CONSERVATION STATUS OF INDIGENOUS WOODY PLANT SPECIES USED BY PASTORALISTS OF SOUTH WESTERN UGANDA

BY

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DECLARATION

I Dina Nabasumba, declare that this dissertation is my original piece of work and has never been submitted for any master's award in Makerere University or any other institution of higher learning.

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DEDICATION

I dedicate this book to National Agricultural Research Organization of Uganda.

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ABSTRACT

The conservation status of indigenous woody plant species used by pastoralists of south western Uganda was assessed between August and December 2013. The objectives of the study were; i) to identify the indigenous woody species used by pastoralists; ii) to determine the population structure of plant species used; iii) to assess changes in the diversity of indigenous woody plant species overtime; and iv) to analyze human factors affecting conservation of priority indigenous woody plant species and identify mitigating strategies. Methods of data collection included a survey of 100 households in Ankole ranching scheme and inventory of woody plants in 55 nested plots of 50 m × 50 m. The results show that 70 species are used by the pastoralists. These belong to 31 families with family Fabaceae having the highest number of species. The major uses include human and livestock medicine, firewood, fodder, food, poles and timber. The major species used are: *Vernonia ammygdalina, Acacia sieberriana, Acacia hockii, Carissa edulis* and *Albizia coriaria* respectively. The plants exhibit an inverse J population structure depicting a sustainable population. Based on the IUCN Red list most species are categorized as Least Concern (LC) with one species (*Rytigyna macrura*) as Data Deficient. In terms of trends in diversity, there was no significant difference between the species recorded in 2013 and the baseline inventory data of 1998, although there was an increase in number of species in the current study. Species such as *Asparagus flagellaris, Microglossa angolensis, Nuxia congesta, Ficus ovata, Gardenia* sp, *Lantana trifolia* and *Duranta erecta* were added in the inventory of 2013. Over grazing and uncontrolled harvesting are the leading human induced threats to the conservation of woody plants. Other factors include fires and agriculture. In conclusion, pastoralism production lands have a high potential for the conservation of indigenous woody plants. Integrating the conservation of species in restoration programs of rangelands, development of domestication packages for major species used, establishment of community based conservation platform, species re-introduction for indigenous woody species which were found missing in the current inventory and zoning of grazing sites in paddocks are recommended to enhance conservation of indigenous woody plant species.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background

Pastoralism refers to a livelihood strategy and set of cultural practices based on cattle herding involving mobility to make maximum use of resources in arid environments (MacGregor, (2006). Outside protected areas, pastoralism production lands constitute part of the increasingly important human inhabited areas, where populations of useful naturally growing woody species are threatened with extinction (Tabuti, 2007). Moreover, little is known about the conservation status of indigenous woody species in such un protected sites.

Traditionally, pastoralism production systems were sustained through normadism a practice where the pastoralists moved through pre-determined routes with their cattle in search of water and pasture (Wurzinger *et al.*, 2008). The woody plants served as livelihood security for the survival of people and livestock during the long dry season (Lykke *et al.*, 2004). The seasonal migration of pastoralists ensured that sustainable utilization of indigenous woody species and ultimately conservation was achieved (Alexandra, 2007). The time lag of no active pastoralism in a particular area promoted natural regeneration of woody species in previously utilized land. This land use system favored successful recruitment of woody plants into successive growth stages for a healthy population.

However, sedentary pastoralism where pastoralists keep considerable herds of cattle in a defined area and on permanent basis is gradually replacing the traditional nomadic pastoralism (Wurzinger *et al.*, 2008). This change has adversely affected the conservation of woody species in the wild but the magnitude is unclear necessitating investigation. For example, reduction in vegetation cover and diversity has been reported among Borana pastoralists in northern Kenya following intensive livestock grazing in a semi-sedentary system (Dabasso *et al.*, 2012).

Conservation refers to the measure of equilibrium between biological and ecological functions of a population relative to economic as well as socio benefits (DeFries *et al.*, 2004). Efforts towards the conservation of species targeted by pastoralists may be gauged from their conservation status. Usually, population structure assessments (which display diameter size class distributions of plants) are used to give insights into their conservation status (Alexandra, 2007). Besides, the International Union for Conservation of Nature developed the Red list criteria for determining the conservation status of taxa (Rodrigues *et al.*, 2006). Such information helps to guide decision making regarding priorities and approaches to be used to enhance the conservation of target species.

Woody plant species may have various types of population structure distributions which reflect the action of biotic and abiotic factors that a population has been exposed to in the past. Some of the factors include deforestation, overgrazing, bush burning and mining among others. Such factors shape the population structure of species and ultimately their conservation status (Muleke *et al.*, 2013).

Other than the traditional *in-situ* conservation of woody plants, recent conservation approaches for threatened species include re- introduction into natural ecosystems. Besides, considering that the existing protected areas are small remnants of transformed habitats, selective breeding for better growth performance appears to be one of the future options for plant conservation (Hayward, 2009). This approach however requires sound knowledge of the status of indigenous woody species in the wild.

There is a need therefore to assess the conservation status of indigenous woody plant species, in an increasingly sedentary pastoralism production system where there are several threats to survival of such species (Muleke *et al.*, 2013). This information is necessary for promoting approaches that can enhance survival of woody species in pastoralism production systems while meeting the demands of the communities.

1.2 Statement of the problem

Indigenous woody plant species play a major role in sustaining the livelihoods of pastoralists in the drylands. They provide a wide range of products and ecosystem services, and are regarded as vital components of sustainable pastoralism production systems (Barrow and Mlenge, 2003). However, several studies show that threats to survival of several indigenous woody species are increasing in pastoralism production lands arising from demographic dynamics and associated impacts (Muleke *et al.*, 2013). Despite the importance of woody plants and the existence of several threats, there is lack of quantitative data on the species used by pastoralists (Teklehaimanot *et al.*, 2007). The need for information on the conservation status, showing the probability of survival of such species in view of the prevalent human induced factors affecting their population is urgent. Failure to obtain this information risks stagnation of approaches which could enhance sustainability of grazing practices and improve the pastoral areas. It is in line with the latter knowledge gap that this study focused on the indigenous woody species used by pastoralists, their conservation status and human induced factors affecting their conservation. Changes in species composition and diversity overtime were also investigated to show the trends in species survival. The key questions which were investigated were: which indigenous woody species are being used by the pastoralists and for which purpose?, what is the conservation status of the indigenous woody species used?, what changes have occurred in composition of indigenous woody species in previously assessed sites? and which human factors are impacting on conservation status of indigenous woody species in pastoral lands?. The information gathered guides the conservation strategies for woody plant species in pastoral production lands.

1.3 Aim and Objectives

1.3.1 Aim of the study

The aim of this study was to determine the conservation status of indigenous woody plants used by pastoralists of south western Uganda, to recommend appropriate management strategies.

1.3.2 Specific Objectives

The specific objectives were:

1. To identify the indigenous woody species used by pastoralists.
2. To determine the population structure of the woody species used.
3. To assess changes in the diversity of woody species overtime.
4. To analyze human factors affecting conservation of indigenous woody species and identify mitigating strategies.

1.4 Hypothesis

The hypothesis tested was:

Ho: There is no difference in the diversity of indigenous woody species between 1998 and 2013.

1.5 Justification

Woody plant species are vital components of sustainable pastoralism production systems due to their importance in human livelihoods, livestock production and ecosystem health. Most indigenous woody species in pastoralism production lands face degradation especially from demographic pressure and a variety of land use demands. Results from this study can be used in efforts to restore the productivity of pastoralism production lands. This will be achieved by utilizing the information generated on indigenous woody species used by pastoralists. This information will be used by different agencies such as National Agricultural Research Organization (NARO) to define a research agenda in indigenous woody species for the benefit of communities and ecosystem health of drylands. The information will as well be used by academic institutions especially departments of Forestry, Environment and botanical studies to train students at different levels in biodiversity aspects in pastoralism production systems and management options. Information on the conservation status of species in the wild, human

factors affecting such species and changes in species diversity overtime will be used by actors in conservation such as District Forest Departments to guide local leaders and policy makers in determining strategies for woody plants conservation while increasing direct benefits of woody plants to communities.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Introduction

Woody plants large comprise two broad categories of flora which are trees and shrubs. Trees are perennial woody plants with many secondary branches, supported clear of the ground on a single main stem or trunk with a clear apical dominance. Shrubs on the other hand are perennial woody plants characterized by multiple stems, absence of a clear canopy and with a relatively limited height of less than 3 m (Richardson, and Rejmánek, 2011).

The importance of woody plants in sustaining the livelihoods of communities in dry lands need not to be over emphasized (Lykke *et al.,* 2004). They are important sources of food, fodder, construction materials, medicines and crafts alongside ecosystem functions. Pastoralism production lands existing outside protected areas contain populations of indigenous woody plant species which are increasingly becoming threatened with extinction (Tabuti, 2007). This is partly due to utilization pressure, human demographic dynamics and the associated impacts on individual species and the ecosystem at large (Muleke *et al.*, 2013). Understanding the conservation status of plant species which reveals the state of balance between ecological functions of plant populations relative to the socio benefits is required (DeFries *et al.*, 2004).

Several users of woody plant species have failed to strike a balance between ecological benefits and socio-economic benefits. The probability of survival of several species has therefore been compromised to varying degrees due to unsustainable use. This has affected species numbers and reduced the net productivity of pastoralism production lands (Mbaziira, 2014). The practice of overstocking livestock by some pastoralists has in most cases exacerbated the problem.

The present study documented the indigenous woody species used in pastoralism production systems. The different uses either for direct consumption such as food, fodder, medicines, construction materials or ecosystem services such as shade, wind breaking among others have

various impacts on the status of target species. The conservation status of species was evaluated through population structure assessment, evaluation of human factors and application of the IUCN Red list criteria (Reynolds *et al.*, 2007). The present study was further strengthened by a trend analysis of woody plant species involving a comparison between records of 1998 (Zwick and Lloyd, 1998) and 2013. Information from previous studies and the information generated through this study are helpful for monitoring the changes in species used as well as species diversity overtime.

2.2 Uses of Indigenous Woody Plant Species to Pastoralists

Woody plant resources within the dry land silvo-pastoral systems are used for the productivity of livestock (Kakuru *et al.*, 2004). In some communities, woody plant species are sources of food, fodder, medicine, fuel wood, construction materials and are sold to generate income (Wolfang, 1990). The plants are also useful for various ecosystem services such as climate amelioration which is critical for the dry lands. In some semi arid areas, the population of indigenous woody species used for different purposes ranges as high as 300-800 species. However, provision and access to plant resources is declining as natural habitats come under increasing pressure from development, conservation exclusion and agriculture expansion (Bharucha and Pretty, 2010).

In the past utilization of indigenous woody plant species was sustainable due to nomadic pastoralism. This was due to the fact that migration from one place to another regulated pressure on the plants permitting regeneration. Under the current sedentary pastoralism, over exploitation of wild resources is reported to be on the rise (Tabuti, 2007). Pastoral farmers are indiscriminately cutting woody plants to meet their needs for wood products.

However, a lot of knowledge on the useful woody species is held by the local users and not documented (Wezel and Lykke, 2006). Failure to document the different species and their uses is detrimental to their conservation. Continued over exploitation does not only directly threaten the wild populations but creates a knowledge gap especially among the young generation. To reduce the knowledge gap, this study documented the indigenous woody species and their uses to

pastoralists. This information will help both the old and young generations to engage in efforts that ensure survival of target species.

2.3 Methods of Identifying Indigenous Woody Plant Species

Worldwide, many important tree/shrub resources are threatened thereby threatening the livelihoods of local community members who depend on them. Effective management of these species requires (among other factors) knowledge of species that are preferred locally and can therefore be successfully incorporated into conservation plans. Such knowledge may be obtained through some of the following methods: use of focus group discussions with different specialist groups, key informant interviews and semi-structured interviews (Tabuti *et al.*, 2009). Other methods include; guided field visits, participatory observations and vegetation sampling (Lucena *et al.*, 2007). Selection of a specific method however depends on the level of precision required and reliability of the data to be collected, time available for the study, costs involved and access to information from the previous studies. The present study used semi structured questionnaires administered during household interviews. This method ensures the collection of reliable data since it enables quick assessment of the credibility of responses (Horton *et al.*, 2004).

2.4 Assessment of Conservation Status of Plant Populations

2.4.1 Overview

The conservation status of wild plants is usually assessed in terms of population structure or size class distribution as well as pressure of utilization (Alexandra, 2007). Plant population structure reflects the action of biotic and abiotic factors to which a population has been exposed, thus the likelihood of survival. Three population structure patterns displayed as curves are exhibited by most woody species (Peters, 1996). These are: inverse j shape, bimodal pattern and decreasing pattern. The nature of the curve has implications regarding management of a particular species to guarantee survival.

2.4.2 Inverse J-shape (Type I)

The Inverse J-shape pattern of population structure shows that there are more small woody plants than the larger ones. It is characterized by abundant species with constant rejuvenation and recruitment especially in a naturally controlled recruitment structure (Lykke, 1998). Under a mature tree, there are many seedlings that could replace a mother tree if it died. Strategies that enhance such regeneration and recruitment pathway will lead to a self sustaining plant population and promote conservation of the species. This pattern is likely to be found in natural or protected areas where there is high rejuvenation of species (Schumann *et al.*, 2010).

2.4.3 The bimodal pattern (Type II)

This pattern shows that the plants recruit seedlings in pulses such that there are discontinuities in the population structure. Usually the population displays a two layered vertical structure of a species and abundant regeneration in the under storey (Peters, 1994). The newly established seedlings and saplings grow to larger sizes before the next recruitment, thus causing a large distinction between classes. Seedling establishment may be sufficient to maintain the population depending on the frequency of the pulses. Woody species can only show a bimodal population structure if the prevailing environmental factors are not favorable for germination for a long time and if harvesting is concentrated on a particular size class such as poles or mature trees. This pattern is common in semi arid savannahs where rainfall variability and fires drive spatial heterogeneity in recruitment of species (Wiegand *et al.*, 2006).

2.4.4 The decreasing pattern (Type III)

This pattern depicts a population structure shaped by external disturbance in which regeneration is not keeping pace with mortality. Most individuals are of the same size class and the population has an irregular diameter size structure (Shoronova and Tetioukhin, 2004). The pattern shows no signs of seedling recruitment. Harvesting or disturbance above a fixed diameter limit removes woody plants that could provide seeds for the next regeneration. Species exhibit such a pattern if

a large number of poles and mature trees were harvested before seed production such that there are a few or no seedlings available for recruitment (Mueller *et al* ., 2005).

This study assessed the size class distribution of indigenous woody plants in pastoral production lands. Diameter classes of the species were grouped to obtain the patterns of population structure exhibited and their implication on conservation of the species evaluated.

2.5 IUCN Red list Categories

The International Union for Conservation of Nature (IUCN) has developed Red list criteria for classifying the conservation status of taxa. The system uses quantitative criteria on population size, rate of decline and area of distribution. Assessments of individual species are based on information on occurrence, population, trends, habitat preferences, threats and conservation actions needed (Butchart *et al*., 2007). The resulting Red list categories act as a guide in decision making to determine conservation measures required for specific species (Rodrigues *et al.*, 2006). Depending on the information available species can be extinct (E), extinct in the wild (EW), critically endangered (CE), endangered (E), vulnerable (V), near threatened (NT) least concern (LC), data deficient (DD) or not evaluated. This study assessed the conservation status of the species identified according to the criteria described above. It is hoped that results from this study will guide local leaders and political practioners impacting on the study area to make decisions that enhance conservation of indigenous woody species for socio-ecological benefits to the community.

2.6 Assessment of Species Richness and Diversity over Time

Monitoring the changes in species composition is important for the conservation of biodiversity. The increasing pressure of vegetation clearance, logging and grazing has led to the loss of large numbers of native plant species from the wild (Cornes *et al.*, 2010). It is necessary to keep track of the changes in species and habitats overtime. The need for periodic biodiversity inventories to

check the rate of species loss and improve vegetation condition is well recognized (Eilu *et al.*, 2008). In the present study baseline data were obtained from Zwick and Lloyd (1998), who assessed the flora of Ankole Ranching Scheme (Ranch 48a) in 1998. The previous study recorded 39 species of flowering plants and these data are contained within the present records. This approach enables determination of changes in species diversity that could have taken place between the two study periods. This is necessary to inform the selection of conservation strategies that are appropriate for the area.

2.7 Factors Influencing the Conservation Status of Indigenous Woody Species

2.7.1 Deforestation

Pastoralism production lands are homes to about 350,000 plant species, of which 3000 are useful to mankind (Jama and Zeila, 2005). However by 2005, 10 – 20% of pastoralism production area globally was already naturally degraded to different extents mainly due to deforestation. The major causes of deforestation include collection of fuel wood in different forms and clearing of land for agricultural activities. About 90% of the total populations who live in rural areas in Uganda directly depend on firewood for their energy needs, and a big fraction of the urban dwellers depend on charcoal (Kakuru *et al.*, 2004). Consequently, ultimate loss of biodiversity is reported to be on the rise. The current rate of woody species harvesting in pastoralism lands necessitates an assessment of the conservation status of woody species through assessment of their size class distributions. This is to ensure that appropriate strategies that enhance production of such species to supply the demanded products while ensuring ecosystem health are promoted.

2.7.2 Overgrazing

Herbivores have a major impact on the conservation status of woody species. They hinder plant growth by grazing on leaves, feeding on twigs, trampling and are sometimes vectors for plant pathogens (Begon *et al.*, 2006). Recurrent grazing activity often impedes regeneration and

recruitment of woody species and can lead to local species extinction especially where selective grazing is applied on certain species.

Traditionally, survival of indigenous woody species in pastoralism production lands was permitted by the seasonal migration behavior of pastoralists (Alexandra, 2007). The time lag of no active pastoralism in a particular area ensured natural regeneration and recruitment of woody species in a previously utilized land. In recent pastoralism production systems, the rate of animal turnover on grazing lands is increasing, livestock populations have not only altered the species composition of these areas but also altered the size class distribution of certain species (Zhao *et al.*, 2007). It is therefore necessary to ascertain the magnitude to which grazing is affecting the conservation status of valuable indigenous woody species. This information is necessary in guiding the selection of conservation strategies that can sustain livestock and woody species production.

2.7.3 Fires

Human induced fire is an ancient practice in most pastoralism production lands and is the leading factor shaping the savannah vegetation as compared to other human induced disturbances (Sheuyange *et al.*, 2005). The study shows that frequent fires reduce the shrub cover significantly while tree cover is not severely affected.

Despite the fact that pastoralists use frequent fires to enhance regeneration of fresh pastures, abandonment of fields under nomadic pastoralism improved the vegetation structure (Sheuyange *et al.*, 2005). However, use of frequent fires in a sedentary pastoralism production system may have huge effects on the population structure. This is because it could hinder regeneration and recruitment of seedlings and small woody plants in restricted habitats into successive growth stages (Yates *et al.*, 2009). Assessing the occurrence and use of fires in sedentary pastoralism needs to be conducted to develop appropriate management practices of woody species under changing land use (Angassa and Oba, 2008).

2.7.4 Land conversion

Increase in human population growth in most developing countries and Uganda in particular is creating significant challenges for woody species in pastoralism lands. Major effects are expected in sedentary pastoralism where land which accommodated seasonal migration of pastoralists was permanently taken over. The population growth has created an increase in food demand and pastoralism lands have therefore been converted into mechanized agricultural lands to respond to market opportunities (Homewood *et al.*, 2001). Such changes in land use have always neglected the short and long term benefits of woody species in the livelihoods of pastoralists and have therefore not been given significant attention.

The effects of land conversion in dry lands are witnessed in severe wind throws, shortage of water and forage resources which aspects were being offset by the dual nature of woody species. Understanding the magnitude of land conversion of grazing lands through inventory is required. This information is helpful in determining the plausible options which can accommodate integration of trees in the new land use for production and ecosystem functions. It is therefore necessary for stakeholders in conservation and productive use of woody species to analyze human forces on population structure of woody species if increasing loss of biodiversity in grazing lands is to be checked and complementary woody species-livestock production systems are to be promoted (Reynold *et al.*, 2007).

2.7.5 Climate variability and change

Climate change refers to any change in climate overtime due to natural variability or as a result of human activity (Ding *et al.*, 2001). Climate change poses one of the most recent threats to survival of biota in biological systems. Among the most profound aspects is the change in temperature and precipitation averages which alters the biophysical habitat of most species. It is predicted that the negative impacts of climate change are likely to affect warmer climates and extensive production systems more seriously than intensive systems (Fuhrer, 2003). The prediction poses a threat on conservation of indigenous woody species in the pastoralism

production lands due to the inherent semi arid conditions and extensive production systems therein. In this study, climate change could help in explaining the current status of woody species diversity as compared to the results from the study conducted in 1998. This information is useful in determining the best strategies needed to prevent the loss of species due to climate variability and change.

2.7.6 Existence of alien invasive species

Invasive species affect the conservation of indigenous woody species in pastoral production lands. Their developed propagation system coupled with vigorous growth gives them a high competitive and survival advantage compared to indigenous woody species. Invasive species in so many cases form bushy patches in grazing lands thus reducing space for colonization of indigenous vegetation (Mugasi *et al.,* 2000). Information on invasive species in the region can therefore be used to explain the conservation status of indigenous woody species used by pastoralists.

2.8 Relationship between disturbance and IUCN Redlist categories

Disturbance in all forms as has been discussed in the latter section influences conservation status of woody plants. Due to differences in magnitude of the biotic and abiotic pressures on woody plants the International Union for Conservation of Nature identified threat categories of plant species (Reynolds *et al.*, 2007). Therefore it is necessary to monitor the conservation of woody species outside protected areas such as pastoral lands. The activity helps to identify the major pressures affecting plant populations to generate information which can guide identification of appropriate measures commensurate to the risk of extinction.

CHAPTER THREE

3.0 STUDY AREA AND METHODS

3.1 Study Area

The study was conducted in Nyabushozi County, Kiruhura district (00° 12'S, 31° 00'E) in south western Uganda (Figure 1). The district lies approximately 247 kilometers from Kampala, the capital city of Uganda. Kiruhura district is located between Kamwenge and Kyegegwa districts to the north, Sembabule district to the north-east, Lyantonde district to the east and Isingiro district in the south-east (Ntakyo, *et al.*, 2011). The study covered the sub counties of Kenshunga, Kikatsi, Ssanga and Nyakashashara.

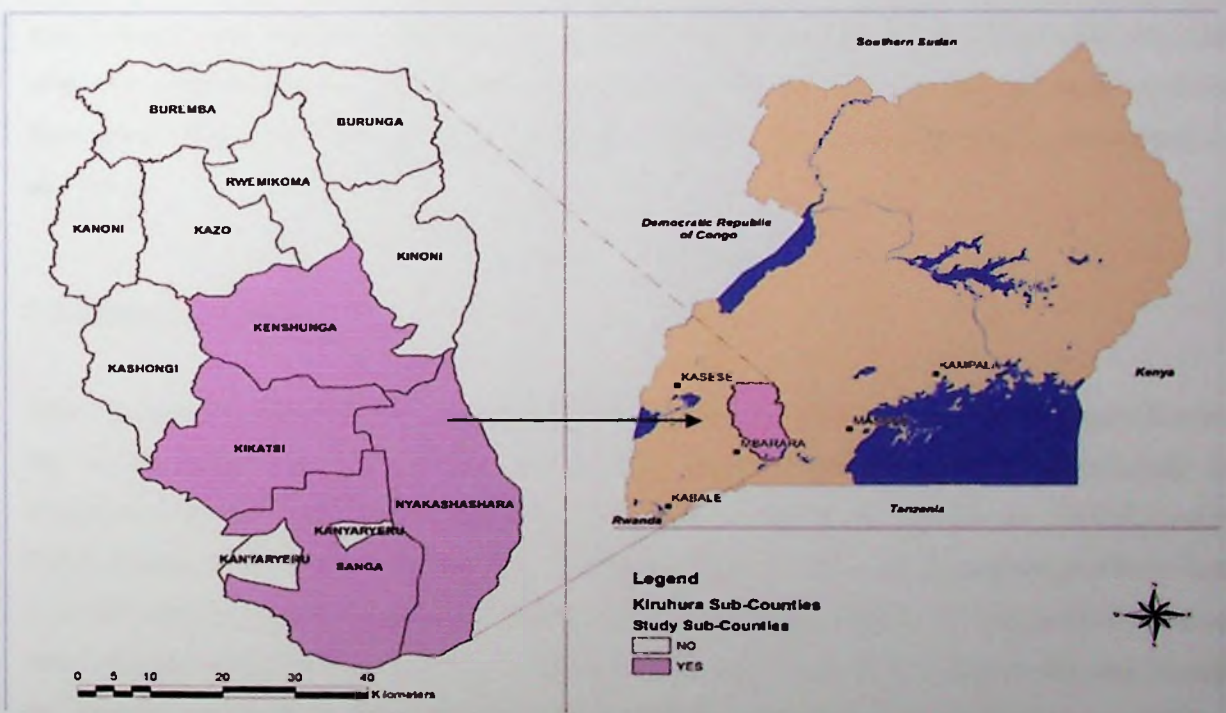

Figure 1: Map of Uganda showing the location of Kiruhura district and the study sub-counties.

3.1.1 Climate

The climate is semi arid, with average annual rainfall of 1000 mm. Distribution is bimodal with the first rains received from March to May with a peak in April. The second rainy season is between August and December with a peak in November. Temperatures range between 20°C and 30° C. Peak temperatures occur in July and January and are usually characterized by wild fires, scarcity of pasture and water (Ntakyo *et al.*, 2011).

3.1.2 Topography and Soils

The altitudinal range of the district is 1250 m -1525 m above sea level. It is characterized by undulating hills and valleys rising about 100 m - 200 m above flat bottoms. Soils are of Alisol type characterized by poor drainage and a dense sub surface clay layer. These soils are acidic, with low organic matter content and with Aluminum and Manganese toxicity. Such conditions have partly shaped the land use type in the area which is predominantly pastoralism (Ntakyo *et al.*, 2011).

3.1.3 Flora and Fauna

The vegetation is dominated by savannah grassland with scattered trees. Acacia species dominate the woody vegetation interspersed with grasses mainly *Themeda triandra, Brachiaria* spp, *Cynodon* spp and *Cymbopogon* spp. This was mainly shaped by the erratic rainfall, grazing activities and frequent fires. In terms of livestock, cattle are the most important livestock in the area followed by goats. The cattle population is dominated by indigenous long horned cattle and exotic breeds mostly Friesian and their crosses. Livestock production practices are characterized by ranching in extensively grazed transhumant herds of cattle and goats. Besides, a variety of wild animals mainly buffaloes, antelopes, waterbucks and kobs graze between Lake Mburo National Park and the ranches in Nyabushozi County (Ocaido *et al.*, 2009).

3.1.4 People and Culture

The population of Kiruhura district comprises 14,000 people (UBOS, 2012). This comprises diverse ethnic and socio-economic backgrounds. The dominant tribe is Banyankole mainly comprising pastoralists (Bahima) and cultivators. Although the tribes are not confined to specific areas, there are more Banyankole in the county of Nyabushozi largely surviving on sedentary pastoralism. Other tribes include Banyarwanda, Baganda and Bakiga. Grazing of livestock in the past was mainly through normadism especially in the dry season. However, this practice was replaced by sedentary pastoralism due to population growth that has reduced land for normadism (Ntakyo *et al.*, 2011).

3.2 Materials and Methods

3.2. 1 Selection of Sampling Sites

The study was conducted in the ranches of Ankole Ranching Scheme (ARS). The scheme covers 38,850 ha utilized by 856 households in the sub counties of Nyakisharara, Kenshunga, Ssanga and Kikatsi. This area has a history of grazing lasting for over 500 years in semi or fully nomadic practices (Ocaido *et al.*, 2009). The Ankole ranching scheme with 50 ranches was established through Government of Uganda's strategy to promote sedentary pastoralism. The main objective of the scheme was to obtain a large block of commercially and economically productive beef ranches. Pastoralists therefore possess valuable information on indigenous woody species that have been important in their production system. Following a change in land use practices from pure nomadic pastoralism to sedentary pastoralism, pastoralists in the area possess useful information on the effect of land use change on woody plant resources. This information is required for determining sustainable livestock-tree production systems. In this study 100 households were involved while 11 ranches were accessed for the plant inventories.

3.2.2 Questionnaire Survey of Indigenous Woody Species Used by Pastoralists

Data were collected through a survey of 100 households (Kotrlik, & Higgins, 2001). Households were selected using simple random sampling techniques to cover at least 10% of the beneficiaries of the scheme (856 households). Pre-tested semi-structured questionnaires were administered to respondents during household interviews. Data collected included socio-economic profiles of the respondents (age, sex, marital status, main occupation, educational level and area of land occupied). The respondents also named and ranked the priority indigenous woody species as well as their uses (to humans, animals and their environment) in relation to pastoralism. The main questions were: i) which species are used locally by the pastoralists and for what purpose? ii) In which period of the year (wet or dry season) are the species mostly used?

3.2.3 Inventory of Population Structure of Indigenous Woody Species

The population structure of indigenous woody species used by pastoralists was assessed in 11 ranches selected using simple random techniques in the sub-counties of Kikatsi, Kenshunga, Nyakashashara and Ssanga. For each sub county selection of representative ranches was done by listing the ranches on pieces of paper and pick representative number of papers for the ranches required.

Using 100 m measuring tapes, nested plots of 50 m x 50 m were established 100 m away from the edge of every ranch (Figure 2). Each plot was divided into smaller plots of 25m x 25m and 10m x 10m. Trees (>20cm DBH) and poles (10 cm -19.9 cm DBH) were assessed in the entire plot of 50 m x 50 m. Saplings (5.5 cm-9.9 cm) were assessed in a smaller plot of 25m x 25m while seedlings were assessed in a sub plot of 10m x 10m (Cole, *et al.*,2012) . The first plot was selected randomly by allocating and picking a number indicating a side of a transect line. Subsequent plots were established 50 m apart in an alternate pattern along a transect line laid in the longest direction in each ranch. Up to 5% of every ranch was assessed and a total of 55 plots were covered.

Seedlings (≤ 30 cm height) were evaluated based on principles of vegetation cover analysis by Braun-Blanquette (Westfhoff and Van Der Maarel, 1980). This method provides for a quick evaluation of small classes of vegetation by using area cover scales. Usually, a scale of 1-5 is used where 1 represents 1-20% species area cover, 2= 21%-40%, 3 =41%-60%, 4= 61%-80%, 5= 81%-100%.

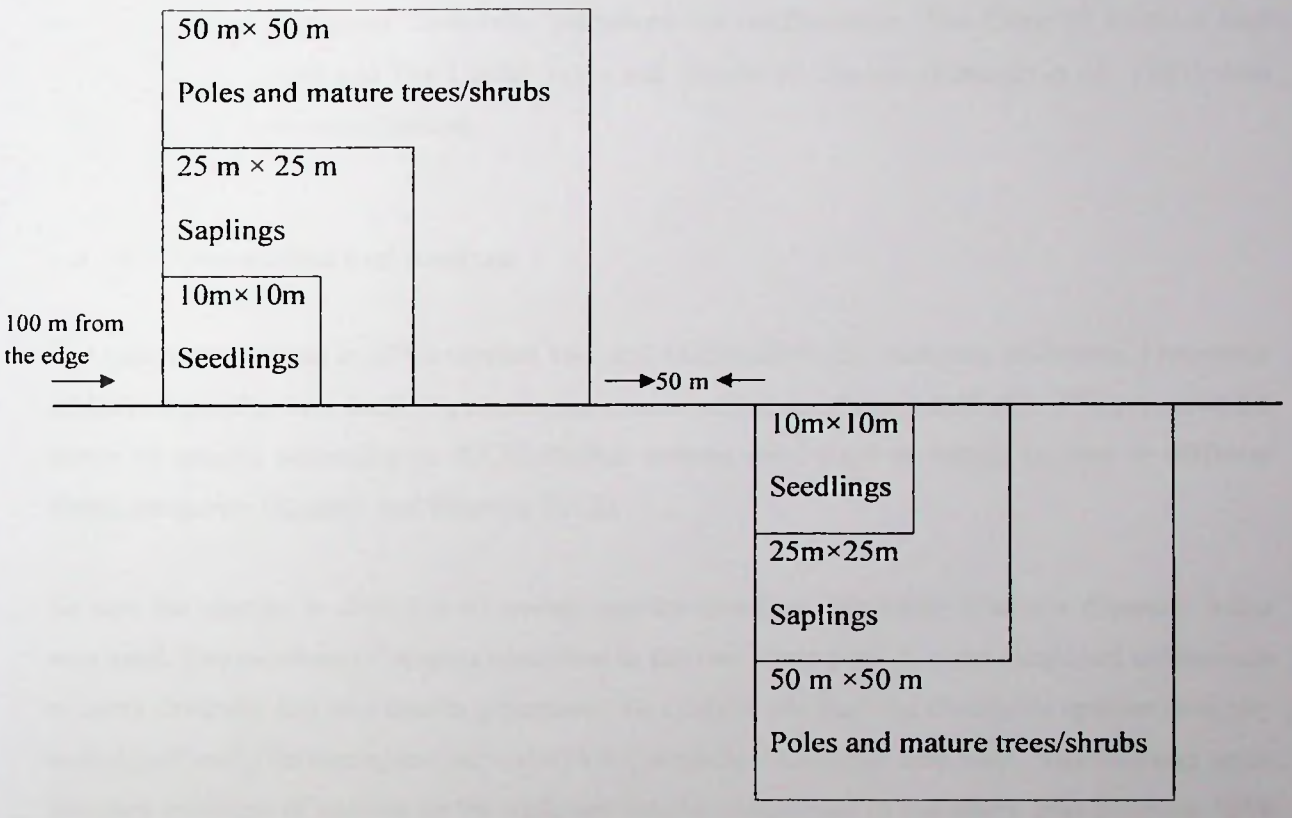

Figure 2: Illustration of 50 m × 50 m nested plots laid out on alternate sides of the transect for plant inventory and assessment of human factors affecting conservation.

Evidence of human disturbance was assessed in the same plots where species inventory was conducted. The signs included physical detection of browsing, bush burning, tree/shrub cutting or growing of crops in the ranch respectively. Different codes (Appendix V) were assigned to

signs of disturbance recorded. Data were collected on occurrence as well counts of disturbance indicators or scale of occurrence for the case of fire and agriculture.

3.2.4 Identification of Species

Preliminary identification of woody plants was done by key informants who gave the local names. However specimens of each species encountered were collected, pressed in newspapers and delivered to Makerere University herbarium for confirmation. The Flora of Tropical East Africa (Polhill, 1966) and The Useful Trees and Shrubs of Uganda (Katende *et al.*, 1995) were also used in species identification.

3.3 Data Presentation and Analysis

The data were entered in SPSS version 16.0 and Microsoft Excel computer softwares. Frequency tables and graphs were used to generate summaries using descriptive statistics. The conservation status of species according to IUCN Redlist criteria were used to assign species to different threat categories (Kalema and Beentje, 2012).

To test the change in diversity of woody species overtime, Shannon-Wiener's diversity index was used. The numbers of species identified in the two study periods were subjected to Shannon wieners diversity test and results generated. To analyze whether the change in species diversity was significantly different, one way ANOVA (un stacked samples) was used. Analysis was made between numbers of species in the different families identified in the study area between 1998 and 2013.

CHAPTER FOUR

4.0 RESULTS

4.1 Woody Plant Species Used by Pastoralists

A total of 70 indigenous woody plant species (40 shrubs and 30 trees) occurring in 31 plant families was used by the pastoralists. The uses include food, fodder, human medicine, animal medicine, fuel wood, poles (for construction and fencing), timber (for construction and troughs) crafts materials and provision of shade. The main uses were medicine (to both people and animals) while the least use was provision of materials for crafts (Figure 3). Other than species useful for food and fodder which are mainly resorted to in the dry season, most woody species were reported to be resorted to throughout the year to supply products for several needs.

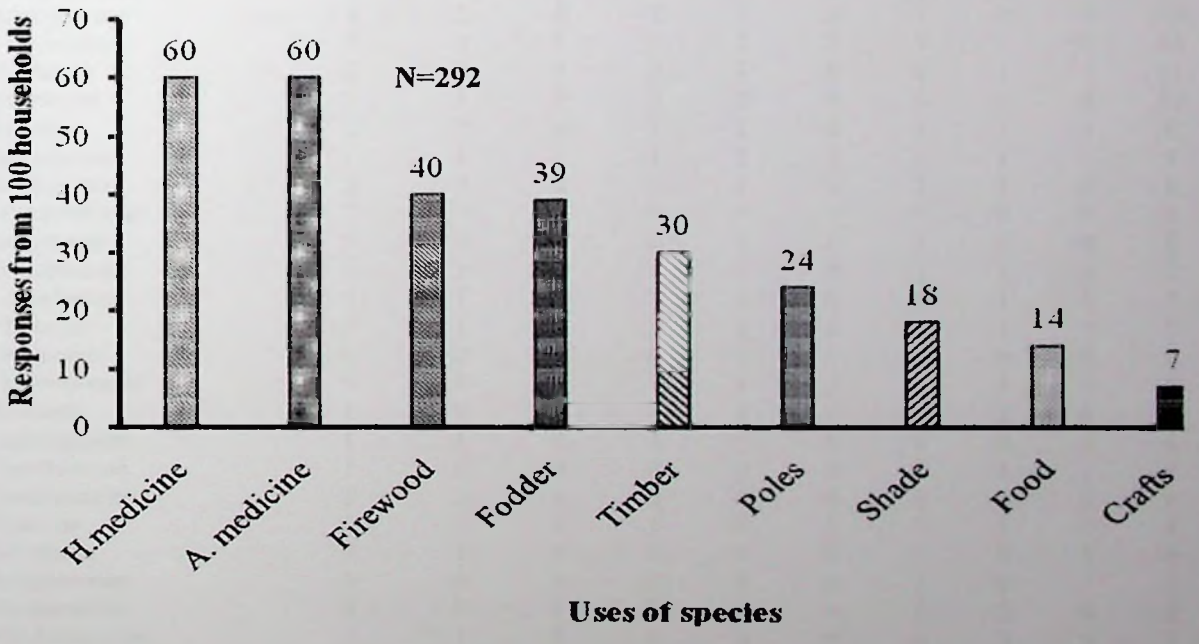

Figure 3: Uses of indigenous woody plant species to pastoralists

The family Fabaceae had the highest number of species with the majority belonging to the genus *Acacia*. Most of the species (12) are used as human medicine (Medicine H) and animal medicine (Medicine A). The families Capparidaceae, Convulvulaceae and Myricaceae had one species each. All the species were multi-purpose providing more than one product and/or service (Table 1).

Table 1: Numbers of woody plant species in different families used by pastoralists

Family	Number of woody plant species for different uses (N=70)									
	Medicine (H)	Medicine (A)	Crafts	Firewood	Fodder	Food	Poles	Timber	Shade	Total
Fabaceae	13	13	1	11	9	0	11	10	7	75
Euphorbeaceae	5	5	0	2	1	1	2	2	0	18
Tiliaceae	3	3	4	1	3	1	1	1	1	18
Capparaceae	3	3	0	2	3	0	2	1	1	15
Moraceae	2	2	1	2	1	0	2	2	2	14
Anacardiaceae	2	2	0	2	1	2	2	2	0	13
Apocynaceae	3	3	0	2	2	2	1	0	0	13
Verbenaceae	2	2	1	2	2	2	1	1	0	13
Rubiaceae	2	2	0	2	1	0	2	1	1	11
Asteraceae	3	3	0	2	3	0	0	0	0	11
Rutaceae	2	2	0	1	1	0	1	1	1	9
Sapindaceae	1	1	1	1	1	1	1	1	1	9
Ebeneaceae	2	2	0	1	1	0	1	1	0	8
Flacourtiaceae	2	3	0	1	1	1	0	0	0	8
Solanaceae	2	2	0	1	1	1	1	0	0	8
Celastraceae	1	2	0	1	1	0	1	1	0	7
Loganiaceae	1	1	0	1	1	0	1	1	1	7
Ulmaceae	1	1	0	1	1	1	1	1	0	7
Lamiaceae	2	2	0	0	1	1	0	0	0	6
Phyllanthaceae	1	0	0	1	1	0	1	1	1	6
Rosaceae	1	0	0	1	1	1	1	1	0	6
Asparagaceae	1	1	0	1	1	0	0	0	0	4
Bignoniaceae	1	0	0	0	0	0	1	1	1	4
Draceanaceae	2	2	0	0	0	0	0	0	0	4
Oleaceae	0	1	0	1	0	0	1	1	0	4
Salicaceae	3	1	0	0	0	0	0	0	0	4
Boraginaccae	0	0	0	0	0	0	1	0	1	2
Nytaginaceae	0	0	1	0	1	0	0	0	0	2
Phytolaccaceae	1	1	0	0	0	0	0	0	0	2
Convulvulaceae	0	1	0	0	0	0	0	0	0	1
Myricaceae	1	0	0	0	0	0	0	0	0	1

Vernonia ammygdalina was the major species used for both human and animal medicine. Several species were used for firewood (40 species) with *Acacia sieberriana* being the dominant. The species for firewood were mainly used in producing charcoal for commercial purposes. For other purposes, *Acacia hockii, Carissa edulis*, *Albizia coriaria* and *Grewia kakothamnos* dominated species used for fodder, food, poles, timber and crafts respectively (Table 2). *Albizia coriaria* was as well found to be useful in providing shade in the grazing grounds (Appendix I).

Table 2: Major indigenous woody species used for different purposes

Purpose	Major woody species used	Family	Frequency of responses (N=100 households)
Food	*Carissa edulis*	Apocynaceae	99
Timber	*Albizia coriaria*	Fabaceae	79
Human medicine	*Vernonia ammygdalina*	Asteraceae	78
Firewood	*Acacia sieberriana*	Fabaceae	77
Fodder	*Acacia hockii*	Fabaceae	73
Animal medicine	*Vernonia ammygdalina*	Asteraceae	71
Poles	*Acacia sieberiana*	Fabaceae	69
Shade	*Albizia coriaria*	Fabaceae	24
Crafts	*Grewia kakathamnos*	Tiliaceae	3

4.2 Population Structure of Woody Plant Species within the Ranches

A total of 39 woody species comprising 22 shrubs and 17 trees was recorded in 55 plots covering 13.75 ha in the ranches (Table 3). This represents 56% of the species recorded in household surveys. The pooled data for the plots show that the general population structure pattern for shrubs and trees was the inverse j shape (Figure 4). However, regeneration of seedlings of shrubs was higher than trees but generally trees had a more sustainable recruitment of individuals into successive growth stages than shrubs.

Table 3: Indigenous woody plant species/ha recorded in 11 ranches of Ankole Ranching Scheme

Name of Species	Plant status	Seedlings	Saplings	Poles	Mature trees	Species/ha
Acacia hockii	Tree	961	424	140	2	111
Rhus natalensis	Shrub	327	165	74	0	41
Acacia gerrardii	Tree	233	86	116	1	32
Grewia mollis	Tree	216	59	59	3	25
Hoslundia opposite	Shrub	313	1	0	0	23
Asparagus flagellaris	Shrub	223	0	0	0	16
Acacia sieberiana	Tree	51	82	65	5	15
Carissa macrocarpa	Shrub	181	18	3	0	15
Scutia myrtina	Shrub	112	31	10	0	11
Capparis fascicularis	Shrub	130	0	0	0	9
Euphorbia candelabrum	Tree	40	45	19	21	9
Teclea nobilis	Tree	51	41	17	0	8
Maytenus senegalensis	Shrub	77	17	9	0	7
Clerodendrum myricoides	Shrub	88	0	0	0	6
Allophylus sp	Tree	46	26	15	0	6
Duranta erecta	Shrub	58	1	0	0	4
Pluchea ovalis	Shrub	48	6	2	0	4
Flueggea virosa	Shrub	40	6	3	1	4
Lantana trifolia	Shrub	43	0	0	0	3
Acacia persiciflora	Tree	26	7	1	0	2
Jasminum pauciflorum	Tree	5	23	6	0	2
Grewia kakothamnos	Shrub	23	0	0	0	2
Rytigyna macrura	Shrub	22	0	0	0	2
Nuxius congesta	Tree	2	4	10	0	1
Carissa edulis	Shrub	8	6	0	0	1
Microglossa angolensis	Shrub	14	0	0	0	1
Solanum renschii	Shrub	12	0	0	0	1
Erythrococca bongesis	Shrub	10	0	0	0	1
Triumfetta rhomboidea	Shrub	9	1	0	0	1
Erythrina abyssinica	Tree	0	4	5	0	1
Ehretia cymosa	Shrub	0	4	3	0	1
Albizia glaberrima	Tree	0	0	3	3	0
Ficus ovata	Tree	0	1	4	0	0
Euclea latidens	Tree	4	0	0	0	0
Gardenia sp	Tree	2	0	1	0	0
Albizia coriaria	Tree	0	0	0	1	0
Croton megalocarpus	Tree	1	0	0	0	0

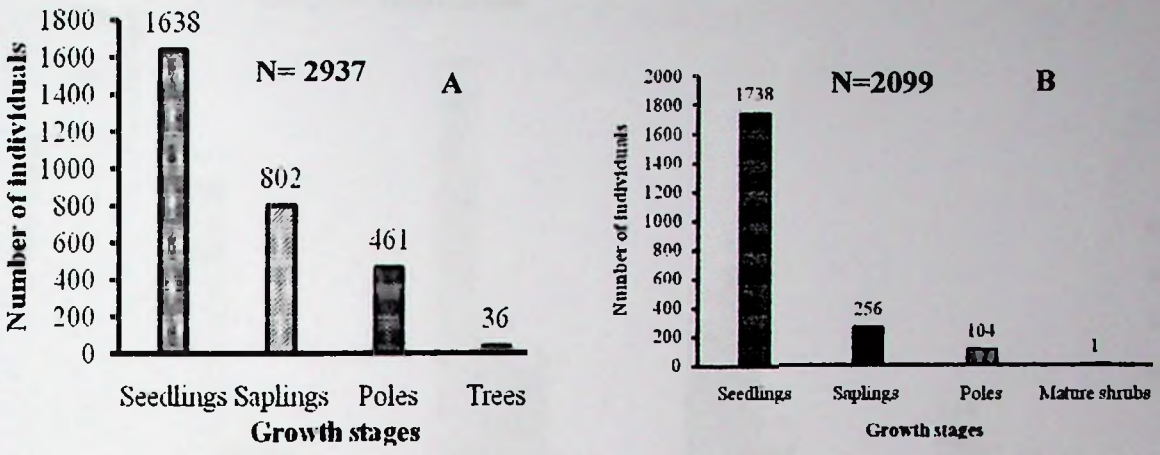

Figure 4: General population structure pattern of trees (A) and shrubs (B) in 13.75 ha

Similar with the general population structures of trees and shrubs, the inverse j shape was attained when data are analyzed on the basis of sub counties (Figures 5, and 6). However, there was a large range in the populations of poles and trees/mature shrubs compared to other size classes. In tree species, the range was 92% while in shrubs the range was as high as 99%. Similar results are depicted in population structure patterns of trees and shrubs at sub-county level. In all the sub-counties, most species had no mature individuals (>20 cm DBH).

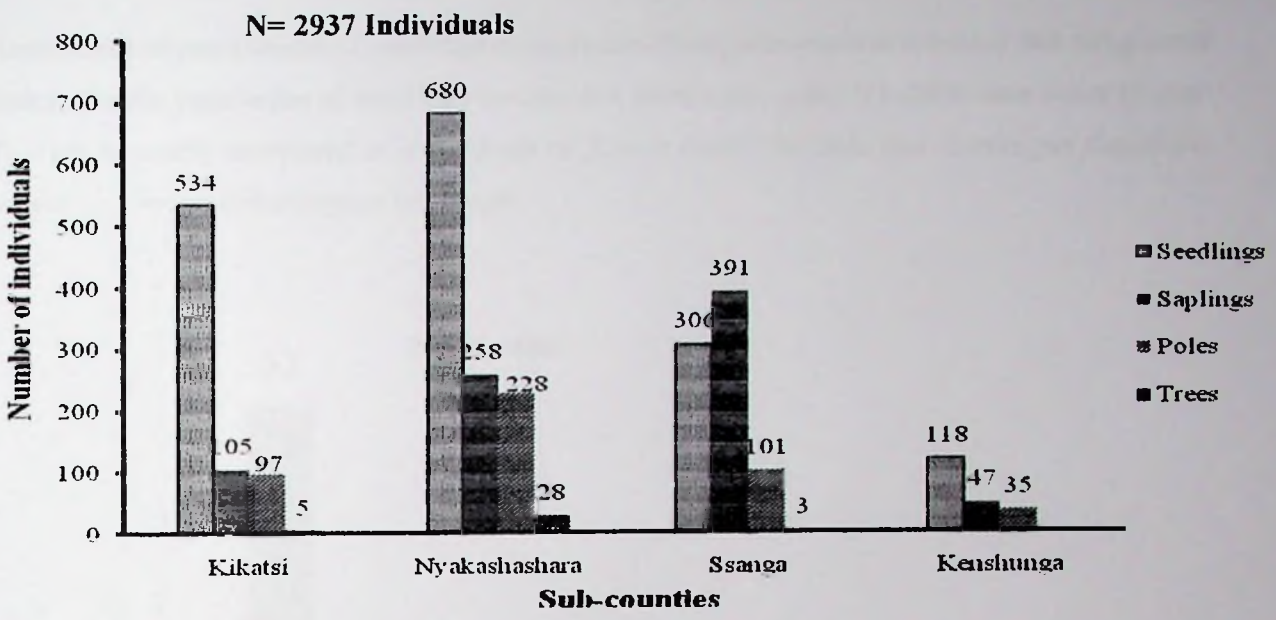

Figure 5: Population structure of trees in Kikatsi, Nyakashashara, Ssanga and Kenshunga

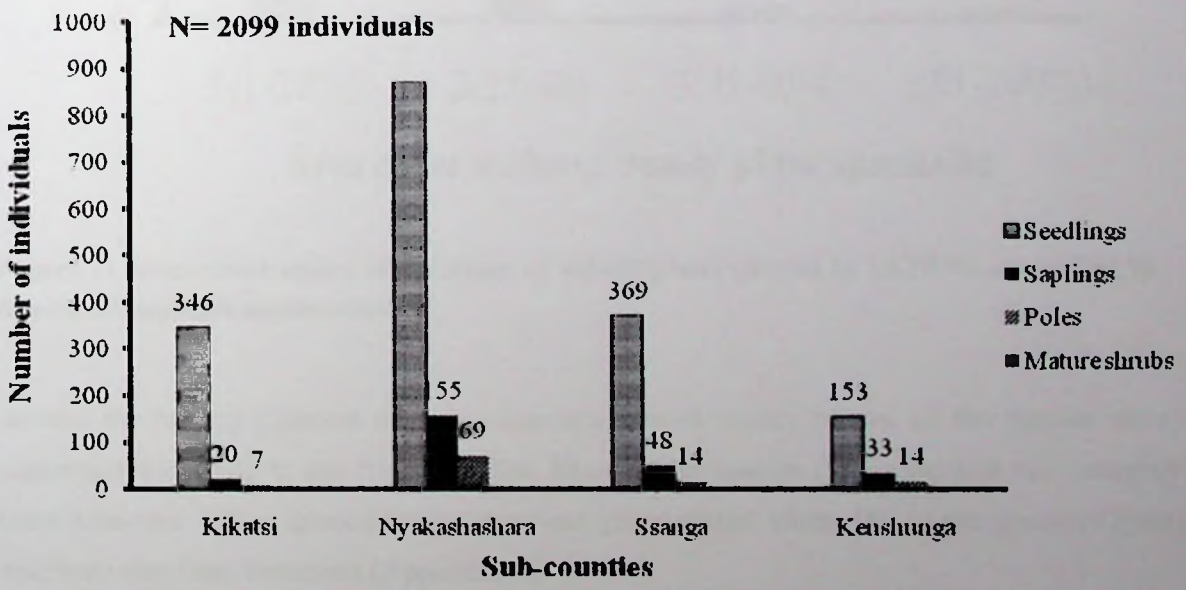

Figure 6: Population structure of shrubs in Kikatsi, Nyakashashara, Ssanga and Kenshunga

Assessment of populations of seedlings using Braun-Blanquette method revealed that the general pattern for the population of seedlings in trees and shrubs was scale 1(1-20%) area cover (Figure 7) .This is mainly composed of individuals of *Acacia hockii* for trees and *Asparagus flagellaris* as well as *Grewia kakothamnos* for shrubs.

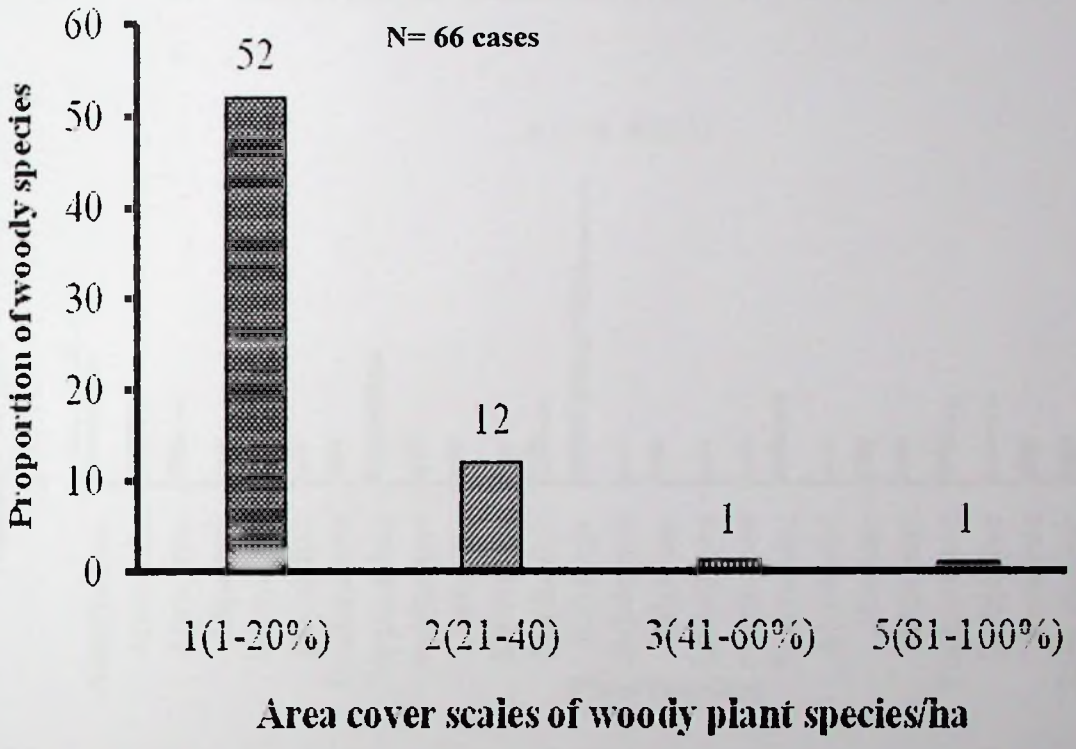

Figure 7: Area cover scales of seedlings of woody plant species in 13.75 ha according to Braun-Blanquette assessment

Besides the inverse j pattern of population structure of woody plants, all the species were not threatened according to the IUCN Redlist. Most of the species (56%) were in the category of Least Concern. Other species (43%) were not yet assessed while 1% of the species (*Rytigyna macrura*) was Data Deficient (Appendix II).

4.3 Changes in the Diversity of Indigenous Woody Species Overtime

The present study recorded 37 species of trees and shrubs belonging to 23 families (Figure 8). There were 16 species of trees and 21species of shrubs. Results of the previous inventory recorded 29 species belonging to 20 families. The latter comprised 7 tree species and 22 shrub species (Appendix III). Shannon Wiener's diversity index indicates an increase in the diversity of species in 2013 ($H^{/}$ =2.92) as opposed to the results of 1998 ($H^{/}$ =2.77).

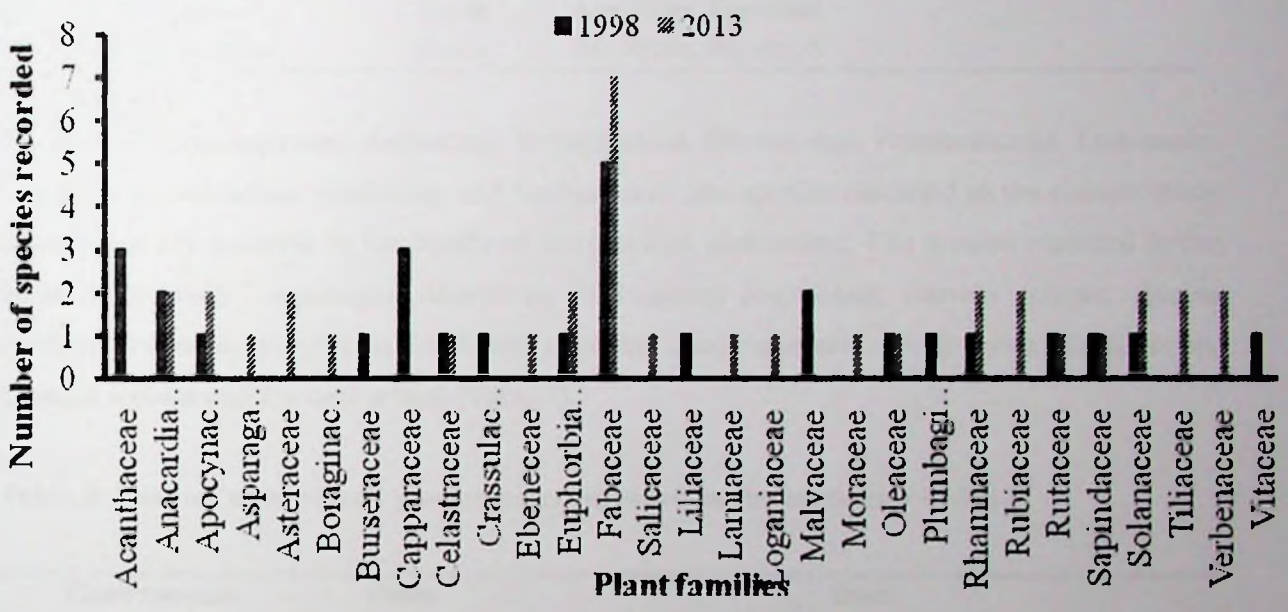

Figure 8: Family composition of woody plant species in the inventory of 1998 and 2013

Families Acanthaceae, Burseraceae, Crassulaceae, Liliaceae, Plumbaginaceae and Vitaceae had no species recorded in the current study yet they had species in the previous study. The extra species in the previous assessment were *Barleria dentate, Ecbolium subcordatum, Justicia unyorensis, Commiphora* sp, *Kalanchoea crenata, Asparagus falcatus, Plumbago zeylanica* and *Cyphostemma Serpens* (Table 4).

Table 4: Uses of more woody plant species recorded in the inventory of 1998

Plant Species	Plant Status	Uses
Barleria dentata	Shrub	Medicine, firewood
Ecbolium subcordatum,	Shrub	Medicine, firewood
Jusiticia unyorensis	Shrub	Medicine, fodder, firewood
Commiphora sp	Shrub	Medicine, crafts work, firewood, poles
Kalanchoea crenata	Shrub	Medicine ,firewood
Asparagus falcatus	Shrub	Medicine, fencing poles, firewood, crafts work
Plumbago zeylanica	Shrub	Medicine ,firewood
Cyphostemma serpens	Shrub	Medicine, firewood

The families Asparagaceae, Asteraceae, Boraginaceae, Ebeneaceae, Flacourtiaceae, Lamiaceae, Loganiaceae, Moraceae, Rubiaceae and Verbanaceae had species recorded in the current study which were not recorded in the results of the previous assessment. The species recorded in the latest study were; *Asparagus flagellaris, Microglossa angolensis, Ehretia cymosa, Euclea latidens, Trimerria grandifolia, Huslondia opposite, Nuxia congesta, Ficus ovata, Gardenia* sp, *Lantana trifolia* and *Duranta erecta* (Table 5).

Table 5: Uses of 'new' woody plant species recorded in the inventory of 2013

Plant species	Plant status	Uses
Asparagus flagellaris	Shrub	Fodder, medicine, firewood,
Duranta erecta.	Shrub	Fodder, medicine, firewood, poles,
Ehretia cymosa	Shrub	Poles, shade
Euclea latidens,	Tree	Fodder, medicine, firewood, poles, timber
Ficus ovata	Tree	Medicine, firewood, poles, timber, shade
Gardenia sp,	Tree	Fodder, medicine, firewood, poles, timber, shade
Huslondia opposite	Shrub	Food (fruits), fodder, medicine
Lantana trifolia	Shrub	Food (fruits), fodder, medicine, firewood
Microglossa angolensis	Shrub	Fodder, medicine, firewood
Nuxia congesta	Tree	Fodder, medicine, firewood, poles, timber, crafts, shade
Trimerria grandifolia	Shrub	Medicine

Unlike in the previous assessment where the extra species were all shrubs, the other species which were recorded in the latest study included both shrubs and trees. The additional tree species recorded in the present study were *Euclea latidens, Croton megalocarpus, Albizia glaberrima, Erythrinna abbysinica, Nuxia congesta, Ficus ovata* and *Gardenia* sp. However there was no significant difference in the diversity of species between records of 1998 and 2013 ($P>0.05$), which results were in favor of the null hypothesis.

4.4 Human Factors Affecting the Conservation of Indigenous Woody Species

Four types of human induced factors affecting the conservation of indigenous of woody plant species were identified: these were grazing and associated impacts, harvesting, fires and agriculture (Figure 9). Grazing ranked the highest followed by harvesting. Grazing was characterized by feeding on leaves as well as trampling which stagnated proper growth of plant species.

Most of the grazing activities were observed on *Acacia* species which comprise the most preferred fodder species from the household survey results. Harvesting was mainly observed in complete cutting of trees for charcoal burning, firewood and provision of fencing materials and construction materials of kraals.

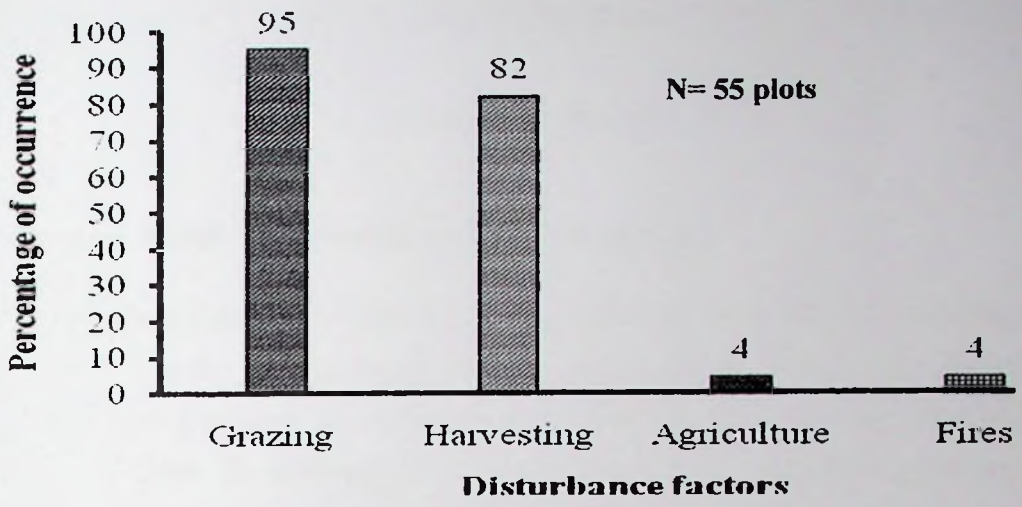

Figure 9: Factors affecting conservation of indigenous woody species

From sub-county assessments, grazing and harvesting were highest in Nyakashashara and Kikatsi sub counties and lowest in Kenshunga and Ssanga sub counties (Figure 10). However, the four factors identified were recorded in Ssanga sub-county while Kenshunga, Nyakashashara and Kikatsi had no cases of agriculture and fires recorded.

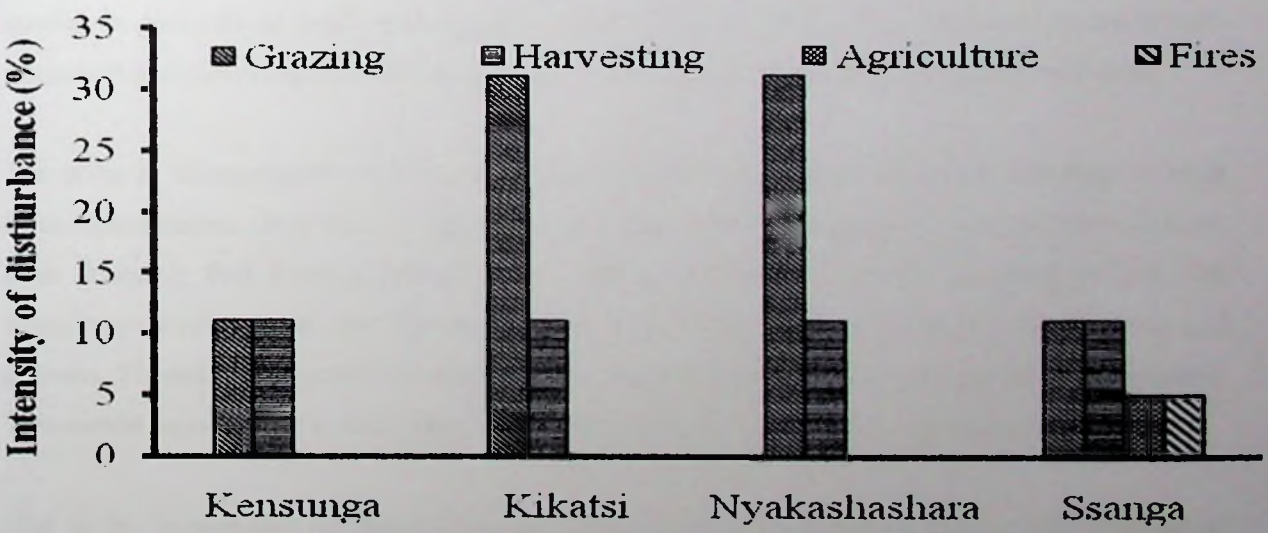

Figure 10: Human factors affecting conservation of woody species in Kenshunga, Kikatsi, Nyakashashara and Ssanga

CHAPTER FIVE

5.0 DISCUSSION

5.1 Indigenous Woody Plant Species used by Pastoralists

Woody plant species play an important role in sustaining the livelihoods of pastoralists. The present study recorded seventy woody species being used to meet several immediate needs which concur with Kakuru *et al.*, (2005). In some semi arid areas, the population of indigenous woody species used for different purposes ranges as high as 300-800 species. However, provision and access to plant resources is declining as natural habitats come under increasing pressure from development, conservation exclusion and agriculture expansion (Bharucha and Pretty, 2010).

The prevalence in the use of plants for medicinal purposes can be attributed to the distant location of modern health facilities. Semi arid areas where pastoralists operate are often isolated thus limiting access to services (Reynolds *et al.*, 2007). The indigenous exploration of the use of the species as curative or preventive medicine is a great opportunity for conservation of these species in pastoralism production systems. This is due to the fact that communities are always interested in conserving resources which offer immediate direct benefits to their livelihoods.

The order in frequency of use of species by the respondents follows a pattern common in most rural communities. Over 90% of Uganda's rural population depends on woody biomass to meet their domestic fuel needs (Kakuru *et al.*, 2004). Food being a basic necessity of life, the importance explains the fact that fuel wood was third in rank to medicine for humans and animals. Therefore, promotion of alternative energy sources such as biogas should be considered. This would promote the conservation of woody species by reducing the pressure of utilization.

Due to the importance of livestock in the livelihoods of pastoralists coupled with scarcity of pastures especially in the dry season, pastoralists explored several woody species to be important in supplementing fodder materials. Woody plants provide supplementary feeds to livestock

especially in the dry season when ground forage is lacking (Teklehaimanot *et al.*, 2007). The latter analysis can be based on to justify the fact that several woody plant species are being used as fodder by pastoralists. Therefore, deliberate efforts targeting conservation of fodder trees in grazing lands should be enhanced. This can be through use of fodder trees in boundary planting or in demarcation of paddocks.

Whereas a few species were used for food (as fruits), most of the species reported had high frequencies of utilization from the respondents. This emphasizes the importance of indigenous wild woody species as safety nets for food security in pastoralism production systems (McGarry and Shackleton, 2009). The integration of such species in food security programs is necessary for enhancing resilience of pastoralism production systems to climate variability and change.

Most of the species were of low timber value (7%) to the pastoralists. This could be due to the fact that most species were shrubs in nature, a characteristic common for woody species in savannah grasslands (Sankaran *et al.*, 2005). Shrubs are characterized by multiple stems of small sizes, irregular branching and low stem height. Such attributes limit the use of shrubs for timber. However, the few species considered for timber purposes were key in providing shade in the paddocks. Therefore maintaining a sustainable population of these species in the paddocks is important for enhancing the productivity of livestock.

5.2 Population Structure of the Indigenous Woody Species

The population structure patterns of woody plant species provide an important indicator of conservation status of plants. The general inverse j shape pattern of population structure displayed by the trees and shrubs is typical of a self sustaining population where seedlings are recruited continuously into bigger size classes (Peters, 1996). The inverse j shape population structure was mainly contributed by different species of the genus *Acacia.* The dominance of *Acacia* species in the results is due to their morphological structures (numerous thorns and small leaves) which enable them to minimize water loss and therefore thrive in drought prone semi-arid areas (Tabuti, 2007).

Grazing lands are important sites for conservation of biodiversity (Fischer *et al.*, 2006). This is due to the fact that the contribution of woody plant species to ecosystem functioning is disproportionately large given the small area occupied and low biomass of any given tree. For instance the extensive shade provided by the wide canopy of the few *Albizia coriaria* trees encountered contribute to temperature regulation and hydrological cycle while regulating several metabolic processes of the livestock.

Therefore since woody plant species fulfill unique functional roles in a wide range of savannah ecosystems, their loss may result in undesirable ecological regime effects (Manning *et al.*, 2006). The sustainable population structure observed could be due to improvement in land tenure which increased control of use of woody plant species. Previously, most of the grazing lands in Uganda were considered to be common property for all pastoralists and no one was held responsible for over exploitation of plants (Jama and Zeila, 2005). Security of land tenure which enhances ownership of woody species by individuals provides an important platform for ensuring sustainable conservation of species by local communities (Banana *et al.*, 2011).

Although most of the species were mentioned as providing many products rather than services, awareness creation on the ecosystem services of woody species is needed. This will increase the participation of pastoralists in ensuring the conservation of indigenous woody plant species and prevent local extinction of species (Kalema and Beentje, 2012).

Nonetheless despite the inverse J shape pattern, the large range between populations of poles and trees/shrubs cannot be underestimated. This could be attributed to exploitation of specific size classes such as poles thus hindering recruitment into trees. Harvesting of specific size classes of woody plants usually removes species which could provide seeds for the next generation (Mueller *et al.*, 2005). Such results call for intervention actions to check the population gap if regeneration of woody plants species in pastoral lands is to be sustained.

5.3 Changes in the Diversity of Indigenous Woody Species Since 1998

Periodic inventories of plant biodiversity are necessary in reducing the risk of species extinction especially in un protected habitats (Eilu *et al.*, 2008). Forces which influence changes in species composition can be ascertained and control measures enforced. Although anthropogenic and demographic forces keep acting on species populations, thus affecting the diversity of indigenous woody species (Chillo *et al.*, 2011), the diversity of indigenous woody plant species between inventories of 1998 and 2013 did not change significantly which results are in favor of the null hypothesis. However Shannon-Wiener's diversity index provides evidence of the increase in species diversity especially in the inventory of 2013.

The difference in composition of families and species between results of 1998 and 2013 inventory studies could be attributed to changes in the intensity of human activities such as grazing, harvesting and fires. On one side, grazing leads to an increase in the abundance of woody species in an area as the grass layer is reduced thus creating open spaces for germination (Briggs *et al.*, 2002). This could have led to the increase in species diversity in the current study.

However, opening of spaces can lead to abundance of species to a certain extent beyond which several woody species disappear at the expense of new vegetation patterns (Kassahun *et al.*, 2008). This is especially reflected in the mixed composition of extra trees and shrubs in the results of the latter inventory as opposed to the previous assessment in 1998. However, changes in species composition directly influences livestock activities as some plants may not favor productivity of certain livestock types.

On the other hand, anthropogenic factors lead to biodiversity loss as species fail to gain resilience from the exploitation pressure or fail to regenerate due to erosion of soil seed banks (Kassahun *et al.*, 2008). Forces such as over utilization of species and frequent fires have been reported to reduce the shrub cover significantly while tree cover is not severely affected (Sheuyange *et al.*, 2005). Therefore the different capacity of trees and shrubs to absorb disturbance shocks could have led to the absence of plant species which were recorded in the

previous assessment while tree species emerged. The response of plant species to biotic and abiotic forces therefore gives insights on management decisions for certain species to ensure retention of sustainable populations and enhance regeneration.

5:3:1 Implication of the trend in species diversity to the livelihoods of pastoralists

Demographic forces such as grazing intensity and bush encroachment are disturbance factors that may alter the floristic composition of indigenous plant species (Angassa, 2014). The change in floristic composition can lead into dominance of certain species of socio-economic value but on the other hand can lead to colonization of invasive species which can be dangerous especially to livestock (Kassahun *et al.*, 2008). The extra species recorded in the inventory of 2013 are native to semi arid environments. Secondary data about the species reveal that all the species serve multiple purposes in the livelihoods of pastoralists similarly to the purposes of species identified in the household survey. Therefore the increase in species diversity provides more sources of wood based products needed by the pastoralists for livelihood sustainability.

5.4 Human Factors Affecting Conservation of Indigenous Woody Species

Human activity in different forms is one of the key factors affecting the conservation of biodiversity. In privately owned forests, deforestation is mainly influenced by location, patchiness, and production of external environmental goods and services the level and strength of market signals for both forest products and crops grown on forest soils (Banana *et al.*, 2007). Such results explain the intensity of the four human induced factors on woody species in the different sub counties studied.

The uses of species as poles and firewood were among the most important according to the results of household surveys. This is in agreement with the recorded prevalent signs of harvesting. The major livelihood activities for the rural households in dry lands include livestock grazing and charcoal production and or a combination (Kalema, 2010). These activities leave behind disturbance signs that can be detected on woody species.

On the other hand, grazing has significant negative effects on the conservation of biodiversity in pastoralism production lands (Smet and Ward, 2005). It hinders plant growth due to loss of leaves that are eaten by livestock, feeding on twigs and trampling (Begon *et al.*, 2006). Harvesting on the other hand is usually done to provide firewood in different forms. Up to 10-20% of the woody species in pastoralism production lands is lost annually due to harvesting (Jama and Zeila 2005).

The various disturbance activities may be linked to the large range between individuals in the different size classes in the population structure graphs. Due to the limited effort on conservation of biodiversity outside protected areas, the sustainability of plant populations in grazing lands is uncertain. There is a need for establishment of community platforms which can be used to create awareness to reduce pressure of harvesting and grazing on woody species.

Worth noting is the occurrence of grazing, harvesting, agriculture and fires disturbance factors in Ssanga sub-county as opposed to other sub-counties where grazing and harvesting were the only disturbance factors recorded. This could be attributed to the proximity of Ssanga sub-county to major access routes and urban centers where access of the ranches by the frontier community is enhanced.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

A total of 70 indigenous woody plant species are used by the pastoralists of south western Uganda. The main uses were human medicine, animal medicine, fuel wood, fodder, timber, poles, food, crafts materials and provision of shade. However, the diversity of woody species recorded secures pastoralism production lands as prime areas for conservation of woody species.

In terms of population structure, the species conform to inverse J shape pattern indicative of a sustainable population of woody plant species. Besides, the populations of indigenous woody plant species assessed were not threatened basing on IUCN Red list criteria. However, the large gap (92-99%) in populations of poles and mature trees/shrubs calls for interventions of sustainable conservation approaches.

There was an increase in the diversity of indigenous woody species between the two successive inventories of 1998 and 2013. The increase in diversity of indigenous woody plant species recorded is a good indicator of species colonization and regeneration. Increase in species diversity is a promising avenue for enhancing the resilience of pastoral production lands to climate change effects and therefore boost the sustainability of pastoralism production systems.

Overgrazing and unsustainable harvesting are the major human factors affecting the conservation status of indigenous woody plant species in pastoralism production systems of south western Uganda. This is reflected in the low values of poles and tree populations which are the dominant stages of harvesting value. Appropriate regulatory mechanisms to reduce the magnitude of damage of overgrazing and unsustainable harvesting on woody species are needed.

6.2 Recommendations

The conservation of indigenous woody plant species should be deliberately integrated into the rangelands management programs spearheaded by the Ministry of Agriculture, Animal Industries and Fisheries (MAAIF), since they directly contribute to the livelihoods of pastoralists. This will sustain the benefits of indigenous woody plant species to pastoralists while maintaining peoples' interest in conserving the species on their land.

The development of domestication packages for major woody species used by pastoralists is recommended for continuity of a sustainable population structure of woody species. This is due to the fact that the population of mature individuals in both trees and shrubs was too low and may affect successive recruitment. This measure will help in supplementing natural regeneration of selected woody species and enhance conservation. This strategy should be complimented by evaluating the production pathways of selected species in agro-pastoral farming systems, which can be spearheaded by Research and academic Institutions.

Re-introduction of indigenous woody plant species which were found missing in the inventory of 2013 should be done. This should be accompanied by establishment of long term permanent sample plots and community based conservation plants to enable diversity monitoring under the supervision of local governments. This measure will help in engaging pastoralists in conservation of indigenous woody species despite the changing pastoral practices.

The protection of seedlings and saplings from grazing/browsing should be promoted to reduce the negative impacts of feeding by livestock. This could be done by fencing off (zoning) some sites within the paddocks to allow growth and recruitment within vulnerable size classes thus achieving a sustainable population structure of plant species. The approach of zoning has been proved successful in conservation of biodiversity in tropical high forests and can yield potentially positive results upon appropriate implementation in pastoralism production lands. Research support to determine the growth rate of species in the wild can guide establishment of the time period for which a site should be fenced off to enable species' recruitment.

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APPENDICES

Appendix I: Indigenous woody plant species used by pastoralists

Family	Species (Scientific Name	Local Name	Responses for Uses of Species from 100 households								
			Food	Fodder	Human Medicine	Animal Medicine	Firewood	Poles	Timber	Shade	Crafts
Anacardiaceae	*Rhus natalensis* Bernh. ex Krauss	Omusheshe	84	70	47	35	37	28	12	0	0
	Rhus vulgaris Meikle	Obukanza	30	0	5	3	2	1	1	0	0
Apocynaceae	*Carissa edulis* (Forssk.) Vahl	Omuyonza	99	28	23	13	5	0	0	0	0
	Carissa macrocarpa (Eckl.) A. DC.	Amatungu	5	3	23	16	3	1	0	0	0
	Thevetia peruviana (Pers.) K. Schum.	Omusenene	0	0	1	1	0	0	0	0	0
Asparagaceae	*Asparagus flagellaris* (Kunth) Baker	Akashebashebe	0	5	13	14	2	0	0	0	0
Asteraceae	*Microglossa angolensis Oliv. & Hiern*	Kyakuyambaki	0	2	16	12	1	0	0	0	0
	Microglossa pyrifolia (Lam.) Kuntze	Omuhe	0	0	0	3	0	0	0	0	0
	Pluchea ovalis (Pers.) DC.	Omuneera	0	1	3	0	0	0	0	0	0
	Vernonia amygdalina Delile	Omubirizi	0	57	78	71	11	0	0	0	0
Bignoniacea	*Markhamia lutea* (Benth.) K. Schum.	Mushambya	0	0	1	0	0	4	3	1	0
Boraginaceae	*Ehretia cymosa* Thonn.	Ekikobokobo	0	0	0	0	0	1	0	1	0
Capparaceae	*Capparis fascicularis* DC.	Kagyezanda	0	27	0	20	0	0	0	0	0
	Capparis tomentosa Lam	Omukorokombi	0	4	20	27	2	1	0	1	0
	Maerua triphylla A. Rich.	Omwoyante	0	64	23	24	6	2	2	0	0
	Bosci coriacea Pax.	Enzizi	0	0	1	0	0	0	0	0	0
Celastraceae	*Maytenus heterophylla* (Eckl. & Zeyh.) N. Robson	Kabaruka	0	0	0	2	0	0	0	0	0
	Maytenus senegalensis (Lam.) Exell	Omunyabiruko	0	11	42	42	17	15	4	0	0
Convulvulaceae	*Astripomoea malvaceae* Klotzsch.	Bingiribeta	0	0	0	2	0	0	0	0	0

Draceanaceae	*Dracaena fragrans* (L.) Ker Gawl.	Omugorora	0	0	1	1	0	0	0	0	0
	Dracaena steudneri Engl.	Ekigorogoro	0	0	1	1	0	0	0	0	0
Ebeneaceae	*Diospyros abyssinica* (Hiern) F. White	Omuhogo	0	0	1	1	0	0	0	0	0
	Euclea latidens Stapf	Omusikizi	0	5	18	21	17	15	8	0	0
Euphorbeaceae	*Croton megalocarpus* Hutch.	Omutugunda	3	0	3	3	0	0	0	0	0
	Erythrococca bongensis Pax	Omushongashongi	0	0	5	6	0	0	0	0	0
	Euphorbia candelabrum Tremaux ex Kotschy	Enkukulu	0	0	46	29	7	5	2	0	0
	Euphorbia tirucalli L	Enkoni	0	0	2	4	0	0	0	0	0
	Flueggea virosa (Roxb. ex Willd.) Royle	Omubwera	0	13	34	30	10	8	3	0	0
Fabaceae	*Acacia abyssinica* Benth.	Omunyinya	0	6	7	9	16	16	12	3	0
	Acacia campylacantha A.Rich.	Kibeere	0	0	3	3	3	3	2	0	0
	Senna didymobotrya (Fresen.)H.S.Irwin & Barneby	Omugabagaba	0	0	4	4	0	0	0	0	0
	Acacia gerrardii Benth.	Omutongole	0	42	39	42	74	68	44	8	0
	Acacia hockii De Wild.	Orugando	0	73	40	46	62	37	24	0	0
	Acacia persiciflora Pax	Omulemampango	0	1	3	3	1	3	2	0	0
	Acacia sieberiana DC.	Omutyaza	0	46	40	41	77	69	55	15	0
	Erythrina abyssinica DC.	Ekiko	0	0	33	23	37	36	15	1	1
	Erythrophleum pyrifolia	Omurama	0	4	18	16	18	14	4	3	0
	Indigofera emerginella Steud.ex.A.Rich	Ishekazibasumba	0	0	0	3	0	0	0	0	0
	Albizia coriaria Oliv.	Omusisa	0	37	59	58	73	77	79	24	0
	Albizia glaberrima (Schum. &Thonn.)Benth.	Omushebeya	0	1	2	4	3	3	3	1	0
	Sesbania sesban (L.)Merr.	Omunyeganyega	0	2	5	4	3	2	0	0	0
	Tamarindus indica L.	Omukoge	0	0	1	0	0	0	0	0	0
Flacourtiaceae	*Dovyalis macrocalyx* (Oliv.) Warb.	Entagyegyera	12	1	2	2	1	0	0	0	0
	Macrotyloma axillare (E. Mey.)	Akaenabakuru	0	0	0	1	0	0	0	0	0
Lamiaceae	*Clerodendrum myricoides(Hochst.)R.Br.ex Vatke*	Ekisekasheke	0	0	1	2	0	0	0	0	0
	Hoslundia opposite Val	Esitimwe	3	6	31	25	0	0	0	0	0
Loganiaceae	*Nuxia congesta* R. Br.	Omumuli	0	4	3	8	10	10	8	1	1
Moraceae	*Ficus natalensis* Krauss ex Engl.	Omutooma									

			0	24	15	23	33	30	27	6	2
Moraceae	*Ficus ovata* Vahl	Omukunyu	0	0	3	2	4	4	4	1	0
Myricaceae	*Myrica kandtiana* Engl.	Omugyegye	0	0	1	0	0	0	0	0	0
Nytaginaceae	*Boerhavia diffusa* L	Obukegate	0	1	0	0	0	0	0	0	1
Oleaceae	*Jasminum pauciflorum* Benth.	Omuremanjojo	0	0	0	1	2	3	2	0	0
Phyllanthaceae	*Margaritaria discoidea* (Baill.) G.L.Webster	Omutyibare	0	2	2	2	7	6	4	1	0
Phytolaccaceae	*Phytolacca dodecandra* L Herit	Omuhogo	1	1	0	0	0	0	0	0	0
Rosaceae	*Rubus pinnatus* Willd.	Encerere	22	2	3	0	1	1	0	0	0
Rubiaceae	*Gardenia Sp*	Entarama	0	1	14	19	15	17	4	1	0
	Rytigynia macrura Verdc.	Omurokora	5	0	1	3	1	0	0	0	0
Rutaceae	*Teclea nobilis* Del.	Omuzo	0	4	2	4	8	7	5	1	0
	Zanthoxylum chalybeum Engl	Entaleyerungu	0	0	13	9	0	0	0	0	0
Salicaceae	*Trimeria grandifolia* (Hochst.) Warb	Omwatanshare	0	0	3	1	0	0	0	0	0
Sapindaceae	*Allophylus Sp*	Omutete	24	45	46	41	45	46	21	3	1
Solanaceae	*Capsicum frutescens* L	Esheka	54	2	15	6	3	0	0	0	0
	Solanum renschii Vatke	Omulyanyonyi	0	0	5	4	0	0	0	0	0
Tiliaceae	*Grewia mollis* Juss.	Omukoma	0	60	19	25	46	44	29	3	0
	Grewia kakothamnos K. Schum.	Omukomakoma	85	60	19	25	0	0	0	0	3
	Triumfetta rhomboidea Jacq.	Omuhingura	0	2	22	14	0	0	1		1
Ulmaceae	*Scutia myrtina* (Burm. f.) Kurz	Omugasha	81	15	13	9	18	1	5	0	0
Verbenaceae	*Duranta erecta* L	Omuhwahwa	0	3	5	4	7	4	1	0	0
	Lantana trifolia L.	Ehuuki	71	4	33	31	3	0	0	0	0
	Verbana officinalis L	Omugoshora	1	0	0	0	0	0	0	0	0

Appendix II: Conservation Status of Indigenous Woody Species Used by Pastoralists

Family	Species (Scientific Name)	Local Name	Conservation status
Anacardiaceae	*Rhus natalensis* Bernh. ex Krauss	Omusheshe	Least Concern
	Rhus vulgaris Meikle	Obukanza	Not yet assessed
Apocynaceae	*Carissa edulis* (Forssk.) Vahl	Omuyonza	Not yet assessed
	Carissa macrocarpa (Eckl.) A. DC.	Amatungu	Not yet assessed
	Thevetia peruviana (Pers.) K. Schum.	Omusenene	Not yet assessed
Asparagaceae	*Asparagus flagellaris* (Kunth) Baker	Akashebashebe	Not yet assessed
Asteraceae	Microglossa angolensis Oliv. & Hiern	Kyakuyambaki	Not yet assessed
	Microglossa pyrifolia (Lam.) Kuntze	Omuhe	Not yet assessed
	Vernonia amygdalina Delile	Omubirizi	Least concern
Bignoniacea	*Markhamia lutea* (Benth.) K. Schum.	Mushambya	Least concern
Boraginaceae	*Ehretia cymosa* Thonn.	Ekikobokobo	Least concern
Capparaceae	*Capparis fascicularis* DC.	Kagyezanda	Not yet assessed
	Capparis tomentosa Lam	Omukorokombi	Not yet assessed
	Maerua triphylla A. Rich.	Omwoyante	Least concern
	Bosci coriacea Pax	Enzizi	least concern
Caesalpiniaceae	*Erythrophleum pyrifolia*	Omurama	Not yet assessed
Celastraceae	*Maytenus heterophylla* (Eckl. & Zeyh.) N Robson	Kabanika	Least concern
	Maytenus senegalensis (Lam.) Exell	Omunyabiruko	Not yet assessed
Compositae	*Pluchea ovalis* (Pers.) DC.	Omuneera	Not yet assessed
Convulvulaceae	*Astripomoea malvaceae*	Bingiribeta	Not yet assessed
Draceanaceae	*Dracaena fragrans* (L.) Ker Gawl.	Omugorora	Least concern
	Dracaena steudneri Engl.	Ekigorogoro	Least concern
Ebenaceae	*Diospyros abyssinica* (Hiern) F. White	Omuhogo	Least concern
	Euclea latidens Stapf	Omusikizi	Not yet assessed
Euphorbeaceae	*Croton megalocarpus* Hutch.	Omutugunda	Least concern
	Erythrococca bongensis Pax	Omushongashongi	Least concern
	Euphorbia candelabrum Tremaux ex Kotschy	Enkukulu	Least concern
	Euphorbia tirucalli L	Enkoni	Least concern
	Flueggea virosa (Roxb. ex Willd.) Royle	Omubwera	Least concern
Fabeceae	*Acacia abyssinica* Benth.	Omunyinya	Least concern
	Acacia campylacantha A.Rich.	Kibeere	Not yet assessed
	Senna didymobotrya (Fresen.)H.S.Irwin & Barneby	Omugabagaba	Not yet assessed
	Acacia gerrardii Benth.	Omutongole	Least concern
	Acacia hockii De Wild.	Orugando	Least concern
	Acacia persiciflora Pax	Omulemampango	Not yet assessed
	Acacia sieberiana DC.	Omutyaza	Least concern
	Erythrina abyssinica DC.	Ekiko	Least concern

	Indigofera emerginella Steud. ex A. Rich.	Ishekazibasumba	Not yet assessed
	Albizia coriaria Oliv.	Omusisa	Least concern
	Albizia glaberrima (Schum. &Thonn.)Benth.	Omushebeya	Least concern
	Sesbania sesban (L.)Merr.	Omunyeganyega	Least concern
	Tamarindus indica L.	Omukoge	Least concern
Flacourtiaceae	*Dovyalis macrocalyx* (Oliv.) Warb.	Entagyegyera	Least concern
	Macrotyloma axillare (E. Mey.)	Akaenabakuru	Not yet assessed
Lamiaceae	*Clerodendrum myricoides(Hochst.) R.Br.ex Vatke*	Ekisekasheke	Least concern
	Hoslundia opposite Val	Esitimwe	Not yet assessed
Loganiaceae	*Nuxia congesta* R. Br.	Omumuli	Least concern
Moraceae	*Ficus natalensis* Krauss ex Engl.	Omutooma	Least concern
	Ficus ovata Vahl	Omukunyu	Least concern
Myricaceae	*Myrica kandtiana* Engl.	Omugyegye	Not yet assessed
Nytaginaceae	*Boerhavia diffusa* L	Obukegate	Not yet assessed
Oleaceae	*Jasminum pauciflorum* Benth.	Omuremanjojo	Not yet assessed
Phyllanthaceae	*Margaritaria discoidea* (Baill.) G.L.Webster	Omutyibare	Least concern
Phytolaccaceae	*Phytolacca dodecandra* L Herit	Omuhogo	Not yet assessed
Rosaceae	*Rubus pinnatus* Willd.	Encerere	Not yet assessed
Rubiaceae	*Gardenia Sp*	Entarama	Least concern
	Rytigynia macrura Verdc.	Omurokora	Data deficient
Rutaceae	*Teclea nobilis* Del.	Omuzo	Not yet assessed
	Zanthoxylum chalybeum Engl	Entaleyerungu	Least concern
Salicaceae	*Trimeria grandifolia* Hochst	Omwatanshare	Least concern
Sapindaceae	*Allophylus Sp*	Omutete	Least concern
Solanaceae	*Capsicum frutescens* L	Esheka	Not yet assessed
	Solanum renschii Vatke	Omulyanyonyi	Not yet assessed
Tiliaceae	*Grewia mollis* Juss.	Omukoma	Least concern
	Grewia kakothamnos K. Schum.	Omukomakoma	Least concern
	Triumfetta rhomboidea Jacq.	Omuhingura	Not yet assessed
Ulmaceae	*Scutia myrtina* (Burm. f.) Kurz	Omugasha	Least concern
Verbenaceae	*Lantana trifolia* L.	Ehuuki	Not yet assessed
	Duranta erecta L	Omuhwahwa	Least concern
	Verbana officinalis L	Omugoshora	Not yet assessed

Appendix III: Changes in the Diversity of Woody Species between Records of 1998 and 2013

Family	Species in 1998	Plant status	Species in 2013	Plant status
Acanthaceae	*Barleria dentata*	Shrub	-	-
	Ecbolium subcordatum	Shrub	-	-
	Justicia unyorensis	Shrub	-	-
Anacardiaceae	*Rhus natalensis*	Shrub	*Rhus natalensis*	Shrub
	Rhus sp	Shrub	*Rhus vulgaris*	Shrub
Apocynaceae	*Carissa edulis*	Shrub	*Carissa macrocarpa*	Shrub
	-	-	*Carissa edulis*	Shrub
Asparagaceae	-	-	*Asparagus flagellaris*	Shrub
Asteraceae	-	-	*Microglossa angolensis*	Shrub
Boraginaceae	-	-	*Ehretia cymosa*	Shrub
Burseraceae	*Commiphora sp*	Shrub	-	-
Capparaceae	-		*Capparis fascicularis*	Shrub
	Cadaba farinosa	Shrub	-	-
	Capparis erythrocarpos	Shrub	-	-
	Capparis tomentosa	Shrub	-	-
Celastraceae	*Maytenus heterophylla*	Shrub	*Maytenus senegalensis*	Shrub
Compositea	-		*Pluhea ovalis*	Shrub
Crassulaceae	*Kalanchoe crenata*	Shrub	-	-
Ebeneaceae	-		*Euclea latidens*	Tree
Euphorbiaceae	*Erythrococca bongensis*	Shrub	*Erythrococca bongensis*	Shrub
			Croton megalocarpus	Tree
Fabaceae	*Acacia gerrardi*	Tree	*Acacia gerrardi*	Tree
	Acacia hockii	Tree	*Acacia hockii*	Tree
	Acacia polycantha	Tree	*Acacia persiciflora*	Tree
	Albizia coriaria	Tree	*Acacia sieberiana*	Tree
	Albizia sp	Tree	*Albizia coriaria*	Tree
			Albizia glaberrima	Tree
		-	*Erythrinna abbysinica*	Tree
Flacourtiaceae	-	-	*Trimerria grandifolia*	Shrub
Liliaceae	*Asparagus falcatus*	Shrub	-	-
Lamiaceae	-		*Huslondia opposita*	Shrub
Loganiaceae	-		*Nuxia congesta*	Tree
Malvaceae	*Abutilon mauritianum*	Shrub	-	-
	Abutilon sp	Shrub	-	-
Moraceae	-	-	*Ficus ovata*	Tree
Oleaceae	*Jasminium eminii*	Shrub	*Jasminum pauciflorum*	Tree
Plumbaginaccae	*Plumbago zeylanica*	Shrub	-	-

Rhamnaceae	*Scutia myrtina*	Shrub	*Scutia myrtina*	Shrub
Rubiaceae	-	-	*Rytigyna macrura*	Shrub
		-	*Gardenia sp*	Tree
Rutaceae	*Teclea nobilis*	Tree	*Teclea nobilis*	Tree
Sapindaceae	*Allophylus africanus*	Tree	*Allophylus sp*	Tree
Solanaceae	*Solanum incanum*	Shrub	*Solanum incunum*	Shrub
			Solanum renschii	Shrub
Tiliaceae	*Grewia kakothamnos*	Shrub	*Grewia mollis*	Tree
	-		*Grewia kakothamnos*	Shrub
	-		*Triumfetta rhomboidea*	Shrub
Verbenaceae	-		*Lantana trifolia*	Shrub
	-		*Duranta erecta*	Shrub
Vitaceae	*Cyphostemma serpens*	Shrub	-	-

ppendix IV: Checklist for Data Collection through Household Survey

ame of interviewer.....Date.....

ART I. PROFILE OF RESPONDENTS

ame of the respondent.....Sex.....

ge.....Education level.....Occupation.....

illage.....Parish.....Sub county.....

ART II. HISTORY OF GRAZING ACTIVITIES

. What are the main livestock animals reared?

.Cattle 2. Goats 3. Sheep 4. Others.....

. Which ranch number do you use in grazing.....?

. When did you acquire the ranch (alternatively a year can be specified)?

1. 10 years ago 2. 20 years ago 3. 30 years ago 4. 40 years ago

5. 50 years ago 6. More than 50 years ago 7. Others

5. What is the size of your ranch? (Acres)

1. 50-100 . 100-200 3. 200-300 4. 300-400 5. 400-500 6. 500-600 7. >600

5. What is the main practice of livestock grazing?

1. Communal grazing.....2. Zero grazing.....3. Paddocking

4. Rotational grazing..... 5. Nomadic grazing.....

PART III. ASSESSMENT OF INDIGENOUS WOODY SPECIES USEFUL TO PASTORALISTS

1. Are trees and shrubs useful in pastoralism? 1. Yes 2. No
2. If yes do you use trees/shrubs in pastoralism? 1. Yes 2. No
3. What are the major useful indigenous tree/shrubs species used in pastoralism?

e of es ıses	Food	Fodder	Human medicine	Veterinary medicine	Fuel wood	Poles	Timber	Others 1	Others 2	Others 3

PART IV: PERIOD OF USE OF THE SPECIES

ɔose of species	Dry season	Wet season	All year round
er			
cine to people			
cine for animals			
wood			
er			
s			
s 1			
s 2			

Appendix V: Data collection sheet for Assessment of Population Structure and human induced factors affecting the conservation status of indigenous woody species

Date:.....

Name or farmer.....**Parish**..... **Sub-county** .....
Ranch number.....

Plot No.	Name of Species	Mature trees (50X50) ≥20cm		Poles (50X50) (10-19.9cm)		Saplings (20X20) 5-9.9 cm		Seedlings (10X10) <30 cm hgt	
		Num	DBH	Num	DBH	Num	DBH	Scale	No

ASSESSMENT OF HUMAN FACTORS AFFECTING THE CONSERVATION STATUS OF PRIORITY INDIGENOUS WOODY SPECIES IN PASTORALISM PRODUCTION SYSTEMS, SWAEZ

Plot No.	Name of species	Stage of growth	Species condition						Grazing	Fires	Settlement	Agriculture	Harvesting
			1	2	3	4	5	6	Scale	Scale	Scale	Scale	Scale

1. Grazing 2. Fires 3. Settlement 4. Agriculture 5. Harvesting
5. Pests/Diseases