ECOLOGICAL EFFECTS AND COMMUNITY PERCEPTION OF CATTLE GRAZING IN MIOMBO WOODLANDS IN KILOSA DISTRICT, TANZANIA

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ABSTRACT

The study was conducted in Kilosa District to assess ecological effects and community perception of cattle grazing in Miombo woodlands. The ecological study conducted within Ihombwe village Community Based Forest Management (CBFM). Soil samples collected for analysis of soil physical and chemical properties before and after cattle grazing within 30 plots. Circular plots design used for inventories and all plants, trees with height ≥ 1cm, coppices and root sprouts were identified and measured to species level. Results showed that, in high grazing intensity there was a decrease of plant species composition after cattle grazing at $p < 0.01$ significance level. Other results showed that, there was significant decrease in trees species seedlings, coppices and root sprouts regeneration in high grazing intensity after cattle grazing at $p < 0.01$, $p < 0.05$ and $p < 0.01$ significance level respectively. Furthermore, results showed that an average bulk density changed from 1.41-1.48g/cm^3, soil pH decreased from 6.01 – 5.84 in high grazing intensity after cattle grazing. Ihombwe and Ulaya Mbuyuni village were used for socio-economic study. A total of 357 respondents and 4 key informants were interviewed. Approximately 80% of respondents agreed that grazing cattle in Miombo woodlands have negative ecological effects and have socio-economic benefits to local communities. Estimated 95% of livestock keepers were willing to pay for cattle grazing in Miombo woodlands. Generally, the results showed that, light grazing have no significance effect in Miombo woodlands compared to high grazing. The study recommends that, central and local government could allow light grazing of cattle in forests with participatory management approaches like CBFM since it has no detrimental ecological effects and should set up a legislation that can regulate grazing and set up affordable price for grazing in Miombo woodlands since majority have willingness to pay.

DECLARATION

I, JOHN MTIMBANJAYO do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is the result of my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted for degree award in any other institution.

____________________________ ______________________

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The above declaration is confirmed by;

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Dr. A.Z. Sangeda Date

(Supervisor)

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Dr. L.P. Lusambo Date

(Supervisor)

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DEDICATION

This thesis is dedicated to my beloved mother (the late Dorothea Milinga), my father, Mkalabule Rashidi Mtimbanjayo, my brother Juma Rashidi Mkalabule, my sister Paulina Milinga, my wife Innocensia Protas Kimaryo, and my adorable children Radji and Ryan.

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LIST OF ABBREVIATIONS

AU– IBAR	African Union Inter-African Bureau for Animal Resources
BD	Bulk Density
CBFM	Community Based Forest Management
CEC	Cation Exchange Capacity
DBH	Diameter at Breast Height
FAO	Food and Agriculture Organization of the United Nations
IRA	Institute of Resource Assessment (University of Dar Es Salaam)
KDC	Kilosa District Council
MNRT	Ministry of Natural Resource and Tourism
MJUMITA	Mtandao wa Jamii wa Usimamizi wa Misitu Tanzania
NAFORMA	National Forest Management
NGO	Non-Government Organization
PES	Payment for Ecosystem Services
PLFAs	Phospholipid Fatty Acids
REDD	Reducing for Emissions from Deforestation and Forest Degradation
SNAL	Sokoine National Agriculture Library
SPSS	Statistical Package for Socio Science Program
SSA	Sub Saharan Africa
SUA	Sokoine University of Agriculture
TAFORI	Tanzania Forest Research Institute
TFCG	Tanzania Forest Conservation Group
URT	United Republic of Tanzania
WOCAT	World Overview of Conservation Approaches and Techniques

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background Information

Miombo woodland is characterised by tree species from three genera in the legume subfamily Caesalpinioideae; *Brachystegia*, *Julbernardia* and *Isoberlinia*, although their dominance varies throughout the ecosystem based on rainfall and soil type (Banda *et al.*, 2006). Over 100 million people are directly or indirectly dependent upon Miombo woodland for their daily needs (Syampungani *et al.*, 2009). With the population of Sub-Saharan Africa expected to double by 2050 (Eastwood and Lipton, 2011) pressure upon Miombo woodland is increasing.

Tanzania mainland covers 48.1 million ha of forest and woodlands and 77.2 billion number of trees (NAFORMA, 2015). The main regions dominated by Miombo woodlands are Tabora, Rukwa, Kigoma Iringa, Lindi, Mtwara, Ruvuma, Morogoro, Coast and Tanga. Major species are *Brachystegia* and *Jubernardia* and other commonly species group are *Pterocarpus angolensis*, *Albizia sp* and *Afzelia quanzesis*.

Grazing lands are defined as "land used for animal production e.g. natural or semi- natural grasslands, open woodlands, improved or planted pastures" (WOCAT, 2008). Grazing lands represent both a source of animal feed and a key element in biodiversity protection. More than half of the world's land surface is grazed (Follet *et al.*, 2001) and just under one third (31%) is grasslands, shrub lands and savannah (Pineiro *et al.*, 2010).

In Sub-Saharan Africa (SSA) there are 25 million of pastoralists and 240 million agro-pastoralists depend on livestock as their primary source of income (AU-IBAR, 2012).

Tanzania has grazing land which is estimated to be 51% of country's total land area of 943 000 km^2. Tanzania is the second largest livestock population in Africa after Ethiopia, comprising 25 million cattle complemented by 16.7 million goats, 8 million sheep, 2.4 million pigs and 36 million chickens. About 98% of cattle are indigenous breeds and short horn zebu is the most widespread cattle breed. Agro-pastoralists households' account for 80% of livestock production, pastoral communities 14% and remaining 6% comes from the commercial ranches and dairy sector (URT, 2015).

It estimated that, the pastoral economy is the basis of the livelihood of 10% of the population in Tanzania. Large part of Tanzania's arid and semi-arid areas is used by pastoralists. According to Odhiambo (2006), the pastoralists are found in Manyara, Arusha, Dodoma, Singida, Shinyanga and Mwanza regions. Some pastoral communities have also migrated to Morogoro, Mbeya, Rukwa and Tabora regions. The pastoral system is characterized by large herds of indigenous breeds of animals that are reared mainly with occasional trading. Animal depends entirely on natural resources (land, water and pasture). As a result mobility in response to climate and season in search for water and pasture is common (Odhiambo 2006).

To date, pastoralism continues to be the main source of beef for Tanzanians (URT, 2015). In addition to this contribution, livestock convert forages and crop residues into edible products, acts as an inflation free saving, is a value storage and investment channel, and serves as a source of income and employment in the rural areas. Livestock also provides hides and skins for industries and fulfills cultural roles in the community (MLD, 2006).

Generally, communal land is owned by pastoralist in a socio-spatial organization which is composed of the household, the neighbourhood and the section. For the case of Maasai in

Tanzania, land areas have been controlled through clans, group of neighbourhoods or prophets (Laibons) with areas of different sizes. Since these areas are arid and semi-arid in nature, the pastoralists migrate with their livestock in search for pastures and water, as they need to access wider areas for optimum productivity. Therefore, resources base of pastoralists land is not an individually owned capital, but to a certain extent a flexible asset with specific uses and access mechanism (Sandford and Habtu, 2000).

Payments for ecosystem services (PES), is also known as payments for environmental services (or benefits), are incentives offered to farmers or landowners in exchange for managing their land to provide some sort of ecological service. They have been defined as "a transparent system for the additional provision of environmental services through conditional payments to voluntary providers. These programmes promote the conservation of natural resources in the marketplace (Tacconi, 2012).

Some PES programs involve contracts between consumers of ecosystem services and the suppliers of these services. However, the majority of the PES programs are funded by governments and involve intermediaries, such as non-government organisations. The party supplying the environmental services normally holds the property rights over an environmental good that provides a flow of benefits to the demanding party in return for compensation. In the case of private contracts, the beneficiaries of the ecosystem services are willing to pay a price that can be expected to be lower than their welfare gain due to the services. The providers of the ecosystem services can be expected to be willing to accept a payment that is greater than the cost of providing the services.

1.2 Problem Statement and Justification of the Study

Kilosa District is an area of land scarcity and limited grazing areas (Benjaminsen *et al.*, 2009). However, the limited grazing areas have been progressively lost, poor cattle carrying capacity, increases of livestock death and poor forage yield are things that increases pressure to farmers crops, protected areas and forest reserve. Factors that contribute to land scarcity and limited grazing areas are existence of estate farms for sisal, large research farms, several agricultural irrigation schemes, sugarcane plantation, mining areas, several protected areas such as Mikumi National Park, Selous game reserve, Kilombero game controlled area and competitive land uses such as established wildlife management area, hunting blocks, protected areas buffer zones and several forest reserves (Brehony *et al.*, 2003) and most of the remaining land is Miombo of which grazing is not allowed by law (KDC, 2012).

According to Tanzania Wildlife Act No. 5(2009), Forest Act No. 14(2002), Energy and Mineral Act No. 10(2010) and Land Act No. 5(1999), grazing in protected areas, reserved forests and mining areas are strictly prohibited. Despite these legislations, some districts in Tanzania have declared (through Bylaws) to allow livestock grazing in forest reserves during critical dry seasons to serve massive death of livestock and reduce unnecessary conflicts among land users.

On the other hand, higher government levels and policy makers see pastoralism as a cause of environmental degradation and is seen as a transitional stage from nomadic to modern production system (Odhiambo, 2006). The speech of government leaders confirm that pastoralism is perceived as a problem. “We will take deliberate measures to improve our livestock industry. We have to move from being nomadic cattle herder to settle modern livestock keepers” (Kikwete, 2005).

However, there is little knowledge of ecological effects and community perception of cattle grazing in Miombo woodlands. Some studies such as Sangeda *et al.* (2015) investigated regeneration potential of Miombo woodlands in Kilosa and recommended a follow up study to assess the effect of cattle grazing in plant species composition and regeneration in Miombo woodlands. Another study by Lusambo (2002) reported that, there is a need of introducing licensing procedures and costs to enable pertinent people to access resources in the protected Miombo woodlands in Kilosa District. This study therefore, will address the recommendations of earlier studies to fill the gaps that were not addressed to assess ecological effects caused by grazing cattle in terms of species composition, similarity, diversity, dominance and regeneration in Miombo ecosystem by comparing effects caused by light versus high grazing intensities.

Findings of this study will be useful in the ongoing debate and discussions for forest policy review especially on sustainable management strategies in Miombo ecosystems that are the largest share of forest vegetation in the country (NARFOMA, 2015). Community perception can have significant effects on policy making and strategy implementation. Also this information can help policy makers and other stakeholders to change or adopt the strategy.

1.3 Objectives of the study

1.3.1 Overall objective

The overall objective of the study was to assess ecological effects and community perception of cattle grazing in Miombo woodlands.

1.3.2 Specific objectives

The specific objectives of the study were to:-

i. Assess grazing intensity effects on plant species compositions, similarity, diversity and regeneration.
ii. Assess grazing intensity effects on soil bulk density, pH and CEC
iii. examine perception of the local communities towards grazing in Miombo woodlands.
iv. Assess livestock keeper’s willingness to pay for grazing in Miombo woodlands.

1.4 Research Hypotheses

i. H_o = Cattle grazing in Miombo woodlands has no significant ecological effects

ii. H_a = Cattle grazing in Miombo woodlands has significant ecological effects

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Factors Influencing Vegetation Composition in Miombo Woodlands

Miombo woodland contains diverse types of tree, grasses, legumes, and other herbaceous species. However in Miombo woodlands, many forbs and some browse plants play an important role in improving the nutrition of grazing animals. In Miombo woodlands, the most desirable plants for cattle are grasses which provide the bulk feed and legumes provide feed with high protein component as well as increase soil fertility. In Miombo woodlands, vegetation composition varies depending on climate, soil types and topography factors (Ulrich *et al.*, 2014).

2.1.1 Climate

Climate plays a primary role in determining the types of vegetation and the subsequent growth responses. Rainfall reliability, distribution, intensity and evaporative demand strongly influence the amount of water available for plant use. If climatic factors such as temperature and precipitation change in a region beyond the tolerance of a species phenotypic plasticity, then distribution changes of the species may be inevitable. There is already evidence that plant species are shifting their ranges in altitude and latitude as a response to changing regional climate (Parmesan and Yohe, 2003).

2.1.2 Soil

Soil texture; structure, microbial communities and depth are the primary determinants of soil moisture, nutrients availability to plant roots. Living organisms in the soil such as the earthworms, insects, nematodes and microorganisms like bacteria, fungi, actinomycetes, algae, and protozoa play part in improving soil structure, tilt, aeration, water permeability and soil nutrient availability to the plants. The physical properties of soil such as soil texture, soil structure, and bulk density affect the capacity of the soil to retain and supply water while the chemical properties such as soil pH and cation exchange capacity (CEC) determine its capacity to supply nutrients to plants. The nutrients contents that are present in the soil are essential and make the plants grow and enable them to complete their life cycle (Nielsen *et al*., 2010).

2.1.3 Topography

Topography can play a decisive role in the dynamics and structuring of soil, Litter and plant species richness. Topographic features like altitude, slope, and surface curvature can affect soil and litter by modulating changes in environmental factors, above and below ground water routes, sediment deposition, plant species composition and processes such as percolation and lixiviation (Huggett, 2007). These features change within shorter distances when the terrain becomes more heterogeneous, as is commonly observed in tropical regions with mountainous terrain (Unger *et al*., 2012).

According to Gao *et al.* (2011) the amount of incident solar radiation can alter air and soil temperature and moisture which affect the plant species composition. The sunlight regime also causes variation in the metabolism of microorganisms that control nutrient cycling by imposing different litter decomposition and mineralization rates (Austin and Vivanco, 2006).

2.2 Tree Species Natural Regeneration

The common mechanisms of regeneration in dry forests and woodlands include current-year seedlings; seedling sprouts that occur after seedling shoot dieback (including sprouts from underground rootstocks), coppice or sprouts from stumps of mature trees and root suckers that arise from lateral roots. The importance of each of these regeneration mechanisms depends on the floristic composition of the forest/woodland and the type of disturbance. Ky-Dembele *et al.* (2007) found that in Bukina Faso the Miombo woodlands regeneration dominated by seedlings and seedling sprouts that made up 88 per cent of the regeneration stock.

2.2.1 Factors affecting natural regeneration of Miombo tree species

Seedlings, coppice and sprouts face frequent and severe, grazing, fire and farming pressure which negatively affects rate of growth. Trees cut during the dry season dormancy period regenerate better than those cut in the growing period damage that can retard their recruitment into the tree layer. Between fires, seeds have to germinate and build enough root reserves to survive the next fire.

Sankaran *et al.* (2007) given disturbances, sprouts would need to grow rapidly to escape damage. Once dry forest has been cleared and the land abandoned, regeneration often takes place but the speed of forest/woodland recovery depends on the methods used in clearing, the sources available for regeneration and site history (type, frequency and intensity of stress and/or disturbance). Initially regeneration is mostly from trunk and root sprouts, hence tree species composition in regrowth stands tends to remain similar to that of the preceding old-growth stand. Consequently, the regrowth forest consists of multi-stemmed trees often with a stem density higher than in the previous old growth woodland it replaced.

2.2.2 Tree growth and regeneration management

The height of cutting also influences coppicing. The greater the height at which the stem is cut, the greater the number of resultant coppice shoots (Shackleton 2001and Kaschula *et al.,* 2005). Subsequent to cutting, coppice regrowth can be managed according to conventional silvicultural practices, that is, thinning the number of shoots to enable those that remain to grow more vigorously.

There is a trade-off between number of coppice shoots maintained and length and thickness of the shoots. The more shoots the greater the inter-shoot competition and the longer it will take for reestablishment of apical dominance. If the shoots are not thinned, there will be more shoots, but they will be shorter and thinner than if thinning took place. If the number of coppice shoots is reduced by thinning, browsing or fire, then apical dominance will be re-established sooner, and height growth will accelerate. In such a situation there will be fewer shoots per stump, but longer and thicker (Chidumayo *et al*., 2010).

2.3 Stocking Rate

Grazing has disturbing effect on herbage species of rangelands such as soil compaction. Severe soil compaction inhibits both seed germination and growth and also induces early seedlings mortality. Low stocking rates or grazing pressures promote plant production by maintaining high leaf area per unit land area and high stocking rates reduce plant production. Overgrazing reduces the ability of pasture to reproduce and lead to changes in botanical composition (Morris *et al.*, 2000).

2.4 Grazing and Browsing Practices

The rangeland vegetation of the Eastern Africa is well adapted to defoliation by grazing and browsing. This is probably due to its long association with herbivores, first wild herbivores and more recently livestock which entered Eastern Africa at least 3000 years ago (Herlocker, 1999). Degree of grazing strongly affects the structure, composition, quality, and productivity of rangeland vegetation. Earlier studies have reported that, light to moderate levels of grazing minimize both primary (vegetation) and secondary (herbivores) productivity and encourage perennial (Herlocker, 1999).

2.5 Community's Perception

Perception is ability to perceive in natural understanding that come to have knowledge through the experience (Korten, 2001). Community attitude refers to the whole system of knowledge, including concepts, beliefs and people's perceptions. Good community's perception and attitude depends on people's empowerment and understanding about things. The stock of knowledge and the processes whereby it is acquired, that is augmented, stored and transmitted (Werner, 2000).

2.6 Payments for Ecosystem Services

Payments for ecosystem services (PES) have been proposed as mechanisms to deliver better conservation by linking beneficiaries of an ecosystem service with providers using a mechanism to pay the people who manage the natural habitats that provide the service. In developing countries these have included payments for ecological tourism (Clements *et al.,* 2010), water provision (Pagiola, 2008; Asquith *et al.,* 2008; Wunder *et al.,* 2008), forest carbon (Reducing Emissions from Deforestation and Forest Degradation plus carbon enhancement, REDD + (e.g. Burgess *et al.,* 2010; Clements 2010), pollination of crops (Ricketts, 2004) and delivery of biodiversity outcomes (Sommerville *et al.,* 2010; Clements *et al.,* 2010; Aryal *et al.,* 2009). Examples of the schemes involved in the PES programme in Tanzania and Kenya are the Reduced Emissions from deforestation and forest degradation (REDD+) and pilot projects exist in almost both countries with a greater investment in Tanzania (Burgess *et al.,* 2010).

2.7 Conceptual Framework

According to Mayeta (2004), a conceptual frame work binds facts together and provides guidance towards collection of appropriate data. A researcher performed without a conceptual framework is usually sterile for reasons that the researcher does not know quite well what data to collect and when he/she has collected them, he/she cannot put them to use (Kajembe, 1994). The conceptual frame work that underlined this study (Figure.1) indicates ecological effects and community perception of cattle grazing in Miombo woodlands in Kilosa District.

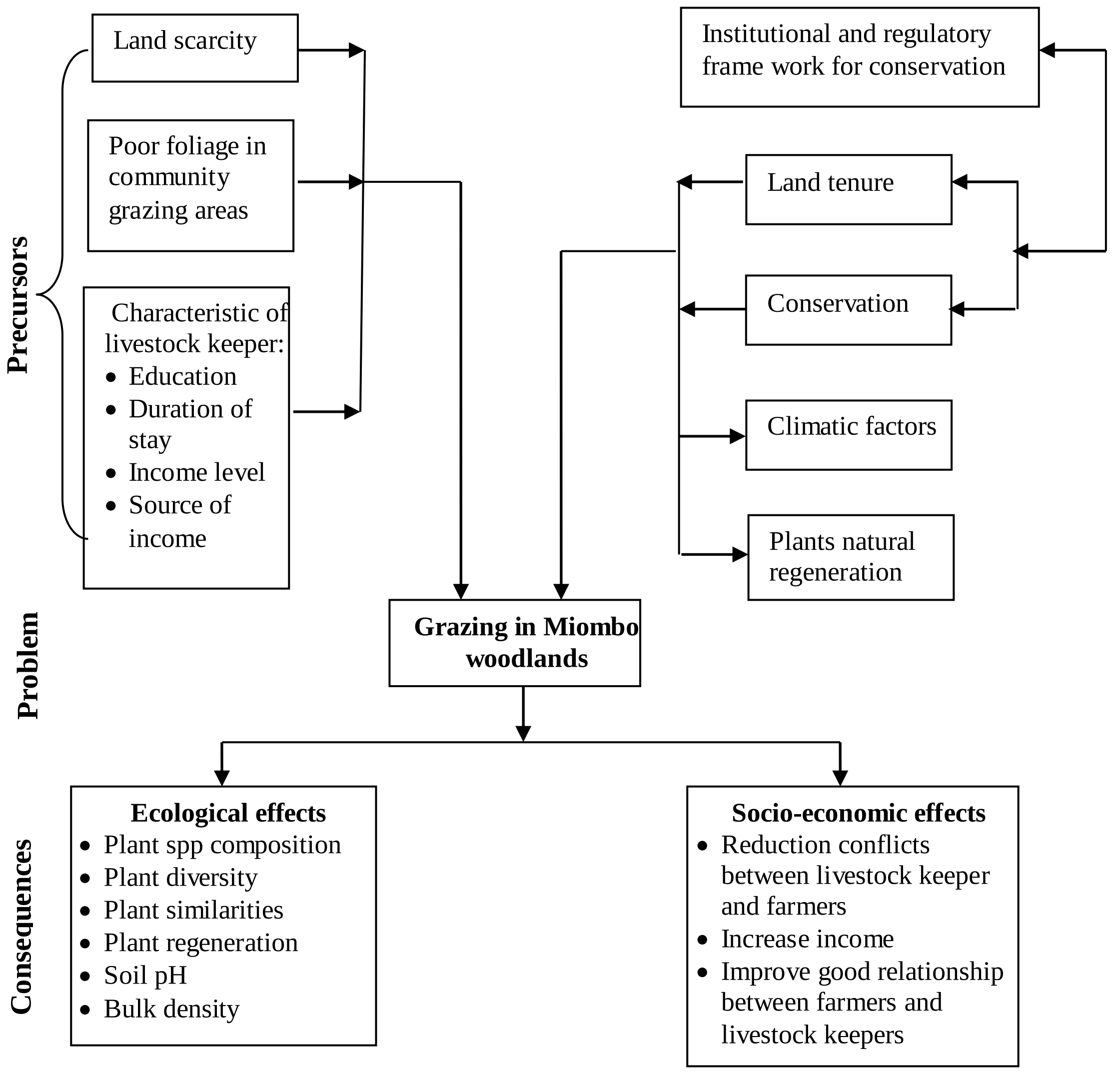

Figure 1: A conceptual framework: Ecological effects and community perception of cattle grazing in Miombo woodlands in Kilosa District

CHAPTER THREE

3.0 METHODOLOGY

3.1 Description of the Study Area

3.1.1 Location

Kilosa District is located in east central Tanzania, about 148 km from Morogoro town. Kilosa extends between latitude 5°55' and 7°53' South and longitudes 36°30' and 37°30' East. To the east is bordered with Morogoro and Mvomero districts, to south is bordered with Kilombero and Kilolo districts and to the west is bordered with Mpwapwa, Kongwa and Gairo Districts (KDC, 2012).

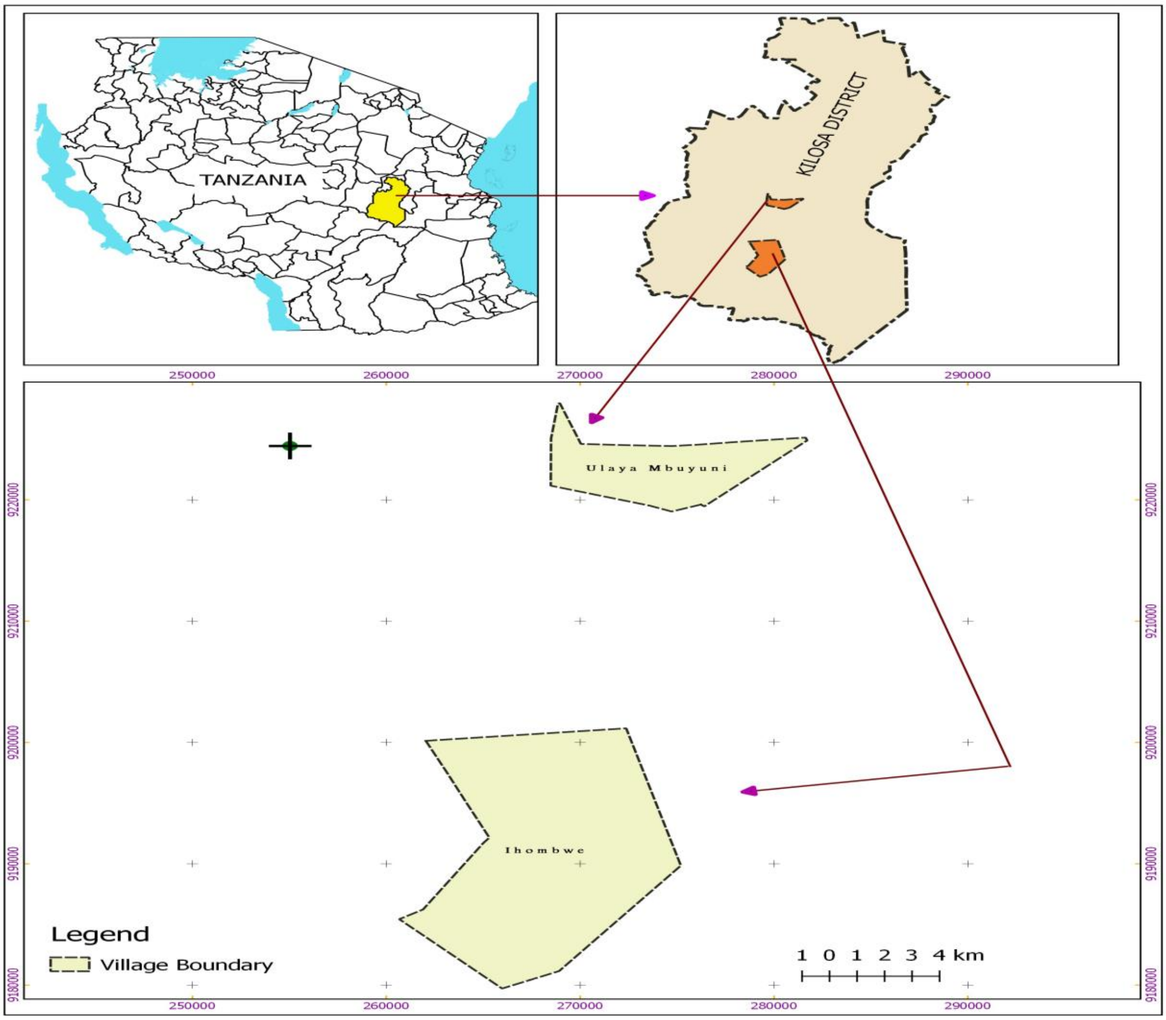

Figure 2: Map of villages of study area in Kilosa District, Tanzania

3.1.2 Climate

Rainfall distribution in the District is bi-modal with 'short rains' starting in November and ending in January, and 'long rains' starting in March and ending in May with a peak in April. The average annual rainfall varies from year to year and between ecological zones. Average annual rainfall ranges from 1 000 mm to 1 400 mm for the Southern flood plains and ranges from 800 mm to 1 100 mm for the Northern part of the District. Mountain forest areas can receive up to 1 600 mm annually. Temperature in the district varies with altitude. Average annual temperature in the district is 25°C with coldest month being July with 19°C and hottest month being March with 30°C (KDC, 2012).

3.1.3 Population

The District covers 12,394 square kilometers; is divided into 35 wards and 118 registered villages with 752 hamlets; has two parliamentary constituencies and two township authorities (Kilosa and Mikumi). Kilosa District has a population of 438,175 people (KDC, 2012).

3.1.4 Social economic activities

The District is endowed with great potential for economic development and prosperity. The District has a very good climate and arable land favorable for agriculture. Generally agriculture has continued to dominate the livelihood and economy of the district. Besides farming, livestock keeping, trade, fishing and tourism play a significant role in the district economy. Given the diversity of ecological zones in the district, a wide range of crops are grown in the area. These include maize, paddy rice, sorghum and millet, beans, coffee, bananas, sunflower, cotton, soya beans, sesame, onions, cabbages, tomatoes, egg plants, carrots, peppers, sugarcane, sisal, mangoes, oranges and lemons. Most farmers own small farms with an average of 0.8 ha. Crop yields in these farms are generally low caused by poor methods of farming employed by famers. Most farmers produce at subsistence level and depend on rain-fed agriculture. Irrigation is practiced in a few areas such as Lumuma with crops under irrigation being mainly horticultural crops such as onions. There were 200 000 cattle, 100 000 goats, 40 000 sheep, 10 000 pigs and 750 000 chickens in the District in the year 2011 (KDC, 2012), and the number increased substantially between 2009 and 2011 (KDC, 2012).

3.1.5 Vegetation

Kilosa District is endowed with both natural forests and woodlands. Woodlands and forest cover about 40% of the total land area. The current coverage of central government forest reserves is about 97 700 ha managed by the Tanzania Forest Services. District Council Forest Reserves cover an area of 24 654. Mikumi National Park overlaps with about 212 500 ha of the district. The area under Village Land Forest Reserves is about 124 335 ha (KDC, 2012).

3.2 Research Design

The Cross-sectional design was used in this study where data collected at once. This design has chosen and allows collection of data within short period of time. The use of this design has been recommended (Kothari, 2004).

3.3 Sampling Procedure and Sample Size Determination

3.3.1 Sampling procedure

Both purposive and random sampling techniques were used. Purposive sampling technique was used to select villages for socio-economic study and key informants. Two villages (Ulaya Mbuyuni and Ihombwe) were selected purposely based on availability of resources and are the project pastoral villages compare to the rest of the project villages. Among the two villages selected purposely, one village (Ihombwe) was randomly selected for ecological studies.

3.3.2 Sample size determination for socio-economic study

The sample size of respondents was determined by Yamane's formula (Yamane, 1967). A total of 210 respondents sampled from Ihombwe village and 147 respondents sampled from Ulaya Mbuyuni. All respondents were identified by using a random number table from their village register book.

The formula used to determine sample size was given by:

$$n = \frac{N}{1 + N(e)^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

Where:

n = Sample size,

N = Population size and

e = Sampling error (5%).

3.4 Data Collection

The study was carried out in two phases. The first phase involved carrying out reconnaissance survey while the second phase involved mainly questionnaire survey and ecological survey. Reconnaissance survey was conducted to provide general picture of the research areas and test the data collection tools for main study. For this study pre-testing of the questionnaires was done in Ihombwe village, Kilosa District. Whereby, a total of 27 respondents were used to check for clarity, comprehensiveness, redundancy and meaningfulness of the items. The respondents used during reconnaissance were not involved in the main study. Therefore, the tools were refined to get the final version that was used.

3.4.1 Primary data

Primary data collected from the respondents from two villages (Ihombwe and Ulaya mbyuyuni) by using researcher's direct observation, key informants interview and semi-structured questionnaires (Appendix 1, 2 and 3). Data obtained were properly recorded and analysed.

Plate 1: Photo showing researcher of study and respondents during questionnaire survey in Ihombwe village: Source by assistance researcher (2016)

3.4.1.1 Semi-structured questionnaires

Both closed and open ended questions were used to collect both qualitative and quantitative data. The questionnaires were designed to answer specific objectives 3 and 4.

3.4.1.2 Key informants interview

Checklists were used to collect information from key informants. A key informant is an individual who is accessible, willing to talk and has a great depth of knowledge about issues under discussion (Mayeta, 2004) and provides access to the large body of knowledge of the general community. Key informants are not only members of the clientele, but are most often informed outsiders (Mettrick, 1993). For this study, discussions were conducted with the TFCG project officer, Kilosa District forest officer and village's chairman (Ihombwe and Ulaya Mbuyuni). Key informant interviews were collected to answer the specific objectives 3 and 4.

3.4.1.3 Researcher's direct observation

Preliminary observation through seeing in experimental survey block were as follows; most of plots were harvested for charcoal production, most of stumps were regenerating via coppices and root sprouts, the block were grazed illegally by pastoralists, some lands were bared and encroached.

3.4.1.4 Ecological survey and sampling intensity

Ecological survey was conducted within Ihombwe village forest. The forest is managed through Community Based Forest Management (CBFM). Three cattle grazing intensities (no grazing, light and high) of 50m x 50m plot size were established in the forest. Each grazing intensity was replicated ten times to make a total of 30 plots. All 30 plots were fenced by four wire lines to avoid small ruminants entering in plots. Plants species composition was identified by using concentric radius method and physical observations before and after grazing to assess the effects of cattle grazing.

No grazing intensity plot (10 plots) was used as control where no cattle were grazed. Light grazing intensity plots (10 plots) involved grazing 10cattle/0.25ha/day whilst high grazing intensity plots (10 plots) involved grazing 20cattle/0.25ha/day. Cattle selected for grazing were of the same conditions in terms of body weight and sex. Grazing time was five hours per day and it was done using the experience of the livestock keeper. Details of the grazing schedules are attached in Appendix 5.

Three plots were randomly selected in each grazing intensities for soil sample collection. Three soil samples of each plot were collected by using soil core. Soil sample collected diagonally and in one direction to avoid biasness and experimental errors. Soil core measuring diameter 4.5cm and height 4.5 cm and soil sample of depth of 15 cm from soil surface were collected using double cylinder, drop-hammer sampler for the assessment of bulk density. Thirty (30) soil samples composite were collected in all 30 plots for other physical and chemical properties analysis Soil samples were placed in a clean labeled plastic bag and then sent to the soil laboratory for analysis.

In the laboratory, all soil samples were ground and passed through a 2mm sieve to remove stones and gravel. Fine and coarse roots were also removed. Subsequently, soil samples collected at 0–15 cm depth were analysed for bulk density soil pH, soil texture and cation-exchange capacity (cmol(+)/kg). Soil pH was determined electrometrically using 10 g of soil sample diluted in 25mL distilled water, which is using a 1:2.5 ratio (10g/25mls) of soil to water. Soil texture was determined by the hydrometer method and the textural classification was done by the use of the soil texture triangle. Samples for bulk density estimation were oven-dried at 105^{o}C to constant weight and the weight was recorded (accuracy 0.01 g). The volume was calculated from length and cross-sectional area of the soil core, and bulk density was determined as dry weight (g) per unit volume (cm^3). Soil pH, bulk density and soil moisture contents before cattle grazing, sample analyses were conducted at the Laboratory of Forest Biology, Sokoine University of Agriculture, but soil texture and all parameters after cattle grazing, sample analyses were conducted at the Soil Science Laboratory at the Department of Soil science, Sokoine University of Agriculture.

Circular sample plots design was used as adopted from several small scale inventories carried out in Tanzania (Malimbwi *et al.*, 2005). The plant species were identified in every 2m radius within the sample plot of 50m x50m. Plant species were identified and measured to species level using a botanist and experienced local plant identifiers. Tree with height ≥ 1cm, coppices and root sprouts were marked by color, measured, monitored and identified to species level. Variables recorded in each plot included; Botanical names, local names, number of stems, stems height, number of stumps, seedlings, saplings, coppices and root sprouts. These variables were recorded in the field inventory form provided in Appendix 4.

Cattle effects were assessed by comparing changes and variation of standing plant species composition, dominance, diversity, similarity, seedlings, coppices and root sprouts status, soil bulk density, cation exchange capacity and soil pH. Also disturbance assessment was assessed through counting the number of damaged plants, coppices, root sprout, introduced invasive species in each inventory plot after cattle grazing.

Plate 2: Photo showing wire fence construction of grazing plot in Ihombwe village, Kilosa, Tanzania: Source by researcher (2017)

Plate 3: Photo showing soil samples analysis in Forest biology laboratory at Sokoine University of Agriculture, Morogoro, Tanzania: Source by researcher (2017)

3.4.2 Secondary data

Secondary data were collected from village offices, District forest office, MJUMITA and TFCG project office, reports, journals, magazines, books, Regional and District forest offices, information centers such as Sokoine National Agriculture Library (SNAL), TAFORI, MNRT, Internet and from other relevant documents.

3.5 Data Analysis

3.5.1 Analysis of ecological data

3.5.1.1 Effects of plant species based on grazing intensity

Plant species compositions, diversity, evenness and similarities within the plots were assessed based on the Shannon-wiener index of diversity (H') and Simpson index. The inventory data were analyzed by using Microsoft Excel Program and the following stand parameters were computed.

i. **The Shannon-wiener index of diversity (H')**

This is the most widely used index of diversity, which combine species richness and evenness frequently. It is not affected by sample size of a given study. The knowledge of species diversity is useful for establishing the influence of biotic disturbance and state of succession and stability in the environment (Misra, 1989).

The index was calculated as follows:-

$$H' = -\sum_{i=1}^{s} Pi\ In\ Pi \qquad (2)$$

Where

H'=Shannon index of diversity, Σ = Summation symbol, S = Number of species,

P_i = Proportion of individuals or abundance of species 1 in the sample

In = Logarithm to base **e** and - = Negative sign multiplied with the rest of variables in order to make H' positive.

ii. **Index of dominance (Simpson index)**

The index of dominance is a measure of the distribution of individuals among the species in a community.

According to Misra (1989) index was calculated as follows;

$ID = \Sigma(n_i/N)^2$ ……..……………………………..…..…………………..……(3)

Where

ID = Index of dominance, n_i = Number of individuals of species **i** in the plot,

N = Total number of individuals of all species in the plot and Σ = Summation

iii. **Plant species evenness (H'/H)**

Evenness = H'/In(S)………………………………………..……..……… (4)

Where

H'= Shannon index of diversity, In= Logarithm to base e and S= Number of species,

iv. **Plant species similarities index *(JI)***

This index measures similarity between communities based on species composition. It is useful in comparing communities under different sites/management. Jaccard index of similarity (JI) is used to estimate the proportion of species shared between two range sites**.** The JI is a measure of similarity in species composition between two communities and is designated to equal 1 in cases of complete similarity and 0 if they are dissimilar i.e. have no species in common (Williams *et al.*, 2008).

The following formula was used (Evariste *et al.*, 2010)

$JI = j/(n1 + n2 - j)$ = ……………………….…..………..………….. (5)

Where,

JI = Jaccard index of similarity, J = The number of species common to the sites and tenure types, n1 = The number of species occurring in light grazing intensity, n2 = The number of species occurring in high grazing intensity.

3.5.2 Analysis of socio-economic data

Household data from questionnaire was coded, tabulated, entered into computer and analyzed using Statistical Package for Social Science (SPSS) program. Descriptive statistics was used to determine perception of local communities toward ecological, socio-economic effects of cattle grazing in Miombo woodlands and willingness of livestock keepers to pay for grazing their cattle in Miombo woodlands through frequency and percentage of respondents. Content analysis was used to analyse data obtained from key informants; TFCG project officer, Kilosa District forest officer and village leaders.

CHAPTER FOUR

4.0 RESULTS AND DISCUSIONS

4.1 Effects of Grazing on Species Composition and Similarity

4.1.1 Species composition

Results showed that, there were forty six (46) plant species identified within 30 fenced plots at Ihombwe community based forest (Table1). After grazing, there were forty seven (47) plant species identifies in the plots. Black jack specie (weed) was observed in high grazing intensity after end of grazing rotation period. For both situation (before and after grazing) plant species *Brachystegia boehmii, Brachystegia bussei/microphylla, Brachystegia spiciformis, Hyperrhenia spp, Themeda triandra and Pseudolachnostylis maprouneifolia* were the most dominant over the other plant species.

These common plant species of Miombo woodlands are almost similar to those reported by Nduwamungu (2001), Sangeda *et al.* (2015) and Ishengoma *et al.* (2015) in Kilosa District. The most frequently encountered species in Miombo woodlands were *Brachystegia boehmii* and *Brachystegia spiciformis.*

Other species such as *Albizia versicolor, Fluggea virosa, Millettia spp, Terminalia sericea, Markhamia spp, Swartzia (Bobgunnia) madagascariensis, Cyperus spp* and *Annona spp* appeared once in each plot despite of being in the same ecological zone where rainfall pattern and edaphic factors are almost the same. This variation is presumable linked to existence of different level of disturbance in the forest, Luoga *et al.* (2000) argue that among the factors associated with the variation in species composition and richness in Miombo woodlands is disturbances, especially when edaphic factors are similar. Furthermore, Munishi (2005) argue that sparse distribution of some species may be an indication of natural phenomena (species having restricted range) or as results of human impacts and utilization pressure. Appendix 6 and 7 shows separate species compositions and similarities in different grazing levels.

Table 1: Plant species compositions identified in 30 plots in Ihombwe village forest

Woody	Grass	Weed	Legume
Acacia nigrescens	*Aristida spp*	*Amaranthas spp*	*Crotalaria spp*
Acacia macrothyrsa	*Bothrochloa spp*	*Borhavia difusa*	*Neorautanenia spp*
Acacia Senegal	*Chloris spp*	*Sida spp*	*Rynchosia spp*
Annona spp	*Cynodon spp*	*Solanum spp*	
Afzelia quanzensis	*Digitaria spp*	*Oxigonum spp*	
Albizia versicolor	*Echinochloa spp*	*Cyperus spp*	
Brachystegia boehmii	*Heteropogon spp*	*Black jack spp*	
Brachystegia bussei/microphylla	*Hyperrhenia spp*		
Brachystegia spiciformis	*Themeda triandra*		
Buckea Africana	*Urochloa spp*		
Combretum molle	*Panicum spp*		
Combretum zeyhen			
Combretum/Terminalia spp			
Dalbergia melanoxylon			
Diplorynchus condylocarpon			
Dichrostachys cinerea			
Faidherbia albida			
Flueggea virosa			
Pseudolachnostylis maprouneifolia			
Pterocarpus angolensis			
Sclerocarya birrea			
Xeroderris stuhlmannii			
Sterculia quinqueloba			
Markhamia spp			
Swartzia (Bobgunnia) madagascarien			
Terminalia sericea			

Results in figure 3 showed typical situations where the preferred plants for timber and charcoal were no longer available and mostly lesser preferred ones were not taken. During key informant discussion, 83% reported that, most of plant species have medicinal values. Similar study by Shangali *et al*. (1998) who found that traditional medicine is the leading trees use at Udzungwa forest.

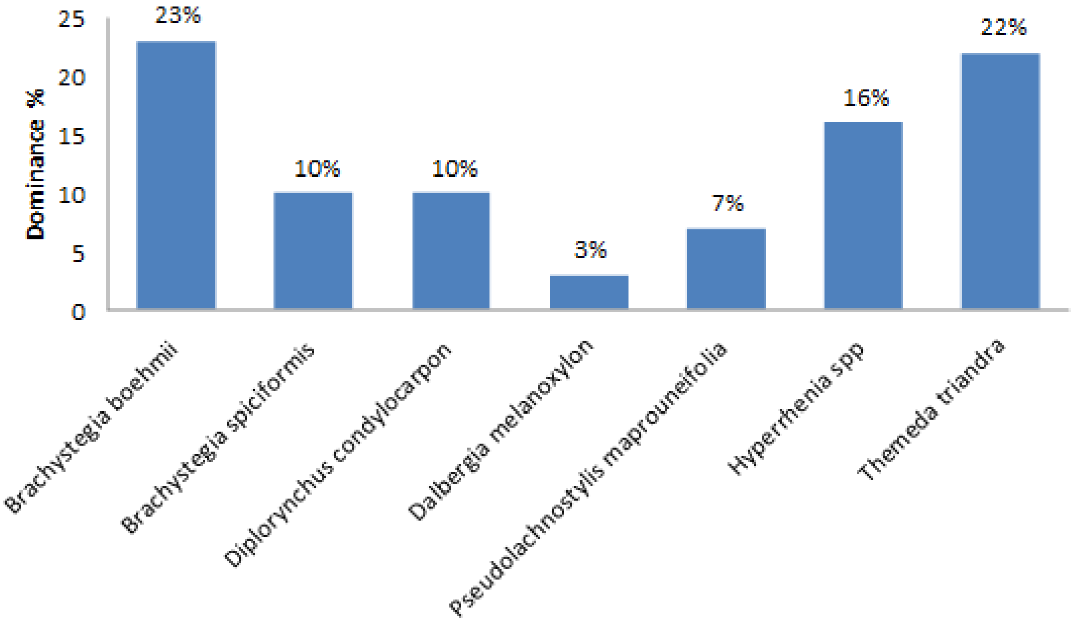

Figure 3: Percentages of dominant grass and tree species in Ihombwe village forest

Contribution of grass such as *Urochloa*, *Themeda triandra*, *Hyperrhenia*, *Echinochloa*, *Cynodon*, *Chloris*, *Digitaria* and *Heteropogon species* and weeds on ground cover was higher before grazing in all grazing intensities. Frequent burning practices, charcoal making and other human disturbances made favourable condition for these grass and weed species seeds to germinate very quickly as their seeds could be scarified by fire.

After grazing, the high grazing intensity plots were mostly dominated by weed species compared to before grazing where grasses were dominant all over the plots. New weed specie (Black jack) was observed after cattle grazing in the high grazing intensity plots. The most frequently occurring invader plant species were; *Amaranthas, Cyperus, Oxigonum, Solanum,* and *Sida species*. The condition might be contributed by overgrazing. Similar study by Kigomo (2003) reported that when the grazing areas are excessively overused, usually invaders or undesirable plants increase. The invader plants were found to be few in the original vegetation, but with increasing grazing pressure, they replaced the decreasers and increasers.

Compared to the proportion of the species identified, grasses were observed in low frequency after grazing. This might be due to the gradual disappearance of desirable species through overuse and disturbance by cattle. Changes are induced in the dominant growth forms of herbaceous plants as tall perennial bunch grass species give away to shorter rhizomatous and stoloniferous perennial grasses which are replaced by annual grass and forbs species. Moreover, overgrazing changed the botanical composition of the plants as it tends to reduce perennial grassland vegetation types and allow invasion by annual forbs and grasses.

Likewise after grazing, few leguminous plants species were found in the high grazing intensity plots. The legume plant species with higher frequency in the grazing areas were; *Neorautanenia, Rynchosia* and *Crotalaria* species. According to the livestock keepers, the leguminous plant species are among the highly desirable species which were highly preferred by the animals. The reduction in the proportion and disappearance of *Neorautanenia* and *Crotalaria species* as highly desirable species might be due to their gradual disappearance through overuse and disturbance by livestock. The results were in agreement with those of Kigomo (2003) who reported that highly desirable species were highly palatable and preferred by livestock which resulted into decline in number with increasing grazing pressure.

4.1.2 Plant species similarities

Results in Table 2 showed that, similarity value of the plots before grazing cattle were ranging from 0.5 – 1. That means the sites were somehow similar in type of species. This could be due to the fact that, the experimental areas were relatively undisturbed by anthropogenic factors such as agriculture, grazing, and settlements. Secondly it might also be due to the abandonment of farming activities by the peasants and the successional changes in the vegetation as lands had been left to fallow for a very long time in the areas (Fonge *et al.*, 2011).

Table 2: Plant species similarities in Ihombwe village forest

Similarities comparison between light and high grazing intensity plots		
Plant category	**Before cattle grazing**	**After cattle grazing**
Woody	0.55	0.53
Grass	1	0.91
Weed	0.5	0.49
Legume	1	0.33

After grazing, plant species similarities still revealed similarity between light and high grazing intensities except for the legumes and weeds. So grazing had no much effect on changing plant species composition.

4.1.3 Plant species diversity, richness and evenness

The stability of any community is directly dependent on the diversity. The higher values of diversity indicate greater stability of community structure. Findings in Table 3 revealed that, the Miombo woodlands Shannon – Wiener diversity index in all grazing intensities ranged from 2.47 – 2.71 implying that the plant species diversity is normal. The obtained results are within the good diversity range of 1.5 and 3.5 recommended by Kent *at al.*, (1992). The good plant species diversity can be used to justify the good effort in conservation activities.

Table 3: Plant species diversity, richness and evenness in Ihombwe village forest

Index	Grazing intensity					
	No grazing		Light grazing		High grazing	
	Before	After	Before	After	Before	After
No. of individual plants	699	699	690	683	745	560
Species richness	38	38	34	32	36	33
Species diversity	2.7	2.7	2.6	2.59	2.5	2.47
Species evenness	0.72	0.72	0.74	0.73	0.7	0.7

The variations in the numbers of plant species within and between forest sites could be contributed by varying levels of disturbances (land degradation, wildfires, grazing) in the plots. Similar study by Sangeda *et al.* (2015) reported that tree harvesting reduces species diversity.

A paired t-test was used to assess the effects on individual plant species seedlings by cattle grazing in Miombo woodlands. The results revealed that, there was a decrease of plant species after light grazing compared to before cattle grazing, although the decrease was statistically not significant at $p < 0.05$. It was further noted that, there was a decrease of plant species after high grazing compared to before grazing and this decline was statistically significant at $p < 0.01$. That means, although species types were not changing significantly, the amount of decrease was substantial.

4.1.4 Tree species regeneration

4.1.4.1 Regeneration from tree seedlings

After grazing, results revealed that, diversity index value and number of regenerating species was higher in No grazing intensity compared to light and high grazing intensity (Table 4). That means, cattle grazing has reduces the number and diversity of regenerating tree species. Similar results were reported by Sangeda *et al.* (2015) in the sustainable Charcoal Project sites in Kilosa District that, the low diversity of regeneration through seedlings can be caused by several factors including high intensity wildfire and seed dormancy.

Table 4: Regenerating from seedlings in Ihombwe village forest

Indices	Grazing intensity					
	High grazing		Light grazing		No grazing	
	Before	After	Before	After	Before	After
No. of individual plant	100	66	116	107	118	118
Species richness	9	7	7	7	11	11
Species diversity	1.7	1.5	1.6	1.6	1.9	1.9

However, regeneration in terms of seedlings was observed to be poor in those areas dominated by tall grass species that were too dense. Dominant grass species in those plots were *Themeda triandra* and *Hyparrhenia spp*. After cattle grazing, results showed that, diversity of regenerating tree species, number of individual plants and plant species richness further decreased under both light and high grazing. This is probably due to further effects caused by the grazing animals.

A paired grazing intensity samples t-test was conducted to assess the effect on tree species regeneration by grazing cattle in Miombo woodlands. There was statistically no significant effect of tree species seedlings regeneration after light grazing compared to before cattle grazing ($p < 0.05$). However, there was a statistically significant decrease of tree species seedlings regeneration after high grazing compared to before grazing ($p < 0.01$). Generally these findings denote that high grazing have more ecological impacts in Miombo regeneration through seedlings compared to light grazing.

4.1.4.2 Regeneration from tree stumps (coppices and root sprouts)

Table 5 showed that, there were 181 stumps that were identified in all three grazing experiment sites. The identified tree stumps were those trees harvested for charcoal making between 2012 and 2015 years. The most frequently harvested tree species for charcoal making were *Brachystegia boehmii (43.1%)*, *Brachystegia spiciformis* (23.2%), *Diplorynchus condylocarpon (11.6%)*, *Pseudolachnostylis maprouneifolia (14.4)*, *Combretum molle (0.6%)*, *Combretum/Terminalia spp (0.6%)*, *Acacia nigrescens (0.6%)*, *Brachystegia bussei/microphylla (1.7%), Pterocarpus angolensis (2.2%)* and *Xeroderris stuhlmannii (2.2%)*. Similar to those reported by Sangeda *et al.*, (2015) in the sustainable Charcoal Project sites in Kilosa District, Tanzania.

Some valuable timber tree species such as *Pterocarpus angolensis* and tree species of high conservation importance like *Dalbergia melanoxylon* were occasionally observed felled for charcoal in the grazing intensity plots. During discussion with key informants it was revealed that before TFCG and MJUMITA project, there were illegal exploitation of forest products such as timber and logs and at the beginning of the project there was a provision to harvest timber trees that are naturally deformed and badly damaged either by fire or other natural calamities and human disturbances. Some of these trees would have been removed during that time.

Table 5: Regeneration from tree stump in high grazing intensity in Ihombwe village

S/N	Botanical name	Stump number	Coppices		Root sprouts	
			Before	After	Before	After
1	*Acacia nigrescens*	5	13	11	8	5
2	*Brachystegia boehmii*	29	35	27	17	13
3	*Brachystegia spiciformis*	13	25	19	13	12
4	*Dichrostachys cinerea*	5	13	10	11	9
5	*Diplorynchus condylocarpon*	13	17	13	18	15
6	*Flueggea virosa*	6	11	10	9	7
7	*Pseudolachnostylis maprouneifolia*	11	30	11	10	8
8	*Xeroderris stuhlmannii*	7	15	12	9	5
	Mean(M)		19.88	14.13	12	9.25
	Standard deviation (SD)		8.967	5.963	3.8	3.732
	Degree of freedom (df)		7		7	
	t-test (t)		2.804		7.00	
	P value		0.026		0.000	

Before = Before cattle grazing, After = After cattle grazing

Tree species *Brachystegia boehmii* and *Brachystegia spiciformis* were observed to exhibit both coppicing and root sprouting while *Brachystegia bussei/microphylla, Diplorynchus condylocarpon, Combretum* and *Acacia spp* were observed to regrow robustly in terms of coppicing. Similar results by (Shirima *et al.*, 2015) reported that, Miombo woodlands demonstrate a remarkable capacity to recover after disturbance due to tree regeneration from the roots and stumps and they have been shown to do this after agriculture, charcoal production and selective logging. This could also be attributed by increasing of solar radiation when cover is reduced after grazing.

Furthermore, results revealed that, there was a statistically significance decrease of plant coppices and root sprouts regeneration in high grazing intensity after grazing (Table 5). Similarly, there was no statistically significance decrease of root sprouts regeneration in light grazing intensity after cattle grazing as shown in Table 6.

Table 6: Regeneration from tree stump in light grazing intensity in Ihombwe village

S/N	Botanical name	Stump number	Coppices		Root sprouts	
			Before	After	Before	After
1	*Brachystegia boehmii*	33	36	34	24	24
2	*Brachystegia bussei/microphylla*	9	17	17	15	15
3	*Brachystegia spiciformis*	21	19	18	13	12
4	*Combretum molle*	13	24	24	9	7
5	*Diplorynchus condylocarpon*	9	13	11	3	3
6	*Pseudolachnostylis maprouneifolia*	10	32	31	26	26
7	*Pterocarpus angolensis*	5	16	15	14	14
8	*Xeroderris stuhlmannii*	12	25	24	13	12
	Mean(M)		22.75	21.75	14.63	14.13
	Standard deviation (SD)		8.067	7.96	7.463	7.284
	Degree of freedom (df)		7		7	
	t-test (t)		3.742		1.871	
	P value		0.007		0.104	

Before = Before cattle grazing, After = After cattle grazing

These findings further confirms that, light grazing has less ecological effects to Miombo woodlands as compared to high grazing intensity.

4.2 Effects of Grazing on Soil Properties

4.2.1 Soil bulk density and moisture content

Results shown in table 7 revealed that, the average soil bulk density was 1.4g/cm^3 for both grazing intensities. Before grazing, control plots had moisture content 4.57cm^3 followed by 3.81cm^3 in light grazing plots and lastly 3.59cm^3 in high grazing plots.

Table 7: Bulk density and moisture content in soils of Ihombwe village forest

Average	Grazing intensity					
	High grazing		**Light grazing**		**No grazing**	
	Before	**After**	**Before**	**After**	**Before**	**After**
Bulk density (g/cm^3)	1.41	1.48	1.432	1.434	1.421	1.412
Moisture contents (cm^3)	3.59	3.46	3.81	3.75	4.57	4.61

After grazing, there was increase in BD that could be caused by trumpling effects of cattle grazing which also lowered moisture content. Similar study by Shemaghindem (2013) in communal grazing area of Chalinze, Bagamoyo Tanzania suggested that, the higher BD is due to soil texture, human and animals traffic in Miombo woodlands. Continuous human activities disturb soil bulk density and water retaining capacity (Bescansa *et al.,* 2006). Frequent human disturbance in soil properties could rapidly alter microbial community composition due to the different competitive ability of specific microbial groups. The groups with the capacity of rapid adaptation to the frequently changing soil environment (e.g., bacteria) could take advantage of new resources in disturbed habitats (Cookson *et al.,* 2008; Sun *et al*., 2011).

4.2.2 Soil pH

Results revealed that, there is a trend of decrease in soil pH after grazing (Table 8). However the pH decrease is more pronounced in high grazing intensity than in light. Similar study by Shelukindo *et al.,* (2014) reported that, nearly all surface soils had lower pH values than those in the sub-soils, a trend which indicates leaching of exchangeable bases from surface to the sub-surface horizons.

Table 8: Soil pH for soils of Ihombwe village under different grazing intensities

Average	Grazing intensity					
	High grazing		Light grazing		No grazing	
	Before	After	Before	After	Before	After
Soil pH	6.01	5.84	5.95	5.92	6.13	6.15

After grazing, there was change of soil pH for high grazing intensity compared to before grazing while there were little changes of soil pH for light grazing intensity compared to before. The decrease in average of soil pH could be due to the overgrazing activities in the plots. The results are in line with Ingram *et al*. (2008) who reported that, light grazing showed no effect on soil organic C content and microbial community composition based on concentrations of PLFA biomarkers in a mixed-grass ecosystem. As the disturbance ceased, microbial biomass increased, probably because more time and resources were available for specific microbial groups that have a slower growth rate and vice versa (e.g., fungi) (Zhang *et al.*, 2005).

4.2.3 Cation Exchange Capacity (CEC)

According to Msanya *et al.* (2001) CEC is a measure of the capacity of soil to retain nutrients (against leaching) and gives an idea of the potential fertility of the soil. Table 9 results show that, the top surface for 30 plots of study area had low average values of CEC which ranges 0.077 - 0.121 cmol(+)/kg. This might have been contributed by soil movement and accumulation of clay soil in the sub-surface horizon.

Table 9: Cation exchange capacity for soils of Ihombwe village under different grazing intensities

Average	Grazing intensity					
	High grazing		Light grazing		No grazing	
	Before	After	Before	After	Before	After
Cation exchange capacity (units)	0.081	0.074	0.077	0.0767	0.121	0.122

Results revealed that, under high grazing intensity CEC decreased compared to before grazing. The average changes of CEC in the high grazing intensity could be due to overgrazing activities. These results are in line with a study by Ma *et al.*, (2015) who suggested that, CEC and soil microbial community composition are significantly related to the habitat (mean annual precipitation and temperature, radioactive dry index, elevation, soil texture, pH, soil nutrient content, water holding capacity) and land management (tillage, grazing, historical tillage, flooding).

Similar study have been done by Shelukindo *et al. (*2014) which indicated very low to medium levels of CEC and reported that, it could be attributed to the nature of parent materials, modes of formation coupled with frequent fires, grazing, charcoal burning and continued deforestation of the Miombo woodland ecosystem.

4.2.4 Soil texture

Table 10 results showed that, 50% of wire fenced plots had sandy clay loam, 30% had sandy clay and 20% had clay soil.

Table 10: Soil texture properties for soils of Ihombwe village under different grazing intensities

	Soil texture class			
Grazing intensity	**sandy clay loam**	**Sandy clay**	**Clay**	**Total plots**
No grazing plots	3	4	3	10
Low grazing plots	7	1	2	10
High grazing plots	5	4	1	10
Total				**30**

Similar results reported by Shelukindo *et al.* (2014) revealed that sandy clay and sandy clay loam textures predominate in both the top and sub soils in Miombo woodlands. These are due to combination of the crystalline nature of many of the rocks, low relief, moist climate, and a warm temperature has produced highly weathered soils that are often more than 3m deep on the plateau. Shallow, stony soils are common along escarpments and in selbergs in Miombo woodlands.

After grazing results revealed that, there was no change of soil texture for both light and high grazing plots. This is to confirm that, cattle have no influences in changing soil texture.

4.3 Perception of Local Communities Towards Grazing in Miombo Woodlands

Results in Table 11 show that, socio-economic characteristics of respondent's such as gender, age, education level, migration status, duration of stay, source of income and income level that were used to describe the perception of sample respondents on grazing in Miombo woodlands.

Table 11: Perception of respondents on grazing based on socio-economic characteristics

Characteristics	Total	Perception			
		Disagree		Agree	
		N	%	N	%
Age					
20 – 30	83	25	30	58	70
31 – 40	104	28	27	76	73
41 – 60	119	24	20	95	80
> 60	51	4	8	47	92
Total	357	81		276	
Gender					
Male	196	13	7	183	93
Female	161	68	42	93	58
Total	357	81		276	
Education level					
No formal education	85	46	54	39	46
Primary education	223	35	16	188	84
Secondary education	30	0	0	30	100
Adult education	19	0	0	19	100
Total	357	81		276	
Source of income					
Livestock	61	24	39	37	61
Agriculture	256	49	19	207	81
Salaried employment	40	9	23	31	77
Total	357	82		275	
Income level					
100,000 – 499,000	51	4	8	47	92
500,000 – 999,000	118	23	19	95	81
1,000,000 – 2,000,000	148	43	29	105	71
> 2000000	40	11	28	29	72
Total	357	81		276	
Duration of stay					
Indigenous	215	43	20	172	80
Migrant					
1 - 5 years	60	16	27	44	73
6 - 10 years	57	15	26	42	74
> 10 years	25	7	28	18	72
Total	357	81		276	

Agree = Grazing cattle in Miombo woodlands has negative ecological effects and has socio-economic benefit effects to livelihood of communities.

Disagree= Grazing cattle in Miombo woodlands has ecological benefits and has socio-economic benefit effects to livelihood of communities.

4.3.1 Communities perception on grazing based on their age

Results revealed that for both villages Ihombwe and Ulaya Mbuyuni, 92% of respondents with age more than 60 years had agreed, 92% with age between 41 – 60 years had agreed, 80% with age between 31 – 40 years had agreed, 70% with age between 20 – 30 years had agreed that, grazing cattle in Miombo woodlands has negative ecological effects and has socio-economic benefit effects to livelihood of communities.

The age of most household heads were between 20 – 60 years. This indicate that the surveyed areas (Ihombwe and Ulaya Mbuyuni) comprise matured and energetic people who are involved in performing majority of the household activities such as agriculture, livestock keeping, petty business and charcoal harvesting activities as a source of income and food. As a matter of fact, an increase in age of the house hold head increased the chances of positive perception on ecological and socio-economic effects of cattle grazing in Miombo woodlands.

Age is an important parameter in socio analysis since different age group performs different roles. Similar findings by Makawia (2003) who reported that majority (64%) of respondents interviewed in Kikatiti and Kisongo – Arusha were of the age between 31 – 50 years. The older people are more open minded and often, express high perception on environmental conservation such as ecological benefits by cattle grazing in Miombo woodlands, unlike the youth whose major interest is to create economic benefits out of the environment (Han and Zhao, 2007).

4.3.2 Communities perception on grazing based on their gender

Results revealed that, in both villages 54.9% of respondents were males and 45.1% were females and this means that men are the majority as household heads. Approximately 93%

males agreed and 58% female respondents agreed that, grazing cattle in Miombo woodlands has negative ecological effects and has socio-economic benefit effects to livelihood of communities.

Similar results by IRA (2001) in Malagarasi-Muyovozi Wetlands are not different from the typical traditional African societies where the majority of household are male headed (Magembe, 2007). Njuki *et al.* (2004) reported that women bear most of the household workload and therefore the best source of labour.

4.3.3 Communities perception based on their level of education

Approximately 62% of respondents had attained a primary level of education, 24% had no formal education, 8% attained secondary education and 5% attained adult education. Adult education and secondary education 100% of respondents had agreed and 68% of respondents with primary education agreed that, grazing cattle in Miombo woodlands has negative ecological effects and has socio-economic benefit effects to livelihood of communities.

Increase in education level is leads to the increase in knowledge and good perception. Education is an important factor for making various decisions in life, direct influence on people's knowledge and participation in natural resources management and promotes utilization of natural resources. The significance of education in explaining the awareness of the people on the importance of natural resources conservation is well documented (Mwambo, 2000). According to Kalineza *et al.* (2002) and Rogers (2003), people who are knowledgeable are more likely to adopt new innovations and more knowledgeable on the ecosystem services and management approaches compared to those who are not knowledgeable.

From these findings, one could say that the most rural children after completing primary education they usually remain in the villages and tool up farming activities, while those who finished above primary education tended to migrate to urban area to look for jobs. Likewise low level of education observed in the study areas could contribute to unsustainable utilization of natural forests resources as they tend to relay more on surrounding resources for their survival.

4.3.4 Communities perception on grazing based on their source of income

The result showed that, both villages 72% of respondents depends on Agriculture, 17% depends from livestock's and 11% from salaries as source of income. Approximately 77% of employed respondents were agreed and 61% livestock keepers agreed that, grazing cattle in Miombo woodlands has negative ecological effects and has socio-economic benefit effects to livelihood of communities.

Majority of rural communities rely on Miombo woodlands for food and income generation. The data revealed that crop farming and livestock keeping as the leading income generation activity for many farmers and livestock keepers. Livestock were kept free range practice whereby Cattle, goat, sheep were grazed in open areas including natural forests in the areas during dry season. The occupation of an individual can greatly affect the utilization of land resources. For instance, farmers and livestock keepers devote much time in natural areas for cultivation and grazing as compared to those employed and doing other activities such as formal employment.

4.3.5 Communities perception on grazing based on their level of income

For both villages, 71% of respondents with the income level between 1 000 000 – 2 000 000 tshs agreed, 81% with income level between 500 000 – 999 000 tshs agreed and 92% of respondents with income level between 100 000 – 499 000 tshs agreed that, grazing cattle in Miombo woodlands has negative ecological effects and has socio-economic benefit effects to livelihood of communities.

Sustainable use and conservation of natural resources to a larger extend depends on the economic status of the community in question, which would ultimately determine the level of utilization and management. Wide spread poverty, land pressure and unemployment, limited and insecure local production bases, often means absence of alternatives, hence community members have little choice but to over exploit Miombo woodlands resources to generate subsistence, income and employment to meet their ends. Thus both low and high income earners are responsible for the present Miombo woodlands condition meanwhile, high income individual may increase their financial to exploit resources extensively while low income may compel individual to increase dependence on the natural resources for survival. FAO (2003) reported that, as income increases the living standard improves and hence people become less dependent for natural resources.

4.3.6 Communities perception based on their duration of stay

Majority of respondents have stayed in both villages more than 6 years and agreed that, grazing cattle in Miombo woodlands has negative ecological effects and has socio-economic benefit effects to livelihood of communities.

According to Mayeta (2004), the longer a person stays in a particular place the more he/she becomes involved in natural resource conservation and hence more such a person becomes aware of the broader role of natural resources conservation to an individual, national and international economy. Similar observation has been reported by Magembe (2007) in Great Ruaha River catchments. Similarly, the more time a person stays in a particular area, the more indigenous resource conservation knowledge and positive attitudes towards conservation.

4.4 Willingness of Livestock Keepers to Pay for Cattle Grazing in Miombo Woodlands

Table 12 results showed that, 95% of respondents had willingness to pay for their cattle grazing in Miombo woodlands and 5% respondents were not willing to pay for their grazing. Reasons for accepting payment were because of climatic change (existence of long dry seasons) which leads to shortage of feed in allocated grazing areas, to avoid farmers-livestock keeper's conflicts and to improve cattle productivity. Some commonly cited reasons for not supporting were that, Miombo woodlands are god made forest (natural forests) and not plantation forest, did not believe payment would work to improve both their cattle health and environment. Other causes for not being willing to pay more were that the respondent could not afford to pay because of many cattle they own and did not believe it costs more rather than government improving grazing areas infrastructures and Miombo woodlands grazing regulation.

Table 12: Livestock keepers willingness to pay for grazing cattle in Miombo woodlands Ihombwe and Ulaya Mbuyuni villages

	Willingness	
	N	**%**
Yes	58	95
No	3	5
Total	**61**	**100**

Mean= 1.05, SD= 0.218, n=61 (Livestock keepers)

Comparable studies by Ozanne and Vlosky (1997) reported that, 60% to 80% of the sample would be willing to pay a premium for ecosystem services. One possible explanation for this lower estimate of willingness to pay may be that respondents were allowed to express support for environmental certification without having to pay a premium.

Those who reject the idea of valuation of ecosystem services argue that nature should be conserved and valued for nature's sake, and that nature's value is impossible to quantify because its value is inherently infinite (Mc Cauley *et al.*, 2006). They posit that the attempt to force the idea of ecosystem services into the market system leads to conservation only when it is deemed useful for human life, abandoning ideals environmental conservation when qnature conflicts with human interest or simply does not affect human activity (Mc Cauley *et al.*, 2006). There are also those who support the valuation of nature from a purely practical standpoint, expressed in the idea that "something is better than nothing." They realize and acknowledge the problematic nature of the quantitative valuation of nature but at the same time argue that practically, in a highly commodified society, it is a necessary measure (Costanza *et al.*, 1992).

Commodification of natural capital results in undervaluing ecological systems by not accounting for the innumerable wide-range services provided. PES may decrease in utility as wealth becomes concentrated to the point that natural resource scarcity results in higher short-term value for unsustainable resource extraction, and the long-term cost to engineer limited-range replacement services is externalized onto citizens. This occurs either through increased expense to the existing systems or as justification to privatize services for further profit (Costanza *et al*., 1992).

CHAPTER FIVE

5.0 CONCLUSIONS AND RECCOMENDATIONS

5.1 Conclusions

The results of this study reveal that, light intensity cattle grazing in Miombo woodlands have no significant effects on plant species composition, similarity, diversity, regeneration, bulk density, soil pH, and CEC. Negative ecological effects were revealed under high grazing intensity compared to light grazing. Furthermore, majority of communities' perception had agreed that, overgrazing in Miombo woodlands have negative ecological effects. Approximately 95% of livestock keepers were willing to pay for their cattle grazing in Miombo woodland.

5.2 Recommendations

Based on the findings of this study, the following should be taken into consideration for sustainable Miombo woodlands management:-

i. Central and local government could allow controlled/light grazing of cattle in forests with participatory management approaches like CBFM since it has no detrimental ecological effects. Grazing can be allowed in specific season of the year.

ii. Central and local government should continue to collaborate with various agencies including NGO's working directly with communities in providing extension services and awareness that will help communities to adopt principles of rangeland management and sustainable Miombo woodlands utilization.

iii. Central and local government should set up a legislation that can regulate grazing and set up price for grazing in Miombo woodlands since majority have willingness to pay.

iv. The strategic destocking of livestock should be practiced by livestock keepers so as to avoid overgrazing and decline of vegetative ground cover.

v. Balancing the grazing and browsing animals' species in the area is of paramount importance so as to keep ecological balance and to increase the productivity the community grazing areas.

vi. Future studies should focus on the effects of grazing goats and other small ruminants in Miombo woodlands.

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APPENDICES

Appendix 1: Household questionnaire

Introduction

My name is John Mtimbanjayo, a student from Sokoine University of Agriculture, Morogoro. I am conducting a survey in your village as the requirement of my study. The purpose of my study is to assess the ecological and socio-economic effects of cattle grazing in Miombo woodlands.

As a member of this village (heads of this household or spouse of the household head), you have selected among others as a useful informant to assist us (Sokoine University of Agriculture) to gather relevant information/ data. Your views are important and your participation is voluntary and you are assured that, the information you provide will be confidential and used for the sole purpose of academic use.

Kindly respond to the questions below correctly.

A. General information

1. Date of interview:

…………………………………………………………………………………

2. Name of enumerator: …………………..…………………………

3. Village: …………………Ward: ……………………Division……

B. Socio-economic information

4. Name of respondent…………………………………………………

5. Age: ………………………………………………………….……………

6. Sex: ……. ……,1= Male, 2= Female

7. Education: 1= No formal education, 2=Primary, 3=Secondary, 4=Tertiary, 5=adult education, 6=Higher learning

8. Migration status. 1= Indigenous, 2=Migrant

9. If migrant, what prompted you to migrate in this village………………………

10. Number of years household head has been living in the area: ………………

11. Which one of the following constitute main source of income for your household?

S/N	Source of income	Yes	No	Weekly/monthly/annual income
1	Livestock			
2	Agriculture			
3	Charcoal making			
4	Fishing			
5	Beekeeping			
6	Salaried employment			
7	Casual labor			
8	Others (Please mention)			

12. Do you have any cattle? 1= Yes, 2= No

13. If yes, what is grazing methods?

Grazing method key: 1= Grazing carried out, 2= Stall feeding, 3= Others (specify)

14. If grazing is carried out, give the approximate number of days grazed in each area.

Month	Crop land	Grazing land	Woodlands	Others
January				
February				
March				
April				
May				
June				
July				
August				
September				
October				
November				
December				

C. Perceptions of household's ecological effects

15. To what extend do you agree with the following statements about benefits of cattle grazing in Miombo woodlands, please rank according to your level of understanding.

Key: 1= Disagree, 2= Agree.

S/N	Perceived benefits	1	2
1	Reduce wild fire intensity		
2	Reduce soil fertility		
3	Increase Miombo woodlands protection		
4	Improve forage yield in grazing area		
5	Strengthen participatory management		
6	Improve health/growth of Miombo		
7	Reduce plant species resources competition		
8	Enable seeds disperse		
9	Others (Specify)		

16. To what extend do you agree with the following statements about negative effects of cattle grazing in Miombo woodlands, please rank according to your level of understanding.

Key: 1=Disagree, 2= Agree

S/N	Perceived effects	1	2
1	Increase illegal Miombo products exploitation		
2	Causes water source draining		
3	Increases water pollution		
4	Increases soil erosion		
5	Causes invasive species		
6	Increase feed competition with wild animals		
7	Disturbing the natural visual beauty		
8	Causes disappearance of indigenous species		
9	Affects plant species regenerations		
10	Causes compaction of the soil		
11	Others (specify)		

D. Perceptions of household's socio-economic effects

17. To what extend do you agree with the following statements about effects of cattle grazing in Miombo woodlands, please rank according to your level of understanding.

Key: 1= Disagree, 2= Agree

S/N	Perceived effects	1	2
1	Improve health of cattle		
2	Improve cattle productivity		
3	Reduce farmer- conflicts		
4	Reduce crops damage		
5	Increase income to the households		
6	Reduce land uses competition		
7	Strengthen good relationship among communities		
9	Reduce dangerous animals nearly settlements		
10	Others (Specify)		

E. Livestock keeper's willingness to pay information

18. Are you willing to pay for cattle grazing in Miombo woodlands? 1=Yes, 2=No

19. If yes, indicate reason(s) why are you willing to pay for Miombo woodlands conservation? 1 …………..................., 2 ………..……………………..,

20. If yes, how much are you willing to pay for one cattle grazing per day in Miombo woodlands for conservation? …………………………………..……

21. If no, indicate reason(s) why are you not willing to pay for cattle grazing in Miombo? 1………………, 2 ………………………..,

22. Mention any solution(s) that will reduce cattle grazing pressure in Miombo woodlands while improving cattle health and productivity during dry seasons……………………

Appendix 2: Check list for forest and TFCG officers

Name of the Officer………………………….Date…………………………………..

Dear Sir/ Madam,

This interview is a part of the research regarding the cattle grazing in Miombo woodlands. Researcher is from the Sokoine University of Agriculture. He feels honored to be given an opportunity to talk to you regarding this matter. He is kindly asking for your cooperation so as to obtain relevant and reliable information about the problem under scrutiny.

Questions

1. Are there pastoralists in Kilosa who graze Livestock in Miombo Woodlands?
2. What is the general situation of grazing areas?
3. Do you think it is important to graze cattle in Miombo? Please give reasons
4. Is it allowed today to graze in any Miombo woodland?
5. Is there any cost for cattle grazing in Miombo woodlands?
6. What measures do you think are appropriate for cattle grazing and Miombo woodlands conservation?
7. What are your opinions on cattle grazing pricing for Miombo woodlands conservations and how should it be carried out?
8. What are the associated costs for conserving Miombo woodlands?
9. Can you list any positive or negative effects of cattle grazing in Miombo?
10. In your own view, what has been done and has to be done to ensure that there is efficient cattle feeds allocations and sustainability of Miombo woodlands?

Appendix 3: Checklist for other Key informants in the village

Name of the Officer……………………………….Date………………….……………..

Dear Sir/ Madam,

This interview is a part of the research regarding the cattle grazing in Miombo woodlands. Researcher is from the Sokoine University of Agriculture. The researcher is delighted to have your opinions to investigate the problem.

Please assist to answer the following questions

1. Is there enough cattle grazing areas allocation in your village?
2. Is cattle grazing areas allocated having enough feeds throughout the year?
3. What are your grazing areas in this village?
4. Do you graze in Miombo woodlands?
5. If grazing is to be allowed in conserved Miombo woodlands, are you willing to pay small amount of money for conservation?

If yes, how much are you willing to pay per day?................................

6. Mention solutions that will increase availability of cattle grazing areas and improve Miombo woodlands conservation

1 …………………, 2 ………, 3 ………………, 4 ……………………..

Thank you very much for your cooperation!!!

Appendix 4: Plant species identification form

Date……………………………Name of recorder…………………..……..

Village………………………………Ward…………………………………

Division……………………………District…………………………………

Plot treatment………………………………………………………………….

Plot code……………………………………………………………………….

Plot code	Botanical name	Local name	Stumps	No. of coppice	No of rout sprouts

Appendix 5: Experimental survey design

No	Treatment	Fenced plots replication per treatment	grazing period-three two months of wet season												Total grazing days/plot for 2 months	
			Early of month (day/cow)		Middle of month (day/cow)		End of month (day/cow)		Early of month (day/cow)		Middle of month (day/cow)		End of month (day/cow)			
			No. day	No. cow	No. day	No. cow	No. day	No. cow	No. day	No. cow	No. day	No. cow	No. day	No. cow	No. day	No. cow
1	No grazing	10	1	0	1	0	1	0	1	0	1	0	1	0	1	0
2	Light grazing	10	1	10	1	10	1	10	1	10	1	10	1	10	6	10
3	High grazing	10	2	10	2	10	2	10	2	10	2	10	2	10	12	10
	Total	**30**													**18**	**20**

Appendix 6: Plant species compositions and similarities before cattle grazing in 30 plots

High grazing plots	Light grazing plots	Zero grazing plots
Woody	**Woody**	**Woody**
Acacia nigrescens	*Acacia nigrescens*	*Acacia macrothyrsa*
Diplorynchus condylocarpon	*Acacia Senegal*	*Acacia nigrescens*
Annona spp	*Afzelia quanzensis*	*Acacia Senegal*
Brachystegia boehmii	*Brachystegia boehmii*	*Afzelia quanzensis*
Brachystegia bussei/microphylla	*Brachystegia bussei/microphylla*	*Albizia versicolor*
Brachystegia spiciformis	*Brachystegia spiciformis*	*Brachystegia boehmii*
Combretum molle	*Buckea Africana*	*Brachystegia bussei/microphylla*
Combretum zeyhen	*Combretum molle*	*Brachystegia spiciformis*
Dalbergia melanoxylon	*Combretum zeyhen*	*Buckea Africana*
Dichrostachys cinerea	*Dalbergia melanoxylon*	*Combretum molle*
Faidherbia albida	*Diplorynchus condylocarpon*	*Combretum/Terminalia spp*
Flueggea virosa	*Millettia stuhlmannii*	*Dalbergia melanoxylon*
Pseudolachnostylis maprouneifolia	*Pseudolachnostylis maprouneifolia*	*Dichrostachys cinerea*
Pterocarpus angolensis	*Pterocarpus angolensis*	*Diplorynchus condylocarpon*
Sclerocarya birrea	*Sclerocarya birrea*	*Faidherbia albida*
Xeroderris stuhlmannii	*Sterculia quinqueloba*	*Markhamia spp*
Grass	*Xeroderris stuhlmannii*	*Pseudolachnostylis maprouneifolia*
Aristida spp	**Grass**	*Pterocarpus angolensis*
Bothrochloa spp	*Aristida spp*	*Sterculia quinqueloba*
Chloris spp	*Bothrochloa spp*	*Swartzia madagascarien*
Cynodon spp	*Chloris spp*	*Terminalia sericea*
Digitaria spp	*Cynodon spp*	*Xeroderris stuhlmannii*
Echinochloa spp	*Digitaria spp*	**Grass**
Heteropogon spp	*Echinochloa spp*	*Aristida spp*
Hyperrhenia spp	*Heteropogon spp*	*Bothrochloa spp*
Themeda triandra	*Hyperrhenia spp*	*Chloris spp*
Urochloa spp	*Panicum spp*	*Digitaria spp*
Panicum spp	*Themeda triandra*	*Echinochloa spp*
Weed	*Urochloa spp*	*Heteropogon spp*
Amaranthas spp	**Weed**	*Hyperrhenia spp*
Borhavia difusa	*Amaranthas spp*	*Panicum spp*
Sida spp	*Borhavia difusa*	*Urochloa spp*
Solanum spp	*Oxigonum spp*	**Weed**
Oxigonum spp	**Legume**	*Amaranthas spp*
Cyperus spp	*Crotalaria spp*	*Borhavia difusa*
Legume	*Neorautanenia spp*	*Oxigonum spp*
Crotalaria spp	*Rynchosia spp*	*Sida spp*
Rynchosia spp		*Solanum spp*
Neorautanenia spp		**Legume**
		Crotalaria spp
		Neorautanenia spp
		Rynchosia spp

Appendix 7: Plant species compositions and similarities after cattle grazing 30 plots

High grazing plots	**Light grazing plots**	**Zero grazing plots**
Woody	**Woody**	**Woody**
Brachystegia boehmii	*Acacia nigrescens*	*Acacia macrothyrsa*
Brachystegia spiciformis	*Afzelia quanzensis*	*Acacia nigrescens*
Pseudolachnostylis maprouneifolia	*Dalbergia melanoxylon*	*Acacia Senegal*
Diplorynchus condylocarpon	*Diplorynchus condylocarpon*	*Afzelia quanzensis*
Dalbergia melanoxylon	*Millettia stuhlmannii*	*Albizia versicolor*
Xeroderris stuhlmannii	*Sclerocarya birrea*	*Brachystegia boehmii*
Brachystegia bussei/microphylla	*Pseudolachnostylis maprouneifolia*	*Brachystegia bussei/microphylla*
Acacia nigrescens	*Pterocarpus angolensis*	*Brachystegia spiciformis*
Flueggea virosa	*Sterculia quinqueloba*	*Buckea Africana*
Combretum molle	*Brachystegia boehmii*	*Combretum molle*
Sclerocarya birrea	*Brachystegia spiciformis*	*Dalbergia melanoxylon*
Annona spp	*Combretum molle*	*Dichrostachys cinerea*
Combretum zeyhen	*Combretum zeyhen*	*Diplorynchus condylocarpon*
Dichrostachys cinerea	*Xeroderris stuhlmannii*	*Markhamia spp*
Faidherbia albida	***Grass***	*Pseudolachnostylis maprouneifolia*
Grass	*Digitaria spp*	*Pterocarpus angolensis*
Themeda triandra	*Chloris spp*	*Sterculia quinqueloba*
Hyperrhenia spp	*Cynodon spp*	*Terminalia sericea*
Urochloa spp	*Echinochloa spp*	*Xeroderris stuhlmannii*
Echinochloa spp	*Heteropogon sp*	**Grass**
Cynodon spp	*Hyperrhenia spp*	*Themeda triandra*
Chloris spp	*Panicum spp*	*Heteropogon sp*
Aristida spp	*Themeda triandra*	*Hyperrhenia spp*
Bothrochloa spp	*Urochloa spp*	*Echinochloa spp*
Digitaria spp	*Aristida spp*	*Bothrochloa spp*
Heteropogon spp	*Bothrochloa spp*	*Aristida spp*
Weed	**Weed**	*Chloris spp*
cyperus spp	*Solanum spp*	*Cynodon spp*
Solanum spp	*Oxigonum spp*	*Urochloa spp*
Amaranthas spp	*Amaranthas spp*	*Digitaria spp*
Sida spp	*Borhavia difusa*	**Weed**
Black jack spp	**Legume**	*Borhavia difusa*
Oxigonum spp	*Crotalaria spp*	*Oxigonum spp*
Legume	*Neorautanenia spp*	*Solanum spp*
Rynchosia spp	*Rynchosia spp*	*Amaranthas spp*
		Sida spp
		Legume
		Crotalaria spp
		Neorautanenia spp
		Rynchosia spp