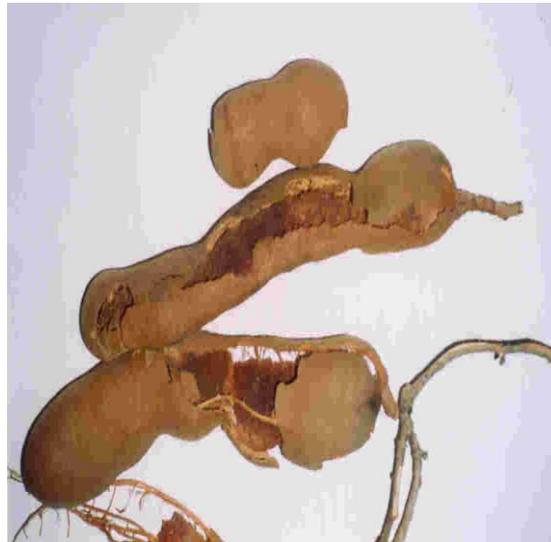


NETWORK OF UGANDAN RESEARCHERS AND RESEARCH USERS (NURRU)

RESEARCH REPORT

Potential of domesticating indigenous fruit trees for food security and household incomes in Lira district



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DEDICATION

*To the poor and food insecure rural households of Lira district
Who should know why?*

ACKNOWLEDGMENTS

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ABSTRACT

The potential of domesticating indigenous fruit trees for food security and household incomes in Lira district was assessed between August 2003 and July 2004. The specific objectives were to (1) determine fruit tree species diversity in the farming systems (2) generate a species priority list, characterise and document the values of indigenous fruit trees as perceived by farmers (3) develop criteria for selecting indigenous fruit trees for on-farm cultivation (4) assess the opportunities and constraints to promotion of indigenous fruit tree cultivation under the PMA and NFP programmes (5) assess farmers attitudes towards indigenous fruit tree cultivation.

One hundred and twenty semi-structured questionnaires and interviews using Participatory Rural Appraisal (PRA) method was used collect data. The questionnaire covered socio-economic variables of the respondents; opportunities and constraints to on-farm cultivation of indigenous fruit tree. It also included questions designed to collect information on farmers' attitudes towards indigenous fruit tree cultivation as well as uses of indigenous fruit trees by the local communities. On-farm walks were conducted to assess the proportion of farmland under indigenous fruit trees. Preference matrix ranking was used to generate a species priority list of indigenous fruit trees preferred by the local people. SPSS and MINITAB statistical package were used to analyze the questionnaire responses. Logistic regression analysis was carried out to show the influence of socio-economic characteristics on local people's willingness to plant indigenous fruit trees. On-farm diversity of indigenous fruit tree species was analyzed using Shannon-Wiener's diversity index (H').

It was found that on-farm diversity of indigenous fruit tree species was relatively high ($H' = 2.164$) with shear butter trees (*Vitallaria paradoxa*) being the most abundant. The average proportion of farmland under indigenous fruit trees was however low ($23.3\% \pm 5$). Shear butter trees, *Vitex doniana*, *Anona senegalensis* and *Tamarindus indica* were the most preferred indigenous fruit trees by the local people although their population are declining due to harvesting for charcoal production and firewood. The choice of fruit trees for on-farm cultivation varied from their food, medicinal to cash values. Peoples' willingness to plant indigenous fruit trees was influenced by their gender, education level, farm size and occupation status. Lack of awareness of the need to plant and manage indigenous tree resources; lack of seedlings in local nurseries; unclear markets, food values and poor propagation knowledge were the major hindrance to cultivation of indigenous fruit trees.

There is a need to: formulate clear policies and by-laws on conservation of indigenous fruit trees; address the issue of marketing and pricing of indigenous fruit tree products; provide material support to encourage identification and selection of species for domestication, improvement and commercialization; initiate education campaigns among farmers on the food and income potential of indigenous fruit trees, the dangers of deforestation and encouraging on-farm fruit tree-planting and agroforestry.

Key words: Domestication, indigenous fruits, farming systems, food security, Uganda.

CHAPTER ONE

INTRODUCTION

1.1 Background to the study

Rural poverty and malnutrition are often linked to poor farming, low agricultural production and limited off-farm incomes (Shah and Strong, 1999). According to the World Bank (1996), the growth rate in food production in Africa south of the Sahara should increase annually by 4% to achieve food security compared with the actual average of less than 2% over the last 30 years. Alternative sources of nutrition and income need to be introduced to supplement the agricultural crops that are currently grown. Brownrigg (1985) observed that small-scale subsistence farmers need to be helped out of poverty by diversifying agriculture and maintaining indigenous varieties of both food and fruit crops.

Today with a new understanding of the values of indigenous fruit trees in providing food security and meeting nutritional and economic needs (Chin, 1985; Roshetko and Evans, 1997), these trees are receiving more attention than before. Indigenous fruit species are high in fibre and minerals. Apart from their value in assuring food and nutritional security, the income potential from these trees is also enormous in the impoverished economy (Maghembe *et al.*, 1998). By selling condiments from these trees, farmers' annual incomes may be doubled (ICRAF, 2000).

1.2 Rationale and significance of the study

Many farmers in Uganda have not embarked on on-farm cultivation of indigenous fruit trees as significant components of their farming practices. Fruit trees are commonly found in home gardens and planted around homesteads as short-term relief for food shortages when new crops are still maturing. As a result, farmers have not considered the cultivation of indigenous fruit trees as a means of improving food security and enhancing their livelihood. This situation prevails in the Lango region and there is a need to upgrade the agricultural productivity in the region, alleviate poverty and improve the livelihood of the subsistence farmers by promoting on-farm fruit tree cultivation. In agroforestry, the practice is referred to as fruit tree domestication. As such, there was a genuine desire to assess the domestication potential of selected fruit trees for incorporation in the farming practices in the Lango region.

Uganda's policy framework for poverty reduction is the Poverty Eradication Action Plan (PEAP). One of its pillars is the Plan for Modernisation of Agriculture (PMA). PMA is a government strategy and operational framework for reducing poverty through improved agricultural production (Ministry of Agriculture, Animal Industry and Fisheries, 2000a & b). It is based on the understanding that increasing agricultural productivity, profitability and shifting from low value to higher value commodities will reduce poverty. Furthermore, it aims at transforming subsistence agriculture into market oriented agricultural production. The National Forest Plan (NFP) on the other hand aims at improving the farming practices by delivering agroforestry technologies.

The PMA, NFP and the accompanying improvement in agricultural service delivery through the National Agricultural Advisory Services (NAADS), offer prospects for scaling up on-farm fruit tree cultivation and making them prominent in the farming practices in the Lango region. This study has therefore been significant and timely as it has generated information required to enhance the achievement of the NFP, PMA and NAADS goals i.e. helping rural farmers to improve their incomes and opportunities to eradicate poverty.

The rationale for linking this study to the PMA and NFP is that both are central elements of the Government of Uganda's plan for eradicating poverty. A very large number (over 80%) of the people of Uganda are subsistence farmers and can be classified by all standards as poor. As many as 35% of the total population live in abject poverty (Ministry of Finance, Planning and Development, 2000). Smallholder agriculture is the main means of livelihood and needs to be integrated with on-farm tree/fruit tree planting for purposes of maintaining a sound environment and increasing the agricultural productivity per unit area of land.

1.3 Research problem

Little research has been undertaken on indigenous fruit trees in Uganda. Moreover, there is a dearth of information on indigenous fruit trees that can be incorporated in the farming practices. Under the proposed programmes for improved delivery of agricultural and forest services, each district will be expected to work within the framework of the NFP, PMA and NAADS. In the NFP, districts will be expected to develop and advise on agroforestry technologies (Forest Sector Coordination Secretariat, 2002). The promotion of on-farm tree planting and indigenous fruit tree domestication will be prominent features in the delivery of

service to farmers. However, this will be hampered by lack of information on the fruit trees that can be selected for domestication.

At the same time, the NFP (Ministry of Water, Lands and Environment, 2002) emphasizes the development of efficient and profitable commercial forestry in the country. Forestry in this context encompasses farm forestry. The need to provide information on selected indigenous fruit trees to support the implementation of the NFP, PMA and NAADS in Lira district and the policy implications, provided the impetus to carry out this study.

1.4 Research objectives

1.4.1 Overall objective

The overall objective of the study was to assess the potential of domesticating indigenous fruit trees for improved food security and household incomes in Lira district.

1.4.2 Specific objectives

- i. To determine fruit tree species diversity in the farming systems.
- ii. To generate a species priority list, characterise and document the values of indigenous fruit trees as perceived by farmers.
- iii. To develop criteria for selecting indigenous fruit trees for on-farm cultivation.
- iv. To assess the opportunities and constraints to promotion of indigenous fruit tree cultivation under the PMA and NFP programmes.
- v. To assess farmers attitudes towards indigenous fruit tree cultivation.

1.5 Research questions

The study sought answers to the following questions:

How do farmers perceive PMA and NFP? Which indigenous fruit trees are valued by farmers and why? Which indigenous fruits are sold in the local market and how much are the sold? What are the features of fruit trees that can aid their selection for on-farm cultivation? What are the attitudes of farmers towards cultivation of indigenous fruit trees? Which are the sources of planting materials and mode of regeneration of indigenous fruit trees? What are the local methods of propagating or managing indigenous fruit trees? What other tree species are grown together with fruit trees? Which agricultural crops would grow alongside fruit trees?

What opportunities and constraints exist for promoting on-farm cultivation of indigenous fruits trees under PMA and NFP?

1.6 Scope of the study

The overall objective of the study was to assess the potential of domesticating indigenous fruit trees for improved food security and household incomes in Lira district. As such, the study was limited to determining fruit tree species diversity in the farming systems; generating species priority list, characterizing and documenting the values of indigenous fruit trees as perceived by farmers; developing criteria for selecting indigenous fruit trees for on-farm cultivation; assessing the opportunities and constraints to promotion of indigenous fruit tree cultivation and assessing farmers attitudes towards indigenous fruit tree cultivation.

The scope of this research was therefore wide and could not be done only in one or two parishes. In order to have meaningful results and make realistic policy recommendations for incorporation of indigenous fruit tree cultivation in the farming practices in Lira district, the study covered all parishes of Adwari sub-county.

1.7 Limitations of the study

Insecurity in the study area was the major limitation to the study. The rebel activities made the area (Adwari) virtually inaccessible. This interfered a lot with farm walks and mobilization of respondents. Farmers were scattered in many places and their mobilization was quite difficult.

1.8 Structure of the report

This report is divided into five chapters. The present chapter (introduction) provides the background information to the study, an overview of the research problem and justification of the study. The objectives and related research questions, limitations and scope of the study are also presented. Literature review is presented in chapter two. The study area and methods are described in chapter three. The results and discussions are presented in chapter four. The conclusions and recommendations are in chapter five while raw data and research instruments are presented as appendices.

CHAPTER TWO LITERATURE REVIEW

2.1 General

Indigenous fruit trees have enormous potential in contributing to nutrition and cash economy of small-scale farmers (Okafor, 1988). Many of them are available in the dry seasons when food supplies are low, thus contributing significantly to the nutrition of low-income rural households (Karachi *et al.*, 1991; Maghembe and Seyani, 1991). *Tamarindus indica* for example is used to make juice in many countries of Africa (Kainja, 1991), while *Sclerocarya birrea* and *Uapaca kirkiana* are processed to make wine (Gambo *et al.*, 1990). Some indigenous fruits can be processed to make jam, chutneys and animal-feed concentrates but, as Campbell (1978) noted, indigenous fruits are not normally included in agricultural policies and have been neglected by research and extension programmes.

2.2 Indigenous fruit trees as nutrition supplement

With the increased climatic instability causing frequent agricultural crop failure, the role of indigenous food tree species in providing nutritional supplement to mankind is being recognized (Maghembe, 1995). Studies have shown that during the time of drought indigenous plants provide important sources of food and income for small-scale farmer households (Eriksen and Mutimba, 1998). A study by Mwanjumwa (1982) of the potential of using local fruits to meet the requirements of limiting micronutrients, vitamin A, C and calcium in the diet of the rural Kenyan populations revealed that wild fruit species were high in dry matter, fibre and minerals.

Wild fruit form important component of food source for people living in drier areas (Arum, 1989). Fruits such as *Tamarindus indica*, *Adasonia digitata* and *Strychnos spinosa* are utilized on day-to-day basis for dietary supplementation and are often sold in local markets. They have been used as life-sustaining food during famines brought about by prolonged drought (Arum, 1989).

2.3 Collection and marketing wild fruits

According to Campbell (1989), children are the major collectors of wild fruits, with adult women are the second major collection group of wild fruits. Local tenurial arrangements and access rights however affect the gathering activities. In Zimbabwe communal land fruit trees are individually owned if they are inside the home compound. In fields, trees and their products are

held privately only when crops are present. On communal grazing land, trees can be cropped by anyone, subject to restrictions on collection of unripe fruit. Indigenous fruit trees occur on these different land types and are also subject to local land rights (Gumbo *et al.*; 1990).

Marketing of wild fruits is also the domain of women and children (Gumbo *et al.*; 1990). Although women are responsible for the sale of wild fruits, they do not control money they receive from selling such fruits (Gumbo *et al.*, 1990).

2.4 Wild plants in farming systems

According to Alcorn (1984), farm households that use wild plants vary in size, composition, area of land owned, form and organization of labour. They include small-scale subsistence and infrasubsistence farmers with small parcels of land, shifting agriculturists, cattle ranchers, extractivists, pastoralists, agropastoralists, village-based communities, farmers of forest gardens, home gardens, tree orchards and terraces. The magnitude of the contribution of wild plants to their economy varies as well. Different patterns of farming integrating wild plants are found in areas, regions and countries, and even among villages within the same area, corresponding to their characteristic social, cultural and historical backgrounds (Alcorn, 1984).

Households with no tenure rights to their land (Salick and Lundberg, 1990) are always reluctant to plant fruit-trees because they fear other families might take over their land before the fruits became ripe. This situation has hindered fruit tree growing by many communities.

2.5 Domestication of indigenous fruit trees

Past utilization strategies of wild fruit trees were not sustainable because the strategies were relying on nature to supply and conserve the resources. Although some of the strategies served well in the past, they are not sustainable in the present (Ondachi, 1999; Maundu, 1996). Fruit tree domestication process has the primary purpose of enhancing the productivity and sustainability of farming systems (Simons, 1996). Introduction of fruit trees on farmland ensures that each household plants and manages the trees, which make the farming systems more sustainable and beneficial.

The idea of domestication is to identify and improve agroforestry tree species according to

farmer and market demand, and to make the planting material available to farmers (Ondachi, 1999). Domesticating trees involves accelerated and human-induced evolution to bring species into wider cultivation through a farmer-driven or market-led process (Simons, 1996). Domestication efforts focuses on priority species that have been determined by farmers because of their values and profitability following rigorous characterization methodologies to be (Gumbo *et al.*, 1990). Therefore, domestication is an interactive procedure involving the identification, production, management and adoption of desirable germplasm.

2.6 Challenges in conserving indigenous fruit trees

Indigenous fruit tree species have faced a great danger in the recent past due to high population growth, which exerted high pressure on woodland resources (Ondachi, 1999). For a long time, mankind has relied on nature to provide wild fruits without managing them or putting in any effort to propagate them. This, coupled with lack of *ex situ* conservation strategies, has led to loss of wild fruits in the natural woodlands and forests (Ondachi, 1999). It is no longer possible to leave such strategies to nature to provide the genetic resources. Planting of indigenous fruit trees on-farm therefore not only has the potential of improving food security but also conservation of biodiversity on-farm (Brownrigg, 1985).

CHAPTER THREE

STUDY AREA AND METHODS

3.1 Location and size

Adwari sub-county is located in Otuke county in the Northern part of Uganda ($2^{\circ} 25' - 2^{\circ} 47'$ N and $33^{\circ} 02' - 38^{\circ} 38'$ E). Broader in the east-west than north-south direction, it forms a wide wedge shape, irregular in nature. This sub-county and county is in a drier part of the district. The sub-county is bordered by sub-counties of Okwang in the west and Orum in the east (NEMA, 1997).

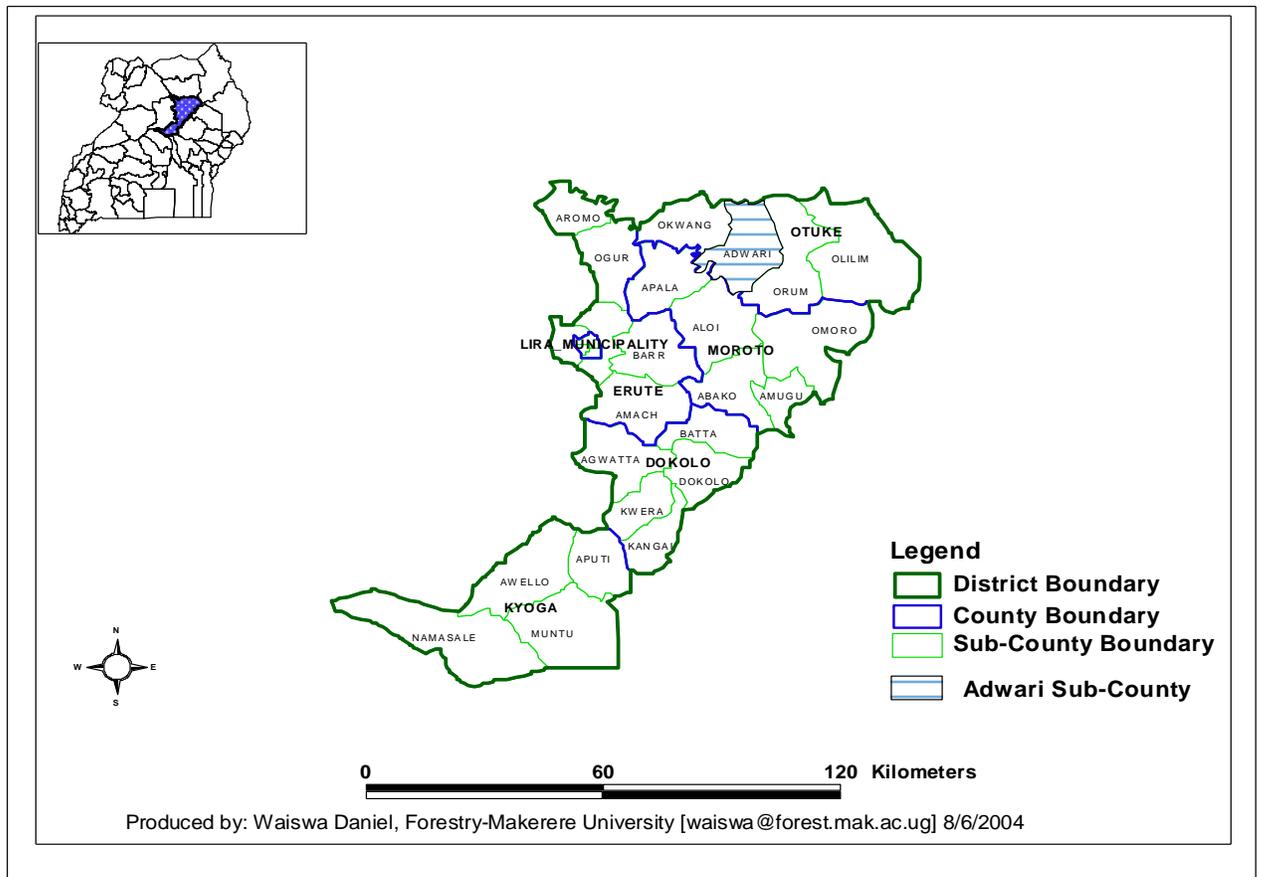


Figure 3. 1 Location of Adwari Sub-County in Otuke County, Lira District

3.2 Geology and soils

The geological composition of the soils of Adwari are considered to be mainly undifferentiated acid soils (NEMA, 1997). The deeply weathered soils have low cation exchange capacity and are virtually devoid of weathered minerals. They have a ferratic B-horizon and high clay content as well as strong water retention at wilting point. Nair (1985) indicates that these soils under the US soil taxonomy are oxisols and are referred to as low active clays.

The soils have good physical properties and their great depth, high permeability and stable microstructure makes them less susceptible to soil erosion. Their main problem is the poor chemical properties, strong inactivation of phosphorous and deficiency of nitrogen, phosphorous, manganese and zinc, which are very soluble at low pH and often reach toxic levels. Their nutrient ion is easily upset with inappropriate management (District Planning Unit, 2004).

3.3 Climate

The large swamps surrounding Adwari modify the climate. The rainfall is bimodal with peaks occurring during April/May and August/October. The average annual rainfall is 1200 mm. The rain is usually convectional and comes in the afternoons and evenings. A short dry spell is from June to July and long dry period is from December to March (Meteorological Department, 2004).

The average minimum and maximum temperatures are 22.5° C and 25.5° C, respectively. Absolute maximum temperature hardly falls below 13° C. This has been measured over a five-year period by the Meteorology Department (District planning Unit, 2004).

3.4 Vegetation

Adwari is mainly covered with wooded savanna, the predominant being the *Butryospermum* savanna associated with *Hyparrhenia* spp. Large areas of original tree-savanna occupied areas have been taken over by farming and grazing. The woodland reserve has been degraded by tree harvesting for fuel requirements and at present consists of bush vegetation (Forest Department-Lira District, 2004).

3.5 The people and the economy

The local communities in the area are Langi, who have lived in the place for a long period practicing shifting cultivation and pastoralism until they lost their cattle to the Karimojong rustlers (Planning Unit-Lira, 2004; NEMA, 1997). About 82% of the total population (and 79% of the households) derive their livelihood from farming. Production is at subsistence level with poor performance given the rudimentary method of production (NEMA, 1997). This has often resulted into annual food shortages, especially between April and July. The problem of poor production is compounded by unpredictable rain, pests and diseases such as cassava mosaic and recurrent food sales to meet household income needs.

3.6 Methods

3.6.1 Research design

The study involved a review of literature and relevant documents, socio-economic survey of the farmers, holding discussions with Sub-county and Parish Chiefs and Community Development Officer. In-depth interviews using questionnaire and preference ranking technique (a PRA method) were also used.

3.6.2 Reconnaissance survey

The purpose of conducting the reconnaissance survey was to collect information on the various aspects of the study as stated in the objectives. It was also used to develop a fieldwork procedure and to test the validity and reliability of questionnaire. The survey also gave an overview of the local community's perceptions of the indigenous (wild) fruit trees.

Individuals from all parishes in Adwari sub-county were mobilized and randomly interviewed. Information on the demographic and socio-economic characteristics of the respondents as well as specific issues relating to indigenous (wild) fruit trees was sought. This helped to revise the questionnaire before conducting the main interviews with the farmers. The insecurity in the sub-county however did not allow comprehensive on-farm walks. The sampling frame was checked and factors such as accessibility considered while planning the main survey.

3.6.3 Literature review and synthesis

Literature review and synthesis of information on the values and potential of indigenous fruit trees in the livelihoods of the rural poor was undertaken.

3.6.4 Questionnaire design, sample size and sample selection

Semi-structured questionnaire and interviews using participatory Rural Appraisal (PRA) method (Jackson and Ingles, 1998) was used (Appendix 1). The questionnaire covered socio-economic variables of the respondents; opportunities and constraints to promotion of indigenous fruit tree cultivation under the PMA and NFP programmes. It also included questions designed to collect information on farmers' attitudes towards indigenous fruit tree cultivation as well as uses of indigenous fruit trees by the local communities.

A total of 240 respondents were envisaged to be randomly selected and interviewed in all parishes of the sub-county. However, only 120 households were interviewed because the security condition in the area could not allow wide coverage and efficient mobilization of the respondents. Community Development Officers, Sub-county and parish chiefs were all involved in the mobilization of the respondents.

3.6.5 Farm walk

On-farm walks were conducted in Omito parish. Thirty farms were randomly sampled and surveyed. The aim of the farm walk was to observe and record indigenous fruit trees on the farms and assess by eye the proportion of farmland under fruit tree cultivation (Appendix 2).

3.6.6 Preference ranking

Preference matrix ranking was used to generate a species priority list of indigenous fruit trees preferred by the local people. Each respondent was asked to indicate 15 species in order of preference. The highest priority species out of fifteen was assigned 15 points, 14 points to the second highest and the lowest ranked species assigned 1 point. The points for each species were summed across all respondents. The species were then prioritized according to the total points scored.

3.7 Data analysis

SPSS and MINITAB statistical package were used to analyze the questionnaire responses. Logistic regression analysis (Green, 1995) was carried out to show the influence of socio-economic characteristics on local people's willingness to plant indigenous fruit trees. The dependent variables were regressed on the socio-economic variables. The description of the explanatory (independent) variables regressed (Table 3.1).

A dummy variable as a proxy for the dependent variable having a value of 1 was assigned a 'yes' response and a value 0 was assigned to a 'no' response (Koutsoyiannis, 1977). The linear logistic regression model has the form: $e^{\alpha + \beta_1 \chi_1 + \beta_2 \chi_2 + \dots + \beta_n \chi_n} / 1 + e^{\alpha + \beta_1 \chi_1 + \beta_2 \chi_2 + \dots + \beta_n \chi_n}$. Where e is the base of natural logarithms, α is the coefficient of the constant (intercept), β_n are slope parameters (corresponding coefficients) and χ_n are the values of the variables.

Shannon-Wiener's diversity index (H') was used to analyse on-farm diversity of indigenous fruit tree species. The index was chosen because it indicates the distribution of species and the number of species categories. The higher the value of the index, the more diverse the farms were in terms of indigenous fruit tree species and vice versa. The values of the index usually lie between 1.5 and 3.5, although in exceptional cases, they can exceed 4.5 (Kent and Coker, 1992).

$$H' = - \sum_{i=1}^s p_i \ln p_i$$

Where H'= Shannon-Wiener's diversity index

S = the number of species

p_i = the proportion of individuals or the abundance of the i^{th} species
expressed as a proportion of total number of individuals

ln = log base_e

DAFOR- an acronym for Dominant, Abundant, Frequent, Occasional and Rare (Forest Department, 1996) was used to rate to occurrence of indigenous fruit tree species on-farm. DAFOR scale was used because it is suitable for data generated by rapid assessment of plant species. The following criteria were used to rate the occurrence of the species in the study: rare (1-20), occasional (21-40), frequent (41-60), abundant (60-80) and dominant (>80).

Table 3.1. Explanatory variable and their expected signs

Variable	Description	Expected sign
Age	0 = Less than 25, 1 = Greater than 25 years	+
Education	0 = Non-formal, 1 = Formal	+
Family size	0 = Small (< 5), 1 = Large (> 5 persons)	+
Farm size	0 = Small (< 3 ha), 1 = Large (> 3 ha)	+
Gender	0 = Male, 1 = Female	+
Income (Ug. Shs.)	0 = Less than 200,000, 1 = Greater than 200,000	+
Land ownership	0 = Do not own land, 1 = owns land	+
Marital status	0 = Not married (single, divorced, widowed), 1 = married	+
Occupation	0 = Non-farmers, 1 = Farmers	+

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Demographic and socio-economic characteristics of respondents

The demographic and socio-economic characteristics of the respondents are presented in Table 4.1. The majority (66%) of the respondents were aged between 20-40 years. The average family size was seven people per household. Seventy four percent of the respondents were male and about 75% were subsistence farmers.

Eighty five percent of the respondents were married. Majority of the respondents had either primary or secondary education. About 68% of the respondents had an average annual income ranging from Shs. 150,500. More than 92% of the respondents owns land and about 72% owns more than 6 ha of land. However, much (60%) of the land owned has less than 25% tree cover.

4.2 Indigenous fruit trees that are grown/retained on private land

Ninety two of the respondents said they have indigenous fruit trees in their private lands. Fifteen indigenous fruit tree species were retained on private land. Shear butter tree (*Vitalleria paradoxa*), *Tamarindus indica*, *Bridelia scleroneura* were the most commonly to retained fruit trees on private land (Table 4.2).

Table 4. 1 Demographic and socio-economic characteristics of respondents (N = 120)

Variable	%
<i>Sex</i>	
Male	74
Female	26
<i>Age (years)</i>	
< 20	8
20 - 40	66
> 40	26
<i>Marital status</i>	
Single	9
Married	85
Divorced	6
Widowed	0
<i>Level of education</i>	
None	8
Primary	34
Secondary	49
College	9
<i>Occupation</i>	
Farmer	75
Trader	8
Service worker	25
Others (Student)	8
<i>Family size</i>	
< 5	25
6 to 10	55
None	2
> 10	19
<i>Annual income (Shs.)</i>	
< 100, 000	21
101,000 - 200,000	68
201,000 - 300,000	8
> 300,000	4
<i>Land ownership</i>	
Yes	92
No	8
<i>Size of land owned (ha)</i>	
< 1 ha	0
1 to 3	4
4 to 6	15
> 6	72
<i>Proportion of land under tree cover (%)</i>	
< 25	60
26 to 50	28
> 50	2

Table 4. 2 Indigenous fruit trees that are grown/retained on private land (N = 120)

Variable	%
<i>Wild fruit trees in the farmland</i>	
Yes	92
No	0
<i>Wild fruits trees retained on private land</i>	
Shear butter (Yao)	92
<i>Tamarindus indica</i> (Chwao)	62
<i>Bridelia scleroneura</i> (Orweco)	55
<i>Anona senegalensis</i> (Obwolo)	51
<i>Vitex doniana</i> (Owelo)	51
<i>Ximenia Americana</i> (Olimu)	51
<i>Carisa edulis</i> (Achuga)	42
<i>Vanueria apiculata</i> (Amalera)	34
<i>Diospyros mespiliformis</i> (Chumu)	32
<i>Strychnos spinosa</i> (Akwalakwala)	32
<i>Ficus sur</i> (Ebuu/Oduru)	26
<i>Ficus sycomorus</i> (Olam)	25
<i>Lantana camara</i> (Cholawinyo)	23
<i>Phoenix reclinata</i> (Otit)	4
<i>Borassus aethiopum</i> (Tugu)	2

Local names are in brackets

4.3 Diversity of indigenous fruit trees on farms

A total of 16 indigenous fruit tree species was recorded in the 30 farms surveyed. Their diversity on-farm (Table 4.3) was relatively high ($H' = 2.164$). Other than shear butter trees, these indigenous fruit trees were not deliberately planted. They grow on their own on the farm and were tended. Due to prolonged drought, continuous cultivation, fuelwood and charcoal burning, most of the indigenous fruit trees had disappeared or were threatened to disappear. Indigenous fruit trees although nutritious, are not very popular with the younger generations. Some were associated with poverty while others were considered primitive. There was therefore a tendency towards the exotic fruits. This has also been observed in other countries (Chweya, 1997; Gumbo *et al.*, 1990).

Table 4. 3 Diversity of indigenous fruit trees on farms

Species	Number of species	Rank	Pi	ln Pi	Pi ln Pi
<i>Anona senegalensis</i>	101	2	0.175	-1.743	-0.305
<i>Borassus aethiopum</i>	27	7	0.047	-3.062	-0.143
<i>Bridelia scleroneura</i>	22	8	0.038	-3.267	-0.125
<i>Carisa edulis</i>	33	6	0.057	-2.861	-0.164
<i>Diospyros mespiliformis</i>	11	11	0.019	-3.960	-0.075
<i>Ficus natalensis</i>	3	14	0.005	-5.259	-0.027
<i>Ficus sur (Ebuu)</i>	3	14	0.005	-5.259	-0.027
<i>Ficus sycomorus</i>	9	12	0.016	-4.161	-0.065
<i>Grewia mollis</i>	40	4	0.069	-2.669	-0.185
<i>Lantana camara</i>	1	16	0.002	-6.358	-0.011
<i>Shear butter</i>	176	1	0.305	-1.187	-0.362
<i>Strychnos spinosa</i>	6	13	0.010	-4.566	-0.047
<i>Tamarindus indica</i>	35	5	0.061	-2.802	-0.170
<i>Vanueria apiculata</i>	11	10	0.019	-3.960	-0.075
<i>Vitex doniana</i>	82	3	0.142	-1.951	-0.277
<i>Ximenia americana</i>	17	9	0.029	-3.525	-0.104
Total	577		$H' = - \sum Pi \ln Pi =$		2.164

Frequency distribution analysis indicated that three of the indigenous fruit trees- *Vitalleria paradoxa* with 176 trees (30.5%), *Anona senegalensis* (17.5%), *Vitex doniana* (14.2%) occurred at a high density on farms (Table 4.2). However, species occurrence rating using DAFOR scale (Table 4.1) showed that 50% and 31% of the indigenous fruit trees species were rated as rare and occasional respectively. There were no frequent and abundant species.

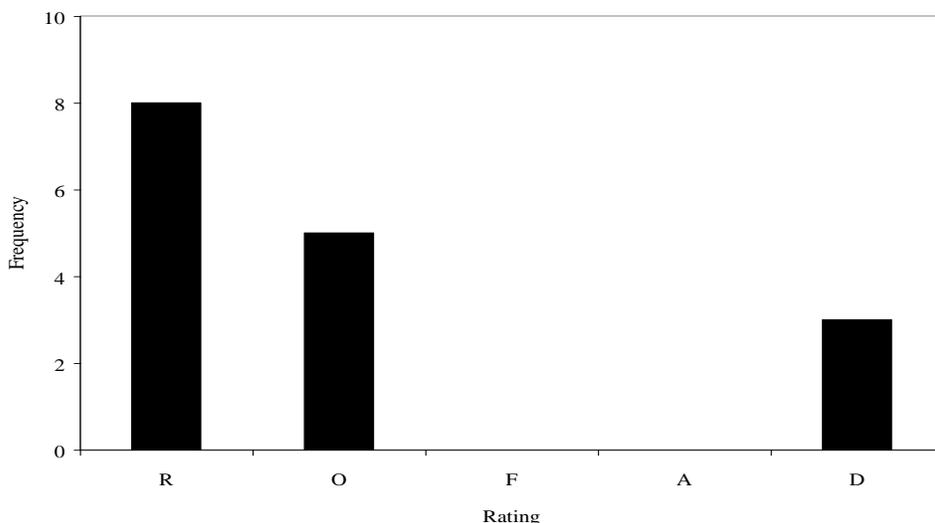


Figure 4.1: Indigenous fruit tree species occurrence rating on farms.

The average proportion of farmland under tree cover was low ($23.3\% \pm 5$) (Table 4.4). There were only six farms with fruit tree cover greater than or equal to 40% of the total farmland area. The low proportion of farmland under tree cover implies that a lot has to be done if framers are to meaningfully integrate indigenous fruit trees in their farming systems.

Table 4. 4 Proportion of farmland under indigenous fruit tree cover

Farm number	Area under tree cover (%) SE \pm 5	Farm number	Area under tree cover (%) SE \pm 5
1	30	15	10
2	15	16	45
3	25	17	20
4	10	18	15
5	15	19	15
6	40	20	30
7	20	21	10
8	20	22	15
9	10	23	30
10	25	24	40
12	30	25	20
13	50	26	15
14	15	27	40
15	10	28	50
16	45	29	30
17	20	30	10
Average farmland under tree cover		=	23.3 (\pm 5)

The high percentage of rare and occasional indigenous fruit tree species on-farm raises concern over the status of the species over time as clearing for agriculture, fuelwood and charcoal production continues. As noted by Sheail *et al.* (1997) to leave nature alone would defeat the purpose of nature conservation. Therefore, there is a strong need to advocate for the management of indigenous fruit trees on-farm. Although these fruit trees may not have high commercial value now, their existence is of high conservation importance.

4.4 Regeneration of fruit trees and local people's perception of whether indigenous fruit trees should be cultivated

Majority (85%) of the respondents said that indigenous fruit trees were growing naturally. Only a small proportion (15%) said that some indigenous fruits were planted (Table 4.5). The indigenous fruit trees found in cropland were either planted or preserved when new plots were being cleared. Some may have regenerated from coppicing like *vanueria apiculata*.

Table 4. 5 Mode of regeneration and local people’s perception of whether wild fruit trees should be cultivated (N = 120)

Variable	%
<i>Mode of regeneration of fruit trees</i>	
Both planted and growing naturally	15
Growing naturally	85
<i>Should wild fruits be cultivated?</i>	
Yes	89
No	11

4.5 Criteria for identifying suitable wild fruit trees for on-farm cultivation

Farmers who either retained or planted indigenous fruit trees in their land had different criteria to choose or retain indigenous fruit trees. Food value and cash values were the most commonly used criteria. More than 60% of the farmers mentioned provision of food as their main selection criteria. Other criteria used for identifying suitable trees for on-farm cultivation included medicinal value, growth habit (does not shade the agricultural crops), early fruiting, ease of management and drought resistance (Table 4.6).

Table 4. 6 Criteria used to identify wild fruit trees for on-farm cultivation (N = 120)

Criteria	%
Food value (domestic consumption)	66
Cash value	58
Medicinal value	28
Growth habit (doesn't shade crops)	27
Ease of management	6
Drought resistance	4
Early fruiting	2

4.6 Sources of planting and the period local people have planted indigenous fruit trees

The majority (55%) of the respondents said they have never planted indigenous fruit trees, 15% reported having planted indigenous fruit trees less than ten years. Eleven percent said they have grown these indigenous fruit trees for 10 years and 6% reported to having growing the fruit trees since childhood (Table 4.7).

Farmers reported three sources of planting materials for indigenous fruit trees. These sources

included wildlings (47%); Government/NAADS/Extension Agents (42%) and local tree nurseries (17%).

Table 4. 7 Sources of planting and the time local people have grown indigenous fruit trees (N=120)

Variable	%
<i>Sources of planting materials</i>	
Wildlings	47
Government/ NAADS/Extension workers	42
Local nurseries	17
<i>Time one has grown wild fruit trees</i>	
Since childhood	06
< 10 years	15
Over 10 years	11
Never grown them	55

4.7 The demographic and socio-economic variables that influences farmers' willingness to plant indigenous fruit trees

The logistic regression analysis of the relationship between the demographic and socio-economic variables and peoples' willingness to plant indigenous fruit trees on-farm (Table 4.8) indicates that gender, education, farm size and occupation influences farmers' willingness to plant indigenous fruit trees.

Table 4. 8 Logistic regression of socio-economic characteristics that influences the local people's willingness to plant indigenous fruit trees

Variable	Coefficient	S.E	± Probability (5%)	R	Odd ratio
Age	-0.73	0.19	0.64	-0.05	-0.13
Education	1.21	0.37	0.03	0.11	0.14
Family size	-0.97	0.16	0.40	-0.08	-0.01
Farm size	1.17	0.44	0.04	0.16	0.19
Gender (sex)	0.83	0.25	0.01	0.18	0.16
Income	0.54	0.18	0.09	0.07	0.09
Land ownership	-0.88	0.40	0.82	-0.02	0.01
Marital status	-0.67	0.15	0.55	-0.04	-0.11
Occupation	1.11	0.39	0.01	0.13	0.17

Gender significantly influenced local people's willingness to plant indigenous fruit trees on their farms (R = 0.18, P = 0.01). Women are willing more than men to plant indigenous fruit trees in

their gardens. The marginal change on the willingness to plant indigenous fruit trees as a result of gender, is 0.16 indicating that the probability of planting of indigenous fruit trees by female increases by 16%. There is therefore an incentive to encourage women to invest their labour in fruit tree planting.

Education level positively influenced local people's perception to plant indigenous fruit trees. People with formal education are expected to be more willing to plant the tree than the uneducated people because they are better informed and conscious of food security. The marginal effect of 0.14 of the willingness to plant indigenous fruit trees as a result of education implies that there is a 14% greater chance of planting trees if the respondent had formal education. Education increases people's environmental awareness, appreciation of the value of trees and people's ability to communicate (Obua *et al.*, 1998).

People whose occupation was farming were willing to plant the indigenous fruit trees than non-farmers. The marginal change on the willingness to plant these fruit trees as a result of occupational status is 0.17 implying that if the respondent is a farmer, the probability of planting indigenous fruit trees increases by 17%. Farmers usually attach values to trees and withstand high risks associated with planting and managing trees in their gardens.

Farm size positively influenced peoples' willingness to plant indigenous fruit trees ($R = 0.16$, $P = 0.04$). The larger the farms the more willing people are to plant indigenous fruit trees. Larger farms may have greater incomes and more cash reserves to sustain risks of crop failure and allocate resources to new inputs. Small farms are scarce in cash reserves and arable land.

Age, family size, income, land ownership and marital status did not influence people's willingness to plant indigenous fruit trees. As such, people would plant the indigenous fruit trees irrespective of their age, family size, income, land ownership and marital status.

4.8 Socio-economic values of indigenous (wild) fruit trees

In spite of the fact that few farmers are growing or managing indigenous fruit trees, many people seem to know their values. All respondents said that families depend on indigenous fruits trees at time of food shortage and that indigenous fruit trees are a good source of income. Asked whether indigenous fruit trees has a medicinal value, the majority (85%) and

only 15% did not know about the medicinal value of fruit trees. The majority (57%) reported that indigenous fruit trees could be intercropped with agricultural crops (Table 4.9).

Table 4. 9 farmers' perception on the values of indigenous (wild) fruit trees (N = 120)

Variable	%
<i>Families depend on indigenous fruits trees at time of food shortage</i>	
Agree	100
Disagree	0
Don't know	0
<i>Indigenous fruit trees is a good source of income</i>	
Agree	100
Disagree	0
Don't know	0
<i>Indigenous fruit trees has a medicinal value</i>	
Agree	85
Disagree	0
Don't know	15
<i>Indigenous fruit trees can be intercropped with agric. crops</i>	
Agree	57
Disagree	21
Don't know	23

Asked whether they would grow indigenous fruit trees if planting materials were provided, 85% of the respondent said they would. Many (77%) said they would grow fruit trees for domestic consumption and sale and 62% said they would grow for shade on compounds. Others said they would plant indigenous fruit trees for domestic consumption only, firewood, building materials and as ornamental/amenity (Table 4.10).

Table 4. 10 Farmers' perception on whether they would grow indigenous fruit trees if given planting materials and the reasons for growing fruit trees (N=120)

Variable	%
<i>Would you grow indigenous fruit trees if planting materials were available</i>	
Yes	81
No	11
<i>Why would you grow them</i>	
Domestic consumption only	06
Domestic consumption and sale	77
Provide shade on compound	62
Firewood	11
Building materials	42
Medicinal value	17
Amenity	08

4.9 Indigenous fruit trees preferred by the local people

A wide range of trees has been identified as sources of edible fruits. The highest ranked species was Shear butter trees followed by *Vitex doniana* and *Anona senegalensis* (Table 4.11). Plates 1 (a) – 1 (l) show some of this preferred species.

Table 4. 11 List of farmers' priority indigenous fruit tree species (in order of importance)

Indigenous fruit trees	Weight	Rank
Shear butter tree (Yao)	754	1
<i>Vitex doniana</i> (Owelo)	517	2
<i>Anona senegalensis</i> (Obwolo)	463	3
<i>Tamarindus indica</i> (Chwao)	418	4
<i>Bridelia scleroneura</i> (Orweco)	361	5
<i>Vanueria apiculata</i> (Amalera)	288	6
<i>Ximenia americana</i> (Olimu)	275	7
<i>Carisa edulis</i> (Achuga)	239	8
<i>Diospyros mespiliformis</i> (Chumu)	214	9
<i>Borassus aethiopum</i> (Tugu)	201	10
<i>Ficus sur</i> (Ebuu/Oduru)	178	11
<i>Strychnos spinosa</i> (Akwalakwala)	155	12
<i>Ficus sycomorus</i> (Olam)	113	13
<i>Lantana camara</i> (Cholawinyo)	86	14
<i>Phoenix reclinata</i> (Otit)	52	15

Local names are in the brackets

Plate 1 Some of the indigenous fruit trees preferred by the local communities



Plate 1 (a) *Vitellaria paradoxa* (Shear nut tree).



Plate 1 (b) *Vitex doniana* (Owelo).



Plate 1 (c) *Phoenix reclinata* (Otit).

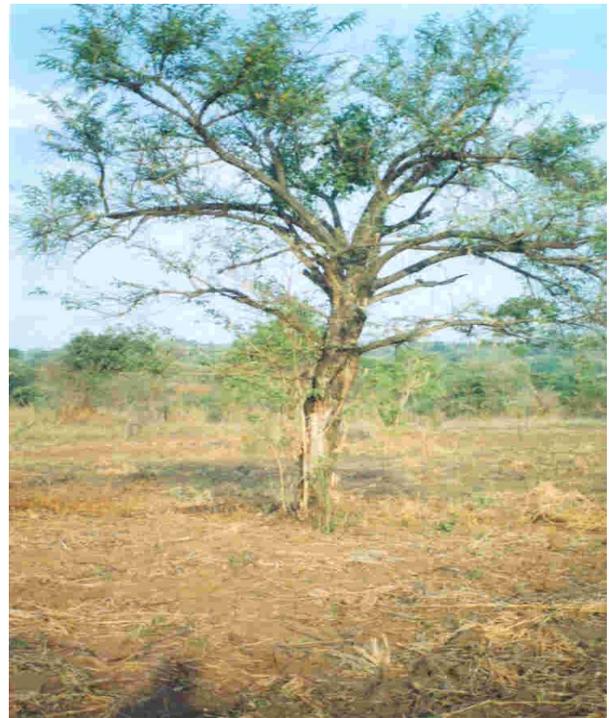


Plate 1 (d) *Bridelia scleroneura* (Orweco).

Indigenous fruit trees preferred by the local communities (Continuation)



Plate 1 (e) *Carisa edulis* (Achuga).



Plate 1 (f) Fruits of *Carisa edulis*.

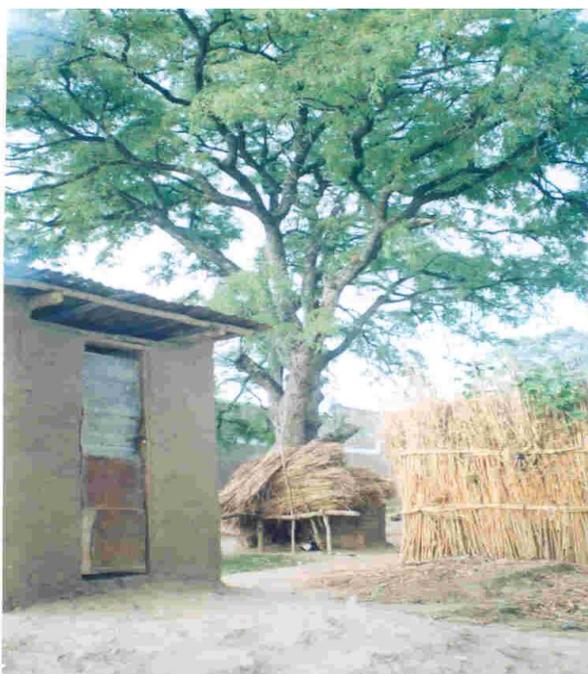


Plate 1.(g) *Tamarindus indica* (Chwao).

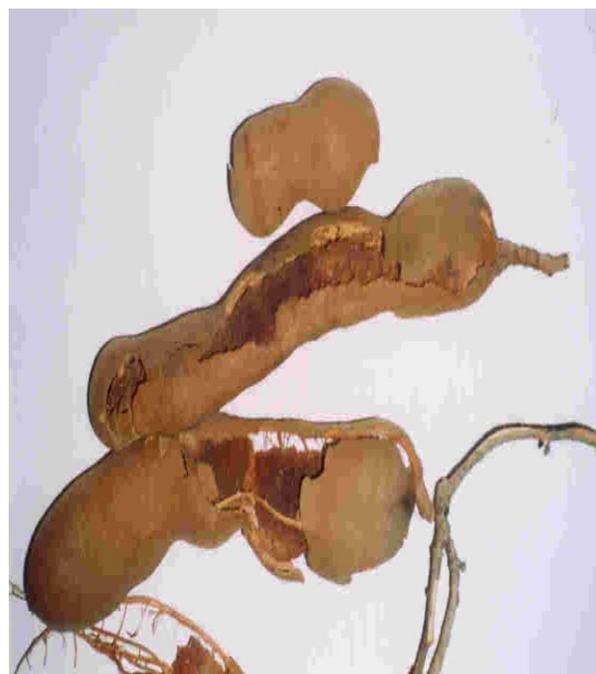


Plate 1 (h) Fruits of *Tamarindus indica*.

Indigenous fruit trees preferred by the local communities (Continuation)



Plate 1 (i) *Borassus aethiopum* (Tugu).



Plate 1 (j) *Anona senegalensis* (Obwolo).



Plate 1 (k) *Psidium guajava* (Guava) – naturalized.

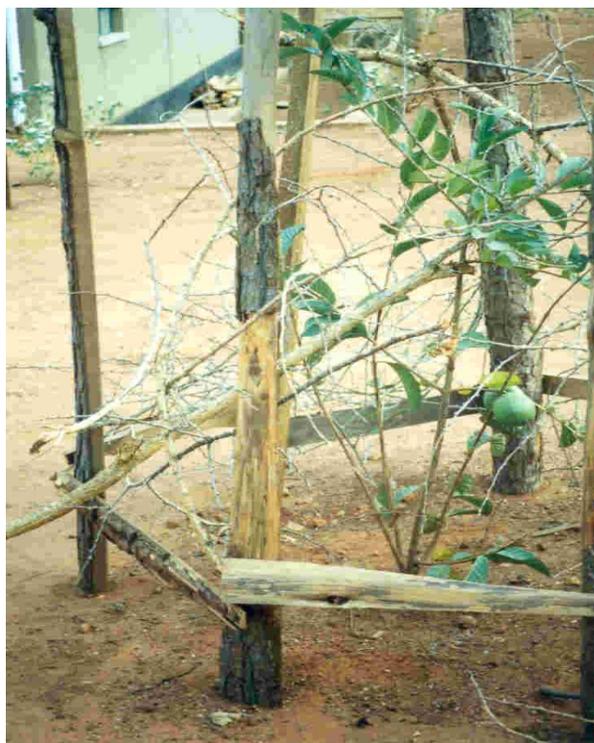


Plate 1 (l) One of the management technique to protect fruit trees by local people

4.10 Tree species grown together with indigenous fruit trees on farmland

Many tree species including exotic fruit trees were grown or retained to grow together with indigenous fruit trees on farm by local people (Table 4.12). The most common were *Mangifera indica*, *Carica papaya*, *Citrus limon*, *Citrus sinensis*, *Citrus reticulata*, Combretum species, *Psidium guajava*, *Senna siamea* and *Piliostigma thonningii* (Ogali). Others included *Markhamia lutea*, *Acacia* spp., *Albizia coriaria* (Itek), *Eucalyptus* spp and *Terminali glaucescens* (Opok).

Table 4.12 Other tree species grown together with indigenous fruit trees on farmland (N = 120)

Tree species	%
<i>Acacia</i> spp. (Okutu)	59
<i>Albizia coriaria</i> (Itek)	43
<i>Carica papaya</i> (Apapalo)	68
<i>Citrus limon</i> (Alemon awach)	41
<i>Citrus reticulata</i> (Magada)	46
<i>Citrus sinensis</i> (Acungwa)	66
Combretum spp.(Odugu)	66
<i>Eucalyptus</i> spp.	61
<i>Grewia mollis</i> (Opobu)	40
<i>Mangifera indica</i> (Aeme)	80
<i>Markhamia lutea</i> (Nsambya)	56
<i>Moringa oleifera</i>	27
<i>Piliostigma thonningii</i> (Ogali)	40
<i>Psidium guajava</i> (Amapera)	45
<i>Senna siamea</i> (Agacia)	48
<i>Terminali glaucescens</i> (Opok)	21

Local names are in the brackets

4.11 Agricultural crops grown alongside indigenous fruit trees

A large number of crops were grown alongside indigenous fruit trees (Table 4.13). Sorghum (83%), millet (74%), pigeon peas (57%), sesame (51%) and beans (49%) were the major ones. Many farmers said they are not willing to invest their labour on growing and managing indigenous fruit trees alone but would prefer to retain or plant fruit trees together with food or cash crops if planting materials for fruit trees were available.

Table 4. 13 Farmers’ responses to agricultural crops grown alongside fruit trees (N=120)

Crop	%
Sorghum	83
Millet	74
Pigeon peas	57
Sesame	51
Beans	49
Cassava	43
Cotton	43
Sunflower	42
Yams	42
Cow peas	40
Groundnuts	36
Pumpkin	34
Maize	32
Green gram	23
Sweet potatoes	21
Banana	15
Soya beans	13
Cucumber	9
Ginger	9
Passion fruits	9
Curcuma spp. (Bingali)	8
Rice	4
Tobacco	4

4.12 Local people’s perception of NAADS, NFP, PMA and extension workers

Ninety six percent of the respondents said they have ever had about NAADS (National Agricultural Advisory Services), NFP (National Forest Plan) and PMA (Plan for Modernization of Agriculture). They said NAADS helps in training farmers on modern farming methods, giving advice to farmers to form farmers' group in order to be supported and giving guidance on growing high yielding crops that are early maturing (Table 4.14). This information is vital in scaling up the activities of NAADS and achieving the objectives of PMA and NFP.

Majority (85%) of the farmers said they have ever been visited by extension workers. The information given to them by extension workers included advice on planting seasons/timely planting, early land preparation, pest-control, marketing information, post-harvest handling, crop rotation, group farming for cash & poverty alleviation, soil fertility maintenance (Table 4.14).

Table 4. 14 Farmers' perception about NAADS, NFP, PMA and extension workers (N = 120)

Variable	%
<i>Ever heard about NAADS, NFP and PMA</i>	
Yes	96
No	4
<i>What do you known about NAADS, NFP, PMA</i>	
Training farmers on modern farming methods	95
Advising farmers to form farmers' group in order to be supported	59
Guidance on growing high yielding crops that are early maturing	32
<i>Ever been advised by extension worker</i>	
Yes	85
No	8
<i>What information have you been given by extension worker</i>	
Information on planting seasons/timely planting	68
Early land preparation	51
Pest-control	34
Marketing information	28
Post-harvest handling	23
Crop rotation	21
Group farming for cash & poverty alleviation	4
Soil fertility maintenance	13

4.13 Indigenous knowledge of propagation and management of indigenous fruit trees

Table 4.15 indicates that the local people practice very little or no management of indigenous fruit trees. Only a small number (21%) of the respondents indicated they were carrying out some form of management.

Table 4. 15 Management of indigenous (wild) fruit trees on private lands (N = 120)

Variable	%
<i>Any form of mgt of indigenous fruit trees</i>	
Yes	21
No	74
<i>Kinds of Management carried out</i>	
Pruning	58
Weeding	55
Fire control	15
Termite control	4
Pollarding	2

Knowledge of propagation was very low among the respondents. Only 25% said they were practicing some form of artificial propagation (Table 4.16). It is clear that farmers still regard indigenous fruit trees as wild and planted by God. There has been little effort to plant indigenous fruit trees. Lack of awareness and unavailability of seedlings were said to be major constraints to planting indigenous fruit trees.

Table 4. 16 Local methods of propagating indigenous (wild) fruit trees (N = 120)

Variable	%
<i>Do you know any local method of propagating indigenous fruit trees</i>	
Yes	25
No	66
<i>Description of the methods</i>	
Transplanting	55
Direct seeding/sowing on the farm	21
Sowing on the nursery	25
Cuttings	8

4.14 Market potential of indigenous (wild) fruits

Fruits of shear butter (*Vitellaria paradoxa*) and *Tamarindus indica* were reported to be sold in the local market (Table 4.17). Though their prices are lower than prices of fruits such as *Mangifera indica* (mangoes), *Psidium guajava* (Guava), and *Citrus reticulata* (Tangerine) (Table 4.18), this shows that indigenous fruit trees have the potential for commercialization. Lack of a developed market for indigenous fruits can be explained in part by the fact that many people have free access to wild fruits and do not perceived them as having market. Savanna woodlands are important sources shear nuts, tamarind, *Vitex doniana*, *Bridelia scleroneura*, *Borassus aethiopum*, *Ximenia americana* and *Vanueria apiculata* which are freely harvested and consumed locally.

The other reason for lack of a developed market for indigenous fruits could be related to consumers taste and preference for exotic fruits like apples, citrus (lemon, tangerine and orange), mangoes, guava, avocado, bananas and pawpaws. Many urban consumers indigenous (wild) fruits as food for the poor. This perception of the wild fruits affects their market

demand and consumption., a problem that needs to be overcome under the NFP and PMA if indigenous fruit trees are to be domesticated to improve household food security and nutrition.

Table 4. 17 Indigenous (wild) fruits sold in local markets (N =120)

Variable	%
<i>Are wild fruits sold in local market</i>	
Yes	100
No	0
<i>Wild fruits sold in local market</i>	
Shear butter	96
Tamarindus indica	47
<i>Prices of wild fruits in local markets</i>	
Shear butter	
100 -200= (Mugful)	91
4,000-8,000= (Basinful)	15
Tamarindus indica	
50 -200=	47

Table 4. 18 Exotic fruits sold in the local markets

Exotic fruits	Quantity	Price (Shs.)
<i>Mangifera indica</i> (Mangoes)	1 dish	500 -1000
<i>Psidium guajava</i> (Guava)	1 dish	800 -1500
<i>Carica papaya</i> (Pawpaw)	1 fruit	200 - 500
<i>Citrus limon</i> (Lemon)	1 dish	300 - 500
<i>Citrus reticulata</i> (Tangerine)	1 dish	1000 -1500
<i>Citrus sinensis</i> (Orange)	1 dish	500 - 1000
Musa spp (Sweet bananas)	1 bunch	300 - 500
<i>Persea americana</i> (Avocado)	1 fruit	100 - 300
Apple	1 fruit	500 - 600

4.15 Conservation status of indigenous fruit trees

Figure 4.1 shows that the population of the 10 most preferred indigenous fruit trees is declining. This poses a major concern for the domestication potential of the fruit trees because the wild populations would be the major source of planting materials. Decline in the wild populations would adversely affect any effort under NFP and PMA to domesticate the indigenous fruit trees.

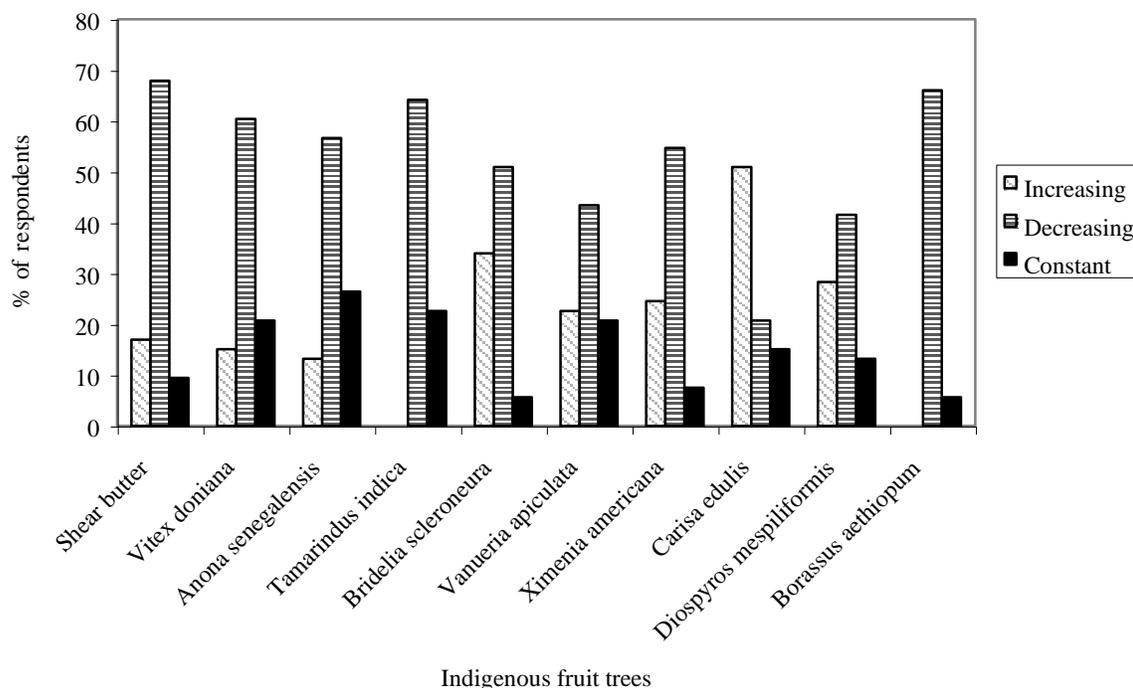


Figure 4. 1 Conservation status of indigenous fruit trees in Adwari Sub-county

4.16 Conservation threats to indigenous (wild) fruit trees

The main threats to indigenous fruit trees are tree cutting for charcoal production and firewood, reported by 68% and 55% of the respondents respectively. Wild fires in the dry season and clearing agricultural land were other important threats stated by 34% and 32% of the respondents (Table 4.19). Exploitation of wood for making mortars, timber and house construction, beehives and inability of some trees to sprout once cut down were considered to be less serious threats to the conservation of the indigenous fruit trees. Plates 2 (ha) – 2 (h) show some of the threats.

Table 4. 19 Reasons for decreased in number of indigenous (wild) fruit trees over the past years

Reason for decrease	%
- Charcoal burning	68
- Firewood	55
- Wild fires in dry seasons	34
- Clearing land for Agriculture	32
- Making mortars	23
- Exploitation for timber and house construction	21
- Beehives	11
- Some trees don't sprout once cut down	2

Plate 2 Conservation threats to indigenous fruit trees



Plate 2 (a) Heap of firewood by roadside for sale. Plate 2 (b) Sacks of charcoal by roadside for sale.

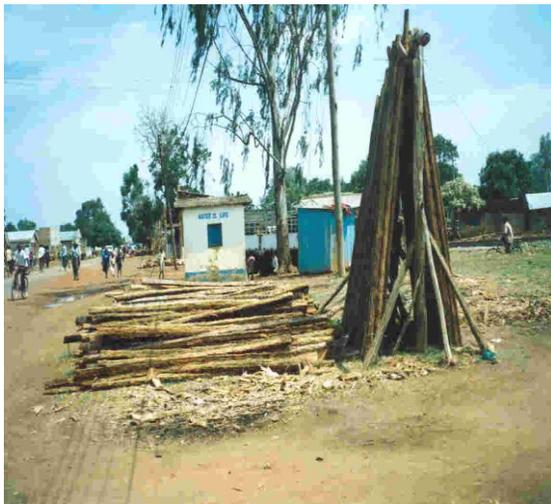


Plate 2 (c) Timber from *Borassus aethiopum* being sold.



Plate 2 (d) Beehives made from *Borassus aethiopum*.

Conservation threats to indigenous fruit trees (Continuation)



Plate 2 (e) Old winnower nearly being disposed.

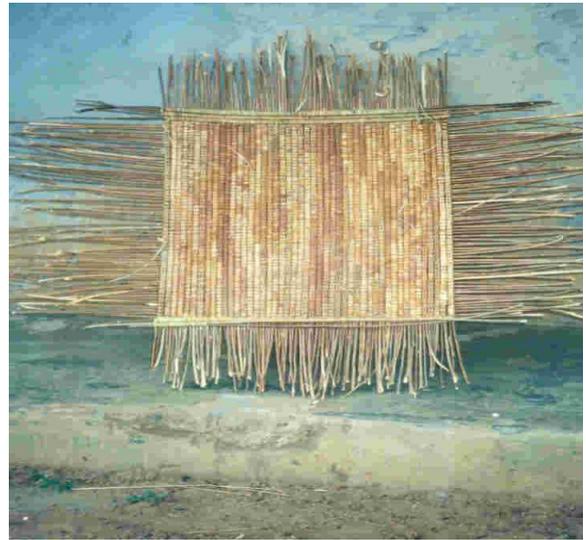


Plate 2 (f) New winnower being woven from the fibres of *Grewia mollis*.

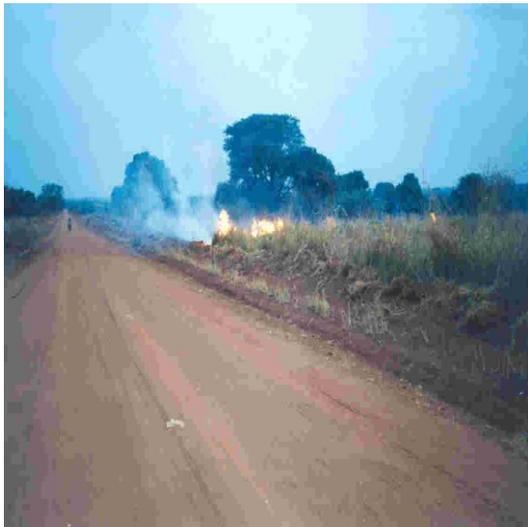


Plate 2 (g) Bush burning- a big threat to indigenous fruit trees.



Plate 2 (h) Land cleared off vegetation for agriculture.

4.17 Constraints to planting/managing wild fruit trees on farmland and the suggested solutions

A number of factors hindered planting and management of indigenous fruit tree species on the farm. The factors include lack of awareness by farmers on the need to plant and manage indigenous fruit tree species; unclear information about food values of the wild fruits; lack of seedlings of indigenous fruit tree species in local nurseries; lack of clear markets for indigenous fruits, slow growth and low prices of indigenous fruits and poor propagation knowledge. Other problems are insecurity in the area; competition of trees with crops; fruit trees attracting birds which destroy crops; lack of awareness of planting seasons and lack of money to buy improved planting materials (Table 4.20).

Farmers suggested provision of better planting materials; sourcing information on planting seasons; information on the food values of wild fruits; improving security; developing markets of indigenous fruits and establishing demonstration tree nursery (Table 4.20).

Table 4. 20 Constraints to planting/managing wild fruit trees on farmland by local people and the suggested solutions (N = 120)

Variable	%
<i>Constraints</i>	
- Lack of awareness on the need to plant and manage indigenous fruit tree species	68
- Unclear information of food values of the wild fruits	63
- Insecurity in the area	65
- No clear market for wild fruits	60
- Some wild fruit trees take so long to fruit	50
- Fruit trees attract birds which destroy crops	50
- Limited knowledge of nursery and tree propagation	36
- Some wild fruit competes with crops	34
- No planting materials	29
- Planting seasons of wild fruits are unknown to farmers	24
- No money to buy planting materials	19
<i>Solutions to such problems</i>	
- Provide planting materials	68
- Acquaint farmers with information on planting seasons	64
- Educate farmers on the food values of wild fruits	62
- Provide security to the area	62
- Assure farmers of the markets of wild fruits	57
- Give money to farmers to buy seedlings	57
- Provide demonstration nursery to farmers	44

4.18 Opportunities for domesticating/ planting indigenous fruit trees by local people

In spite of the numerous constraints, there are opportunities for domesticating indigenous fruit trees. Opportunities include land availability, interest in and willingness to plant indigenous fruit trees, time availability, increasing support by the NAADS/Extension agents and willingness of the local people to be trained on indigenous fruit tree propagation techniques for improved fruit yield (Table 4.21).

Table 4. 21 Opportunities for domesticating/ planting indigenous fruit trees by local people (N = 120)

Opportunities	%
- Land availability	70
- Interest and willingness to plant indigenous fruit trees	58
- Time availability	49
- Increasing support by the NAADS/Extension Agents	38
- Willingness to be trained	17

CHAPTER FOUR

CONCLUSIONS AND RECOMMENDATIONS

4.1 Conclusions

- i. Species diversity of indigenous fruit trees on-farm was relatively high with Shear butter trees (*Vitallaria paradoxa*) being the most abundant. The average proportion of farmland under indigenous fruit trees was however low.
- ii. Shear butter trees (*Vitallaria paradoxa*), *Vitex doniana*, *Anona senegalensis* and *Tamarindus indica* were the most preferred indigenous fruits the local people.
- iii. The population of preferred indigenous fruit trees is generally in decline. This is a major concern for the domestication potential of the fruit trees. The major reasons for decline included cutting for charcoal production and firewood.
- iv. Many farmers planted or retained indigenous fruit trees on-farm mainly because of the food, medicinal and cash value although their market prices are lower than those of exotic fruits.
- v. Many farmers have positive attitudes towards on-farm cultivation of indigenous fruit trees. However, gender, education level, farm size and occupation status influenced their willingness to plant fruit trees.
- vi. Lack of awareness by farmers on the need to plant and manage indigenous fruit tree species, unclear information about food values of the wild fruits, lack of seedlings of indigenous fruit tree species in local nurseries, lack of clear markets for indigenous fruits and poor propagation knowledge were the major hindrance to cultivation of indigenous fruit trees.

4.2 Recommendations

In order for indigenous fruit trees to meaningfully contribute to household food security and incomes, there is need to:

- i. Formulate clear policies and by-laws on conservation of indigenous tree resources. Trees are assets, which contribute to the well-being of the rural community and through their longevity, serve as a cultural linking element throughout generations. Policy-makers and decision-makers also need to be kept informed of the latest advances in domestication and commercialization;
- ii. Address the issue of marketing and pricing of indigenous fruit tree products. There is a need to distinguish fruits with a local or national and a regional or international market. It is also important to analyze the market environment for indigenous tree fruits compared with alternative possibilities such as exotic fruits or agricultural crops. It should also be noted that some markets involve higher risks and distant markets involve higher transport costs. Relating these to product prices and potential benefits to the farmer is crucial;
- iii. Provide material support to encourage identification and selection of species for domestication, improvement and commercialization. Training of extensionists on indigenous tree fruits is needed;
- iv. Establish a community nursery for the collection of native seeds and propagation of native species for distribution farmers. However, current political situation in the Adwari can not warrant the setting of such community nursery of indigenous fruit trees.
- v. Initiate education campaigns among farmers on the food and income potential of indigenous tree resources, germplasm conservation and propagation techniques, the dangers of deforestation and the importance of sustainable use of resources by encouraging on-farm tree-planting culture and agroforestry initiatives.

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APPENDICES

Appendix 1 sample questionnaire

Questionnaire No.....

Parish.....

Village.....

PART 1: DEMOGRAPHIC AND SOCIO-ECONOMIC CHARACTERISTICS OF RESPONDENTS

- 1.1 Sex: Male [] Female []
- 1.2 Age:..... Years
- 1.3 Marital status: Single [] Married [] Divorced [] Widowed []
- 1.4 Level of education: None [] Primary [] Secondary [] College []
- 1.5 Occupation: Farmer [] Trader [] Service worker []
Other
- 1.6 Family size (number of people per household): < 5 [] 6-10 [] > 10 []
- 1.6 Annual income (Shs): < 100,000 [] 101,000-200,000 []
201,000-300,000 [] Over 301,000 []
- 1.7 Do you own land? Yes [] No []
- 1.8 If yes, what is the size of your land? < 1 ha [] 1 – 3 ha [] 4- 6 ha [] > 6 ha []
- 1.9 What proportion of your land is under fruit tree cover?
< 25% [] 26 – 50 % [] Over 50% []

PART 2: QUESTIONS SPECIFIC TO FRUIT TREE DOMESTICATION

- 2.1 Do you have any wild (indigenous) fruit trees grown or retained in your land?
Yes [] No []
- 2.2 If yes, name them.
.....
- 2.3 Are the fruit trees planted or growing naturally?
.....
- 2.4 If planted, what features (criteria) do you use in identifying suitable wild (indigenous) fruit tree for on-farm cultivation? (Go to 2.7)
.....
- 2.5 Do you think indigenous (wild) fruit trees should be cultivated?
Yes [] No []
- 2.6 If yes, where would you get the planting materials?
.....
- 2.7 For how long have you been growing indigenous fruit trees?.....

.....
PART 3: SOCIO-ECONOMIC VALUE OF INDIGENOUS TREES

2.8 For each of the following statements, indicate whether you agree, disagree or don't know (DK).

Statement	Agree	Disagree	DK
Families depend on indigenous fruits at times of food shortage			
Indigenous fruit trees is a good source of income			
Indigenous fruit trees have medicinal value			
Indigenous fruit trees can be intercropped with agricultural crops			

2.9 Rank ten (10) indigenous fruit trees that you prefer most (assign ten points to the most preferred fruit tree, 9 points for the second preferred and 1 point for the 10th preferred species).

Indigenous (wild) fruit tree	Ranks

2.10 What other tree species are grown together with fruit trees on your farm?

2.11 Which agricultural crops would grow alongside fruit trees?

2.12 Have you heard about NAADS, NFP and PMA?
 Yes [] No []

2.13 If yes, what do you know about each of them ?

2.14 Has an extension officer advised you on how to cultivate indigenous fruit trees?
 Yes [] No []

2.15 If yes, what information have you been given?

2.16 Do you carry out any form of management of the indigenous fruit trees on your land?
 Yes [] No []

2.17 If yes, what kind of management?

- 2.18 Do you manage trees on your farm?
Yes () No ()
- 2.19 If yes how?.....
- 2.20 Do you know any local method of planting/propagating indigenous fruit trees?
Yes [] No []
- 2.21 If yes, describe it.
.....
.....
- 2.22 Are there some indigenous/wild fruits sold in the local market?
Yes [] No []
- 2.23 If yes, can you list them and the prices ?
.....
.....
- 2.24 How much is a heap, debe or dishful of each type of fruits sold in the market?
.....
.....

PART 4: PROBLEMS AND OPPORTUNITIES FOR DOMESTICATING INDIGENOUS FRUIT TREES

4.1 Has the population of the following indigenous (wild) fruit trees increased (+), decreased (-), or remain constant (0) in your community over the past years? Tick one

Fruit tree	Increased (+)	Decreased (-)	Constant (0)
<i>Anona senegalensis</i> (Obwolo)			
<i>Diospyros mespiliformis</i> (Chumu)			
<i>Borassus aethiopum</i> (Tugo)			
<i>Bridelia scleroneura</i> (Orweco)			
<i>Carisa edulis</i> (Achuga)			
<i>Ficus sur</i> (Ebuu/Oduru)			
<i>Ficus sycomorus</i> (Olam)			
<i>Lantana camara</i> (Cholawinyo)			
<i>Phoenix reclinata</i> (Otit)			
Shear butter (Yao)			
<i>Strychnos spinosa</i> (Akwalakwala)			
<i>Tamarindus indica</i> (Chwaa)			
<i>Vangueria apiculata</i> (Amalera)			
<i>Vitex doniana</i> (Owelo)			
<i>Ximenia americana</i> (Olimu)			

- 4.2 If it has increased or decreased, can you explain why?
.....
- 4.3 What constraints (problems) hinders you from planting and managing indigenous (wild) fruit trees on your farmland?
.....
- 4.4 How would you like such problems to be overcome?
.....
.....

4.5 What do you see as the opportunities for domesticating / planting indigenous fruit trees on your land?

.....

4.6 Would you grow indigenous fruit trees if the planting materials were available?

Yes [] No []

4.7 If yes, why would you grow them you?

- (a) Domestic consumption only
- (b) Domestic consumption and sale
- (c) For sale only
- (d) To provide shade on compound
- (e) Others specify []

Appendix 2 Farm transect walk

Farmer’s No.

Parish.....

Village.....

1. Farm size (ha).....

2. Location distance of farm from home.....

3. Proportion (%) of land under:

- (a) Agricultural crops.....
- (b) Tree cover.....
- (c) Fruit trees.....
- (d) Housing.....

4. Agricultural crops in the garden/farm at the time of visits:

.....

5. List the trees and fruit trees and their number on the farm/garden (**refer to Table 1**).

6. Note colour and type of soil e.g. (**refer to Table 2**)

Local name	Type	Colour
	Clayey	Dark Soils: black, dark gray or dark brown
	Sandy	Moderately dark soils: brown to yellow-brown.
	Loamy	Light colored soils: Pale brown to yellow
	Clay-loamy	
	Stony	
	Rocky	

7. Profile diagram of a typical garden in each village or parish (sketch in the field)

Table 1. Data sheet- Indigenous fruit tree and other non-fruit tree species diversity in the

