Determination, Propagation and Evaluation of important Trees/Shrubs with potential for Agroforestry in Teso and Lango Farming Systems

FINAL TECHINCAL REPORT

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List of abbreviations

COARD	Client-Oriented Agricultural Research and Dissemination Project
CORF	Client-Oriented Research Fund
DFID	Department for International Development (UK)
FORRI	Forestry Resources Research Institute
ICRA	International Centre for Client Oriented Agriculture
ICRAF	World Agroforestry Centre
KARI	Kawanda Agricultural Research Institute
NARO	National Agricultural Research Organization
NEMA	National Environment Management Authority
SOCADIDO	Soroti Catholic Diocese Integrated Development Organization

Acknowledgements

Project Administrative Summary

Project Title	Determination, Propagation and Evaluation of important Trees and Shrubs with potential for Agroforestry in the Teso and Lango Farming Systems.	
Reference No.	**CORF 1024**	
Lead Organization	Forestry Resources Research Institute (FORRI)	
Project Leader	Dr. John Okorio	
Collaborating Organizations & Names of project implementers	**Organization**	**Name**
	Kawanda Agricultural Research Institute (KARI)	Dr. Sophie Musana
	Soroti Catholic Diocese Integrated Development Organization (SOCADIDO)	Mr. Michael Opoi
	District Environment Office, Kumi District	Mr. Ateker Okiria
	District Agriculture Office, Kumi District	Mr. Valdo Odeke
	District Forestry Office, Katakwii District	Mr. Joseph Opusi
	District Forestry Office, Lira District	Mr. P. Okwir
Purpose	To document indigenous knowledge and current initiatives on agroforestry practices in the two farming systems, identify appropriate propagation techniques for selected indigenous tree species, and test and promote potential agroforestry technologies in the target areas	
Location (Districts, Sub-counties)	**District**	**Sub-county**
	Katakwii	Katakwii
	Kumi	Nyero
	Lira	Dokolo
Start date	July 2002	
End date	September 2004	
Total Cost	**93,126,949/=**	

EXECUTIVE SUMMARY

CHAPTER 1: BACKGROUND

1.1 Introduction

The Teso farming system covers the districts of Katakwii, Kaberemaido, Kumi, Soroti and Pallisa. This farming system has an area of 14,000 km2 and a population of about one million people (Rwabogo 1998). The population is over 90% rural and depends almost entirely on agriculture. It is an agro-pastoral system, which is still based on the production of annual crops and livestock in a mixed farming system at subsistence level. The Lango farming system covers an area of 13,741 km2 and has also a population of about one million people (Rwabogo 1998). It covers the districts of Lira and Apac and is characterized by cultivation of annual crops such as millet, groundnuts, maize etc.

The rural economy of both farming systems is predominantly small-scale subsistence agriculture, which is dependent on human labour and use of simple hand and animal drawn tools such as hoes, machetes, ox-plough etc. Traditionally, cattle keeping which had become the major income earning activity supplemented this type of farming. Over-grazing then became prevalent which lead to high competition for land use between crop cultivation and cattle keeping. Grazing was on communal land but because of land pressure, it was shifted to gazetted forest reserves (in the case of Lango) which became the major grazing lands. Between 1930's to late 1980's, animal traction had become the most commonly used method of land preparation, which resulted in an agricultural revolution with more food production for home consumption and for sale. However, during the late 1980's all the cattle in these farming systems were raided by the Karimojong leaving the population with no or few assets. This insecurity continued from 1990's up to 2000. The population in these areas were left seriously impoverished and had no alternative sources of livelihoods except the natural resources. The existing woodlands were cleared to provide building poles for the rehabilitation of the devastated homes, and firewood and charcoal for sale in towns to generate income.

The woodlands in these farming systems have continued to decline as a result of a combination of drought, agricultural expansion, population pressure and over exploitation. In addition, there is reduced natural regeneration of the remaining woodlands as result of these factors. It is important to note that these farming systems have low levels of crop/livestock integration, are growing in terms of human population, suffer increasing land fragmentation and face declining natural resource base. Increasing population pressure is also creating rise in demand for

agriculture land, hence continuous encroachment on natural woodlands leading to greater exposure of soil to continuous erosion from wind and water (ICRA, 1999).

The majority of the population in both farming systems gets all wood for fuel and construction from little available natural woodlands. For example, wood products provide almost all the domestic needs for fuel in the Teso farming system (Teso Conference 1996). In the past, these areas used to be covered by large chunks of *Comretum – Acacia - Butyrospermum* savanna woodlands. Currently in Kumi district, woodlands occupy only 0.9% of the total area (Biomass Study, 1992). The way forward for these farming systems is to increase tree cover through different agroforestry strategies. Increasing tree cover will help to address environmental issues such as deforestation, soil and water conservation, soil fertility and mitigation of climatic change, provision of energy, building materials, food and medicine. The strategies to be used among others include promotion of on-farm planting of neglected but important trees in the woodlands that are used by the communities. Such specieds provide wood and non-wood product such as poles (Combretum species), fruit trees (Shea butter, *Tamarindus indica*) plus many medicinal species.

1.2 Agroforestry initiatives in Teso and Lango farming systems

The earliest records of agroforestry initiatives in both farming systems was the work done by the CARE project in the early 1980's in collaboration with the Forestry Department. The project covered several districts in the country including Kumi, Soroti, Pallisa and Lira. The main focus of the project was the raising of seedlings mainly of *Sesbania spp* and *Leuceana spp* in Forest department run tree nurseries. These seedlings were later distributed to farmers free of charge to plant on their farms. The project had limited success mainly due to limited sensitization of farmers on agroforestry practices and their associated benefits. The efforts of CARE were supplemented by several NGO's and COB's in these farming systems from late 1980's and early 1990's.

The Soroti Catholic Diocese Integrated Development organization (SOCADIDO) has been very active in promoting agroforestry activities in the Teso farming system since 1995 (Okorio and Opoi 1997). The overall objective of its programme is to improve the social, economic and nutritional well being of the people in the Soroti Catholic Diocese (Soroti, Kumi, Kaberemaido and Katakwii districts), in addition to conserving the natural resource base through activities that integrate tree planting in the farming system. In Lira district agroforestry activities have been initiated by various farmer groups' e.g. women groups. These groups deal with a wide range of developmental activities including tree planting on their farms. Most of them collaborate with the district government offices of agriculture, forestry or environment.

1.3 Justification of project

Review of existing literature and experience from past agroforestry initiatives reveals that little information has been documented on the potential of indigenous tree species for agroforestry in the Teso and Lango farming systems of northern and eastern Uganda respectively. For a long time, however, traditional agroforestry practices have existed in these regions. It is common practice for example in Lango, to intercrop *Cajanus cajan* with millet and simsim, while in Teso, *Tamarindus indica, Mangifera indica* and *Vitellaria paradoxa* are commonly retained or planted on farmlands [Djimde and Hoekstra, 1988].

Generally, trees are useful in the livelihoods and production strategies of rural households and communities. They are a source of fuelwood, poles, fruits, medicines and timber, in addition to providing important services especially shade and windbreaks. Of particular importance, however, is their contribution to the local diet and household food security. A variety of fruits are consumed in households, either eaten fresh or used to spice up various foods. The sale of fruits generates cash income to households. Although the potential role of indigenous trees in providing a variety of products and services has been identified, little information is available on their identification, use and management by the rural communities [Muok *et al* 1999]. This information is useful when assessing the potential of tree growing as a strategy for rural development in these farming systems.

It is, therefore, apparent that little information is available on the indigenous tree species that have potential in the Teso and Lango farming systems. In addition, not much is known on how to propagate them in order to be able to produce them in large numbers for use by the rural communities. The only reported work is that of Duli (1994) who studied the age distribution and propagation techniques for the shea butter tree (*Vitellaria nilotica*) in Acwao forest reserve in Lira district. He found that the shea butter tree population cannot be sustained by natural regeneration and hence there is need for artificial regeneration. The results from this project will help to fill some of the missing gaps as far as tree management, utilization and propagation by rural households are concerned.

1.4 Purpose of project

The purpose of the project was "to document indigenous knowledge and current initiatives on agroforestry practices in the two farming systems, identify appropriate propagation techniques for selected indigenous tree species, and test and promote potential agroforestry technologies in the target areas".

CHAPTER 2: METHODOLOGY

2.1 Output 1: Farmer's indigenous knowledge on agroforestry and recent agroforestry initiatives in the two farming systems documented.

2.1.1 Introduction

The determination of important tree and shrub species in Teso and Lango farming systems started with field surveys conducted in both farming systems. The surveys were intended to capture the role of trees and tree growing practices in these farming systems. The overall objective of the study was to identify the current indigenous agroforestry systems with the aim of establishing important trees and shrubs for agroforestry development in both farming systems. The specific objectives of the surveys were: -

- ✓ Determine indigenous tree and shrub species with potential for agroforestry and establish farmers' most preferred species for future planting.
- ✓ To identify trees / shrubs commonly growing on key niches on farms, their propagation, management, uses and the factors determining their arrangement.
- ✓ To study the role of trees in the farming system, identifying trees / shrubs used for major functions, their sources and availability, and
- ✓ To identify actors in agroforestry and assess the role of gender in decision-making, division of labour and distribution of benefits from tree growing. ????

2.1.2 Study areas

The Teso farming system covers the districts of Katakwi, Kaberamaido, Kumi, Soroti and part of Pallisa. Its area is about 14,000 km^2 and has a population of about 1 million [Rwabogo, 1998]. This population is over 90% rural and depends almost entirely on agriculture. The Teso farming system is an agro-pastoral system, which is based on the production of annual crops and livestock in a mixed arrangement at subsistence level. The Lango farming system covers an area of 13,741 km^2 and has a population of approximately 1 million people [Rwabogo, 1998]. It covers the districts of Lira and Apac and is characterized by cultivation of annual crops like millet, groundnuts, simsim and maize.

The rural economy of both farming systems is predominantly small-scale subsistence agriculture largely dependent on human labour and use of simple hand tools such as hoes, machetes and ox-ploughs. Traditionally, cattle keeping was an integral part of these systems but with time, over

1.5 Specific objectives of project

The specific project objectives were to:-

- Document indigenous knowledge on agroforestry in the Teso and Lango farming systems;
- Identify appropriate propagation techniques for priority indigenous trees species that have potential for agroforestry in the two farming systems;
- Test and promote on-shelf agroforestry technologies in the two farming systems; and
- Build the capacity of farmers, extension providers, local leaders and other stakeholders on agroforestry.

1.6 Expected project outputs

The expected project outputs were: -

- Indigenous knowledge on agroforestry in the Teso and Lango farming systems documented;
- appropriate propagation techniques for priority indigenous trees species that have potential for agroforestry in the two farming systems identified;
- On-shelf agroforestry technologies in the two farming systems tested and promoted; and
- Capacity of farmers, extension providers, local leaders and other stakeholders on agroforestry built.

grazing became prevalent which has led to high competition for land use between grazing and cultivation. Today, however, the combined effect of insecurity and cattle rustling has reduced livestock populations in these areas significantly. In their struggle to survive, the impoverished populations are left with no options but to rely on natural resources in the area. Thus, existing woodlands have been subjected to the twin pressures of providing energy and construction materials for an increasing human population and at the same time give way for agriculture and settlement.

2.1.3 Study design and sampling strategy

The study was done in three (3) phases. First, participatory rural appraisals (RRA) were carried out in two districts (Kumi and Katakwii) in the Teso faming system and in one district (Lira) in the Lango farming system. These sample areas cover about 50% of each farming system. The aim of the PRA's was to narrow down the scope of work and to allow for more rigorous inquiry in a subsequent household survey. The preliminary findings of these two phases were then scrutinized at stakeholder feedback workshops. The findings and discussions in this paper are the outputs of this hierarchical process.

After consultation with the district departments of agriculture, forestry and environment, each district was stratified into three (3) easily discernible agro-ecological zones (dry, middle and wet) based on climatic and vegetation characteristics. One sub-county was randomly selected to represent each agro-ecological zone.

During the PRA, one parish was identified in each selected sub-county to ease mobilization of the groups. Given low variability within sub-counties, the non-random selection of parishes at this stage was likely to have had very minimal effect on the findings. Within a parish, informants were mobilized from several villages. One of the villages in the parish hosted the exercise at a convenient venue.

In total 326 households were randomly selected from the target villages, that is, 119, 100 and 107 from Katakwii, Kumi and Lira districts respectively. Within individual farm-households, the head or spouse responded to the interview on behalf of the household. Tables 1 and 2 below show the districts, sub-counties and the parishes that were selected for the study in Teso and Lango farming systems respectively. Figures 1, 2 and 3 show the study areas by sub-county for Kumi, Katakwii and Lira districts respectively.

Table 1: Districts, sub-counties and parishes covered by the PRA and household surveys in the Teso farming system.

District	*Sub-county*	*Parish*
a) Participatory Rural Appraisal		
Kumi	Nyero	Aguruut
	Kapir	Omiito
	Kachumbala	Kawo
Katakwii	Katakwii	Aliakameri
	Kapelebyong	Nyada
	Kuju	Wila
b) Household survey		
Kumi	Ongino	Kanapa, Ongino
	Nyero	Aguruut, Moruita
	Ngora	Tididiek, Kobuku
	Kapir	Omiito, Kapir
	Kachumbala	Komuge, Kawo
	Kidongole	Kaena, Chodong
Katakwii	Katakwii	Aliakameri, Abila
	Kapujan	Orimai, Kokorio
	Magoro	Omasia, Kamenu
	Kapelebyong	Nyada, Amaseniko
	Acowa	Angolebwal, Aakum
	Kuju	Alere, Amilimil
	Asamuk	*Obur, Odoon*

Table 2: District, sub-counties and parishes covered by the PRA and household surveys in the Lango farming system.

District	*Sub-county*	*Parish*
a) Participatory Rural Appraisals		
Lira	Adwari	Okorokwo
	Dokolo	Igulu
	Amelo	Kawo
b) Household survey		
Lira	Aputi	Otira, Anywali
	Muntu	Alemere, Amolatar
	Awelo	Akongomit, Anamwany
	Batta	Abyenek, Aderolongo
	Dokolo	Agwecibange, Atur
	Kangai	Agwenya, Adwila

Figure 1: - Map of Kumi district showing the sub-counties where the field surveys were conducted

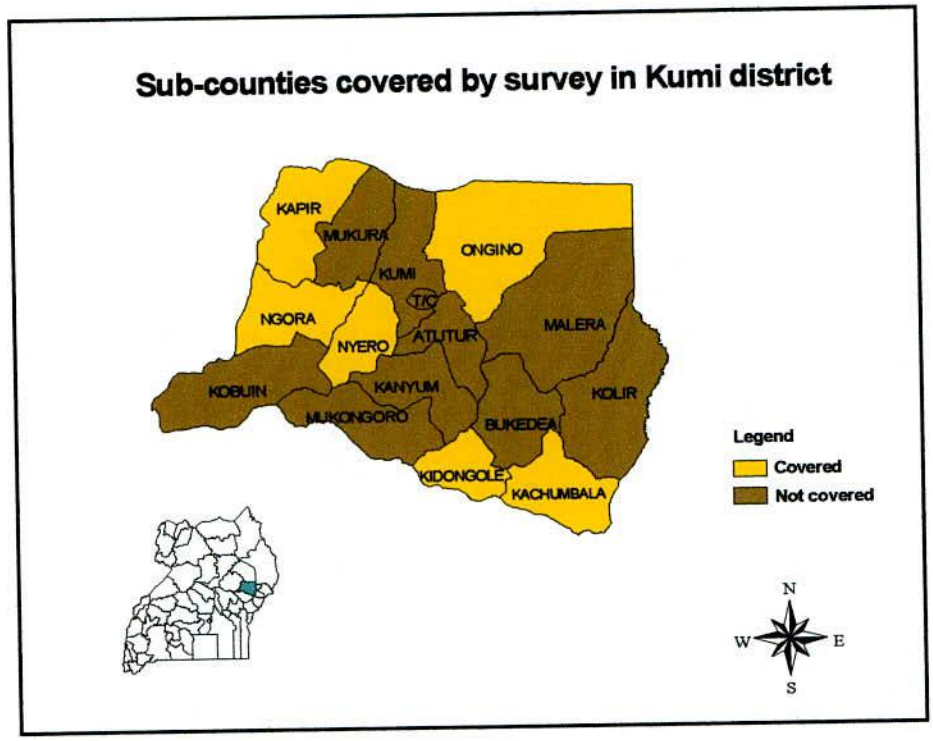


Figure 2: Map of Katakwii district showing the sub-counties where field surveys were conducted

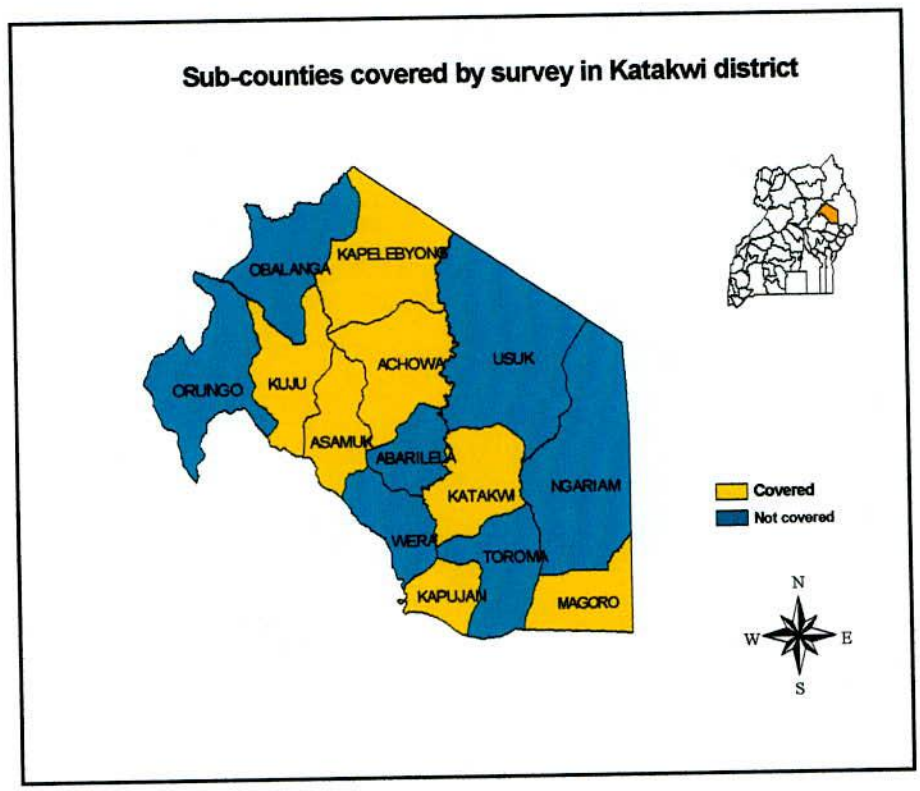
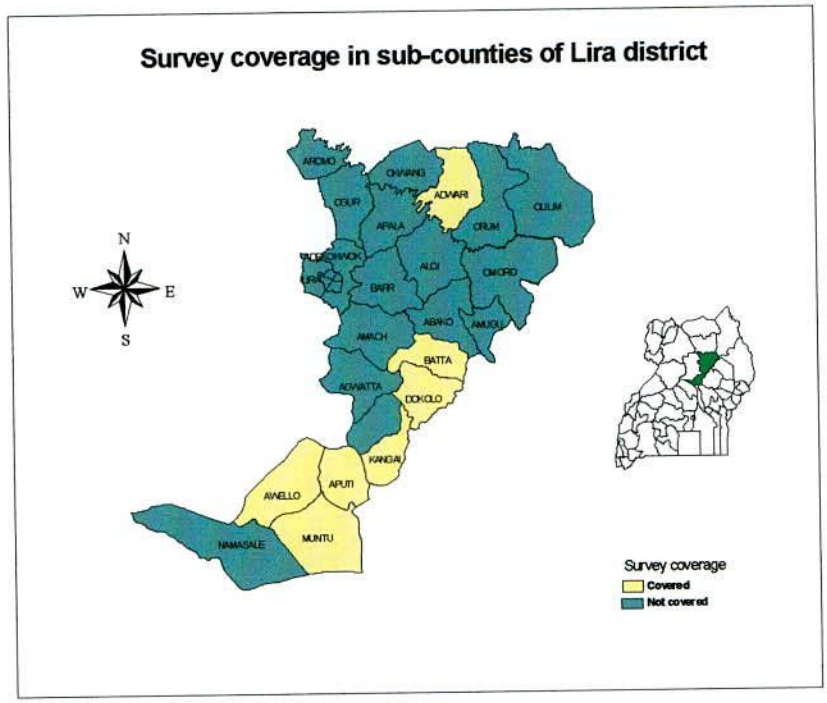


Figure 3: - Map of Lira district showing the sub-counties where the field surveys were conducted



2.1.4 *Methods and tools used in the study*

In the participatory rural appraisals three (3) tools, that is, focus group discussions, semi structured interviewing and preference ranking were used. Four (4) focus groups (women, men, youth and elderly) enabled gathering of information specific to particular interest groups and ensured active participation. Semi structured interviews facilitated rapid but flexible data capture during the interviews, while preference ranking was instrumental in prioritization of responses.

A formal household survey verified the hypotheses drawn from the PRA and refined the information that was collected. It also focused on areas that required quantitative information that had not been gathered during the rapid appraisal.

Stakeholders' feedback workshops presented an overview of preliminary findings to departmental heads directly involved in the natural resource management (Agriculture, Forestry and Environment), the secretaries for production and other major stakeholders in agroforestry in the three districts. Discussions were generated on the extent to which findings were in harmony with the local situations and evaluated the potential of candidate indigenous species for agroforestry development in these areas.

2.1.5 *Data analysis*

Data from the PRAs were partly analysed in the field with informants but further analysis were done after collation and tabulation on computer. Data from scoring and ranking exercises were used to generate both quantitative and qualitative analyses. Quantitative data was entered in computer using Excel spreadsheet and analysed using SPSS. This basically involved cross tabulation and comparison of means across groups and sites. Results were summarised in tables and/or figures and presented in this report.

2.2 Output 2: Appropriate propagation techniques for indigenous tree species identified and promoted

2.2.1 *Introduction*

Once the important tree and shrub species with potential for agroforestry in the Teso and Lango farming systems were determined, the next stage was to determine how they could be propagated for widespread adoption in the respective farming systems. Therefore, in each farming system, priority species were identified and phenology (flowering and fruiting) and propagation studies were conducted on them.

2.2.2 *Methods used*

Phenology studies

Selected tree species were subjected to phenology studies (flowering and fruiting) in the two farming systems. The species studied covered fruits, wood, medicinal and shade trees. The selected individual trees were mature, healthy and well branched. A sub-county which had at least most of the identified species was selected in each farming system. Thirty (30) individual trees of each species were selected for observation, and these trees were at least 100 m from each other. They were clearly marked with tapes and visited once a month to record when it starts to flower and fruit in a two year period.

Propagation studies

Later, propagation studies were conducted for 4 priority species to determine the best propagation method for each. Add more text

2.2.3 *Data analysis*

Qualitative and quantitative data on the phenology and propagation of the tree species were collected. These data were then entered in the computer, analyzed (frequencies and means) and presented in form of tables ~~and figures~~ that are presented in this report.

2.3 Output 3: Existing (on-shelf) agroforestry technologies tested and promoted

2.3.1 *Introduction*

Agricultural productivity in Uganda is seriously declining as the rapidly growing population over-exploits its land resources. The major consequences of this are perpetual food shortages, malnutrition, shortage of wood products, low incomes and environmental degradation. Agroforestry research and development in the country dates back to the late 1980s. The Forestry Resources Research Institute (FORRI) has been working with the World Agroforestry Centre (ICRAF) to develop, test and validate various agroforestry technologies in pilot sites in Uganda to address these issues. These include among others use of improved fallows, boundary tree planting, Soil and water conservation, high quality fodder and improved fruit trees. However, only few farmers in the country have access to these technologies. On-farm trials from Western and Embu areas of Kenya, Lake Victoria Crescent and the Kigezi highlands in Uganda have demonstrated the potential and viability of some of the agroforestry technologies in improving farmers' livelihoods and conserving the natural resource base.

The project identified four existing agroforestry technologies that were promoted to farmers in the two farming systems. However, only three were promoted during the study. These were: - improved fallows, boundary tree planting and improved tropical fruits (mangoes and oranges).

Improved fallows are defined as the use of quick growing and high quality short-term leguminous trees or shrubs to improve the soil physical and chemical properties. This technology is ready for transfer to farmers in the areas where soils are highly depleted; is adaptable and fits into the existing farming systems. It is a simple technology that farmers can easily propagate, manage and utilize. The improved shrub species that were promoted in this project included *Tephrosia* spp. and *Crotalaria* spp.

Boundary tree planting is one of the promising agroforestry technologies that can help reduce land degradation and pressure on indigenous forests (Djimde and Hoekstra, 1988). In this technology, tall upper-storey trees are planted on the boundaries of annual and/or perennial

crop plots or scattered within them. In this project boundary tree planting using Grevillea robusta was promoted.

Improved tropical fruit (mango, avocado, citrus) have been tested and validated and found them to be adaptable and ready for transfer to farmers through the work of FORRI and ICRAF that has been going on in central Uganda. Due to their monetary value, they are economically viable and potentially attractive to the users.

2.3.2 Materials and methods used

For each technology, a number of farmers were selected in the districts of Lira, Katakwii and Kumi to demonstrate the technologies. In total, 90 farmers demonstrated the improved fruits, 150 farmers demonstrated boundary tree planting with *Grevillea robusta* and 45 farmers demonstrated the use of improved fallows using *Tephrosia*, and *Crotalaria* shrub species (Table 3).

Table 3: The number of participating farmers in the two farming systems

Technology	***Number of farmers demonstrating***		
	Male	***Female***	**Total**
Improved fruits	*50*	*40*	**90**
Improved fallows	*25*	*40*	**45**
Boundary tree planting	*80*	*70*	**150**
Total	*155*	*130*	**285**

For the improved fruit trees and boundary tree planting with Grevillea, assessments were made on species survival, growth performance (heights and crown diameter) and pest and disease incidence. For both technologies, survival assessments were done one season after field establishment, while the growth of the tree species was assessed each season. Pest and disease occurrence surveillance was done continuously.

2.3.3 Data analysis

Quantitative and qualitative data was collected from the three agroforestry technologies that were evaluated. Field data was entered in excel package and later analyzed using GENSTART package. Summary statistics (means, percentages) were derived and presented in from of tables in this report.

CHAPTER 3: FINDINGS

3.1 Output 1: Farmer's indigenous knowledge on agroforestry and recent agroforestry initiatives in the two farming systems documented.

3.1.1 Teso Farming System

3.1.1.1 Tree growing practices in the farming system

Tree growing practices are dynamic and evolve over years. Thus, to understand the existing practices in Teso, a historical perspective into past and present practices was necessary. During the PRA, this study explored the trends that tree growing in the Teso farming system has taken in the last three decades.

- ***Tree growing practices before the 1970s***

Retaining trees in homesteads is an old tradition in Teso. On clearing a portion of unsettled land, the owner usually planted or retained some trees as a claim of ownership on that land. For many generations, trees have been let to grow around homes as landmarks for identification or along boundaries for demarcation. These trees served as windbreaks and provided various tree products. It was also common to plant trees in graveyards in memory of the deceased.

In the past, due to low human population, swamps covered large areas in the landscape. These were originally virgin lands, but as population increased, they became ideal locations for communal grazing and watering of livestock. In many swamps, trees were retained to provide shade for livestock and herdsmen. Forests formed a large part of natural vegetation cover. These were inhabited by wild game and were useful as hunting grounds. As human population increased, there was increased dependence on these areas for firewood, medicines and poles for building. Subsequently, forested areas gave way to human settlement and agriculture. The surviving portions remained under enormous pressure from charcoal and brick burners.

The colonial administration also promoted tree growing in public places. Many administrative headquarters (e.g. sub-county, county) were planted with *Milicia excelsa* trees. Besides demarcation and ornamental functions, these trees provided shade and served as windbreaks. Trees were also planted along roadsides for the same purposes, in addition to providing fruits and building poles. Roadside plantings acted as boundary markers and landmarks to travelers. Trees

were also widely planted and retained around schools, missions and market places. Traditionally, trees in public places offered shelter during festivals and clan meetings.

- ***Changes in tree growing practices and utilization***

Since the 1980s, there has been restricted access to firewood by individuals in the community. This has been the result of increasing population and scarcity of trees resulting in commercialization of tree products like firewood and poles. The sale of tree products has increased due to poverty and it is seen as one of the few ways people can get money to educate their children. In the last decade, charcoal burning has become common with charcoal being a convenient source of energy for cooking in upcoming urban areas.

The construction of permanent houses has brought about high demand for timber especially hard wood species like *Milicia excelsa*. There is also increasing demand for furniture in the upcoming institutions like schools. In the last 10 years, there has been a lot of tree felling for brick burning both for construction and as a source of income. While changes in tree utilization date as far back as the 1970s, it took until the 1990s for these to translate into changes in tree growing practices. The last decade saw the beginning and spread of deliberate tree planting. This has been attributed to increased awareness about the need for tree planting, commercialization of tree products and increased knowledge on tree management. For about 15 years now, raising and purchase of seeds and seedlings has been going on. This is due to improved knowledge and skills in tree growing and the discovery of improved, quick maturing varieties through tree research.

- ***Changes in tree coverage and species diversity***

Tree coverage has reduced, by about 25% to 80%, due to population increase and settlement, creating demand for firewood and farmland. There is also increased construction of permanent houses and burning of bricks and charcoal for income generation. Frequent wildfires and premature tree felling limit the chances for tree regeneration. The main factors that contribute to loss of tree cover in the Teso farming system include human settlement, firewood cutting, charcoal burning, brick burning, agriculture, wild fires and timber cutting.

Tree species diversity has generally reduced due to over exploitations and poor extraction methods, especially by herbalists. The main tree species that have become rare in the last three decades include *Milicia excelsa, Fagara chalybea,* and *Ficus platyphylla.* Others are *Pseudocedrela kotschvi, Balanites aegyptica, Teclea nobilis, Vitellaria paradoxa, Combretum*

molle, Acacia petersiana, Terminalia brownii, Ficus ingens, Markhamia lutea, Senna spp., Thevetia peruviana and *Jathropha carcus.*

- ***Current tree growing practices in the farming system***

Though tree-growing practices are seen in context of the wider landscape, this study had particular interest in the on-farm situation. It is evident that deliberate planting of trees on-farm is not as common as retaining trees already growing on-farm. The lack of planting materials is cited as a key hindrance to tree planting on-farm. However, the attitude that trees are "God given" and grow naturally also persists. For various reasons though, there are marked patterns in the types of trees retained in various locations on the farm. Commonly trees are planted or retained in homesteads, swamps, along farm boundaries and on croplands.

Trees are planted in homesteads more than in any other part of the farm. This location is preferred to others due to ease of supervision and management of the trees. These trees serve as windbreaks, provide shade, fences / hedges, firewood, poles and fruits. They also act as ornamentals and landmarks to facilitate identification of homes. Common tree / shrub species found around homesteads are *Tamarindus indica, Mangifera indica, Melia azedrach, Markhamia lutea, Artocarpus heterophyllus, Citrus spp., Ficus natalensis* and *Senna siamea.* Other species like *Carica papaya, Diospyros mespilformis, Persea americana* and *Thevetia peruviana* also exist in many households.

Trees are left to grow in swamps purposely to conserve the watersheds mainly by effecting rainfall formation. These trees provide shade (for livestock and herdsmen), firewood and a habitat for various bird and animal species. Swampy areas have various fruit and medicinal tree and shrub species growing on them. The most common species retained in swamps are *Acacia spp. (e.g.Acacia polycantha, Acacia sieberiana, Acacia busei), Carissa edulis, Diospyros mespilformis, Balanites aegyptica, Zyzyphus abyssinica, "Emwok", "Esiepet"* and *Eucalyptus spp.*

Trees are left to grow along external farm boundaries to act as boundary demarcations to avoid land disputes. Tree mortality is noted to be low and growth rates high in this location. Both internal and external boundary plantings serve as windbreaks and control soil erosion to the benefit of adjacent gardens. In addition, they provide a source of building poles and firewood near the home. Common tree species growing along farm boundaries include *Ficus natalensis, Thevetia peruviana, Janthropha curcas, Markhamia lutea, Teclea nobilis, Borassus aethiopum, Acacia hockii, Fagara chalybea* and *Harizonia abyssinica.*

Most crop gardens have trees left scattered on them. Most of these are retained after clearing the land, to provide shade for crops and / or fruits. They also act as windbreaks and improve upon soil fertility. Building poles and firewood are the other benefits from trees on croplands. Species commonly found growing on croplands include *Harrizonia abyssinica*, *Combretum collinum*, *Carissa edulis*, *Acacia hockii* and *Teclea nobilis*.

In some areas, fallowing is done for 1 to 3 seasons to enable soil regain fertility. The duration of fallows depends among other factors on the amount of land available. Longer fallows comprise small trees and shrubs that are retained to provide firewood and building materials.

Due to small farm size few farming households deliberately set aside part of their land for tree planting. Tree growing in woodlots is intended to provide poles for building, but also ensures a steady firewood supply and source of income to the household. The trees commonly grown in woodlots are exotic species (*Eucalyptus spp, Melia azedrach, Senna spp.*), but indigenous ones like *Ficus ingens*, *Terminalia brownii*, *Combretum collinum* and *Albizia coriaria* also occur.

Hilly areas, grasslands, forested areas and roadsides are the main areas in the landscape where trees exist in fairly large numbers. Apart from roadsides, trees in the other locations are mainly part of natural vegetation. They provide various tree products and services ranging from firewood, poles, medicines, shade and windbreaks. On these hills, trees are particularly important for soil conservation. They are retained there primarily because there is little agricultural activity going on in such areas due to poor soils. Common tree and shrub species in hilly areas are *"Ewoke"*, *Garchinia buchananii*, *Hymenocadia acida*, *Vitellaria paradoxa*, *Combretum collinum*, *Diospyros mespilformis*, *Crysopteryx febrifuga*, and *Carissa edulis*.

Grasslands are considered not good for crop cultivation. The trees are retained here so as to improve on the fertility of soils. The common tree and shrub species in grasslands are *Albizia coriaria*, *Diospyros mespilformis*, *Teclea nobilis* and *Fagara chalybea*.

Forests have a wide variety of tree species, as part of natural vegetation. The trees are left to grow there as this is considered communal land for hunting. These areas in turn, provide firewood, medicine and building poles to the community. In addition, forests are a source of wild browse to livestock and also serve a big role in environmental conservation. The forests, however, are increasingly used as sources of fuel wood for charcoal burning.

Trees are also commonly planted and / or retained along roads and paths to provide shade, fruits and building poles and also serve as landmarks to guide travelers. The most common tree and

shrub species along roads are *Ficus natalensis, Ficus platyphylla, Tamarindus indica, Vitex doniana, Mangifera indica, Markhamia lutea, Melia azedrach, Milicia excelsa, Combretum collinum* and *Thevetia peruviana*.

3.1.1.2 The role of trees in the farming system

Understanding the vales attached to various tree products and services are important in prescribing agroforestry tree species for a farming system. Due to variations in physical and socio-economic factors, this often varies between locations and social groups.

The provision of firewood, building poles, medicines, fruits and shade are the most important uses of trees in the farming system. It was hypothesized that gender impacts on the importance different categories of people attach to trees. Though there was consensus that poles and firewood are the main tree products in the farming system, women, unlike other groups indicated firewood as the higher priority (table 4). Women ranked poles relatively lower than men and the youth. All three groups recognized the medicinal importance of trees, though women ranked it higher than the other groups. The role of fruits was ranked low in all groups. The provision of timber was ranked fairly highly by men, but not mentioned by the youth. Women and the youth ranked windbreaks among major roles of trees in the farming system.

Table 4: The role of trees as ranked by different gender groups in Teso farming system

Men		***Women***		***Youths***	
Rank	***Role***	***Rank***	***Role***	***Rank***	***Role***
1.	Poles	1.	Firewood	1.	Poles
2.	Firewood	2.	Medicine	2.	Firewood
3.	Timber	3.	Shade	3.	Medicine
4.	Medicine	4.	Poles	4.	Windbreaks
5.	Shade	5.	Windbreaks	5.	Fruits
6.	Fruits	6.	Timber	6.	-

3.1.1.3 Main sources of tree products

Table 5 shows the availability, purchase and planting of trees for various products in the farming system. Firewood is the only source of energy in most rural households in the farming system. It is

used mainly for cooking, but also lighting and warming the house at night and for keeping vigil at funerals. Some households light a fire in the kraal at night to generate smoke to keep off mosquitoes. Commercially, firewood is used for charcoal making and metal fabrication. It is also sold in trading centres and/or used for distilling "waragi", a local potent gin. Rangelands are the main sources of firewood for household.

Poles are used in various sizes depending on the purpose. They are mainly used in hut construction as support for mud walls and roofing. Poles are also useful in constructing shade for resting, shelters for bathing, kraals, making local bridges and slabs for latrines. They are also used to make granaries for food security and racks for drying simsim. Other uses of poles include making parts of musical instruments, ox-carts and handles of tools such as hoes, axes, etc. The main sources of poles to households are the rangelands (47%) and woodlands/forests (30%). Thirty nine percent of households depend mainly on on-farm sources for poles especially individual land holdings.

Table 5: The availability, purchase and planting of trees for various uses in Teso farming system

	Respondents (%)		
Tree product or service	***Experiencing shortage***	***Purchase product***	***Plant trees for it***
Firewood	73.6	38.1	12.1
Poles	70.3	49.5	38.5
Traditional Medicine	-	39.2	23.5
Fruits	62.3	61.5	54.0
Shade and shelter	7.9	-	63.4

The medicines are mainly used for treatment of various diseases for both humans and livestock. Traditional medicine is usually used as "first aid" before a patient is taken to a clinic. Women use parts of various trees and shrubs for maternity purposes and for making "love portions" deemed useful in ensuring marital stability. Rangelands and forests are the main sources of medicinal shrubs and trees to most households. Dependence on on-farm sources for medicines is also prominent in the drier parts of the farming system. 62% of farm household visited had medicinal trees and/or shrubs growing on their farms. Few (24%) of the households, however, indicated having planted medicinal trees deliberately on their farms.

Lack of knowledge on the propagation of medicinal species and the unavailability of germplasm are some of the main reasons for not planting medicinal trees on-farm. It is also believed that

traditional medicines are abundant in the wilderness. There is also concern on the poor growth of medicinal species.

One of the main roles of indigenous trees is their contribution to the local diet and household food security. A variety of fruits consumed in households, either eaten fresh or used to spice up millet meal. The leaves of some trees are eaten as vegetables. The sale of fruits provides an opportunity for generating cash income to some households. Some fruits (e.g. Shea nut) are used for extraction of oil used for cosmetic purposes and also sold for income.

The main sources of fruits consumed by households are rangelands, forests and individual farms. The purchase and collection of fruits from other farms are minimal. Up to 62% of households indicated facing shortage of fruits (table 5). Overall, 62% of households buy fruits. The main reason for not planting indigenous fruit trees is the tendency to rely on naturally growing trees. Also, many farmers do not know how to propagate indigenous fruit trees and lack the planting materials. Other factors included termites, long gestation period land shortage and drought.

The use of trees for shade is common around homesteads. Trees are planted or retained to provide shelter from the sun during the hot season. Their location near the home has commonly resulted in shade trees doubling as ornamentals. Most (93%) of the households have shade trees on their farms. In 63% of the households, shade trees have been deliberately planted mainly around homesteads (table 5). The dependency on naturally growing trees for shade is the main reason for some farmers not deliberately planting shade trees. The other major factors are lack of knowledge about propagation and unavailability of planting materials.

3.1.1.4 Priority indigenous tree species in the farming system

The determination of important trees and shrubs began by identifying priority species for each of the major roles during the participatory appraisals. These species were subjected to rating across key selection criteria in the household survey. This section presents priority indigenous trees and shrubs according to major roles.

Priority tree species for building poles in the farming system are shown in table 6. The PRA identified specific qualities of a "good pole". Apparently, there is no perfect pole, as quality of a pole depends on the purpose for which it is sought. Generally, poles are gauged basing on their strength (i.e. not breaking easily), straightness, flexibility against strong wind and resistance to termites and borers. They should also be fast growing, attaining good size and coppicing well, in addition to serving multiple functions. The most important indigenous species for poles were identified as *Prosopis africana* and *Terminalia macroptera* (table 6). 75% of the respondents

indicated *Prosopis africana* as the best, while 9% opted for *Terminalia macroptera*. The other candidate indigenous species for poles are *Haeria reticulata, Bridelia micrantha, Pseudocedrella kotschyi, Combretum collinum* and *Crossopteryx febrifuga*.

Table 6: High priority indigenous tree species for poles in Teso farming system

Tree species name		Ranking points		Percentage preference*
Scientific	**Ateso**	**Total**	**Mean**	
Prosopis africana	*Eikiiki*	519	4.36	74.8
Terminalia macroptera	*Ekoboi*	354	2.98	9.2
Haeria reticulate	*Emutur*	143	1.20	3.4
Bridelia micrantha	*Erieco*	167	1.40	2.5
Pseudocedrella kotschyi	*Eputon*	117	0.98	1.7
Combretum collinum	*Ekulony*	101	0.85	1.7
Crossopteryx febrifuga	*Eterai*	176	1.48	1.7

*** Respondents mentioning species as the best for the poles.**

Table 7 below shows priority indigenous tree species for firewood. Good firewood is determined from its ability to light easily and sustain a steady flame without producing lots of smoke. Producing embers that are used for ironing and preserving fire overnight was another attribute of good firewood. It should also be easy to split and not thorny.

Table 7: High priority indigenous tree species for firewood in Teso farming system

Tree species name		Ranking points		Percentage preference*
Scientific	**Ateso**	**Total**	**Mean**	
Combretum collinum	Ekulony	423	3.56	50.4
Combretum fragrans	Ekimeng	281	2.36	10.1
Vitellaria paradoxa	Ekungur	279	2.35	20.2
Acacia hockii	Ekisim	190	1.60	5.0
Combretum molle	Ekworo	174	1.46	4.2
Tamarindus indica	Epeduru	125	1.05	2.5
Terminalia macroptera	Ekoboi	111	0.93	2.5
Bridelia micrantha	Erieco	153	1.29	1.7

*** Respondents mentioning as best indigenous species for firewood**

The most important indigenous firewood species are *Combretum collinum*, *Combretum fragrans* and *Vitellaria paradoxa* (table 7). Over 80% of the respondents indicated one of these three species as being the best indigenous species for this use, especially *Combretum collinum*. Others that were identified included *Acacia hockii, Combretum molle, Tamarindus indica, Terminalia macroptera* and *Bridelia micrantha*.

Priority indigenous fruit trees are shown in table 8 below. The criteria for determining the quality of a fruit varies from one fruit type to another. Thus, a wide range of criteria were identified e.g. taste (sweetness or sourness), attractive colour, fleshiness and marketability were considered. The ideal fruit tree should also be resistant to pests (especially termites) and diseases, have a short gestation period and bear many fruits regularly. It should also be able to serve other functions in the seasons when it is not fruiting.

Table 8: High priority indigenous fruit tree species in Teso farming system

Tree species name		***Ranking points***		***Percentage preference****
Scientific	***Ateso***	***Total***	***Mean***	
Vitellaria paradoxa	Ekungur	563	4.73	84.9
Tamarindus indica	Epeduru	448	3.77	10.1
Carissa edulis	Aimuriei/Aimuria	266	2.24	1.7
Ximenia americana	Elamai	204	1.71	0.8
Vitex doniana	Ekarukei	273	2.29	0.8
Bridelia micrantha	Erieco	26	0.22	0.8

*** Respondents mentioning as best indigenous fruit species.**

The most important indigenous fruit species are *Vitellaria paradoxa* and *Tamarindus indica*. Up to 95% of respondents indicated one of these two as the best fruit species (table 8). The other candidate species are *Carissa edulis, Ximenia americana, Vitex doniana* and *Bridelia micrantha*. Most indigenous fruit species score highly on taste and ability to bear many fruits. On the other hand, many indigenous fruit species take long to fruit and have low commercial value (apart from *Vitellaria paradoxa* and *Tamarindus indica*). *Vitellaria paradoxa* has all attributes except that its takes long to fruit.

Table 9 shows priority tee species used for shade by the households. The trees preferred for shade have large, wide spreading canopies, which do not shed leaves throughout the year. There is also need for shade trees to be fast growing, multi-purpose and not susceptible to caterpillar attack. The ability to withstand strong wind was another attribute of a good shade tree.

Table 9: High priority indigenous tree species for shade in Teso farming system

Tree species name		*Ranking points*		*Percentage preference**
Scientific	***Ateso***	***Total***	***Mean***	
Tamarindus indica	Epeduru	437	3.67	32.8
Vitellaria paradoxa	Ekungur	388	3.26	15.1
Ficus natalensis	Ejinga	379	3.19	39.5
Piliostigma thoningii	Epapai	191	1.61	5.0
Vitex doniana	Ekarukei	168	1.41	1.7
Terminalia macroptera	Ekoboi	145	1.22	1.7

*** Respondents mentioning as best indigenous species for shade**

The most important indigenous shade species are *Tamarindus indica*, *Vitellaria paradoxa* and *Ficus natalensis*. About 90% of the respondents gave one of these three species as the best species for this purpose. General consensus was evident on *Tamarindus indica* and *Vitellaria paradoxa* rankings (table 9). Respondents did not concur on *Ficus natalensis* for shade. Though 40% felt it was the best species, others (16%) did not rank it among the priority 5 species for this purpose.

Table 10 shows priority indigenous trees for medicine. Good medicinal species need to be effective with no side effects and should preferably not be very bitter. The ability for the medicine to be preserved e.g. by drying was another important attribute in addition to being traditionally accepted. The most important indigenous medicinal species are *Fagara chalybea* and "Abwac". Over 70% of the respondents indicated one of these to be the best medicinal species. The other candidate species for this purpose are *Teclea nobilis* and "Esuroi".

3.1.1.5 Tree establishment and management by households

Table 11 and 12 show the most common tree propagation and management techniques used by households in the Teso farming system respectively. A majority of households use seedlings, wildings and natural regeneration as the major methods of tree propagation or tree establishment in both Kumi and Katakwii districts (table 11). Very few households use stem cuttings and grafted seedlings as methods of tree propagation. Generally in the farming systems 51, 25, 15, 6 and 2%

of the households use seedlings, wildings, natural regeneration, stem cuttings and grafted seedlings respectively.

Table 10: High priority indigenous medicinal tree species in Teso farming system

Tree species name		*Ranking points*		*Percentage preference**
Scientific name	***Ateso***	***Total***	***Mean***	
Fagara chalybea	Eusuk	429	3.61	50.4
-	Abwac	339	2.85	21.0
Teclea nobilis	Ekudep	219	1.84	4.2
-	Esuroi	201	1.67	7.6
Carissa edulis	Aimuria	159	1.34	1.7
-	Eyaratum	121	1.02	4.2

*** Respondents mentioning as the best indigenous medicinal species**

Table 11: Tree propagation techniques used by households in the Teso farming system

Method of propagation	*% Households using it*		
	Kumi	***Katakwii***	***Mean***
Seedlings	58	44	51.0
Wildings	19	30	24.5
Natural regeneration	10	20	15.0
Stem cuttings	6	5	5.5
Grafted seedlings	2	1	1.5

A majority of households use tree seedlings for tree propagation. It is imperative, therefore, that they be trained on seed collection and nursery establishment and management skills as it seems that most of the seedlings currently being planted are got free from NGO's or/and government departments. If farmers are helped to develop these skills, then there will be an element of sustainability in tree growing activities. However, a good number of households still depend on natural regeneration for tree establishment. It would be necessary to compare and refine this indigenous knowledge that households have. Grafting of seedlings for improved growth and productivity is not common among households, but it is a skill that needs to be imparted to them.

The major forms of tree management found in the farming system were weeding of tree seedlings and pruning of mature trees (table 12). Coppicing and pollarding of mature trees were done

occasionally, while root pruning of trees was not done at all by households. Generally 51, 35, 3, 2, 0 and 8 % of the households in the farming system managed trees through weeding, pruning, coppicing, pollarding, root pruning and protect trees from fire and livestock respectively (Table 12).

Table 12: Tree management techniques used by households in the Teso farming system

Method of propagation	*% Households using it*		
	Kumi	*Katakwii*	*Mean*
Weed seedlings	49	52	50.5
Prune tree crowns	44	25	34.5
Coppice trees	5	1	3.0
Pollard trees	2	1	1.5
Root prune trees	0	0	0.0
Protect from fire & livestock	0	15	7.5

The main tree management practiced by farmers is weeding and pruning of trees. However, elements like root pruning that are important when intercropping trees with crops is not performed. Assisting farmers in acquiring this skill is very important so as to improve the productivity of tree/crop systems in the area.

3.1.1.6 Factors affecting tree growing by households in the farming system

The major constraints to tree growing in the farming system are shown in table 13. Poor soils and lack of planting materials were ranked as the most important factors that affect tree growing in the farming system. Other constraints to tree growing in the farming system included lack of skills in tree growing, lack of awareness, drought, bush fires, pests (termites) and diseases lack of capital inputs and damage by livestock.

For agroforestry practices to be adopted by a majority of farmers in the farming system, it will be important to address issues on lack of knowledge on tree growing and the lack of planting material or germplasm. This calls for intensive sensitization of the communities on tree growing, local seed collection, handling and storage. It will also be necessary to organize proper channels for seed supply and demand for households. The issues of pests and diseases also needs serious attention, especially termites that have proved to be a major limiting factor in tree planting efforts in the area. Research will need to find appropriate and affordable methods of controlling termites. Some work has already started in Kumi district through the Agroforestry Programme of

FORRI mainly on identification of termites and the testing of some indigenous methods of termite control.

Table 13: Factors hindering tree growing in the Teso farming system

Factor	Ranking		
	Kumi	Katakwii	Mean
Lack of technical skills in tree growing	2	4	3.0
Lack of planting materials	4	1	2.5
Lack of awareness	2	4	3.0
Bad weather e.g. drought	3	3	3.0
Bush fires	-	3	3.0
Damage from livestock	2	5	3.5
Pests and disease (termites)	4	2	3.0
Lack of capital and inputs	3	-	3.0
Poor soils	1	-	1.0

NB: - The smaller the figure, the more serious the problem, while a dash indicates factor is not important in the district

Several factors hinder women and the youth in the area in tree growing. Women consider tree growing a man's domain, while the youth lack land and are not interested in long gestation enterprises such as tree growing. Minimal efforts in tree growing by these gender categories presents a future problem of scarcity of tree products and services if steps are not taken to encourage and support them to participate. More sensitization, therefore, is required though extension services to involve these gender groups in tree growing. The role of extension services in creating awareness on available means of production of enterprises has been underscored elsewhere (Swanson, et al., 1997; Van den Ban and Hawkins, 1996; Mulofwa *et al.*, 1994).

3.1.1.7 Opportunities for agroforestry development in Teso farming system

Currently there are several institutions actively involved in promoting agroforestry activities in the farming system. Soroti Catholic Diocese Integrated Development Organization (SOCADIDO) has been one of the major institutions instrumental in promoting tree growing and sensitization on environmental issues. Other institutions include NEMA, District Departments of Environment, Forestry and Agriculture Apart from these institutions; there are other opportunities that exit to promote the use of agroforestry technologies in these areas. Poor soils as indicated in Kumi district create an opportunity of using short-term shrubs as improved fallows to enhance soil fertility. Kumi also has little tree cover which has resulted in serious shortages of tree products and services. These can be overcome by promoting agroforestry technologies such as boundary and scattered

tree planting for wood and energy requirements of the households. The use of shrubs such as *Calliandra* and *Leuceana* as sources of fodder for livestock is another opportunity as feed for livestock is usually scarce especially during the dry seasons. The other major opportunity is the willingness of local governments to promote tree growing as an option for improving rural livelihoods. The promotion of improved tropical fruits such as mangoes and oranges in the farming system will greatly improve the income and nutritional status of households.

3.1.2 Lango Farming System

3.1.2.1 Tree growing practices in the farming system

To understand existing tree growing practices in Lango, a historical perspective into past and present practices was necessary. During the rapid appraisal, this study explored the trends that tree growing in the Lango farming system has taken in the last three decades.

- **Tree growing practices before the 1970s**

In the past, leaving parts of farmland under bush for some seasons was a very common practice. Trees were left on croplands to provide shade, fruits and manure on the gardens. Land then was abundant and fallow areas were left for several years, which enabled the growth of various trees and shrubs. These areas were also the main hunting grounds. In many homesteads, trees were left to grow in areas that were used as burial or ancestral grounds. This practice was a way of marking these grounds for identification by future generations. Retention of trees near homes for windbreaks was also common, while at the same time the trees provided fruits and medicines.

It has been an old practice in Lango to grow trees along roadsides. The trees were mainly to provide shade for travelers. The owners of land that bordered the roads also planted trees on roadsides to demarcate the boundaries. This was aimed at preventing encroaching on private lands. During pre-colonial time, there were many trees growing in rangelands and swamps as part of the natural vegetation. These trees existed because human population was low and tree products were abundant. Also, swamps were sites for traditional prayers e.g. "rain making dances" and trees were left there for cultural reasons. The fear of provoking the wrath of evil spirits prevented the cutting of some big trees that often grew there.

Colonial and post independence governments shouldered most of the tree planting responsibility in the 1960s. Tree planting was mainly done in Government forest reserves, rangelands, swamps and in emerging urban areas. Government took deliberate efforts to plant and conserve trees in

selected areas for purposes of protecting the environmental. As towns developed, some trees were left to serve as windbreaks and ornamentals.

Trees in public places were often planted deliberately to serve as memoirs of important occasions. These trees grew to provide shade and windbreaks around public places like churches, schools and administrative buildings. On conversion to timber, these trees generated revenue for the institutions.

- **Changes in tree growing practices and utilization**

The Lango farming system has experienced dramatic changes in tree growing in the last three decades. In the past, tree conservation for cultural purposes was central to Lango tradition. Tree preservation used to be common in sacred places. This is not the case today due to increasing levels of poverty amongst an ever-increasing population. Traditional use of practices has been eroded as modern cultures have set in. Trees that used to grow in rangelands have given way to human settlements due to increasing population. This has triggered off shortages of tree products resulting in restrictions to their access by individuals. Firewood and poles have subsequently taken on commercial value.

Charcoal burning has become common in the last decade as it is seen as a convenient source of energy for cooking in upcoming urban areas. Brick burning is also picking pace due to increasing tendency for people to construct permanent houses. In the Lake belt, the use of trees for boat making has increased in both the size and number of boats. As such, big trees that used to exist in the swamps have been cut for timber and used for boat making. In some areas of the Lake belt, flooding has also destroyed some of the trees that used to grow in the swamps.
In the 1990s, after farmers realizing that trees had disappeared from the landscape, the practice of growing trees on the farm as woodlots became common. This was in attempt to keep pace with increasing need for timber for construction. Tree growing was eventually seen as a viable economic undertaking.

- **Changes in tree coverage and species diversity**

Tree coverage in the farming system has decreased due to increasing human population creating demand for more firewood and farmland. The need for income to sustain large populations has caused increased boat making and fishing activity. Tree cover has also reduced due to increased charcoal burning and flooding in swamps.

Tree species diversity has generally reduced as high value species are particularly targeted. *Vitellaria paradoxa, Ximenia americana, Terminalia macroptera, Senna siamea, Combretum collinum, Albizia coriaria* and *Milicia excelsa* used to be common prior to the 1970s, but have since become very scarce. Charcoal burning, road construction, and felling for timber, firewood and poles have been the main causes. Other factors are bush fires and poor management and clearing for human settlement.

- **Current tree growing practices in the farming system**

Though tree-growing practices are seen in context of the wider landscape, this study had particular interest in the on-farm situation. It is evident that deliberate planting of trees on-farm is not common as retaining trees already growing on-farm. The lack of planting materials is cited as a key hindrance to tree planting on-farm. However, the attitude that trees are "God given" and grow naturally still persists.

For various reasons, there are marked patterns in the types of trees retained in various locations on the farm. This section explores locations on-farm where trees are commonly found and reasons for this distribution. The main locations where trees are commonly found include homesteads, swamps, crop land, range lands, forests, degraded areas, public lands, woodlots, boundaries of gardens and around kraals.

Trees are commonly planted or retained around homes to act as windbreaks that protect grass-thatched houses from strong wind. These trees also provide shade and medicines to humans and livestock, building poles and fruits. In many areas, the common species growing around homesteads are *Markhamia lutea, Mangifera indica, Melia azedarach, Eucalyptus spp, Senna siamea* and *Citrus spp*. Areas near the home are preferred to other farm locations due to ease of tree supervision and management.

Trees are commonly retained along external farm boundaries as boundary markers to prevent land disputes. Boundary plantings are also useful for soil erosion control and provision of shade and windbreaks to adjacent gardens. In addition, they provide a source of building poles and firewood near / within the homestead. Many farm boundaries have *Borassus aethiopium*, "Omara-omara", *Ficus natalensis* and *Markhamia lutea* growing on them.

It is common for farmers when clearing land to retain some trees and shrubs on their gardens for various reasons. These trees provide shade for crops and improve on soil fertility while providing useful products like fruits, firewood and poles to households. *Albizia coriaria, Markhamia lutea, Mangifera indica* and *Citrus spp.* are some common species found on croplands.

In some households, a portion of the land is set aside for tree growing. Trees in woodlots are mainly intended for providing building poles. The poles can also be sold to generate income. *Eucalyptus spp., Markhamia lutea, Senna seamea* and *Melia azedarach* are some of the common tree species grown in woodlots.

Other locations in the landscape important for tree growing were identified as swamps, grasslands and public places. Trees are planted in swampy areas mainly because of the presence of abundant water that can ensure tree survival despite the long dry season. In places where there is land shortage like the Lake zone, tree growing is done in swamps to release other locations for crop cultivation. *Eucalyptus spp.* and *Senna siamea* are the common tree species in swamps providing shade (for livestock and herdsmen), firewood and a habitat for wildlife. In some swamps different types of fruit and medicinal species commonly exist.

Trees growing in grasslands are mostly part of natural vegetation. They are left to grow there as the land is not fertile enough to support crop cultivation. Tree planting is also done as an attempt to improve on the soils in these areas. *Ficus ovata, Combretum collinum, Terminalia macroptera* and "Lovo" are the common species growing in the grasslands. In many public places like markets, schools and church compounds, trees are planted to create shade for people gathering in these places. Also, the shrubs provide privacy and serve as "urinals" for large gatherings. Trees in public places also provide products e.g. firewood and timber in the long run. The common tree species in public places are *Ficus natalensis, Mangifera indica, Antiaris toxicaria* and *Ficus sp.*

3.1.2.2 Role of trees in the farming system

Understanding the importance attached to various tree products and services are important in prescribing agroforestry trees for a farming system. Due to variations in physical and socio-economic factors, this often varies between locations and social groups. This section analyzes the role of trees in different ecological zones and gender groups, and describes the nature of each role.

The provision of building poles, firewood, fruits and windbreaks are the most important uses of trees in the farming system. It is evident that the main uses of trees in the farming system varies significantly. For example, the importance of fruits is not recognized in areas surrounding Lake Kyoga. Windbreaks are also ranked lower in wetter areas than in dry areas, while the importance of soil conservation and boat making are important to the dry areas and Lake zones respectively.

It was hypothesized that gender impacts on the importance different categories of people attach to trees. Though there was consensus that poles, firewood, windbreaks and fruits are the main tree uses in the farming system, men unlike other groups ranked windbreaks as a lower priority, relative to other groups (Table 14). Women ranked medicines fairly high though other groups did not mention it. All groups recognized the importance of trees for timber, though women ranked it lower compared to other groups. Also worth noting is the fact that men did not mention the importance of trees in soil management but pointed out income and boat making among the major roles of trees.

Table 14: The role of trees as ranked by different gender groups in Lango farming system

Men		Women		Youth	
Rank	**Role**	**Rank**	**Role**	**Rank**	**Role**
1.	Poles	1.	Poles	1.	Poles
2.	Firewood	2.	Firewood	2.	Firewood
3.	Timber	3.	Windbreaks	3.	Windbreaks
4.	Fruits	4.	Fruits	4.	Timber
5.	Windbreaks	5.	Medicines	5.	Charcoal
6.	Boat making	6.	Soil management	6.	Soil conservation
7.	Income	7.	Timber	7.	Fruits

3.1.2.3 Main sources of wood products for households

Table 15 shows the availability, purchase and planting of trees for various products and services. Planting of trees for firewood is not common and only 17% of households reported having ever planted trees for firewood. Sixty three per cent of the households purchased firewood at least once in a month. The tendency to depend on naturally growing trees for firewood is the main reason why many households do not deliberately plant trees for this purpose. Lack of planting materials and knowledge on propagation of some species also hinder tree planting for firewood production. Land shortage was also mentioned as a hindrance.

Poles are used in various sizes depending on the purpose. They are mainly used in hut construction as support for mud walls and roofing. Poles are also useful in constructing shade for resting, shelters for bathing, kraals, making local bridges and slabs for latrines. They are also used to make granaries for food security and racks for drying simsim. Other uses of poles include making parts of

musical instruments, ox-carts and handles for tools such as hoes, axes, etc. The main sources of poles are the forests, individual land holdings, rangelands and swampy areas. The collection of poles from other farms free of charge is minimal. The supply of poles is generally below households' requirements. Up to 72% of the households visited faced a shortage of poles, while about 74% of the households purchased poles (table 15). About 65% of households had planted trees for pole production. The main constraints in planting trees for poles are the lack of planting material, land shortage and a general reluctance to plant pole trees due to dependency on existing ones. There is also lack of knowledge on tree planting.

Table 15: The availability, purchase and planting of trees for uses in Lango farming system

	Respondents (%)		
Tree product or service	***Experiencing shortage***	***Purchase product***	***Plant trees for it***
Firewood	72.1	62.5	16.5
Poles	71.7	73.8	65.1
Fruits	58.7	68.9	79.2
Windbreaks	98.1	-	79.2

Trees play a major role as windbreaks protecting grass-thatched roofs from strong winds. These trees in turn provide shade and support for climbers e.g. passion fruits. Nearly all households (98%) expressed need for windbreaks on-farm. Up to 79% of the households had planted trees on-farm purposely to serve as windbreaks (table 15). This practice is more pronounced in areas near the lake.

One of the main roles of indigenous trees is their contribution to the local diets and household food security. A variety of fruits consumed in the households, either eaten fresh or used to spice other foods. The sale of fruits provides an opportunity for generating cash income to some households. Most households get much of the fruits they consume from their own farms and from forests. The collection of fruits from other farms free of charge is minimal. On the other hand, some households rely mostly on rangelands and the markets for their fruit supply. Up to 59% of households indicated facing shortage of fruits (table 15). On the other hand, a larger percentage of households (69%) purchase fruits, while 79% of households had planted fruit trees on-farm. Farmers that had not planted indicated lack of planting material and knowledge on tree planting as the hindrances to planting fruit trees. Others had little interest in fruit tree growing and regarded natural stands as sufficient.

3.1.2.4 *Priority indigenous trees in the farming system*

Generally, poles are gauged basing on their strength (i.e. not breaking easily), straightness, flexibility against strong wind and resistance to termites and borers. They should also be fast growing, attaining good size and coppicing well, in addition to serving multiple functions. The priority indigenous pole species as determined from the total ranking points accumulated are *Markhamia lutea*, *Senna siamea* and *Terminalia macroptera* (table 16). The majority (66%) of respondents reported that *Markhamia lutea* as the best indigenous pole species. Though *Senna siamea* was ranked higher than *Terminalia macroptera*, the latter was more frequently mentioned as first priority.

Table 16: Priority tree species for poles in the Lango farming system

Tree species name		***Ranking points***		***Percentage preference****
Scientific	***Luo***	***Total***	***Mean***	
Markhamia lutea	Sambia	226	4.19	66.4
Senna siamea	Gasia	174	3.22	9.3
Terminalia macroptera	Opok	159	2.94	12.1
Bridelia scleroneuroidii	Orweco	107	1.98	7.5
Combretum collinum	Odugu	83	1.54	2.8
Piliostigma thonningii	Ogali	72	1.33	1.9

* Respondents mentioning as best indigenous species for firewood

Good firewood is determined from its ability to light easily and sustain a steady flame without producing lots of smoke. Producing embers that are used for ironing and preserving fire overnight is another attribute of good firewood. It should also be easy to split and not thorny. *Combretum collinum* ranked highest among indigenous species for firewood (table 17). This is determined from total ranking points accumulated. The other priority species are *Albizia malacophylla, Combretum fragrans, Terminalia macroptera, Bridelia scleroneuroidii and Vitellaria paradoxa*.

The service of trees as windbreaks protects grass-thatched houses from strong wind. The trees that serve as windbreaks are ideally tall with a large, dense canopy. They also need to have strong root system and flexible trunk that does not break against force of the wind. Table 18 presents the priority indigenous species for windbreaks in the farming system. *Markhamia lutea* was ranked the

best indigenous species for windbreaks as determined from the total ranking points accumulated. *Ficus natalensis, Melicia excelsa, Albizia coriaria, Melia azedarch, Combretum molle and Vitellaria paradoxa* are the other important priority species for this purpose.

Table 17: Priority indigenous tree for firewood in the Lango farming system

Tree species name		Ranking points		Percentage preference*
Scientific	**Luo**	**Total**	**Mean**	
Combretum collinum	Odugu	509	4.76	86.0
Albizia malacophylla	Abata	235	2.20	3.7
Combretum fragrans		225	2.10	1.9
Terminalia macroptera	Opok	199	1.86	4.7
Bridelia scleroneuroidii	Orweco	199	1.86	1.9
Vitellaria paradoxa	Yao	145	1.36	5.6
Combretum molle	Iyoro	109	1.02	0.0

* Respondents mentioning as best indigenous species for firewood

Table 18: Priority indigenous trees for windbreaks in the Lango farming system

Tree species name		*Ranking points*		*Percentage preference**
Scienticic	***Luo***	***Total***	***Mean***	
Markhamia lutea		314	2.94	33.6
Ficus natalensis		278	2.60	26.2
Melicia excelsa		267	2.50	17.8
Albizia coriaria		265	2.50	12.1
Melia azedrach	Ilira	179	1.67	0.9
Combretum molle	Iyoro	171	1.60	4.7
Vitellaria paradoxa	Yao	126	1.18	3.7

* Respondents mentioning as the best indigenous windbreak species

The criteria for determining the quality of a fruit varies from one fruit type to another. Thus, a wide range of criteria pointed e.g. taste (sweetness or sourness), attractive colour, fleshiness and marketability are considered. The ideal fruit tree should also be resistant to pests (especially termites) and diseases have a short gestation period and bear many fruits regularly. It should also

be able to serve other functions in the seasons when it is not fruiting. Priority indigenous fruit species as determined from total ranking points accumulated in the survey are *Vitex doniana, Vitellaria paradoxa, Tamarindus indica, Carissa eduli, Strychnos spinosa, Annona chrysophyla and Ximenia americanas.*

Table 19: Priority indigenous fruit trees in the Lango farming system

Tree species name		Ranking points		Percentage preference*
Scientific	**Luo**	**Total**	**Mean**	
Vitellaria paradoxa	Yao	304	2.84	46.7
Tamarindus indica	Cwao	279	2.61	23.4
Vitex doniana	Owelo	338	3.16	10.3
Carissa edulis	Acuga	239	2.23	7.5
Strychnos spinosa	Akwalakwala	205	1.92	2.8
Annona chrysophyla	Obwolo	105	0.98	3.7
Ximenia americana	Olimo	102	0.95	3.7

* Respondents mentioning as best indigenous fruit species.

3.1.2.5 Tree establishment and management by households

Tables 20 and 21 show the most common tree propagation and management techniques used by households in the Lango farming system respectively. A majority of households use seedlings, wildings and natural regeneration as the major methods of tree propagation or tree establishment in the area (table 20). Very few households use stem cuttings and grafted seedlings as methods of tree propagation. Generally in the farming systems 44, 25, 19, 10 and 2% of the households use seedlings, wildings, natural regeneration, stem cuttings and grafted seedlings respectively.

A majority of households use tree seedlings for tree propagation. It is imperative, therefore, that they be trained on seed collection and nursery establishment and management skills as it seems that most of the seedlings currently being planted are got free from NGO's or/and government departments. If farmers are helped to develop these skills, then there will be an element of continuity. However, a good number of households still depend on natural regeneration for tree establishment. It would be necessary to compare and refine this indigenous knowledge that households have. Grafting of seedlings for improved growth and productivity is not common among households, but it is a skill that needs to be imparted to them.

Table 20: Tree propagation techniques used by households in the Lango farming system

Method of propagation	*% Households using it*
Use of tree seedlings	44
Use of wildings	25
Use of natural regeneration	19
Use of stem cuttings	10
Use of grafted seedlings	2

The major forms of tree management found in the farming system were weeding of tree seedlings and pruning of mature trees (table 21). Coppicing and pollarding of mature trees were done occasionally, while root pruning of trees was not done at all by households. 62, 15, 10, 3, 0 and 3 % of the households in the farming system managed the trees through weeding, pruning, coppicing, pollarding, root pruning and protect trees from fire and livestock respectively (Table 21).

Table 21: Tree management techniques used by households in the Lango farming system

Method of propagation	*% Households using it*
Weeding of seedlings	62
Pruning of tree crowns	15
Coppicing of trees	10
Pollarding of trees	3
Root pruning of trees	0
Protection from fire and livestock	3

The main tree management practiced by farmers is weeding and pruning of trees. However, elements like root pruning that are important when intercropping trees with crops is not performed. Assisting farmers in acquiring this skill is very important so as to improve the productivity of tree/crop systems in the area.

3.1.2.6 Factors affecting tree growing by households in the farming system

The major constraints to tree growing in the farming system are shown in table 22. Lack of planting materials and damage from pests (e.g. termites) and diseases were ranked as the most important factors that affect tree growing in the farming system. Other constraints to tree growing

in the farming system included lack of technical skills in tree growing, lack of awareness, land shortage, drought, bush fires and damage by livestock.

For agroforestry practices to be adopted by a majority of farmers in the farming system, it will be important to address issues on lack of knowledge on tree growing and also the lack of planting material or germplasm. This calls for intensive sensitization of the communities on tree growing, local seed collection, handling and storage. It will also be necessary to organize proper channels for seed supply and demand for households. The issues of pests and diseases also needs serious attention, especially termites that have proved to be a major limiting factor in tree planting efforts in the area. Research will need to find appropriate and affordable methods of controlling termites. Some work has already started in Kumi district through the Agroforestry Programme of FORRI mainly on identification of termites and the testing of some indigenous methods of termite control.

Table 22: Factors hindering tree growing in the Lango farming system

Factor	Ranking
Lack of technical skills in tree growing	3
Lack of planting materials	1
Lack of awareness	4
Bad weather e.g. drought	6
Land shortage	5
Bush fires	7
Damage from livestock	8
Pests and disease (termites)	2

NB: - The smaller the figure, the more serious the problem, while a dash indicates factor is not important in the district

3.1.2.7 Opportunities for agroforestry development in Lango farming system

Currently there are several institutions actively involved in promoting agroforestry activities in the farming system. Several CBO's in the Lango farming system have been promoting tree growing and sensitization on environmental issues in the area. Other institutions include NEMA, District Departments of Environment, Forestry and Agriculture Apart from these institutions; there are other opportunities that exit to promote the use of agroforestry technologies in these areas. Little tree cover has resulted in serious shortages of tree products and services. These can be overcome by promoting agroforestry technologies such as boundary and scattered tree planting for wood and energy requirements of the households. The use of shrubs such as *Calliandra* and *Leuceana* as

sources of fodder for livestock is another opportunity as feed for livestock is usually scarce especially during the dry season. The other major opportunity is the willingness of local governments to promote tree growing as an option for improving rural livelihoods in these areas. The promotion of improved tropical fruits such as mangoes and oranges in the farming system will greatly improve the income and nutritional status of households.

3.2 <u>Output 2:</u> *Appropriate propagation techniques for indigenous tree species identified and promoted.*

3.3 Output 3: *Existing (on-shelf) agroforestry technologies tested and promoted.*

4.3.1 Improved tropical fruits

Tables 23 and 24 show the survival of improved orange and mango cultivars planted in the three districts. Gnerally, the survival rates of the mango cultivars on-farm were high, with Bire cultivar showing the best survival across three districts (table 11).

An assessment of the fruit tree mother garden established in Kumi district was conducted during the project period. Percentage survival of the various fruit cultivars tested is indicated in table 13. The survival of Boribo mango cultivar was very low followed by Glenn. The main cause of the deaths was due to goats browsing on them.

Table 23: Survival of mango cultivars planted on-farm in the study area

District	***Sub-county***	***Parish***	***Cultivar***	***Percentage (%) survival***
Kumi	Nyero	Aguurut	Bire	48
			???	
Katakwii	Katakwii	Aliakamer	Bire	
			???	
		Abwaget	Bire	
			???	
Lira	Dokolo	Atur	Bire	
			???	
		Abyenek	Bire	
			???	
Mean survival for cultivars				

Table 24: Survival of orange cultivars planted on-farm in the study area

District	***Sub-county***	***Parish***	***Cultivar***	***Percentage (%) survival***
Kumi	Nyero	Aguurut	Washington navel	87
			Valencia	83
Katakwii	Katakwii	Aliakamer	Washington navel	
			Valencia	
		Abwaget	Washington navel	
			Valencia	
Lira	Dokolo	Atur	Washington navel	
			Valencia	
		Abyenek	Washington navel	
			Valencia	
Mean survival for cultivars				

25

Table 13: Survival of the various fruit cultivars in the tree mother garden in Kumi district.

Cultivars	**Survival (%)**
Apple mango	100
Glenn	66
Bire	100
Florigon	83
Boribo	33
Tommy artkins	83
Washington navel	83
Valencia	66

Figure 4:



Figure 5:



Figure 6:



Boundary tree planting

Figure 8: -



Table 14: Farmers evaluation of the improved fallow shrubs in the study areas

Improved fallow species	***% farmers ranking as best fallow***	***Attributes of fallow species***
Crotalaria grahamiana	43	• Gives good soil cover/canopy • Good at weed suppression • Shows a high soil fertility improvement • Has high leaf biomass production • Maintains soil moisture due to high shading • Able to control *striga* weed
Crotalaria paulina	29	• Has big leaf size that gives high biomass litter • Controls weed to some level • Soil clearly shows black colour difference
Crotalaria ochloreuca	23	• Eaten by goats and humans • Takes short time to mature and release leaf litter • Is generally weed tolerant • Fits well in the local cropping season • Soil fertility improvement can be realised easily and quickly • Is a good prolific seed producer making it sustainable
Tephrosia vogelli	5	• Good for soil fertility improvement • Good for trapping fish • Good for mole rat control using pounded leaves sprayed on the ground • Pest and disease resistant • Useful for control of ticks in cattle when pounded

4.3.2 Improved fallows

The growth of the improved fallow shrubs was very good in all the districts. Assessment of the maize test crop after fallowing the land showed that where the fallows had been established, there was clear evidence of soil fertility replenishment as shown by high crop yields got from these plots. The best performing shrub was *Crotalaria grahamiana* followed by *Crotalaria paulina and C. ochloreuca, Tephrosia vogelli* performed worst. Table 14 shows farmer's evaluation of these shrubs. Most farmers ranked C. *grahamiana* very high (43%) followed by C. *paulina* and C. *ochloreuca* (29 and 24% respectively).

Figure 7: -



5 CONCLUSIONS AND RECOMMENDATIONS

5.1 Lessons learnt

5.1.1 General

5.1.2 Partnerships and collaboration

5.1.3 Environmental impact

5.1.4 Stakeholders

5.1.5 Social equity

5.1.6 Economic impact

6 ANNEXES

References

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