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**POTENTIAL FOR ON-FARM APPROACH IN CONSERVATION OF INDIGENOUS
TREE SPECIES AMONG SMALLHOLDER FARMERS OF MURANG'A DISTRICT,
KENYA.**

BY

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**A Research Project Submitted in Partial Fulfillment of the Requirements for the
Degree of Masters of Environmental Planning and Management**

JULY, 2002

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*Potential for
on-farm approach in*



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DEDICATION

This research work is dedicated entirely to The Lord. For “In the past I knew only of what others had told me [*about Him*], but now I have seen [*Him*] with my own eyes” Job 42:5.

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ABSTRACT

Today the world suffers from several environmental problems such as resource degradation, which has prominently affected biological diversity. One of such biological resources is indigenous tree species. Currently, their status in many parts of the world especially in developing countries is scarcely known. These trees occurred naturally in the world's indigenous forests that are almost gone with only one percent being managed and sustainably utilized. The underlying pressure is caused by increasing population that is characterized by clearance for agriculture, fuel logging, road construction and settlement. This is more so in high agricultural potential areas such as Murang'a district, where most indigenous trees and shrubs have disappeared. The threats to indigenous tree species in this area, thus necessitated the study to establish the place of indigenous trees in smallholders' social and economic decisions.

The study pursued a concept of on-farm conservation of indigenous tree species with a particular reference to smallholder farmers. It identified the status of on-farm indigenous trees and factors that influence their conservation within farmland. Further, it examined the existing local potential among farmers and within their environment that could be harnessed to promote on-farm conservation.

In carrying out the study, a questionnaire, an interview schedule and a guide, and an observation record sheet were used to collect data. Data collected were collated, coded and analyzed using SPSS 6.1 Version. Data were analyzed descriptively using multi-response cross tabulations and contingency tables that generated frequencies and percentages. Additional descriptive analytical tools, such as Strength, Weaknesses, Opportunities and Threats (SWOT), Content and Structural-functional analyses were used. Statistical significance testing was also employed using the Chi-square at 0.05 alpha levels to test relationships and association between variables.

The study established that about 43.5 % of surveyed farmers incorporated indigenous trees in their farms. Farmers raise trees largely from seedlings or wildlings. These trees have been planted and/or retained in home gardens, woodlots, compounds, crop fields, roadsides and riversides. The small number of farmers incorporating indigenous tree species in their farms was attributed to scarcity of land, farmers' attitudes, dying traditional beliefs and taboos, slow growth rates of these trees and lack of seeds and seedlings.

Factors such as economic, socio-cultural, ecological and farmers' preferences were found to influence the choice of on-farm tree species. Economic factors undermined on-farm conservation of indigenous trees. For instance, majority of the farmers preferred exotic species due to the fact that exotic trees possess multiple uses value and have capability to generate income faster than

indigenous trees due to their fast growth. Additionally, farmers had different preferences for tree species this was hinged on the tree uses or special their functions. For example, Indigenous species are preferred because of their special functions that include provision of medicines for livestock and humans, their effects on soil nutrients enhancement and cultural value.

The agricultural activities determined the spatial pattern of the distribution of indigenous trees among the farmers. The agro-ecological three, for instance, had more indigenous trees than the other two agro-ecological zones. This is because in this agro-ecological zone, there are few cash crops such as coffee and tea that requires clearance of indigenous vegetation during their establishment. In intensively cultivated areas such as in agro-ecological zone two, indigenous tree species existed only in places such as riversides, bushes, grazing fields and farm boundaries.

The study revealed a wealthy of knowledge in on-farm trees management among the farmers. This knowledge includes the ones regarding placement, compatibility with agricultural crops, and palatability to livestock, rituals and other uses. The respondent had less knowledge about disease and insect pests affecting indigenous trees. The study further found out that the existing local potential among farmers has been less utilized in promotion of on-farm conservation of indigenous trees, among them the local groups / institutions.

The study found out that there is potential for on-farm conservation of indigenous tree species since the local community member expresses their need for medicinal, ecological , socio-cultural and economic values. For this potential to be realised, the study recommends the following: 1) Awareness creation programmes that focus on the economic and ecological value of indigenous trees; 2) Improvement of agricultural and forestry extension services so that farmers are taught appropriate farming methods; 3) Promotion and utilization of the strategy of contacting farmers through local groups/institutions; 4) The need to research on how to incorporate indigenous trees species in farming systems given the decreasing land holdings; 5) The need for clear cut policies on the on-farm conservation of indigenous tree species to assist agricultural and forest extension officers in promoting these tree species within the farm lands and also to define incentives necessary to encourage farmers to conserve indigenous species within their farmlands.

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ABBREVIATIONS

AAS	African Academy of Sciences
BSP	Biodiversity Support Programme
FAO	Food and Agriculture Organization
ICRAF	International Centre for Research in Agro-forestry
IUCN	International Union for Conservation and Nature
KENGO	Kenya Energy and Environment Organization
KFMP	Kenya Forest Master Plan
OAS	Organization of American States
RRA	Rapid Rural Appraisal
SWOT	Strength ,Weakness , Opportunity and Strength
UNEP	United Nations Environment Programme
UNESCO	United Nations Education Social and Cultural Organization
WRI	World Resource Institute

EPIGRAPH

"It appears prudent to focus more efforts on the 90 % of the earth's land area that is either in private lands or public ownership but exploited by private interests... where most biodiversity [including indigenous trees species] exist" (Dickinson III, J.C.,1995).
(Emphasis in normal bold added).

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Today the world suffers from several environmental problems. One such problem is biological resource degradation due to human population pressure and unsustainable exploitation strategies. Resource degradation has prominently affected biological diversity. The later is disappearing globally and locally and threatened now than before (Wood, 2000).

One of the threatened biological resources is indigenous tree species. Currently, their status in many parts of the world especially in developing countries is unknown. These trees used to occur naturally in the world's indigenous forests which are now cleared. Natural forests are gone with only a small percent (1%) of world's indigenous forest being managed and sustainably utilized (Mugabe and Clark, 1996) The underlying cause is the increasing population that contribute to the clearance of indigenous forests for plantation, ranching, fuel logging, road construction and spontaneous settlement (FAO, 2000).

As a result, indigenous trees are decreasing throughout the world especially in the developing countries where forest reserves remain the major source of wood. This situation is no exception to Kenya where between 1967 and 1990, for example, about 2.2% of forest was lost from a previous 5.2% of its national average (Irandu, 1990).

The rising loss of indigenous trees species could have some far reaching effects such as threatened sources of medicines, food, fuelwood and building materials. Some of the effects could have negative environmental implications such as water catchment deterioration, soil impoverishment and general loss of biological diversity (Mantel,1997).

The above situation calls for alternative management strategies that promotes conservation of indigenous tree resources. One such strategy is the on-farm approach in conservation of these tree species among the smallholder farmers. This strategy may be appropriate because most smallholding farming areas have high population and private land tenure system. These, thus, limit the establishment of community forest where indigenous trees may be conserved (Bradley and Ngugi, 1986). This study therefore assessed the potential for this approach in conservation of indigenous trees .

There exists few studies that focus on potential for on-farm approach in conservation of indigenous trees with a particular emphasis on social and economic aspects of smallholder farmers. This is in spite of the social, cultural, ecological and economic values they attach to these trees. This study, therefore, focused on these aspects of smallholder farmers hitherto not well considered earlier.

1.2 Statement of the Research Problem

Murang'a district could have few indigenous tree species given that most of the natural vegetation have been cleared and replaced with exotic trees and cash crops. Loss of these tree species is of great concern since they have sustained the livelihoods for centuries (Cunningham, 2001).

This problem can best be addressed through on-farm strategies level given the socio-economic activities in the high agricultural potential areas such as Murang'a District, where most of the farmers are smallholders and where the scarcity of land limit the establishment of communal forests where indigenous trees can be planted. The extent to which on-farm

strategies in the conservation of indigenous trees have been implemented successfully, however, is still scantily documented.

Against this background, the purpose of the study was to examine the potential for on-farm approach to conservation of indigenous trees among the smallholder farmers in Murang'a District.

1.3 Research Questions

In trying to examine the potential for on-farm approach to conservation of indigenous trees species, this study attempted to answer the following questions which constitute the statement of the problem :

- 1.3.1 what is the status of indigenous trees within the farmlands in the study area?
- 1.3.2 what factors influence the conservation of indigenous trees within the farmlands in study area?
- 1.3.3 What are the potential inherent among farmers in form of materials , knowledge and opportunities that is pertinent for the promotion of the conservation of indigenous tree species within the farmlands in the study area?
- 1.3.4 Which measures are necessary for the enhancement of the on-farm conservation of indigenous trees in the study area?

1.4 Objectives of the Study

The purpose of the study was to explore the potential for on-farm approach to conservation of indigenous trees as an alternative strategy after protected area approaches has shown little success in conservation of these trees in most regions of the world. Specifically the objectives of the study were to:

- 1.4.1 examine the status of indigenous trees within the farmlands in the study area;
- 1.4.2 assess factors affecting on-farm conservation of indigenous trees on the smallholders' farmlands;
- 1.4.3 examine the potential inherent among the farmers in form of materials, knowledge and opportunity that is pertinent for promotion of conservation of indigenous trees species within the farmlands;
- 1.4.4 suggest measures for enhancing conservation of indigenous trees in smallholders' farmlands.

1.5 Research Premises

The study's research premises which guided data collection , analysis and interpretation were that :

- 1.5.1 the status of indigenous trees within the farmlands in the study area is scantily known;
- 1.5.2 socio-economic status of smallholder farmers influence the conservation of indigenous trees depending on their capability to exploit their farm potentials;
- 1.5.3 there exist an enormous potential among the smallholder farmers that can be exploited for the promotion of conservation of indigenous trees within the farmlands in the study area;
- 1.5.4 to achieve sustainability in conservation of indigenous tree species in the study area on-farm approach need to be adopted.

1.6 Justification of the Study

On-farm tree planting by farmers is being emphasized countrywide in an effort to conserve the country's woody biomass. This is because forest reserves and trees on open lands can no longer meet the people's demand for tree products due to population increase, changes in

conservation status of forest reserves and reduction in the size of protected areas (KFMP, 1994).

High agricultural potential areas such as Murang'a District are usually characterized with high population (Bradley and Ngugi, 1986), which leads to increasing land pressure. As a result, natural vegetation is replaced with fast growing plant species such as exotic trees and cash crops to cater for food needs and associated wood scarcity. This poses a major threat to indigenous trees species, thus calling for a study of this nature to establish the place of indigenous trees in smallholders' farmers socio-economic decisions.

Most of the on-farm tree growing activities, otherwise known as agroforestry, are usually concentrated in Arid and Semi-arid areas (Ngonda, 1988). This study focused on the status of indigenous trees in high potential areas where scarcity of land limits the establishment of communal forestry where these tree could be raised.

Much information on indigenous trees conservation is centered on the knowledge of specific ecological situations in different geographical regions. Whereas numerous recommendations are made within such ecological knowledge. In the recent times, however, it has been acknowledged that trees management are determined by socio-cultural and socio-economic conditions (Emerton, 1996). This study thus adopted a humanistic approach. The major purpose being to understand the role of socio-cultural and socio-economic aspects of the community in natural resources management in general and specifically indigenous trees to enhance environmental quality.

Smallholder farmers were vital in this study since they constitute majority of the farmers in the high potential areas of the study area. Their needs and abilities, therefore, should be understood for their effective involvement in the management of indigenous trees. This in turn, can help re-orient external support and establish workable partnerships that can lead to sustainable management of indigenous trees.

It is in recognition of diverse benefits offered by indigenous trees to often resource constrained farmers, hence, the choice of smallholder farmers. Trees have sustained livelihood of local communities over centuries as a source of food, shelter, medicine, fuelwood and fodder. In addition, the potential offered by on-farm conservation amidst the noted failure of protected areas approaches, provide a good foundation for this study.

1.7 Significance of the Study

There is a growing emphasis in the use of indigenous knowledge systems for natural resource conservation (Koskey,1997). Indigenous trees serve as the record for this knowledge (Dickinson III, 1995), and extinction of these trees will mean that this knowledge will also be lost. This study findings, therefore, was meant to serve as a starting point for awareness creation on the need to conserve these trees by smallholder farmers using their knowledge systems.

Loss of each plant can take with it 10 to 30 animals directly or indirectly dependent on it (UNEP/WR I,1994). Findings and recommendations of this study are therefore necessary for enactment of indigenous trees conservation policy to address the problem.

This study assisted in understanding the needs, values, priorities and potential of smallholder farmers in implementation of on-farm conservation of indigenous trees and biological diversity in general. It is expected that the findings may form a basis for rural policy review and subsequent sustainability of indigenous trees resources conservation activities if adopted.

1.8 Scope and Limits of the Study

Given the constraints of time, finances and logistical problems such as transportation difficulties, it was not possible to cover the whole District, hence, two Divisions of Murang'a District were covered, that's Kiharu and Mathioya. The two Divisions were selected for they have the characteristics inherent of the smallholding farming in the whole District. Ngonda (1986), observes that smallholder farmers exhibit almost similar farming systems and socio-economic characteristics. Interview with Government officers in different Departments whose work coverage included the whole district, however, provided a cursory view of the broad issues that allowed indepth understanding of the whole District.

The study focused on smallholder farmers with landholding not exceeding 5 hectares. This is because it is within this range that majority of farmers were most likely to have low capital input for production and tend to clear their land of indigenous trees in favour of fast growing exotic tree and cash crops. They, therefore, form a good target population for on-farm indigenous trees conservation.

The study, also focused on women and youth groups. The reasons for the choice of women groups relates to the important role women play in environmental management, agricultural production and as custodians of natural resources. Youths groups were considered as they represent future land resource users (Wamugunda, 1988).

Indigenous tree species are many in the District, and it was not possible to consider all of them. A list of widely used/known ten indigenous trees and ten exotic trees was thus prepared in close collaboration with elders, officers in Forest Department and Agriculture Department.

The study was restricted to areas of indigenous knowledge on tree growing (sowing, raising and other management operations) and not on broad themes of indigenous knowledge in forestry.

1.9 Definition of Operational Terms

The terms defined below are only indicative of the specific manner in which they are applied in this study.

1.9.1 Indigenous trees These are native trees having originated in that particular area or environment

1.9.2 "Shamba" System This is a farming practise allowing farmers to cultivate forestry land while the trees are still small and leaves cultivation when trees are tall.

1.9.3 Conservation These are measures which ensure wise use of tree resources so that they are used by present as well as future generation.

1.9.4 Biological resources These are living resources in form of plants and animals such as forests and wild animals.

1.9.5 Agroforestry This is deliberate integration of trees and shrubs with crops and animal in the same farm management system with a view of accruing benefits from both ecological and economical interactions.

1.9.6 Farming System This is a class consisting of all farms with similar land use, environment, and economy; comprising the farm household, its land and the system of cropping or livestock production for consumption or sale. It is a decision-making unit and a land use system based on agriculture (FAO, 1986a)

1.9.7 On-farm Trees Conservation Refers to trees deliberately combined with agricultural crops or animals in a farming system either in temporal or spatial sequence. Its objective is to achieve both ecological and economic benefits.

1.9.7 Smallholding farming This is a farming system where land ownership is less than five hectares.

1.10 Chapter Outlines

Chapter 1, Constitutes introduction which discusses, background and statement of the problem. Research questions, objectives and premises of the study. It also discusses the justification, significance, scope and limits of the study, definition operational terms and chapter outlines.

Chapter 2, Contains literature review and theoretical framework which helped to shape the theoretical orientation of the study. First the review considers the status of vegetation and status of on-farm trees in Kenya, with an objective of indicating their spatial extent and quality. The review also focuses on the value of on-farm trees in general and indigenous trees in specific. The chapter further reviews the factors that influence conservation of on-farm indigenous trees. Particularly, it focuses on the land issues in Kenya and rural problems and their influence in on-farm trees conservation. Also the applicability of existing potential

in conservation of indigenous trees is explored. The chapter concludes with a synthesis of reviewed information in the conceptual framework which explains how agriculture and population affect indigenous vegetation and how subsequent needs make smallholder farmers adopt on-farm trees conservation.

Chapter 3, Presents the background information of the study area, including its location in the national context, its physical characteristics and socio-economic profiles. This helped in getting an indepth understanding of the study area.

Chapter 4, Presents research design and methodology, which focuses on population description, nature and sources of data, sampling methods and sample size. It also describes methods of data collection. The chapter also discusses methods of data analysis and research limitations experienced while carrying out the study.

Chapter 5, Presents data presentation and discussions of results. It discusses various demographic and socio-economic characteristics of the study population . In addition to this, it discusses status of on-farm trees, where they are growing, reasons for selecting these sites. It also discusses the factors affecting on-farm conservation of indigenous trees. Further, it discusses the on-farm trees management practices and existing potential for the promotion of on-farm conservation of indigenous trees.

Finally, chapter 6 is the conclusion of the study which is divided into summary of findings, conclusions, recommendations and areas for further research.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

This chapter reviews literature relevant to the study in order to contextualize the problem of the study. It is divided into: The status of indigenous vegetation, status of on-farm trees in Kenya, benefits of on-farm trees, value of indigenous trees, factors affecting on-farm conservation of trees, land issues and rural problems and how their influence on on-farm conservation in Kenya, local resources potential and conceptual framework .

2.2 Status of Indigenous Forests

Global forest areas has declined by about 6% over the last century (FAO,1984). Tropical defforestation had been almost 17 million hectare per year indicating 50% increase since 1980 (FAO,1984). Further, annual rate of defforestation in 76 tropical countries which contain 96% of the world tropical forests rose from 0.1% in 1976 to 0.9% in 1980 (UNEP/WRI,1994).

On the regional basis, West Africa, has the highest rate of deforestation with an annual loss of 2.1% followed by Central America (1.9%) and Mexico (1.8%) (UNEP,1991). In East Africa, Kenya has lost about 2.2% of the forest from 5.2% in 1967 to 3% in 1990 (Irandu,1990). According to KFMP(1994), the annual loss of forests in Kenya is 5,000 Ha/year. Accelerated deforestation is due to increasing demand for wood products and pressure on land brought about by rapid increasing human population. Commercial logging and increásing scarcity of fuelwood demand are too much from the few forests remaining. Forests have further been reduced by overgrazing, road and railway construction (Foley and Benard, 1984).

Most Kenyan Indigenous forests are shrinking, with others such as Kakamega and Nandi greatly threatened (KFMP,1994), impacting on the livelihood of the affected household and ecological system differently. Deforestation for instance, is associated with deterioration of water catchments, increased soil erosion, interference with nutrient cycles, alteration of micro-climate and erosion of Kenya's important natural genetic base (KENGO,1988).

In most developing countries, people are more dependent on forests for fuelwood, timber, fooder and medicines. Kenya is no exception. Unfortunately for Kenya, the majority of rural people have limited access to and right to use of forest resources (Poole,1992). The remaining indigenous forests are diminishing and cannot therefore be relied upon because of the gazettement of most of them (KFMP,1994). This calls for consideration of on-farm conservation of indigenous trees as palliative measures to this shortfall.

2.2.1 Trees Growing High Potential Agricultural Areas of Kenya

In many high potential agricultural areas of Kenya, trees protected, cultivated and managed have assumed an important place as one of many smallholders' land use options. It is in precisely in these areas, where pressures on agricultural land are greatest, that the proportionate area of land used for growing trees increases so substantially. In the face of these types of pressures, and because cash returns for trees are relatively low, there must be strong reasons why farmers grow trees rather than other potentially more profitable crops.

The rural afforestation efforts of the government, aid agencies and local organizations in Kenya have seldom taken account of the extent of existing tree growing activities. Even when project design and implementation has been hampered by lack of information on why farmers

have undertaken these types of activities on their own. In particular, the relationships between land use, capital, labour, and land ownership with respect to tree growing are not well understood.

Important gains in understanding the role of trees on farms in Kenya have been made with the recent collection of inventory information about trees in smallholder agriculture. These land use studies, typically of areas with high population densities and heavy intensities of agricultural land use, have suggested that planted and managed trees and shrubs usually cover between 5 and 10 percent of the area of agricultural land. While arid and semi-arid lands are increasingly important as areas of new settlement, they pose special problems for tree growing which are beyond the scope of this study. On average, over 20 percent of the total high potential agricultural land area has been used for growing trees, or has otherwise been left under natural woody cover (FAO, 2000).

Although planted tree species are predominantly of exotic varieties, such as *Gravillae robusta*, *Eucalyptus spp*, and *Acacia mearnsii*, a number of indigenous species such as *Markhamia spp*, *Croton spp*, and *Sesbania sesban* also feature in farmers' range of choices. The dominant species vary from district to district in Kenya. In Kakamega District, for example, woodlots are usually dominated by *Eucalyptus saligna*, while in Murang'a District they are dominated by *Acacia mearnsii*. These contiguous, non-linear, and usually monospecific tree management units may be extremely small, with 10 trees or so, but are more commonly around 200 m² in area. Hedges (contiguous, linear, and usually monospecific tree management units) are frequently composed of *Cupressus lusitanica*. They are usually planted in the first instance, but as they grow to maturity, may come to include other species

established as a result of natural regeneration. In some areas, although there is little completely untouched woodland remaining, there are large areas of natural vegetation, which have been highly modified, such as in bush/fallow systems (Bradley and Kuyper, 1985).

The importance of tree cultivation and management as part of the farming system becomes somewhat clearer when other agricultural land uses are considered. Although the predominance of particular crops in this district is mostly limited by the agro-climate, the predominance of trees does not seem to be so constrained. Smallholder coffee, for instance, accounts for between 0.1 and 33 percent of the land area depending on the agro-ecological zone. Woody cover (planted trees, woodlands, bushland and so on) accounts for at least 15 percent and as much as 35 percent of the total agricultural land area across all zones. This challenge accepted ideas that population growth and agricultural intensification are incompatible with the conservation and management of tree cover. This experience suggests that this is not always the case. Even in the most heavily populated areas such as Murang'a and Kisii Districts, trees continue to be an important feature of land use. Interesting also is the gradual transition in the type of woody biomass that predominates as population pressures increase. Natural forest and bushland are cleared as agricultural development is intensified, but replanting follows, apparently using trees that are much more productive than the forests and bush they replaced (Bradley, 1991).

There have been a few efforts that have attempted to assess the impact of tree growing on the smallholder economy or why trees have assumed such an important role. A number of these attempts have focused on cultural attitudes toward trees, such as gender restrictions on tree planting in Kakamega (Chavangi, 1987). In Murang'a, districts, household characteristics

(farm size, household composition, cropping patterns and so on) have been closely related to patterns of tree cultivation and management (Bradley and Ngugi, 1986). Cowen's fascinating history of wattle production in Central Province (Cowen, 1978) provides important perspectives on the growth and spread of this tree planting practice, but does not address the question of why trees continues to be maintained as a land use practice in the face of more lucrative land use alternatives in the Post-Independence economy such as coffee and tea.

A few studies have sought to explore the economic rationale for farmer tree growing in Kenya. Lubega's study of agroforestry systems in dryland areas of Machakos District explored the potential economic impacts of alley cropping on maize production (Lubega, 1987).

2.3 Benefits of On-farm Trees

The widespread occurrence of trees in traditional agricultural systems throughout the tropics provides evidence of the benefits that farmers obtain from their presence. These benefits can be divided into a number of broad categories.

The most widespread benefit from on-farm trees conservation systems is their function of maintaining or restoring the productivity of the land. This underlies all systems of non-contiguous cultivation that incorporate a period of tree fallow in the farming system. It is pointed out that, a widespread flaw in programmes designed to modify or replace shifting cultivation is the failure to recognize the fallow as an integral part of the agricultural system. The soil enriching impact of trees is also commonly one of the principal economic incentives

to participation in *Shamba systems* within the forest; they add fertility to the land through leaves fall (King, 1968).

Trees also perform this soil-enriching function in certain permanent cultivation systems; for example, being intercropped as alley crops to raise nutrients to the surface layers of the soil through litter or green mulch, a function often combined with addition of nitrogen through use of leguminous tree species. In other words, they provide a low-cost alternative to fertilizers and soil conditioners. Trees are also employed to protect the soil, by providing shade, shelter from wind, protection from destructive rain impact on the soil, reduction in soil loss through row plantings to check runoff, among others.

A second widespread beneficial impact of trees is in increasing the total output of the land by adding a tree crop to one or more lower layers of crops. The intercropped species selected have root and above ground structures that make complementary use both of different layers of the soil and of the space exposed to sunlight above the soil surface. A wide variety of such vertically structured multiple crop combinations are found in the tropics.

Associated with this benefit is the advantage obtained by diversifying the range of outputs from the farm, by including a number of products of tree species in order to reduce the risk to subsistence or income due to the failure of individual crops, and to provide usable or saleable produce over a wider seasonal time-span than would be possible with only one or a few crops. In one of the more commonly occurring on-farm tree conservation, the homestead

trees planting provide products that complement the high-calorie foodstuffs grown elsewhere in the farm system (Wiersum, 1981).

A third category of benefit is that of raising incomes by exploiting tree crops that provide higher returns from the land than alternative crops. Recent studies have shown, for example, that *Eucalyptus* grown on irrigated land in Gujarat, to produce poles and firewood for sale (Gupta, 1979), and *Albizzia falcataria* grown on agricultural land in Mindanao, Philippines, for sale as pulpwood (Noronha, 1982) produced higher returns to the farmers than the agricultural cash crops they displaced.

By better use of available resources, trees can also be an additional source of income. Less labour-intensive systems of tree growing can be used to allow farm families to utilize more of the available land. Tree growing is less tied to seasonal patterns than most crop production and, where land is not a constraint, more use of labour resources is possible than with agricultural crops. This, for example, was an important factor in bringing about the increase in the net incomes of the pulpwood tree-farmer programme in the Philippines (Noronha, 1982).

Tree products can equally contribute to reduction in costs. Materials needed to meet essential local needs, such as fuel, forage and building materials, may be provided at lower cost by growing trees rather than using alternative sources of supply.

Trees can also provide a capital reserve for use in emergency, or to meet exceptional cash outlays. Trees are widely grown for this purpose by farmers as they do not have to be harvested at a particular time, and usually accrue in value over time, they have unique value in this respect.

Usually the tree component of an agricultural system contributes more than one of the above economic benefits. The leguminous *Acacia senegal* planted in the fallow areas in Sudan, for example, not only enriches the fallow, it also produces a marketable product, gum arabic, which is an important source of income to the farmers, as well as fuelwood, fodder, fibre for rope-making, and other outputs of local value.

2.3.1 Value of Indigenous Trees

Over the years indigenous trees have played significant roles. As part of communal heritage they have provided food, shelter, fuelwood and medicine. They also have cultural, aesthetic and scientific values. They provide basic survival items which are still vital today and will remain to be so in future (BSP,1993).

Different communities rely on indigenous trees to supplement cultivated produce for their basic nutritional requirements (BSP,1993). During drought when food reserves run out, wild foods are often the main source of calories and nutrients (Kang'ethe,1987). Indigenous trees have some fruits and seeds with high nutritional value (KENGO,1985). The evergreen indigenous trees provide fodder for goats, cattle, camel among others during long dry periods (BSP,1993).

Naturally growing trees are also used as building materials such as timber, poles, rafter and roofing materials. This helps them to maintain an acceptable standards of living (Walters and Hamilton,1993). Timber from indigenous trees such as *Markhamia Lutea* is durable. Some of the timber are also termite resistant (Kang'ethe,1987). Timbers are put into various uses. Local timber from *Croton Macrostachyus*, for instance, are used for making handcraft such as traditional stools whose sale earn a living (KENGO,1985). Some furniture such as mortars and musk are also made from indigenous trees species.

Indigenous trees form the basis of traditional systems of both human and animal medicines all over the world (Walters and Hamilton,1993). In developing countries 80% of local people continue to rely chiefly on herbal / traditional medicines for primary health care (BSP,1993). Demand for herbal medicines developed over a long period of time through close interaction between local people and the natural world has risen because modern medicines are too expensive for many people in developing countries to afford. Traditional medicine is often trusted at least for certain ailments and its promotion affirms the value of local cultures (Walters and Hamilton,1993).

In many countries, indigenous trees are a source of energy, for instance, in the form of fuelwood and charcoal accounts for about 70% of Kenya's total end use energy. The domestic sector consumes 58% of the total energy used in the country, the bulk of which is in form of woodfuel (Bradley,1981). In the recent past local communities have begun to understand the economic value of indigenous trees they have in their farms. A tree like *Butea Monosperma* which is planted in East Africa is important for lac production which is used for various purposes. The Kamba people are known to use indigenous trees such as

Bracheleana Hullenis and *Dalbergia Melanxylon* to make wood carving for sale (Kangethe,1987).

Indigenous trees are important for environmental conservation. They help in protecting water sources, and are best suited for management of wetlands and water catchment areas (Kang'ethe,1987) as they take less water. Studies conducted by Kenya Soil Survey indicated that infiltration rate were high for indigenous forest top soil (Nair,1984).

Indigenous trees are good to use for soil conservation as they have micro-site effects. Those with nutritious biomass help in formation of top soil much faster. Such trees enrich the soil by adding manure when the leaves fall and decompose. Indigenous legumes trees have been recommended for their capacity to add nitrogen to the soil, hence increasing soil fertility (Walters and Hamilton,1993; Backers,1985). They are also best for soil erosion control as they hold together soil particles more effectively than exotic trees.

Indigenous trees species are important for biodiversity conservation itself. The presence of indigenous trees in most farms in the natural setting also contribute to knowledge and beauty (UNEP/ WRI,1994). Decreasing natural setting implies that indigenous trees must be planted on the farms.

Local cultures use wild plants for many purposes often unknown elsewhere (Walters and Hamilton,1993). Trees often possess spiritual or cultural significance for the members of the community. Being an integral part of the natural and cultural environment, trees are used during rituals and ceremonies (Backers,1985).

Against the stated values of indigenous trees, it is crucial that their conservation becomes a priority. This is due to the envisaged great loss to humanity in case of their extinction.

2.4.0 Factors Influencing Conservation of On-farm Trees

The economic pressures militating against on-farm trees conservation are of overlapping kinds. First, there are the pressures that are causing the breakdown of existing systems, and the destruction and removal of the trees they contain as is happening, for example, to the village tree resources of the plain areas of Bangladesh and the gum gardens of the Sudan (Douglas, nd). Secondly, the pressures that discourage the introduction of trees in situations where there are no trees in the agricultural system at present.

The most widespread constraint to both retaining and adding trees is probably that of growing competition for land under pressures of expanding populations on a limited land base. Though trees constitute a productive element in so many traditional agricultural systems in the tropics, and are essential for sustained production from the land, as land becomes scarcer, the overriding need to produce food and income in the short term naturally takes precedence over these longer-term values. A central challenge in introducing on-farm trees conservation is to do so in a manner that meets these immediate needs as well as the longer-term aims of stability and sustained productivity (Poulsen, 1981).

This conclusion about the impact of growing pressure on the land base needs to be qualified. Some of the more widespread on-farm trees conservation systems are tree gardens of Asia and the compound farms of Africa where they responded to earlier, slower increases in pressure on the land. As the forests receded, farmers took to planting tree species of

economic value on the farm, usually around the house, working out over time the most efficient and sound mixture and structure of different species (Okigbo, 1977).

Such systems have often proved very resilient. In Java, their area has even increased as population has grown in recent times, apparently because their productivity is higher than the areas devoted solely to crops. These systems, however, eventually also break down. As overall farm size decreases with the fragmentation accompanying population growth, the proportion devoted to home gardens rises at the expense of the area of staple food crops. When farm size falls below a certain point, farmers increasingly forego the tree products in favour of staple food crop production (Wiersum, 1981). This underlines a basic constraint in on-farm trees conservation in terms of their contribution to alleviating the situation of the very poor: that it is often difficult to adopt them on very small farms, and that they contribute nothing directly to the landless unless schemes can be devised to give these people access to land.

Population growth also endangers existing on-farm tree conservation systems through the resultant growing pressure on the tree resource, raising the value of the latter to the point at which economic pressures to cut and use it exceed its value as a continuing part of the agricultural system. Recent work in Bangladesh has shown that the village tree resource though it is comprised mainly of fruit trees planted in the village areas, is being cut at a rate far in excess of its replacement, principally to provide fuel. With the other locally available organic fuels from agricultural wastes already fully used, the tree resource provides the only reserve from which to accommodate the rising fuel needs of growing populations. At the

same time, this population growth requires more housing in the village area, so reducing the area available for the tree resource.

A powerful component in the increase in economic pressures to cut and use existing tree resources is the growth in urban and industrial demands for wood, in particular for fuelwood and charcoal. It is necessary, also, to recognize that rising values for tree products also provide a major economic incentive to investment in husbanding and growing trees. Brokensha and Riley (1978), for example, have described the process in an area in Kenya of transformation of wood from an abundant, free item to a commodity of value, to be brought under control, protection and perpetuation.

Shifts in the values and costs of other uses of the land can also have impacts on trees a management. Bradley (1991) has described an example of market pressures that have encouraged farmers to introduce crops, which directly or indirectly lead to the removal of trees. "Modernization" of tropical agriculture, and the economies of scale, support services and marketing opportunities it attracts, favour monocultures that replace the traditional multiple cropping systems of tropical agriculture in which trees often featured. Similarly, trees are also usually incompatible with mechanization, creating impediments to the use of machinery, and are therefore removed. New varieties of tea and coffee to be grown in the open also result in the removal of the shade tree intercrop.

The discussion so far has been mainly in terms of economic pressures that discourage the retention of trees in existing systems. There are also economic costs for farmers in

introducing trees. One of the most important of these is the relatively long production period of most tree species. Poor farmers can seldom divert resources from producing to meet immediate needs for food and income to a tree crop which will start producing returns at best a few years into the future, hence, the widespread preference in on-farm trees and other tree species which yield outputs of value other than wood, and do so early in their production cycle (Poulsen, 1981).

The length of the production period imposes another economic constraint; it increases the level of risk for those, such as tenant farmers or farmers practicing shifting cultivation on state land, who do not have security of tenure of the land they cultivate. Few will invest in a long-term crop such as trees if they fear that they will not be present to harvest the returns in the future. Openshaw and Morris (1979), have pointed out that this is a fundamental constraint to on-farm trees conservation may well need changes in basic legislation affecting control of the land.

Rocheleau *et al* (1988), has drawn attention to a number of other features of trees which could make them costly to the farmer, for example, competition with neighbouring crops for water, nutrients and light; and emission of substances toxic to other plants. It is important to recognize both what the costs of trees are to farmers, and that these costs may weigh much more heavily in his economic calculations than in those of a forester or entrepreneur. Protection of trees against livestock or termites, for example, may impose a cost greater than the farmer can meet. Formulation of viable on-farm trees conservation depends very heavily on being able to identify tree species that do not place such "costs" on farmers, a

characteristic likely to outweigh such conventional forestry choice criteria as yield and form in the farmer's calculations (Poulsen, 1981).

On-farm trees conservations may sometimes enable economic use to be made of surplus labour, however, in other instances shortage of labour may prove to be a serious constraint. Some on-farm trees management practices compete with peak season labour demands. In off-season periods, labour often migrates to work opportunities elsewhere. Some of the operations, such as the logging of smallholder grown trees for timber and poles require labour inputs in excess of what can be provided by the farm family, so that they have to hire additional help.

There can also be more fundamental economic pressures preventing or discouraging farmers from introducing trees into their agricultural practices. Farmers in the developing world are widely faced with pressures to change their agricultural system, changes which usually cannot be accomplished solely with traditional knowledge, skills and resources. During the transitional period to the new system the farmer is likely to find it difficult to abandon such traditional practices as burning and overgrazing which are inimical to tree-growing (Openshaw and Moris, 1979). Similarly, the tradition of investing wealth in livestock in grazing systems in Africa has persisted because alternative investment outlets have not been developed in these systems, to the point where livestock numbers build up to levels which result in destruction of the tree vegetation (Rocheleau *et al*, 1988). As was pointed already the constraints to on-farm trees conservation stems from the much wider changes and disruptions that are occurring in the rural societies and economies of the developing world such as Kenya.

2.4.1 Land issues and their Relationship to On-farm Conservation in Kenya

Land is an indispensable factor in agricultural production. As the agrarian sector continues to sustain a large portion of Kenya's economy by serving both formal and informal sectors, land shall always occupy a central position in development issues. There is a desire for every self dependent adult to own land. Landlessness is, therefore, a social, political, economic and cultural problem. Mbithi and Barnes (1975), points out that the demand for land causes discontent and dissatisfaction with the government, since many of the landless are jobless, they are unable to meet daily basic requirements.

Pressure on the land is building up steadily, particularly in the high potential regions. Such pressures lead to land subdivisions and fragmentations, subsequently resulting in changes within the production systems or structures and quite often, low yields associated with socio-economic forces acting on individual land units. The overall ecological balance may be disturbed in some cases, resulting from the complexity of factors involving clearance of vegetation cover, poor soil cover, erosion and unreliable water regimes including unstable stream/river flows.

It would seem rational for the government to enact strong policy regulations, as a mean of regulating use and abuse of land resource. As already stated, land policy issues are very sensitive. In addition, the influences of Kenya's history have characterized the entire structure, resulting in a wide range of land sizes of holding, forms of ownership and patterns of production. In turn, these have created difficult policy formulations concerning employment opportunities, income distribution and the design of some development programmes. Regional disparities with respect to ecological potentials have also played a big

role in this. The colonial policies were also crop specific rather than farming system oriented, thus making this sector highly vulnerable to unpredictable human and natural forces.

According to Economic management for Renewed Growth of 1986 (Kenya Government, 1986), there has not been a major land policy since independence. In recognition of the sensitivities of land issues, Kenya Government appointed a commission to review tenure laws and practices that will be in conformity with her development needs.

As the whole the government respect the sanctity of private land ownership, but the land should be used in a socially responsible and productive ways. Pertinent to this, two cardinal points are observed: First, despite growing population pressure on land, there must be prevented beyond the point where total returns to land begin to diminish; and second, land should not be allowed to lie idle or under-utilized in large holdings; steps must be taken to induce land owners to put under utilized land to more productive use (Kenya Government, 1986).

In the high potential areas of Kenya as the study area, population densities are exceptionally high. FAO (1984), estimates a density of 0.24 persons per hectare. In the note of this, it is clear that that these areas will not be continue to produce surplus food resources if appropriate farming techniques for improved on-farm production are not sought. Such cannot, however, be realized without researching into the right methodologies conversant with the specific people traditions or cultural values, finances and level of technology.

Research history in Kenya depicts that most the agroforestry efforts within Smallholders farming category are concentrated in the arid or semi-arid zones, where absolute tangible results has been achieved (UNESCO,1983).

2.4.2 Rural Problems in Kenya and their Relationships to On-farm Trees Conservation

Rural households in Kenya face two basic problems: First, the food production is under stress; and second, there is a critical shortage of domestic energy. Woodfuel is the major source of energy in rural Kenya; with high population densities and very small farms, the pressure in land resources is severe. This is common in the highlands and other regions of good land potential.

About 85% of Kenyans as a whole depend on fuelwood or charcoal for domestic needs. Bradley (1991), estimates the annual consumption to be some 22-23 million tonnes. High levels of woodfuel consumption have been linked by many authors to deforestation, soil erosion, and increased stress on rural economy, which add inequality among inhabitants of rural areas. Whereas wood biomass is absolutely more plentiful in higher potential areas due to agro-climatical conditions, it is acutely scarcer due to prevailing land use patterns and social institutions.

Hosier (1985), describes the social fabric in rural Kenya as more complex than allowed for by neo-classical economic theory. That's rural households are in the midst of transition from a traditional, subsistence system of production to capitalist one. Basing on evidence from studies already done in Kenya and in India, Hosier (1985), concludes that if transformation to capitalism is really a dominant process in rural Kenya, then it should be reflected in the use of energy, a critical resource for rural production.

The studies from Kenya show that, households in different categories appear to treat wood differently: First, within the surplus, farmer category, wood consumption increases with income; it appears to be inferior economic good. Second, for wage workers, consumption decreases as income rises; wood appear to be an inferior economic good, and third, households in other categories demonstrates no consistent pattern.

Bradley, Chavangi and Van Gelder (1985), reports that past emphasis had focused on the sub-humid and semi-arid areas of Africa, particularly the Savannah zones of West Africa. On the Kenyan situation, they revealed that, the locus of woodfuel problems is those areas of highest population density, the high potential zones of the highlands such as Murang'a district.

It is here that the supply of wood-based energy is most threatened. Similarly, the hope of communal land reserves is less tenable. In the Kenya highlands, agricultural lands are now almost completely privatised; there is virtually no community land left. The forest lands, natural forests under government control.

Smallholder farmers in these critical areas have no recourse but to rely on the supply from their own farms. The problem reduces to one of providing sufficient fuelwood from a half hectare of farm to sustain a family of seven or more (Bradley,1991). The supply is envisioned to emanate from their own farms and from woody biomass cultivated and managed by farmers themselves. Appropriate institutional guidance is obligatory in assisting the smallholder farmers to discover suitable methods of diversification and intensification of production. This calls for on-farm approach to conservation of indigenous species which offer diverse benefits to the farmers.

2.5 The Role of Potential Inherent Among the Smallholder Farmers in On-farm Trees Conservation

Rural people have a great deal of useful knowledge to contribute in their role as natural resources conservators. Tengnas (1994), shows the need to harmonize indigenous or local knowledge and the expert knowledge in Agroforestry. This is in agreement with an observation made by Warner (1993) that one of the richest but not utilized sources of knowledge is the indigenous knowledge of farmers.

On-farm conservation must be based on understanding that farmers' knowledge base is different from the experts' base and that the two pools of knowledge are mutually reinforcing. Holding and Kareko (1997), presents a two half-cup measures analogy of the two set of knowledge where if the two cups are combined, an overflowing cup of knowledge is derived. In other word, both the farmer and the experts have something to learn from each other.

Vlaenderene (1996) and Tengnas (1994), have noted this educative effect. On the need to promote knowledge, Backers (1985) attributes the loss of indigenous tree species to the disappearance of knowledge of the affected trees. Bucker's observation is just one aspect that represents the dire consequences following failure to tap indigenous knowledge of trees.

Gift (1996), further observed that, even if rural people are not familiar with production ecology of a particular plant or groups of plants, information about local preferences and uses of products can help in identification of most appropriate species for introduction into an area, or the most important qualities to seek through planting. Not only, can people's past experience and traditional knowledge help to guide on-farm conservation of indigenous trees, but their judgments and skills in their own right can make significant contribution. Local

people can use their experience in innovation and evaluation to identify and develop useful on-farm conservation practices and their full involvement can inspire wide adoption of new practices. Consequently, active local participation is important for importing and adopting traditional tree management practices and for fitting trees into new situations such as settlements, cropping systems or rangelands (Rocheleau *et al*,1988).

Unlocking the storehouse of rural people's knowledge and finding ways of integrating it with modern scientific ideas is the key to tackling on-farm conservation of indigenous trees needs and problems. This is because local knowledge of the environment is unsurpassed and any outside plan or modern or scientific techniques introduced will inevitably have to face the rigours and idiosyncrasies of a given environment (Chamber,1983).

Kerkhoft (1990), cites a case in Zimbabwe where a seedling production programme depended on local propagation of useful trees through cuttings, stumps, wildings and direct sowing and use of locally available materials. These methods were found easier than standard nursery techniques. Backers (1985), underscore the need to analyse the local situation making use of indigenous knowledge in formulating and planning conservation programmes. There is, however, a limit to what the community can offer in terms of knowledge and support hence the need to incorporate other actors in promoting on-farm conservation of indigenous trees.

2.6 Conceptual Framework

There is no universal theory that explain why and how on-farm conservation of indigenous trees can be achieved among smallholders. Review of literature brings into light farmer's preference for both indigenous and exotic trees in their farming systems. Although both

contribute to ecological and socio-economic needs of the farmers, most smallholder farmers, due to their economic status prefer to plant exotic species than indigenous ones. Exotic species though have high economic returns lacks ecological benignness and lack people's cultural attachment which influence their decision and support for on-farm trees conservation. What influence farmers to continue planting exotic trees species in favour of indigenous ones?

As already observed in the discussion above, improved smallholder farming systems must enable the farmer to produce his/her basic needs, both food and wood from the small parcel of land, for own consumption and for sale to earn cash income. It must be as much as possible self-contained, probably requiring only very few external inputs, while maintaining sustainable productivity by ensuring favourable relationships between input (of resources) and output (of benefits).

The techniques involved in production, through simple and within reach, understanding or execution of the smallholders, should not be static but open to gradual improvement and modernization. Such a system should ensure a high degree of stability (socio-economic and ecological) both in short and long term. As a whole the four agro-ecosystem properties (productivity, stability, sustainability, and equitability) must be well represented by producing high values. This should be in relation to other production systems dominated by monocultures.

As such conceptual model of on-farm conservation of indigenous trees has costs on one side and benefits on the other. This general framework requires careful management strategies to realize the system's potential. Both costs and benefits influences the suitability of the system

in the way they interact, collectively resulting in a complex system, sometimes with conflicting demands and decisive trade-offs. It is therefore, arduous to exactly define the configuration of an ideal system under which to promote on-farm conservation of indigenous tree species.

The study, thus, was based on the assumption that indigenous vegetation has been cleared in Murang'a District following increased population and intensified agriculture. This is in view of Malthusian theory that the power of population is indefinitely greater than the power of the earth to produce subsistence for human (Juma and Ojwang',1996). Consequently, indigenous trees have been cleared and replaced with cash crops and exotic trees. This in turn has resulted to loss of on-farm benefits from these indigenous tree species.

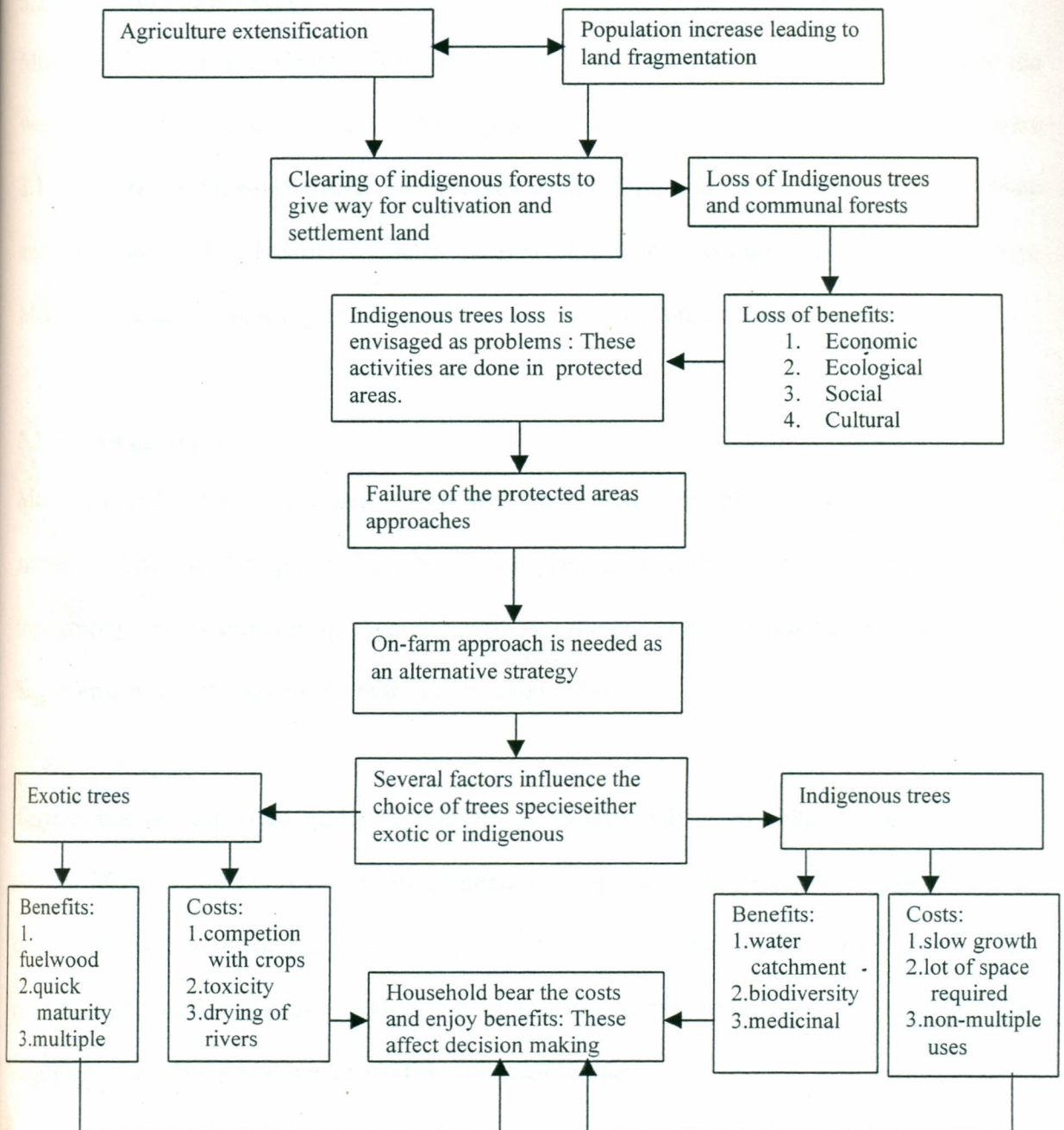
To alleviate this, on-farm strategy has been envisaged by the farmers. This incorporate indigenous and exotic trees species. The benefits accrued from both exotic tree species are economic, social and ecological. They are all enjoyed by a particular household on the farm.

Since exotic trees have been reported to dominate in most farms in the District there is likelihood that indigenous trees could be few. This could mean loss of services and function offered by these species.

The model shows that both indigenous and exotic trees impact on the environment differently. Indigenous species on the farm, on the one hand, leads to increased medicinal plants, biodiversity conservation and rehabilitation of soil and water catchment. On the other hand, exotic trees leads to improved soil nutrients, have a variety of uses and are quick to mature.

Both indigenous and exotic tree species have some drawbacks. Indigenous trees species have slow growth rate and limited uses. Exotic tree species have led to drying of rivers, some compete with crops for water and nutrients, and some emit toxic substances.

Figure 2.1 Conceptual Model Showing Factors Affecting the Need and Adoption of On-farm Approach To Conservation of Indigenous Trees



Source: (Author)

CHAPTER THREE

3.0 AREA OF STUDY

3.1 Introduction

This study was carried out in Murang'a District which has the following characteristics:

3.2 Physical Set-Up

3.2.2 Location and Extent

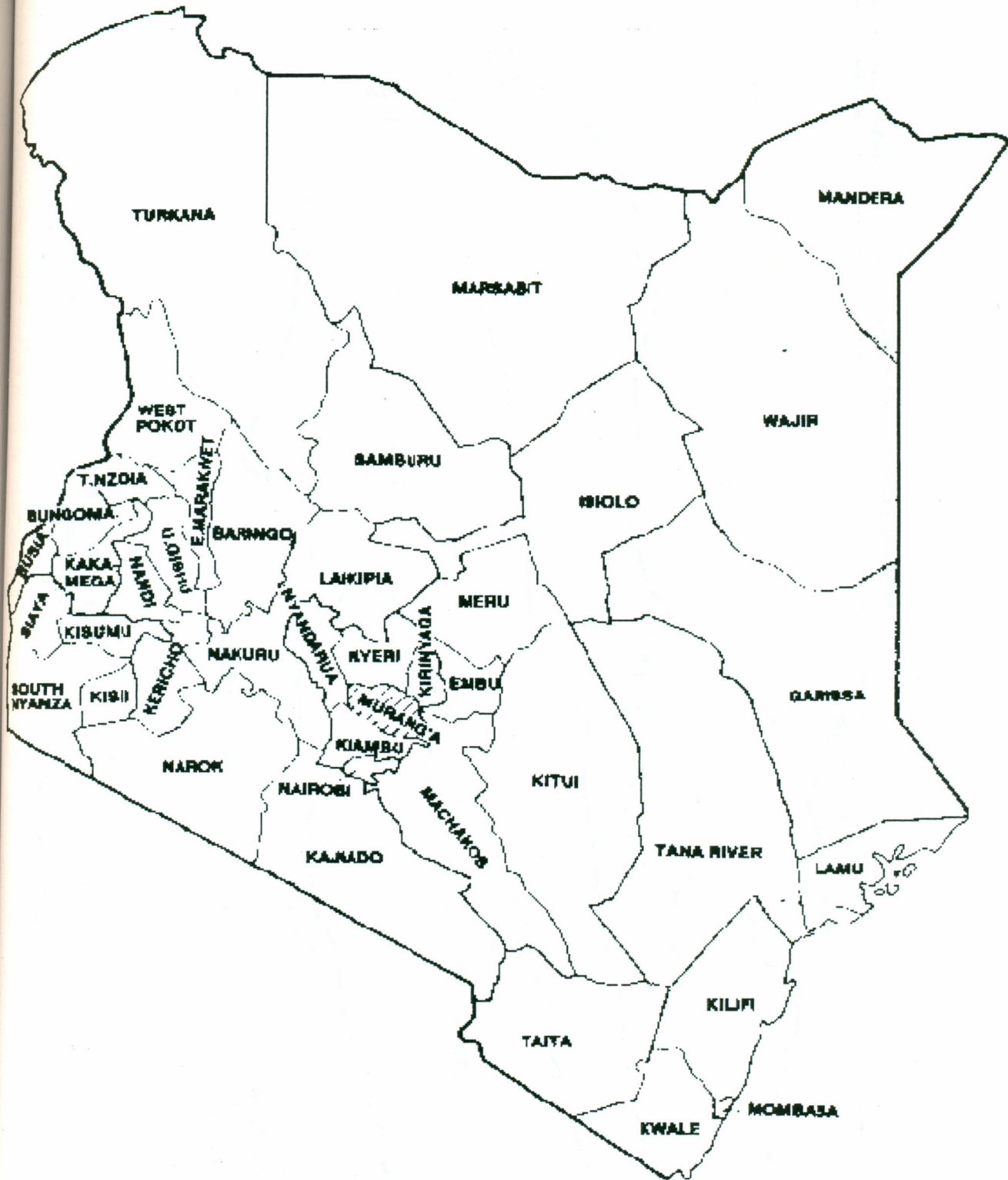
Murang'a District is in Central Province, Kenya. It is bordered to the north by Nyeri, to the west by Nyandarua, to the south by Maragwa, and to the east by Kirinyaga Districts (Figure 3.1). It lies between longitude 36° East and 37° 27' East and between latitude 0° 34' South and 1° 07' South. The District occupies an area of 748 km², comprising of three Divisions: Mathioya, Kiharu and Kangema (Figure 3.2) (Kenya government, 1997).

3.2.3 Topography

Murang'a District rises gradually from altitude of 914M in the east to 3,353M along the slopes of Aberdare Ranges in the west. The highest area in the West has a deeply dissected topography and is drained by several rivers. All the rivers flow from the Aberdare Ranges South-east wards to join the Tana River (Bradley, 1991).

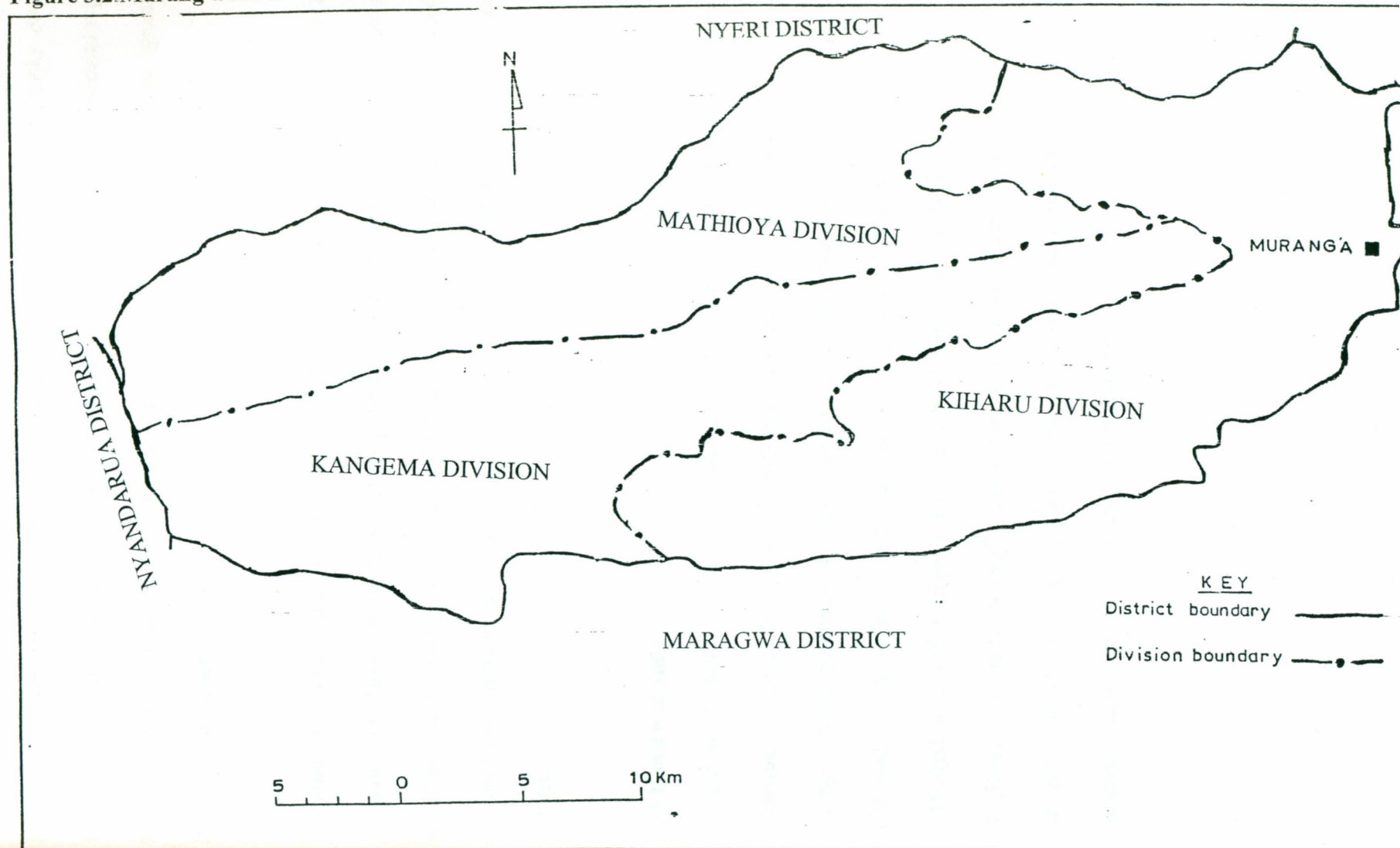
Terrain has an important effect on agriculture in that only crops like tea can do well on slopes. Most of indigenous trees are planted on slopy land. In recent times they are being cleared to pave way for tea plantations. The steep terrain also hinder construction of rural centers and roads. This also hinders the establishment of certain types of projects, which requires a very large expanse of land (Kenya Government, 1997)

Figure 3.1: Location of Murang'a District in the Kenyan Context



Source : (Kenya Government, 1997)

Figure 3.2: Murang'a District and its Administrative Divisions



Source: Kenya Government, 1997

3.2.4 Geology

The geology of the District consists of volcanic rock of the Pleistocene age of recent and tertiary eras, and basement system rocks of Archean type. Volcanic rocks occupy the western part of the District bordering the Aberdares while rocks of the basement type are in the eastern part. It is underlain by tertiary lava (Phonolites) and intermediate igneous rocks (Kenya Government, 1994).

Volcanic rock retains the precipitation received in the area as ground water thus provides constant water flow for the rivers. During the rainy season, however, landslides are common occurrence. The geology of the area affects the distribution of indigenous vegetation and as such affects the indigenous trees composition within the different agro-ecological zones of the District.

3.2.5 Land and soils

The district's soils correspond entirely with the typical Aberdares–Mount Kenya toposequence. About 50% of the District is composed of red loams (nitsols). The nitsols have high agricultural potential, however, this potential decreases from the north-western to the south-eastern side of the district. Coupled with high rainfall regime in the north-west part of the District, tea, coffee, tropical fruits and food crops such as maize, beans and potatoes do well (Kenya Government, 1997). These variations in soil characteristics especially in north-west part of the District where cash crops are predominant indigenous trees are threatened with clearance to pave way for these crops establishment.

The rest of the District comprises shallow poorly drained and in some instances stony soils, which consists mainly of the sandy and black cotton soils. Due to low rainfall regimes, only drought resistant crops and hardy cereals are grown here (Bradley and Ngugi, 1986).

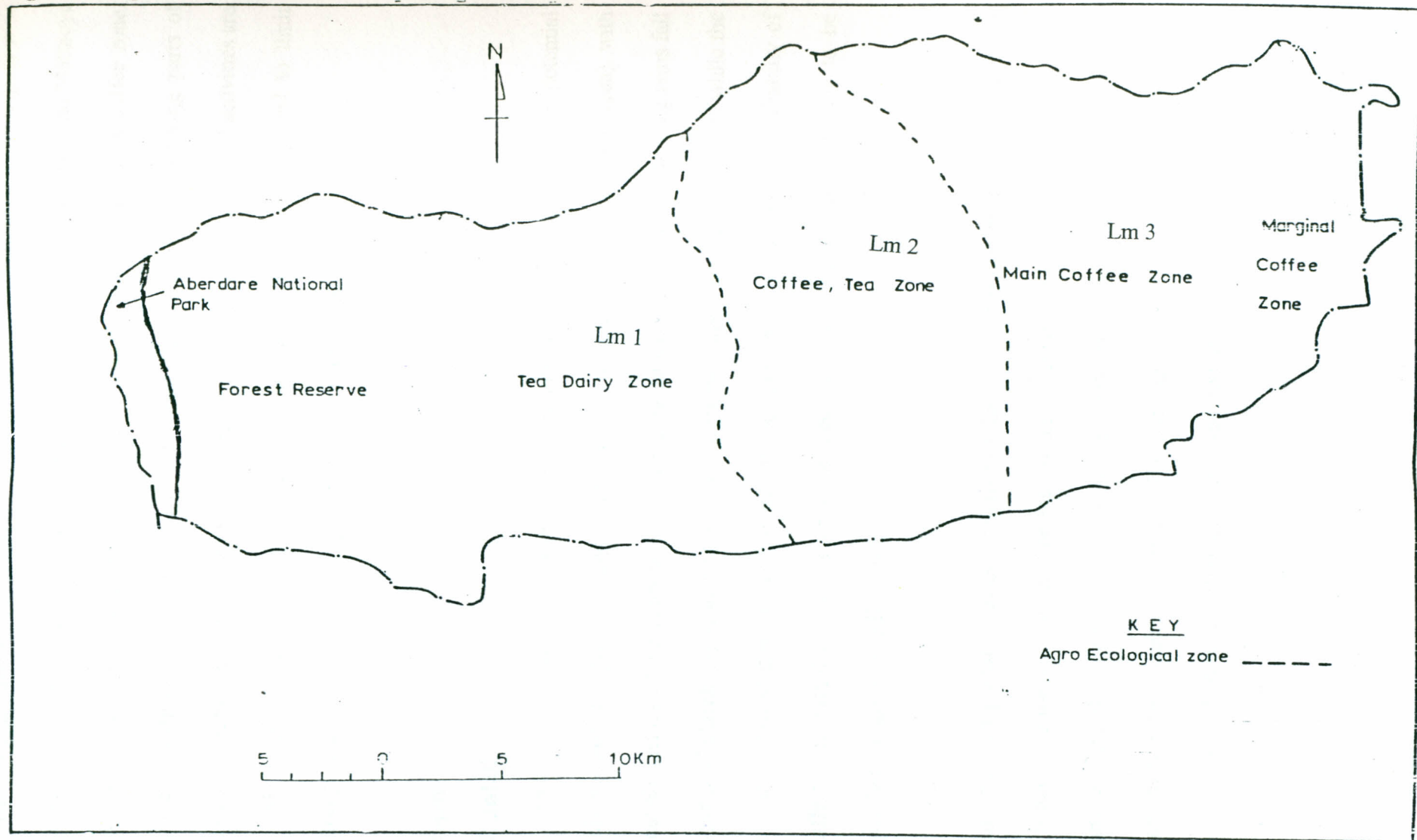
Out of the total District area, 87% of the land is suitable for agriculture and of this 59% is high potential land, 23 % is medium potential, 8 % is marginal and 9% is semi-arid normally used as rangelands (Kenya Government, 1994).

Land in the District falls into 3 land tenure categories: Freehold land which was formerly owned by white settlers, and is now privately owned mainly by smallholder farmers, accounting for around 2.6% of the total land; trust or government land, which consists of forest and other reserves, including Aberdares National Park and alienated land formerly owned by settlers in the former scheduled land are accounting for 35.9 % of total land area. The formerly scheduled land is partly in hand of county and municipal councils and partly owned by large scale plantation farmers. The last category, freehold land formerly referred to as native reserves is currently owned by smallholders with fragmented plots, accounting for 60% of the districts land area (Bradley and Ngugi, 1986). The size of the land holding influences on-farm trees growing (Ngonda, 1988).

3.2.6 Agro-ecological Zones

The district can be divided into three agro-ecological zones: High potential (Lm 1), medium high potential (Lm 2) and medium potential (Lm 3) (Figure 3.3). The forest areas, small scale tea growing and dairy farming areas coincides with agro-ecological.

Figure 3.3: Agro-ecological Zones of Murang'a District



Source: (Kenya Government, 1997)

zones Lm1 and Lm2 and this comprises high potential land. Part of agro-ecological zone Lm1 is occupied by Aberdare Forests and game reserves and it is in Kangema and Mathioya Divisions. Agro-ecological zone Lm3 is of medium potential and is mainly a coffee zone. Semi-arid and marginal rangelands, also, falls under this zone mostly covering parts of Kiharu Division (Kenya Government,1997). In these zones different agricultural activities are carried. This affect on-farm trees planting especially where trees are perceived to limit agricultural production through shading and competition for nutrients (Bradley,1991).

3.2.7 Climate

3.2.7.1 Rainfall

Murang'a District is divided into three climatic regions. The western region (high potential area) with equatorial type of climate, the Central region (medium potential area) with subtropical climate and the eastern part with dry conditions (low potential) The long rains fall in the months of March, April and May, with April recording the highest amount while the short rains are received during the months of October and November. The availability of rainfall affects the establishment of on-farm tree especially where seedling have to be watered for them to grow (Bradley,1991).

In high and medium potential areas, rainfall is reliable and well distributed throughout the year and is adequate for cultivation. The high potential areas in the Western region receives average annual rainfall of between 1,400 mm and 1,600 mm, the average annual rainfall in medium potential areas ranges of between 900 mm and 1,400 mm and the average annual rainfall in low potential areas is between 500mm and 900mm .

3.2.7.2 Temperature

The temperature in the District varies with altitude. In the eastern lower area, the maximum annual temperature ranges between 26 and 30°C, while the minimum annual temperature ranges between 14 and 18°C. In the western, higher and wetter and colder areas, the minimum annual temperature can be as low as 6°C, however in normal circumstances the maximum temperature can reach 30°C. The temperature in the Central region fall between temperature upper part and those in the Western part of the district (Kenya Government, 1997). Different plants have different temperature requirements for their establishment. The same applies to indigenous trees. The choice of indigenous trees to establish on-farm should put this into consideration (Thuo,2000).

3.2.8 Water Resources and Drainage

The district receives more than 875mm of rainfall annually and relatively high precipitation is retained as ground water in volcanic rocks. Most of the rivers in the district flow throughout the year. The perennial flow is further regulated by forest vegetation in the elevated areas of Western part of the district. Clearance of the forest is affecting the volume of these rivers and thus reducing water available for irrigation. Planting of exotic species have affected the volume of water in the area (Bradley,1991).

Main source of surface water are rivers, streams and springs. These are further supplemented by sub-surface water especially in the south-east part of the district. Abundant surface water is found in western part of the district, where more than 1,400 mm of rainfall is received. Artificial water reservoirs have been constructed to hold run-off or spring water for irrigation. There are also seasonal rivers that spring up during heavy rains. There are also boreholes owned by private individuals or organizations. Due to the fact that most of rivers flow

permanently from Aberdare Ranges across the district to the southern part of of the district which is relatively dry with less rainfall make irrigation potential of the district high. This has contributed to construction of dams across the rivers, thus affecting water resources accessibility in some areas (Kenya Government,1997).

4.2.9 Vegetation

The major vegetations zones in Murang'a District correspond to climatic conditions of the district. The area falls into three ecological zones as defined in the National Atlas of Kenya.

Land uses correspond closely to the ecological zones. These zones are:

(i) Zone 1: Forest

This covers the area around and on the slopes of Aberdare Ranges, consisting primarily of forest vegetation forming the Aberdare Forest Reserve. The forest vegetation is composed of closed stands of trees of one or more storeys, with and interlaced upper canopy, rising from 7.5 meters to 40 metres or more in height. The ground cover is dominated by herbs and shrubs. Most of indigenous trees are found in this zone. On the fringes, however, where the forest has been cleared for cultivation, intensive agriculture is practiced, including the growing of coffee and tea.

(ii) Zone 11: Wooded and Bushed Grassland

This occurs in the central part of the district, neighbouring the Aberdare forest to the West. Land is dominated by bracken and sedges. The pastures are Kikuyu grass with high percentage of molasses grass. Tall species of Astoria and Panic grass are common.

Agricultural potential is highest in this zone. Intensive agriculture is practiced, with crops including coffee, tea, tobacco and maize. Livestock is also reared in the area, which is generally capable of supporting one stock per 1-1.5 hectares.

(iii) Zone 111: Wooded grassland

This occurs in parts of Kiharu Division and the zone has a variable vegetation cover. wooded grassland vegetation is common as characterized by broadleaved cumbersome species and other closely related shrubs that are mostly evergreen such as *Acacia lahai*. The agricultural potential is high, soil and topography permitting. Areas under range use are extensive and under close management, their carrying capacity is high at less than two hectares per stock unit.

3.3 Socio-Economic Set-Up

3.3.1 Population Profile

The population of Murang'a District was estimated to be 529,848 people in the Year 2002. Mathioya, Kangema and Kiharu Divisions has population of 130,076; 100,000 and 278,992 people respectively, with annual growth rate of 2.46%. The District have a population density of 510 people per square kilometre. This population growth rate will have an influence on the indigenous trees on the farmlands. Further, more land will be required to meet populations food and fuelwood demand.

In the Year 2001 there were more female than males. This is particularly so in the age bracket of 20-80 years. The female-male ratio was 107:100. The youths population in 0-9 years bracket comprise 61.5 % (Kenya Government,1997).

3.3.2 Economic Potential

3.3.2.1 Agricultural Activities

Agriculture is the most important activity in the district although food production is not sufficient to support the District population. Substantial amount of maize, beans and potatoes, therefore, are purchased from other districts. The major cash crops grown in the district are coffee and tea, mostly on smallholdings. These cash crops act as important source of income in all parts of the district. Horticultural crops are also widely grown including temperate fruits such as plums and pears. Nyayo Tea Zone on the slopes of the Aberdare ranges are the only large farms in the district (Thuo,2000). Creation of Nyayo tea plantation led to further loss in indigenous forests. Establishment of cashcrops, also, have led to loss of indigenous trees within private lands.

3.3.2.2 Livestock Production Activities

Livestock activities are found in all parts of the District. The main livestock reared include cattle, sheep, goats, pigs, poultry and bees. The main types of livestock in the district are similar in all divisions. The livestock products include milk, eggs, skins and honey. Due to high population density, zero grazing is practiced. There is however, grazing along the roads and rivers banks. Livestock affect establishment of trees especially those planted on roadsides and on riverbanks (Rochelaeu *et al*,1988).

3.3.2. 3 Forestry

The district forest comprise of 20, 942 ha of gazetted forest. At present, the district has the Aberdare national park and reserves as the gazetted forest which are vital water catchment for district and beyond. In the district trees widely grown in gazetted forest and on-farms are eucalyptus (blue gum), gravillae and cypress. There are, however, remnants of indigenous trees including *Cordia africana*, *Albizia gummifera*, *Prunus africana* among others in the

forest reserve and in most farms, particularly in areas unsuitable for cultivation such as sloping lands. Agroforestry is widely practised in the district, however, most trees under this system are of exotic species (KFMP,1994).

3.3.2.4 Tourism

Tourism potential exist in the upper zones of the district bordering the Aberdare ranges. Tourist attractions include the famous sites of *Mukurwe wa nyagathanga* (the historical origin of Kikuyu community). Other tourist attraction sites include several waterfalls at various locations in the upper parts of the district where such rivers like Mathioya and Sagana descend from the slopes of Aberdare Ranges.

3.2.2.6 Commerce and Trade

(a) Formal Sector

Most of the commercial activities are concentrated in major urban centres which are characterised by periodic markets days, mostly held twice a week. The activities include several retail and wholesale outlets and hotels. In areas where electricity is available, smallscale industries have come up such as metal fabrication and saw mills (Kenya Government,1997). As this expands, it is envisaged that fuelwood demand will rise and food demand will also rise, it is expected that this will lead to clearance of indigenous trees in favour of exotic trees and cash crops. The growth in this sector and improvement in electric power supply may reduce fuel demand from trees and may give on-farm indigenous trees to establish.

(b) Informal Sector

The informal sector, play not only an important role in provision of services but also in job creation in most towns and urban centres of the district. Most of these activities comprise of barber shops, shoe shiners, radio repairer, tailoring, garages, fruits and vegetable hawking among others (Kenya Government, 1997).

The informal sector is a major source of employment in the District due to the ease of entry and exit facilitated by low capital requirements. The general suitability of business locations for informal sector activities is an added attraction. These have created conducive environment for establishment and exploitation of micro business opportunities in urban centres such as Murang'a municipality, Kiria-ini and all divisional headquarters. Proper planning of this sector will create alternative source of income and will reduce such activities as charcoal burning and logging of wood for sale. This may give a boost to indigenous trees to thrive within the farmlands.

3.3.2.6 Communication Network

The district has a total road length of 1635 KM distributed into various categories such as classified, unclassified, surface bitumen and gravel roads. The existing road network is insufficient for the transportation needs of the district. This insufficiency particularly affects the ability to transport the agricultural produce from farms to markets. This cause a great deal of wastage and loss of income to farmers. This loss in agricultural crops leaves the farmers with little financial resources for use, in turn they revert to cutting of on-farm trees for sale to cater for the cash deficit (Cunningham, 2001).

The district is also covered by a railway line. Its usage is confined to the activities of National Cereals and Produce Board (NCPBD) and bulky agricultural inputs such as fertilizers. This provide an opportunity for agricultural growth, since, it allows for fast delivery of farm input and transportation of bulky farm produce such as coffee and tea. The establishment of these crops has led to diminishing of indigenous trees on the farmlands.

Telkom and Postal Corporation of Kenya has branches in all divisional headquarters and major market centres where postal and telephone services are offered. These can be optimised in the linking of the District with other areas to promote business. This will lead to reduction of overreliance on agriculture as the major source income as it is at the moment.

CHAPTER FOUR

4.0 RESEARCH DESIGN AND METHODOLOGY

4.1 Introduction

This chapter deals with research design and methodology which focus on population description, nature and sources of data, sampling methods and sample size. It also describes methods of data collection, data analysis and presentations, and limitations experienced while carrying out the study.

4.2 Research Design

This study was based on survey design employing both formal and informal methods of data collection. Formal methods involved use of questionnaires, interview schedules and direct observation. Informal methods, on the other hand, comprised of use of Rapid Rural appraisal (RRA) methods, mainly focus group interviews.

The combination of formal and informal methods assisted in realizing the best attributes of both methods. The two categories were thus mutually reinforcing. Kumar (1993), notes that formal methods are often of limited values in studying social economic changes, highly interactive social situations or people's underlying beliefs and value systems in a setting. Under such circumstances as in this study, informal data gathering techniques were necessary.

The formal methods as advanced by Emerton (1996), generated quantitative data that was analysed statistically. To draw conclusions further random sampling was used in the selection of sample areas. This allowed the study to meet the requirements for statistical significance testing of variables as stipulated by Kuper and Kuper (1996) and Andersen (1980) on the use

of survey models in research. On their part, informal methods gave an in-depth analysis of the phenomenon investigated but not of its extent or pervasiveness.

4.3 Population Description

The study drew samples from the following populations the smallholder farmers; Government Ministries which included Departments of Agriculture, Forestry and Provincial Administration; and the community based organizations including women, welfare and youth groups.

4.4 Nature and Sources of Data

The purpose of this study was to inquire into the potential for on-farm strategies in conservation of indigenous tree species in Murang'a District. To realize this goal two types of data were collected: primary (first-hand information) and secondary (documented information). Primary data was obtained through the field surveys; information was generated from questionnaires, individuals and focused group discussions and through observation, all targeting to answer the research questions guiding the study. The secondary sources on the other hand entailed an explorative review of relevant literature on natural resources conservation strategies in general and indigenous tree species in specific.

4.5 Research Instruments

The research instruments in the study were questionnaires, interview schedules, a guide to focused discussions, camera and observation record sheet.

4.6 Methods of Data Collection

Several methods were used in collecting data from both primary and secondary sources. The process entailed administration of questionnaires, recording of observations made, conducting

interview schedules, transect walks, listening to oral traditions, community timeline, seasonal calendars, photographs and review of recorded literature.

4.7 Methods of Sampling

Since the study did not cover the entire population. A sample upon which inferences were made was taken. This gave representative information about population at a minimum cost and time. The following sampling methods were adopted:

4.7.1 Multi-stage Cluster Sampling

To ensure a fair coverage of large area with heterogenous ecological characteristics, multi-stage sampling was employed (Koskey,1997). Murang'a District was clustered into three ecological zones, namely: Lm 1, Lm 2 and Lm 3. After this was done, the agro-ecological zones were further subdivided based on administrative boundaries of Locations, then Sub-locations (Mulusu,1990). Multi-stage sampling ensured equal representation of all the three ecological zones within the study area. After multi-stage, random sampling of the Sub-locations were done from which population samples were taken.

4.7.2 Stratified Random Sampling

After the clustering of the study area, the next stage involved determination of the population into different characteristics such as women and men, young and old, and officials from government ministries' departments. Random samples were taken from these stratified groups. The sampling procedure ensured that each of the stratified population whose activities affect conservation of on-farm indigenous tree species had equal chances of being interviewed.

4.7.3 Snow Ball

Snow ball sampling techniques was used in identification of field workers (includes agricultural extension officers, social worker among others) and provincial administrators. Though snow ball sampling is known to introduce biases (Peter,1994), they assisted in generation of information of qualitative nature without pressure of generalization.

4.8 Sampling Frame, Selection and Size

After various resource persons were identified by the use of snow ball sampling, a meeting was arranged and a list of all farmers owning land less than 5 acres was prepared. From this list, random selection was done. A total of 90 respondents were sampled, that's 30 from each ecological zone. This number of respondents were deemed sufficient as other similar studies based on the same research design used equivalent or small sample size and produced reliable and varied results (Chavangi *et al*,1984; Karembu,1992). Further, given the homogeneity of the smallholder farmers in the area *vis a vis* production activities, this allowed the study to extrapolate the findings from the sampled sites of the district (Ngonda,1988).

4.8 Pilot Study

Before the main study was undertaken, a pilot study was carried out. This helped in testing the clarity, effectiveness, adequacy and relevance of research instruments, methodology, and variability of the study in general. Further, this study assisted in identification of tree species present in study area (Appendix iv). After this identification, a checklist comprising of widely used/known ten most common indigenous and ten exotic trees species was prepared. This was done in conjunction with officers in the Departments of Forestry and Agricultural, local elders and provincial administrators (who included chiefs and assistant chiefs). This was done in line with similar study by Cary and Williams (2000). The checklist was then used in the main study (Appendix v) .

4.9 Methods of Data Analysis

At the end of data collection from the field data was collated and analysed. This was made easy by coding of all responses, after which the standard Statistical Package for Social Scientists (SPSS) 6.1 version was used. Owing to the nature of the study, both descriptive and inferential statistics were used.

4.10.1 Descriptive Statistics and Tools Used in Data Collection

Descriptive statistics involved the use of Multi-response cross tabulation and contingency table to generate frequencies and percentages. This was appropriate because most data were envisaged to be normal.

Descriptive tools such as SWOT Analysis, Content Analysis, Structural-functional Analysis methods were used to analyze descriptive data generated by focus group discussions and oral narratives. Responses were also presented verbatim in some cases.

4.10.1.2 SWOT Analysis

SWOT Analysis was used to analyse descriptive data generated by focus group interviews as prescribed by Holding and Kareko (1997). SWOT analysis provides decision makers with information that form the basis for decision and action aimed at achieving set objectives. Most of this analysis was with focus group discussions, a task which started in the field. Here the groups were expected to rank the various strengths, weaknesses, opportunities and threats of items considered in the interview. This exercise allows the decision maker(s) to exploit opportunities while combating threats. In other words, results of SWOT Analysis provide pointer towards change in objectives, policies, strategies or institutional

arrangements based on existing and latent strengths and opportunities while critically evaluating weaknesses or threats.

During SWOT sessions with chosen groups, notes were taken for purposes of recording information generated during the interviews by a secretary who was one of the group being interviewed and not the researcher. In addition, the researcher played the role of a facilitator to guide direction of the interviews. This avoided much digression from the subject of discussion. Finally, the information from all groups was cross tabulated to show general trends in discussion between groups.

4.10.1.3 Content Analysis

This was used to analyse interview data from various groups. The information collected was categorised into identifiable themes (Cary and Williams,2000) to ascertain the respondent's view and attitudes on on-farm conservation strategy to indigenous tree species. This method was useful in analysing data of this nature especially in assessing the verbal discussions and interviews (Cary and Williams,2000). Further, it allowed for classification of data to facilitate the search for patterns within discussion and across the discussions.

4.10.1.3 Structural-Functional Analysis

This was used to analyse and to distinguish between manifested and latent functions of socio-cultural values observed by the community which contribute to the management of indigenous tree species (Koskey,1997). It was done through listening to oral tradition and narratives from different groups within the community.

4.10.2 Inferential Statistics

Inferential statistics on the other hand entailed the use of the Chi-square. A contingency table was, for instance, further treated to Pearson Chi-square (X^2) test to find out the statistical significance of the relationships and associations between variables (Gupta, 1992).

4.11 Data Presentation

The analysed information was presented in frequencies, percentages, figures, tables, plates, and discussions.

4.12 Research Limitations

During the study, various limitations were encountered which could have affected the findings of this study. These includes:

- (i) Views and knowledge on indigenous tree species by the community members was not from recorded sources, hence, there is likelihood that some may have been left out during interview thus those given may have been incomplete.
- (ii) Most of the values of indigenous trees are latent thus people may have made assumptions on them thus not giving them during interview therefore affecting the study findings.
- (iii) The study was limited in ecological assessment as such it was limited to ecological values given by the respondents.
- (iv) The study did not consider all tree species growing in the area, it was limited to a checklist of ten indigenous tree and ten exotic trees prepared during pilot study. This restricted the interview to the species in the checklist.
- (v) The sample size chosen for the study was small given the time constraints, thus a slight difference in the study findings may be expected if a large sample is taken.

CHAPTER FIVE

5.0 DATA ANALYSIS AND DISCUSSION

5.1 Introduction

This chapter presents the study findings and discusses emerging issues. It is divided into four sectors: demographic and socio-economic characteristics of the respondents, status of indigenous trees species, factors influencing on-farm conservation of indigenous trees species and existing potential among the farmers that could be used in the promotion of on-farm conservation of indigenous tree species.

5.2 Socio-economic and Demographic Characteristics of the Households

The majority of the household heads were male and this explains why men in Murang'a District have greater influences on most household activities including tree planting, cultivation of agricultural crops and income generation. Table 5.1 shows the details of household characteristics of the respondents. There were more male respondents because most families have men as household heads. In many respects it also shows that Kikuyu culture is dominated by patrilineal control over land use practices.

Nevertheless, the trend has started to change because some of the women respondents mentioned that they were allowed by their husbands to manage trees on family land as long as the products can benefit the whole family. This is an important observation in terms of tree farming although an earlier report by Bradley (1991) indicated that male dominance was a significant factor limiting the adoption of agroforestry technologies. Viewed against this background, it can be said that tree farming programmes should involve more women as they are more involved in crop cultivation than men, and would

Table 5.1: Demographic Characteristics of the Households

Factors		Responses	Percentage
Sex	Male	60	66.7
	Female	30	33.3
Marital status	Married	60	66.7
	Single	20	22.2
	Living separate	10	11.1
Educational status	No formal education	17	18.9
	Primary education	30	33.3
	Secondary education	25	27.5
	Tertiary education	18	20
Age class	<20	5	5.6
	20-29	15	16.7
	30-39	25	27.5
	40-60	35	38.9
	>60	10	11.1
Number of children	Range	1- 12	
	Average	6.2	

therefore look after the trees growing in the crop fields if they are equipped with sufficient knowledge of trees planting and management.

5.2.1 Marital Status of the Respondents

More than the 60% of the respondents (Table 5.1) were married. Married people are respected under the Kikuyu culture because one can inherit land or acquire tenurial rights to it from the parents. Single people have limited rights to land ownership and this is a major problem because it implies that single people cannot freely plant trees. The proportion of

single people in this study was over 20% of the respondents. Marital status tends to restrict the adoption of farming technologies because of its direct relationship with land use rights. Since single people are in most cases juveniles, it would be appropriate to encourage them to plant trees because they have prospects for living long and probably harvesting them.

5.2. 2 Education Status of the Respondents

About 33% of the respondents had primary education, 27% secondary education, 18%

tertiary education and 20% had no formal education at all (Table 5.1). As noted by FAO

(1986a), education is a critical factor in the adoption of any technology including trees

planting and agroforestry because farmers need to be sufficiently literate in order to

understand the techniques of modern farming in which tree planting is incorporated. Since

population of Murang'a district is increasing at a rate of about 3.0% per annum, it is expected

that land scarcity will remain a major constraint to tree planting. New approaches that can

accommodate trees amidst the growing population, need to be developed and implemented.

Environmental education can be used as a means of sensitising the population on such

approaches.

5.2.3 Age of the Respondents

It was noted that about half of the respondents (49.8%) were below 40 years old and this in

effect shows that most of the farmers are within the active age group and can be involved in

tree planting. People between 40 to 60 years could also be involved in planting trees because

they have control over land rights and can encourage their kin to manage the trees.

5.2.4 Number of Children Per Household

When population is considered in terms of the under the dependent age bracket per respondent. The number of children ranged from 1– 12 per household giving an average of 6.2 children per household (Table 5.1). According to National Development Plan of 1997-2001 (Kenya Government,1997), the national average number of children per household is 6 and people below 18 years form more than 60% of the national population. This shows that the demand for tree products will increase and younger people should be encouraged to plant trees to meet future demands.

5.2.5 Land Ownership by the Respondents

About 98% of the respondents owned farm land and the remaining 2% of the respondents had hired land from neighbours and relatives. As noted earlier, land tenure and ownership are key in the adoption of the tree planting particularly in densely populated areas such as Murang'a district.

5.2.6 Land Size Per Household

52.2% of the respondents could not give the accurate the size of their land as land ownership is usually by the family heads who have subsequently divided land into pieces for their sons and daughters who have independent households. Nonetheless, about 83% of the respondents estimated that they own about 0.2- 4 hectares and 15% had 5 hectares. Generally, the land holdings in agro-ecological zone 2 are small but relatively bigger in agro-ecological 1 and 3 where most farmers own over 5 hectares of land per person. Land fragmentation is not pronounced in the district but about 7% respondents claimed that they own other pieces of land within the district.

Table 5.2: Sizes of Landholding among Farmers

Land sizes(Ha)	Respondents	Percentage
0.2- 1	32	35.3
2	25	27.8
3	10	11.1
4	9	10
5	14	15.6

5.2.7 Land Use

People in Murang'a district are basically cultivators. Seventy two percent of the respondents said they keep livestock. About 86% of the respondents said they plough their land throughout the year and 14% said they practise fallowing. Ahn (1993) noted that repeated cultivation leads to soil exhaustion, loss of crumb structure and subsequent erosion. As a result, there is a need to introduce measures that would help to improve the soil and maintain its fertility through land use practices. It was found that the land in Murang'a district is intensely used although in some places it was left under fallow. The reasons for leaving land under under fallow are presented in Table 5.3.

Table 5.3: Reasons Given by Farmers for Leaving Land Fallow

Reason for fallowing	% response
Soil regeneration	75.7
Reduced yields	45.7
Use as pasture	32.9
Enough land	10

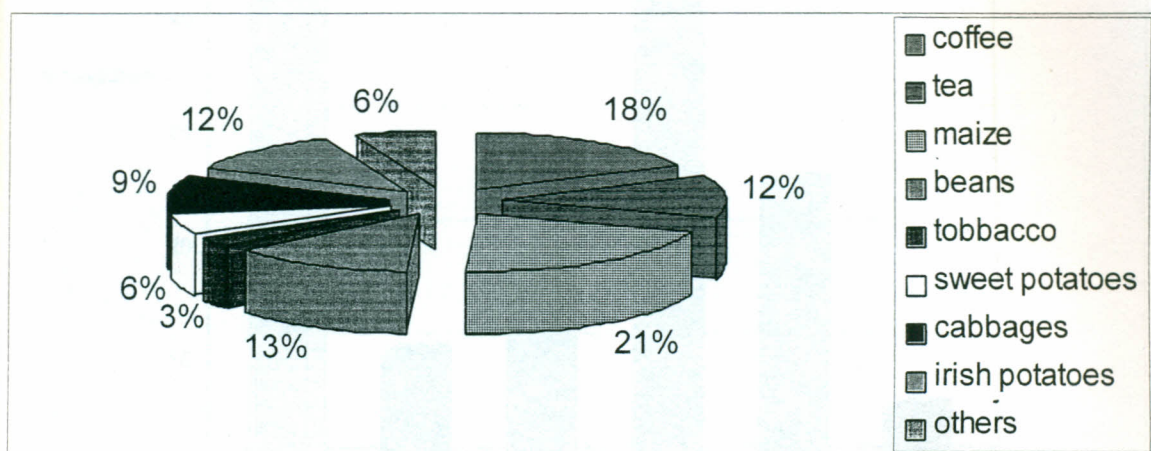
The majority of the respondents practise fallowing for soil regeneration prior to growing the next crop. This is a traditional method of maintaining soil fertility that depend on the length of fallow. Bradley and Ngugi (1986), reported that the population pressure on land in the Murang'a district has reduced the length of fallow or removed it completely. The use of vegetation in soil management is practised by farmers in Murang'a district and this provides a good basis for promoting tree planting technologies. It was noted that farmers in Gaturi and

Njumbi used species like *Sesbania sesban*, *Cordia africana* and *Croton macrostachyus* as indicators of soil fertility.

5.2.8 Agricultural Crops

Several crops are grown in the Murang'a District (Figure 4.1). Plantation crops such as coffee and tea are grown extensively as perennial crops in agro-ecological zones 2 and 1 respectively. In agro-ecological zone 3 most of the farming involves planting of maize and beans. Other crops such as millet, sorghum, beans and maize are grown as annual crops.

Figure 5.1: Agricultural Crops Grown



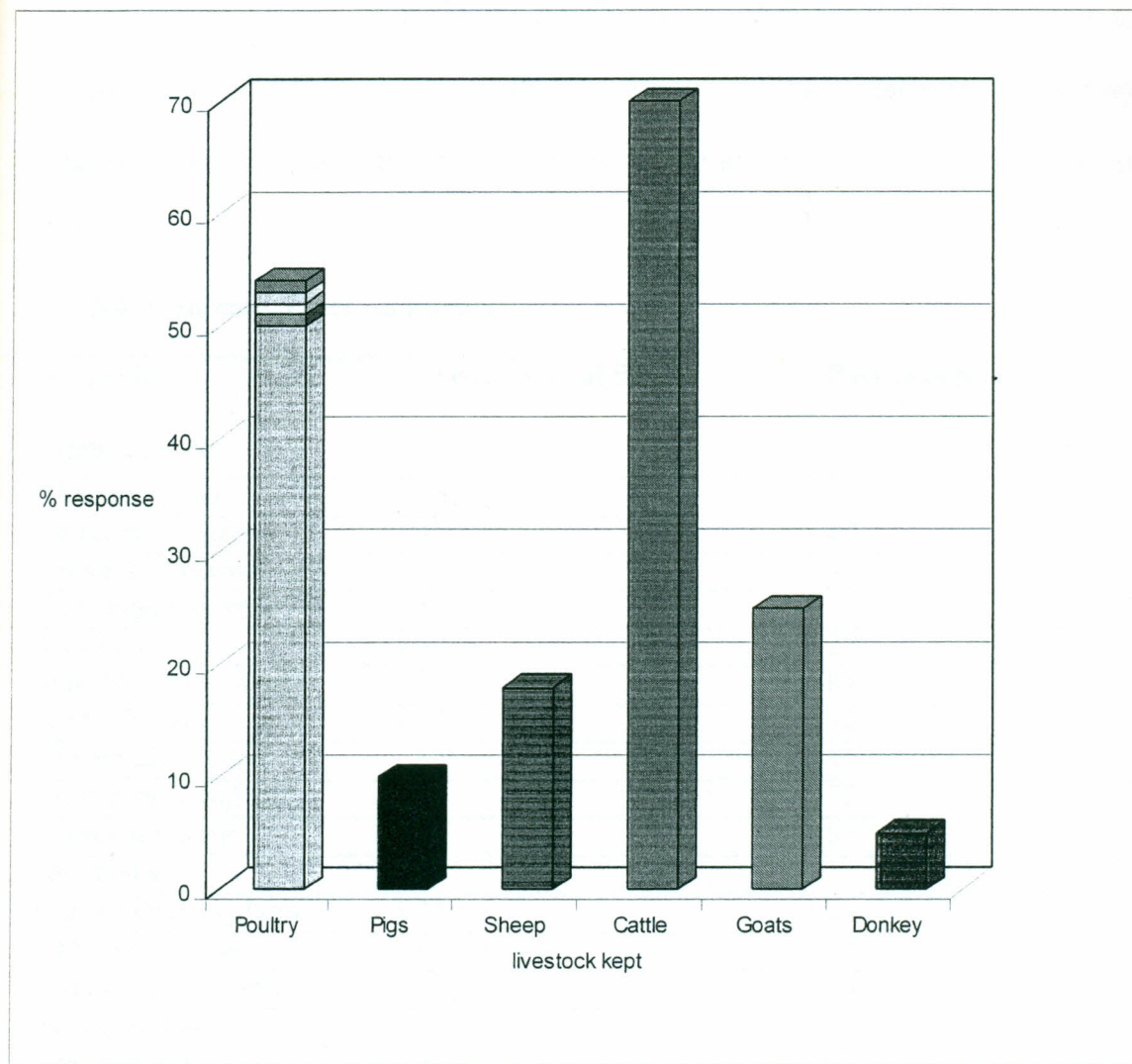
Over 90% of the respondent practised subsistence farming and major crops grown are coffee (*Coffea coffea*), tea (*Thea sinensis*), maize (*Zea mays*), beans, cabbages, sweet potatoes and irish potatoes, sorghum, among others. Some of the food crops are sold to obtain family income or bartered with other commodities.

5.2.9 Responses on the Types of Livestock Kept

Livestock farming is important in the area although is less developed than crop cultivation. Cattle keeping is common and pigs ,sheep, goat and poultry are also reared (Figure 4.2). The

animal are reared in small number because of lack of grazing land, as such zero grazing is usually practised.

Figure 4.2: Responses on the Types of Livestock Kept



5.3 Status of On-farm Trees

Objective one of the study was to examine the status of indigenous trees within the farmlands of Murang'a district. This survey involved recording of tree species on the farm using a list of twenty common trees in the area (10 indigenous and 10 exotic). Based on this checklist, the specific species were marked present or absent and results have been

summarized by use of frequencies and percentages (Table 5.4). From the survey, it was revealed that most trees on the farm had either been planted or regenerated naturally.

Respondents were asked whether trees on their farms were promoted by various institutions or planted out of farmers own initiatives. Both situations were reported. Institutions promoted tree planting in two different ways: firstly by availing seedlings to farmers free of charge or for payment of a minimal fee. Secondly, by assisting farmers to establish on-farm tree nurseries.

Table 5.4: Common Trees on Farms

Tree species	Frequency of 90	Percentage
Indigenous trees		
<i>Markhamia lutea</i>	76	84
<i>Bredelia micrantha</i>	42	47
<i>Spathodea campanulata</i>	32	35
<i>Croton megalocarpus</i>	19	21
<i>Acacia lahai</i>	22	24
<i>Croton Macrostachyus</i>	73	81
<i>Cordia africana</i>	29	32
<i>Erythrina abyssinica</i>	37	41
<i>Vernonia auriculifera</i>	68	75
<i>Sesbania sesbania</i>	78	87
Exotic trees		
<i>Leucaena leucocephala</i>	23	26
<i>Eucalyptus saligna</i>	87	97
<i>Calliandra calothyrsus</i>	63	70
<i>Azadirachta indica</i>	38	42
<i>Eriobotrya japonica</i>	60	67
<i>Persea americana</i>	76	84
<i>Mangifera indica</i>	38	42
<i>Gravillae robusta</i>	81	90
<i>Cupressus lusitanica</i>	46	51
<i>Acacia mearnsii</i>	46	51

About 19% farms had on-farm tree nurseries, 6.9% which were group owned. This strategy was employed by the Department of Agriculture in the Ministry of Rural Development.

Farmers also took their own initiative to promote indigenous trees species. Majority of indigenous tree species such as *Vernonia auriculifera* had been retained on-farm because of their medicinal value and sources of fuelwood and poles. These trees were therefore promoted.

Most farmers efforts were geared towards exotic trees. Out of 90 respondents, for instance, more than 50% promoted exotic species (Table 5.4). Although indigenous tree species such as *Markhamia lutea*, *Sesbania sesbania*, *Erythrina abyssinica*, *Croton macrostachyus* and *Vernonia auriculifera* were few (on many farms) they were common on most farms. These indigenous trees are planted with exception of *Croton Macrostachyus*, *Croton megalocarpus* and *Vernonia auriculifera* which are easily regenerated naturally.

On the whole, indigenous tree species were scattered all over the farms. Observations made during the survey showed presence of single indigenous tree species on farm . This was true of *Erythrina Abyssinica*. Such species had either been exploited for various uses or were not actively promoted in agroforestry. Others, including *Acacia lahai*, are threatened to extinction. Exotic tree species registered high individual species that were planted as woodlots by many farmers . High frequency of exotic species in the study area has been reported by Bradley (1991) and is associated with high growth rate. Table 5.5 is a summary of data on tree species that had been planted and not regenerated naturally.

Few exotic trees such as *Leucaena Leucophala* and *Azadirachta Indica*, however, were somewhat uncommon perhaps because they were recently introduced in the district. *Acacia mearnsii* which was common in most farms as indicated in Bradley (1991), is being

overtaken by *Eucalyptus spp.* This can be attributed to the decline in the use of tanin in leather industry following increasing use of synthetic substances.

Table 5.5: Trees Planted on the Farm

Tree species	Frequency of 90	Percentage
Indigenous trees		
<i>Markhamia lutea</i>	67	74.0
<i>Bredelia micrantha</i>	11	12.0
<i>Spathodea campanulata</i>	21	23.0
<i>Croton megalocarpus</i>	10	11.1
<i>Acacia lahai</i>	4	4.8
<i>Croton Macrostachyus</i>	33	37.0
<i>Cordia africana</i>	7	8.0
<i>Erythrina abyssinica</i>	1	1.2
<i>Vernonia auriculifera</i>	2	2.4
<i>Sesbania sesbania</i>	73	81.0
Exotic trees		
<i>Leucaena leucocephala</i>	23	26
<i>Eucalyptus saligna</i>	87	97
<i>Calliandra calothyrsus</i>	63	70
<i>Azadirachta indica</i>	38	42
<i>Eriobotrya japonica</i>	60	67
<i>Persea americana</i>	76	84
<i>Mangifera indica</i>	38	42
<i>Gravillae robusta</i>	81	90
<i>Cupressus lusitanica</i>	46	51
<i>Acacia mearnsii</i>	46	51

Indigenous trees with highest percentage were *Markhamia lutea* and *Sesbania sesban*. *Croton macrostachyus* recorded an observation attributed to limited farmers' effort to plant it. These three species are common where subsistence farming is largely practiced (especially in agro ecological zone three) and their promotion is attributed to farmer's knowledge of their propagation and traditional value among Kikuyu community. Some species such as *Erythrina abyssinica* and *Vernonia auriculifera* were uncommon.

5.3.1 Sites Where Trees Were Established

Further, to the understanding of the status of on-farm trees, it was necessary to look into the methods and sites of tree establishment. The knowledge of the site where each species was established was important as it gave information on whether these trees can co-exist with crops or not. Sites where on-farm trees are planted/retained were categorised as shown in the Table 5.6.

About half of the respondents reported that trees were grown in fallow and gardens together with agricultural crops either under spatial or temporal management. This deviates from Warner's (1993) that almost no trees were grown in gardens although they are largely planted close to homestead. As reported by Bradley (1991) lack of land forces the farmers to interplant some trees with agricultural crops. About 70% of the farmers said they use random tree planting pattern in order to ensure minimal effects of trees on agricultural crops.

Indigenous trees such as *Markhamia lutea*, *Sesbania sesban* and *Erythrina abyssinica* were traditionally accepted as being harmless to the crops. Table 5.5, shows the extent to which indigenous and exotic trees were incorporated on-farm, 30.2% as opposed to 64.4% for exotic species. Although there were 52.6 of indigenous trees on the farms, 26.3% of these trees had naturally regenerated.

Since about half of the farmers had planted trees with agricultural crops, there is urgent need to guide the farmers on tree management aspects like optimum spacing so that crops are not affected by the shading effect of the tree branches and crown. The significance of optimum tree spacing in agroforestry has been discussed by Rocheleau *et al* (1988) as a way of increasing crop production in terms of total yield of mixed crops and diversity of products.

In addition farmers employ far less formal irregular spacing in order to minimise the interference of tree growth with agricultural crops. According to Okafor and Fernades (1989) and Nair (1984) homesteads are better placed for tree management, protection and harvesting. It was observed during the study that within the home gardens the extent of surveillance is higher than on distant sites and trees are protected from destructive agents like livestock, fires and communal interference. Further, to ensure protection of trees within homestead, propping up of stems was done in order to protect them from agents of destruction.

Tree products, such as medicinal products can be harvested near the homesteads and easily monitored. Trees when young are sometimes destroyed by straying livestock (Plate 1) and destroyed by children. Conservation of tree resources around homestead is also practised among other communities in Africa. Rocheleau *et al* (1988), for example, observes that "... trees around houses and compounds are a tradition throughout Africa ... That community meetings are often held under especially large, shady trees that may have special significance for local people."

Plate 1: Livestock Grazing in a Farm

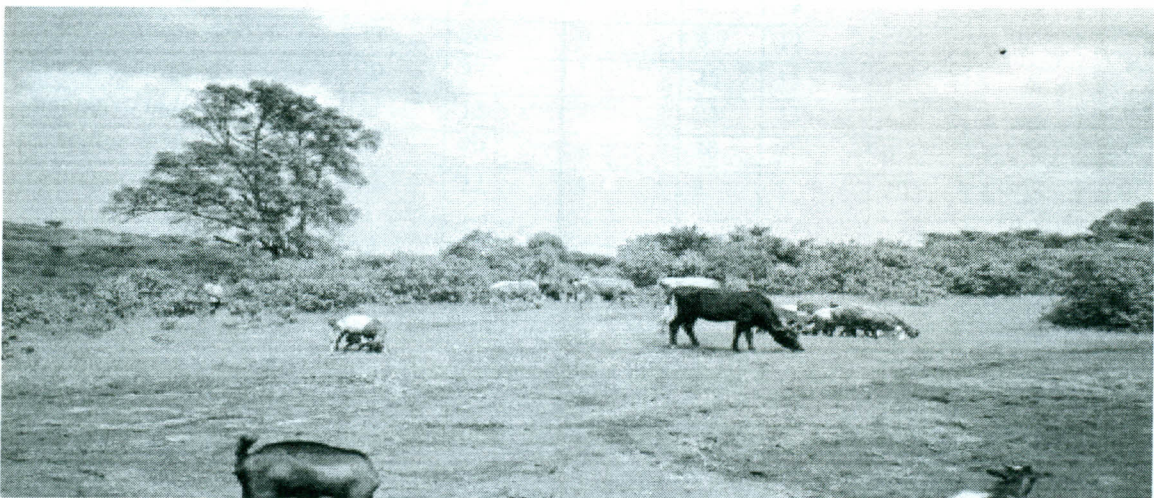


Table 5.6: On-Farm Trees Planting Methods and Sites

Trees	Planting methods			Planting sites				
	DS	SD	WA	CL	Hs	Wl	Rs	Edg
Indigenous species								
<i>Markhamia lutea</i>	7	44	22	57	13	1	1	29
<i>Bredelia micrantha</i>	-	5	5	10	1	-	6	22
<i>Spathodea campanulata</i>	-	17	3	5	15	-	-	2
<i>Croton megalocarpus</i>	-	-	2	4	2	-	-	6
<i>Acacia lanai</i>	-	2	2	10	1	-	-	16
<i>Croton Macrostachyus</i>	-	16	18	25	20	-	1	16
<i>Cordia africana</i>	-	2	4	13	1	-	3	14
<i>Erythrina abyssinica</i>	-	-	5	13	1	-	-	3
<i>Vernonia auriculifera</i>	-	-	2	25	4	-	2	25
<i>Sesbania sesbania</i>	26	28	15	25	6	3	8	6
Exotic trees								
<i>Leucaena leucocephala</i>	10	12	1	9	5	2	-	12
<i>Eucalyptus saligna</i>	30	40	18	-	2	50	22	9
<i>Calliandra calothyrsus</i>	10	31	20	25	5	3	-	1
<i>Azadirachta indica</i>	16	20	-	8	12	-	-	3
<i>Eriobotrya japonica</i>	33	26	9	8	12	-	-	1
<i>Persea americana</i>	20	37	16	25	15	-	-	1
<i>Mangifera indica</i>	23	13	-	23	23	-	1	3
<i>Gravillae robusta</i>	8	70	-	30	7	4	1	20
<i>Cupressus lusitanica</i>	12	32	4	2	5	20	6	13
<i>Acacia mearnsii</i>	18	12	12	3	-	25	3	6

key

Ds – Direct seeding

WA- wildling

Rs – Riverside

Cl - Cropland

Sd – Seedling

Rds – Roadside

Hs – Homestead

Wl – woodlot

Edg-edge

The species considered inappropriate for mixing with agricultural crops were grown separately as woodlots, for example *Eucalyptus spp*, *Cupressus lusitanica*, *Acacia mearnsii*, *Pinus patula* and in some cases *Gravillae robusta*.. The size of the woodlots in Murang'a

district, however, are small because of land shortage. Most of these woodlots had exotic trees with few indigenous species.

Some trees were grown on compound for ornamental purposes, for example providing shade, and improving landscape scenery. The major species are *Cupressus lusitanica* and *Gravillae robusta*.

Roadsides were also planted with rows of trees such as *Eucalyptus spp* and *Gravillae robusta* especially in agro-ecological zone 3 such as in Njumbi, Kiru and Rwathia areas. The farmers indicated that roadside planting maximises on land use in a situation where land is scarce and to act as slopes stabilisers where land is gently sloping. Boundaries were also planted with trees such as *Erythrina abyssinica*. It was found that *Erythrina abyssinica* was less valued by local people, they were mainly used as boundary markers because land owners on either side would not suffer loss of crops due to shading.

5.3.2 Reasons for Establishing Trees on Certain Sites

The study found that, the farmers planted trees on particular sites for various reasons as summarized in the Table 5.7.

Table 5.7: Reasons for Planting Trees on Selected Sites

Reasons	Responses	Percentage
Protection of the species	45	50.0
Economic expectation	40	44.4
Soil improvement	25	27.8
Land utility	23	25.6
Nature of products	25	27.8

5.4 Factor Influencing Establishment of On-Farm Trees

The second objective of the study was to assess factors influencing the establishment of on-farm trees. The study found out, that there are various factors influencing farmers' decision to establish different trees in their farms. These are usually based on a each household unit and are influenced by economic, social and ecological conditions prevailing within various farming systems and ecological systems .

5.4.1 Economic Factors

These are direct or indirect benefits which a farmer get from on-farm trees and they do influence decisions farmers take on establishment of on-farm trees.

(a) Direct Economic Benefits

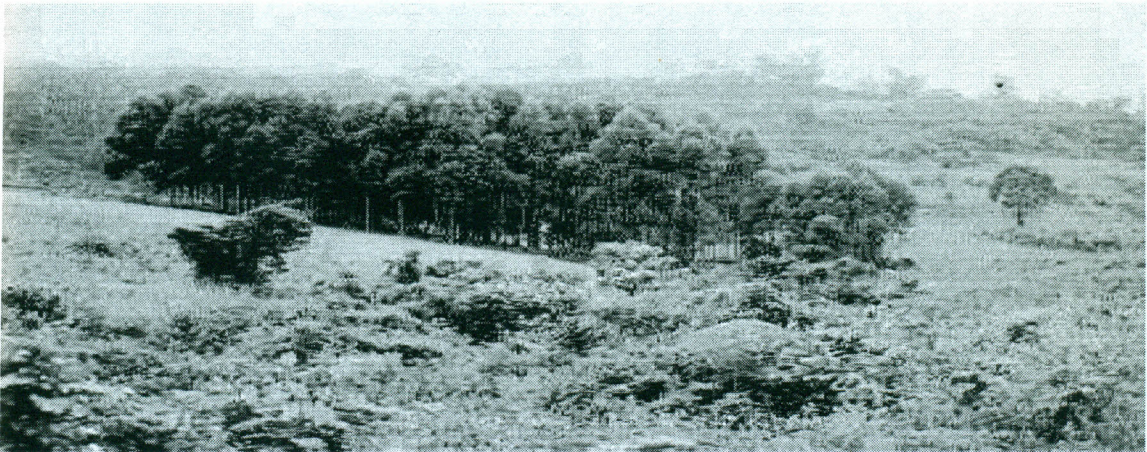
These are benefits that a farmer get from trees on their farms. Most farmers, for instance, indicated that their firewood needs are usually met by use of trees in their farms. There are, however, some of the direct benefits farmers accrue from sale of trees or their products. These include:

(i) Sale of a Whole Tree

The sale of the whole tree was widely mentioned by the farmers who usually sell to other people for timber, poles, charcoal burning and firewood. The price for the different trees differ depending on the size and the use into which a particular tree is put. The indigenous tree which were mentioned as being saleable as whole tree included *Markhamia lutea*, *Croton macrostachyus*, *Croton megalocarpus*, *Terminalia brownii* and *Combretum molle*. The indigenous tree sold in this kind are rarely used for timber as they lack timber qualities. As such their sale is usually for charcoal burning and other uses such as for poles and firewood. They are rarely grown for this purpose since they are slow in growth. An increasing market for timber is likely to promote exotic species as opposed to indigenous trees species. The

Protection of the trees was most important reason for planting trees on selected sites. It was noted that most trees were planted in the garden and woodlots because farmers felt that trees on such sites could be easily be protected unlike in the fallow fields and at the roadsides which were exposed to public interferences. The trees that hampered the growth of agricultural crops were grown seperately in pure stands as woodlots (Plate 2).

Plate 2: Trees Growing in a Woodlot



The economic value of the tree species was also an important factor in determining where to plant the same tree. Species like *Eucalyptus saligna* and *Cupressus lusitanica* which grows fast and can be sawn into timber in approximately 20 years were grown in woodlots.

In terms of soil improvement, species such as *Croton macrostachyus*, *Markhamia lutea* and, *Sesbania sesban* are grown for soil improvement. Other species such as *Spathodea campanulata* and *Cordia africana* are mainly grown by farmers in Gaturi and Gitugi locations because they are good for soil improvement. These species shed a lot of leaves that decay and add organic matter into the soil.

exotic trees such as *Gravillae robusta* and *Eucalyptus spp* are well suited for timber and are also fast growing (Plate 3). This explains why they are dominant in Murang'a District.

Plate 3: Eucalyptus Tree with a Huge Stem Suitable for Timber



(ii) Sale of Charcoal and Firewood

Some of the benefits farmers get from on-farm trees are from sale of charcoal and firewood . Among the trees used for these purposes were *Acacia mearnsii*, *Croton Macrostachyus*, *Croton megalocarpus*, *Terminalia brownii* and *Combretum molle*. The demand for each tree for fuelwood varied . *Croton macrostachyus* for instance was used by 81% of the respondents for charcoal in Murang'a District. High number of respondents (95%) reported that indigenous trees have high quality charcoal compared with exotic ones. Despite this factor farmers do not use them in favour of exotic species. Bradley (1991), observed that farmers switched from indigenous to exotic tree species for charcoal burning after exhaustion of the former.

In agro-ecological zone 2, farmers have opted to use exotic tree species because there are few indigenous trees. The use of exotic trees such as *Eucalyptus spp*, *Acacia mearnsii* and *Gravillae robusta* therefore varied from one area to another. It was reported, for instance, that *Acacia mearnsii* had high quality charcoal than *Eucalyptus spp*. Due to scarcity of *Acacia mearnsii* on farms, however, farmers are now using *Eucalyptus spp* for charcoal.

Inadequate sources of fuelwood has attracted the sale of firewood. It is a common practice in Murang'a District to see burdles of firewood piled in roadsides and market places for sale the sale of firewood was a supplement to any source of income, and it involved both indigenous and exotic tree species. the sale of dried wood has been observe in areas with similar ecological and socio-economic characteristics such as Kisii District, where firewood shortage is critical (Bradley,1991). Also an observation of many market places have a sections where charcoal is being sold. Further an interview with the farmers revealed that most of them have at one point or the other burned and sold charcoal in their farms. There was also charcoal burning activities in most areas.

(iii) Sale of Seeds and Seedlings

The study revealed that some farmers also sell seeds from trees to institutions such as schools and also to individuals. Their number was, however, small and it contributed marginally to income of the concerned farmers. The sale of seedlings was widely practiced and majority of respondents had either participated in the sale or buying of the seedlings (Plate 4). In the sale of seedlings majority of transaction involved sale of exotic species and especially those of fruit products such as *Mangifera indica*. Indigenous trees seedlings are less traded with. Among the problems explaining this was due to the non- awareness of the

potential of these species, and also these tree species produce few seeds that could be used for their establishment.

Plate 4: Institutional Tree Nursery Where Trees Seedlings are Raised



(b) Indirect Economic Factors

There are also some benefits which the farmers get from on-farm trees though they do not receive direct income from them. These include:

(i) Medicinal

Most farmers are aware of the medicinal properties of indigenous trees. 98% of the farmers interviewed, for instance, reported that most indigenous trees can be used to cure a number of diseases in both human and livestock (Table 5.8). This indicates that local people still depend on indigenous trees as sources of medicines.

Croton macrostachyus was reported to cure stomach ailment and for wounds to stop bleeding. *Bredelia micrantha* was used to cure livestock diseases such as East coast fever. Overall *Croton macrostachyus* was said to be popular (80%) and *Sesbania sesban* being the least popular (16%) as having medicinal values. The use of herbal medicines saves time and

money, that could have been spent on the acquisition of conventional medicines. *Erythrina abyssinica* was used to cure mumps. This concurs with findings of Kang'ethe (1987) who based his study in Luhya community.

The study further, revealed that most farmers had a lot of interest in planting trees with medicinal properties. They also conserve indigenous trees with these properties within their farms. This confirms the study by Poole (1992) who observed that the use of natural medicines from plant species was a major source of awareness on the importance of such plants to their welfare.

(ii) Fuelwood

On-farm trees were important sources of fuelwood. Most farmers depended on this source for their household energy needs. Where on-farm sources are inadequate farmers buy or obtain for free from the neighbours. In extreme cases farmers relied in less valuable sources of energy such as crop residues. Indigenous tree species such as *Bridelia micrantha* (43%), *Markhamia lutea* (83%) and *Croton macrostachyus* (81%) are used for fuelwood. Other indigenous tree except *Erythrina abyssinica*, however, were reported to have better quality fire.

(iii) Fodder

Most farmers in Murang'a District keep livestock through a zero grazing system. This is due to shortage of land for free range grazing. Consequently, they use some trees as source of fodder for their livestock. The use of indigenous trees for fodder was minimal with *Sesbania sesban* and *Acacia lahai* rating 16%. They are used as fodder mainly for goats. Exotic species such as *Calliandra calothyrsus* and *Leucaena leucophala* were popular on fodder production

and were rated at 59% and 27%, respectively. These findings thus, contradicts Backers (1985) and ICRAF (1986), who indicates that *Bridelia micrantha* and *Erythrina abyssinica* were used for fodder.

(iv) Buiding Materials

More than half of the farmers (54%) indicated their prefernce for *Markhamia lutea*, *Croton megalocarpus* and *Croton macrostachyus* for timber. They consider them to be of high quality and durable as compared to timber from exotic trees such as *Cupressus lusitanica*, *Eucalyptus spp* and *Gravillae robusta* which they consider less durable. Indigenous trees have a major set back in fulfilling the need in that they are slow in growth, thus cannot cope with demand for timber. This situation is further complicated by increasing disappearance or even extnction and replacement of indigenous tree species by exotic ones (Bradley,1991). This have led to shift from indigenous to exotic trees for timber production.

Other products such as poles are required for building of structures, including fences, chicken and cattle sheds. *Markhamia lutea* and *Croton macrostachyus* are used for this purposes. Their shortage, however, has led to use of *Eucalyptus* tree species for these purposes. The poles are also used to support bananas and stalking tomatoes. Other species used for this purposes are *Bridelia micrantha*, *Spathodea companulata*, *Vernonia auriculifera* and *Calliandra calothyrsus*.

(v) Growth Rate

Preference for on-farm tree planting was also based on the rate of growth in most cases farmers went in for trees with short rotational periods, thus, suggesting why indigenous trees species were less popular. Faster growing exotic trees species such as *Gravillae robusta* and

Eucalyptus spp are usually planted in favour of indigenous trees species which took long time to mature. Indigenous trees such as *Sesbania sesban*, *Croton macrostachyus*, *Vernonia auriculifera*, *Spathodea companulata* and *Trema orientalis*, however, took shorter time to mature are preferred (Table 5.8). This confirms the report by ICRAF (1986) and Backers (1985) on the choice of on-farm trees.

(vi) Multi-Purposefulness of Some Trees

Trees such as *Gravillae robusta*, *Sesbania seban*, and *Calliandra calothyrsus* which have more than one purpose were preferred. *Sesbania sesban*, for instance, was a source of of fodder, firewood and was reported to be important for Nitrogen fixation.

(vii) Preference Based on Gender

This is an indicator economic factor that influenced the choice for on-farm trees. Women preferred indigenous trees which are good for fuelwood and medicines while men exotic trees which are good for timber either for domestic use or sale. Women activities, thus, promoted indigenous tree as they are best sources of fuelwood and medicines while men promoted exotic tree such as *Eucalyptus spp* and *Gravillae robusta*. Since men have more say in household decision making affairs, more exotic trees ends up being planted.

(viii) Farmers' Perception

The study noted of the poor regard for indigenous trees. The farmers, for instance, reported that these trees took long to mature. The fact that most of these trees are naturally regenerated make farmers take them for granted, in comparison to exotic trees which have to be planted. Further, exotic trees are fast maturing than their indigenous counterpart, this coupled with

scarcity of land influence farmers' decision on tree planting on their farm. There is also inadequate knowledge among farmers on the status of indigenous trees on their farms.

Table 5.8: Indirect Economic Benefits / Factors Accrued From On-farm Trees

Benefits/factors	Tree species	No. of farmers	Percentage
Medicine	<i>Croton macrostachyus</i>	67	74
	<i>Markhamia lutea</i>	17	19
	<i>Bredelia micrantha</i>	39	43
	<i>Spathodea companulata</i>	40	44
	<i>Croton megalocarpus</i>	24	27
	<i>Acacia lahai</i>	23	26
	<i>Erythrina abyssinica</i>	31	34
	<i>Vernonia auriculifera</i>	41	46
	<i>Sesbania sesban</i>	41	46
	* <i>Azadirachta indica</i>	59	65
Firewood	<i>Croton macrostachyus</i>	73	81
	<i>Markhamia lutea</i>	75	83
	<i>Bredelia micrantha</i>	42	47
	<i>Spathodea companulata</i>	33	37
	<i>Croton megalocarpus</i>	24	27
	<i>Acacia lahai</i>	40	44
	<i>Erythrina abyssinica</i>	73	81
	<i>Vernonia auriculifera</i>	72	80
	<i>Sesbania sesban</i>	63	70
	◆ * <i>Gravillae robusta</i>	73	81
	* <i>Calliandra calothyrsus</i>	54	60
	◆ * <i>Eucalyptus spp</i>	76	84
	* <i>Persea americana</i>	57	63
	* <i>Eriobotrya japonica</i>	39	43
◆ * <i>Acacia mearnsii</i>	33	37	
Fodder	<i>Acacia lahai</i>	14	16
	<i>Sesbania sesban</i>	48	53
	* <i>Leucaena leucocephala</i>	23	26
	* <i>Calliandra calothyrsus</i>	53	59
Building materials (i) Timber	<i>Markhamia lutea</i>	73	81
	<i>Spathodea companulata</i>	28	31
	<i>Croton megalocarpus</i>	26	29
	<i>Croton macrostachyus</i>	53	59
	<i>Erythrina abyssinica</i>	11	12
	◆ * <i>Gravillae robusta</i>	69	77
	◆ * <i>Eucalyptus spp</i>	78	87
	* <i>Persea americana</i>	78	24
	<i>Cupressus lusitanica</i>	45	50
	(ii) Poles	<i>Markhamia lutea</i>	46
<i>Bradelia micrantha</i>		28	31
<i>Croton macrostachyus</i>		39	43
<i>Vernonia auriculifera</i>		36	40
Fast growing	<i>Croton macrostachyus</i>	31	34
	<i>Sesbania sesban</i>	41	46
	<i>Vernonia auriculifera</i>	24	27

- Fuelwood and charcoal
- *Exotic species

5.4.2 Socio-Cultural Factors

The study observed that different socio-cultural factors influenced on-farm tree planting in Murang'a District. They include beliefs and social practices associated with trees (Table 5.9).

Table 5.9: Socio-cultural Factors Influencing Choice of On-Farm Tree Species

Factor	Trees	Frequency	Percentage
Shade	<i>Markhamia lutea</i>	54	60
	<i>Croton macrostachyus</i>	41	45
	<i>Bredelia micrantha</i>	11	12
	<i>Albizia gumifera</i>	11	12
	<i>Acacia lahai</i>	8	9
	<i>Vernonia auriculifera</i>	18	20
	<i>Sesbania sesban</i>	23	26
	<i>Spathodea companulata</i>	8	9
Beauty	<i>Markhamia lutea</i>	12	13
	<i>Bredelia micrantha</i>	11	12
	<i>Spathodea companulata</i>	32	35
	<i>Croton macrostachyus</i>	21	23
Fencing	<i>Acacia lahai</i>	13	14
Religion	<i>Ficus natalensis</i>	2	2

(i) Beliefs Factors

Ficus natalensis among the Kikuyu community have a strong religious belief attached to it. This belief was found to least hold by the farmers. This can be attributed to changes in religious beliefs with the advent of Christianity. In places where the beliefs are still strong they have contributed to conservation of this tree species.

(ii) Shade Trees

Different indigenous tree species provided shade for human, animals and crops (Table 5.9). *Vangueria apiculata* and *Spathodea companulata*, for example were planted in the homestead to provide shade for humans. *Spathodea companulata* was mainly used as ornamental plant while *Acacia lahai* provided animal shade particularly in the agro-ecological three. Deep rooted trees such as *Markhamia lutea*, *Cordia africana*, *Sesbania sesban* and *Vernonia*

auriculifera provided shelter to crops. *Croton macrostachyus* was reported to provide shade for humans, animals and crops. Farmers gave an indication that they could mention more trees but restrictions were made only to those on the checklist.

5.4.3 Ecological Factors

A variety of factors or qualities resulted to planting of indigenous trees. These qualities made indigenous trees environmentally friendly. They include:

(i) Enhancement Soil Fertility

A number of indigenous trees were planted/ retained on the farm because they enhanced soil fertility. Farmers expressed their liking for such trees because they improve farm output and reduce dependence on chemical fertilisers. These included *Sesbania sesban*, and *Acacia lahai* which are leguminous in nature thus capable of fixing nitrogen from atmosphere.

Markhamia lutea, *Vernonia auriculifera* and *Croton macrostachyus* enhances soil fertility through litter fall. Farmers reported that they use *Vernonia auriculifera* and *Vangueria apiculata* as fertility indicators as these two are known to grow on fertile soils. Nair (1984) emphasis this point by arguing that a major recognized avenue for promoting a tree for on-farm planting is its contribution to addition of organic matter to the soil through litter fall.

(ii) Trees Co-existing with Crops

Trees which could co-exist with crops were most preferred by farmers, especially those that enhance soil fertility, acts as shelter belts and check soil erosion. Such farmers took care of the trees as they attend their crops. These trees are those that least compete with crops for nutrients, water and had no shading effect.

Indigenous trees such as *Markhamia lutea*, *Vernonia auriculifera*, *Sesbania sesban*, *Croton macrostachyus* and *Acacia lahai* were growing naturally on crop land. This shows that some indigenous trees had desirable characteristics for intercropping with crops. Trees found on boundaries such as *Bridelia micrantha* and *Vangueria apiculata* did not compete with crops. A number of exotic trees such as *Eucalyptus spp* and *Cuppressus lusitanica*, on the other hand, could not co-exist with crops. This observation remains a strong factor for on-farm promotion of indigenous trees.

(iii) Wind Breaks

Boundary and shade trees helped to break wind. This factor is important in protecting crops and houses against destruction and also reduces soil erosion. *Markhamia lutea*, *Croton macrostachyus* and *Spathodea companulata* are indigenous trees used as windbreak. Nair (1984) observes that use of trees and other woody perennials to protect agricultural fields from adverse effects of wind is a widespread practice in many agricultural systems (Plate 2).

(iv) Soil Erosion Control

A number of indigenous trees were conserved in the farmland to help check soil erosion. Deeply rooted species such as *Markhamia lutea* helped to bind together the soil particles. Indigenous trees were reported to be more effective in checking soil erosion compared to exotic ones that have roots spreading on the surface.

5.5 Local Potential that Can be Utilised in Promotion of On-farm Conservation Indigenous Trees

The third objective of the study was examine the existing potential among the farmers that could be used in promotion of on-farm approach to conservation of indigenous trees. To get

into this potential local support resources, management practices inherent among the farmers, and existing local groups and institutions were considered.

5.5.1 Local Support Resources

The survey looked into the local support resources which farmers can utilise to support on-farm tree conservation. In the course of the survey, these resources were found to be locally available or within farmers' vicinity, partly utilized or could be utilized in future to support on-farm conservation of indigenous trees.

In order to give a clear background in support resources available, farmers were asked to state the costs they incur in tree growing and how they mitigate the costs or planned to mitigate them.

Table 5.11: Farmers' Responses on Costs Incurred in Tree Planting and Management

Cost incurred	Frequency	Percentage
Buying seedling	23	25
Labour	16	17.5
Fencing	5	5
Buying tubes	3	2.5
Transport	3	2.5
Spraying	2	1.3

Buying seedlings (25%) and labour (17.5%) were the major costs incurred by the farmers in the survey. Other costs given by the farmers included, fencing (5%), buying tubes (2.5%), transport of seedlings from the source (2.5%) and spraying (1.3%). In mitigating the above costs, farmers gave the following strategies in the Table 5.12.

Majority of the farmers (25%) gave establishing an on-farm nursery as a means of achieving self-sufficiency in seedling production and to offset transport costs of procuring seedlings from external sources.

Table 5.12: Farmers' Responses on Mitigation Measures to Reduce Costs Incurred in Tree Planting and Management

Mitigation measures	Frequency	Percentage
Establish nurseries	23	25
Use of local materials in nurseries establishment	3	2.5
Local methods for pest control	2	1.3
Local fencing materials	2	1.3
Proper scheduling of tasks	7	7.5

Another 2.5% of the farmers indicated use of local materials in seedling production. This is related to the input side of establishing a home nursery or commercial nursery, for instance, use of local polythene bags as tubes for establishing seedlings, cheap fencing materials such as use of Neem tree to make pesticides.

In addition, proper scheduling of tree planting and management practices could reduce labour costs. The farmers (7.5%) considered this as a solution to their labour predicament. The farmers contended that labour was cheaper during the off crops planting, weeding and harvesting season. Proper scheduling of tree planting and management operations is needed to avoid neglecting of farm trees in favour of crops.

One among the most important potential support resources in on-farm tree conservation considered by the study was income from trees and their products. The results indicated that 23.8% of the farmers had ever earned income at least from the sale of a tree or tree products.

Among the income source from trees were from the sale of poles (8.8%), timber (7.6%) and withes (7.5%). Other sources included; rafter (3.8%), charcoal (3.8%), fruits (2.5%), seedling (1.3%) and firewood (1.3%).

Table 5.13: Percentage of Farmers with Income Obtained from Sale of Trees and their Various Products

Product	Frequency	Percentage
Poles	8	8.8
Rafters	3	3.8
Timber	7	7.6
Withes	7	7.5
Charcoal	3	3.8
Seeds	2	2.5
Fruits	2	2.5
Seedlings	2	1.3
Firewood	2	1.3

Further, rating of income showed that the proceeds were adequate for 2.5%, inadequate for 3.8% and negligible for 17.5%. The situation is, however, set to improve given that most cash crops such as coffee and tea are fetching low prices for farmers. They did not authenticate that increase in income would raise investments or income ploughed back to on-farm conservation of trees. Nevertheless, such commitment is expected as findings by Banes *et al* (1984) contend that adoption of agroforestry first means putting money into the farmers' pockets. It, therefore, follows that farmers would be enticed to invest where they are certain to reap benefits, a situation that may avert the tendency by small-scale farmers to rely on crops or livestock as exclusive income source.

5.5.2 On- Farm Trees Management Practices

The study identified variety of on-farm tree management practices. These are practices by the farmers to ensure that the trees grow and survive in the farming system. Some of the farmers had prepared nursery beds where seeds were germinated and seedlings raised in large numbers. Nearly one-tenth (11.4%) of the respondents said they had treated before sowing. These involved activities such as manuring (1.6%) and roasting of seeds (7.1%). (2.9%) respondents did clearing bushes. Bush clearing and burning stimulated seed germination. This was common with those with *Acacia mearnsii* trees. The seeds from these trees are

roasted before sowing and some farmers claimed that that more seed germinated after such treatment.

Majority of the farmers (81.4%) said they did land preparation, watering (30%), pruning (55.7%), physical protection by erecting barriers and / or fencing (72.9%) and spot weeding (1.4%) to control the aggressive weed species that would outgrow the seedlings. Land is prepared before rain begins and involves clearing and burning or removing plant debris and bigger logs from the garden. Because of land scarcity, agricultural crops are grown in the same garden with tree seedling and both are managed at the same time. The main objectives of proper land preparation and intercropping of tree with crops are to maximize land productivity, efficient land use and high survival rate of the tree seedlings. Where it is desirable and possible, when agricultural crops are harvested, the trees are then managed as a woodlot. Thirty percent of the respondents said they watered the trees. These are mainly farmers who have raised their own seedlings and watered them in order to maintain adequate moisture supply during the dry season. About 56% of the respondents said they pruned their trees in order to reduce the amount of branching and to promote vertical growth. The commonly pruned species were *Gravillae robusta*, *Cupressus lusitanica*, *Eucalyptus spp* and *Croton megalocarpus*.

The trees were protected from livestock by fencing, a practise reported by 73.9 % of the respondents. It is worth noting that although the fences were meant to protect the trees, in some cases it was not the primary objective especially where the garden had other crops too. On the homestead where trees are likely to be destroyed, protection was done by erecting barriers around the individual trees. Spot weeding was noted in areas where woodlots could not be weeded or in grazing lands. Although this was considered economical, it is not

effective because the aggressive weed species were reported to have overrun the tree seedling especially the slow growing indigenous species. Other tree management practices included slicing of the bark usually done in *Persea Americana*. The slicing was done to stimulate earlier fruiting. Trenching was reported to assist in stopping the competition between *Eucalyptus spp* and other crops.

A Chi square analysis was done to get the association between tree management practices and different agro- ecological. The result showed that there was no significance for various tree management practices such as land preparation and watering. There were significant differences in the level of pruning, physical protection and farmers' care for trees in the District (Table 5.10).

Table 5.10: Chi-square Analysis for Tending Practices

Practices	Chi- value	P -value	Significance
Land preparation	3.96	0.41	Ns
Watering	3.18	0.53	Ns
Pruning	15.55	0.01	**
Physical protection	10.36	0.03	*
Care	16.87	0.49	**

* Significant at $P < 0.05$

** Significant at $P < 0.01$

Ns Not significant

Land preparation and watering did not vary among villages because land preparation is a practice that is done for not only trees but also even for agricultural crops. Farmers who had tree nurseries did watering. Pruning, physical protection and attention to the trees were different in agro-ecological zones. The difference in the intensity of land use and scarcity of trees could also have forced the farmers to manage the trees differently.

5.5.3 Local Institutions / Groups

In order to get deep insight into the existing potential, the survey further sought possible options for the promotion of on-farm conservation of indigenous trees. Many local institutions and groups exist in Murang'a District and have been formed to meet different aims and have different membership composition.

Table 5.14: Farmers' Responses on Local Group / institution Affiliation

Group affiliation	Activities	Frequency	Percentage
Merry -go-round	Revolving fund	9	10
Welfare	Burial arrangement	2	2
	School fees committee	3	2.8
Women	Tree Nurseries	14	15
	Provision of improved jiko	1	1.5
	Poultry rearing	3	3
	Dairy Farming	2	2
	Rental houses	3	3.8
Youths	Tree nurseries	2	1.3
	Vegetable farming	3	3.8
Church	Tree nurseries	2	1.3
	Religious Fellowship	6	6.3

Majority of the farmers who belonged to local groups were not engaged in activities related to conservation of on-farm trees, save for women groups (2.5%), youths (1.3%) and the church groups (1.3%). Thus their activities were dominated by other non-tree conservation activities such as revolving funds for housekeeping (10%), burial arrangement and school fees harambees (4.8%) and religious fellowships (6.3%). This suggests that these groups have been under-utilized as forums for disseminating on-farm tree conservation activities. Further, the study investigated whether there were any gender disparities in the composition of groups (Table 5.15). The findings indicated that women were more involved in-group activities than men. These findings have far-reaching effects in the realization of on-farm conservation of indigenous trees where group based approach is necessary. Whereas women continue to play a special role as change agents and implementers of on-farm tree growing initiatives their

active participation is bound to be impeded by their often overburdened family chores and cultural inhibitions in tree planting (Bradley,1981).

Table 5.15: Farmers' Response on Group Affiliation Based on Gender

Gender	In group(s)	Not in group(s)
Women	18	9
Men	9	44
Total	27	53

This demand more involvement of men to ensure gender parity and effectively realize the latent potential in promotion of on-farm approach to conserving indigenous trees.

The use of local institutions and groups can help in promotion of on-farm conservation of indigenous trees; first, local institutions could be used to harness local potential in tree management. In the study of role of local institutions in management of trees among Turkana people, Barrow (1996) notes that local groups serves as important channels of tapping indigenous potential. Second, local groups can be used to channel available external support to farmers .The survey indicated that the farmers need support in training (30%), provision of seedling (17.5%) and seeds (25%) and offering marketing possibilities for their tree products (2.5%). Meeting these requirements may not be easy when dealing with an individual farmer. By bringing farmers into groups, however, it will be easy to realize their expectations.

Finally, these groups can be forums for awareness creation to dissipate some of reasons that farmers in the survey gave for not conserving indigenous trees in their farmlands. This is particularly important given that majority of farmers (86%) in the survey were willing to establish indigenous trees on their farms. The minority (13.2%) of the farmers said they would not plant indigenous trees on their farms since they were ignorant on the potential offered by planting / conserving them.

CHAPTER SIX

6.0 SUMMARY OF THE FINDINGS, CONCLUSION AND RECOMMENDATIONS

6.1 Introduction

This chapter presents a summary of research findings, conclusion and recommendations. The chapter begins by highlighting all the salient findings of the study from which conclusions are drawn. In highlighting the findings, each objective is tackled separately. Further, the chapter discusses recommendations based on the findings of the study, and especially on the potential inherent among the smallholder farmers that could be used to promote on-farm approach as complementary to other natural resources conservation approaches/strategies. It also suggests areas within on-farm approach to conservation of indigenous species that require further studies to get into in-depth understanding of its requirements for effective adoption. The findings and recommendations are based on the objectives of the study.

6.2 Summary of the Findings

6.2.1 Status of On-farm Indigenous Trees

The first objective of the study was to assess the status of on-farm indigenous trees. The study established that about 43.5 % of farmers incorporated indigenous trees in their farms. Farmers planted and /or retained several species in garden. Such species are compatible with agricultural crops and farmers decide the suitable species depending on their objectives. In other cases, these trees simply regenerated naturally. The small number of farmers incorporating indigenous trees species in their farms was attributed to scarcity of land, farmers' attitudes, dying traditional beliefs and taboos, slow growth rates of these trees and lack of seeds and seedlings. Farmers raise trees largely from seedlings or wildlings. Trees existed in homegardens, woodlots, compounds, crop fields, road sides and riversides.

6.2.2 Factors Influencing On-farm Conservation of Indigenous Trees

On the factors influencing conservation of indigenous tree species the study found out that, various factors such as economic, socio-cultural and ecological influenced the choice of tree species for on-farm planting. Economic factors overrides on-farm conservation of indigenous trees decisions as exotic trees grow faster and were easy to propagate.

The agricultural activities determined the spatial pattern of the distribution of indigenous trees among the farmers. Farmers have got knowledge about indigenous trees regarding placement, compatibility with agricultural crops, palatability to livestock, and rituals. The respondents had less knowledge about diseases and insect pests affecting indigenous trees. Farmers raise trees largely from seedlings or wildlings. The agro-ecological zone three had more indigenous trees than in other two agro-ecological zones. This is because in this agro-ecological zone, there are few cash crops such as coffee and tea that calls for clearance of indigenous vegetation during their establishment. In intensively cultivated areas such as in, agro-ecological zone two, indigenous tree species existed only in places such as riversides, bushes, grazing fields and farm boundaries.

Additionally, smallholder farmers had different preferences for tree species that were hinged on the tree uses or special functions of these species. Majority of the farmers in the study showed preference towards growing of exotic species. Nevertheless, indigenous species are fast picking up, for example, *Croton macrostachyus*, *Sesbania sesban* and *Markhamia lutea* had remarkably high proportion in indigenous trees category that may in future bridge the gap between presence of exotic and indigenous tree species in farmers' fields. Among the main uses of exotic trees that make them most preferred among the farmers are woodfuel providers; possess multiple uses and have more capability to generate income faster than

indigenous trees. Indigenous species on the other hand were mainly preferred because of their special functions that included provision of medicines for livestock and humans, their effects on soil nutrients enhancement and cultural value.

6.2.3 Existing Potential Among the Farmers pertinent for the Promotion of On-farm Conservation Indigenous Tree Species

The third objective of the study was to examine the status of existing potential among smallholder farmers that is pertinent to the promotion of on-farm conservation of indigenous trees. The study revealed a wealth of knowledge in tree growing and uses among the farmers in the study area. On tree growing, the farmers have used different local methods to plant and manage tree to maturity. Farmers exhibited vast knowledge in seedling production namely, mode of trees propagation, pest control in on-farm nurseries and in seed pre-treatment. Knowledge in trees management in the study area was manifested in the area of minimizing negative tree-crops interactions, pest control and performing field operations such as weeding transplanting and manuring.

The study found out that the existing potential among the farmers have been put into little use notwithstanding the consensus of its importance as expressed by most natural resources managers. As a possibility of harnessing this potential, the study disclosed a growing spirit of group formation that comprised women and youths groups, church groups, welfare associations and merry-go-round. These local institution or groups, however, have hitherto not been seriously considered as avenues for the promotion of on-farm conservation of indigenous tree species

6.3 Conclusions of the Study

The study found out that indigenous trees were not popular among the farmers. As such, few of the farmers had incorporated them on their farms. They have planted and / or retained several indigenous species in their gardens. Such species are the ones which are compatible with agricultural crops and farmers decide the suitable species depending on their agricultural activities in their lands. Farmers raise trees largely from seedlings or wildlings. These trees are mainly in home gardens, woodlots, compounds, crop fields, road sides and riversides.

Indigenous trees, however, have potential for on-farm conservation given their variety of economic and economic values. Also, farmers' knowledge about indigenous trees regarding placement, compatibility with agricultural crops, palatability to livestock, and rituals provide the basis for their promotion. The respondent, however, had less knowledge about diseases and insect pests affecting indigenous trees. Farmers raise trees largely from seedlings or wildlings. These trees are mainly in homegardens, woodlots, compounds, crop fields, road sides and riversides. Although, economic value for on-farm trees among the farmers is deeply entrenched in their farming systems, intensification of awareness creation programmes on the importance of indigenous trees is likely to change farmers' perceptions towards them.

Central, however, to realizing on-farm conservation of indigenous trees, are optimising farmers' input. These poses two challenges to conservation agencies and other stakeholders. First, it involves removing the obstacles that hinder farmers' conservation of indigenous trees on their farms. This demands the strengthening of physical and human resources in support of on-farm conservation of indigenous trees. In this regard, more support resources; training and collaboration of stakeholders are prerequisites. With this in place, even farmer centred problems would be addressed.

The relevance of indigenous trees should be made clear especially those related to their medicinal values. This can be done through campaigns and extension. This will assist in promotion of indigenous trees among the farmers .

There is a need to improve agricultural and forestry extension services by the government, NGOs and other agencies, so that farmers are taught appropriate methods of raising and tending trees growing on the crop fields. Further, this will assist in improving farming methods which will assist in protection and preservation of trees naturally growing in the gardens from mechanical injuries during cultivation and from fire used in disposing debris. Trees and seedlings damage by grazing livestock should be minimized by encouraging farmers to practice controlled grazing and growing fodder crops. Farmers should be advised on how to intensively manage the trees alongside crops. Improved tree production through species selection and proper management will help to expand on-farm conservation of indigenous trees while at the same time increase tree products to meet the demands of rising population in Murang'a District.

Farming systems need to be improved to increase agricultural productivity. This can be done through intensification of agriculture by the farmers. This will give alternative sources of income to reduce over-reliance on on-farm trees for their livelihood. Also soil conservation measures should be improved to alleviate soil erosion. In this way land productivity will be maintained. Further, economic diversification is necessary to allow farmers have other sources of income a part from farming activities. Such activities as cottage industries and ecotourism should be explored as alternatives avenues.

The strategy of contacting farmers through local groups/institutions needs to be promoted since it facilitates contact among farmers within a short time. The groups/institutions can also learn from one another cutting down resources needed for necessary awareness creation.

There is need to undertake research on how to incorporate indigenous trees species in farming systems given the decreasing land holdings. Much of this research should be based on planting sites, management of trees and their uses.

There is need for clear cut policies on the on-farm conservation of indigenous tree species. This will assist agricultural and forest extension officers have a guide on how to promote this tree species within the farm lands. These policies should define such issues as pertaining incentives necessary to encourage farmers to conserve indigenous species within their farmlands.

6.5 Areas for Further Research

There are areas where it is felt the study did not cover adequately due to its scope and limitations, as such it is recommended that further research on the following: First, there is need to explore on the ecological and socio-cultural impacts of loss of indigenous trees in Murang'a District; Second, the study is required to identify quick growing indigenous trees species that can give the similar products as the ones from exotic trees and still be established together with agricultural crops; Third, there is a need to test the efficacy of various awareness creation approaches in changing behaviours and attitudes towards conservation of indigenous tree species.

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APPENDIX I

FARMERS' INTERVIEW SCHEDULE

The information that this questionnaire seeks to collect will be used for academic purposes.

The responses will be treated with utmost confidentiality.

SECTION A

Background Information:

1. Household serial No
2. Sex of respondent
 - (1) Male..... (2) Female.....
3. Age of the respondent
 - (1) <19..... (2) 20-29..... (3) 30-39..... (4) >40.....
4. Marital status of the respondent
 - (1) single (2) married (3) separated
5. Number of children (if any)
6. Highest education standard attained
 - (1)Primary..... (2) Secondary..... (3)Tertially..... (4) never.....
7. (i) Do you own any land? (1) Yes (2)No.....
 - (ii) If yes how many acres ?.....acres
9. What farming activity do you carry out on the land?
 - (1) Cultivation..... (2) livestock rearing.....
 - (3) Bee keeping.....
10. How many acres of your land is under cultivation?
 - (1) All of it..... (2).....acres (ha)
- 11 (a) If (all of it) is under cultivation, are there periods when you leave some parts of land uncultivated? (1) Yes..... (2) No.....

(b) If your answer is yes, why do you leave this land uncultivated?

.....
.....

12. What crops do you grow on your land?

1..... 2.....
3..... 4.....
5..... 6.....

13(a) Do you keep any animals?

(1) Yes..... (2) No.....

(b) If your answer is yes, which animals do you keep?

(1) Cattle (2) Sheep (3) goats
(4) Pigs (5) poultry..... (6) others.....

(c) Why do you keep the animals mentioned ?

(1) Home use..... (2) commercial.....(3) both.....(4) others.....

14 (a). Do you belong to local group (s) or institution(s)

(1) Yes (2) No

(b) If yes, give the details of the kind / type of group or institution

.....
.....
.....

(c) What are the activities of the group(s) or institution(s) that you belong ?

.....
.....
.....

16 (a) Did you plant these trees or they have been growing naturally?

(1) Planted.....

(2) Growing naturally.....

(b) If they were planted, how many were planted and how many have survived? For each of these species, indicate

Species	No. Planted	No. Surviving

17. For each species , indicate why did you plant or retain it at the site where they are growing?

Species	Site	Reasons

18. What cause tree loss in the your farm?

- (1) (2) (3)
 (4)..... (5) (6)

19(a) What method do you use to propagate trees growing in your farm?

- (1) Sow seeds..... (2) plant seedlings/wildlings..... (3) cuttings.....
 (4) others

30. How have the trees affected the performance of the crops and what crops are these?

Tree	Crop	Negative effect	Positive effect

31. What are the benefits of having the trees among the crops?

.....

32. What products do you expect to get from your trees ?

- (1) Firewood.....
- (2) Timber.....
- (3) Stakes.....
- (4) Fruits
- (5) Poles
- (6) Medicine.....
- (7) Others

33. What product(s) have you got so far?

Species	Products

34. What product(s) have you got from on-farm trees so far?

Species	Products

35(a). Are there species of interest to you but you don't have them on your land ?

- (1) Yes.....
- (2) No

(b). If yes, indicate the species of interest and the sites where you intend to plant these trees.

Species	Site	Reasons

(c) Why don't you have the above species on your farm?

.....

36. What advantages do the indigenous trees have on your farm over exotic ones?

.....

37. How often do you get technical advice on tree planting on your farm?

.....

38. In which aspects do you require the technical advice?

- (1) Planting
- (2) Seed collection.....
- (3) Tending
- (4) Harvesting.....
- (5) Others

39. Where on your land do you think indigenous trees can perform best?

- (1) Among crops.....
- (2) compound.....
- (3) Terraces
- (4) others

40. In your opinion what do you think can be done to enhance conservation of indigenous trees within your farm?

Thank you.

APPENDIX II

INSTITUTIONAL INTERVIEW SCHEDULE

1. Name of the institution.....

2 (a) Is the institution involved tree planting activities?

Yes..... No

(b) If yes, what materials do you give to farmers?

(i) seeds (ii) seedlings..... (iii) both

(c) If they are seeds, where are your sources?

.....
.....

(d) If they are seedlings where are the trees nurseries situated?

(i) Within your institutional compound.....

(ii) Demonstration plots.....

(iii) On-farm tree nurseries.....

(iv) Any other

3. What type of tree species do you give to farmers?

(a) Exotic (b) Indigenous.....(c) Both

4. If they are indigenous enumerate them

.....
.....
.....
.....
.....

5. If they are exotic, enumerate them

.....

.....

.....

.....

.....

6. Which species do the farmers prefer?

.....

.....

.....

.....

7. What are the advantages of indigenous trees over exotic trees?

Indigenous trees	Advantages	Exotic trees	Advantages

8. Enumerate species preferred by farmers

.....

.....

.....

9. What are the reasons for farmers preferring these species?

.....

.....

.....

10. What problems do you face while encouraging farmers to plant indigenous tree?

.....
.....
.....
.....

11. What are your efforts towards overcoming these problems?

.....
.....
.....
.....

12. What do you think can be done to enhance conservation of indigenous trees within farmland?

.....
.....

Thank you

APPENDIX III

AN OBSERVATION RECORD SHEET

The checklist given below guided the process of observation to provide evidence of on-farm trees conservation.

Date.....

Name of the farmer

1. Trees on farm

Indigenous trees	Exotic trees

2. Sites where trees are planted

Sites	Species
i) boundary planting	
ii) homestead	
iii) woodlot	
iv) dispersed on farms	
v) others	

3. Trees management techniques

Techniques	Species
i) Coppicing	
ii) Pollarding	
iii) Side pruning	
iv) Root pruning	
v) Others	

2. Seedling production and/ nursery management techniques

Traditional/ local	Conventional
i) Wildings	i) Direct sowing
ii) Tree / shrubs retained	ii) Bare roots
iii) Banana stalks / used times tins and containers	iii) Polythene bags
iv) Others (specify)	iv) Others (specify)

APPENDIX IV
LIST OF TREES IDENTIFIED IN THE STUDY AREA

Botanical Names	Trade or Common Names
<i>Markhamia lutea</i>	Muu
<i>Bredelia micrantha</i>	Mukoigo
<i>Spathodea campanulata</i>	Nandi flame
<i>Albizia gummifera</i>	Peacock flower /* Murukue
<i>Acacia lahai</i>	Mugaa
<i>Croton Macrostachyus</i>	Croton /* Mutundu
<i>Vangueria apiculata</i>	-
<i>Erythrina abyssinica</i>	Red-hot-poker tree /* Muhuti
<i>Vernonia auriculifera</i>	Muthakwa
<i>Sesbania sesban</i>	Mucungiri
<i>Ficus natalensis</i>	Fig tree / Mugumo
<i>Jacaranda mimosifola</i>	Jacaranda
<i>Senna spectabilis</i>	-
<i>Kigera africana</i>	Sausage tree /* Muratina
<i>Terminalia brownii</i>	Mururuku
<i>Carica papaya</i>	Paw paw
<i>Pinus patula</i>	Mexican weeping pine
<i>Prunus africana</i>	Red stinkwood /* Muiru
<i>Citrus limon</i>	Lemon
<i>Acacia hockii</i>	Mukunga
<i>Juniperus procera</i>	Pencil cedar /* Mutarakwa
<i>Podocarpus milanjanus</i>	Podo
<i>Citrus sinensis</i>	Sweet orange
<i>Cordia africana</i>	East Africa cordia /* Muringa
<i>Croton megalocarpus</i>	Croton /* Mukinduri
<i>Newtonia buchani</i>	
<i>Hagenia abyssinica</i>	
<i>Ocotea usambarensis</i>	
<i>Trema orientalis</i>	*Muhethu
<i>Syzigium guineense</i>	Java plum
<i>Mitragyna stipulosa</i>	
<i>Leucaena leucocephala</i>	#Lucina
<i>Eucalyptus saligna</i>	Blue gum /* Mubao
<i>Calliandra calothyrsus</i>	Calliandra
<i>Azadirachta indica</i>	Neem tree
<i>Eriobotrya japonica</i>	Loquats
<i>Polyscias kikuyensis</i>	*Mutati
<i>Combretum molle</i>	*Murema
<i>Persea americana</i>	Avocado
<i>Mangifera indica</i>	Mango /* Muyembe
<i>Gravillae robusta</i>	Silky oak / *Mubariti
<i>Accia mearnsii</i>	Black wattle /* Muthanduku
<i>Cupressus lusitanica</i>	Mexican cypress

KEY

* Kikuyu# kiswahili

N/B trade names without symbols are in English

APPENDIX V

A Checklist of Common Tree on the Farm Used During Interview

Trees
Indigenous trees
<i>Markhamia lutea</i>
<i>Bredelia micrantha</i>
<i>Spathodea campanulata</i>
<i>Croton megalocarpus</i>
<i>Acacia lahai</i>
<i>Croton Macrostachyus</i>
<i>Cordia africana</i>
<i>Erythrina abyssinica</i>
<i>Vernonia auriculifera</i>
<i>Sesbania sesbania</i>
Exotic trees
<i>Leucaena leucocephala</i>
<i>Eucalyptus saligna</i>
<i>Calliandra calothyrsus</i>
<i>Azadirachta indica</i>
<i>Eriobotrya japonica</i>
<i>Persea americana</i>
<i>Mangifera indica</i>
<i>Gravillae robusta</i>
<i>Cupressus lusitanica</i>
<i>Acacia mearnsii</i>