p. 10). In the PAP area a similar high percentage of the farmers are involved in selling agricultural products, especially coffee and beans.

In Gituza (see below) a fairly large percentage of the households hire labour. However, it is unclear how much households spend on (or earn from) hired farm labour. It does imply that there is enough income generated to pay for extra labour.

Tree component

As in all of Rwanda, farmers in this agroecozone plant trees. In Gituzu 94.6 percent of the farmers surveyed reported planting trees. Trees were planted "on farm boundaries, around homesteads and in the fields. Woodlots are planted on hillsides and some planting takes place on agricultural land lying fallow" (Gibson and Mueller, 1987:12). The trees species planted reflect the species which were available before the CARE project began (see Table 5.11).

Table 5.11 Tree species planted

Species	Mean number	% of all respondents
<i>Eucalyptus</i>	313.9	80.0
<i>Euphorbia</i>	(hedge)	75.8
Avocado	4.9	59.2
Ficus	23.1	56.3
Markhamia	16.0	38.8
Papaya	3.6	38.3
Grevillea	6.1	34.2
Cypress	15.4	26.7
Erythrina	6.9	23.3
Black wattle	55.5	10.8
Guava	4.2	9.6
Dracaena		5.6
Mango		5.6
Vernonia amygdaline		5.6

less than 5%:

Citrus, Iboza riparia, Securidaca spp., Senecio stuhlmannii, Jackfruit, Rhizinus, Solanum, Callitris, Mulberry, Jacaranda, Pine

Source: Gibson and Mueller, 1987: 70

In the PAP area in 1983 about 80 percent of the households had planted one or more fruit trees. Neumann notes (1983) that Rwandan farmers were "unfamiliar with fruit tree cultivation", a finding that is not supported by studies in the BGM region and Gituza (see above).

In Gituza, Gibson and Mueller (1987) found that seedlings of indigenous trees are collected as "wildlings" or come from natural regeneration in the fields. The exotic species such as *Eucalyptus* spp., cypress, and *Grevillea robusta* are primarily from the sector nursery, but a large percentage of *Eucalyptus* spp. and *Grevillea robusta* were

collected as seedlings from natural regeneration on the farmer's fields. The majority of the seedlings of the exotics avocado and guava, also came from the sector nursery.

Although a large proportion of all farmers plant trees, farmers who have large landholdings and more than one plot, plant more trees than younger farmers, smaller households, those with smaller landholdings, those with only one plot, and/or those who have been farming in the Gituza commune for five years or less. Those farmers who have planted a larger number of trees, have usually done so in the form of a *Eucalyptus* spp. woodlot.

Gibson and Mueller (1987) suggest that the planting of woodlots reflects not only the greater resources of these farmers, but also the division of labour in Gituza. Men are generally responsible for planting and cutting trees. "Those farmers who obtain firewood from their own farms or have to cut trees for firewood have planted more trees than those who collect dead wood or get firewood from uninhabited land" (Gibson and Mueller, 1987: 13).

The implication is that a large household that has been living on their farm for more than five years will have exhausted the off-farm fuelwood supplies, especially dead wood, and will need to cut trees either on or off the farm. Since men are responsible for cutting down trees they "have a larger interest in planting trees than farmers whose wives collect firewood" (Gibson and Mueller, 1987:13).

Indigenous trees are often left on the farm during clearing. In Gituza "78 percent of the respondents have a total of 52 different indigenous trees and shrubs on their farms" (Gibson and Mueller, 1987:13). The primary use of the most common species is fuelwood. This is an interesting finding, for in Zambia, Zimbabwe, and Tanzania the trees most commonly left in the fields were for fruit, not fuelwood.

Livestock component

In Rwanda, livestock has not been fully integrated into the farming system. In a country of declining soil fertility, better utilization of manure, especially effective collection and storage, has become a development goal. In Nyabisindu the PAP project has been promoting the use of "specially built structures that conserve and compost animals manures and discarded feed" (Sands, 1987:36).

Table 5.12 Livestock Ownership in Gituza

Type of animal	% households with livestock	Mean/household	% Stall fed
Cattle	15.8	2.1	*
Goats	75.0	4.0	*
Sheep	12.1	2.2	*

* Only 29 cases of stall feeding were reported in the entire commune

Source: Gibson and Mueller, 1987

It is unclear how successful this has been, but Neumann (1983) has noted that animals are rarely kept in stalls and that the manure obtained is inadequate. In the BGM region, however, a fairly high percentage of farmers did keep animals in stalls, so an increase is likely to occur in the PAP region as well.

In Gituza, cattle are "grazed collectively on Commune pastures and State owned land" (Gibson and Mueller, 1987: 10), and goats and sheep are left to forage around the farm. Livestock management is still based on access to extensive areas of pasture, and there has been little movement into stall feeding. Pasture quality is low, since steep sideslopes which are used for pasture are covered by "a tough and unpalatable bunchgrass" (Mueller, 1988:2). It is not surprising that 28 percent of the farmers complained of shortages of fodder, either seasonal shortages and/or shortages created by insufficient land.

Labour

Labour shortages occur, especially during the peak periods of the agricultural cycle. In Gituza 25 percent of the households hire seasonal labour and 5 percent have full time hired labour. Gibson and Mueller (1987) regard households to be experiencing labour shortage and they stress the need to consider labour needs, especially already existing seasonal labour shortages, when promoting agroforestry and agricultural intensification.

This concern has also been expressed in the PAP project. Small intensively worked fields require large amounts of labour input. In the Nyabisindu area great amounts of time are spent travelling to the different fields. The more fields a household has, the more time is spent travelling from one to another, and less time is available for the actual agricultural activity.

Perception of trees

As noted above, there are cultural taboos which prohibit the planting of *Markhamia lutuea* in banana fields. *Markhamia lutuea* "volunteers" are left in the field and managed as one of the many plants intercropped in the field. It is unclear what is the cause of the prohibition (nature, ancestors, etc.), but it does not inhibit the planting of *Markhamia lutuea* elsewhere on the landholding as long as it is not a banana field.

Farmers are interested in planting more trees. In Gituza 87 percent of the farmers surveyed said they would like to plant more trees. Those who said they did not want to plant more trees cited lack of land or old age.

Use of tree products

In Gituza, fuelwood is not recognized as being a serious problem; only 27.8 percent of the farmers surveyed stated that fuelwood was scarce. Fuelwood is used for cooking, beer brewing and heating, but agricultural residues are also used by 67.9 percent of the households for beer brewing and 18 percent of households for cooking. This suggests that agricultural residues are readily used when fuelwood is not available. The responsibility for collecting fuelwood seems to be equally shared between men, women and children. "While men cut and split trees, women and children collect dead wood or cut branches off trees" (Gibson and Mueller, 1987: 11). As noted above, the responsibility of both cutting and planting trees has probably encouraged male awareness of fuelwood use and

the need to plant fuelwood trees.

Fodder is far more of a problem in the PAP area than in Gituza. The small fields and shortage of on-farm and off-farm pasture has led to overgrazing of available pasture and low livestock output. A large component of the PAP project is to increase fodder production and by stall feeding to develop an integrated farming system of crops and livestock (Neumann, 1983).

As noted above, although pasture is being degraded in the Gituza commune, only 27.6 percent of the farmers stated that there was insufficient fodder (Gibson and Mueller, 1987). In the evaluation of the CARE project in 1988, it was noted that some farmers (20%) were using *Leucaena* spp. and *Grevillea robusta* for fodder.

In the CARE project, 54 percent of the farmers were using tree products from trees planted since 1985. The major use of the trees was for fuelwood (41%), fruit (23%), fodder (20%), compost (9%), and poles (9%). However, the "techniques for improving soil fertility through the use of trees, (such as alley cropping; mulching with leaves from boundary hedges; incorporation of nitrogen rich leaves into the soil from single intercropped trees, etc.) are not widely practised" (Westwood, 1988:3). As with the BGM program, when farmers start to manage the trees, their first priorities are not soil fertility, but fuelwood, fodder, and in Gituza, fruit.

Interventions in support of tree growing

The PAP, PIASP, and CARE projects were all joint projects with government institutions such as ISAR or MINAGRI. These projects all had an agroforestry component and were promoting the increase of tree planting. The PAP project had five components concerned with trees: community afforestation, fruit tree programme, afforestation of roads, farm woodlots, and planting of trees in fields (Neumann, 1983). The community afforestation component used umuganda labour to reforest community managed areas, usually eroded hilltops.

The fruit tree programme distributes fruit trees, by 1983 it had distributed 5 million fruit trees, mainly avocado, guava, annona, and papaya. By 1981, 1,350 km of roadside had been planted with the support of the project. The species were *grevillea robusta*, *Cypresses lucitanica*, *Cedrela serrulata*, *Pinus* spp., ornamentals, and fruit trees. Farm woodlots are encouraged in the eroded areas of farms which can no longer be used for crops. Farmers are planting *Eucalyptus* spp. for their woodlots. The planting of trees in fields is linked to the government's promotion of erosion control. Much of the PAP research has been conducted on which trees, management strategies, etc., can be effectively utilized by the household when integrating more trees into the farming system.

A decentralized network of nurseries covering the project area support the multicomponent PAP tree program. In 1983, 75 nurseries were each producing 15,000 to 40,000 trees annually (Neumann, 1983).

The CARE project used information from the diagnostic survey to design the agroforestry extension activities. Fruit trees and a much larger number of other tree species were made available to farmers. The first year survival rate for the trees was 80

percent overall, a later evaluation found that after three years tree survival had dropped to 46 percent. Some species did markedly better or poorer than the overall figure reveals. While none of the *Maesopsis eminii* survived, and only 10 percent of the *Sesbania* and 8 percent of the *Callistris* spp survived, survival rates of over 60 percent occurred with avocado, Coeur de Boeuf, *Cupressus lusitanica*, *Eucalyptus camaldulensis*, *Grevillea robusta*, *Leucaena leucocephala*, and papaya (Gibson and Mueller, 1987; Westwood, 1988).

The PIASP project began in 1983 and is basically an extension of the ecofarming strategy which was developed by the PAP in the Nyabisindu area. Both projects share the main objective of improving degraded soils. Trees and shrubs are selected on the following criteria: "rapid growth, timber quality, suitability of leaves and fruits for food and fodder, as well as low competition with field crops for nutrients" (Wanjama *et al.*, 1988:22). An evaluation in 1988 reported that about 8.75 percent of all households in the project's area had adopted parts of each component (bush fallow, trees and hedges).

Preferred species for tree planting

Since there have been relatively few exotic species available to the farmer, preference for a species may be more a statement of familiarity with a tree, rather than a marked preference for the attributes of a particular tree. In Nyabisindu although the PAP was promoting species diversity, farmers preferred *Eucalyptus* spp., a tree with which they were familiar.

When asked what trees they would like to plant in the future, farmers in Gituza had a definite preference for fruit trees, especially avocado, papaya, citrus, and mango. The primary reason given for the desire for fruit trees was home consumption, but a small percentage of the respondents cited potential sale, especially of citrus. Non-fruit trees mentioned were *Eucalyptus* spp, *Grevillea robusta* and cypress, trees with which the farmers were familiar and which were available from the sector nursery.

Conclusions: Rwanda

Where are farmers planting or not planting trees?

In the Rwandan case studies, farmers were planting fruit trees around homesteads, and those trees that provided fuelwood, fodder, *etc.*, were planted on home boundaries, in woodlots, and in the fields. As with the other countries in the study region, fruit trees had a very important niche in the farming system. However, unlike Zambia and Zimbabwe, in Rwanda the trees were exotic fruit trees, especially avocado, rather than indigenous species or the ubiquitous mango.

The diversity of trees and the large number of trees planted is similar to the pattern of tree planting found in the highlands of Tanzania. The multistoried field, with trees planted and naturally occurring trees left standing (bananas, annuals, *etc.*), appears to be a highland adaptation to small fields, bananas, and relatively high rainfall.

The relation of the tree planting to security of tenure is probably important. The Rwandan farmer has very secure tenure of landholdings and knows that he will benefit from any improvements he makes on his property.

How does tree planting relate to ecozone, cultural traditions and values?

Although there is agroecozone variation in the amount of rainfall, altitude, *etc.*, the structure of the household and its landholdings are very similar throughout Rwanda. Nuclear families, small farms, dispersed settlements, banana beer, similar crops, *etc.*, occur in all the agroecozones. What appears to be an important variable in tree planting is not the ecozone, but the recognition by the farmer of a scarcity, especially fuelwood.

Until this recognition occurs, projects find it difficult to engage the farmer in planting trees for that purpose. Once the recognition does occur, and there is a desire for trees for whatever purpose, then the project can provide a wider variety of species and then the extension aid to educate the farmer on how to plant and maintain the desired trees.

Although the data mention that certain trees cannot be planted, *etc.*, there do not appear to be many species which are taboo, so such prohibitions should not hinder tree planting.

What incentives are there for tree planting?

There are several incentives for tree planting in Rwanda: fuelwood, fodder and stakes are becoming increasingly difficult to obtain, and the farmers are, therefore, becoming more interested in planting trees which will fulfill their needs.

However, what the government and development agencies perceive as the incentives, and what the farmer perceives as the incentives need not be one and the same. The government does, and should, take a long-term view of the future needs of farmers and the country. The farmer is, perhaps, more concerned with the household's immediate needs. For example, while recognizing the need for soil improvement, the farmer might have a stronger immediate incentive to use a tree for stakes than for green manure.

How does tree planting by farmers relate to government efforts and extension attempts to promote tree planting?

The multistoried banana field was an indigenous effort rather than government promoted. The government and development agencies have made a concerted effort to build upon the existing land use system. The case studies illustrate that the projects have been effective in expanding the options for the farmers in trees and techniques. The projects appear to be flexible enough for a farmer to make use of the various trees and techniques to fit the needs of his household, rather than the goals of the project. This combination of the indigenous systems and the projects has had a real impact on tree planting in the communities.

An additional benefit to the communities has been the increase in trained extension personnel. Rwanda has a crucial shortage of educated development-oriented staff. The projects have been training extension workers and producing training material that can be used throughout the country in the training of extension staff and farmers.

3. Rwanda Summary

1. Although tree planting by farmers has been successful in the project areas, the uses of the trees which are being promoted may not be the ones that the farmer finds relevant. Soil conservation and improvement do not appear to be as important to farmers as fodder, stakes and fuelwood.
2. There is a need to expose the farmers to new species and to give more training to farmers in how to take care of these species. Survival rates for new species are lower than species for which the farmers are familiar, which implies that more extension is needed (or that the species are less well suited to the site).
3. Farmers are planting many types of trees and are interested in planting even more in the future.

6. COUNTRY REPORT: BURUNDI

1. General information

1.1 Background

Population

The population of Burundi is estimated to be almost 5,000,000 and is growing at approximately 3 percent a year (Besse and Nzojibwami, 1990:1). Over 90 percent of the population resides in rural areas. The national average population density is 180 person/km², but there is great variation within the country with some areas having a population density as low as 50 km² or as high as 1000 km². Population densities are higher in the highlands and lowest in the piedmont areas.

The population is a young one with 55 percent under the age of 20. There are two internal migration streams, from rural to urban areas and from the rural plateau to the rural piedmont. Until recently there had been government restrictions on rural-urban migration, currently, however, there is migration, predominately male, to Bujumbura and other urban areas such as Gitega. The Bujumbura sex ratio of 127 (127 males to 100 females) reflects the high proportion of men who have come to the city in search of wage paying jobs. Rural to rural migration is from areas of high population density to those of relatively low population density (Besse and Nzojibwami, 1990).

Burundi and Rwanda are the most ethnically homogeneous countries in the region. In Burundi about 85 percent of the population is Hutu, most of the remainder is Tutsi, except for a small number of Twa. The Tutsi were the ruling group when Burundi was a kingdom and it has been the dominant group since Burundi became a republic in 1966 (Besse and Nzojibwami, 1990).

Topography

Burundi is a land of hills and mountains. The Plateau is cut by innumerable streams which create a landscape of steep sided hills and wetlands in the valleys.

Climate

The rainfall pattern is bimodal with rainfall peaking in April. The driest period occurs from June to July. The short rainy season from October to December is more variable and less certain than the longer rainy season of February to May.

Vegetation

The natural vegetation has been degraded to the point where there is little forest cover except in the highest elevations. The forests, both natural and planted, only cover 5 percent of Burundi. The species varies depending on the particular ecozone. In the High Plateau, for example, much of the forest is planted in *Ficus* spp. and *Eucalyptus* spp. (ISABU and ICRAF, 1988).

Soils

Although there is local variation, in general the soils of Burundi are well drained with good structure, but they are infertile and because of current land use patterns eroded. Some areas, such as the Congo-Nile Divide and Bututsi (see below), have highly acidic

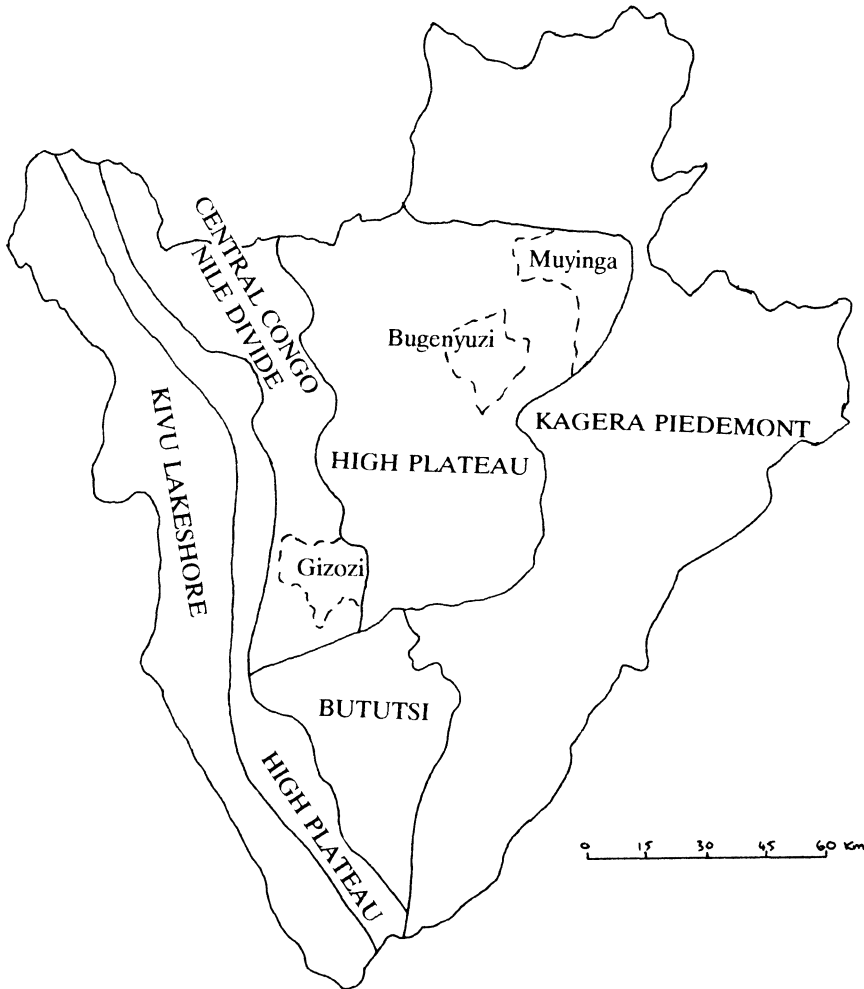
soils with aluminum toxicity (ISABU and ICRAF, 1988; Jones and Egli, 1984).

1.2 Agroecological zones

Burundi and Rwanda are both within the African Great Lakes Highlands and share similar agroecological zones. The zonal differences which occur are the Volcanic Highlands of Rwanda, and the Bututsi zone in Burundi. Almost all (85%) of Burundi is within the AFRENA highland zone, an area designated as between 1000-2500 m above sea level with more than 1000 mm of rainfall per year (Jones and Egli, 1984; Hoekstra, 1988).

A World Bank study (Jones and Egli, 1984), supplemented by ICRAF's work on the highlands of east and central Africa, is used as the basis for the discussion of Burundi agroecosystems (Hoekstra, 1988). (See Figure 6.1 and Table 6.1).

Figure 6.1
BURUNDI: AGROECOLOGICAL ZONES



Source; Jones and Egli, 1984.

Table 6.1 Agroecological Zones

Zone	Rainfall (mm)	Altitude (m)	Area (% Country)
A. High Plateau	1000 - 1200	1550 - 1800	23
B. Kagera Piedmont	850 - 1000	1400 - 1550	42
C. Kivu Lakeshore	1000 - 1200	1400 - 1800	13
D. Central Congo-Nile Divide	1400 - 2000	> 1800	16
E. Bututsi	1300 - 1500	> 1800	6

Source: Jones and Egli, 1984

The major land use patterns of the agroecological zones are:

Table 6.2 Agroecological Systems and Land Use Patterns

Zone	Description
A. High Plateau	Land is intensively used; wet valley bottoms have been developed for dry season fields. Only fallow for uplands is during dry season; only fallow for wetlands is during rains. Crops: beans, sorghum, sweet potatoes, cassava, banana, coffee.
B. Kagera Piedmont	Cropping intensity less than Plateau; little wetland developed. More than seasonal fallow occurs. Crops: beans, groundnuts, sorghum, maize, cassava, banana, coffee.
C. Kivu Lakeshore	As in High Plateau, except no valley wetlands to develop. Crops: beans, sorghum, sweet potatoes, banana, cassava.
D. Central Congo-Nile Divide	Cropping intensity is low and fallow is used to slow the further nutrient decline of the poor soils. Crops: peas or pole beans, maize, millet, wheat, sweet potato.
E. Bututsi	Cattle raising is the principal economic activity. During the dry season (June to September) cattle are transhumed to Mosso or Imbo. Wetlands not developed, population absent during potential dry season cropping. Crops: peas, potato, coffee.

Source: Jones and Egli, 1984; Gillespie, 1989

1.3 Tenure

The tenant system which existed prior to 1976 was changed by legislation, so farmers were able to acquire rights to land which they had previously farmed. These rights are inherited by their sons. Although land can also be acquired by purchase, leasing, or through commune distribution, much of the land held by the great majority of the farmers has been inherited. It is a usufruct system, for if the land is not farmed the rights to it end and the land becomes available for Commune distribution.

In areas which are dependent on livestock, such as the Bututsi agroecozone, the right to pasture are based on the colline, *eg.* the residents of a colline [literally, hill] have rights to certain areas for pasture with each colline having its own pasturage.

Recent legislation in 1986 has clarified the rights to the wetlands (marais). The person who develops a field in the wetlands now has usufruct rights to the plot, rather than the person who has a field adjacent to the marais.

In summary, Burundi farmers appear to have secure usufruct rights for their fields. The concept of labour investment and rights to upland (itongo) and wetland (marais) fields has been utilized to formulate a land tenure system that rewards land development with security of tenure.

1.4 Economy

The economy of Burundi is primarily agricultural, with little industrial production that is not related to agricultural processing. Of the eight countries in the study area, Burundi is grouped as one of the seven having a "low income economy" (see Table 6.3). Within these seven countries, Burundi ranks 5th, with only Tanzania and Malawi reporting lower per capita incomes.

Table 6.3 Distribution of Gross National Product

Country	Agriculture (%)	Industry (%)	Services (%)	Per Capita GNP (US\$)
Kenya	31	19	50	330
Rwanda	37	23	40	301
Uganda	76	5	19	260
Zambia	12	36	52	248
Burundi	59	14	27	241
Tanzania	61	8	31	180
Malawi	37	18	45	164

Source: World Resources Institute/UNEP/UNDP, 1990

There was no per capita income growth in Burundi from 1984-1987, and slightly negative growth in 1981-84. IMF support in 1986 and increased financial support by donors has helped "in maintaining overall levels of investment and expenditures" (Schlesinger *et al.*, 1989:3). There was an increase in GDP in 1988 of about 3.7 percent, but since the population growth rate is an estimated 3 percent a year, per capita income grew only slightly (Schlesinger *et al.*, 1989).

The Burundi economy is dependent on the export of coffee for the largest part of its export earnings. Coffee production and export accounts "for 80-85 percent of the total value of exports, about 30 percent of farm cash incomes, and a substantial portion of government revenues" (Schlesinger *et al.*, 1989:4). Other exports are tea, cotton fabrics and bottles (EIU, 1988). Burundi is at a severe disadvantage in producing agricultural exports that are competitive on the world market. Burundi is landlocked and is dependent on the infrastructure of Tanzania, Kenya, and Uganda for most of its exports and imports. Unfortunately the infrastructure of Uganda and Tanzania are in extremely poor condition, and while roads in Kenya are in good repair, the facilities of the port of Mombasa are overextended, hence delays are common and port fees are expensive.

The World Bank is Burundi's largest external creditor and "continues to mount the most ambitious assistance programs" (Schlesinger, 1989:6). The Rural and Agroforestry Nursery Sector of the World Bank-Fonds d'Aide et Cooperation Reforestation Project operate agricultural development projects in two-thirds of the country (Besse and Nzojibwami, 1990).

1.5 Rural Sector

Burundi is a nation of rural dwellers, with over 90 percent of the population residing in the rural area. The rural household, referred to as the *rugô*, is based on the nuclear family and usually includes one husband, one wife, and their children who are still residing with them. The life cycle of the family may create a household which includes for brief periods newly married children or for longer periods aging parents who can no longer maintain themselves. The head of the household is the husband, a woman is only considered to be household head if she is widowed or has been abandoned by her husband. About twenty percent of Burundi households are female headed. There is regional variation, with areas such as the Butusi having a higher percentage (25%) of female households (Adelski and Rosen, 1990).

A study in 1982 found household size to be, on the average, about 4.5 persons. The regional variation on this average was small, with a range of 4.13 to 4.92 (Rep. du Burundi, 1982 cited in ISABU and ICRAF, 1988). A more recent study in the High Plateau agroecological zone (Bugenyuzi) revealed a larger household (5.1), while a nationwide survey in 1988 found the average household size to be 5.4 (Adelski and Rosen, 1990). The increase in family size may be a reflection of the increasing population growth rate. Female headed households are smaller than male headed households: 4.7 compared to 5.9 household members (Warner, 1991).

The *rugos* are dispersed, although in areas of high population density they may be quite close to one another. The fields are close to the house and pasture may be found

throughout the area.

Although in areas such as Bututsi, landholdings exceed several hectares, the average size of landholdings nationwide is under 1 hectare (0.88ha) (ISABU and ICRAF, 1988). Households will have several fields (*champs*), and the fields are divided into parcels (*plots*). "Generally, a field has a boundary delimited by roads, pasture, shrubs or trees, streams, *etc.* These fields are then partitioned into several parcels each with a specific crop or a single type of crop association" (Moussie and Muhitira, 1989: 8). Cash crops, especially coffee, are monocropped in smaller parcels of the household's landholdings.

The bimodal rainfall pattern allows the household to have at least two cropping seasons a year, and if the wetlands (*marais*) are used, three cropping seasons. As in Rwanda, a household will have a combination of plants which will include legumes, grains, root crops, and bananas. The particular crop planted, *eg.* whether the legume will be beans (*haricot*) or peas (*petit pois*), will depend on altitude, rainfall, *etc.*, but each household will include a legume, root crop, *etc.*, in its crop repertoire. Bananas are grown for fruit, cooking, and beer. Banana beer is made and sold throughout the country and is on the household level an important source of income, as well as a cause of expenditure.

On the national level, only about 20-30 percent of the households have cattle, and if they do so there are usually only two or three head of cattle. The Bututsi agroecozone is the primary area of cattle production and the traditional residential area of the Tutsi, the dominant ethnic group in Burundi. Cattle are culturally highly valued as they are a source of prestige, and in the past, since Hutu were not allowed to own fertile cattle, they served as an indicator of membership in the ruling Tutsi tribe. Since the cattle are a hardy but low milk producing breed, milk production demands cannot be met, especially in the urban areas. The lack of fodder is the reason cited for the lack of more livestock production. In some areas sheep and goats are replacing cattle, but fodder even for small ruminants is becoming increasingly difficult for households to obtain.

Labour

Labour appears to be a constraint felt by most households, especially in areas that have three agricultural seasons per year. The common pattern is for a labour shortage to appear when fields for beans have to be prepared during the second season (January to June) and when harvesting is still occurring during the first season (September to January). In the High Plateau site of Bugenyuzi commune, for example, 37 percent of the farmers said they hired labour to complement the family labour, mostly during this period. This was also the period when help was given by relatives, friends, and neighbours.

Credit

The agricultural credit and cooperative system are services which are not very developed. The Banque Nationale de Developpement Economique does not lend money to farmers unless their property is regarded as being sufficient for the loan, and the majority of farmers cannot meet their standards. The cooperative societies only lend money to farmers for commercial crops, such as coffee, tea, or cotton.

The lack of credit facilities for the smallholder also appears to occur in the livestock

sector. Credit that is available is for the large producer and not for the average farmer (ISABU and ICRAF, 1988).

Fuelwood

Since only 5 percent of Burundi is covered by forest, it could be assumed that there is a fuelwood shortage in the country. However, in the case studies below it does not appear to be a severe problem.

There are stands of *Eucalyptus* spp. and *Cypress* spp. in parts of Burundi that were planted during the colonial era. Currently there are afforestation efforts, primarily with *Eucalyptus* spp. and *Pinus* spp. by the Department of Water and Forests. The SRDs (Societes Regionales de Developpement) also have afforestation projects for denuded hillsides. However, these projects are more focused on soil conservation than on fuelwood production, and what impact they will have on any wood shortages is unclear.

1.6 Government policy on land use, crops and trees

During the colonial era, the Belgian authorities worked through the Bami [king] of Burundi and the feudal network of chiefs to encourage changes in the farming system. The diffusion of coffee, for example, quickly occurred after the colonial administrative authorities "worked out the appropriate cultural practices. The feudal network ordered them to be carried out." (Jones and Egli, 1984: 14). The farmers obeyed and coffee growing was soon adopted throughout the Kingdom. Although the Bututsi are still the dominant ethnic group, since independence and the founding of the republic in 1966 the feudal system has gradually been dismantled, with a movement away from labour demands and land tenancy under a patron, toward obligations owed to the state.

As a result of the structural adjustment programme, since 1986 there has been a government policy shift that "favors rural over urban dwellers, producers over consumers, and farmers over the salaried and educated classes" (Schlesinger *et al.*, 1989:1). The principal objective of government developmental policy is for continued self-sufficiency in food. Specifically:

- Increasing crop and livestock production (including milk, eggs, fish, *etc.*).
- Increasing the income of farmers by the intensification and diversification of crops.
- Increasing government spending on both improving the quality and increasing the quantity of cash crops.

Government interventions

Within the scope of the overall strategy, specific responsibilities for meeting government objectives are divided among the various agricultural, livestock, and water/forestry departments, ministries, institutes, and projects. Agricultural focus is on projects that are zonal rather than national and that are concerned with providing improved seeds, expanding extension activities (concerning improved seeds), and increasing cash crop production and processing.

Although there is a national project to encourage the growing of plants for fodder, most

of the livestock projects appear to be in Bututsi, where livestock plays a dominant role in the local economy. These projects are concerned with improving pasture, introduction of new breeds, and dairies. The government and development agencies perceive livestock as being vital for the development of a smallholder mixed farming system, and recognize the need for more manure for the fields and more milk production for the urban areas. Unlike Rwanda, forestry is not within the same department as agriculture, rather it is within the department primarily concerned with the conservation of natural resources within the Ministry for Management, Tourism and the Environment. As a result of this, forestry is still primarily concerned with afforestation and forest preservation, and when the Department of Forestry is strengthened by funding from an international agency, the funds are used for training in the conservation of wood resources, rather than the extension activities that encourage smallholders to plant trees (ISABU and ICRAF, 1988).

Integrated rural development projects that are concerned with crops, livestock, forest, conservation, *etc.*, are under the Societies Regionales de Developpement. Agroforestry research is being conducted by ICRAF and ISABU.

It is believed by the Government that there is a national fuelwood shortage. Fuelwood is the energy source of choice in the rural areas, and is used in the urban areas as well. Bujumbura, for example, consumes about 3 percent of the fuelwood annually utilized in Burundi. The small farmer is perceived as continuing as the major supplier of wood for his own needs, and the needs of the urban areas and wood industries.

2. Agroecological zone analysis

2.1 High Plateau

A case study by ISABU (Moussie and Muhitira, 1989) of Bugenyuzi commune in Karuzi is the primary source, and information on the tree component of the farming system is supplemented by a study by Lamfalussy and Delince (1987b) of Muyinga province. Other sources for the High Plateau zone are ISABU and ICRAF, 1988 and Jones and Egli, 1984.

Definition of zone

Altitude is between 1550 and 1800 metres.

Rainfall is between 1000-1500 mm in a bimodal pattern with a dry season during June, July, and August.

Very little natural vegetation is still standing. It is a man-made landscape and most of the wood species are being planted or maintained by farmers as part of the farming system (ISABU and ICRAF, 1988:84).

Soils are variable in the zone and because of the steep slopes, there is localized soil erosion. There are many marshy streams which cut through the plateau; there are 0.75

km or more of these watercourse per km² in the zone (Jones and Egli, 1984: 26). The soils of the wetlands (marais) are good, and the dry season marais fields are important to the farming system.

Population density in the zone ranges between 100 - 400 persons/km².

Case study: Bengenyuzi intensive landholdings

Location

Bugenyuzi commune, Karuzi

Population

The average *rugo* size is 5.1 members. Adult men and women make up 49 percent of the family, with 51 percent being children. It is a stable community, 96 percent of the farmers are native to the province, and 85 percent of these farmers were born on the farm on which they are currently residing.

Educational levels are low. Only 22 percent of the heads of households had any formal education, and only 7 percent completed primary school. However, about 39 percent of the farmers said they could read in Kirundi. Current enrollment of children in the commune in school is 52 percent, and more would attend if schools were available.

Land acquisition and tenure

There are two types of land available to the farmer: land on the hills and land in the valleys. The most common way of acquiring land is by inheritance. About 85 percent of the farmers reported acquiring most of their hillside fields from their fathers. In the marais, 63 percent said they had acquired the land through inheritance. Land was also acquired by purchasing, leasing, and distribution by the Commune (see Table 6.4).

Table 6.4 Land Aquisition by types of field

How Acquired	Hillside (%)	Marais (%)
Inheritance	85	63
Direct purchase	25	12
Leasing (rent)	15	5
Communal associations	9	10
Farmer's associations	0	2

Source: Moussie and Muhitira, 1989:6

Land use system

The land use system is based on small intensively worked landholdings, with each household having a number of fields in different sites. The average landholding in Bugenyuzi is about 0.77 ha. Of this about 0.5 ha. is covered in food crops, 0.11 ha. in cash crops (primarily coffee), and 0.17 ha. in seasonal fallow.

There is disparity in landholding size within the community. 29 percent of the *ruغو* hold 49 percent of the land in the commune with an average landholding of 1.31 ha., while 42 percent of the farmers have less than 23 percent of the total with average landholdings of 0.6 ha.

Household landholdings are divided into several fields. A field will usually have a boundary formed by roads, pasture, shrubs, trees, or streams. These fields are then subdivided into several parcels each with a specific crop or a particular type of crop association. The average number of fields per *ruغو* is 5.4 with an average area of 0.164 ha. per field. Cash crops are usually grown in the smaller parcels, and food crops in larger. The average *ruغو* will have 9.4 parcels, including the holding in marais.

There are three agricultural seasons in the High Plateau:

The "first season" is from September to January and is dependent on the short rains. The five major crops grown are colocase (coco yam), manioc, sorghum, banana and sweet potatoes.

The "second season" is from January to June and is dependent on the long rains. The five major crops grown are beans, sweet potatoes, manioc, maize and peas.

The "third season", the dry season, is from June to September and is dependent on the marais. The major crops are beans and maize, which are mostly intercropped. Rice is growing in importance, and if it is planted in December/January, it is harvested in May/June.

Crops are usually interplanted, with over 90 types of crop associations found in the region. The associations reflect season, crop characteristics, and microenvironmental variation in soil. The four most common crop associations practised are: banana and colocase, manioc and sweet potato, beans and sweet potato, and beans and maize. Manioc and sweet potato dominate in areas of especially poor soils. Banana and colocase are grown in fields closest to the *ruغو*, and "most of the compost holes are situated in this area under the cover of the banana trees" (Moussie and Muhitira, 1989:20). Manioc and sweet potato are usually planted far from the *ruغو* and may be used to open new land that may in the future be planted under other crops, such as beans, sorghum or maize. Coffee is growing in importance as a cash crop, primarily through the extension efforts of the SRD (Societes Regionales de Developpement) Kirimiro and Buyenzi. About 96% of the farmers in the Bugenyuzi commune grow coffee. The average number of trees per farmer is 265, of which 103 (39%) had, at the time of the study, not reached bearing age. The high percentage of young trees reflects the intense extension activity, which included the free distribution of seedlings to the farmers, during the three years prior to the study (1986-1989). Surplus food crops are also sold for income (see household income below). Avocado is reported in the Buyenzi area of the High Plateau as being an important source of income (ISABU and ICRAF, 1988).

The intensity of land use and the lack of more than a seasonal fallow encourages the farmers to utilize techniques other than fallow to maintain soil fertility (see Table 6.5).

Table 6.5 Soil Improvement and Conservation Practices

Cultural practices	Farmers practising (%)
Anti-erosion techniques	41
Trees (private)	68
Chemical fertilizers	48
Produce and use of manure	77
Produce and use of compost	78

Source: Moussie and Muhitira, 1989:23

The primary anti-erosion technique is digging ditches; only 11 percent of the farmers who reported utilizing anti-erosion techniques, planted grasses, such as *Tripsacom laxum* and *Setaria* spp., along the slopes and/or ditches.

The Commune is regarded as having abundant trees, mostly *Eucalyptus* spp., both in communal woodlots and household holdings (see tree use below).

Manure is from small ruminants, primarily sheep and goats, because only 11 percent of the *rugos* have cattle. There is a recognized shortage of manure, and farmers use manure discriminately, usually on beans and maize. Manure will only be applied to other crops after the needs of these crops are satisfied.

Composting is done in holes, which are aged from 6 months to a year. Compost holes are usually dug in banana fields close to the *ruغو*. Although the use of chemical fertilizer is accepted by the majority of farmers, its high cost and lack of availability inhibits its use. It is used by households who have relatively high incomes and/or means of transport (bicycle). Of the farmers who purchased chemical fertilizers the quantities were small (about 20 kg) and were selectively applied to beans, followed by maize and peas.

Household income and expenditure

Aside from coffee, other sources of income from agricultural activities by the Bugenyuzi commune are the sale of food crop surplus, especially colocase and manioc. However, only 64 percent of the farmers produce enough colocase or manioc for sale, and the Commune does not produce a food crop for which all households are self-sufficient. Food processing, specifically making sorghum and banana into beer for home consumption and sale, is another important source of income (see Table 6.6). The disparity in income between households is muted by the average income figures. Although the *ruغو* average is reported as over 23000 Fr. Bu, over 62 percent of the households earn less than 20000 and 23 percent earn more than 30000 Fr. Bu.

The low cash income of the *ruغو* precludes the purchase of large quantities of expensive agricultural inputs such as fertilizer, improved seeds, tools, and livestock.

Table 6.6 Bugenyuzi cash revenue by source of income

Source of income	% Share	Fr. Bu per <i>ruغو</i>
Agricultural activities		
Coffee	30.6	7160
Banana beer	19.6	4576
Food crops	19.4	4531
Livestock	7.7	1810
Other export crops (tobacco)	1.3	302
Other activities		
(commerce, off-farm labour, etc.)	21.4	5003
Total average	100.0	23382 = \$150 US

Source: Moussie and Muhitira, 1989:35, for 1986-87

Tree component

Although the Moussie and Muhitira (1989) survey of Bugenyuzi reports the percentage of *rugos* (68%) who utilize trees as a technique of soil conservation, the trees that were planted, other than *Eucalyptus* spp., and where they appeared on the farming landscape, was not examined.

However, there are other studies of the northwestern area of the High Plateau which reveal the importance of trees in the farming system. Throughout the zone, *Grevillea robusta*, avocado (*Persea americana*), and *Ficus* spp. are found on farms. Avocado is sold throughout the plateau and is perceived by the farmers as a good cash crop. Avocado trees are usually planted on the homestead or within view of the house to inhibit filching by older children (Getahun pers. comm.) On the borders of the fields are *Dracaenan* spp., and *Euphorbia tirucalli* are planted, and *Albizia* spp. and *Cassia spectabilis* are used as the upper story in coffee fields, especially in the drier areas. Other trees found on farms are *Polyscias fulva*, *Markhamia lutea*, *Spathodea campanulata*, and *Maesopsis eminii*. It is also common to find small woodlots of *Eucalyptus* spp. It has been estimated that in the northwestern area of the Plateau there are 30 - 50 trees per hectare, all perceived by the household as having at least one positive use (ISABU and ICRAF, 1988: 93).

In Muyinga Province, an in-depth study of trees in the farming system was conducted by Lamfalussy and Delince in 1986-87. Although the Muyinga's easternmost region is in the Kagera Piedmont, most of the province is within the northeastern area High Plateau agroecological zone. In Muyinga the number of trees found on farms was very high (see Table 6.7). The number of trees was also found to be a fairly good indicator of the wealth of the farmer when compared to the ownership of livestock, especially cattle. The larger the number of trees the higher percentage of farmers who owned livestock (goats excluded).

Table 6.7 Trees on farm

Number of trees on farm	0 - 9	10 - 49	50 - 99	100 - 499	500+
% of farms (<i>rugo</i>) in each tree category	3.4	20.5	17.1	45.9	13.2
% of farms by tree category, with livestock component-					
Cattle	0.0	0.0	2.9	6.8	9.8
Goats	32.4	61.0	52.0	63.8	47.0
Sheep	0.0	11.2	11.7	25.7	31.8

Source: Lamfalussy and Delince, 1987b: 27,31

The ten most prevalent species of trees on farms and the number of each species is presented in Table 6.8. The most common tree species are *Persea americana* and *Ficus ingens*, but the largest number of trees per species is found with *Euphorbia tirucalli* and *Eucalyptus saligna*.

Table 6.8 Trees: frequency, location and uses

Species	Households (%)	Average no. trees	Location	Uses
<i>Ficus ingens</i>	79.9	4.0	Dispersed*	Fuel/construction
<i>Persea americana</i>	76.5	3.9	Dispersed	Fruits/fuel
<i>Euphorbia tirucalli</i>	69.4	40.6	Hedges	Construction/fuel
<i>Eucalyptus saligna</i>	65.0	27.8	Woodlots	Construction/fuel
<i>Markhamia cutea</i>	57.3	7.5	Dispersed	Construction/fuel
<i>Grevillea robusta</i>	55.9	5.8	Dispersed	Cottage crafts/fuel
<i>Mangifera indica</i>	36.0	2.4	Dispersed	Fruits/fuel
<i>Dracaena afromontana</i>	30.4	12.1	Hedges	Construction/fuel
<i>Erythrina abyssinica</i>	28.0	2.8	Dispersed	Fuel/Cottage crafts
<i>Vernonia amygdalina</i>	26.8	3.1	Dispersed	Fuel/medicinal

* Dispersed or in groups in the fields or parcels

Source: Lamfalussy and Delince, 1987b: 30-62

Beside the fruit of the avocado and mango, the major use of the trees is construction, fuelwood, and cottage crafts. Of the trees listed above, not one has fodder mentioned as the principal use. In Muyinga, the site of the study, livestock were grazed on

communal pasture or were fed agricultural residue.

In the year preceeding the study, only a small percentage of farmers in Muyinga reported buying trees, either forest or fruit species, fuelwood species, or species providing wood for cottage crafts and building material (see Table 6.9). Farmers expressed reluctance to buy seedlings and of the tree species listed above, seedlings are primarily obtained through natural regeneration. However, in the case of three species wildings are used (*Grevillea* spp., *Markhamia* spp., and *Vernonia* spp.), cuttings are used for four species (*Dracaena* spp., *Erythrina* spp., *Euphorbia* spp., and *Ficus* spp.), seed is planted for two species (*Persea* spp. and *Mangifera* spp.), and a seedling is planted for only one species (*Eucalyptus* spp.).

Table 6.9 Trees and products purchased

What is purchased	% of farmers
Forest species*	1.8
Fruit species	5.3
Fuelwood	2.3
Wood for cottage crafts / construction	6.1

* Forest species is used to denote tree species which are for construction materials, fuelwood *etc.* *e.g. Eucalyptus* spp. and does not include species that are regarded as being agroforestry species

Source: Lamfalussy and Delince 1987b:30

Livestock component

According to Moussie and Muhitira (1989: 24) in Bugenyuzi commune, 55 percent of the *rugos* have goats, 41 percent have sheep, and 11 percent have cattle. Other studies have noted that there has been a shift from cattle to sheep and goats throughout the zone. There is concern that the decline in the number of cattle will have a negative impact on manure availability for soil improvement.

Labour

There are seasonal shortages of labour. One of the peak periods for agricultural activities is December to January, which is the end of the first season and the beginning of the second. Land preparation followed by bean planting are the activities for which most of the paid labour is utilized. The use of labour provided by relatives and friends for these same activities, reflects this peak labour period. Further labour shortages can be projected as coffee production increases and educational opportunities for older children expand.

2.2 Central Congo-Nile Divide

The primary source for the Central Congo-Nile Divide agroecological zone is Depommier and Kaboneka's (1988) study of Gisozi Commune. Other sources used are Ntagunama, 1989 and Jones and Egli, 1984.

Definition of zone

A ten year average rainfall at the Gisozi weather station was 1414 mm per year. This places Gisozi in the drier area of the zone. Rainfall is in a bimodal pattern, with a dry season of about 4 months during June to September.

The altitude of the commune is over 2000 m, with greater altitude giving higher the rainfall.

The soils are primarily ferralsols with a high acidic pH (4 - 5) and aluminum toxicity. Soils in the marais are regarded as being the best in the region.

The vegetation is pasture rather than trees, the principal grasses are *Eragrostis* spp. and *Hyparrhenia* spp. Natural woody vegetation is almost absent in the farmland in the commune.

Case study: Gisozi communal lands

Location

Gisozi commune is in the southern area of the Central Congo-Nile Divide, near the Bututsi agroecozone.

Population

The population density is about 155/km². This is lower than the national average, but is regarded as being high given the natural resources of the region. Gisozi experiences a high outmigration of males to the urban areas. On average each household has 0.7 persons residing outside the commune. The result is a sex ratio of 91 males to every 100 females which would be even lower if only adults were represented. Even so, only 11 percent of the households are female headed, a figure below the national average. There are fewer than 6 persons (5.73) per household in residence.

Land use system

In the area of the C.V.H.A. project (Cultures Villageoises de Haute Altitude) in Gisozi, about 7% of the commune area was under national and communal woodlands. The woodlands were planted with *Pinus* spp., *Eucalyptus* spp., *Acacia mearnsii*, *Callitris*, and *Cupressus*. There is about 0.17 ha. of woodlands per household.

Average landholding, excluding woodlands and pasture, is about 0.81 ha. Of this:

Hillside fields	0.322 ha.	(40%)
Marais	0.006 ha.	(1%)
Cash crop - tea	0.065 ha.	(8%)
Fallow	0.413 ha.	(51%)

Since Gisozi commune is over 2000 m in altitude, the favoured crops of the High Plateau, banana, sorghum, and manioc, do not grow well. Bananas continue to be grown,

but they are not a major crop in the commune. During the first season (September to January) the major crops are maize, sweet potato, haricots, and "other cereals". The major crops of the second season (December to June) are wheat, sweet potato, potato, haricot and petit pois. Tea is the major cash crop. As throughout Burundi the fields are subdivided into parcels, and the average household has approximately 14 parcels in cultivation.

About 60 percent of the commune land is in pasture. This is a very important resource to farmers in the commune. A large percentage (42.9) of the households only use communal pasturage for their livestock. A much smaller percentage use only "private" pasture (15.9), but 31.8 percent reported using a combination of private and communal pasture.

Although most households (53.9%) fallow some fields for at least a season, 38.1 percent of the households did not have any land in fallow. Since fallow is not sufficient for soil conservation, all farmers reported utilizing manure and compost on their fields, and virtually all of the farmers (94.6%) reported planting grasses (usually *Setaria* spp.) to impede erosion. Only a third of the farmers reported using chemical fertilizer, primarily for the cash crop tea. None of the farmers reported using mulch, terraces, or planting trees for soil conservation or improvement.

Tree component

In Gisozi commune forty different tree species were found on the farms (see Table 6.10 for the 10 species most frequently found). As can be seen from the table, *Eucalyptus* spp. is almost universally planted by farmers. *Eucalyptus* spp. is not a new tree to the farmers in Gisozi; it was introduced at the beginning of the century and is found throughout the region. *Eucalyptus* spp. is continuing to be planted in large numbers, Depommier and Kaboneka (1988) found that it was the tree most frequently planted during the five years preceding their study and the tree that farmers reported as being the most important.

Data were, unfortunately, not collected on the number of trees of each species that each farmer had on his landholdings. However, it can be inferred from where the farmers obtained their wood whether the on-farm trees provided an adequate supply of wood for their household uses. Of the households who were asked what was the principal source of wood, 93.6 percent said that it was their private woodstock. As a secondary source of wood, 25.4 percent reported buying fuelwood or charcoal, and 17.5 percent reported obtaining wood from a neighbour. From this it appears that households are almost self-sufficient in construction material, but experience a shortfall in fuelwood.

It should be noted that except for avocado (*Persea americana*), none of the ten most common species are used for food, and only *Dracaena afromontana* is used for fodder. The primary uses of the trees are for construction, fuelwood, cottage crafts, and hedges. Living in an environment without any remaining natural forest has encouraged a household level of self-sufficiency for most wood needs.

Table 6.10 Trees: Frequency, location and uses

Species	Households(%)	Location	Major uses
<i>Eucalyptus</i> spp.	98.4	Woodlots	Construction/poles/ fuel
<i>Aruninaria alpina</i>	79.4	<i>Rugo</i> /in fields	Construction/ cottage crafts/fuel
<i>Acacia mearnsii</i>	76.2	Woodlots/in fields	Construction/fuel
<i>Erythrina abyssinica</i>	76.6	Hedges/in fields	Hedges/construction
<i>Ficus</i> spp.	57.1	In fields/hedges	Construction/hedges
<i>Cupressus lusitanica</i>	42.9	Woodlots	Construction/ cottage crafts
<i>Persea americana</i>	41.3	In fields/ <i>Rugo</i>	Fruit/fuel
<i>Solanum aculeastrum</i>	36.5	Border fields/hedges/fields	Construction/fuel/ hedges
<i>Iboza riparia</i>	25.4	Hedges	Hedges
<i>Dracaena afromontana</i>	23.8	Hedges	Hedges/fodder

Source: Depommier and Kaboneka 1988: 24-49

Livestock component

In Gisozi commune there is a disparity in livestock ownership (see Table 6.11). Almost one third of the households own no cattle, and the majority have neither sheep nor goats. In Muyunga, a colline to the north of Gisozi, a similar disparity was attributed to ethnicity, since the Tutsi lineages in the village were the major owners of livestock (Kayondi, n.d.). For all animals the principal source of fodder is pasture, with planted grasses such as *Setaria* spp. and *Tripsacum laxum* being a secondary source, and agricultural residue a minor source. Although none of the farmers in the Depommier and Kaboneka study reported using fodder from trees (farmers did note that *Draconia afromontan* could be used as a fodder), other studies in the region have found that certain species of trees and shrubs have been used as important, if not principal, sources of fodder.

Farmers do perceive the lack of pasturage as a constraint on livestock production, although it is recognized more as a constraint for cattle than for goats and sheep. The traditional practice of moving the livestock to other communes during the dry season has been in principle banned, so farmers must be able to increase fodder production if livestock is to be expanded, or given the condition of the pasture, maintained.

Labour

The majority (55.6%) of the households employ seasonal labour during the agricultural cycle. As in the High Plateau there are labour peaks during which households will try

to obtain additional labour.

Table 6.11 Livestock

Animals	% of households owning animals	For households owning animals:	
		average no./household	range
Cattle	68.0	4.35	1-14
Goats	42.9	1.92	1-13
Sheep	36.5	1.46	1-5

Source: Depommier and Kaboneka, 1988:19

Perception of trees

A study by the Projet C.V.H.A. found in discussion with farmers that the three most important roles of trees were for construction, heating (fuelwood), and timber; of less importance were income, soil conservation or soil improvement (Ntagunama, 1989). In a grassland environment it is to be expected that farmers would stress the role of trees as fulfilling their most basic needs (shelter and fuel), before expressing interest in income and soil improvement.

Conclusions: Burundi

Where are farmers planting or not planting trees?

Farmers are planting trees throughout the landscape. Some species are planted closer to the homestead, others dispersed in the fields, in woodlots, in borders around fields, or planted as hedges. Farmers mentioned as a minor problem, if at all, the problem with protecting seedlings from livestock. The high density of population, the use of hedges, the relatively small number of livestock, *etc.*, has prevented livestock from being a deterrent to tree planting.

How does tree planting relate to ecozone, cultural traditions and values?

There were marked differences between the High Plateau and Congo-Nile Divide in the choice of species. In the High Plateau the trees found were often those that appear in East and Central Africa: mango, *Markhamia lutea*, and *Euphorbia tirucelli*. The Divide's extremely poor soils, its high elevation and low temperatures, *etc.* have resulted in a different repertoire of trees than is found not only in the High Plateau of Burundi, but in other countries in the region as well. *Eucalyptus* spp. with its high tolerance of the very soil conditions found in the Divide is the tree of major importance and popularity with farmers. Fruit trees are less prevalent in the Divide than in other regions. *Euphorbia*, which is almost universally found as hedging elsewhere in the region, is absent.

Given the absence of natural forest and the limited number of species that would do well in the Divide ecozone, farmers have developed and appear to be expanding a repertoire

of trees which satisfy household needs for wood for shelter and fuel.

Cultural traditions were not mentioned by the studies consulted as either a help or a hindrance to tree planting in Burundi. However, there does appear to be a class linkage, since the wealthiest households have more land, animals, and trees.

What incentives are there for tree planting?

The major incentive for tree planting in Burundi is the lack of alternatives for obtaining construction material, fuel, and in some areas fruit. As mentioned above, a household's principal source of wood is its own landholdings. This is not to say that national forests are not being degraded, but in the two agroecological zones studied, farmers appear to be intensively using their own stock of trees. A relatively small number of farmers buy wood products, and it is interesting to note that in such cases it is usually for fuel.

How does tree planting by farmers relate to government efforts and extension attempts to promote tree planting?

The efforts by government and development agencies is to encourage farmers to plant more trees, and in some projects, a wider variety of trees, than were planted in the past. As in Rwanda the new generation of projects are emphasizing trees for soil improvement and fodder, but, as in Rwanda, farmers in Burundi are more concerned with wood for construction and fuel.

3. Burundi Summary

- 1) Farmers are planting trees in Burundi, although the species of trees may be more limited in purpose than both development agencies, and increasingly farmers, might prefer. Although composting is common, farmers are less concerned with using trees for soil improvement/conservation and fodder than what they perceive as their more critical need for building material and fuel.
- 2) Farmers appear to have been successful, at least in the sites of the case studies, in satisfying these needs. Burundi is regarded as being self-sufficient in food, and based on the data in the case studies, farmers are producing enough wood from their landholdings to be almost self-sufficient in wood as well.
- 3) Knowledge of tree planting and care does not appear to be a constraint, although for new exotic trees some instruction may have to be given. What does appear to be a constraint is the lack of clearly defined benefits for planting new varieties, especially if the extension services stress their uses for fodder, green manure, *etc.*
- 4) There is a lingering sense of disparity of land size, herd size, number of trees, and income. Educational levels are low, population growth rates are high, and seasonal labour shortages are common throughout the country. The government and development agencies may have to address the question of equity, especially if the government objective of mixed farming is to be attained.

7. COUNTRY REPORT: TANZANIA

1. General information

1.1 Background

Population

The population of Tanzania is approximately 22 million with an average annual growth rate of 3.4 percent. The distribution of the population is highly uneven, with about 75 percent of the people living on about 15 percent of the land area. This settlement pattern is a reflection of the Tanzanian topography and climate. Over 50 percent of the country is hilly/mountainous and a further 25 percent is "undulating". The highlands and the central plateau support about 70 percent of the population. The highest mean population densities are in the northern moist highlands, but the dry plateau areas are considered to be overpopulated in respect to the resources of the region.

It is Tanzania's growth rate, rather than the size of the current population, which is a matter of concern. If the rate of growth continues, Tanzania will have a population of over 40 millions in 20 years.

There is some variation in the description of Tanzanian agroecological zones and this is a reflection of the complex interplay between topography, climate and subsistence systems.

Topography

There are 4 distinct regions:

- The coastal plain which rises from sea level to 200 m.

- The central plateau with elevations up to 1000 m.

- The rivers complex

- The high volcanic and massif mountains, the highest being the northern highlands with Mt Kilimanjaro and Mt. Meru

Climate

There are 3 main zones:

- The humid and warm coastal region with bimodal rains totalling 1100-1300 mm per annum (the rains come during the December and March equinoxes and the December rains are of shorter duration and are unreliable)

- The hot and dry zone of the central plateau with a mean annual rainfall of 500-800 mm

- The semi-temperate zone on the mountain slopes with rainfall varying from 750-2000 mm per annum

The rains are unpredictable: major droughts occur every 9-10 years and minor droughts occur every 4-5 years.

1.2 Agroecological zones

Four zones agroecological zones can be identified, and related to farming system:

Coastal zone: Based on cassava, coconut, macadamia nut, banana, *etc.*, with little livestock.

Unimodal upland plateau: There is a gradient from primarily agricultural with no livestock (in areas associated with heavy tsetse fly infestation and at the higher end of the rainfall spectrum) to primarily pastoral (extremely low rainfall). Livestock utilize about 50-60 percent of the total land area, but only contribute about 5 percent of the GDP.

Highland zone: The northern highlands are the highest (Mt. Kilimanjaro is almost 6000 m), while those in the south rise to 2000 m or more. Variations in the agroecosystems reflect differential access to markets, colonial and extension contact, as well as adaptation to altitudinal potentials. The best documented agroecosystem is the Chagga coffee-banana complex in Kilimanjaro, but agroecosystems based on tree crops have developed in the central highlands (Uluguru) and in the southern highlands (Mporoto, Kipengere, and Rungwe Mountains).

River valley: Disappointingly, there appears to be little current data about the valleys. The common land uses are agricultural with little livestock (tsetse fly area), and a high proportion of field/homegarden in trees, primarily fruit.

(Sources: ICRAF, 1979; TATF and ICRAF, 1988b.)

Table 7.1 Description of Zones

Zone	Rainfall (mm)	Pattern	Altitude (m)	Land use
Coastal	1000-1300	Bimodal	sea level - 200	Agricultural/tree crops
Upland (Central)	500-800	Unimodal	< 1000	Agricultural/agro-pastoral/pastoral
Highlands (North)	750-2000	Bimodal	900-1900	Intense land use
Highlands (South)		Unimodal	up to 1900	Tree crops/zero grazing
Riverine "semipermanent"		Unimodal /bimodal		Agriculture/tree crops

There is a definite link between the environment and the land use system. Agropastoralism is the primary land use system in the upland plateau areas. The tie between ecozone and subsistence system, specifically the level of reliance on livestock, is related to the amount of rainfall. In the drier areas, there is more emphasis on the livestock component of the agropastoral system. Given the lack of certainty of the rains, it is not surprising that the herd rather than the field is given higher priority in resource management decision making. Studies have shown that livestock provide the safety net: they can be sold during an agriculturally bad year to purchase food, provide milk and draught power, and they also serve as a source of prestige and brideprice.

Similarity in land use is what also links the highlands. Although the specific crops may vary, throughout the highlands a land use system is found based on high population densities (at least 4 times greater than the national average of 20 per km²), on small fields, reliance on permanent fields (with some crop rotation), and marketing (or attempts to do so) of cash crops.

1.3 Tenure

Land and trees: traditional

Although there was variation between tribal groups and regions, land was usually held by a clan, subclan, or lineage with use of land granted to its members. The head of the particular kin group was recognized as steward of the land, and it was his responsibility (perhaps in consultation with the elders) to assign fields to individuals. When the field was harvested, the land reverted to his jurisdiction. Under such a tenure system, to plant a tree was to impose a degree of ownership since the harvest of the tree (especially fruit trees) was over a long period of time (Brain, 1980). Lineage leaders were wary of tree planting since it disenfranchised the lineage in favor of the rights of the individual and hence eliminated their role as stewards of the land.

With coffee, and later tea, individual land holdings in the highlands were established, although there were some rights still held by the lineage or clan head. However, if one looks at the areas in which the cash crop trees were initially planted, it is apparent that these were already areas of high population density with individualization of land holdings preceding in some areas the introduction of tree crops. In these instances, tree crops reinforced a process that had already begun.

Land and trees: current

With villagization, the government was in a position to implement a new land tenure policy. Currently all land belongs to the state. Villages and individuals have use of the land for certain specific purposes (cash crops are strongly encouraged) and periods of time (99 year lease for commercial concerns). In the new villages, land was allotted to each household (actually each wife was given an allotment), and communal land, ideally to be worked upon by all, was set aside. The traditional land tenure system based on kin group was no longer valid.

However, villagization was not uniformly imposed throughout Tanzania. In some areas people were moved, sometimes forcibly, over great distances and had to leave home, ancestors, and crops behind. In other areas, especially in the highlands, where population

densities were already high and societies such as the Chagga well organized, villagization was a mere formality. Some leaders assumed new titles, villages became larger or smaller on paper and land tenure remained much as it was before with individual farms left intact.

Ironically, villagization has resulted in individuals, rather than the village/community, gaining long term land tenure, for tenure is now based on the individual allotment and with the push to permanent fields the farmer now views the allotment as being "owned" and belonging to his heirs. Whether it was the original intent of the government, inheritance from parents to children (or in matrilineal areas to the sister's children) continues to occur, especially if there are trees planted on the land. The new system has given clearer rights to those who have planted trees because in the new villages former tribal rules which may have discouraged tree planting are no longer in effect.

Individualization of land holdings has weakened the control of tribal leaders and appears to have contributed to the disappearance of the kin-based stewardship system. The village leaders have assumed the responsibility of the traditional kin leader as steward of the land. If a parcel of land becomes "ownerless" through death or migration, the parcel is then assigned to someone else in the village.

Although one of the goals of villagization was to eliminate inequities in size of land holding, disparities in farm size continue. If a family was not moved during villagization and had prior rights to land in the area, these rights appear to have been recognized and maintained. It is only in areas where villages were newly created that land parcels held by families are the same size, and as inheritance and the granting of new parcels to new families continues, disparities are forming in these communities as well.

There has been recent discussion in the government of allowing individuals to have legal (government recognized) rights to use and own land (Mwihomeke, 1990). Since in many communities individuals already have village level recognition of land ownership, if this policy-change does occur it will reaffirm existing claims, and would probably have the greatest impact on communities created during villagization. A projected benefit of individual land ownership would be the consolidation of farm plots into larger fields and a decrease in the walking time and distance (Mwihomeke, 1990).

In summary, land and tree tenure in Tanzania support the planting of trees by the individual farmer. However, competitive rights to resources may not be as supportive. In agropastoral areas, the rights of the tree and its planter are superseded by the rights of grazing. It is not surprising that trees in such societies are planted around the homesteads where clear rights are established and animals are not allowed to browse.

Government interventions

Government policy was to foster a tenure system that would both eliminate inequities in land holdings and encourage increased agricultural production. Villagization did indeed allow the government in many areas to "start over" as people were moved away from their ancestral areas (although the majority were moved less than 10 kilometres) to new settlements. However, as mentioned above, inequities did remain in previously settled areas, and agricultural production declined.

1.4 Economy

The basis of the national economy is agricultural. About 92 percent of the population is directly dependent on agriculture and pastoralism for its livelihood. Agri-business and processing supports another 4 percent of the population. The remaining 4 percent are employed in the government services, industry, and commerce.

An oft-quoted figure for per capita income is US\$150. However, per capita income of the farmers who live in the dry areas (70%) is US\$120 per annum. Since agricultural production cannot meet domestic needs, food is usually imported annually. In recent years (1988-90) extremely good rains have resulted in sufficient harvests of maize and beans, if not in other staples and dairy products.

Livestock utilize over half of the total land area, but their contribution to the national economy is small (less than 5 percent) and dairy products are imported since there is a national shortage of both meat and milk. Animal productivity is low because of inadequate fodder and water supply and what is regarded by some as poor grazing management. Livestock are responsible for much of the environmental degradation in the drier areas.

Urban incomes are higher, yet there has been a concerted effort by the government to decrease the income differential between the richest and poorest within the country, regardless of residence or occupation. In this it has been successful, and the ratio has dropped from 1:17 to 1:11, with income disparity declining in all the sectors. However, this has not been the result of the increase in income of the poor, but rather of the general decline in income throughout the country.

One of the major purposes of villagization was to concentrate the population and make it easier to provide basic social services. Although the level of social services has been less than originally envisioned, the services which are available have improved the quality of life with regard to health and education. Life expectancy has risen and literacy rates have dramatically increased. Health and education services are basic and are targeted to the village level. Health centres are staffed by nurses and paramedics, while doctors are placed at regional or district level facilities; villages have primary education, but public secondary schools are few and distant. Personnel are available at the facilities, but medication, books, supplies, *etc.*, are rare and hard to come by through official channels. The adult literacy campaign was highly successful, but there are few books at the village level available for the newly literate to maintain their skills.

1.5 Rural sector

Although polygamy is allowed by Tanzanian law, the structure of the typical household is nuclear. There is household size variation by region, with a national average of 5.3 members per household.

The government's policy has been to discourage rural-urban migration and anti-loitering campaigns, especially for women, still continue in Dar Es Salam, during which people are gathered up and sent out of the city. Anti-migration policy, however, has not been

very effective. In a national study conducted in 1980 (Collier *et al.*, 1986), 27 percent of the households had previous members (nuclear family) who had migrated out of the village. The overwhelming percentage (80%) of the migrants were sons or daughters, and of these almost 35 percent had gone to an urban centre. Over half of the total migrants sent remittances back to the village. The amount of the remittance sent is dependent on the intentions of the migrant. A migrant who intends to stay in the urban area will send about 10 percent of his/her earnings home. Those who intend to return home send a larger proportion (35%) of their earnings. Remittances contribute about 4 percent of aggregate rural income.

The size of landholdings is positively correlated with household size. Larger households can provide the labour for larger farms (and the inverse is true as well, larger landholdings can support a larger number of household members). In 1980 fewer than 3 percent of the households had more than 12 acres and fewer than 7 percent had less than one acre. The distribution of land was not affected by villagization since land allotment is in relation to size of household and labour pool. The average household holds 4.7 acres in 2.5 plots. The plots are not usually far apart, since with relocation there has been the spatial concentration of plots within the village. In villages in Mbozi in Mbeya district, farmers have several plots, but they are contiguous to one another and to manage the logistics of agricultural activities in widely separate fields.

Livestock holdings vary by region. Although the motivations to keep large herds are based on social (prestige and brideprice) as well as economic reasons, those who own livestock have a potentially substantial source of income, and livestock ownership is a decisive factor in explaining income inequality between and within regions.

Labour

In the rural sector, labour and capital, not land, are the constraints on food production. Increases in production are linked to increasing areas under production rather than increasing production of the existing fields. Although village holdings are finite, there is land that can be brought under production. The correlation between the size of family and the size of land holding is telling: the current dryland agricultural system based on hoe/ox plow labour and few external inputs (manure, fertilizer, *etc.*) is limited in production potential. Freeing labour from communal obligations, *etc.*, will not provide the extra labour that is needed for increased production. Capital to fund more inputs or mechanization is not available.

This labour constraint is especially relevant when considering the labour needs of fuelwood collection. Estimates of the time needed to collect fuelwood vary widely and this reflects the differences in site location, methodology, seasonality, and year of study (see Table 7.2).

Fuelwood

With the exception of Dodoma, the estimates for fuelwood collection are under 85 days per year, or approximately 1 of every 4 to 5 days are devoted to collecting firewood. Whether this is a serious burden on women or whether it will serve to motivate tree planting for fuelwood remains unclear. Villagization has probably played a major role in increasing the time spent on the collection of fuelwood. Access to natural resources,

which had been abundant for scattered households, became more scarce when villages were created. Women have to go further to collect fuelwood than they did in the past.

In the drier areas of the upland plateau, such as Singida and Shinyanga, fuelwood is reported as being purchased by villagers, a reflection of the willingness to exchange money rather than time for fuelwood (Nilsson, 1983).

Table 7.2 Estimates of household time spent gathering fuelwood

Location	Year	Mandays	Source
Dodoma	mid 1970's	200/300	Minzava, 1980 (citing Minzava, 1977)
Shinyanga	1983	38/65	Barrow et al., 1988 (citing Kikula et al., 1983)
Usambara	1977	72	Fleuret and Fleuret, 1978
Mbeya	mid 1970's	65	Nilsson, 1986 (citing Brush, 1977)
Iringa	1980	65/85	Kikula and Nilsson
Kilimanjaro	1983	3/28	O'king'ati and Mongi, 1986
Multiregional	1982/83	17/70	Mascarenhas et al., 1983

The poor state of the economy has increased the dependency on fuelwood. Kerosene has become expensive, and throughout the 1980's it was in short supply. Charcoal in the urban areas has become inflated in price as the price of kerosene has risen. In the rural areas kerosene when available is used for lighting. During the dry season, cow dung, a low status fuel, is widely used in agropastoral areas for fuel.

1.6 Government policy on land use, crops and trees

Land use

The Arusha Declaration of 1967 was the beginning of a radical departure in land use policy; the new goal was the complete transformation of the rural areas of Tanzania. Although specific policies and interventions have shifted over time, there is still a basic dedication to rural equality and provision of social infrastructure.

There have been four sets of policies which have been emphasized and promoted in roughly this order of priority: villagization, communalization, social infrastructure, and agricultural output. The policies are interrelated, and the sequential change in emphasis has not resulted in the disavowal of the previous interventions. Rather there has been an evolution of policy as existing policy was viewed as inadequate or objectives changed. The cornerstone of all four policies has been the Ujamaa village.

The Ujamaa village was an attempt to make an ideological abstraction real: the village would be an organization of peasants who would raise their living standards "by hard and disciplined communal work" (Collier *et al.*, 1986:2). The first Ujamaa villages were voluntarily formed during the 1960's, but few of these survived by 1970. The government then began to encourage villagization by "rewarding" the formation of villages by

preferential allocation of social services.

Whereas the initial villages were begun by peasants dedicated to socialistic principles, this phase included villages in which members were interested in receiving the services, but lacked an interest in, and dedication to, communal production and distribution. There was also a subtle shift in policy from that of encouraging villagers to work collectively to improve their standard of living, to the burden, and the initiative, of such improvements being assumed by the government. This shift in policy reflected the government decision to take a more interventionist approach in village development. The original Ujamaa villages which had survived were disbanded and the peasant organizations were brought under central control (Collier *et al.*, 1986).

The villages were given a formal organizational structure for political and labour management (elected chairman and council, *etc.*). Communalization was seen as less of a priority than the process of villagization and social infrastructure. However, the government realized that it could not afford to provide inducements to the entire rural population. When inducements were scaled down, villagization slowed.

In 1973 the government abandoned its strategy of voluntary inducements (which it could not provide) and a strategy of forced villagization was adopted. In 1974 the villagization policy was enforced and by 1975 the majority of the rural population was resident in villages. These new villages were not the communally organized Ujamaa village: in order to be so the village was required to satisfy stringent criteria of communal activity and in 1978 not one Tanzanian village met the criteria. The purpose of the village during this period was to have a geographical consolidation of the population so that services, land reform, and marketing could be more effective.

Given the time constraint, site selection for these villages was not given adequate supervision nor was the natural resource base or the environmental impact of such resettlement considered (Mlay, 1986). Village sites were chosen because of nearness to roads and the existence sufficient land for 300 or more families. The criteria of the number of families (300 was the official minimum although smaller villages did occur) was not based on environmental or agricultural conditions, but on the number of children needed to maintain an elementary school.

The purpose of the village was: to provide a large enough population for social services; to act as an agent of land reform (*i.e.* to allocate land among private cultivators); to be the primary unit for the marketing chain (as a collection point); and to be the potential unit for communal production, although this was by this period given low priority (Collier *et al.*, 1986).

By 1975, the highest priority was to increase agricultural production. Farmers were encouraged, and in some cases coerced, to plant a minimum of three acres of food crops and one acre of cash crops. Agricultural production has remained in the forefront of government objectives. The social infrastructure has deteriorated from its peak because of the lack of funds, and villagization has remained at the same level for the last decade. Communalization rhetoric reappeared in the early 1980's, but it never gained momentum since agricultural production continued to be the primary objective of agricultural policy.

The decline of interest, beyond the ideological, in communal production is probably the result of the very low returns per acre of the village communal fields. The results of a study in 1980, found that the "communal shamba absorbs approximately 20 per cent of village labour and 8 percent of village land, yet it produces less than 2 per cent of agricultural output." (Collier *et al.*, 1986).

The poor financial condition of the country, with per capita income falling and with increasing dependency on donors and food imports, has intensified the government's drive for higher agricultural production, and relegated the objective of communal production to the past.

A restructuring of the economy is now in progress. The government is withdrawing from its role as collection and marketing agent for agricultural products, and the producer is being forced through lack of alternatives to assume control of marketing. The tacit objective of social and economic equality is being replaced by a somewhat reluctant acceptance that to increase agricultural production on a national level will entail the creation of an entrepreneurial elite. This is in opposition to the former policy which perceived the commercialization of Tanzanian agriculture as benefiting primarily a minority of prosperous farmers, thereby generating inequality. To prevent this, post Arusha policies "turned the terms of trade against the farmer", reduced market networks, regulated landholding, introduced communal production, and provided basic social services (Collier *et al.*, 1986). All but the last of these reduced agricultural production and incomes, while a fairly high degree of rural inequality has persisted.

Crops and trees

The initial policy emphasized food production because national self-sufficiency in food was a major objective of the government. Large commercial plantations of coffee and tea were nationalized and put under communal production. After the decline in production in both food and cash crops, the newly formed villages were encouraged to allot 3 acres for food crops and 1 acre for cash crops to each farmer.

With the exception of cash crops, trees were absent from much of the land use planning during the 1960's and into the 1970's. Villages were encouraged to clear as much forest and woodland as possible, so that the land could be put into production. The government lauded the villages which had cleared the largest areas as being at the forefront of production, they were seen as "good" villages and were rewarded. Therefore with villagization deforestation did occur around the settlements, and the pressure on the local forest resources increased.

During this same period there was a programme for village afforestation for fuelwood, but beyond announcing such a programme (in 1967) little appears to have been achieved before 1978 (see Skutch, 1985). Approximately 85 percent of fuelwood consumption is by households and the remainder is by industrial users. A significant user of fuelwood is tobacco curing, primarily by small farmers. Beer brewing is extremely common and is a major source of income for women. Brewing requires large amounts of fuel, but is culturally valued and it is too important a source of income for women for it to be discontinued.

Government interventions

In response to studies conducted during the 1970's found that wood consumption surpassed the production capability of the natural forest, and that woodland was being depleted at an "alarming" rate (about twice the estimated rate of regeneration for the Miombo woodland; a depletion rate equivalent to 375,000 hectares a year) a national tree planting campaign was launched in 1980 (Skutsch, 1983).

"Miti ni Mali" (Trees are Wealth) was a remarkable campaign, spearheaded by the Forestry Division in cooperation with the Institute of Adult Education. The Institute of Adult Education prepared a booklet in Swahili, which was free, and sponsored a series of seminars for village leaders. A series of radio broadcasts were developed which extolled tree planting. A booklet in English which discussed timber, fuelwood, fruit and ornamental tree species, was prepared for village managers, forestry extension personnel and school teachers. The Forestry Division was to provide seedlings and technical assistance in planning and establishing plantations and nurseries. The emphasis of the campaign was the establishment of village woodlots.

The campaign was successful in creating more awareness in the villages of the need for afforestation, but not in the establishment of village woodlots. Although 25 percent of the villages reported planting woodlots (21 percent planted the previous year), survival rates were extremely low. Initial reports which gave number of seedlings planted were succeeded by surveys which showed very low survival rates of communal woodlots (Mascarenhas *et al.*, 1983; see also Mnzava 1984). The reasons given for this was delayed planting (mobilization of labour), lack of water, neglect of weeding, lack of explanation to the farmers as to who would benefit from the village woodlots (and doubts concerning village officials' honesty), and the lack of village participation in deciding which trees would fulfill their needs.

The village afforestation programme has been criticized for not involving the villages, and by inference the farmer, in the project design and implementation. It appears that in the vast majority of the villages, an explanation of what was going to happen to the income from the village woodlot was not forthcoming (Nilsson, 1983). For many farmers, contributing labour to establish a resource which they would later have to pay to utilize, was unappealing. As Skutsch (1985) notes, in some villages there was a distrust of both the village officials and the motivations of the government. The villagers were not motivated to take part in a programme in which village officials would be given control of the income or the government given control of the land.

Tree selection was another aspect of its failure. The seedlings supplied by the Forestry Department reflected the government's concern about fuelwood. Farmers in Tanzania, as in other countries in the region, are fairly disinterested in planting trees for fuelwood alone; a multipurpose tree is perceived as being more desirable, or a tree from which monetary benefits are fairly certain. Hence, fruit trees are planted by farmers throughout Tanzania. A common complaint about *Eucalyptus* spp., a favourite of the Forestry Department, is its susceptibility to termites and therefore the uncertainty of benefit outweighs the effort of planting and caring for the seedlings. Farmers also perceive *Eucalyptus* spp. as having a detrimental effect on agricultural crops and water (Mwihomeke, pers. comm.).

However, if village woodlots had low survival rates, school gardens and individual farmers seedlings fared much better. If the government objective of village woodlots was redefined to include "trees grown in the village" the results of the campaign and its aftermath become more positive.

Table 7.3 Planting groups and survival rates

Planting groups	0-25	26-50	51-75	76-100	N.K.
Village/Communal	50	35	15	-	-
School	10	20	40	25	5
Individual	14	46	32	4	4

Sources: Mascarenhas *et al.*, 1983: 90; Nilsson, 1983

Small farmers and trees

The afforestation programme has primarily been concerned with fuelwood. In part this was designed to redress the stress on the natural forest resources as the Tanzanian population was relocated from scattered households to villages. Currently there is growing concern with other benefits of tree planting: soil conservation and watershed management. Although Tanzania has promoted communal rather than individual solutions to the fuelwood, tree planting has been more successful with individual farmers planting trees on their allotted land.

The planting of exotic fruit trees reflects the preference for trees which can be used for food, income, and perhaps, fodder and fuelwood. Indigenous fruit trees are slower growing and have less commercial potential than exotics, and although they may be maintained, they are not usually planted (Mwihomeke, pers. comm.).

2. Agroecological Zone Analysis

2.1 Unimodal Upland Plateau

Definition of zone

Crop growing period ranges from 90-270 days.

Rainfall is unimodal; the average rainfall per month is more than 75 mm for the drier months in between the rainy peaks. Within the plateau, rainfall varies from 650 mm to 1000 mm.

Altitude ranges from 600 m - 1500 m.

The natural vegetation in this zone is "miombo" (*Brachystegia/Julbernardia* woodland) and *Acacia* woodland. Clearing to eradicate tsetse fly, expand agricultural fields, and maintain grazing areas have led to widespread deforestation, especially in the Shinyanga and Dodoma areas.

The 36.5 million ha. of unimodal upland plateau constitute about 40 percent of the total land area in Tanzania. Out of these, 11 million ha. are forest reserves and these constitute 90 percent of the reserves in the country.

About a third of Tanzania's population live in this agroecological zone. Settlement is limited by poor infrastructure and prior tsetse infestation. Forty percent of the nation's cattle and thirty-two percent of the goats are in this zone. There is ethnic variation: the Sukuma dominate the eastern part and have a strong agro-pastoral tradition and in the southwest, the Nyambezi and Sumba are mainly agriculturalists.

There are 4 major land use systems:

Sukuma agro-pastoral system: This is the best documented system. Research interest has been focused on the Sukuma in part because of the environmental degradation in the region.

Cotton-cereal system with cattle:

Cotton-cereal system without cattle:

Tobacco-cereal system. This system utilizes large quantities of fuelwood for the drying of the tobacco leaf.

(Primary sources: TATF and ICRAF, 1988a and 1988b; Barrow *et al.*, 1988.)

Case study: Sukuma Agro-Pastoral System

Location

Sukumaland covers the regions of Mwanza and Shinyanga. Elevation ranges from 1000-1500 m above sea level and the area receives a mean annual rainfall of approximately 600-700 mm with the rains beginning in November and ending in April/May.

Population

In 1987 the population in Mwanza and Shinyanga was about 3,100,000 and it was growing at an annual rate of 3.4 percent a year. Eastern Sukumaland has the highest population densities and this is explained by the constraint of tsetse infestations on pastoral expansion to the west and south.

Land tenure

Traditionally the Sukuma recognized rights of usufruct rather than individual ownership of land. As long as the field had crops there were recognized rights of occupancy. However, once the field was harvested it once again reentered the "pool" of land for free grazing. Perennial crops such as cassava are not open to grazing. It is unclear whether if an area is planted in trees it would remain ungrazed or be recognized as "belonging" to an individual.

Tree tenure

Land tenure is separated from tree tenure and hence in Sukuma society the individual who planted the tree became the recognized owner. This did not imply that he owned the land, only the tree. As mentioned above, it is unclear how the trees would fare if they were distant from the homestead. Villagers are, however, willing to plant trees around the homestead. Barrow *et al.*, (1988: 13) note that "for these trees there is a certain security of tenure. There is also the habit of claiming ownership to clumps of bushes or trees by individuals within the precincts of the village."

Land use system

The Sukuma are agropastoralists. Crops grown are: cotton, rice, sorghum, millet, and potato. The major food crops are sorghum and millet. Rice is grown on the bottomlands which retain water.

Cotton is the major cash crop and is grown as a monoculture. The government encourages farmers to plant at least half a hectare. Most farmers exceed this and field sizes for cotton vary from less than a hectare to over three hectares. Because of frequent droughts in the area, farmers are also encouraged to cultivate at least half a hectare of drought-resistant crops like sorghum, millet, and cassava. Intercropping is common, especially sorghum and millet with legumes and sunflower. Although cotton is the primary cash crop, sunflower, surplus maize, *etc.*, are readily sold for cash.

Livestock are part of the agropastoral system. The local rule of thumb is that for every person there is a cattle counterpart. Cattle are kept mainly as capital, both social and financial. Cattle have proven to be the great frustration of planners in the region, especially since herd size rather than productivity of the herd appears "to be of paramount" importance. Cattle provide milk primarily for home consumption, and are sold only under duress. Oxen are used for ploughing, and also for transport (ox-cart).

In spite of the ecological pressure towards closer integration, there is a notable lack of integration of the agricultural and pastoral forms of land use. The use of land for agriculture and other purposes is perceived as being in direct competition with the use of land for grazing. The Sukuma utilize the pastoral risk reduction strategy of maintaining large herds, so the land for agricultural expansion is limited. The government has a destocking goal of 10 percent reduction in herd size, but it is unlikely to be met.

Farm manure is not applied on crop fields. Several reasons were given for this: insecurity of land tenure; distance to agricultural fields; cultural beliefs that cattle and crops should not "mix"; and the competitive use of manure as a fuel.

Tree component

Sukumaland is severely deforested. In the past there was, as throughout the region, deliberate deforestation efforts as part of the tsetse eradication campaign. Deforestation has continued because the growing population has needed agricultural land and tree products. Within settlements, trees are cleared as a result of the cultural practice of clearing trees to prevent the nesting of grain-eating birds near the fields (see Mnzava, 1980).

TABLE 7.4: COMMON TREES IN THE SUKUMA AGROPASTORAL SYSTEM

Tree/shrub	Identified uses	Density of planting	Location	Comments
Cassia siamea	firewood, shade, windbreak	woodlot, scattered single trees	homesteads, schools, government woodlots, compounds, along roads	very common, exotic, almost naturalised
Delonix regia	windbreak, pods firewood, shade	single trees	homesteads, schools, compounds roads nr villages and trading centres	very common, wide canopy, seeds profusely in the rainy season
Albizia lebbek	windbreak, firewood, shade	single trees	homesteads, villages, schools, trading centres	very common, introduced seeds profusely in the rainy season
Acacia arabica/nilotica	windbreak, firewood, shade	woodlot, single trees	dam protection nr Kwimba town, village homestead compounds, schools, roads, gardens	very common, indigenous, thorny, grows very fast and sheds leaves in wet season, birds like nesting in the crown
Melia azedarach	windbreak, poles, firewood, shade, ornamental	woodlot, single trees in mixtures with other species	village homesteads, compounds nr roads, villages and trading centres	very common, introduced into area, good growth
Parkinsonia aculeata	ornamental, shade, very few identified for firewood	scattered single trees	a few trees in every village homestead compound, around schools and garden boundaries	common, fast growth, potential for browse not yet realised
Leucaena leucocephala	firewood, poles, browse	scattered single trees	homesteads compounds, along paths in trading and village centres, gardens, fodder trials at Malya livestock resource centre	introduced grows very well, seeds profusely, browsed at early stage, withstands fire - with regrowth
Eucalyptus camaldulensis E. citriodora	firewood, poles	woodlot, single trees	nr villages in homestead compounds, around schools, paths, trading centres.	introduced, grows well, very common
Euphorbia tirucali	fencing	perimeter live fencing	homestead enclosures & cattle boma fencing	indigenous species, apart from fencing, finger-like nodules are used in divination, not useful for fuelwood
Tamarindus indica	edible fruit, shade	scattered single trees	village homesteads, few in gardens	indigenous? very suitable species for semiarid areas but grows slowly deeperown with dense foliage reduces cropgrowth beneath shade
Gmelia arborea	firewood, poles	few scattered single trees	school compounds, village compounds	introduced, not yet widely grown
Azadirachta indica	firewood, shade	few scattered single trees	school compounds, village compounds	introduced, potential not realised, good growth
Acacia albida	shade	very few trees	only at Magu District headquarters	not common, the few trees look healthy- flowering
Mfausiku (family Mimosideae)	live fencing	perimeter fencing	homestead enclosure & cattle boma & gardens near cattle paths - fencing	perhaps one of the most common fencing materials, veg. propagated and fast growth
Sisal	live fencing, poles, sisal fibre	linear and several numbers of plants density	homestead enclosure & boundary fencing around cattle bomas	most building poles for roofing, also all ropes for holding the grass thatch, common useful plant for fibre
Mangoes, pawpaws, guavas, lemons & oranges.	common fruits	individual trees at times in clusters	around homesteads and in gardens	very common

Source: TATF and ICRAF, 1988.

The agropastoral land use system is by far the most deforested of the systems. This lack of trees results in fuel scarcity for household consumption and as a consequence cow dung and crop residues are burnt. There is also a lack of timber and poles for house construction. Most houses in rural Shinyanga are built from sun dried mud bricks. Houses are flat roofed, some with sod-like covers. Sisal poles are extensively used in building and roofing since other building materials are not available.

There are differing accounts of what species are used to build cattle enclosures. Barrow *et al.* (1988:17) note "that most cattle enclosure...are built from *Acacia* spp. and *Dichrostachys cinerea*. Thus the building of cattle bomas form a significant strain on the regenerating vegetation. TATF and ICRAF (1988a, 1988b) report the use of *Euphorbia tirucali* for fencing of bomas and homesteads but add that the species is fast growing and is not useful for fuelwood (see Table 7.4).

Labour

The household provides most of the labour, but it is "not sufficient to carry out all the necessary operations" (TATF and ICRAF, 1988a:8). Ox-ploughing during land preparation, and exchange labour during peak periods, supplement familial labour. Wage labour also occurs, especially for farmers with large fields of cotton. Given the variety of crops/needs of livestock there is no "off" period during the agricultural year because there are always agricultural tasks to be done. Seasonal labour shortages, especially for weeding, serve as a production constraint (TATF and ICRAF, 1988a).

Perception of trees

The Sukuma are regarded as having a rather adversarial attitude toward trees (Wood, 1966). A dislike for bush in distant fields (a survivor of the anti-tsetse campaign) combined with the cutting of trees near the fields (to stop the nesting of grain-eating birds) could lead to such a conclusion.

However, a look at Table 7.4 reveals that a large number of trees (both species and number) are currently found in Sukuma areas. A further look at the table shows that almost all of the trees are planted in protected areas, *eg.* homesteads or school gardens, or used for living fences. Insecurity of land tenure was identified by the TATF and ICRAF report (1988a) as a constraint for tree planting. However, this might be only part of the reason, since a serious constraint on the survival of tree seedlings is heavy browsing by livestock. The TATF and ICRAF report (1988b:40) notes that "tree planting by village officials is constrained to marginal planting sites where cattle are unlikely to venture." Grazing practices follow a fundamental principle: all uncultivated lands are subject to public right of pasture. To plant trees and define the area as cultivated, would effectively take the land out of the grazing "pool" and this is not likely to be a popular move given the social and economic value of cattle.

Use of tree products:

The burden of collecting firewood falls upon women. It is estimated that women spend 38-65 man days per year collecting firewood (Kaale *et al.*, 1983). Villagers perceive firewood as being in short supply. When fuelwood becomes too difficult to find, cow dung and crop residues form an important source of energy (up to 24 percent of fuel used). Fuel wood can account for up to 30 percent of the family income (Barrow *et al.*,

1988). Prices for fuel are high; TATF and ICRAF (1988a) report prices of up to TSH 1,000 for a 1m³ stack of fuelwood and TSH300 for a bag of charcoal.

The building materials used reflect the lack of timber. Sisal poles are used for roofing, and sun baked bricks are used for walls.

Interventions in support of tree growing

The government has initiated tree planting programmes in the area. The Forestry Department's programmes attempt to establish plantations and woodlots. Seedlings were supplied to villages, school, institutions, and individuals. Among the species introduced were *Cassia siamea*, *Albizia lebbek*, *Melia azedarach*, and *Leucaena leucocephala* (see Table 7.4). Financial limitations were the major constraint in not meeting seedling distribution goals.

Preferred species for tree planting

Individual farmers appear to be growing fruit trees and multipurpose trees, rather than trees only for fuelwood. Barrow *et al.*, (1988) noted that women preferred to plant fruit trees rather than trees for fuelwood. However, part of the explanation lies in the fact that fuelwood planting in the village was tied to organizational (UWT - Women Organization of Tanzania) tree plantations, and the women said that they were not interested "due to an already heavy workload, and that they did not have time to work on the afforestation programmes" (Barrow *et al.*, 1988:21). Again, when having a tight work schedule, time might be better spent on planting fruit trees around the homestead where tenure rights are clear, rather than providing labour to an organization project where the benefits are uncertain.

Conclusions: Unimodal Upland Plateau

Where are farmers planting or not planting trees?

Tree planting does occur among the Sukuma, but only on a very limited part of the potential landscape. This limitation is the result of the lack of integration in the agricultural and pastoral subsystems of the agroecosystem. Since there are traditional rights to grazing on harvested fields, perennial crops are perceived as being in competition with livestock. This perception combined with the belief that trees are "bad" for cattle, does not create a situation conducive to large scale woodlot or village forest projects.

However, tree planting in home compounds, roads, *etc.*, does illustrate that trees can be integrated into the agroecosystem, but on an individual, small scale basis, rather than in a large communal woodlot.

How does tree planting relate to ecozone, and to cultural traditions and values?

The ecozone is semi-arid (although ICRAF also uses the term sub-humid). Cattle are highly valued not only for prestige and as "capital on the hoof", but also for providing an economic safety net during times of drought and crop failure. Beyond the compound, tree protection from browsing appears to be difficult, if not impossible. The cultural mechanisms for tree protection do not appear to exist. Protected and managed grazing areas, however, do exist in some villages in the area (Barrow *et al.*, 1988). Whether the

cultural mechanism that protects grazing could be utilized to protect trees should perhaps be explored.

What incentives are there for tree planting?

Part of the reluctance to plant "outside the compound" may be the uncertainty as to whether the tree will be protected from animals if it is planted in the fields. Planting trees in the village/communal plot also involves uncertainties over benefits. At one site in the Shinyanga area, although individual households had a seedling survival rate of 40 percent and schools 50 percent, the village 2 acres had no seedlings survive. The fact that individual households and schools had high survival rates, whereas the village had none, shows that there was adequate knowledge of tree management, but the ability to protect and/or the perception of possible negative results from the village forestry project, resulted in failure at the village level (Mascarentes *et al.*, 1983). The problems of getting labour to plant, water, weed, *etc.*, the village plot on schedule were not solved by the village leaders.

How does tree planting by farmers relate to government efforts and extension attempts to promote tree planting?

The government efforts in Shinyanga are directed to tree planting as a solution to projected and current fuelwood shortages and soil conservation. Programmes were oriented toward communal/village woodlots. Seedlings were provided by the Forestry Department and villages were to provide the land and labour for the establishment of the woodlots. Communal woodlots were not a success and survival rates were very low.

Tree planting did occur, as did the maintenance and care of the seedlings, but not in a village woodlot setting. Individuals and schools had much higher seedling survival rates. In the villages there is a perception of fuelwood shortages, although whether it is perceived as a chronic problem rather than a crisis is unclear. What is clear is that farmers appear to be more motivated by tree planting which has clear benefits.

Therefore, it is not a surprise that fruit trees and multipurpose trees continue to be the trees of interest to the villagers. Fruit trees are well known, and provide nutrition and on occasion income. Programmes in Shinyanga were designed according to what was perceived on the national level as the problem(s), rather than to what the villagers themselves perceived as their problems.

Nationally, there are signs that government programmes are becoming more responsive. There has been a shift in policy towards the decentralization of nurseries, using more indigenous species, providing seedlings to individuals (by 1986, 60 percent of seedling were going to farms rather than woodlots), and promoting fruit and multipurpose trees rather than just fuelwood varieties (Scherr, 1986).

2.2 Highlands

Definition of zone

Crop growing period ranges from 150-270 days.

Rainfall is between 750-2000 mm, bimodal in the northern highlands and unimodal in the southern highlands. The highlands of Tanzania have a higher potential for crop production than any other zone in the country: rainfall is adequate; soils are better (higher organic content, *etc.*); and the photosynthetic conditions for grains are good (Lundgren and Lundgren, 1982).

Altitude is from 1000 - 2000 m (or more). There are two distinct highlands: the Rift valley volcanic highlands which separate into 2 distinct geographical areas - the higher northern highlands (including the volcanic peaks of Mt. Meru and Mt. Kilimanjaro), and the southern highlands bordering the lake region; and the block mountain massifs which reach 2000 m, the most important ones are the Usambaras Mts. and the Uluguru Mts.

The above factors have not gone unrecognized by the Tanzanian people. The highlands and mountains have the highest population densities in Tanzania.

There is ethnic variation, although a particular group tends to dominate a particular mountain or escarpment. The Meru, for example, dominate Mt. Meru, the Chagga Mt. Kilimanjaro, the Arusha the Arusha area, and the Luguru the Uluguru Mountains. The mountain groups tend to be well organized with clearly defined rules of descent, inheritance, and leadership.

The farmers of the northern highlands have developed soil and land use systems which utilize crop rotations or permanent crop production based on the "multiple benefits of trees" (ICRAF, 1979:12). Many trees, both in species and number, are grown on each farm plot. The growing of trees together with crops has protected the land on the slopes of the mountains against soil erosion and has enabled the residents of the area to live in permanent homes for generations. Although Kilimanjaro and Meru are the prime coffee growing areas in Tanzania today, the traditional system of integrating crops and trees predated the introduction of coffee.

In the mountain massifs such as the Usambara, cattle are an important component of the land use system. Intense cultivation of slopes has led to severe erosion in the highlands. Farms are fragmented, each farm having 3-4 plots ranging in size from 1/2 to 2 hectares each. Erosion control using Guatemala grass and ridges has been successful among farmers who have relatively large farms and who are motivated to maintain cattle in the highlands (Baum, 1984; see also Brain, 1980). Although population densities are high, farm size is larger than in the Meru-Kilimanjaro area, and farmers still use extensive rather than intensive indigenous land management systems.

(Primary sources: ICRAF, 1979; Fernandes *et al.*, 1984; O'king'ati *et al.*, 1984; O'king'ati and Mongi, 1986)

Case study: Chagga Agroforestry (homegarden) System

Location

The Chaggas are found on Mt. Kilimanjaro in northern Tanzania. The intensive gardens are found on the eastern and southeastern sides of the mountain where the rainfall is highest and more certain. The Chagga homegardens are located mainly between

900-1900 m. (1900 m marks the beginning of the forest reserve). The region has a bimodal rainfall pattern; the range of rainfall is from 1000 - 1700 mm depending on elevation, exposure and aspect (Fernandes *et al.*, 1984 and 1985)

Population

Mt. Kilimanjaro is one of the most densely populated areas in Tanzania. Estimates of population densities of 500 km² are given for the southern slope. Annual population growth is at least 3 percent. The region has both the lowest infant mortality rates and the highest expectancy of life in Tanzania. Household size is 9.9 members which is far above the national average of 5.3.

Land tenure

Traditionally, land tenure was based on a religious belief that there is a "close 'spiritual' link" between one's ancestors and the land. Once a member of the immediate family was buried on the land, tenure was assured for the current owner and his descendants. Although a staunchly Christian area today, Chagga tenure still follows this belief concerning land held on Kilimanjaro. However, tenure for land in the nearby lowlands, which is used by the Chagga for the production of annuals such as maize, beans, and finger millet, is on an annual and usufructuary basis. A plot on Kilimanjaro could theoretically be abandoned for several years, but would still be recognized as "owned", whereas the lowland plots which are allotted by the government could be reallocated to another individual.

Traditionally, land was only divided between the sons, but now daughters can also inherit a part of the homegarden. There is pressure for sons to leave to "make their fortunes" in the urban areas. A common pattern is for a man after marrying and having several children to leave the farm and work elsewhere for a number of years. The wife will manage the farm and take care of the livestock.

Land use system

The Chagga land use system is characterized by intensive smallholder farms producing both subsistence and cash crops. It is referred to as an agroforestry system since it integrates trees with food and cash crops and livestock on the same piece of land. Many families maintain both a homegarden on the mountain and another plot on the drier plain below. The lowland plot is primarily used for growing annual crops, providing fodder for the cattle, and providing fuelwood. The diversity of resources utilized (homegarden, lowland fields, multicrops, livestock, *etc.*) creates a stable subsistence system. Bananas or coffee might fail, but failure of all the crops has never occurred.

Coffee is the major cash crop, and is grown in the homegarden. Cardamom, surplus bananas and other food crops are also sold. The homegarden is small and the average size is 0.68 ha. with a range of 0.2 to 1.2 ha. The homegarden fields are multileveled:

Livestock are part of the agroforestry system. Cattle are kept for milk, while goats and pigs are kept for meat which is either sold or consumed by the household. The number of cattle kept are small, usually 2-3, since animals are stall fed and fodder must be carried to them. Fodder is gathered from the homegarden (tree/shrubs, banana plants and grasses) and is supplemented by fodder which is harvested from the lowland fields

or is purchased. Most families are self-sufficient in fodder (Fernandes *et al.*, 1984 and 1985).

Table 7.5 Homegarden Composition

Level (m)	Description
15 - 30+	large trees providing the canopy and upper zone, usually of valuable timber trees, fodder and fuelwood species
5 - 20	diffuse zone of the preferred fuel and fodder species
2.5 - 5	banana canopy with some fruit and fodder trees
1 - 2.5	coffee with a few young trees/shrubs and medicinal plants
0 - 1	food crops like taro, beans, and fodder herbs and grasses

Dung from the livestock is spread around the banana clumps and coffee bushes. Chemical fertilisers are generally not used, although pesticides and fungicides are sprayed on the coffee (Fernandes *et al.*, 1984 and 1985).

Tree component

Fernandes *et al.*, (1984) found that in addition to the coffee there are an average of 39 other trees/shrubs retained and managed on the homegarden. In a survey of plant species of 42 families there were 53 tree species found. O'king'ati and Mongi (1986) reported similar findings and noted that of the 39 species most were local species, rather than exotics. At both sites, most of the plant species were maintained on the farm for two or more uses.

In the case of trees, the main uses were fuelwood (90 percent of the tree species), medicines for humans and livestock (30 percent of the tree species), poles (25 percent of the tree species), shade (24 percent of the tree species), timber production (23 percent of all trees species), fodder production (10 percent of all the tree species), and other uses (19 percent of all tree species).

Most Chagga farmers will either plant or encourage wildings of valuable timber species. Teak trees, for example, are encouraged and the overhead canopy is thinned to allow growth. Such trees will be "harvested" between 60-80 years of age. When the tree is felled, the present owner of the field will plant another, so that the next owner will inherit a valuable tree.

Labour

The large household size (9.9 members) provides a workforce of four family members. Although there is a peak labour period between January and March, agricultural work

occurs throughout the year. While labour in the homegardens is performed by family members or hired labour, in the lowlands, tractors may be used for plowing. Men are responsible for the fuelwood and women for the fodder.

Currently, labour does not appear to be a serious constraint in maintaining agricultural productivity. The large household size and the availability of seasonal labour provides sufficient labour. However, there is concern that the outmigration of young adults may create a disruption in the transfer of knowledge and experience necessary to maintain the complex Chagga multicropping system (see Fernandes *et al.*, 1984:84).

Perception of trees

The Chagga appear to have a very positive perception of trees. Trees are planted and wildlings are protected, *etc.* in order to obtain a complex mix of trees for different purposes. The natural forest in the region has been transformed into a man-made forest with species utilized by the Chagga replacing "unuseful" trees and plants.

Use of tree products

Even in areas which have electricity, the only source of cooking fuel is fuelwood. Chagga men have the responsibility of "lopping the fuel and fodder trees while the women harvest the fodder grasses and herbs" (Fernandes *et al.*, 1984: 77). It was estimated that the homegarden supplies 1/4 to 1/2 of the fuelwood requirements of the household. The rest is obtained from the forest reserve (illegally) or from the lowland fields from trees such as *Acacia* spp. and *Cambretum* spp.

O'king'ati and Mongi (1986), in a different site from the Fernandes *et al.* (1984 and 1985) studies, found that each household spent an average of 2.1 hours a week collecting fuelwood with truck or ox-drawn carts commonly used for transport. Compared to the rest of Tanzania, this is a very low time expenditure for fuelwood collection. Fuelwood is available for sale, and large beer brewers (women) will buy pick-up trucks of fuelwood (in all probability illegally cut from the forest reserve).

O'king'ati and Mongi (1986) report that in 1983 the average farmer bought more wood products (poles and timber) than he sold:

Table 7.6 Exchange of wood products

Wood products	Bought*	Sold*
Lumber	343.2	-
Logs	-	20.5
Poles	76.1	6.8
*Prices in Tanzanian Shillings		

The income differential might be exaggerated by the structure of the survey (small sample size; and use of the mean, maximum and minimum but not the frequency, *etc.*) but it probably reflects the general trend to buy more products than are sold.

It might also reflect the building demands of the Chagga household. Houses are substantial dwellings (sitting rooms, bedroom(s), verandas, and outside kitchen and stables) which might require more lumber than the homegarden can produce. A useful study would be to find what proportion of the building materials is produced within the homegarden and what proportion is purchased.

Interventions in support of tree growing

There appears to be little government intervention concerned with tree planting in the area. This is understandable, since the government's primary efforts have been focused on areas of severe deforestation and soil erosion. The Forestry Department has a large nursery, and households reported getting fruit and *Cassia siamea* seedlings from it. This is only a small percentage of the total number of seedlings. Far more are obtained from neighbours, churches, the wild, and the farmer's own fields.

Extension services and the Lyamungu Coffee Research Station have periodically tried for several years to get the Chagga to stop intercropping coffee with other crops. Chagga have continued to maintain the coffee-banana crop system. Past experiences with coffee crop failure, non-payment by the government and falling world market prices, *etc.*, have served to reinforce the wisdom of intercropping.

However, other government interventions have had an impact on the region. During villagization the Chagga managed not only to maintain their villages in the highlands, but also to obtain access to fields in the lowlands. The lowland fields have removed some pressure from the highlands and this has allowed further diversification of the agroecosystem.

The cattle improvement projects have encouraged the adoption of hybrid cattle. Milk production is much higher but women fear the new cattle because of the higher fodder demands (O'king'ati and Mongi, 1986). However, since women provide fodder and receive the money from selling milk, the improved breeds are gaining favour, especially with the improvement of roads to the Moshi markets.

Preferred species for tree planting

The Chagga prefer multipurpose trees, especially trees that can be used for both fuelwood and potential income or house construction (poles and timber *etc.*). *Grevillea robusta*, for example, was introduced as a coffee shade tree, but it is now also valued for its timber. It should be noted that not all trees in the agroforestry system have been planted, there are volunteers, wildlings, *etc.*, which are incorporated into the system.

Conclusions: Highlands Zone

Where are farmers planting or not planting trees?

Tree planting occurs in homegardens. Allotted land in the lowlands is planted with maize, millet, and beans, and some trees are left standing, but not planted, in or around the fields. This lack of tree planting in the lowlands is probably a result of the lack of long term tenure, as well as the nature of the plots themselves. These plots are perceived only as a means of supplementing the household income. The maize harvested will be sold, but the millet will be used in banana beer. Millet is imported into the area

since local supplies are insufficient to meet demand. The homegarden is the centre of the household economy and receives the bulk of the family labour and attention.

How does tree planting relate to ecozone, and to cultural traditions and values?

The natural vegetation of the area is montane rainforest. The Chagga have manipulated the rainforest to create a more productive man made forest. They have an intimate knowledge of the crops, plants and trees and their ecological needs. The diversity of crops and crop varieties (there are 15 varieties of banana), trees and useful plants, *etc.*, is culturally valued.

What incentives are there for tree planting?

There are several incentives for tree planting in the Chagga agroforestry system:

Environmental: The Chagga are aware that tree planting is beneficial in terms of soil and water conservation and microenvironmental improvements (providing shade for coffee, taro, *etc.*)

Fuelwood and wood products: The homegardens provide a large proportion of the fuelwood and some building materials.

Income: Tree planting can provide income and/or provide products that would have to be bought if they were not produced in the household.

Diversification and risk spreading: By having a large number trees that provide a diversity of products, there is a minimisation of risk and subsequently the overall stability of the system is enhanced.

How does tree planting by farmers relate to government efforts and extension attempts to promote tree planting?

Although it has been an indigenous effort rather than government induced, Chagga tree planting is in some ways not dissimilar to the government strategy of planting fuelwood trees. A large proportion of the trees planted by the Chagga are used for fuelwood and soil and water conservation. Indigenous trees rather than exotics are preferred, but the forestry department nurseries are a source of fruit tree seedlings.

Little input has been needed from the government for tree planting by this pro-tree and well organized population.

3. Tanzania Summary

1. Community/Village forestry/woodlots have not been a successful basis for afforestation in Tanzania. There has been recognition of this by the government and policy has shifted from the communal woodlot to the individual farmer.

2. Fuelwood trees are not the first choice of farmers. Farmers, both in Shinyanga and Kilimanjaro (and elsewhere) want multipurpose trees and farmers in some areas might prefer a fruit tree. Even in Kilimanjaro where farmers obtained seedlings from churches, neighbours, forests, and gardens, fruit tree seedlings (especially citrus) came, in many instances, from the Forestry Department nursery.

3. At both case study sites, trees were found in the homegardens and not in the fields. This was the result of two different strategies for tree protection and tenure. The Shinyanga, uncertain of being able to protect, or have rights to protect, tree seedlings, plant them on the homestead where grazing is clearly prohibited. The Chagga plant trees in the homegarden since tenure is assured and trees are an integral part of the homegarden agroforestry system. Planting trees in the lowland fields where tenure is less certain would take labour from the tenure-secure homegarden.

4. Knowledge of tree planting and maintenance does not appear to be a constraint in Tanzania but the motivation to do so however, might well be. Farmers want certain types of trees, secure tenure, and clearly defined benefits for tree planting. If any of these are lacking farmers will be reluctant participants in afforestation programmes.

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8. COUNTRY REPORT: MALAWI

1. General information

1.1 Background

Population

The population of Malawi was estimated in 1990 to be approximately 8.4 million people with an average annual growth rate of 3.6 percent a year. Although the average population density nationwide is 85 persons/km² (188 persons/km² on cultivable land), there are wide variations in population density within the country. There is a population gradient from north to south: the lowest population densities are in the north; the central region is more heavily settled; and the southern region experiences the highest densities with some areas having more than 300 people/km². (MATF and ICRAF, 1986; Carr pers. comm.).

Topography

Malawi is a small landlocked country which can be divided into three distinct topographic regions:

On the eastern border is the Rift Valley, containing Lake Malawi and the Shire valley, cutting across the country from north to south. The Rift Valley has the lowest altitudes of the country with the southern portion 250 m below sea level.

The highland areas which arise out of and roughly parallel the Rift Valley. The highland areas consist of mountains in the north (Misuku, Nyika, and Vipya) and in the centre (Ntchisi, Dowa, Dedza and Kirk range) and the Shire Highlands in the south.

The plateau which borders the highlands. This region "has a gently undulating landform within a altitude of between 1000-1400 m" and covers about three quarters of the country's land area (MATF and ICRAF, 1986:4).

Climate

Except for isolated high altitude areas, the rainfall of Malawi is unimodal with one rainy season (November to April). Rainfall varies regionally both in total amount (750 mm - 1600+ mm) and monthly distribution. The Shire valley within the Rift valley and areas of the western plateau within the rainshadow of the highlands and escarpment, are semi-arid and receive below 750 mm of rainfall, while in the plateau and highland areas rainfall may exceed 1600 mm.

Vegetation

Estimates of forest cover range from 9 percent (MATF and ICRAF, 1986:18) to 38 percent (Malawi Government, 1987) of Malawi's land area, with the greatest concentration of forests found in the northern highland region. The natural vegetation on the plateau is miombo woodland. This contains *Brachystegia*, *Jubernardia* and *Isobertina* as the major species, with *Acacia*, *Piliostigma* and *Combretum* species also present. There are also areas of savannah grassland (low altitude) and montane grassland (high altitude).

Soils

Most of the soils along Lake Malawi, in the Shire Valley, and on the plain adjoining Lake Chilwa (southern Malawi) are alluvial in origin, fertile and "highly suitable for agricultural production" (MTAF and ICRAF, 1986: 6). In the other areas of Malawi "the soils are typically formed *in situ* over sedimentary and, to a lesser extent, crystalline rock. Such soils are ancient, heavily leached and, as a rule, they are of medium to low fertility" (MTAF and ICRAF, 1986: 6). However, fertile red loam soils do occur in the Shire highlands and the Lilongwe Plains.

1.2 Agroecological zones

Within a framework based on altitude, climate, soils and vegetation, Malawi can be divided into three major agroecological zones (table 8.1).

Table 8.1 Description of zones

Zone	Altitude (m)	Description
Shire Valley - upper	<250	Southern part of the Rift Valley has a relatively low rainfall, the vegetation is primarily savanna grasslands and thickets.
Shire Valley - lower	300-600	(including the lake shore) also has a vegetation of grasslands and thickets.
Medium Plateau	800-1600	The vegetation in the Northern and Central regions is primarily composed of miombo woodland, dominated by <i>Brachystegia</i> and <i>Julbernardia</i> spp.
Highlands	1600-3000	primarily mountainous, with rainfall generally high and temperatures relatively low. On the high plateau the vegetation is mountain grasslands, while at the lower altitudes miombo woodland is most common.

Source: based on MATF and ICRAF, 1986.

Unimodal Upland Plateau

The medium plateau area lies within the Unimodal Upland Plateau, which is the high potential, unimodal, zone identified by ICRAF. It is a more broadly defined zone than the medium plateau, occupying more than 75 percent of the agricultural land of Malawi and including some of the most densely populated areas. The Unimodal Upland Plateau is defined as:

Crop growing period	90-270 days
Rainfall	unimodal - 760-1140 mm
Altitude	600-1600 m
Vegetation	miombo or acacia woodland (not savanna or montane grasslands)

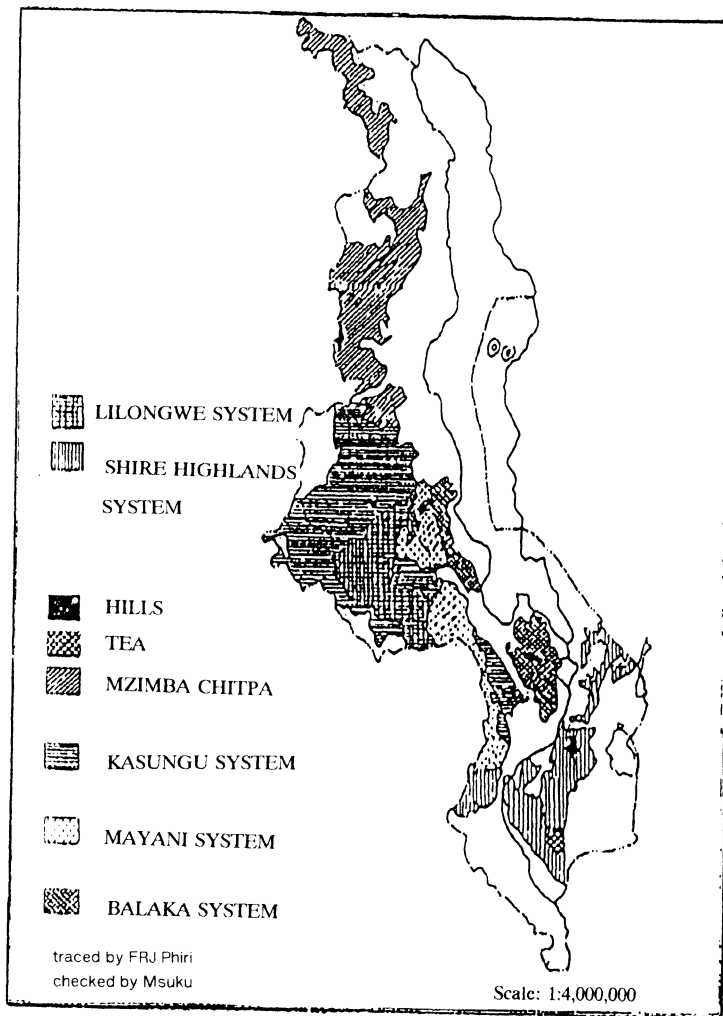
The amount of rainfall (+ or - 750 mm) and length of the crop growing period (a 180 day isoline) can be used to further delineate this zone into two subzones: a drier (semi-arid) zone with a growing period of 90-180 days; and a wetter (subhumid) zone with a growing period of 180-270 days. The western parts of the plateau (excluding the Lilongwe plains) are considered to be in the drier zone, and all the highlands including the Lilongwe plains are in the wetter zone (MTAF and ICRAF 1986).

The pattern of land use is similar throughout the Unimodal Upland Plateau in Malawi, where maize is cultivated by the great majority of farmers. In the Plateau, the southern region is a net importer of maize, while the central and northern regions are the maize surplus areas. This area is also the major producer of groundnuts, pulses, vegetables, and fruits within the country.

It is difficult to distinguish between land use systems in the Upland Plateau due to this apparent uniformity of the land use throughout the zone. However, utilizing criteria based on environmental potential, topography, growing days, population density, relative importance of crops, *etc.*, six land use systems in the Unimodal Upland Plateau have been identified (see Figure 8.1) (MATF and ICRAF, 1986):

1. Shire highlands (Chiradzulu) system. The system occurs in the south of the country, mainly to the east of the Rift Valley. There is high population density with, for example, 50 percent of the households in some areas having farms of less than 0.7 ha (Carr, pers comm.). Relay cropping is a common feature of the system. It is an important source of vegetables for the Blantyre and Zomba urban areas.
2. Mayani system. This includes the hill areas in the centre of the country to the west of the Rift Valley. There is cultivation on the steep slopes prone to soil erosion. Soils are highly leached with pockets of high acidity. This system is an important source of vegetables and fruit.
3. Lilongwe system. This is on the central plain near the capital. The population density is high. The soils are fertile sandy clay loams with potential for intensive crop production.
4. Kasungu system. This is located on the plains mainly in the west of the country. The soils are sandy and of low fertility. Tobacco and groundnuts are important crops.
5. Balaka-Mwanzambo system. A fairly recent settlement area located between the Rift Valley and the escarpment with medium population density. Poor ferruginous soils, high temperature and low rainfall limit its productivity. Cotton is the main cash crop.
6. Mzimba (Chilungu) land use. This system is found in the western part of the Northern Region where population density is still relatively low. The main crops are maize, groundnuts, beans and tobacco. Beyond their intrinsic value, livestock are also important in this system for sociocultural (brideprice) and agricultural (draught) reasons.

Figure 8.1
UNIMODAL UPLAND PLATEAU: LAND USE SYSTEMS



Source: based on MATF and ICRAF 1986: 32

1.3 Tenure

Land tenure

Currently, there are four classifications of land, each having a distinct form of land tenure.

Customary land

About 82 percent of the land in Malawi is classified as customary. Smallholders occupy the customary land, where cultivation rights rather than ownership are granted by the chief through the village headman. Inheritance of usufruct rights is primarily matrilineal in the central and southern areas, and patrilineal in the north. In the matrilineal areas cultivation rights pass through the mother to her offspring, giving her sons and the husbands of her daughters usufruct rights. In the matrilineal, as with the patrilineal, land

is still controlled by the male head of the household until he is deceased.

Each administrative district in the country is divided into areas which are controlled by traditional authorities, and each traditional authority has a number of villages which are controlled by village headmen. Under village headman are family leaders, who are vested with the rights to use, and to exclude others from using, any piece of land which has been allocated to them. In this system, when new settlers entered the community, the village headman would allocate land on behalf of the village. Currently, however, in many areas all the arable land has been claimed.

Traditionally, communal rights for grazing were given to dambos (seasonally flooded depressions) and harvested fields. Currently there is regional variation on access to dambos; whereas in the central and northern regions access is still given, in the more densely settled south most of the dambos have already been claimed, and tenurial conflicts may occur between "livestock producers and vegetable farming" (MATF and ICRAF, 1986:28).

Leasehold land

Estates growing export crops have land held under lease from the government. The estate sector plays an important role in the economy of the country. Estates contribute about 15 percent of the total agricultural output and produce 80 percent of the total agricultural exports (MATF and ICRAF, 1986: 13). Although the estates are certainly larger than the holdings of the smallholder (which average less than 2 hecyares nationally), there is great variation in the size of the estates. According to Carr (pers. comm.) leasehold land is divided "between some 14,000 estates 50 percent of the area of which is made up of estates of less than 200 ha; 80 percent of the number of estates are of less than 50 ha."

Freehold land

Currently the policy is for estates under freehold to be converted into leasehold land. The implication is that the estates will be maintained for export crops, but the form of tenure will be converted from freehold to leasehold. About 2 percent of the land in Malawi is under either lease or freehold.

Public land

About 16 percent of the land in Malawi is classified as public land.

Tree tenure

It has been commonly argued that customary land tenure such as exists in Malawi discourages the household from making long term investments, such as tree planting, on the land. The argument is based on the premise that what the individual has in such a system is usufruct rights to land, but not to a specific parcel of land. However, what is not known is whether what appears to be insecure tenure in theory, is insecure tenure in practice, *ie.*, how long does a particular parcel of land remain in the control of a household? The situation may be one of households retaining control of the same parcel from one generation to another. If such is the case than the household would experience an incentive, rather than a disincentive for tree planting.

It is also not clear whether, as in other countries in the region, the person who plants a tree retains rights to the use of that tree independent of rights to use the land it is planted on. It can, however, be inferred from different studies that planted trees probably belong to the planter, as do managed naturally regenerated trees.

McCall and Skutsch (1987:8) have suggested that in matrilineal areas if a man is residing matrilocally (near his wife's kin) he may be reluctant to make long term investments or improvements in the land, such as tree planting, because of a perceived insecurity in land tenure. It is difficult to judge how much of a disincentive this would be in actual, rather than theoretical, practice. Studies of, for example, the matrilineal Plateau Tonga of Zimbabwe and Malawi revealed that traditionally fewer than 10 percent of the households were matrilocal in residence (Colson, 1973), implying that even if matrilocal residence does create some disincentive for tree planting, its potential impact might be quite small. This projected minor impact is supported by the MAF and ICRAF (1988: 9-10) study of Lilongwe which notes that "in some isolated cases [men obtaining access to land through their wives], this has created some problems for the menfolks who are looked upon as strangers. In some instances, men have tended to have a negative attitude toward land development."

Government interventions

The government has the right to convert customary land to public land for the purpose of public utilities such as schools, demonstration gardens, *etc.*, but the land act forbids the government (namely the minister) to grant freehold estate over customary land.

Since certain export crops (eg. burley tobacco) were not allowed until recently to be grown on customary land, land classification has a significant impact on crop options and potential income for the farmer (see Mbalalange, 1986). McCall and Skutsch (1987:6) noted that "some smallholders are converting their land to leasehold in order that they may grow burley and flue cured tobacco in place of fire cured." Since the easing of government restrictions on smallholders and flue cured tobacco, the pressure to convert from one form of tenure to another may lessen.

1.4 Economy

Agriculture is the most important sector of the Malawi economy and employs 90 percent of the population. Malawi has the lowest per capita income (\$164) of the eight countries in the study area (World Resources Institute/UNEP/UNDP, 1990). The main export crops in 1989/90 were tobacco (63%), tea (14%), sugar (9%), and cotton (2%). The share of tobacco has doubled in the past 15 years, and the economy is now heavily dependent on it for its foreign exchange earnings (Carr, pers. comm.). Subsistence production accounts for two-thirds of all agricultural output, and about 30 percent of the GDP.

In agriculture, the export crop sector includes about 14,000, mainly privately owned, estates which concentrate on tobacco, tea and sugar. At present households on customary land concentrate on food crops with maize being cultivated by virtually all smallholders and occupying 70 percent of the land under crops. Other food crops grown by smallholders are beans, groundnuts, cowpea, pigeon pea, millet and cassava.

Smallholders also produce export crops such as cotton, tea, and tobacco. These export crops are very important to smallholder farmers. Approximately 10% of rural households grow tobacco (MATF and ICRAF, 1986), although until recently it was the lower priced fire cured, air-cured and oriental tobaccos.

Due to its landlocked location, and often long internal distances, Malawi suffers from high transport costs. In addition, the political instability of other countries in the region creates disruption of its transport links with the overseas countries which are among its main trading partners.

1.5 Rural Sector

The population of Malawi is overwhelmingly rural and economically dependent on agriculture; it is estimated that about 90 percent of the population live in the rural areas and derive their livelihood from farming (MATF and ICRAF, 1986). The national average farm size in 1980/81 was 1.7 ha., however, reflecting both population density and available arable land, there was great regional variation. In the north the average size of the landholding was 3.0 ha. while it was only 0.4 ha. in the south. Given the rate of population growth, farm size has probably declined since 1981, and will continue to do so.

The rural household usually resides in a village on hill crests or hillslopes, and walks to its fields. Where population densities are high in the south and central regions, some households are putting up houses on their own farms. The assumption is that residing on the farm rather than in the village is the new emerging pattern. However, since the farm size in these areas is quite small, households are still quite close to one another.

As a result of male outmigration about 30 percent of the rural households are female headed. In the past the male migration stream was primarily to other countries in the region, especially the mining areas. Currently, these employment opportunities have declined and internal employment on estates has risen sharply. Although the percentage of female headed households has been stable, the economic wellbeing of these households has declined because the wages of male household members employed in domestic agriculture is less than that from mining (Carr, pers. comm.). It should also be noted that a higher percentage of females than males (80 percent compared to 61 percent) have never been to school and are illiterate. The great majority of female headed households are, therefore, experiencing declining off-farm income while being managed by an illiterate adult.

In Malawi there has been a general trend for the number of livestock and the areas allocated for grazing to decrease in response to the growth of the human population and the increase of dambos for fields rather than for grazing. Livestock holdings therefore vary by region. Of the livestock found in Malawi, cattle are viewed in some analysis as the most important, yet less than 10 percent of the households own cattle, and these are concentrated in the northern and central regions and in the Shire Valley. Cattle appear to be more economically and culturally important in the north where they are used for draught power, status, and brideprice in patrilineal areas. In other areas poultry, goats, sheep and pigs are an important component in the farming system.

Labour

Due to the sharp seasonality of the farming systems, many households experience labour shortages. This is especially true of female headed households. It is these peak labour demands which are the main constraints to many smallholder farming activities.

Credit

In the absence of a central credit institution in Malawi, smallholders rely on rural development projects and settlement schemes, both under the Ministry of Agriculture, and the Central Loans Board, under the Ministry of Trade and Industry, for seasonal and medium term credit (MATF and ICRAF, 1986: 19). Seasonal credit is mainly for farm inputs such as fertilizer, seeds, and pesticides. Medium-term credit is for the purchase of capital items such as oxen, ox-carts, and farm tools. There is very little purchase of farm inputs outside the credit programmes.

In order to obtain credit the farmer must join a club or group which assumes responsibility that the loan will be repaid. Any club with a record of default does not qualify for credit for the next season. By assigning responsibility to a group for loan repayment, the rate of default is very low (less than 5 percent). However, if a farmer is not a member of a club, seasonal credit is not available.

There are also problems with the form in which the credit is given. Seasonal credit is provided as a "package", rather than reflecting the needs of the individual farmer. The maize package, for example, provides seed and fertilizer for one acre (0.4 ha), so farmers with smaller landholdings cannot participate in the programme (MATF and ICRAF, 1986).

Fuelwood

According to McCall and Skutsch (1987) 60 percent of wood energy was used as domestic fuel in rural areas. Another 11 percent was used as domestic fuel in urban areas, where a significant proportion was in the form of charcoal. The tobacco industry was cited as a very important consumer of wood energy, using an estimated 22 percent of the national wood energy. This is lower than the 40 percent estimate of the World Bank/UNDP Study (1982). Whether it was 22 percent or 40 percent, because of the recent increases in tobacco production in the country, the amount of fuelwood used may be increasing. The tobacco industry has been improving the fuelwood efficiency, but it is unclear whether small producer efficiency has improved as well.

There is a government regulation that 10 percent of the land in tobacco estates should be under woodlots. Parastatals, such as the smallholder Flue-Cured Tobacco Farmers Association, have been encouraging farmers to establish woodlots on their own farms, and the government is encouraging smallholders to have 10 percent of their holding under trees. (MATF and ICRAF, 1986). Although the estates are required to have a portion of their land under woodlots, most of the fuelwood used is bought from households in customary lands (McCall and Skutsch, 1987).

Although it is assumed by the government and various agencies that there is a fuelwood crisis in Malawi, it is unclear if it is perceived as a serious crisis by rural households. A survey was conducted in 1982 to assess the smallholder views of deforestation, but its

research design was flawed since not only were women not included in the sample, but it also did not inquire about the difficulties in fuelwood collection (ESU, 1982). The report of the survey does mention a NSSA rural energy survey conducted in 1981 which found that 60 percent of the women interviewed felt that firewood collection was difficult. However, "since 77 percent of the women find wood within two miles of their homes. . . it is not evident that difficulties are sufficiently acute to generate a great deal of tree-planting in response" (ESU, 1982:1). Although there was regional variation, overall only 9 percent of the women reported buying fuelwood for domestic cooking.

However, in the 1982 survey, 82 percent of the men interviewed said it was difficult to get poles, and 57 percent reported purchasing poles. As expected there was regional variation; 34 percent of the respondents in the better wooded north reported buying poles, compared to 62 percent of the respondents in the densely populated south (ESU 1982:2).

1.6 Government policy on land use, crops and trees

The government pursues a rural development strategy which gives priority to investments with an immediate impact on agriculture. This is pursued through a comprehensive system of agricultural/land use planning regions which cover the whole country.

Until 1976 the main emphasis was on integrated rural development, the aim being to stimulate rapid production increases of particular crops such as cotton, maize, groundnuts and tobacco. Credit was used as the main tool for promoting recommended practices such as using improved seeds and other output-raising inputs. However, smallholder production performance during this period was rather disappointing both on a national and project basis. Growth in agricultural output was found to be more a result of expansion of area under cultivation than of rising labour or land productivity. As population continued to grow, more and more marginal land was being brought into cultivation. In contrast to neighbouring countries, most of Malawi's arable land is already under cultivation. As a result farms are small, and if farmers were not provided with adequate fertiliser within the credit programme, they did not have the means for purchasing additional fertiliser (MATF and ICRAF, 1986).

The development strategy was therefore reoriented to broaden the base of smallholder development beyond that covered by previous projects. The new development program aims to sustain self-sufficiency in food production. The objectives of the National Rural Development Programme (NRDP) are to increase smallholder agricultural production; to provide extension and support services and increase productivity per unit of land; and to preserve and maintain the natural resources. In support of these objectives the present development programme goal is to create a sustained increase in productivity on cultivated land through the use of purchased farm inputs, improved crop varieties, and improved marketing policies and facilities. Additional goals are the expansion of agricultural exports and an improvement in rural incomes.

Administratively, the National Rural Development Programme comes under the Ministry of Agriculture and operates through a hierarchy of Agricultural Development Divisions (ADDs), Rural Development Project Areas (RDPAs), Extension Planning Areas (EPAs),

and Development Areas(DAs). EPAs are considered to be the basic unit for extension and development services. Extension services are provided to both individuals or farmers's clubs (MATF and ICRAF, 1986).

Government interventions

The natural vegetation in large parts of the country was the miombo woodland. In the centre and south of the country most of this has been removed, firstly to clear land for agriculture and then to provide wood for fuel and other uses. Nearly half of the estimated area of about 4 million hectares of indigenous forest remaining is found in the northern region, with two-thirds of the remainder being in the central region. Roughly three-quarters of the overall forest area is on customary land, with the other quarter in forest reserves. Wood can be gathered from common woodlands on the customary land by villagers, free of charge. However, if they want to sell it, rather than use it for own home consumption, they must pay a stumpage fee, which varies with the types of species and intended use to the Forest Department. This fee, however, is seldom collected and, therefore, does not serve as an effective deterrent against felling trees (World Bank, 1990).

Currently, remaining forest cover is being reduced by an estimated 3 percent a year, with the rate being much higher in the densely populated areas. The government regards the control of this situation as a matter of highest priority.

Government concern for the decline in forest cover is not recent. In the past there have been programmes with the shared goal of having trees planted in the rural areas. Prior to independence there was a programme to establish village forest areas to meet rural fuelwood requirements. Traditionally some areas of forest, such as burial grounds, had been protected and controlled communally, and the programme intended to extend such communal control to establish village forest areas. By 1963 more than 5000 village forests had been created to meet rural fuelwood requirements (McCall and Skutsch, 1987). However, after independence when people were claiming land, most of the village woodlots disappeared, and responsibility for forestry extension was transferred to the Agriculture Department and Local Councils as part of agricultural extension (MATF and ICRAF 1986).

In 1976 the Forestry Department assumed responsibility for forestry extension when a National Tree Planting Day was inaugurated by the President Dr Kamuzu Banda. Initially seedlings were prepared in nurseries under the Forest Department and local authorities, and were distributed to schools and colleges. The goal of the planting day was to establish woodlots which would serve as demonstrations for the larger community. In the first year 58,000 trees were planted; by 1984 about "4 million trees had been planted, principally various *Eucalypts* spp., *Cassia siamea* and *Gmelina arborea*" (McCall and Skutsch, 1987:42).

In 1985 the programme was expanded to reach almost every village, and over 16 million seedlings were distributed for planting. National Tree Planting Day is a national holiday, preceded by a large scale publicity campaign. Seedlings now come from a variety of sources other than the Department of Forestry, these include estates, missions, and farmers. It is the largest and most influential tree planting project in the country (McCall

and Skutsch, 1987; MATF and ICRAF, 1986).

Some of the seedlings come from the Wood Energy Project nurseries. Under the NRDP, a Wood Energy Project was begun, and tree nurseries have been established for raising seedling for both sale and demonstration. By 1985 the capacity of the nurseries was up to 7 million seedlings.

The second Wood Energy Project which started in 1986 promotes tree planting by both smallholders and commercial users. The project provides "subsidized seedlings, extension services and tree planting incentives payments" (World Bank, 1990: 9). Unlike the previous phase of the project, rather than concentrating on *Eucalyptus* spp. and other exotic species, a wider variety of species are being considered, including multi-purpose trees and indigenous species. In addition farmers are receiving a small payment for each tree surviving two years.

The NRDP includes forestry and woodlot components (technically the forest woodlots come under the Forest Department but in close cooperation with agriculture). Forest components have been included in seven of the eight ADDS, in conjunction with Rural Development Projects, through the setting up of retain nurseries for sale of seedlings to farmers. The forestry component of the NRDP embodies both physical measures to encourage tree planting by individual farmers, and institutional measures designed to control supply through the market.

Stumpage prices of wood from existing tree stocks on customary and government land have been increased, both to make planted wood more competitive and simultaneously to reduce the tendency to overexploit natural woodland. However, as noted above, since stumpage fees are not enforced they do not serve as a disincentive for felling trees, and are, therefore, unlikely to be an effective incentive for tree planting (World Bank, 1990).

Questions have since been raised about the fuelwood focus of the programmes. This focus was based on the assumed existence of a formal fuelwood marketing system. However, although there is an urban and commercial market for fuelwood (as charcoal), there is little commercialisation of fuelwood in the rural areas among smallholders. Even when the buying and selling of fuelwood is practised by the latter, it is mainly by people residing close to plantations, for activities such as brick making rather than for domestic cooking.

It has been argued that this lack of commercialization of fuelwood provides a disincentive for tree growing for only fuelwood, especially since tree growing is more costly than getting wood free from customary land, or from State Forests, and less remunerative than the cultivation of maize (French, 1986), or the cultivation of poles (World Bank, 1984).

Small farmers and trees

Traditionally, in many of the areas in Malawi indigenous species were retained in agricultural fields as part of the land use system. Some trees were retained because they were "protected species" and included *Azelia quanzensis*, *Pterocarpus angolensis* and *Terminalia sericea*. Others were maintained for outputs valued locally, for example the

leaves of a large number of indigenous species enter into local diets. Some tree species were used for medicine, gums, dyes, soap, and fish poison. Many of the species retained are legumes, valued for their compatibility with crop production.

In one rapid cross-country survey the most commonly retained indigenous trees were recorded to be *Acacia albida*, *Acacia polyacantha*, *Albizia* spp., *Bauhenia thonningii*, *Combretum ternifolium*, *Cordyla africana*, *Erythrina tomentosa*, *Longhocarpus capassa*, *Markhamia obtusifolia*, *Parinari curatifolia*, *Parkia filicoidea*, *Pereopsis angolensis*, *Pterocarpus angolensis*, *Scierocarya caffra*, *Strychnos innocua*, *Terminalia sericea* and *Ziziphus mauritania* (Poulsen, 1981).

Trees have been planted as well. Fruit trees have been widely planted, notably the ubiquitous mango. The fruit of mangoes is apparently an important part of the diet, especially towards the end of the dry season when stocks of other foods are running down (Poulsen, 1981; MAT and ICRAF, 1988). Mango from the household's viewpoint is multi-purpose tree since it is not only a source of fruit, but also a source of fuelwood (through pollarding and pruning) and as a provider of shade (Poulsen, 1981). In some places in the south, indigenous agroforestry systems are to be found, such as bananas, cocoyam, and other crops under a canopy of *Acacia albida*. Such local agroforestry systems aside, planting is largely confined to homestead areas, and to fruit trees and the species promoted by government programmes.

Tree planting by rural households is perceived by the government as the best way to reduce pressures on the remaining tree cover. This perception is reflected in the shift in seedling distribution from school to individuals on Tree Planting Day. The government's concern is that although farmers appear to have knowledge of how to plant and maintain trees, and trees are indeed being planted, not enough trees are being planted to curtail the rate of deforestation (ESU, 1982).

There is also concern that farmers are not planting trees for the right reason, for when queried as to why they are planting trees, respondents cite poles, not fuelwood. This lack of interest in planting trees for fuelwood is found throughout countries in this region. Rural households appear to respond to the first felt need, and a shortage of poles usually precedes a shortage of fuelwood in an area. A household can meet its needs for fuel by using not only trees, but also shrubs, dung, and crop residues while the options for poles are far more limited.

Questions have been raised about the appropriateness of the species available in the rural nurseries, and the extension services effectiveness in reaching farmers. Well over 40 percent of government nurseries were found to be located 5 or more miles away from households' planting sites, and a significant proportion of farmers did not know of their existence (Chisimba, 1987). However, an earlier study showed that even when residing within five miles of a government nursery, over 50 percent of all tree growers produced their own seedling or collected them from under nearby trees (ESU, 1982). Proximity alone does not appear to be the only factor in the utilization of a government nursery.

The main species that have been provided in the past are *Eucalyptus* spp., which are widely utilized by the forest department and tobacco estate plantations.

Though well suited to these applications, the suitability of *Eucalyptus* spp. for smallholders has been questioned since their vigorous competition for soil water and nutrients can make them difficult to incorporate into small farm use. They are also susceptible to termite damage, a problem for farmers unable to use insecticides. However, as mentioned above the number of species offered is expanding, with more emphasis being placed on trees which have a wider range of uses for smallholders (World Bank, 1990).

In summary, farmers are planting trees, but not in the numbers which the government had hoped for, and trees are not being planted for fuelwood.

2. Agroecological Zone Analysis

2.1 Shire Highlands

Definition of zone

Crop growing period is from 210 - 270 days.

Rainfall is from 800 to 1300 mm per annum. The rainy season is from November to April, however showers may occur during the months of May, June, and July.

Altitude ranges from 800-1300 m above sea level. There are higher mountains in the area of the land use system; Zomba mountain, for example, is above 2000 m.

Vegetation has been removed over much of the area. The natural vegetation was predominantly miombo and *Acacia* woodland.

Soils are predominantly ferruginous (luvisols), ferralitic (ferrasols), and intergrades of ferrasols/luvisols with pockets of lithosols.

Case study: Intercropping system

Location

The Shire Highlands land use system lies principally within the Liwonde and Blantyre Agricultural Development Divisions (ADDs). The total land area is approximately 389,500 hectares.

Population

The Shire Highlands system is found in the areas of Malawi with the highest population densities (330/km²). The homestead is usually located on the upland. The area surrounding the homestead is planted with trees and the farms are planted with field crops.

Land tenure

The land farmed by smallholders is held under customary tenure. Inheritance follows a matrilineal system, so the right of access to land passes through women to their

offspring.

Tree tenure

There is a lack of available information on tree tenure. It can, however, be inferred that following a tenure pattern found throughout the region, labour creates certain rights. Trees that are planted or managed, for example, belong to the person who planted or maintained them.

Land use system

The average holding size is small. MATF and ICRAF (1986) have suggested an average size of 0.4 ha (1 acre), others have placed the average size at 0.8 ha., with half of the households having less than 0.7 ha. (Carr, pers. comm.). Some households are landless (MATF and ICRAF, 1986).

The residential pattern of living in villages results in some households being up to 8 km from their fields. There are three types of fields in the land use system: upland; dambo; and homestead garden, although not all households have dambo fields (dimbas). Upland fields are divided into two or three plots on the average. Apart from tobacco, which is grown in a pure stand, all other crops are interplanted with maize.

The most common intercrops are maize/pigeon pea/beans/sorghum on the upland fields and rice/maize in the dambo field (dimba). Most households also have a small compound garden around their home which is commonly used to grow vegetables and fruits for home consumption.

The land use system is based on the complex cultivation practices of relay planting and multicrops. In this land use system a household maximizes crop production from a small area and produces a variety of crops to meet its subsistence needs. When the first rains come, the first crop to be sown is maize. When the maize has germinated, beans, cowpeas and groundnuts are planted in the same field as the maize. Pigeon pea is included in order to improve the fertility of the soil and it is planted late so as to avoid shading the maize.

This being a relay cropping system, a second crop of beans is planted, but this time the maize leaves are stripped off the stalk, laid in the furrows and buried. The stripping of the maize plant is done to reduce the shading effect on the beans, and also as one way of increasing soil fertility (MATF and ICRAF, 1986).

Meanwhile, maize and groundnuts are harvested, and the maize stover and cobs are used as domestic fuel. Pigeon pea is left in the garden until the beginning of the rainy season, when the plants are finally uprooted and the leaves are incorporated into the soil while the woody stems are used as fuel. Bananas are placed on the boundaries of the fields.

All the arable land in this system is under cultivation. The small size of the landholdings makes crop rotation and fallowing impossible for most households. Rotation is practiced by households who grow tobacco, but tobacco is only grown by those who have larger holdings and who do not need the plots for subsistence purposes.

Tree component

In this land use system the natural forest vegetation has been largely removed, leaving only scattered individual trees (Poulsen, 1981; Chisimba, 1987). Although the upland fields may be cleared of trees, it is common to find fruit trees planted around homesteads where they "serve the purposes of providing shade and fruits and sometimes can be pruned for fuelwood" (MATF and ICRAF, 1986:36). As was noted earlier, the mango forms an important season food. Other trees found in the homestead are maintained indigenous trees and exotic trees for poles and fuelwood. Tree are usually planted in December or January (National Tree Planting Day is currently in December) when the rains are established and crops planted.

Livestock component

In this land use system, livestock play only a limited role. Only 4.5 percent of the households own cattle. Some stall fed dairy cattle are kept near Blantyre, and some beef cattle elsewhere. The only significant holding is poultry which 90 percent of households keep, as a source of both meat and cash. Goats are not popular because of their destructive habits; some are kept for religious ceremonies, but they are never left to free graze. The reason for so little linkage between the livestock and crop activities is apparently the lack of adequate grazing or other sources of fodder (Chandele *et al.*, 1987; MATF and ICRAF, 1986).

Labour

The family is the main source of farm labour supply. Although hired labour is easily obtainable, many households do not have the money to do so. Households that have both larger holdings and the necessary funds, hire labour during the peak weeding and input application period of December and January. In other periods there is available labour, but lack of access to moist dambos may not permit the growing of a dry season crop. It was observed in Mulange district, for example, that only 39 percent of the households were growing a dry season crop (Chandele *et al.*, 1987).

However, there is potential seasonal conflict for labour (see MATF and ICRAF, 1986:37). It has been noted that the peak time for weeding and fertilizer application is December and January, but the period when maize is in short supply in the household is from December to February. Men leave the household at this time to find work on estates and in towns, and this results in an exodus of labour from the village during the peak labour demand period. How serious a labour gap can occur is unclear, since which family members are responsible for the weeding and fertilizer tasks is not mentioned. If weeding is, for example, a female task, a male leaving for off-farm employment would not be a labour loss, but a potential income gain. Also, since most households cannot obtain credit, relatively few households (20%) use inputs such as fertilizers, hence labour for its application is not needed.

Perception of trees

Farmers in this land-use system are reportedly well aware of the role of trees, understand the consequences of the large scale removal of trees that has taken place, and most know quite well how to plant and maintain trees (Poulsen, 1981; Utoga-Kafumba, 1984; ESU, 1982). Farmers have reacted to the impact of *Eucalyptus* spp. and other fast growing trees on neighbouring crops by confining them mainly to the homestead area.

Use of tree products

Wood products are in increasingly short supply, with farmers expressing greater concern for shortage of construction poles than of fuelwood (Chisimba, 1987; ESU 1981, 1982). Increasing scarcity of fuelwood supplies has meant that the buying of fuelwood has assumed more importance, particularly in places such as Chiradzulu, Blantyre, Thylo, Mulanje and Zomba (Chisimba, 1987). However, buying by smallholder farmers occurs mostly when very large quantities of wood are needed, such as for brick making or brewing beer (which only a small percentage of people are involved in), and even then the wood is usually purchased from government plantations.

Interventions in support of tree growing

The Forest Department has 10 forest reserves in the area of the land use systems. These forest reserves are used for fuelwood not only by the local households but also by towns and tobacco estates. There are nurseries at EPA (Extension Planning Area) headquarters which have seedlings for sale. Seeds are issued to chiefs to raise their own seedlings and plant village woodlots. Through the Wood Energy Programme, most farmers have planted trees around their home, especially during National Tree Planting Day in December (MATF and ICRAF, 1986).

Preferred species for tree planting

After fruit trees, *Cassia*, *Gmelina* and *Eucalyptus* spp. are the most frequently planted trees (MATF and ICRAF, 1986; ESU, 1982). Poulsen (1981) noted that some farmers have developed their own production of planting stock of these species.

2.2 Lilongwe Plains

Definition of zone

Crop growing period according to one source was 180-210 days (MATF and ICRAF, 1986). Another source suggests a shorter growing season of about 140 days (MAT and ICRAF, 1988). "Silviculturally, the Lilongwe plain is classified as a dry zone, and therefore, not suitable for fast-growing tree species. . ." (MAT and ICRAF, 1988:6).

Rainfall ranges from 800 - 1200 mm per year. More than 80 percent of the rains falls within the months of December to March.

Altitude is mainly between 1100 - 1200 m above sea level and the land use system lies on a plain characterised by gently undulating slopes. Dambo are extensive and occupy an estimated 15 percent of the total land area.

The natural vegetation is *Acacia* woodland, consisting of mainly *combretum*, *Acacia* and *Piliostigma*. However, the natural vegetation has been severely depleted and altered. What remains is not a woodland, but cultivated fields with trees "scattered here and there in the landscape" (MAT and ICRAF, 1988:2).

Soils are ferruginous latosols, dark-reddish brown in colour, well drained, with a moderate Ph. "They have relatively high organic matter content and are of high fertility" (MATF and ICRAF, 1986:48). The dambo soils are predominantly clay in texture. . .

soil reaction is almost neutral to slightly alkaline" (MAT and ICRAF, 1988:4).

Case Study: Maize based system

Location

The land use system covers mainly the Lilongwe plain in the Lilongwe district (Lilongwe ADD). The total area is over 600,000 ha. of which an estimated 61 percent is arable (MAT and ICRAF, 1988).

Population

In the 1980 census it was estimated that about 10% of the Malawi population lived in the district. If this percentage has remained stable, it would mean that in 1990 the population in the district was about 840,000, and is projected to reach 900,000 by the year 2000 (MAT and ICRAF, 1988). Household size is estimated to be five members.

Land tenure

About 92 percent of the total arable land is held by smallholders under customary land ownership. Estates under leasehold control a little under 6 percent of the arable land, and the remaining 2 percent is not being utilized. Of the total land area (not just arable land) 56.2 percent are in small holdings, 3.4 percent are under estate cultivation, and the remaining 40.4 percent consists of dambos, forest reserves, woodlots, and hills.

As throughout Malawi, village headman are responsible for land allocation and settlement of land disputes. A matrilineal system of descent is practiced, whereby men get access to land through their wives and mothers.

Tree tenure

See above in background information.

Land use system

The average land holding size for a smallholder in this land use system is 1.5 ha. Maize, occupies about 60 percent of the cultivated area and is the main crop. Other major crops are groundnuts and tobacco. Minor crops include beans, cassava, sweet potatoes, cowpeas and pigeon pea. Vegetables are grown by every household in the dambos during the dry season and/or the upland fields during the rainy season. Although the dimba (gardens in the dambo) are important, the average area of dimba per household is less than 0.125 ha.

Local maize is intercropped with pulses and/or groundnuts. Hybrid maize is considered to be a cash crop and is grown in pure stands, as is groundnut and tobacco. Households which grow these cash crops practice a crop rotation system in which maize is grown first and is followed by groundnuts and then tobacco. Only about 20 percent of the households grow tobacco.

The crops grown in the dimba gardens are also intercropped, and a year round sequence of crops is practised. The crops grown include maize, cabbages, tomatoes, onions, pumpkins, sweet potatoes, cassava, sugarcane, bananas and fruit trees.

Tree component

The natural vegetation in this area has been severely depleted and altered, and only a few trees are left scattered in the landscape. The trees left in the fields include *Pseudolachnostylis maprouneifolia*, *Diplorhynchus candilocarpon* and *Diospyros kirkii* and they are valued as sources of leaves for fodder; and *Acacia polyacantha*, *Pterocarpus angolensis* and *Piliostigma thonningii* which are used for green mulch. Other commonly retained indigenous trees are *Acacia albida*, *Albizia* spp., *Bauhonia thoningii*, *Markhamia obtusifolia*, *Parinari curatifolia* and *Percopsis angolensis*.

The widespread cultivation of mangoes in fields and around homesteads is again very noticeable in this area, with nearly every field containing some trees. *Eucalyptus* spp., *Cassia siamea*, *Gmelina arborea*, *Toona ciliata* and *Melia azedarach* are the planted trees found most commonly. Some have been established as small woodlots on poorer land within the farm, but most are planted around homesteads, reportedly because households do not wish to incur the considerable "edge effect" crop reductions associated with growing species such as *Eucalyptus* spp. in or around fields. Other problems farmers encounter in growing trees appear to be inadequate seedling supplies, protection against livestock (especially goats), and pests and diseases, especially termites.

Livestock component

As with the other land use systems in Malawi, livestock production is of secondary importance to crop production. Only about 16 percent, 42 percent, and 12 percent of farms keep cattle, goats and pigs respectively. Goats and pigs roam freely in the dry season, but are tethered or penned in the rainy season. During the rainy season cattle are grazed in the dambos and fallows, "away from the cultivated fields under the watchful eyes of herd boys" (MAT and ICRAF, 1988:17), but during the dry season grazing is unrestricted.

Grazing is shrinking as the dambos are being brought into the land use system as agricultural fields. MAT and ICRAF (1988:23) reported one headman as indicating that over the last twenty years the dambo area in his village had decreased to less than a fourth of its previous area. As a result of dambo becoming crop fields, grazing area is declining at a greater rate than the available crop land per household. The dambos still available for grazing are overgrazed and provide poor feed.

About 20 percent of the cattle owners also own oxen. Oxen are used for pulling carts, and are not usually used for field preparation. Manures are used when available, although since animals are not kept in stalls, the amount of manure which is actually gathered and placed on the fields appears to be small.

Labour

Most labour is provided by family members, but in peak labour-demand periods individuals may be hired, and/or communal labour organized and paid in cash and in kind. Labour is more likely to be hired by households growing cash crops such as tobacco or groundnuts.

Perception of trees

There is an awareness of the importance of planted trees as a source of fuelwood,

timber, poles, and for soil conservation purposes. Households are also aware that crop production is below what is needed for subsistence. There are food shortages from December to about March, and one study found that most children in households without off-farm income were underweight during this period (Mtika, 1986). Household management of landholdings appears to focus on maximizing the amount of crop land and with tree production is regarded as a lesser concern, unless there is measurable benefits as with the mango (MAT and ICRAF, 1988).

Use of tree products

It has been estimated that more than 99 percent of the total energy consumed by smallholder households is derived from fuelwood. It is used not only for cooking and heating, but also for curing tobacco. There is an increasing shortage of trees in the area.

Building, fencing, and other construction material are obtained from trees, both indigenous and exotic, from the household homestead and fields, from some woodlots, and from the nearby hills. However, since there are few trees, these materials are in short supply. Those households living near forest reserves can buy fuelwood, poles, *etc.*, from the Forestry department. It is unclear how affordable these products are for the household, although other studies have implied that the low cost of tree products serves as a disincentive for household tree planting (MAT and ICRAF, 1988; World Bank, 1990).

Interventions in support of tree growing

The planting of trees has been encouraged by development projects which provide support to farmers in this area. The Lilongwe Land Development Project (LLDP) encouraged households to plant trees around their homesteads and woodlots on the poorer soils of the landholding. In some areas there has been an agroforestry component in the development project.

Preferred species for tree planting

As noted above, the mango is the most common species in the farming system. It is a multipurpose tree and is used for fruit, shade, and fuelwood. Other planted trees are *Eucalyptus* spp. *Cassia siamea*, *Gmelina arborea*, *Toona ciliata* and *Melia azedarach*. These trees are usually planted in the homestead, although some, perhaps in response to the development programme, have been established as small woodlots on poorer land within the farm.

Conclusions: Malawi

Where are farmers planting or not planting trees?

Trees feature in the land use systems of Malawi, but much of the rural population lives in densely populated land use systems where there is little remaining tree cover other than protected or planted trees on farms. However, the extent and range of tree planting is limited. Even where the removal of existing tree cover has evidently resulted in shortage of wood products for local use, planting is largely confined to homestead areas. With the exception in some areas of mangoes, planted trees are seldom found in fields.

How does tree planting relate to ecozone, cultural tradition and values?

There is considerable uniformity across the ecozones in Malawi. In all land use systems, maize is the dominant crop. To the extent that trees are related to ecozone it is largely through intensity of land use, itself a function of density of population.

A substantial number of naturally occurring trees are valued for their contribution to diets, and health (medicines), or their beneficial effect on crops (shade, soil fertility). These tend to be protected, either off-farm in the more sparsely populated north, or on fields as land is brought under cultivation as in the area of the case studies. However, as intensity of land use increases and farm size decreases, trees disappear. They are also removed where farmers depend on animal traction for ploughing.

What incentives are there for tree planting?

The limited extent of farmer tree growing in Malawi contrasts with situations with similar population densities in other parts of eastern Africa, where tree planting has increased with population density. However, areas of high population density comparable to that of Malawi have occurred in the Bimodal Zone, not the Unimodal Upland Plateau of this region of Africa, so zonal differences may be a major factor.

In Malawi the limited tree planting would appear to be attributable, therefore, to a combination of factors which makes trees a less efficient use of farm resources than alternatives. Agroecozone differences aside, these would appear to be: small size of farm holding; pressure to meet subsistence food needs; availability of more profitable agricultural crops; off-farm employment opportunities and the availability of income with which to meet non-subsistence needs; limited markets and low prices for wood products; and the availability of alternative fuels at lower cost that would be incurred by growing trees.

How does tree planting by farmers relate to government promotional and extension efforts?

The government has pursued a sustained programme of encouraging smallholder, and estate and village, planting of trees. But with its focus on meeting fuelwood needs, it has not been compatible with farmer priorities for fruit and timber. Nor have some of the main species been well adapted to intensive, small farm land use. The fast growing species, with their heavy demands on soil nutrients and water, contrast with the leguminous indigenous species that farmers retain in their compatibility with small farm crop agriculture. Though farmers have grown *Eucalyptus* spp., they have confined it to homestead areas where it does not compete with crops.

3. Malawi Summary

From the background data and the case studies some observations can be made:

- 1) Households are planting trees in Malawi, although the number of trees planted may be smaller than the government and external agencies might prefer.
- 2) Households are in some regions of Malawi experiencing food shortages and seasonal nutritional stress. These are the same areas of extremely small landholdings and relatively few trees.
- 3) Knowledge of tree planting and care does not appear to be a constraint. The ESU study in 1982, for example, noted that respondents reported a high survival rate for trees they had planted. What does appear to be a constraint is lack of land by households in some areas, and the lack of incentive to plant as a result of the availability of wood products from the Forest Department at a relatively low price.
- 4) The agroecozone might exert some impact on tree planting. Other high population density areas in the study area have been in the Bimodal Zone where a pattern developed of increased tree planting, both in number and species, as off-farm availability of wood products declined. This pattern has not developed in the case study areas of Malawi where tree planting does increase, but not in the number and diversity which might be expected.

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9. COUNTRY REPORT: ZAMBIA

1. General information

1.1 Background

Population

The population of Zambia was estimated to be 6.7 million in 1986, and is projected to reach 11 million by the year 2000. The projection is based on a growth rate of 3.3 percent per annum for the nation as a whole, but the urban areas are growing at a much higher rate and the rural areas, because of outmigration, are growing at less than 2 percent a year. Zambia has the highest urbanization in Sub-Saharan Africa with 44 percent of the population living in urban areas. "It is estimated that 41 percent of the rural households face labour constraints in their efforts to increase agricultural production, and that over 30 percent of the rural households are headed by women" (ZATF and ICRAF, 1989:17).

The "line of rail", the railroad line that passes through the Southern, Lusaka, and Copperbelt provinces and the Tanzam road through the north, are the most densely populated areas of Zambia. Southern, Lusaka, Central, and Copperbelt are the most urbanized provinces and contain 55 percent of the total population.

Only a few other areas of Zambia have a population density of more than 10 persons /km²: Mbala in Northern province; settlements along the Zambezi; and the southern districts in Eastern province. The rest of Zambia has a population density of fewer than 10 persons/km².

(Sources: ZATF and ICRAF, 1989; GRZ, 1981 cited in Chidumayo and Chidumayo, 1984)

Topography

Zambia is on the central African plateau and is a country of gently undulating terrain, with an occasional hill range, broken by a series of relatively deep rift "troughs (below 600 m) flanked by the faulted escarpment zone" (ZATF and ICRAF, 1989: 4). Within the plateau are found swamps, lakes, floodplains, dambos (depressions that seasonally become waterlogged), *etc.*, which are utilized by Zambians in local subsistence adaptations. The altitude ranges between 900 and 1500 m above sea level with an average elevation of 1200 m.

Climate

Zambia is subtropical, dry, and seasonal. There are three distinct seasons: the warm-wet season from November to April when almost all the precipitation takes place; a cool, dry "winter" season from May to August during which frost may occur in some areas; and a hot, dry season in September and October.

There is a North/South gradient in rainfall. The north is wetter (over 1200 mm) while the south is semi-arid (700 mm) and drought prone. As a reflection of this, the north western region has a growing period of 210-240 days in comparison to the southern most region which has a growing period of 90-120 days.

Vegetation

Most of the plateau is covered with miombo woodland vegetation. A common figure given for forest cover is 55 percent. Miombo woodland is dominated by trees of the genera *Brachystegia*, *Julbernardia* and *Isoberlinia*. The woodland is two storeyed with a canopy of semi-deciduous trees from 4 m up to 21 m high and with "practically no climbers". The trees are slow growing, but the majority are leguminous and well adapted to fires and water stress.

In the west is found the Kalahari woodland, which alternates with grassland; both are important grazing areas. The *Acacia* woodland dominates in the river valleys on the plateau. The woodland understorey is an important source of fodder, especially in the more arid south.

The long dry season creates the perfect condition for fire in the woodland areas. Due to natural fire and clearing for agricultural fields, most of the original tree cover has disappeared and the current forest is secondary vegetation.

Soils

The soils of Zambia are low in plant nutrients and are not fertile, except for small pockets of red clay. The soils in the high rainfall zone are heavily leached and highly acidic and are therefore a constraint on the potential crops and trees which can be grown in the region.

1.2 Agroecological zones

Table 9.1 Description of zones

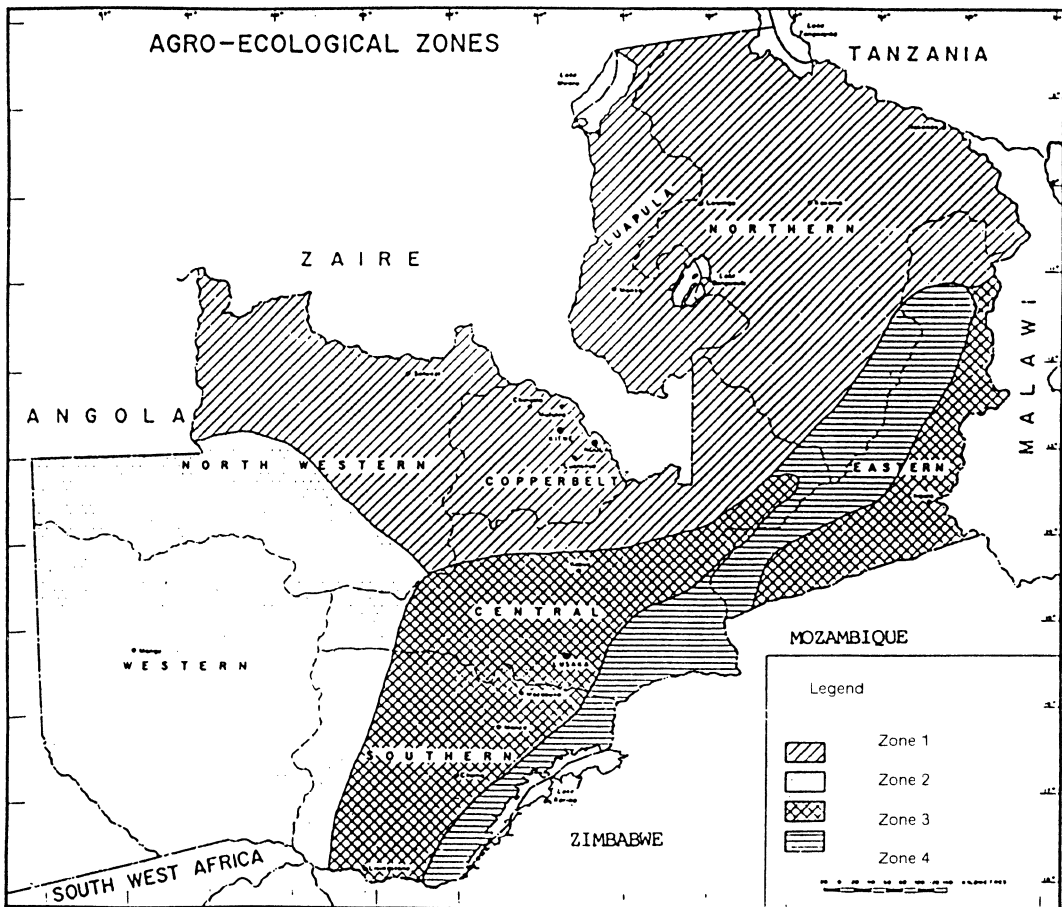
Zone	Unimodal rainfall (mm)	Altitude (m) (average)	Vegetation	Soils
Northern	1000-1500	1200	Wetter miombo woodland	Highly leached Sandveldt soils
Western semi-arid	600-1000	850	Kalahari/miombo woodland/swamp	Infertile Kalahari sands
Plateau	800-1200	1000	Miombo woodland/Acacia woodland	Moderately leached sandveldt, reddish to brownish, clayey to loam soils. Most fertile soils in Zambia
Rift valley	800-1200	600	Mopane woodland/miombo woodland	Shallow Chestnut sands of marginal agriculture

Source: ZATF and ICRAF, 1989

Utilizing altitude, range of rainfall, soils, and suitability for crops as the basis for

categorization, the ZATF and ICRAF reports (1988 and 1989) divide Zambia into four major agroecological zones, (see table 9.1 and figure 9.1) with a total of six land use systems. These four zones are: the Northern High Rainfall Zone, the Western Semi-arid Plains, the Central, Southern and Eastern Plateau and the Luangwa-Zambezi Rift Valley.

Figure 9.1
AGROECOLOGICAL ZONES OF ZAMBIA



Source: ZATF and ICRAF 1989: 13

Unimodal Upland Plateau land use systems

The unimodal upland plateau of Zambia exhibits a diversity of adaptations to specific local conditions. The adaptations may vary more by degree of emphasis of a particular component than by technique or method. Schultz (1976) identified twenty land use patterns based on emphasis of crop and use of particular resources, *etc.* Generalities can be made within an agroecological zone, although unique land use systems (such as the Namwala-Kafue Flats) can be found. The ICRAF (ZATF and ICRAF 1989) delineation of land use systems are at this more general level and are used for this report.

1. Chitemene Shifting Cultivation: This is the land use system which occurs in the largest land area in Zambia. Although it extends further south, it is primarily found in the Northern High Rainfall Agroecological Zone. Population densities are low. The size and shape of the fields have lead to further distinctions (large circle, small circle, block), but the same technique of lopping trees and carrying the branches to a clearing to be burned is used. Chitemene is an effective adaptation to the extremely infertile leached acidic soils of the region. In the great majority of the chitemene farming systems, livestock, especially cattle, are not a component of the subsistence system.
2. Mound System: This occurs in the Northern High Rainfall Agroecological Zone. Population densities are higher than in the chitemene areas, and there is not enough forest to maintain a forest fallow. The mound system is based on grass fallow. Grass is turned under to form a mound on which crops are grown. Unlike the chitemene areas, cattle may be kept and are loosely integrated into the farming system. It should be noted that in the chitemene system, mounding in homegarden plots is also found.
3. Barotse Agropastoral System: This occurs in the Kalahari sands and Zambezi flood plain in Western Semi-Arid Plains Agroecological Zone. The growing period is 180 days in the north, but under 180 days in the south. The system is based on the intensive agricultural production of cassava and a pastoral livestock system which is not integrated with the agricultural system. Transhumance between the flood plain and the upland Barotse sands is an integral part of the livestock component.
4. Maize-Livestock System: This is the dominant land-use system in the low rainfall zone (fewer than 180 growing days) of the Southern, Central and Eastern Plateau Agroecozone. It is a commercial or semi-commercial mixed system with fields under either permanent agriculture or grass fallow cultivation. The livestock component is functionally integrated with crop production. This system is the most important agriculturally. Most of the Zambian maize is produced and the largest herd sizes are found in this system.
5. Luapula Fishing/Cassava System: This is a relatively minor land use system found in Luapula province around Lake Bangeweulu, Lake Mweru, and the Luapula river. Fishing is the most important component of the subsistence system with cassava production on permanent plots and shifting cultivation secondary.
6. Namwala-Kafue Flats Agropastoral System: A relatively small system found in the Southern Province which utilizes the large, seasonally moist depressions of the Kafue flats for grazing large herds of cattle. Cattle are the major component of the subsistence system. The agricultural component, which is based on cassava and maize, is minor.

Table 9.2 Land use system and agroecological zone summary

Land use system	Agroecological zone
Chitemene Cultivation	Northern High Rainfall Zone
Mound System	Northern High Rainfall Zone
Barotse Agropastoral System	Western Semi-Arid Plains Zone
Maize/Livestock System	Central, Southern and Eastern Plateau Zone
Luapula Fishing/Cassava System	Northern High Rainfall Zone
Namwala-Kafue Flats Agropastoral System	Southern Plateau Zone

1.3 Tenure

Land and tree: traditional

In Zambia, rights to land were tied to the individual and his efforts. If there was no prior claim, an individual could claim a piece of land and use the land for as long as he wished until he died or abandoned it (see Amankwah and Mvunga, 1986). This right could be transferred at death to his survivors. Even in Zambian matrilineal societies such as the Tonga, since men cleared the land for fields, they were recognized as having lifetime usufruct rights to the land. The rights to the land cleared was inherited by their matrikin rather than their own children (see Colson, 1973). Some tribes would require the permission of a chief before clearing, others the permission of the village, and others left it up to the individual's discretion. If there was a dispute, it would be brought for resolution to the authority which originally gave (or was supposed to have given) permission.

Planted trees were perceived as belonging to the planter, even after the plot was abandoned. Permission would be asked of the owner of the tree for its fruit, lopping, *etc.* These same rights appear to have extended to fruit trees that "just grew" in the homegarden, but were then managed.

Land and trees: current

Since 1975 all land in Zambia is vested absolutely in the President. Currently there are three basic land designations in Zambia: State, Trust and Reserve.

State land

State land makes up about 6.5 percent of all land and is land that during the colonial period had been Crown land. Crown land was land designated for European settlement (farming and mining) and could be held as freehold. After independence in 1975 freehold was converted to leasehold. Those who held land freehold were granted a statutory lease of 100 years from July 1, 1975. New leases have been granted for 99 years or less. Title is given for the land subject to the length of term of the lease. Although the purpose of conversion (or the stated purpose) was to stop land speculation,

it has served the additional purpose of making land transfers impossible without the approval of the president. Before a transaction can take place, a value is given to the improvements made on the property; the land itself is given no value.

Although a policy of acreage limitation is explicit in the Land (conversion of titles) Act, it has not been implemented. Commercial activities, both farming and mining, are on State lands which parallel the "line of rail". With less than 1 percent of the land, commercial farmers produce over 50 percent of Zambia's marketed agricultural produce (Schultz, 1976).

The government has also extended land holding on State Lands for state farms and settlement schemes; by 1981 almost a third of productive state land was under direct state management. Neither the state farms nor the resettlement schemes are regarded as being successful.

Trust land and Reserve land

Approximately 58 percent of the land is trust land and 36 percent is reserve land. These are areas which were set aside for Zambians during the colonial era. The major distinction between the two are in regard to use of the land by non-Zambians. Whereas the reserves are for the exclusive use of indigenous Zambians, trust lands are for the use or benefit of indigenous Zambians. Nonetheless, leases have been granted for up to five years by the president for missions, trading sites, hotel sites, tourist hotels, *etc.*, in the reserves. In the trust land areas, rights of occupancy for up to 99 years may be granted by the president for any purpose (tied loosely to benefit). Although the president grants the lease, it must be with the approval of the District Council.

Although there is a distinction in regard to non-Zambians, in both trust and reserve lands Zambians are under customary law and practice, and are seldom the recipients of leases and rights of occupancy. A Zambian is given the right to use and this is obtained from his tribe under customary law. This creates a localized set of norms that may vary from one tribe to another. It may also make it difficult for those of one tribe to move into another's area. Inheritance, for example, of many of the Zambian tribes (such as the Bemba) is matrilineal, while others (especially in the pastoral south) are patrilineal.

Maintaining the authority which was formalized during the colonial era, the chiefs have the right to alienate land to villagers for their use and occupation. The chiefs also have the powers to set aside land for specific purposes for the community (burial grounds, grazing *etc.*). The village headman is supposed to assist the chief, since he is the one who lives in the village and is familiar with everyone's needs. The closer to the village, the greater the say of the village headman in an individual's selection of land. Among the Bemba, for example, chitemene land far from the village could be chosen by an individual freely, but the headman's permission was needed if the fields were nearby. The headman also has the responsibility of distributing village gardens and permanent fields, on which individuals can then claim rights. Land conflicts that occur continue to be resolved at the village level.

As in the past, tree tenure is based on rights to the planter of the tree. Rights to the trees continue after the land is abandoned or the settlement is moved. Rights to trees

that germinated "accidentally" and are then were managed (mangoes, guavas and lemons) are usually more tenuous after moving from the site than are the rights to trees that were actually planted (see Holden, 1988: 81).

Government interventions

The current policy gives the president of Zambia ultimate authority over all the land in Zambia. In the State Lands, all transactions must be approved by him. In the Trust and Reserve Lands the president has the right to give leases to the land, with the approval of the District Council. In the Trust and Reserve Lands the impact, except in isolated areas, appears to be minimal. The chiefs and village headman continue to be the final arbitrators, but individual rights are recognized. As in the case of State lands, it is unclear what impact the need to get approval from the president is having.

The current land tenure system has been criticized as not aiding in development: the post-colonial system has continued to foster protection of the Reserve and Trust Lands for Zambians, but is viewed as not having encouraged agricultural development. Although it is possible to have title to land (via lease) in State lands, it is virtually impossible to have a land title in trust and reserve lands. There continues to be the belief within government ministries that in order to increase production farmers need to have clear title to their land. However, studies in other countries in the region have not revealed a link between title and agricultural productivity as long as tenure is well-established in local law.

Part of the inherent problem in the attempts to link title with productivity lies in tying land title with land security. Land security can exist in rural Africa without having a land title. But what of credit?? It has been pointed out that no matter how secure the tenure, land security without a title cannot be used as collateral to get a loan. This overlooks the fact that even with land titles, very few smallholder farmers are willing to put their land at risk to get a loan and would prefer to borrow from money lenders, relatives, and friends.

In the Zambian case, title rather than customary rights will probably have little impact on agricultural production. What would have more of an impact would be the availability of inputs, extension services, and marketing facilities.

(Sources: Banda, 1986; Amankwah and Mvunga, 1986; ZATF and ICRAF, 1988 and 1989; Mudenda, 1981; Holden, 1988; Vedeld, 1981.)

1.4 Economy

The economy of Zambia has been dominated by copper production. The agricultural and forest sectors were regarded as being unimportant and received "benign neglect". This has gradually changed in response to changes in the international copper market and pressure from a growing population.

The international copper market downturn since the late 1970's has created an economic crisis in Zambia. "Between 1980 and 1984, export earnings dropped by 40 percent" (ZATF and ICRAF, 1989:19) and the other sectors of the economy declined during the

same period, the decline in agricultural food production was caused by the drought in 1981/1983. Imports of food increased while foreign earnings plummeted. In 1984, even with the decline in copper earnings, agriculture accounted for less than 13 percent of Zambia's GDP.

The contribution of export crops declined and continues to decline; little cotton is exported so as to encourage the development of local industry; and tobacco production has been declining for two decades.

The economy does not appear to be improving and since Zambia's economic growth is slower than population increase, real GDP and average per capita income continue to decline. The government is currently attempting to restructure the economy and agriculture is now destined to play a major role rather than the minor role it has played in the past. (Sources: ZATF and ICRAF, 1989; World Bank, 1990.)

1.5 Rural Sector

The past dependence of the economy on copper has created a rural sector that is in turn dependent on earnings from migrant labour. In the colonial era, the need to pay taxes in cash strongly encouraged (as was its objective) the male migration to the urban/mining areas. This was especially true in the northern regions where there were neither livestock nor cash crops to sell. Colonial policies created the "line of rail" of commercial farms and mining, with areas such as the north providing the needed labour.

After independence this urban/rural relationship did not change. Prices of domestically produced food were kept low to benefit the urban and mining sector (over 40 percent of the Zambian population) and migration continued to provide cheap labor.

Labour

In the north there is the growing phenomenon of not just men, but also their wives, going to the urban areas. Migration from the rural areas to the urban/mining areas has had a number of impacts on the rural sector and the most important are:

There is a lack of labour, especially male labour, available in the rural areas. In the north, for example, in the chitemene agricultural system, men traditionally lopped the branches and cut the tree tops, and in some areas built fences, but now there is a shortage of men available for these tasks.

The women who are left behind in these areas appear to be overstretched in terms of time available for agricultural tasks. Female headed households make smaller fields, have less diversity of crops, and are less involved in cash crops, but it is unclear what the impact on tree planting or managing is.

Farmers are old; in one village in the Northern Province over half of the farmers were over 50 years of age (Vedeld, 1981:68-69). Many of these are returning migrants, who have not farmed for many years, and are not able to manage their fields as effectively as a more experienced and younger farmer. The absence of adults from the rural community during their youth inhibits the flow of

information concerning farming techniques and management from one generation to another.

Remittances are used to meet day to day expenses rather than as savings or investments for increasing agricultural production. Studies have shown that returning migrants see themselves as 'retiring' to the rural areas and are less involved in cash cropping, *etc.*

Zambian agricultural production is constrained not only by labour shortages created by outmigration, but also by the availability of land, and capital. Since Zambian population density is low, land is usually not perceived as being a limitation on agricultural production. Land sufficiency, however, depends on how much is needed for a particular subsistence system.

Chitemene, the prevalent land use system in the north, requires a large area (the outfield) of forest for lopping the branches that are then brought and burned at the field site (the infield). It has been estimated on a per capita basis that 0.67-1.1 ha. of cleared outfield if needed for 0.06-0.12 ha. infield. Miombo woodlands are slow growing and in many areas there is not enough forest left to maintain the forest rotation and hence land has become a constraint on production in this system. As a response to forest shortages there has been a shortening of fallow time, and development of permanent fields (mounds) and intensification of homegardens (see Chidumayo, 1987).

Potentially, there are three sources of capital: sales of agricultural produce/livestock, remittances, and credit. In livestock areas, money from the sale of animals is usually not invested in agricultural improvements. In areas without livestock, capital is difficult to generate in the village economy. The prices received for agricultural products are low, but they still provide the dominant cash resources for the households. Food processing, *eg.* millet beer, can provide a good source of income. In the Northern Province women earn money through beer making and selling, but since men are the beer buyers, unless there is no one present who drinks, there may be no household level gain in income. Beer brewing is the major means for women to tap into male held income.

Labour migration is the most common source of obtaining initial capital in the Northern Province. However, the urban/mining areas where work may be found, are not a guarantee that capital can be accrued. Since wages are low in the urban areas and costs are relatively high, there is not very much surplus that can be sent to the village. Money may be sent to parents or in-laws, or to buy consumer goods. Bride price has to be paid in cash, so a young man's earnings will be sent to his in-laws rather than invested in farming. Since money cannot be generated easily in the village, men are "forced" to migrate to look for employment.

Credit

Credit facilities are not well developed for the small farmer. The Agricultural Finance Company (AFC) requires a minimum level regarding yields and farm size, and will not give credit for the production of "traditional" crops such as cassava and millet. Less than 5 percent of all peasant households in Zambia receive loans from AFC (Vedeld, 1981 citing Klepper, 1979).

Fuelwood

Wood scarcity does not appear to be perceived as a problem in most of the rural areas. In Zambia, firewood collection is traditionally a woman's responsibility. However, as Chidumayo (1988b) notes, when firewood resources become scarce, men will also get involved in firewood collection. As in the Kilimanjaro area in Tanzania, men will use ox-carts for firewood collection.

Given the lack of perception by rural inhabitants of fuelwood shortages, a study was conducted in three sites (each site was in a different province: Western, Eastern and Lusaka) which used the cutting of live trees and the existence of a trade in firewood as indices of fuelwood scarcity. It was found that less than 30 percent of rural households fell live trees for firewood, and there was little trade in fuelwood except in the Western site of Barotse Floodplain, a virtually treeless area (Chidumayo, 1988b).

1.6 Government policy on land use, crops and trees

In response to the decline in export copper earnings and agricultural production, and the lack of currency to buy food imports, the current government policy goal is to develop the agricultural sector by "maximizing the use of land and labour resources. Agriculture has been earmarked as the only sector with high potential for providing employment in the short run" (ZATF and ICRAF, 1989:20).

In Zambia, farmers are distinguished as being commercial, emergent or peasant farmers by what percentage of crops they sell: a commercial farmer markets nearly all of the output; a peasant farmer markets less than 50 percent; an emergent farmer uses commercial inputs and markets more than 50 percent of the output (Vedeld, 1981: 24). The agricultural policy's main strategies revolve around smallholder peasant and emergent, rather than commercial farmers. Resources will be focused on food production, better prices for farm products, and research extension aimed at the smallholder. The different regions have different priorities:

Urbanized provinces: the aims are to move to an agricultural based economy and achieve self-sufficiency in agricultural products. Of interest to this report is that community and agroforestry based activities for urban fuelwood supply are a "fairly high priority" (ZATF and ICRAF, 1989:21)

Highly developed agricultural provinces (Southern, Central and Eastern): the aims are to extend the use of the oxplough, develop the infrastructure and agro-processing facilities and encourage agricultural and economic diversification.

Least developed provinces (Northern, Luapula, Western and Northwestern provinces, only 11 percent of all cultivated land in Zambia): the aims are to increase production through price changes and other incentives, develop the infrastructure, (Tazara rail, feeder roads, *etc.*) and to encourage food self-sufficiency. This region will be given priority funding to offset regional imbalances (an attempt to stop the outflow of migrants).

It is not surprising given the relatively low population densities and an economy which focused on copper production and commercial farming, that trees were overlooked in agricultural policy and forest policy was based on supplying wood products (especially to the mines) and protecting the forests. Plantations, for example, were established to meet industrial needs and plantations in the Copperbelt Province will produce trees to meet industrial timber needs until the year 2000 (Chidumayo, 1988b).

Fuelwood has only begun to be regarded as a potential problem during the last decade. An FAO report in 1981 showed the eastern half of Zambia as being fuelwood deficient. Although it might be an overgeneralization of localized areas of shortage, this is the region which will have the fuelwood shortages if not now, then in the future.

Village focused tree planting programmes are relatively recent. Post independence, the Department of Agriculture "appeared to be emphasizing the clearing of trees from the land to produce more crops. This tended to paint a picture of trees as something rather nasty to be removed in 'modern agriculture'. Only the planting of fruit trees was given some attention" (Gossage 1989:1)

This anti-tree stance has changed and projects emphasizing planting trees for fuelwood and soil conservation have been implemented. In 1975 the Forest Service started the "Operation Kwacha" programme. Before the programme there was not any organized rural tree planting in Zambia. "Operation Kwacha was a country-wide campaign mounted by the Forest Service to promote tree planting by and for the people" (Chidumayo, 1988b:23). The Forest Service raised and distributed thousands of seedlings. Individuals were charged a small fee for seedlings, institutions such as schools were given them free. Although the majority of the trees were *Eucalyptus* spp., the quantity and precise species are not known, and seedling survival records were not kept. An evaluation (Chidumayo, 1988b) did reveal that seedling survival rates were dependent on the date of planting. World Forest Day, the 21st of March, was when many seedlings were planted - at one site only 2 percent of the seedlings planted on this date survived. While March may be the ideal time to plant a tree in Europe or the U.S., it is the end of the rains in Zambia. Forest Day is now celebrated in December.

Small farmers and trees

The government programme promoted tree planting primarily for fuelwood. However, Chidumayo (1988b) found that tree growers in the programme wanted to use trees for timber and as building poles. Rural households value planting trees first for poles and timber. Fuelwood was considered a byproduct of a tree to be collected after it was felled for another purpose, such as poles.

Private woodlots are planted by men (88 percent at one study site; 77 percent at another). Chidumayo (1988b) suggests several reasons for this:

Men are responsible for construction work, so they will plant trees for poles.

Men control the household budget and since trees are potentially marketable men may discourage women from planting trees.

Men plant trees to reduce their fuelwood collection burden. As fuelwood gets further from the village, it increasingly becomes a male activity.

The second suggested reason is questionable. The planting of trees probably reflects the land tenure rights of men rather than their control of the household budget. Nevertheless, given the responsibilities and rights of Zambian men, they are the primary tree planters.

Even at sites in which the government tried to establish communal woodlots, farmers preferred individual household woodlots. The only communally owned woodlots were those belonging to schools.

What of farmers in non-project areas or farmers who did not take part in the government programme? Studies have shown that Zambian farmers plant fruit trees in the their homegardens or homesteads. In a study in central Zambia, for example, 90 percent of the households had fruit trees (with a mean of 2.9 fruit species per household) (Chidumayo 1988a); in the Northern Province it is reported that "almost all households had some exotic fruits in their home gardens" (Holden, 1988:78).

In summary, farmers in Zambia are planting trees, especially exotic fruit trees in the home garden. The primary purpose of planting non-fruit trees is for construction material, either timber or poles, rather than for fuelwood.

2. Agroecological Zone Analysis

2.1 Northern High Rainfall Zone

Definition of zone

Crop growing period is between 180-240 days

Altitude (average) is 1200 m

Rainfall is from 1000 mm - 1500 mm annually. The rainfall is unimodal with 95 percent of rainfall falling during November to April.

The natural vegetation of this zone is "wetter" miombo woodland.

In this zone there are 2 major land use systems, the Chiemene and the Mound systems, as well as a third minor one, the Luapula Fishing/Cassava system.

(primary sources: ZATF and ICRAF, 1989; Mansfield; Chidumayo, 1987; Holden, 1988; Vedeld, 1981)

Case study: Chitemene Shifting Cultivation System

Location

The Chitemene land use system occurs in most of the Northern, Luapula, Northwestern

and Copperbelt provinces. In this area the soils are sandy loam, leached and highly acidic, and the population density is very low.

Population

In 1985, the rural population in the provinces where chitemene is currently practised was estimated at 1,700,000. Since there are other land-use systems in this zone, it is difficult to determine the number of people actually involved in the Chitemene system. What is more important than the actual number of people is the population density of the areas where the Chitemene system is found. In the districts in Northern province where chitemene predominates the population density is between 1.98 and 3.44 persons/km².

Although other tribal groups practice chitemene, the Bemba are strongly identified with both the chitemene system and the Northern province. The Bemba are matrilineal (inheritance is through the mother's line) and in the past they were hunters and gatherers, and raiders of agricultural populations. With colonisation the raiding was ended and taxes had to be paid. The Northern province was "treated as a labour reserve for mining concerns with no institutional policy as regards agricultural development in the province" (Mudenda, 1981). As a result of the outmigration of men from the north to the mines, Bemba is the lingua franca of the mining areas. In the Bemba communities a large proportion of the households (30-40%) are female headed (Holden, 1988; Vedeld, 1981).

Land tenure

In the chitemene areas, as described above, land far from the village can be used by anybody for chitemene cultivation, "but permission is needed from the headman or village committee to cultivate land near the village" (Holden, 1988: 21). As population has increased, individual rights to land have become more permanent (Holden, 1988:21).

Tree tenure

Planted trees belonged to the planter as do trees that naturally regenerated and were subsequently managed by a farmer.

Land use system

Chitemene utilizes the trees of the miombo woodlands in a forest fallow based system. Traditionally, trees were lopped or topped, the branches were carried to another site and then burned. The field was used for several years, with a new field being made each year. Since the chitemene field moved through a sequence of crops (eg. millet-groundnuts-beans-millet), a household had several fields each of which was in a different stage of the sequence.

The cutting in one area (outfield) and burning in another (infield) was an adaptation to the slow growing miombo. Swidden people in the humid tropics cut the trees and burn on site, but to do so with miombo would greatly lengthen the time for the natural regeneration of the forest. The indigenous method of cutting the outfield and burning the infield allows the tree to resprout and the forest to regenerate more quickly. Currently, because of the increase in population density, trees are cut close to the ground rather than chest high, and regeneration appears to be taking longer (see Chidumayo, 1987).

Fallow time is declining. Chidumayo (1987) found in some areas of the Northern Province that fallow time had been reduced from 25 years (necessary for forest regeneration) to 12 years (when sites had not fully recovered previous growth). Other findings were that field size on a per capita basis had declined (from 1.1 ha. to 0.53 ha.) and that households were making new fields every two years rather than annually. As a response to the decline in forest area and lower yields, these new methods may be part of the transition to a different land use system.

There have also been changes in crops grown. Finger millet was the favoured crop in the past but cassava is now becoming the dominant crop in some areas. Cassava does well in acidic soils, stores well in the ground until harvested, and fits the niche for a crop that can provide sufficient food as the number and size of fields decline. However, it is lower in protein and is demanding in the time needed to safely process it. Millet is needed for beer brewing, hence it will continue to be planted, but it will probably assume a secondary role throughout the region. Other crops planted include sorghum, maize, sweet potatoes, groundnuts and beans as well as vegetables (cucumbers, pumpkins, *etc.*) Some of these crops are planted in the homegarden rather than in the chitemene field.

In response to the decline in forest availability for chitemene, the Bemba are expanding their land use system to include intensively worked permanent fields (grass mounds and cassava gardens) which are located near the village.

Villages near Kasama, a town in the Northern Province, were studied by a team supported by the Soil Productivity Research Programme (SPRP) and NORAGRIC. Their studies revealed that in this area of relatively high population densities (24-82 person/km²) the chitemene system had broken down and been replaced by grass mounds (fundikula) and cassava garden systems. The cassava gardens were the main farming component for the resource-poor households (Holden, 1988).

Tree component

The natural woodland is an integral component of the chitemene system. The system cannot continue without a woodland to serve as the outfield for the ash garden infield. Within the woodland, there are over 30 species of wild fruits that are gathered and eaten (see Hans, 1978 and Hans, 1985, for a lengthy description of wild fruit utilization). When fields are cleared, indigenous wild fruit trees are sometimes left standing in the field. Another tree which might be left is *Pterocarpus angolensis* which is used for planks.

Woodland is also important as a source of gathered edible leaves, caterpillars, and mushrooms. Caterpillars are one of the major sources of protein in the diet as they contain more than 60 percent protein [dry matter basis] and are avidly picked for home consumption and as a cash "crop". Caterpillars are seasonal, and picking is regulated by traditional laws (November 15 - December 15) (Holden, 1988). Caterpillars are dependent on the woodland. They lay their eggs before the rains on the leaves of *Julbernardia paniculata*, a common tree in the miombo woodland. When the eggs hatch the small caterpillars feed on other tree species in the miombo (*Isobertinia angolensis*, *Brachystegia longifolia*, *etc.*). The caterpillars prefer regenerating miombo since the leaves are small and fresh. Little damage is done to the trees themselves since the trees will set out new leaves again when the rains come. This important protein and income

source is declining as a result of the receding woodlands.

Planted trees are part of the chitemene farming system. In Kasama, almost all households had some exotic fruits. In a Bisa village in Mpika district 80 percent of the households had fruit trees planted around the house site (Mudenda, 1981:27). Holden (1988) considered there to be a lack of knowledge in Kasama on the management of exotic fruit trees, but noted that the farmers interest was "considerable" in obtaining improved varieties. Fruit is primarily for home consumption although fruit is sold when markets are available. Fruit trees are planted in the homegarden and "wildings" may be protected and managed (Holden 1988).

Indigenous trees may also be left in the homegarden or around the house site so as to provide "shade, live fence, food, oil, medicine and fish poison" (Holden, 1988:79).

Livestock component

The major tribe in this land-use system, the Bemba, have no cattle-keeping tradition. Although there are pilot projects for the introduction of oxen for ploughing, the Bemba, with no history of cattle keeping, are said to have "a fear of animals". Training in livestock care combined with major changes in the cultural perception of animals will have to occur before livestock can be integrated into the Bemba farming system. These constraints combined with the prevalence of trypanosomiasis in most of Luapula Province, and large areas of the other provinces in the north makes the development of the livestock component of the land use system problematical.

The Bisa, Lala, Mambwe and Inamwanga are in areas with a lower incidence of tsetse and are cattle keeping people, but the number of cattle kept are relatively small when compared with the south.

Labour

Outmigration to the mining areas has created a situation of labour shortages, especially for men and young adults. If remittances are available, female headed households can hire labour to fulfill "male" labour needs. If off-farm income is not available, these households rely on cassava, beer selling, and petty trading (Holden, 1988).

Perception of trees

The Bemba have a very positive attitude toward trees. However, there is a cultural prohibition against collecting the seeds of indigenous fruit trees for planting. Traditional beliefs warn against replicating "God's nature"; forest species are to regenerate themselves without the interference of man.

Use of tree products

One of the by-products of tree planting projects in an area is data concerning fuelwood use. Since in the chitemene areas there has been little project activity, such data are absent. Holden (1988) mentions that in one village in Kasama fuelwood was scarce and people had to walk 5 km to obtain it. Unfortunately, the village was a site for grass mounds rather than chitemene, so even this anecdotal information is not very enlightening. He notes for two other villages in which chitemene is still being practised

that "firewood could be found nearby" (p. 75). However, he does note that charcoal was being manufactured in one village and that "it was quite common" to buy charcoal (p.75).

Houses in Kasama are made of bricks. Farmers in the area expressed an interest in planting trees for building materials. Some households obtained permission from the Forest Department to cut trees for building materials in a nearby National forest, but relations with the Forest Department were not good, and illegal cutting for both building materials and fuelwood probably occurred (Holden, 1988).

Interventions in support of tree growing

In regard to tree planting, there has been little activity by the government in the north. This should change as the new government policy is implemented. However, it appears that the bulk of the resources for agroforestry *etc.* are being focused on the Plateau Maize-Livestock system rather than in the North. (see ICRAF, 1988; Gossage, 1989; Bohlin and Larsson, 1983). Since 1984 there has been agroforestry research by NORAD for the high rainfall and acid soils in the north.

Preferred species for tree planting

When queried, farmers in the Kasama area showed a positive interest in planting more fruit trees. There was also interest in planting *Eucalyptus* spp. for building materials and poles. However, there was no interest in planting trees for fuelwood.

In regard to where to plant, the preferred sites were those close to the village, either the homegarden or permanent field. Planting trees in fallow fields or in the chitemene was not favoured. The reason given for this was the inability to protect these sites from fire which is a problem during the dry season in the more distant fields.

Conclusions: Northern High Rainfall Zone

Where are farmers planting or not planting trees?

Tree planting does occur in the chitemene land use system, but only on a very limited part of the potential landscape. This limitation is a result of the nature of the chitemene system itself; the chitemene field begins, and in the past ended, as miombo woodland. The miombo woodland is rich in indigenous wild fruits. These fruit trees were spared during lopping and cutting, and the fruit was harvested.

However, cultural beliefs prohibited planting seeds or seedlings of wild fruit trees. Exotic fruit trees did not have such a prohibition, and are commonly planted throughout the region. Protection of fruit trees from fire (exotic fruit trees are not as fire resistant as are many of the trees of the miombo woodland) can only occur if they are planted in homegardens and permanent fields.

How does tree planting relate to the ecozone, cultural traditions, and values?

The Northern High Rainfall zone places fewer environmental restraints on tree planting than the semi-arid plains. Acidic soils do, however, require that species be acid tolerant. Cultural traditions favour woodland management rather than tree planting, although the extremely high incidence of fruit trees shows that interest in planting trees for food, and perhaps for building materials, is present.

What incentives are there for tree planting?

Farmers are planting trees to maintain access to fruit as the miombo woodland recedes and wild fruits become more difficult to obtain. The need for building materials might also provide enough of an incentive for planting trees that could be used for building materials and poles. There seems to be little interest in fuelwood species. Although firewood may be recognized as a problem, to plant trees only for the purpose of fuelwood is not very appealing to chitemene farmers. Given the data, it is hard to judge if there is a "real" fuelwood problem.

Marketing incentives do not appear to be very strong, although this should change with the proposed improvements in infrastructure and a more open pricing mechanisms for crops and tree products. The historical reliance of this area on off-farm income, the 'benign neglect' of agricultural extension, *etc.*, and lack of 'surplus' production, has created a situation which will require clear incentives and active extension projects to overcome.

How does tree planting by farmers relate to government efforts and extension attempts to promote tree planting?

There has been little government extension activity in the chitemene areas. Of all the regions of Zambia, this area was perceived as having the least problems with fuelwood and building materials since population density was low and outmigration kept the population growth rate far below the national average. Recent government policy aimed at restructuring the Zambian economy away from mining, and attaining food self-sufficiency, has focused more attention on the North than it has received in the past.

Farmers would probably welcome exotic fruit trees and extension support on tree care. Since tree planting has been on an individual rather than a communal basis, extension services will have to be oriented to provide seedlings and information focusing on the smallholder rather than the community.

2.2 Western semi-arid plains

Definition of zone

Crop growing period of 150 - 210 days

Rainfall is from 600 - 1000 mm annually and is unimodal. The rains begin in November and end in March/April

Altitude is 800 - 1200 metres above sea level.

The natural vegetation of this zone is extremely varied. The uplands are a miombo/Kalahari woodland, the Kalahari sands are grasslands, and there are grasslands and semi-aquatic vegetation on the Zambezi flood plain.

(primary sources: ZATF and ICRAF, 1989; Chidumayo, 1988b; Schultz, 1976)

Case study: Barotse agropastoral system

The major land use system in this agroecological zone is the Barotse agropastoral system. Ninety-five per cent of the total population of the Western province utilize this land use system (ZATF and ICRAF, 1989; citing Kanyangwa and Shula, 1985).

Location

This land use system is located in the Western province of Zambia. The use of both the Barotse upland sands and the Zambezi flood plain is characteristic of this system: land above the flood zone is intensively cropped and after the water recedes farmers utilize the flood plains for livestock grazing and cultivation. The infertile uplands are utilized for cassava and rainy season livestock grazing.

Population

In 1980 the total population in the Western Province was estimated at almost 440,000. The growth rate was quite high - an estimated 3.9 percent a year. The main ethnic groups are the Lozi (traditionally cattle keepers), Mbunda, and Nkoya. There is outmigration of young men to the urban areas. There is also seasonal migration to the sugar estate in Mazabuka.

Tenure

As above for Zambia.

Land use system

The Barotse land use system makes use of three microecozones: the flood plains, the areas above the flood plains (referred to as a "strip" of cultivation), and the uplands of the Barotse sands. The alluvial flood plains are permanent fields, while the 'strip' will be fallowed for a few years, and the Barotse sand fields will be fallowed for longer still.

Different crops are grown on the different fields: maize is grown on the plains and strip; and cassava, sorghum, and millet is grown on the upland sands. Research has shown that in some areas up to 75 percent of the population only have access to the upland fields (Schultz, 1976 citing Maclean, 1965).

Hand hoes and oxploughs are used for preparing the land, those without oxen try to borrow or hire the animals. Weeding is done using the hand hoe. Livestock are integrated into the agricultural system and the fields are manured via kraals. Farmers without livestock are at a disadvantage in agricultural production and they must use fallow as the only means of improving (or maintaining) fertility of the upland fields. The alluvial plains are not so purposefully manured, but after harvest the flood plain is used for dry season grazing.

Drought is a constant threat and the strategy of having fields planted in different crops in different microecozones, cattle, *etc.*, prevents the total failure of the system, but there is little agricultural surplus for marketing.

Tree component

The natural vegetation of the flood plain is grassland. In the uplands there are Kalahari and Miombo woodlands. Fruit and nut trees are reported as being planted in the strip

and uplands.

Livestock component

About 50 percent of the people in the Barotse system own cattle but there is a wide disparity in herd size. The majority of cattle owners have herds of 10-15; only a very small number of owners have large herds of 100-400. The cattle are kept primarily for milk and for plow, and as noted above, they are also important for manure. Social status is achieved by having a large herd.

The uplands are used for grazing during the wet season (when the plains are flooded). It is interesting to note that the quality of the pasturage in the uplands during the wet season may be poorer than the plains during the dry, so that cattle may lose weight during the wet season, a very different situation than that found elsewhere (Schultz, 1976).

Herds (and people) move between the uplands and the plains in a transhumant pattern. About twenty-five percent of the herds stay permanently in the uplands. Shortage of young labour has led to overgrazing around some villages.

Labour

As a result of the outmigration of males, there is a shortage of labour in the clearing of the bush, ploughing, and in canal maintenance.

Perception of trees

There was little data on the perception of trees by farmers in this system. It can be inferred from the ICRAF (ZATF and ICRAF, 1989) and Schultz (1976) studies that fruit trees are planted in the permanent fields, but beyond that there is little data. Fuelwood is perceived as being distant and difficult to collect (Chidumayo, 1988b).

Table 9.3 Frequency of acknowledgement by households (Barotse Floodplain, n = 112)

Description	% households
Wood resources scarce or very far	98
Cut live trees for fuelwood	33
Men involved in fuelwood collection	28
Buy fuelwood	57
Use of cow-dung and crop residues for cooking	96

Source: Chidumayo 1988b

Use of tree products

As mentioned above, the plains area is grassland and virtually treeless. The strip above the plains has been deforested and overgrazed, and the Kalahari woodland and grasslands of the Kalahari sands are far from residences, at least seasonally. Even so only 33 percent of the households reported cutting live trees for fuelwood (see Table

9.3). 75% of households were buying fuelwood and all but a small percentage were utilising cow dung and crop residues for cooking.

Interventions in support of tree growing

There appears to have been little government intervention in this agroecozone. If the new government policy is implemented there should be a restructuring of the price of farm products to encourage the growing of rice. There is a need for a soil conservation programme in the "strip" where soil erosion is occurring. It is unclear from the available data if livestock browsing would be a constraint on tree planting.

Conclusions: Western semi-arid plains

Where are the farmers planting or not planting trees?

Although the data are scanty, planting of fruit trees appear to occur around the house site and homegarden. The sources of the seedlings are not known, but the trees mentioned are mango, citrus and cashewnut.

How does tree planting relate to the ecozone, cultural traditions and values?

In the Barotse land use system, 3 microecozones are utilized: the floodplain, the strip above the floodplain, and the uplands of Kalahari sands. Due to flooding, trees are not being planted in the floodplains; farmers plant trees in the strip and the uplands. Livestock are highly valued, and how much control is exerted over cattle and goat browsing is unclear. Whether there are the same problems in the land use system with livestock as in Sukumaland in Tanzania is not known, and possible similarities can only be inferred.

What incentives are there for tree planting?

In a system where 96 percent of the households perceive fuelwood as distant and 57 percent purchase fuelwood (probably during the rains) there should be some incentive for tree planting. Again the trees that are planted are fruit trees, reflecting the lack of tree planting for fuelwood alone.

How does tree planting by farmers relate to government efforts and extension attempts to promote tree planting?

What could the government do to further encourage tree planting?

There has not been a government tree planting project in this area. The government could encourage tree planting for soil conservation, building materials and fuelwood.

2.3 Central, Southern and Eastern Plateau

Definition of zone

Crop growing period of all plateau areas is below 180 days.

Rainfall ranges from 800mm in the south to over 1000 mm in the north. Most of the area receives between 800 and 900 mm of rainfall per annum.

Altitude ranges from 800 - 1400 m.

Miombo woodland is the dominant vegetation in the eastern and central plateau. In the southern plateau there is not only miombo but *Acacia* woodland "and, on the better soils, *Acacia albida* is common" (ZATF and ICRAF, 1989:50). The dambos (depressions which collect water) and floodplains are grasslands.

In this zone there is one major land use system, the Maize/Livestock System, and one minor land use system, the Namwala-Kafue Flats Agropastoral System.

(primary sources: ZATF and ICRAF, 1989; Schultz, 1976; Kwesiga and Chisumpa, 1990; Gossage, 1989; Bohlin and Larsson, 1983)

Case study: Maize/Livestock System

This agroecosystem is agriculturally the most important in Zambia. As mentioned above, "most of the maize in Zambia is produced here and the largest herd sizes are found in this system" (ZATF and ICRAF, 1989:48). Traditional farmers dominate the farming activities, but there are emergent and commercial farmers in the agroecozone.

Although the soils are variable, it is in this zone that the relatively fertile soils are found. The plateau provinces combined have 82 percent of the Zambian land currently under cultivation. All three provinces produce surplus maize, seed cotton, sunflower, and tobacco. The government's goal of food self-sufficiency is tightly tied to increases in agricultural production in this agroecozone.

Location

This system is found in the southern, eastern, and central plateau of Zambia.

Population

There are about 1.5 million people living in the plateau zone. The population density is about 16 persons/km², which is much higher than the Zambian average, although it is low when compared to other countries in the region. Southern province has the highest population density (27 persons/km²) and Central province the lowest (12 persons/km²). Household size ranges from 5 to 9 persons.

The major ethnic groups are the Tonga in the southern province, the Ngoni and Nsenga in the eastern province, and the Sala, Lenje, and Soli in the central. In the southern and central provinces people live in scattered homesteads. In the eastern province the people live in very large nucleated settlements.

Land tenure

The peasant and emergent farmers in the plateau are under customary land tenure (see land tenure in the general discussion of Zambia). The commercial farmers are under leasehold tenure.

Customary tenure in the plateau does not allow a person and his/her heirs to hold the land in perpetuity. The land must be utilized by a person in order for the rights to be recognized. Also, no land in the Eastern Province "may be enclosed without the consent of the village headman or chief" (ZATF and ICRAF, 1988).

Land use system

The farmers of the plateau have developed an agropastoral system which utilizes the dambos and lowlands for permanent cropland and the uplands for cattle. The dambos are used for wet season cropping and dry season grazing. The livestock rotate through the microecozone; the uplands during the wet season and then the lowlands during the dry season. Crops are the major source of cash earnings, although cattle are important for the long term stability of the agroecosystem.

The commercial farmers are found along the line of rail in the Southern and Eastern provinces. In 1984 they controlled about 16 percent of the cultivated land in the Southern province and a little over 5 percent in the Eastern province. Emergent farmers cropped about 12 percent of the cultivated land in the Southern province and over 20 percent in the Eastern province.

Cropping patterns are similar throughout the plateau system and are influenced by the methods on commercial farms. Extension staff, for example, do not encourage intercropping since commercial farms in the area are mechanized and the fields are not intercropped. Crop yields reflect the type of farmer and the level of inputs. Commercial farmers using high inputs get twice the maize yield (on average) of the peasant farmer.

Tree component

The maize/livestock system is based on the cultivation of major crops in permanent or semi-permanent fields. With the use of the ox plough, fields are cleared of the original vegetation, although valued trees may be left in the fields. In the southern plateau zone, trees such as *Acacia* spp. and figs may be left since both are indicators of the quality of the site (figs are believed to indicate water and *Acacia* spp. soil fertility), but they may also be cleared as they are not regarded as having any other purpose than fuelwood. *Pterocarpus angolensis* is valued for timber and may be left in the field. If wild fruits are located on a potential site, they are left in the field.

Tree planting is around the homesteads and dimbas (fields in the dambos). A large portion of the households have fruit trees. Exotic trees are planted by the farmer, while indigenous trees are left during farm clearing (Kwesiga and Chisumpa, 1990). In the Eastern Province, before a tree planting programme was begun it was found that 60 percent of the households had planted fruit trees (Gossage, 1989). Although homesteads are the most common site of fruit tree planting, dimbas are also used. The majority of dimbas are fenced with live fences (sisal) and thorny bushes to protect the fields from livestock (Kwesiga and Chisumpa, 1990). The dimbas are cultivated in the dry season and this is the same season that livestock are herded to the dimbas for grazing. Fencing is necessary to protect dimbas from the livestock.

Livestock damage can be considerable for unprotected seedlings. In a tree planting project for individual woodlots in the Katete district of the Eastern Province, 37 percent of the mortality of seedlings (*Eucalyptus grandis*) was attributed to cattle grazing (Chidumayo, 1988b). Tall grasses attract livestock, so woodlots have to be weeded as further protection from grazing as well as against the risk of fire. Men are the primary tree planters. In the Eastern Provinces, where people live in large villages and homesteads are small, most of the tree planting takes place in the dimbas. Men "own"

the dimbas, so it is not surprising that the majority of exotic fruit trees are planted by men.

Livestock component

The Maize/Livestock system contains about two thirds of the cattle in the "traditional" sector of Zambia. Most of the cattle are found in the southern plateau, followed by the eastern and central plateau. The number of cattle owned per household follow the same order: southern (16.9), eastern (7-14), and central (5-10). Usually larger households have more cattle than smaller households (ZATF and ICRAF, 1989).

Oxen are used for ploughing and transport, and cattle provide milk and very occasionally meat. Manure is used in the cropping system, but how important this is in crop production is unclear. Use of manure varies between farmers and areas. Cattle are valued as a form of wealth, a potential safety net if the crop fails, and as a means to pay brideprice. Herd size is therefore larger than needed for ploughing, milk, *etc.*

Cattle are communally herded; they are herded into the uplands during the cropping season, and then during the dry season are brought to the dambos to graze on the maize stover and other crop residues. Grazing is allowed on all land on which there are no crops growing.

Labour

As in other areas of Zambia, there are labour shortages as a result of outmigration by young men, especially during planting and harvesting. There is competition for agricultural wage labour with the commercial farmers, who can and do pay more than peasant and emergent farmers can afford. Labour has been identified as a major constraint to increased production in the plateau system.

Perception of trees

Farmers have a favourable attitude towards trees. When queried, 86 percent of the farmers in one survey of the Eastern Province stated that they would like to plant more fruit trees. Fruit forms a very significant part of the diet (Kwesiga and Chisumpa, 1990). Fruit is eaten by all family members, and is especially important from November to March.

Although farmers use the miombo for fruit, fodder, medicinal plants and building materials, *etc.*, farmers were reluctant to use wildings to establish forest trees in their dimbas or fields. A commonly held belief (as in other areas of Zambia, see above) is that "only God can plant forest trees. They had no idea that miombo trees could be raised from seed" (Kwesiga and Chisumpa, 1990: 54).

Use of tree products

In the plateau there is still woodland near some villages, while other villages are far from a source of fuelwood, wild fruits, *etc.* In Katete (see Table 9.4) 56 percent of the households queried, stated that wood resources were "scarce or very far". In another survey Bohlin and Larsson (1983:20) reported that almost two thirds of the households revealed that they were cutting down live trees, "half of these for the single purpose of getting firewood." This is despite the fact that dead parts of trees are preferred to live

ones. In the Bohlin and Larsson survey it was reported that fuelwood was not sold within the village.

In Katete, fuelwood was collected at least once a week by 60 percent of the households, and 25 percent collected fuelwood once or twice a month. When men collect fuelwood, oxcarts are used, so large loads are gathered that last for longer periods of time.

Nearby towns provide a market for fuelwood. In 1983 an ox-cart load of wood would fetch the equivalent of three days pay at the minimum wage (Bohlin and Larsson, 1983).

Table 9.4 Frequency of acknowledgement by households (Katete - Eastern Province)

Description	% Households
Wood resources scarce or very far	56
Cut live trees for fuelwood	9
Men involved in fuelwood collection	40
Buy fuelwood	0
Use of cow-dung and crop residues for cooking	0

Source: Chidumayo, 1988b

Interventions in support of tree growing

Whereas the North and the Western agroecological zones had few projects concerned with tree planting, the plateau has had several. In the Katete district since 1981, there has been a small village tree planting programme which is supported by SIDA (see Bohlin and Larsson, 1983). Although the original goal was communal tree plantations, the only community owned woodlots which resulted were those belonging to schools. *Eucalyptus grandis* was the only tree species planted from 1982-1986. When the programme was evaluated by Chidumayo (1988b) he found that the survival rate was 46 percent. Tree mortality was attributed to termites (although Gossage, 1989, questions this and suggests disease) and livestock grazing. Of the households that planted trees, 100 percent anticipated using the trees for poles and furniture, 14 percent for sale, and 14 percent for firewood.

Preferred species for tree planting

Although the government has promoted tree planting primarily for the production of fuelwood, farmers appear to find fruit trees (especially improved citrus) and multipurpose trees more appealing. However, *Eucalyptus* spp. were successfully introduced into Katete despite the fact that farmers would prefer a less 'one-dimensional' tree.

Conclusions: Central, southern and eastern plateau

Where are farmers planting or not planting trees?

Farmers are planting trees around the homesteads and dambos. These are the areas of the landscape protected from the livestock. By inference it appears that, as with the Tanzanian Sukuma, the grazing of livestock on fallow/ harvested fields makes it difficult to integrate trees into the entire landscape. Dimbas, protected by living fences and thorn bushes, are perceived by the farmer as the best site for tree planting "outside the homestead".

How does tree planting relate to ecozone, cultural traditions and values?

This agroecozone is the most productive in Zambia. Low population density, outmigration, and existing miombo woodlands have buffered the maize/livestock system from the need to plant trees. The miombo is utilized by households for fuelwood, building materials, fruit, honey, *etc.* Kwesiga and Chisumpa (1990) suggest that in the Eastern province the realization (and acceptance) that the woodlands are shrinking and that if they are not managed they will disappear, has not yet occurred. Planted fruit trees have been integrated into the agroecosystem to supplement or substitute wild fruits, but trees have not been planted to replace the trees of the miombo that provide fuelwood, timber, medicine, *etc.*

The cultural belief that trees of the miombo should not be planted by man may inhibit proposed programmes which will be exploring the use and distribution of indigenous trees.

What incentives are there for tree planting?

The primary incentive has been to provide fruit for home use. Marketing of fruit by peasant farmers is occasional and provides little income. Tree product marketing is not discussed in the literature; however, 14 percent of the farmers who planted *Eucalyptus* spp. woodlots in Katete projected selling at least some of the trees. Exotic trees are not prohibited from being planted and could supplement household income that is currently dependent on selling maize, dairy products, beer, *etc.* Fenced dimbas could be expanded for tree planting.

How does tree planting by farmers relate to government efforts and extension attempts to promote tree planting?

Farmers in this agroecosystem have only recently become the recipients of programmes designed to encourage tree planting. Communal woodlots were not a success, but individual farmers have been planting trees provided by these programmes, and survival rates have not been over 40 percent.

Extension attempts will have to deal with the constraint of an agropastoral system; livestock grazing of seedlings. The plateau villagers have developed the dambos as a protected site for fruit trees and extension attempts could be directed at using these fields for other tree planting.

3. Zambia summary

1) Government programmes for smallholders are recent and the new policies are ambitious. Agriculture had been a neglected sector of the economy until the crash of copper prices, and agricultural extension focused on commercial farmers. Forestry policy was devoted to providing timber for the mines and protection of the woodlands. The implementation of the new agricultural policies requires the development of extension services that did not exist in the past. Afforestation for fuelwood appears to be a programme of the Forestry Service, but there are very few trained extension personnel to implement it.

2) Farmers know what they want and it is not a tree that provides fuelwood alone. Farmers in all three case study areas were interested in fruit and multipurpose trees. With a weak market for fuelwood in the North and Plateau, farmers will not be planting trees for fuelwood alone. In the West there was a local market for fuelwood, but the large herds and too few herders raise questions as to the feasibility of woodlots outside the homegarden site.

3) At all the case study sites, farmers were not planting trees in the fallow fields, but rather in protected areas. In the North the protection was from fire, and in the West and Plateau it was from livestock.

4) Knowledge of tree planting and care does not appear to be a constraint, although for exotic trees some instruction may have to be given. What does appear to be a constraint is the lack of clearly defined benefits for tree planting, especially in areas where there is woodland nearby.

5) Lack of young labour has to be considered in project design. Farmers are relatively old and many spent their own youth outside the rural areas. Their knowledge of farming techniques and their ability to do heavy labour may be limited.

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10. COUNTRY REPORT: ZIMBABWE

1. General information

1.1 Background

Population

The population of Zimbabwe was estimated to be 8.6 million in 1987, and based on the current growth rate of 3.1 percent, it is projected to reach 13 million by the year 2000. It is a young population and an estimated 55 percent of the population is under the age of 15. About 25 percent of the population live in urban areas, while the rest of the population are unevenly distributed in the rural areas. Rural population distribution reflects the impact of colonial policy whereby the best land was set aside for the white settler, and the indigenous peoples were relocated on Communal lands in the drier warmer regions. Most of the densely populated rural areas of Zimbabwe are in the Communal lands.

Currently, about 35 percent of the Zimbabwean population live in the drier marginal communal areas. Population density countrywide is approximately 23 persons/km². In the rural areas the highest population densities are in Manicaland, Mashonaland South, and Victoria, all of which have population densities greater than 35 persons/km². Since independence in 1980 redistribution of land has moved slowly and the colonial settlement pattern continues.

The two main indigenous groups in Zimbabwe are the Shona and the Ndebele. The Shona constitute about 80 percent of the indigenous population and occupy the northern and eastern parts of the country. The Ndebele form the other 20 percent of the population and occupy the western part of the country.

(Sources: Mugabe and Taguta, 1985; Mugabe and Taguta, 1985 citing Devries/SADCC, 1984; Weiner *et al.*, 1985; EIU, 1988; Avila *et al.*, 1989.)

Topography

Zimbabwe is a highland country. Four-fifths of the land area is above 600 m, "but less than one twentieth is above 1,500 m" (Mugabe and Taguta, 1985:5). The country is divided into three velds:

The High veld forms the central plateau of Zimbabwe. It runs roughly northeast to southwest and ranges in altitude from 1200 m - 1500+m above sea level.

The Middle veld is on either side of the high veld. It ranges in altitude from 600 - 1200 m and is broken by deep river valleys.

The Low veld is found in a small area to the northwest in the Zambezi Valley, and in a larger area in the south between the Limpopo and Sabi Rivers. The low veld is under 600 m in altitude.

Climate

Except for a small area in the high veld, Zimbabwe is subtropical with an unimodal

rainfall pattern. Zimbabwe is the driest and coolest country in the survey area. The rainy season lasts about five months (summer: November-March), and there is little or no rain during the rest of the year in most of the country. Since rainfall occurs in summer, the winters are relatively cool and dry.

Average rainfall for the whole year is approximately 675 mm, but it is unevenly distributed with the north wetter than the south, and the east wetter than the west. In the northern highlands, Harare, for example, receives an average 870 mm of rainfall annually, while Beitbridge on the southern border with South Africa receives an average of only 325 mm.

Vegetation

The great variation in the vegetation of Zimbabwe reflects the differences in the climate, rainfall, altitude *etc.* of the Natural Regions. In the regions which are the focus of this report, Natural Regions III, IV, and V, the vegetation is predominately in miombo and mopane woodland. In Region IV some areas of mopane which have been cleared are becoming replaced by *Acacia nilotica* and *A. tortilis* (Balderrama *et al.*, 1988).

Soils

Zimbabwe's soils are mainly sandy with localized areas of heavier loamy and clay soils. There are four major types of sandy soils: soils derived from granite, coarse grained, and covering two-thirds of the area in sandy soils; soils derived from gneiss in the southern areas of Zimbabwe; triassic sands in the southwest; and the "so-called Kalahari sands, mainly in the southwest" (Mugabe and Taguta, 1985:8). The coarse grained sandy soils have poor physical characteristics "such as low moisture holding capacity and compaction in the sub-soil" (Mugabe and Taguta, 1985:8). Since their clay and silt content are extremely low, the Kalahari sands of the southwest are even less fertile than the coarse grained sandy soils (Mugabe and Tugata, 1985 citing Devries/SADCC 1984).

1.2 Agroecological zones

Zimbabwe is commonly divided into five natural regions or agroecological zones. The agroecological categories and the criteria of division reflect the government's (both colonial and current) emphasis on agricultural production and potential land use systems. The agroecological zones are primarily based on rainfall since it is regarded as being the most important factor in agricultural production.

5 major agroecological zones can be delineated (see table 10.1 and figure 10.1), which also indicate recommended land use patterns (see table 10.2):

- I Specialised and diversified farming region
- II Intensive farming region
- III Semi-intensive farming region
- IV Semi-extensive farming region
- V Extensive farming region

Table 10.1 Description of zones

Zone	Rainfall (mm)	Pattern (unimodal)	Altitude (veld/range)	Area % country
I	1000-1500+	Throughout year	Middle/high > 900 m	1.8
II	750-1000	Summer	High > 1200 m	15.0
IIa		Reliable 18 pentads*		
IIb		Mid season droughts 16-18 pentads* ⁴		
III	650-800	Infrequent 14-16 pentads*	Middle 900-1200 m	18.7
IV	450-650	Severe dry spells	All 3 velds	37.8
V	< 600	Frequent seasonal drought	Low, lowest (< 600m) in country	26.7

* pentad: centre one of three five day periods (pentad) which together receive more than 40 mm rainfall and two of which receive at least 8 mm of rainfall

Sources: Mugabe and Taguta, 1985; Campbell, 1987; Ivy, 1987; Weiner *et al.*, 1985; Collins Longman Atlas, 1983; Vukasin, 1987; See also Mupawose and Chengu, 1986 for slightly different percentages of regional areas.

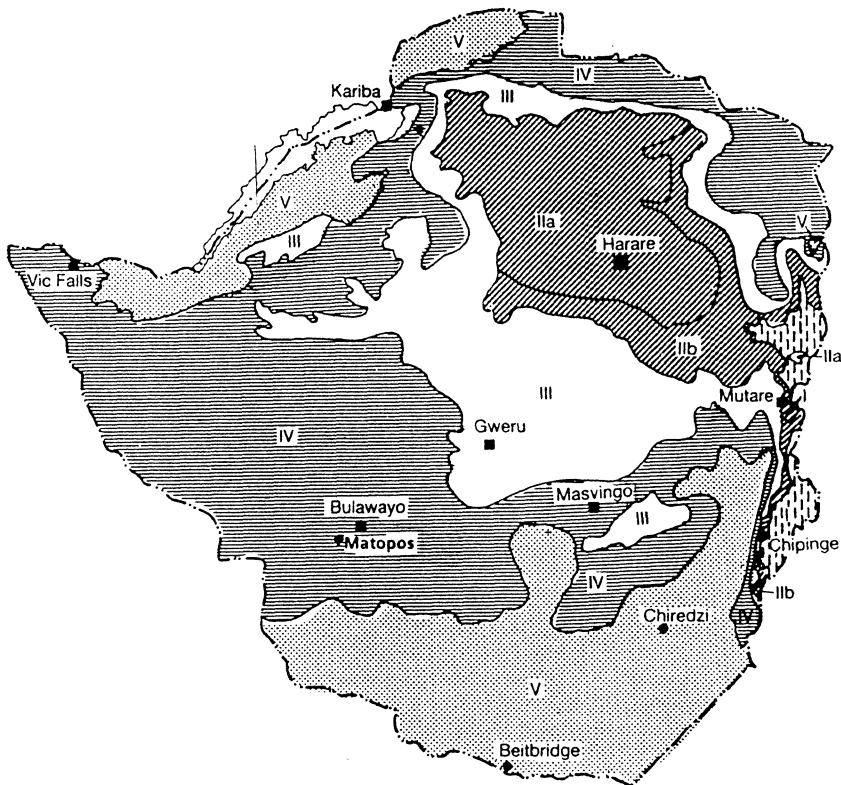
Table 10.2 Agroecosystems and suggested land use

Zone	Farming type	Land use
I	Specialized and diversified	Forestry, fruit, intensive livestock, crop production
II	Intensive	Crops, livestock
III	Semi-intensive	Maize, tobacco, cotton
IV	Semi-extensive	Livestock, fodder
V	Extensive	Livestock on natural veld

Source: Avila *et al.*, 1989

Actual land use patterns differ from the recommended, but planning and extension objectives are to introduce and subsequently maintain the suggested systems. How successful the transformation of current to suggested land use systems will be is uncertain. Farmers in the communal areas follow a strategy that entails a more diverse land use system than that recommended. For example, since the Communal lands disproportionately occupy Regions IV (semi-extensive) and V (extensive), it is not surprising that a cereal/livestock land use system, rather than the suggested livestock, occurs. As will be shown below in the case study, farmers in the Regions IV and V cannot risk replacing the current system, based on grain and livestock, with livestock alone.

Figure 10.1
NATURAL REGIONS OF ZIMBABWE



Source: Avila et al, 1989

1.3 Tenure

Land tenure

The term "land tenure" in Zimbabwe has a different connotation than elsewhere in the region. Land tenure is used to delineate who occupies the land: General lands include what had been European and African Purchase land, and present day Resettlement communities; Communal Lands are the former Native Reserve Lands. "Land tenure change" is synonymous with land reform, *eg.*, redistribution of land from the General lands (large scale commercial farms), rather than changes in the laws concerning specific rights within either Communal or General lands.

Historical

The European/Communal separation of lands began in the 19th century. In the 1890's European settlers began to establish farms in what is now Zimbabwe. A series of wars against the indigenous people gave the settlers control over large areas of the region. The British government insisted that areas, native reserves, should be set aside for the sole use of the indigenous people. The population in the reserves grew more quickly than had been foreseen as people who were displaced by the European farms moved to the already settled Native Reserves.

In 1931 Native Purchase Areas were established for African farmers so that they could purchase small farms. The Purchase Areas were usually located in the Natural Regions IV and V, adjacent to the already existing Native Reserves (Whitlow, 1988). Although the amount of land in the Purchase Areas was small, farmers who were able to get the capital or credit to purchase land in these areas had more access to agricultural extension information than farmers on the Native Reserves. More land was given in 1950 to the Native Reserves, but since the land was in areas of either tsetse infestation or very low rainfall it did not relieve the population pressure in the original reserves.

In 1970 the Land Tenure Act gave equal portions of the land to the indigenous people and Europeans. However, the two populations were neither equal in size, nor was the land equal in quality. The Communal lands remained little changed in size and no territory was gained in the higher rainfall areas (Whitlow, 1988).

Before independence, Zimbabwe was, therefore, divided into 3 major land use categories (excluding non-agricultural lands such as parks and forest reserves):

European Land located in the better agricultural areas and held under freehold.

Tribal Trust Lands in the drier areas and held under customary law which precluded individual freehold.

African Purchases areas usually adjacent to the Tribal Trust Lands and held under freehold by African farmers.

Current

The existing land use patterns reflect the impact of past colonial and current government policy concerning effective (productive) land use. Until recently, the government was reluctant to change the existing patterns of land use and tenure. The reluctance was based on past obligations and beliefs. At the time of independence part of the Lancaster House Agreement was that land could only be bought on a "willing-seller willing-buyer" basis. An additional constraint was that the Agreement stipulated that foreign owners would be paid for their land in foreign currency. This stipulation required that scarce foreign currency reserves, earned by commercial and manufacturing exports, be paid to the commercial landowner (Hoad, 1985). This stipulation served as a brake on land redistribution, especially during drought years when the government was forced to use foreign currency reserves to import food.

During the ten years following independence, the government was concerned that if a more forceful approach was used an exodus of European farmers would ensue and it would be accused of breaking the original agreement. The reluctance of the government to start such an exodus, however, went beyond legal constraints and was based in part on the belief that the large scale commercial farms (LSCF) were more productive than a resettlement of smallholders in the same area would be. The LSCF generate much needed foreign exchange, provide the basis for manufacturing and processing businesses in the urban areas, and except in years of severe drought, maintain Zimbabwe's self-sufficiency in food crops.

However, the LSCF's have the advantage of size and agroecozone. Commercial lands in 1985 "constituted 33 percent of the total land area with an average holding of over 3000 ha. The 'communal lands'...constituted 42 percent of the total land area with an average land holding of 3 ha of arable land, plus grazing" (Bratton, 1987: 221).

Not only are the commercial farms much larger than the communal farms, but they are also on the better agricultural land (see Table 10.3). Smallholders with little acreage in low rainfall areas are more vulnerable to drought than the commercial farmer in the higher rainfall areas.

Table 10.3 Agroecological zone and land use

Zone	Zimbabwe (%)	Commercial (%)	Percent (%)	Communal (%)	Percent (%)
I	1.8	2.7	63.0	0.8	1.8
II	15.0	27.1	74.0	7.7	21.0
III	18.7	22.4	44.0	17.2	44.0
IV	37.8	25.5	27.0	44.9	49.0
V	26.7	22.3	35.0	29.3	46.0

Sources: Bratton, 1987:222, citing Chavunduka, 1982; Mupawose and Chengu, 1986

The delineation of the LSCF as being commercial and the smallholder on Communal lands as being subsistence no longer holds (if indeed it ever did). Smallholders have been increasing their share of the marketed crops, especially maize, as extension activities, price incentives, and transport facilities have refocused on the need of the small producer (see Stanning, 1985; Bratton, 1987). There appears to be a growing belief that placing small producers in the better favoured regions does not necessary mean low production and the loss of Zimbabwean food self-sufficiency.

Little land in Natural Regions I and II has been available for resettlement. The land that has been redistributed in resettlement communities has primarily been in grazing areas in the drier zones IIb, III, and IV. This is a reflection of the fact that the commercial farmers in the better favoured zones I and IIa are less likely to sell their land and also it demonstrates the inability of the government to force such sales under the willing-seller willing-buyer stipulation of the Lancaster House Agreement.

The Lancaster House Agreement ended in 1990. An 1990 amendment to the constitution gives the government power to nationalise land without arbitration over price, and current policy calls for the government to nationalise half of the land currently held by the commercial farmers. The land (6 million hectares) is to be used for resettlement communities. These changes in the constitution and policy abrogate the land redistribution constraints inherent in the Lancaster Agreement. How quickly land nationalisation will occur in reaching the policy goals is unclear. Current policy does, however, appear to be more concerned with resettlement than with past fears of declines in agricultural production.

If all of the land in Region I, for example, was redistributed, it would represent only a very small percentage of Zimbabwean land (see Table 10.3). Even though the Communal lands have relatively high population densities there is little land, especially good land, available for resettlement communities. Moreover, current resettlement schemes place restrictions on the settlers activities. Migrancy, for example, is not allowed, although the small size of farm (5 ha.), especially in regions of frequent drought, may prove untenable without off-farm income.

Government interventions

Until the recent legislation, government policy concerning land had been focused on land acquisition and redistribution, rather than changing the current land tenure laws. Land that was acquired from willing sellers was redistributed to farmers from the communal areas or landless peasants. The amount of land actually transferred has been relatively small: only 5 percent of all Zimbabwean land was under resettlement schemes in 1985.

Currently, freehold tenure on the commercial farms is maintained, customary law controls the distribution of land in Communal lands, and government guidelines are used for land allotments and permits in the resettlement areas (placed within the General lands rather than Communal lands category of land use). Although Communal lands are distributed by the village headman or chief (or increasingly by the Village Development Committee [VIDCO]) the land belongs to the state. Individuals on Communal lands have "rights of avail" *eg.* they have land for cultivation, grazing, as a house site, and as a source of natural resources, such as water and fuelwood (Avila *et al.*, 1989).

Since government guidelines vary depending on the purpose of the settlement (individual *vs.* communal) and its particular goals, land tenure differences occur between communities, irrespective of the fact that there will be one form of land tenure within a resettlement community. Therefore, depending on the particular resettlement scheme, households can hold land under freehold, membership in a cooperative, leasehold, or be under customary law as in a communal area (Avila *et al.*, 1989).

A national system of land tenure which would include all of Zimbabwe under the same land tenure laws has yet to be developed. There are recognized difficulties in designing and implementing a new land tenure system that would continue to allow commercial farms and yet retain the socialistic ideals of the government.

Part of the perceived difficulties may be based on the negative consequences of the Native Land Husbandry Act (NLHA) of 1951. The primary aim of the NLHA was to create in the Communal lands a new tenure system based on individual rights rather than the tribal system of land tenure. It was believed that with secure individual rights a farmer would institute the conservation measures that the colonial government was supporting. The NLHA did result in conservation efforts in the communal areas, but it not only denied land allocation to women, but also "disrupted the traditional system of tribal authority,[and] created a landless class of some 102,000 families who could not be accommodated within the reserves" (Whitlow, 1988:429). It also served as a rallying point against the colonial government by the indigenous leaders (see Balderrama *et al.*, 1988).

Even with its break from the Lancaster Agreement, current policy maintains both privately held and state owned land. In communal areas farmers continue to have entitlement via their Chiefs/Headmen/Village committee to utilize the land, but they do not have title deeds for their holding. Individuals who have held the land for a long period and/or made improvements may assume that they have title to the land, but legally, since there is no provision of individual ownership in Communal lands, they do not have title (see UNDP/FAO, 1989:52). Most farmers, 64 percent according to one study, recognize that there is a possibility that their land may be expropriated (UNDP/FAO, 1989).

Projecting the recent policy changes into the future, people will gradually be resettled as land in the General Lands becomes available and as government guidelines concerning amounts of land per household *etc.* are utilized in the resettlement areas. If this continues eventually all lands, except for any land remaining with commercial farmers, will be held under government permits and guidelines.

1.4 Economy

Of the eight countries in the study area, Zimbabwe is the only one that is characterized as a "middle income" rather than a "low income economy" (see World Bank, 1989). Zimbabwe's per capita income, for example, is 78 percent higher than Kenya's, the country with the next highest per capital income in the survey area (see Table 10.4). The economy of Zimbabwe is the most industrial in the region with industry providing 43 percent of the GDP while agriculture provides 11 percent.

Table 10.4 Distribution of gross domestic product (1987)

Country	Agriculture (%)	Industry (%)	Services (%)	Per capita GNP (US\$)
Burundi	59	14	27	241
Kenya	31	19	50	330
Malawi	37	18	45	164
Rwanda	37	23	40	301
Tanzania	61	8	31	180
Uganda	76	5	19	260
Zambia	12	36	52	248
Zimbabwe	11	43	46	585

Source: World Resources Institute/UNEP/UNDP, 1990

However, the figures of the GDP distribution are to some extent misleading. Although agriculture directly represents a relatively small portion of the GDP, "it accounts for a third of all formal wage employment, whilst 70 per cent of the nation's population are directly dependent on the land. . . and supplies 40 per cent of the inputs to the

manufacturing sector" (Weiner *et al.*, 1985:251 citing Mumbengegwi, 1983). Zimbabwe's economic dependence on agriculture is also reflected in the GDP. In 1983 and 1987, both years of drought, the Zimbabwean GDP declined.

1.5 Rural Sector

Maize is the major crop throughout the country. Other crops grown are wheat, cotton, tobacco and sugarcane. The farming system is radically different in the two land holding systems.

The Communal lands are commonly viewed as being overcrowded, overutilized and unproductive with a subsistence rather than market orientation. Population densities are higher on the Communal lands (25.5 people km²) than in the General lands (7.6 people km²), and in some localities densities of over 100 people km² occur. The high population densities in relation to the natural resources available exert pressures and can lead to environmental degradation in the area.

This degradation of the natural resources is the basis of the cited "overutilization." In a survey of soil erosion in Zimbabwe, although less than 5 percent of the land was identified as being eroded, four-fifths of the eroded land was in the Communal lands area. This represented 8.4 percent of the Communal lands, while only 1.8 percent of the General lands (primarily commercial farms) were identified as being eroded. However, population density is not the only factor leading to erosion, for in areas of equal population density in the Communal and General lands, more erosion occurred in the Communal lands (Whitlow, 1988).

Land use patterns differ between the commercial and the communal. Land is cropped on Communal lands that would not be put under crops on commercial farms. LSCFs in the drier areas rely on cattle production or irrigation, whereas the smallholder on Communal lands produces crops and, ideally, keeps a small herd.

Erosion increases when the drylands are cropped and the process is exacerbated by the concentration of livestock. The smallholder, however, needs to do both in order to live in the drier Communal lands. The current government-promoted farming system is based on mixed farming: cattle and cereal production. Cattle appear to be better integrated into the Zimbabwean farming system than in other agropastoral systems in the region, and they are used for draught, milk, and manure. Since they can be sold in times of crop failure, cattle provide the safety net for households in high risk farming areas.

The belief that the Communal lands are unproductive is debatable. Households on the Communal lands continue to operate their holdings on the basis of first providing for their subsistence needs, and secondly obtaining a cash income from the sale of what was not needed for household consumption. However, the contribution of communal areas to marketed output has increased dramatically since independence. In 1980 the marketed output of maize from the communal areas was only 8 percent of the national total; by 1985 it was over 45 percent (Bratton, 1987:222; see also Stanning, 1985). The refocusing of extension activities, credit *etc.* on the needs of the smallholder appear to be effective.

However, 80 percent of the maize marketed came from communal areas in Regions I - III; a large proportion of the farmers in the drier regions did not have surplus maize to sell. Productivity in both commercial and Communal lands is higher in the wetter zones than the drier and this is an advantage that the extension activities, infrastructure, *etc.*, may not be able to overcome.

Labour

Concurrent with the rest of the region, during the colonial era a combination of taxes that had to be paid in cash and the lack of cash earning opportunities in the communal areas, created a male migrant labour force. In Zimbabwe the migrants worked in the mines, factories, and on the commercial farms. Unlike Zambia, however, males do appear to return later in life to their natal areas (see Table 10.5). This pattern of a man leaving in his youth for off-farm employment and then returning in middle age to his village has been referred to as the Domestic Development Cycle (Balderrama *et al.* 1988:56 citing Low, 1986). This cycle currently continues although, since the imposition of the minimum wage for farm labour, employment on the commercial farms has declined.

Table 10.5 Household composition: % households with one or more adults present

Age	Gender	Regions					Total
		I	IIA	IIB	III	IV	
20-29	Males	32	33	34	32	43	36
	Females	39	44	39	38	43	41
30-39	Males	20	25	30	25	32	25
	Females	37	33	34	37	36	36
40-49	Males	28	24	16	33	28	26
	Females	34	31	20	30	34	31

Source: UNDP/FAO, 1989: 36-37

Male outmigration results in a relatively high proportion of the rural households being female headed (see Table 10.6). Although there is regional and site variation, and no data are presented on Region V, the national pattern appears to be for approximately one-fifth of the rural household to be female headed (UNDP/FAO, 1989).

Table 10.6 % female headed households

Region	I	IIA	IIB	III	IV	Country total
%	6	13	93*	11	9	<u>20</u>

* Small sample size may have skewed data results

Source: Based on UNDP/FAO, 1989: 4 - 5

Credit

Agricultural credit in Zimbabwe is still oriented to the needs of the large commercial farmer. Farmer's cooperatives, for example, are mostly controlled by the large farmer and credit is given to the cooperatives members. Commercial banks require collateral, but farmers on Communal lands do not have title to their land. The Agricultural Finance Company (AFC) lends to smallholders, but only to Master farmers, who are chosen on the basis of their following the rather stringent criteria of AFC extension suggestions. Given the erratic rainfall of much of the communal areas, even if credit is available through AGRITEX, farmers have difficulty in paying back their loans (Mugabe and Taguta, 1985).

The difficulty of smallholders in communal areas obtaining credit is recognized as a serious constraint in agricultural production. However, it should be noted that a programme which can provide credit to smallholders effectively and with some chance of repayment has yet to be designed and implemented either in Zimbabwe or in other countries in the region.

Fuelwood

Although fuelwood shortages occur in localized areas and are projected to become a serious problem nation wide, at the household level fuelwood shortages are not perceived with the same urgency.

Agricultural extension activities

Agricultural extension in the Communal lands is relatively recent. Extension activities before independence focused on the needs of the commercial farmers and not on the needs of the smallholders of the Communal lands. In the European lands in Regions I and II (the high veld) there were good rail and road networks, assured markets for agricultural products, and credit. Although the small number of African farmers who were able to purchase land in the African Purchase areas did do well and became recognized as "master farmers", the great majority of the smallholders were in drier regions, with poor infrastructure and little access to extension information or credit.

Since independence there has been a policy shift to focus on the needs of the smallholder, but it is difficult to judge how much change there has actually been in agricultural extension activities. Certainly the proportion of marketed maize from the communal areas has increased, but it is hard to discern whether this is due to extension efforts or other factors (rainfall, infrastructure, pricing, *etc.*). Currently, AGRITEX (in the Ministry of Agriculture) is the major extension organization in the country. The focus of AGRITEX is to expand extension in the Communal lands "however, the ratio of one extension worker to 800 farmers is not conducive to this" (Mugabe and Taguta, 1985:xxxiv). Since there is not the manpower to reach the individual farmers, extension agents provide information in group settings. Research activities still benefit the commercial farmer, rather than the smallholder (Mugabe and Taguta, 1985:xxvii).

1.6 Government policy on trees

After independence there was concern about the decline of wood resources, especially fuelwood. The Forestry Commission in 1982 established the Rural Afforestation Project.

The goal of the project was to increase wood supplies in the rural areas, "as well as improving the awareness of communal farmers of the need to plant trees" (Grundy *et al.*, n.d.).

The Project goal was to be achieved by establishing nurseries to supply seedlings, planting woodlots to provide wood (fuelwood and poles) for sale, and to create forestry extension services within AGRITEX to "encourage and advise farmers on planting, maintenance and cropping of trees" (Casey and Muir, 1986:4). The Forestry Commission, has the responsibility of implementing the project, but it is a parastatal without its own agricultural extension personnel (Mugabe and Taguta, 1985). AGRITEX which is the primary agricultural extension service in Zimbabwe does not have the resources to develop forestry extension services.

Choice of trees species has also created problems. The Rural Afforestation Project was based on three *Eucalyptus* species. *Eucalyptus* spp. does not appear to be the tree of choice by farmers. In the drier areas there is a concern over water availability and vulnerability to termites, and survival rates appear to be low (see also Clarke, 1990).

Studies have shown that the Rural Afforestation Programme has not been very effective. Even in the areas initially targeted knowledge of the programme is low and seedling availability, primarily of *Eucalyptus* spp., is not sufficient (see Grundy *et al.*, n.d.; Du Toit *et al.* 1984; Casey and Muir, 1986).

Small farmers and trees

Communal farmers in Zimbabwe appear to be primarily planting exotic fruit trees, rather than trees for fuelwood or building materials alone, although a small percentage (11%) of farmers who planted trees did plant *Eucalyptus* spp. (Grundy *et al.*, n.d.; Du Toit *et al.*, 1984; Campbell and Du Toit, n.d.). The Natural Region in which the household resided played an important role in which fruit tree were planted (see Table 10.7). Mango was common in Regions I - III, but avocado was uncommon outside of Regions I - II; almost all peach was grown in Region IIB, while relatively few exotic fruit trees were grown in Region IV (UNDP/FAO, 1989).

Table 10.7 Fruit trees reported grown

Fruit trees	% Farmers/Region					Total
	I	IIA	IIB	III	IV	
Mango	32	58	25	54	8	34
Avocado	65	16	6	1	0	30
Orange	22	4	14	2	2	13
Peach	0	1	44	0	6	7

Source: Based on data presented in UNDP/FAO, 1989: 22-23

Farmers plant exotic fruit trees in the home garden and home sites, and conserve

indigenous trees in the fields and grazing areas. Home sites are where tree planting is concentrated by the household. Few households plant indigenous fruit trees (less than 5 percent), but 10 percent of the fruit trees found on homesites were indigenous trees that had been preserved (Campbell *et al.* 1991).

The indigenous trees that are preserved by the farmer in fields are primarily fruit trees (80%). Even in deforested areas, the most favoured fruit trees have been conserved thus creating a landscape of wild fruit trees which reflect the "people's fruit choice" (Campbell *et al.*, 1991).

Grazing areas are the wood reservoir for the community. Fuelwood and construction materials are collected from the grazing areas. Again fruit trees are rarely cut, and form about 10 percent of the forest cover (Campbell *et al.*, 1991). Although the emphasis is on preservation of fruit trees, trees are also found in home sites, fields, and grazing areas and are conserved for shade, hard wood, browse potential, or religious beliefs. Many of the trees conserved for fruit also provide shade or have significant religious meaning (Campbell *et al.*, 1991; Wilson, 1989).

When trees are planted for wood, it is for construction materials, especially poles, rather than for fuelwood. The perception of a lack of potential construction materials appears to occur before an appreciation of a projected decline in fuelwood. This is because the demands of suitable wood for construction are far more stringent (straightness, length *etc.*) than that for fuelwood (see Campbell and Du Toit, n.d.).

The Tonga people, a small tribal group who live along the Zambezi, practice a tree management system based on *Acacia albida*. The management system is similar to that found throughout the region where *Acacia albida* is preserved: the trees are left in the fields and crops are grown underneath them. Since leaf fall occurs prior to the agricultural season, crops are not overshadowed and the leaf fall serves as a green manure for the crop (Campbell *et al.*, 1991).

2. Agroecological zone analysis

Since most smallholders are in the Natural Regions III, IV, and V these regions will be the focus of the agroecological zone analysis. The first case study site to be discussed is a communal area in southern Zimbabwe. The second case study site is in a resettlement area in eastern Zimbabwe. The land use system in both case study areas are cereal/ livestock with home or vegetable gardens and homesites planted with fruit trees. Both sites are predominately Shona.

2.1 Natural region IV and V

Definition of zone

Rainfall is very variable, although the average annual is 559 mm, it can range from 200-1100 mm. Rainfall is erratic, with dry spells occurring, especially in December and January.

Altitude ranges from 550-750 m above sea level.

Soils are in general shallow, but there is variation in soil types. The soils in the south are generally heavier than the soils in the north. The type of tree stands are used by the Shona as indicator of soil types. Three main vegetation/soil associations are found in Chivi South:

Mopane woodland is found in heavier soils and is regarded as being excellent for livestock.

Miombo woodland is found on sandy soils and is regarded as being poor, in terms of palatable species, for livestock as mopane, but it is important as a source of gathered foods.

Uapaca woodland is found on shallow red mountain soils.

Case Study: Chivi South, Masvingo province

Primary sources: Balderrama *et al.*, 1988; Wilson, 1989

Location

The Chivi Communal Area, Chivi South is located in the Masvingo Province of Zimbabwe.

Population

The people who live in this communal area are Shona. In 1988 it was estimated that the Chivi Communal Area had 136,000 inhabitants living in an area of 2500 Km². This gives a population density of 55 persons/km², which is more than double the national average of 23 per km². Although child mortality is felt to be high, based on crude birth and death rates the population should be growing at approximately 2.7 percent per annum. However outmigration is high and in "similar neighbouring districts the actual growth rate of population is only 1.6 percent" (Balderrama *et al.*, 1988:6, citing GTZ, 1985).

Table 10.8 Sex ratio (male to female)

Age group	Sex ratio	Age group	Sex ratio
0-4	1.01	30-39	1.01
5-9	1.06	40-49	1.06
10-14	1.02	50-59	1.02
15-19	1.01	60+	1.01
20-29	0.50	Total	0.50

Source: Based on Balderrama *et al.*, 1988:C-1, citing CSO (Central Statistical Office), 1984

As can be seen from the sex ratio (Table 10.8), it is young men, especially between the

ages of 20 and 29 who migrate from Chivi South. The sex ratio in the older ages suggest that the outmigration is not permanent, and that the men eventually return to the area.

Average household size is a little under 8 persons. The settlement pattern is dispersed with a village consisting of scattered clusters of houses. The arable land is concentrated around the settlement and the grazing land starts further from the settlement outside the arable land.

Land tenure

Land is currently allocated by the Village Development Committee (VIDCO) chairman to those people indigenous to the area. However, the arable land (land designated for crops) is fully allocated. In the past people had been resettled to Chivi South from other areas, *eg.* people who had been moved from commercial farming areas. Since they were paid for allocating land, the Kraal (Village) Heads supported the in-migration of people from outside the area.

Land use is inherited father to sons, "or, more commonly, given to the eldest son who usually allocates a small portion to his mother" (Balderrama *et al.*, 1988:7). Since there is no arable land for allocation, young men who are not able to get land from their fathers are clearing land that is categorized as grazing land. Older farmers are also clearing grazing land so as to be able to make some claim on it for their children. These farmers are regarded as "squatting" and are not given official recognition by VIDCO.

Although land in general is scarce, most households have sufficient land for crops either through allocation, inheritance or squatting, but at the expense of grazing land. A large proportion of the young may become "landless" as all land, arable and grazing, becomes "owned".

Land use system

Natural Regions IV and V are regarded as being marginal for agriculture, especially those areas in Region V which receive less the 500 mm a year. Commercial farmers in these regions would be primarily ranching or utilizing large scale irrigation. Smallholders do not have either as an option. The smallholder land use system is based on dry fields, vleis (also called dambos), small localized irrigation and livestock.

1. Dry field farming. As an adaptation to the uncertainty of rain and the variation in soils, the farmers in the Chivi South have developed a complex cropping strategy. Households may have fields with heavy soils ("high clay content, high potential fertilizer and relatively good water hold capacity") or light soils ("sandy, have low potential fertility and low water hold capacity") or both heavy and light soils (Balderrama *et al.*, 1988:13). Households plant the crops that will potentially have the best "fit" to the soils of their fields. Households with only heavy soils, for example, plant a higher proportion of maize and bulrush millet than do households with only light soils.

The main staples grown are maize, bulrush millet, finger millet, and sorghum. Although the area is considered to be too dry for maize, farmers utilize a strategy of balancing small grain and maize production. If a household has enough millet stored for several years consumption (finger millet can be stored up to 20 years), the household might

choose to plant maize as the primary crop the next rainy season. Although millet is favoured for beer and household consumption, maize is rapidly becoming the preferred crop, as it is throughout the East and Southern Africa, since it requires less time than millet to harvest and to prepare, suffers less from bird damage, and is readily marketable. Women prefer maize since they are responsible for food processing, and therefore by implication it is the women who, when stores of food allow such a 'risky' crop, have encouraged the growing of the less drought resistant maize rather than the more labour intensive millet (Balderrama *et al.*, 1988).

Draught animals are used to plough the fields. The use of oxen-drawn cultivators for weeding and the extension directives of AGRITEX have encouraged monocrop fields or sections of fields. When intercropping does occur it is usually maize/finger millet or maize/groundnut, but these fields are less than 10 percent of the total in the area. However, multivarietal cropping is common for the small grains (millet and sorghum) with the different varieties having unique characteristics (fast maturing, better in drought *etc.*) which increases the likelihood of obtaining some harvest in all but the driest years.

Livestock manure is used in the fields. Livestock are allowed into the fields after harvest to feed on the crop residue, and supplementary manuring may take place with manure (sometimes composted) taken from the kraal (homesite) and applied in the fields. Occasionally cowpats may be taken from the grazing area and applied to the fields, especially by farmers who have few livestock.

A fairly large percentage of farmers (57%) apply soil from termite mounds to fields of the lighter soils. Termite soil not only improves the texture and adds nutrients, but it also increases the pH of the field soil. A smaller percentage of farmers (38%) apply leaf litter "either directly onto the field or mix it with animal manure to be applied as a compost" (Balderrama *et al.*, 1988: 19).

2. Vlei (Dambos). Pre-colonially when population densities were low, all arable cultivation in this area focused on the vlei. Currently, twenty-six percent of the farmers in Chivi South use vleis, the "low-lying seasonally waterlogged areas in the headwater region of river systems", for cropping. Although the vleis are smaller and less productive than vleis in the wetter areas of Zimbabwe, they are an important resource in this areas. Even with the erratic and low rainfall of the Chivi South area, households with vleis can grow two crops a year and have access to water during most of the year and access to dry season grazing for the livestock.

3. Irrigation. The small scale irrigation in Chivi South is used primarily for the growing of vegetables. The irrigated vegetable gardens may be cooperatively owned or by individuals. In the study by Balderrama *et al.*, (1988), 44 percent of the farmers had irrigated vegetable gardens. Women are the decision makers in vegetable gardening and provide most of the labour in the gardens. Water is usually brought by bucket from the water source (well, stream, *etc.*). The Streambank Protection Regulation prohibits cultivation within 30 m of a streambank and hence if these regulations are followed carrying water from stream to field is both time consuming and hard work.

Although home consumption is the primary expressed reason given for vegetable

gardening, 72 percent also sell some of the produce. Although local market gluts can occur, demand is high and cash returns from selling the produce can be an important part of household income (Balderrama *et al.* 1988).

Livestock component

Unlike most farming systems in the region area, livestock, particularly cattle, are "highly" integrated into the farming system of Chivi South. Cattle are used for the important inputs of draught power and manure, as well as for milk, meat, cash and social exchange. Seventy percent of the farmers interviewed owned cattle, but ownership and possession of cattle are not one and the same.

Those in the community who do not own livestock can become caretakers of animals obtained from a relative or friend. In return the caretakers "obtain draught power, manure and some of the offspring" (Balderrama *et al.*, 1988:42). By the mechanism of "lending" animals, labour and grazing demands of a large herd are dispersed, and households which have experienced the loss of a herd are able to maintain crop production. Through caretaking of cattle and borrowing animals on a short term basis from neighbours, all families appear to be able to get access to draught power. Donkeys are also used for draught power, but less so than oxen, probably because of the inefficiency of the harness used and the unavailability of saddle bags.

Tree component

Trees play an important role in the land use system of the Shona. The Shona have developed a belief system based on the relationship of trees and soil. Trees are used to identify soil type (see above), and specific trees are perceived as having a beneficial effect on soils. Farmers disregard the directives of the agricultural extension agents, and leave trees, especially fruit trees, standing in cropped fields. Crops growing under fruit trees, such as Muvonde (*Ficus capensis*), Mushavi (*Ficus burkai*) and Muchakata (*Paranaria curatellifolia*), are recognized as having higher yields than crops elsewhere in the field.

A household has the right to collect the fruit of trees which it left standing in its field. These fruits are especially important as a source of food during the dry season. Trees are an important source of fodder for animals during the dry season as well. The survey showed that "41 percent of farmers in Chivi South cut tree foliage for their animals during the dry season. Over 30 indigenous tree species were reported by farmers to be used for feeding animals" (Balderrama *et al.*, 1988:52).

In addition to the trees left in the fields, planting of indigenous trees also occurs, although the percentage of trees planted appears to be small, but rising (see Wilson, 1989:373). Since livestock graze in the fields after the annual crop is harvested, seedlings and young trees are vulnerable to browsing unless protected. Although live fencing has been suggested as a means of keeping out livestock, this is not currently being done by farmers.

Impact of off-farm employment

Off-farm employment is linked to the prosperity of the household. Remittances are used to purchase staples during periods of poor agricultural yields and for investment in home

improvements and farm equipment (plough, wheelbarrows, scotch carts) and livestock (especially cattle) during good years. As would be expected, households with off-farm income have more livestock and farm equipment than households without remittances.

In Chivi South, average farm size per household is 2.8 ha. Households with formal off-farm income attract relatives, so even though farm size remains stable, land available per household adult is significantly less when compared to households without formal off-farm income (see Table 10.9).

It appears that rather than experiencing labour shortages, off-farm employment via remittance attracts adult relatives to the household, and, thereby, actually increases the household labour pool (Balderrama *et al.*, 1988).

Table 10.9 Comparison of household size, land per capita and formal off-farm employment

	Households with off-farm employment	Households without off-farm employment
Average farm size	2.8	2.8
Average household size	11.2	6.7
Average number of adults	6.4	3.7
Land/Adult	0.43	0.76

Source: Balderrama *et al.*, 1988:58

Labour

Since women do the majority of agricultural tasks, the Shona farming system is dependent on female, rather than male, labour. Within the community a household can acquire additional labour by hire or through communal work parties. The absence of males does not appear to have led to a serious labour constraint in the farming system, and off-farm income provides long term stability to the household.

Perception of trees

Shona farmers recognize the important contributions that trees make to the farming system. Trees are maintained for their fruit, their contribution to soil improvement, and are utilized for dry season fodder. Wilson (1989) suggests that Shona religious traditions prohibited the cutting of certain species (primarily fruit) which were associated with the land spirit guardian. Such beliefs fostered "indigenous conservation" and people were reluctant to cut trees and destump fields as ordered by colonial edicts. These religious beliefs were reinforced by the concept of the fruit of these trees belonging to the community. Whereas the tree could not be cut for building material without the "owner" of the fields permission, fruit from the tree could be gathered, although it could not be sold in large quantities, by members of the community.

This belief that fruit trees are at some level a community resource has 'carried over' to

include planted exotic fruit trees. Although the trees are recognized as belonging to an individual, close kin and neighbours have the right to gather the fruit of planted trees without asking formal permission.

Use of tree products

Tree are used for food, fodder, and fertility maintenance (see above).

Interventions in support of tree growing

In South Chivi AGRITEX provides extension to the 23 percent of the farmers who are Master Farmers and Master Farmer trainees. Master Farmers have access to the Agricultural Finance Cooperation (AFC) which provides loans and seeds. Only 5.7 percent of the households reported receiving credit from AFC. The low percentage is a reflection not only of the difficulty of obtaining loans, but also the environmental conditions. Persistent drought in Chivi makes the repayment of loans uncertain and many loans at the time of the ICRA study were still outstanding (Balderrama *et al.*, 1988).

Farmers have found that some of the recommendations of AGRITEX extension agents, *eg.* clearing all trees from agricultural fields, are in conflict with religious belief and indigenous good sense. In some districts there has been an agreement by AGRITEX to discontinue attempts to persuade farmers to remove all the trees from the fields (Wilson, 1989).

Preferred species for tree planting

Although indigenous trees are maintained in the fields, except for the exotic fruit trees planted around the homesites, few other trees are planted. The sources of the fruit tree seedlings were not explored in the case study (Balderrama *et al.*, 1988).

2.2 Natural Region III

Definition of zone

Rainfall is variable with a mean annual of between 600 - 700 mm. There are mild to severe mid-season droughts but when rainfall is adequate the area maize production is good. Although classified as a Natural Region III (Semi-intensive farming region) the area of the case study might be better suited to fodder crops and cattle (Grundy *et al.*, n.d.).

Vegetation is primarily dry miombo woodland with mopane woodland occurring along drainage lines. Evergreen woodland occurs in localized areas along the rivers.

Soils are "predominately shallow, moderately leached, coarse gained sand with low fertility and water holding capacity" (Grundy *et al.*, n.d.:6, citing Thompson and Purves, 1978).

Case study: The Mutunda Resettlement Area

Location

Mutanda was established after independence in an area that was characterised by commercial farms. It is about 70 km southwest of the city of Mutare in the Save catchment area. Although classified in Natural Region III it is very close to the drier Region IV and the boundary between the two is more "fluid" than rigid.

Population

In the case study area there were 155 recognized households in six villages, and an additional 10-30 squatter households in an area of 12,000 ha. The population is primarily Shona (Grundy *et al.*, n.d.).

Land Tenure

Farmers in the resettlement area are given 5 ha. each in an area set aside for crops, and have access to the village communal area for grazing and wood. Squatters are villagers who have not been allocated any land for cultivation and are illegally farming in the areas which were set aside for village grazing when the resettlement community was established.

Land Use System

The Mutanda Resettlement Area is located on what had been commercial farms which had primarily been used for grazing. The farms had been abandoned by white farmers during the period of war prior to independence. The prior land use system and the period of enforced "fallow" has resulted in the resettlement area being well wooded when compared to neighbouring communal areas. Although it is not explicitly described, a maize/livestock farming system appears to be the current land use system in the resettlement area.

Tree component

In Mutanda about 74 percent of the households reported having planted trees. Of these households all had planted exotic fruit trees while none had planted trees for fuelwood or construction. Only two of the thirteen trees species which were planted were indigenous fruit trees (*Uapaca kirkiana* and *Ricinus communis* [castor oil]). The most common fruit trees were mangoes, papayas and mulberries.

As in other areas of Zimbabwe, indigenous trees were left standing in cultivated fields. Fruit trees were the most common type of tree cited (60%), but trees were also left for the purposes of shade (40%), if they were good construction wood, had religious significance, or were very difficult to remove. Not all fruit trees were retained - conservation was more likely to occur with large trees of favoured species.

Livestock component

Although little actual data is presented on the number of animals per household, the resettlement areas are structured to provide both land for farming and for communal grazing. A maize/livestock farming system is the goal of the resettlement project.

Labour

Household size and labour data are not presented in the study. However, labour constraints do not appear to be present. Zimbabwean resettlement programmes do not allow the outmigration of males to areas where formal employment is available. It is unclear whether this stricture is being followed in the Mutanda scheme, but no mention is made in the study of overall labour shortages or specific labour constraints in the farming system.

Perception of trees

The people in Mutanda perceive the woodland as being able to provide them with sufficient fuel and construction to meet their fuel and construction needs. This perception that the existing woodland is sufficient probably acts as a disincentive for planting trees for fuelwood and building materials.

However, Grundy *et al.* (n.d.: 13) report that there is also the perception that the wood resources are finite and "many people believed that there would only be sufficient construction and fuelwood for the next five years or less." There has been a reduction in woodland since the resettlement community was established. However, this has been the result of land being cleared for cultivation, not for fuelwood and construction.

Use of tree products

Fuelwood is used by all households in the community for cooking and heating. Increased amounts of fuelwood are used for special occasions, such as wedding and funerals, and brewing. Brick houses and schools are being encouraged by the government and they require wood for kiln firing (see McGregor, 1989a and 1989b).

At the time of the study, marketing or bartering of fuelwood or construction wood did not exist within the community. The quantity of wood available was large enough to also provide wood products for people who do not live in the resettlement area. People who live in the neighbouring communal areas, for example, come to Mutanda to collect poles.

Given the current woodland resources it understandable that trees are not being planted. The most common species in the woodland are also the most frequently used for fuelwood, and while there is more selectivity shown in wood for construction, the preferred species are not uncommon in the natural landscape. This lack of species selectivity may require a severe decrease in the woodland before farmers begin to plant trees to satisfy fuelwood or construction needs.

Grundy *et al.* (n.d.) suggest that the Mutanda resettlement area could be sustainable in the provision of wood resources if the amount of cultivated land is not expanded.

Interventions in support of tree growing

The survey attempted to elicit information regarding the impact of the Rural Afforestation Programme in the resettlement area. Twenty-eight percent of the sample reported that they had heard of the programme. Of those who had heard of the programme, the great majority had learned of it through the Resettlement officer and the Agricultural extension officer. Knowledge of the programme is, of course, different

from becoming an active participant. Since the programme is focused on the planting of *Eucalyptus* spp. and none of the farmers in the sample had planted any *Eucalyptus* spp. it can be assumed that the programme had no impact at the time of the study.

Preferred species for tree planting

As mentioned above, tree planting in Mutanda is of exotic fruit trees.

Conclusions: Zimbabwe

Where are farmers planting or not planting trees?

In the case studies farmers were planting fruit trees in homesites or homegardens. Although these fruit trees are primarily exotics, fruit trees have traditionally had a very important niche in the indigenous farming system. Indigenous fruit trees continue to be preserved in cultivated fields, and are recognized as an important food source, especially for children, during the dry season and drought years.

How does tree planting relate to ecozone, and to cultural traditions and values?

Tree planting appears to relate less to ecozone and more to the wood resources available. When wood resources are plentiful there does not appear to be an incentive to plant trees to provide wood products (fuelwood and construction material), although fruit trees may be planted to provide both food and shade at the homesite or homegarden.

The cultural traditions which valued indigenous fruit trees, preserved them in cultivated fields and assigned them special religious meaning, have currently been expanded to value planted fruit trees in the land use system.

What incentives are there for tree planting?

Zimbabwean farmers are not in a situation which provides incentives for tree planting for wood products. Although there may be localized shortages of fuelwood and other wood products, nationwide there appear to be adequate wood resources. When households can continue to gather from the woodlands the resources that are needed to meet their needs for fuelwood, construction, *etc.* there is little incentive for tree planting for wood products.

The tree planting that does occur is within the compound or fenced homegarden. As in other countries in the region, households may be reluctant to plant outside the compound if there is uncertainty as to whether the seedling will be protected from animals or fire.

There was no mention of the marketing of wood products in the case studies. Even in the drier site in South Chivi fuelwood was not sold or bartered. Rather than buying wood products households attempted to gather what was needed.

How does tree planting by farmers relate to government efforts and extension attempts to promote tree planting?

Households have been planting/managing fruit trees with little government support. The major government programme has been focused on *Eucalyptus* spp., and not fruit trees.

The government efforts have been directed to planting trees to solve a projected fuelwood shortage, rather than to solve the current perceived needs of the smallholder. Programmes need to be more responsive to the needs of the farmers if they are to succeed.

3. Summary

1. Smallholders are settled in the more drought prone regions of the country. Livelihood is based on small agricultural fields and small herds, and in many communities, off-farm income from male members of the household who migrated to the mines and urban areas.
2. Fruit tree are highly valued. Indigenous wild fruit tree are commonly retained by farmers in agricultural fields and grazing areas, and exotic fruit trees are planted in the homesteads. Livestock grazing in fallowed fields encourage tree planting in protected areas, such as the homestead, rather than in crop fields.
3. Fuelwood is not perceived as being a current problem by households, and trees are not being planted for the primary purpose of providing fuelwood. Trees are being planted for other purposes, eg., fruit and to a lesser extent, construction materials. Tree planting appears to be related to a household's ability to meet its needs from wild off-farm resources. When the wild resources decline, the household plants trees to provide the needed tree product, eg., the planting of fruit trees as a response to the decline of wild fruit trees in the area.
4. Government tree planting programmes have been rather narrowly focused on *Eucalyptus* spp., and did not include species preferred by farmers. Participation in the programmes was disappointing, and survival rates of seedlings was low. The tree species favoured by farmers are exotic fruit trees.

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