VEGETATION COMPOSITION, YIELD, AND NUTRITIVE VALUE IN COMMUNAL GRAZING AREAS OF CHALINZE DIVISION IN BAGAMOYO DISTRICT

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ABSTRACT

This study was conducted in Chalinze division in Bagamoyo District to assess and evaluate the condition of pastoral communal grazing area in yield, botanical composition of herbaceous plant species as well as nutritive value. Yield forage samples were collected using 0.25m^2 metal quadrat after which chemical composition, dry matter yield (DMY) and in vitro dry matter digestibility (INVDMD) were analyzed. Line Interception Method was used to estimate forage species distribution. Woody species density was determined by Point Centre Quarter. Soil samples were collected and analyzed for pH, organic carbon, textural class and cation exchange capacity (CEC). Data on DMY, chemical composition, vegetative cover, stocking capacity, and canopy area and tree density were analyzed by the General Linear Model procedures of SAS (1998). Results indicate that Vigwaza village had the highest mean tree density of 2 308 tree / ha, neutral detergent fibre of 73.17%, acid detergent fibre of 25.91% and the lowest stocking rate of 20 ha AU^{-1} during the wet season. Kaloleni village had the mean highest tree canopy area (6.6 m^2) and height (7.5 m), respectively and INVDMD of 47.9% during the dry season. Matuli village had relative higher DMY (1 869 and 4 106 kg / ha), CP content (4.72 and 6.7%) both during dry and wet seasons respectively. Matuli village had higher ADL content (10.5 ± 0.8%) during dry season compared to Kaloleni (7.3 ± 0.8%) and Vigwaza (9.6 ± 0.8%) villages. Calcium content ranged from 0.22 ± 0.01% in Kaloleni to 0.25 ± 0.01% in Vigwaza villages during dry season, while in wet season calcium content ranged from 0.24 ± 0.01% in Matuli to 0.26 ±0.01% in Vigwaza villages. The dominant herbaceous grass species were *Urochloa*, *Panicum,* and *Eragrostis* species. *Acacia polyacantha*, *Dichrostachys cinerea*, *Acacia tortilis*, *Pterocarpus angolensis* and *combretum molle* were the dominant woody vegetation. Based on these results, it can be concluded that the range condition in communal grazing areas in terms of forage

availability and quality is declining and some measures should be taken to prevent range deterioration.

DECLARATION

I**,** MUHIDIN HASSAN SHEMAGHINDE**,** do hereby declare to the Senate of Sokoine University of Agriculture that this dissertation is my own original work done within the period of registration and that it has neither been submitted nor being concurrently submitted in any other institution.

___________________________ ___________________________

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The above declaration confirmed by

___________________________ ___________________________

Professor E. J. Mtengeti **Date**

(Supervisor)

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This work is dedicated to our ALMIGHTY GOD who is the source of all knowledge. To my beloved parents, Ibrahim Amiri Shemaghinde and Zainabu Ibrahim who laid the foundation of my education.

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LIST OF ABBREVIATIONS AND SYMBOLS

ADF	Acid detergent fibre
ADL	Acid detergent lignin
ANOVA	Analytical of variance
AOAC	Association of Official Analytical Chemists
AU	Animal Unit
AUMs	Animal Unit Months
^{0}C	Degree Celsius
Ca	Calcium
CEC	Cation Exchange Capacity
Cm	Centimetre
CF	Crude Fibre
C/N	Carbon Nitrogen Ratio
CP	Crude Protein
CRBD	Complete Randomized Block Design
DASP	Department of Animal Science and Production
DM	Dry matter
E	East
Freq	Frequency
GLM	General Linear Model
GPS	Global Positioning System
Ha	Hectare
INVDMD	In Vitro Dry Matter Digestibility
INVOMD	In vitro Organic Matter Digestibility

K	Potassium
Kg	Kilograms
Km	Kilometres
LSD	Least Significant Difference
M	Meter
MLDF	Ministry of Livestock Development and Fisheries
M^2	Meter square
Mm	Millimetre
Na	Sodium
NDF	Neutral detergent fibre
OM	Organic Matter
P	Phosphorous
PCQ	Point Centre Quarter
pH	Hydrogen concentration
PPM	Parts per million
S	South
SAS	Statistical Analytical System
Se	Standard error
Spps	Species
SR	Stocking Rate
SUA	Sokoine University of Agriculture
TN	Total Nitrogen

CHAPTER ONE

1.0 INTRODUCTION

1.1 General Introduction

Most of the rangeland areas in Tanzania have been used for various activities such as agriculture, national parks and game reserves, and mining, all of which have constrained pastoral mobility. For this reason rangelands are less able to support the rapidly growing and increasing sedentary agro-pastoral population in the country (Sendalo, 2009).

According to Ministry of Livestock Development and Fisheries (2010) Tanzania has grazing land which is estimated to be 51% of country's total land area of 943 000 km^2. The grazing land area supports majority of the ruminant livestock which comprises 19.1 million cattle, 3.6 million sheep and 13.6 million goats. Almost all grazing lands are communally grazed with insufficient or no management system in place and therefore the natural forages within these grazing lands are of low herbage production and quality for most part of the year (Manangwa, 2003). Natural forages are the most adapted species but require some improvement to increase their productivity and quality. However, improvement strategies can properly be planned if there is a thorough rangeland resources inventory, especially the assessment of the vegetation condition in the communal grazing areas in different ecological zones in Tanzania. Effective range improvement strategies will encourage proper grazing pattern that will lead to sustainable rangeland use. Extended dry seasons and shorter rain periods coupled with high temperatures are severely limiting forage supply and availability of water. To cope with the situation, pastoralists had long resorted to seasonal movements from one communal grazing area to another in search of forage and water but their coping strategies have been blocked by expansion of crop agriculture areas to these drylands (Ganskopp and Bohnert, 2002).

1.2 Background and Justification

Historically Bagamoyo District had a few ruminant livestock probably due to the abundance of tsetse flies and poisonous plants such as *Dichapetalum* species in the area (Ngomuo *et al.,* 2003). However, in the early 1980s pastoral production system was introduced by immigrant pastoralists and agro pastoralists who came to the area in search of pasture and water from Central and Northern regions. By 2006 Bagamoyo District was holding the largest number of ruminant livestock compared to the other districts in Coast region (Coastal Region Committee report, 2006).

Livestock estimates by year 2006 was 62 760 indigenous cattle, 10 028 goats, 3 022 sheep and 40 donkeys. Majority of these are concentrated in Chalinze division resulted into overgrazing. There is a need therefore to carry out characterization of the rangelands in the division and with particular emphasis on the current range condition so as to establish the stocking rate of the district rangelands as a whole.

1.3 Problem Statement

Haphazard movement of ruminants due to blockage of their migratory routes by agriculture, national parks and mining and in some cases grazing at the same area for the whole year has resulted into serious rangeland degradation. Increased number of livestock from north and central regions of Tanzania; Manyara, Arusha, Singida, Dodoma and Morogoro towards Bagamoyo, have resulted into overgrazing. Overgrazing reduced range forage species in terms of quantity and quality, ground cover as well as biodiversity. Tall perennial bunch grass species give way to shorter stoloniferous perennial grasses which are replaced by annual grass and forbs species and eventually woody vegetation may become abundant in the absence of fire (Herlocker, 1999).

However, there is little information known about the botanical composition, range forage productivity, nutritive value and carrying capacity of the communal grazing areas and the current management practices that the livestock keepers are trying to cope with the shrinking of the grazing areas and declining pasture quantity and quality in the coastal regions. This study therefore is aimed at assessing the current situation of forage availability and quality in the coastal rangelands and hence suggest on proper rangeland use plan.

1.4 Objectives of the study

1.4.1 General objective

To evaluate range conditions of pastoral communal grazing area of Chalinze division.

1.4.2 Specific objectives

i. To determine botanical composition and yield of forage plant species in communal grazing areas
ii. To estimate the stocking rate of the communal grazing area
iii. To determine the nutritive value of herbaceous forage plant species in communal grazing area

1.4.3 Hypotheses of the study

i. Ho: Grazing land condition differs between villages.
ii. HA: Grazing land condition does not differ between villages.
iii. Ho: Grazing land condition differs between range sites.
iv. HA: Grazing land condition does not differ between range sites.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Factors Influencing Vegetation Composition

Different grasslands contain diverse types of grasses, legumes, and other herbaceous species. Grasses provide the bulk feed. However, many forbs and some browse plants play an important role in improving the nutrition of grazing animals. The most desirable are legumes because they fix nitrogen and therefore provide feed with high protein component as well as increase soil fertility. Vegetation species composition of rangeland varies depending on climate, soil types, topography and biotic factors (Crowder and Chheda, 1982).

2.1.1 Climate

Climate plays a primary role in determining the types of vegetations used for grazing and the subsequent growth responses (Moore and Russell, 1976; McCown, 1981). Rainfall reliability, distribution, intensity and evaporative demand strongly influence the amount of water available for plant use. (Crowler and Chheda, 1982; Herlocker, 1999) reported that in East Africa evapo-transpiration is high, and can reach as high as 2500 mm per year in arid areas and 1500 mm per year in highlands and this may influence plant growth.

2.1.2 Soil type

Soil fertility and the available soil moisture are the major determinants of plant growth and production in tropical region. However, fertility of soil is the principal limiting factor in sub-humid and humid regions because of the leaching effect due to rainfall (Herlocker, 1999).

According to Brady (1974) soil texture; structure, and depth are the primary determinants of soil moisture availability to plant roots. Walker (1993) reported that when adequate moisture is available, rangelands produce more palatable and nutritious fodder. 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, tilth, aeration, water permeability and soil nutrient availability to the plants (Brandy, 1994).

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 (Walker, 1993).

2.1.3 Topography of grazing land

The physical features of the earth like altitude, slope, exposure, mountain chains, valleys and plains mark variations in temperature at different altitudes and result in the division of earths vegetation into different zones such as equatorial, tropical rain forests, desert or grasslands, deciduous forests, coniferous forests, tundra, ice and snow of poles (Herlocker, 1999).

At high altitudes above sea level, the velocity of wind remains high, temperature and air pressure decrease, humidity as well as intensity of light increases. Due to these factors, vegetation at different altitudes is different showing distinct zonation (Tueller, 1973). The directions of mountain chains or ranges and high mountains act as wind barriers and affect the climate and rainfall and other factors which have a significant effect on the growth of vegetation and the distribution of animals (Scott, 1969).

Archer and Smeins (1991) observed that steepness of a slope has a distinct effect on the climate of the area, namely the incidence of solar radiations, rainfall, wind velocity and the temperature of the region. Steepness of the slope decides the rapidity with which water flows away from the surface and determines the characteristic of the soil. A slope remains exposed to the sun and wind and this affects greatly the kind of plants growing there.

Ganskopp and Vavra (1987) observed that topography is a limiting factor to graze wider areas in rangelands because animals for example cattle avoided slopes of 20%. Also physiological state of the animal influences the distribution and utilization of forages in the rangelands. Lactating cows require more water than none lactating; lactating cows have also behavioral requirements of caring for a calf. These two factors can limit them to use rugged terrain (Bailey *et al.*, 2001). Bell (1973) reported that yearling steers, yearling heifers, and non lactating cows utilize extensive pastures more evenly than cow-calf pairs.

2.1.4 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 (Phillipson, 1979). Herlocker (1999) pointed out that the 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 grassland at the expense of woody vegetation (McNaughton, 1976; Pratt and Gwynne, 1977, Deshmukh, 1986). However, many grasses lose vigor and die early when periodically defoliated.

2.1.5 Management of rangeland

Plants and animals are not viewed separately and each is a vital part of the other's environment. Stoddart *et al.* (1975) reported that, change in one part (for example an increase in stocking rate) will change the relationships among all the other system components. It has been observed that, tree cutting changes the physiognomic and compositional nature of the vegetation. Also man's activities play vital role in destruction and changing botanical composition of range vegetation.

2.1.6 Use of indigenous knowledge in natural resource management

Traditional knowledge in natural resources management and utilization has been playing important role in improving and developing land use system in the world (Mwilawa *et al.*, 1996). The pastoralists have been using the traditional grazing management in order to cope up with the relatively arid condition of the environment, prevent overgrazing and ensure the sustainability of the resources base. Pastoralists use flexible grazing strategies. Overall, their gazing management is the result of their cumulative knowledge about resources, assessment of range condition and distribution of rainfall (Ayana, 1999). These traditional practices are good experiences on the basis of which it is possible to develop improved pastoral system.

2.2 Vegetation Productivity

2.2.1 Forage dry matter yield and its importance

Climate and soils set the basic potential for rangeland productivity (Herlocker, 1999). Rainfall is the principal climatic factor. It is effectiveness in stimulating plant growth depends upon its amount, evaporative demand. High intensity rainfall causes significant increases in surface runoff which results in large amounts of water becoming inaccessible to plants. The greater the loss by runoff the less effective rainfall is in supporting plant growth (Pratt and Gwynne, 1977).

Drought play part in destructive, especially when protracted. In withholding the rainfall needed to grow crops and forage, sometimes over very long periods, drought often cause extensive damage to pastoral economy due to losses of perennial grasses and shrubs as well as livestock (Herlocker *et al*., 1993). Soil fertility is limiting rangeland plants productivity in sub humid and humid regions and soil moisture in semi arid and arid regions.

Crowder and Chheda (1982) reported that forage productivity can be quantitatively measured by weight of herbage materials produced over a given period of time. Knowledge of forage yield is used in estimation of both the stocking rate and the amount of available to the ruminants.

Pastoral grazing systems are predominantly dependent on the natural productivity of grasslands, and therefore defined largely by the agro-ecological zone. The populations relying on these systems (Pastoralist) are defined by their mobility in response to environmental variability (Holechek *et al*., 1995). At one extreme the nomadic groups are highly mobile pastoralists, living in areas with major differences in both seasonal and annual climatic patterns. At the other end agro-pastoralists and ranchers operate sedentary systems where seasonal and annual climatic variations are minor. An example of the pastoralists system is that practiced by the Maasai in the sparsely populated areas usually referred to as Maasai rangelands of Tanzania and Kenya (Herlocker, 1999).

In the pure grazing systems, more than 100% of dry matter fed to animals comes from rangelands, pastures and annual forages and purchased feeds and less than 10% of the total value of production comes from non-livestock farming activities (Senft *et al.,*1985). Annual stocking rates are less than 10 livestock units per hectare of agricultural land. This system is characterized by strong interactions between cattle, land, water, plant and animal biodiversity, especially wildlife. As a result, agro-ecological conditions strongly define the nature and scope of cattle-environment interaction. Grazing animals are frequently associated with overgrazing, soil degradation and deforestation.

2.2.2 Forage yield estimate

Pratt and Gwynne (1977) reported that weight of herbage produced is one of the most important characteristics of the range plants and it is probably the best single measure of growth. It is the most convenient term used to express forage productivity and likewise can be used to indicate and measure ecological trend and range condition. The technique also can be used to estimate the abundance of a given species. Forage productivity can be quantitatively measured by weight of herbaceous material, and the knowledge of forage yield can be used to estimate the stocking rate (Crowder and Chheda, 1982).

2.2.3 Frequency of occurrence of herbaceous plant species

The frequencies of occurrence of plant species depict the distribution, the richness and thus the plant species composition in a given rangeland. Plant composition in the rangeland varies depending on topography, climate and soil types (Skerman, 1977). Forage plant species composition can also be disturbed by grazing practices, burning, drought, temperature, pest, cultivation and erosion. These factors to a greater extent affect botanical composition of vegetations in rangelands (Stoddart *et al*., 1975). Butterworth (1985) observed that, changes in plant composition could be the outcome of adaptability of the plant species over a period of time.

2.2.4 Vegetation cover

Cover is expressed in terms of percentage of ground covered by vegetation. It is used as the primary attribute of vegetation in rangeland survey. Cover have positive influence on soil stabilization, water infiltration, control of surface run off and erosion and transport of sediment into water system such as surface water pond or dams. It has great effect on grazing. Range sites with preferred forage cover can strongly influence livestock distribution. Relative abundance of preferred forage cover dictates the grazing pattern of grazing animals (Senft *et al*., 1985). Preference for some types of vegetation can result in variability of utilization and hence cover of some forage species (Holechek *et al.,* 1995).

2.3 Stocking Rate

Stocking rate reflect rangeland productivity, generally varies from season to season year to year according to the availability of forage which, in turn, reflect the amount of rainfall (Heady, 1975). Behenke and Scoones (1993) indicated that, grazing has a heavy disturbing effect on herbage species of arid rangelands, compared to fire, cultivation, deforestation, mining, and urban development, but it has far less devastating effects on the vegetation and habitats.

Low stocking rates or grazing pressures promote plant production by maintaining high leaf area per unit land area. High stocking rates reduce plant production. Morris *et al.* (2000) found that, overgrazing reduces the ability of pasture to reproduce and lead to changes in botanical composition.

The carrying capacity of the grazing lands reflects its potential to support livestock. Proper assessment of carrying capacity, aims at balancing the grazing pressure (stocking rates) to maintain the desired level of animal production without overgrazing the vegetation. However, the carrying capacity of rangelands cannot be estimated accurately without knowing the pressure and livestock management practices (Kidunda, 1996).

According to Meindertesma and Kessler (1997) the carrying capacity of the maasai rangeland between 1970 – 1980 in Arusha was estimated at 1.4-1.5 ha/livestock unit during the wet season and 5ha/livestock unit during the dry season. It was also reported that there are widespread areas where the carrying capacity has declined as a result of rangeland degradation.

The traditional Maasai system (transhumance) of range utilization was sustainable and in harmony with cultivation hence soil erosion was mainly observed in cattle tracks and around watering points (Herlocker, 1999). The major concern was reduction in the livestock carrying capacity because with time, population growth has lead to migration from the densely populated humid lands to colonize and cultivate the marginal lowlands (Herlocker, 1985).

2.4 Factor Affecting Chemical Composition of Forages

2.4.1 Climate

Climate is one the primary factor determining range forage production. It may vary widely with ecological zone as well as season (Crowder and Chheda, 1982). Tropical areas experience distinct wet and dry seasons. The study conducted by Vallentine (1990) showed that livestock spent more time in riparian areas than in other areas of the rangeland during the dry season. This is because the upland forage becomes mature and lower in quality as soils dry up, whereas the quality of riparian forage remains relatively higher because of greater availability of soil moisture (Murray and Illius, 1996).

2.4.2 Soil properties

Tropical soils are generally low in nitrogen, phosphorous, potassium and sulphur. In highly weathered tropical soils forages have a greater tendency to absorb large quantities of silica that significantly depresses digestibility of herbage (D' Hoore and Coulter, 1972; Kidunda, 1996; Crowder and Chheda, 1982).

2.4.3 Plant maturity

Advancing plant maturity is accompanied by an increase in dry matter, which is reflected in the increase of cell wall contents, and a decrease in cell contents. The decline in organic matter digestibility of forages with plant age may be due to the increase in plants structural carbohydrates and lignin as reflected in an increased percentage cell wall contents. The decline in CP content of the forage coupled with decreasing digestibility with age makes forages less nutritious as they mature. However, the CP in grasses decline more rapidly than in legumes (Van Soest, 1994).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 The Study Area

This study was conducted during the dry season in November, 2010 and during the wet season April, 2011. Three villages (Matuli, Kaloleni and Vigwaza) were selected within Chalinze division. The division is located 100 km North West of Dar Es Salaam at S 06^0 38' 260" E 038^0 13'650" and 420 metre above sea level (masl). The division experience mean temperature of 28^{0}C and annual mean rainfall of 900 mm. The long rains cover 120 days between March and June every year while short rains are received for 60 days from mid October to December each year. The selected villages are inhabited by agro-pastoralists except Kaloleni which is inhabited by Maasai pastoralists' who are keeping large population of ruminant livestock stock.

3.2 Field Survey and Data Collection

A field survey was carried out in the three villages after the household survey. During the field survey, grazing sites were identified. In each village two grazing sites were established in its reserved grazing area. Each grazing site coordinate were marked and recorded by using Geographical Positioning System (GPS). The grazing areas of Kaloleni village were located at S 06^0 34'315", E 038 07'575" at 470 masl and S 06^0 35'045", E 038 08' 948" at 464 masl respectively, while the grazing sites one and two of Matuli village were located at S 06^0 39' 296" E 038^0 13'718" at 408 masl and S 06^0 39' 934" E 038^0 13' 307" at 409 masl respectively where as those of Vigwaza were located at S 06^0 42' 389", E 038^0 36' 985" at 400 masl and S 06^0 41' 263", E 038^0 37' 207" situated at 405 masl respectively.

Two transect lines each 500m long were established in each of the grazing site. The distance from one transect line to another within each grazing site was 600m apart. Herbaceous vegetation cover along the transect lines was established by using line interception method. This method involved laying down a tape measure as a sampling unit on the transect line. Five sampling units were established along the transect line and each had 30m in length. Within each sampling unit the distance that was covered by bare soil, desirable and undesirable herbaceous (i.e. grass, grass like and forbs) vegetation species were recorded.

3.2.1 Botanical composition and forage yield determination

Along the transect line at an interval of 50 metre long a sampling plot of 5m radius was established. In every sampling plot, a quadrat frame of 0.5m x 0.5m was thrown randomly twice to obtain forage yield and botanical composition. The herbaceous species within the quadrats were clipped to 5 cm above the ground level. The clipped herbage were sorted out to discard dead litter and thereafter separated into different plant species to determine botanical composition. The samples were then mixed, packed into properly labelled plastic bags and immediately fastened weighed using sensitive balance to record fresh weight. The samples were kept under shade area until sampling for the day was completed and then transported to Sokoine University of Agriculture (SUA) Animal Nutrition Laboratory for DM content determination.

3.2.2 Forage species distribution in the grazing area

The same transect line established in section 3.2.1 was used to assess forage species distribution in the grazing area. This was determined by considering the number of quadrats in which a forage species was recorded, as a percentage of the total quadrats in the respective grazing site.

3.2.3 Woody plant species, density and canopy cover

The woody plants density and canopy cover was estimated by using Point Centre Quarter method in which four trees were selected at a time along the transect line established in section 3.2.1. The sampling point were established on an interval of 100m along the transect line. A cross made of sticks was laid at each sampling point. Each tree falling under each quarter was recorded. In each transect line five sampling points comprising of four trees each were demarcated. The distance of each tree from the cross was measured as quarter distance (D) in meters and was used once. Thereafter the crown diameter and height of each tree was measured in metre. The height was measured by using wooden pole which was calibrated up to 10 metre. The exercise was made possible due to close participation of the researcher, elders and villagers. Other information was species name and canopy area. The species composition, density, canopy cover area, and plant height were rated according to the score narrated by Kuchar (1995) (Appendix 1). These parameters were used to describe and classify the rangeland.

3.2.4 Soil sampling and analysis

A total of 12 soil samples from the study villages, two from each grazing site were collected at a depth of 15cm by using auger. Roots, stone, and other foreign materials were removed (Bremner and Mulvaney, 1992). After removal of foreign materials a 250 gm soils sample was taken from each location and placed in a clean labelled plastic bag and later taken to the soil laboratory at SUA for analysis. Total Nitrogen was determined according to Kjeldah procedure (Bremner and Mulvaney, 1992) while soil cation exchange capacity (CEC) and exchangeable cations (Ca, Mg, K, and Na) were analyzed according to the Soil Survey Laboratory Staff manual (1992). Soil pH was determined on a 1:2 (v/v) soil to 0.01 M $CaCl_2$ slurry (McLean, 1982).

3.2.5 Bulk density determination

Soil core samples measuring 7.5 x 7.5 cm and depth of 5 cm were collected using double cylinder, drop-hammer sampler for the assessment of bulk density. Two samples were collected per transect line and then taken to the Soil laboratory at SUA. The samples were dried at 105°C for 48 hours in a forced-air oven. Bulk density was calculated as mass of dry soil per volume of field-moist soil.

3.3 Estimation of Stocking Rate

Estimation of stocking rate was done according to the livestock keeper's experiences on months of dry and wet seasons. Experiences showed that the months of dry season were between June to October and January to February. Therefore the area experiences the dry season for 7 months and wet season for 5 months. Stocking rate (ha / A.U) during dry and wet season was estimated as follows:

$$SR = \frac{\text{Forage dry matter yield per unit area x Grazing area}}{\text{A.U x daily requirement x No. of days}} \quad \text{..............................(i)}$$

3.4 Identification of Herbaceous Plant Species

The specimen of herbaceous and woody plant species which were collected in sections 3.2.1 and 3.2.3 from each village was subjected to partial ethnobotany process as described by Mtengeti and Mhelela (2006). The process of partial ethnobotany involved the discussion with livestock keepers. The collected herbaceous and woody plant species specimens were displayed before the livestock keepers for them to identify and describe the importance of plants. Thereafter they ranked the herbaceous and woody plants species according to their suitability as ruminant animal feed. The top five woody plant species for every grazing site were tested for their acceptability to the animals. Thereafter the plant species specimen were pressed and preserved ready for scientific identification at SUA and/ or Kongwa Pasture Research herbaria, in Tanzania.

3.5 Testing Acceptability of the Woody Plants

Preference (acceptability) of the plant to the livestock as a feed resource was done according to the procedure described by Mtengeti and Mhelela (2006). The experiment on testing the acceptability of the five dominant woody plant species was conducted for five days. The twigs bundles of 1000g of each species were hanged on the rope to allow free access by the goats aged one to one and half years for 20 minutes. The species positions were randomly changed every day (Appendix 2) and five goats were allowed to have free access to the woody plant species every morning before grazing and each animal had equal chances of taking any species. The refusals from each plant species were weighed and the difference from the original amount offered was calculated as the amount eaten (amount eaten= Amount given-Amount of refusals) in grams (g). (DMI) per minute =Amount eaten/minute x % DM. i.e. Dry matter intake rate was calculated as follows:

$$\frac{\text{Amount eaten} \times \%\ \text{DM}}{20\ \text{minutes}} = \text{g DM/Min} \qquad \text{(ii)}$$

The acceptability was calculated as:

$$\%\ \text{Acceptability} = \frac{\text{Amount eaten} \times \%\ \text{Dry Matter}}{\text{Amount given} \times \%\ \text{Dry matter}} \times 100 \qquad \text{(iii)}$$

3.6 Chemical Composition Analysis and in Vitro Dry Matter Digestibility Determination

The composite sample of herbaceous forage plant species were collected for chemical composition in the Animal Nutrition laboratory at SUA. In addition the samples of woody forage ranked by livestock keepers were also collected for chemical analysis. The samples were oven dried to obtain constant dry weight. The samples were then grounded to pass through a 1 mm sieve. After grounding, the sample was stored in sealed dry jars for chemical composition analysis and in-vitro dry matter digestibility determination. The samples were analyzed for DM, CP, NDF and ADF according to procedure of AOAC (1990). Total nitrogen in the sample was determined by the Kjeldahl technique procedures, using semi automated N- analyzer. Nutrient detergent fibre (NDF), Acid detergent fibre (ADF) and Acid detergent Lignin (ADL) were determined as described by Van Soest (1994). The contents of Phosphorus, Potassium, and Calcium were determined using methods recommended by AOAC (1990). In vitro dry matter digestibility was determined according to Tilley and Terry (1963).

3.7 Data Analysis

Data obtained for forage DMY was analyzed by using Complete Randomized Block Design (CRBD). The soil, botanical composition and range condition data were summarized in terms of average, frequency and percentages. While data collected from soil bulk density was subjected to ANOVA.

The following statistical model was used to analyse the data for botanical composition, forage yield and vegetative cover.

$$Y_{ijk} = \mu + V_i + S_{ij} + (VS)ij + E_{ij} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \text{(iv)}$$

Where:-

Y_{ij} = Observation on the i^{th} village on the j^{th} season, μ = the general mean, V_i = the effect of the i^{th} village, S_{ij} = Effect of the i^{th} village on the j^{th} season, (VS)ij = interaction between village and season and E_{ijk} = the random error.

CHAPTER FOUR

4.0 RESULTS

4.1 Vegetative Ground Cover, Dry Matter Yield and Stocking Rate

4.1.1 Vegetative cover

The mean percentages vegetative cover of different grazing areas both during dry and wet seasons are summarized in Table 1. There was significant difference ($P < 0.05$) between villages in terms of vegetative cover in the dry season, while the same was not revealed in the wet season. The study revealed that Matuli village had relatively higher ($P < 0.05$) mean vegetative cover (35.24%) during the dry season. In the wet season the villages were not significant different ($P > 0.05$) in terms of vegetative cover.

Table 1: Mean percentages of bare soil and, herbaceous vegetation cover in the study villages

	Dry season		**Wet season**	
Village	Bare soil	Herbaceous vegetation cover	Bare soil	Herbaceous vegetation cover
Kaloleni	72.89±5.06^{b}	27.11±3.38^{ab}	30.87±1.98^{a}	69.13±1.66^{a}
Matuli	64.76±5.06^{c}	35.24±3.38^{a}	29.43±1.98^{a}	70.57±1.66^{a}
Vigwaza	75.30±5.06^{a}	24.7±3.38^{ab}	32.33±1.98^{a}	67.67±1.66^{a}

Means with the same superscript in the same column are not significant at ($P<0.05$)

4.1.2 The contribution of individual plant species in vegetative ground cover

The contributions of individual herbaceous species to vegetative ground cover are summarized in Table 2. Results show that *Urochloa, Panicum, Amaranthas* and *Commelina* species contributed more to the vegetative ground cover in the grazing areas both in dry and wet seasons. In dry season, *Urochloa* and *Panicum* species contribution to ground cover ranged from 1.86 to 4.97%. In wet season the *Urochloa* and *Panicum* species contribution to ground cover ranged from 2.97 to 7.98%. In dry and wet seasons *Amaranthas* and *Commelina* species contributed ground cover ranging from 0.52 to 6.74 and 0.52 to 4.63% respectively.

Table 2: Mean percentages of ground cover of grasses and forbs in dry and wet season

Plant species	Dry season			Wet season		
Grass	**Kaloleni**	**Matuli**	**Vigwaza**	**Kaloleni**	**Matuli**	**Vigwaza**
Chloris spp	0.24±0.09	0.31±0.09	0.22±0.09	0.58±0.09	0.35±0.09	0.22±0.08
Cynodon spp	0.53±0.19	0.53±0.19	0.42±0.19	0.67±0.19	0.53±0.19	0.45±0.18
Urochloa spp	4.62±1.73	1.86±1.73	2.93±1.73	7.98±1.73	4.91±1.73	2.97±1.65
Digitaria spp	0.60±0.22	0.82±0.22	0.34±0.22	0.87±0.22	0.74±0.22	0.48±0.21
Panicum spp	4.97±1.90	2.17±1.90	4.50±1.90	6.74±1.90	4.30±1.90	3.77±1.81
Heteropogon sp	1.03±0.33	0.56±0.33	0.50±0.33	0.93±0.33	1.27±0.33	0.61±0.32
Hyperennia spp	0.56±0.24	0.67±0.24	0.78±0.24	0.96±0.24	1.13±0.24	0.62±0.22
Eragrostis spp	0.24±0.22	0.52±0.22	0.98±0.22	0.48±0.22	0.95±0.22	0.61±0.21
Aristida spp	0.38±0.12	0.33±0.12	0.31±0.12	0.55±0.12	0.61±0.12	0.35±0.12
Bothrocloa spp	0.42±0.14	0.32±0.14	0.58±0.14	0.82±0.14	0.63±0.14	0.45±0.13
Echnocloa spp	0.43±0.13	0.42 ±0.13	0.28± 0.13	0.64 ±0.13	0.38±0.13	0.29± 0.13
Forbs						
Solanum spp	2.93±1.73	2.17±1.90	4.50±1.90	2.93±1.73	4.50±1.90	2.93±1.73
Amaranthas sp	2.93±1.73	1.86±1.73	1.86±1.73	2.93±1.73	4.50±1.90	2.97±1.65
Sida spp	4.50±1.90	1.86±1.73	4.50±1.90	0.52±0.22	4.50±1.90	4.50±1.90
Cyperus spp	4.50±1.90	1.86±1.73	1.86±1.73	1.86±1.73	4.50±1.90	1.86±1.73
Oxigonum spp	1.86±1.73	0.95±0.22	0.95±0.22	1.86±1.73	4.50±1.90	1.86±1.73
Commelina spp	4.50±1.90	0.52±0.22	6.74±1.90	4.62±1.73	4.50±1.90	0.52±0.22

4.1.3 The dry matter yield and stocking rate

4.1.3.1 Dry matter yield

The results of the dry matter yield are summarized in Table 3. The results shows that the villages were significantly ($P < 0.05$) different in terms of dry matter yield. The highest dry matter yield in the dry season was recorded in grazing areas of Matuli village (2 211.78 ±50.98 kg DM/ha) followed by grazing areas of Kaloleni (1 597.95 ± 50.98 kg DM/ha), and grazing areas of Vigwaza villages (861.01 ± 50.98 kg DM/ha). In wet season similar trend was observed whereby the highest dry matter yield was recorded in Matuli grazing areas (4 455.1 ± 101.78 kg DM/ha) followed by Kaloleni grazing areas (4 104.9 ±101.78 kg DM/ha) and Vigwaza grazing areas (3 812.2 ± 101.785 kg DM/ha).

4.1.3.2 Stocking rate

The mean stocking rate was recorded in Table 3.The result shows that the stocking rate in grazing areas differed between village and seasons. In the dry season the estimated stocking rate ranged from 0.02 to 1.1 ha /AU. Vigwaza and Matuli grazing areas had the lowest (0.02 ha /AU) and the highest (1.1 ha /AU) stocking rates respectively. In wet season, the estimated stocking rates ranged from 0.4 to 3.0 ha/AU respectively. The highest estimated stocking rate was recorded in Matuli village (3.0 ha /AU) followed by Kaloleni (1.6 ha /AU) and Vigwaza villages (0.4 ha /AU).

Table 3: Least square means of forage Dry matter yields (Kg DM ha^{-1}) and estimated stocking rate

Village	Total AU	Area (ha)	Dry season Dry matter yield (kg DM ha^{-1})	Dry season SR ha/ AU	Wet season Dry matter yield (kg DM ha^{-1})	Wet season SR ha/AU
Kaloleni	1 6312	5 010	1597.95 ± 50.98^{b}	0.47	4104 ± 101.78^{b}	1.6
Matuli	1 980	1 000	2211.78 ± 50.98^{a}	1.0	4455 ± 101.78^{a}	3.0
Vigwaza	4 355	119	861.016 ± 50.98^{c}	0.02	3812 ± 101.785^{c}	0.4

Means with the different superscript along the same column are significantly different at ($P < 0.05$), AU= Animal Unit, SR = Stocking rate

4.1.3.3 The contribution of individual grass species in dry matter yield

The contribution of individual herbaceous plant species to the total dry matter yield of different grazing areas are summarized in Table 4. The result shows that the percentage contribution of individual species differed from one grazing area to the other both in dry and wet seasons. *Urochloa* and *Panicum species* contributed largely to the total dry matter yield both in dry and wet season in Kaloleni grazing sites. In Matuli grazing sites, again the total dry matter yield was highly contributed by *Urochloa* and *Panicum* species in the dry seasons. *Echnocloa, Urochloa* and *Eragrostis* species contributed largely in Vigwaza grazing areas during dry season.

In wet season the yield was contributed by *Urochloa, Panicum* and *Eragrostis* species. *Panicum* and *Eragrostis* contributed more to the yield in Vigwaza grazing sites both in dry and wet season. Generally the total dry matter yield in all grazing areas in this study both in dry and wet seasons were mainly contributed by *Urochloa*, *Panicum* and *Eragrostis* species.

Table 4: The contribution of individual grass species in forage dry matter yield (Kg DM/ha) at different grazing sites during dry and wet season in the study villages

Village	**Kaloleni**	**Matuli**	**Vigwaza**	**Kaloleni**	**Matuli**	**Vigwaza**
	Dry season			**Wet season**		
Plant spp	**DMY**	**DMY**	**DMY**	**DMY**	**DMY**	**DMY**
Chloris spp	45.50	43.15	18.88	198.85	110.63	276.83
Cynodon spp	24.90	93.45	11.28	293.20	110.63	179.23
Urochloa spp	302.20	503.25	101.73	1004.30	1121.03	814.5
Digitaria spp	45.50	143.65	18.88	198.85	94.65	179.23
Panicum spp	231.80	366.65	82.85	209.10	915.75	814.5
Heteropogon	45.50	186.90	41.43	104.55	299.93	260.85
Hyperrhenia	103	186.90	49.03	198.80	110.63	179.23
Sporobolus spp	104.50	205.28	179.23	104.50	205.28	179.23
Eragrostis spp	57.95	143.65	90.45	407.95	837.08	440.08
Themeda spp	418.20	94.65	97.60	418.20	94.65	97.60
Aristida spp	45.50	50.30	49.03	45.50	50.30	49.03
Bothrochloa sp	70.40	50.30	41.43	522.50	299.93	163.25
Echinochloa sp	103	143.65	79.18	397.75	205.28	179.23
Total	**1597.95**	**2211.78**	**861**	**4104.05**	**4455.77**	**3812.79**

DMY= Dry matter yield in Kilogram/hectare.

4.2 Frequency of Occurrence of Herbage Plant Species

4.2.1 Grass species

The botanical composition of the herbage plant species and woody vegetations found in different communal grazing areas are presented in Table 5. The most frequently occurring grass species were; *Urochloa, Panicum* and *Eragrostis* species both in dry and wet season. The percentage frequencies of occurrence of *Urochloa* grass specie in dry season were 27.5, 22.5 and 12.5 while in wet season the grass had frequencies of 25, 37.5 and 22.5 in Kaloleni, Matuli and Vigwaza villages respectively.

In dry season *Panicum* grass specie had percentage frequencies of 20, 20 and 15 while in wet season the grass had frequencies of 35, 22.5 and 25.5 in Kaloleni, Matuli and Vigwaza villages respectively. In dry season *Eragrostis* specie had percentage frequencies of 15, 12 and 15 while in wet season the frequencies of occurrences of the grass were 17, 20 and 18.5 in Kaloleni, Matuli and Vigwaza villages respectively. On average, the grazing areas of Kaloleni village were dominated by *Urochloa, Panicum* and *Eragrostis* grass species. However, during the wet season Matuli grazing areas were dominated by herbaceous; *Urochloa, Panicum, Eragrostis* and *Echnochloa* grass species. While Vigwaza grazing areas were dominated by *Urochloa, Panicum, Echnochloa,* and *Eragrostis* grass species.

4.2.2 Leguminous plants species

The occurrences of leguminous plants are summarized in Table 5. In this study it was observed that there were few leguminous plants species in the study area. The dominant leguminous plant species were; *Rynchosia, Crotalaria* and *Neorautanenia spp.* In the dry season, *Crotalaria spp* had percentage frequencies of occurrence of 5, 12.5 and 10.

In wet season the percentage frequencies of occurrences were 15, 15 and 25 in Kaloleni, Matuli and Vigwaza villages respectively. The *Rynchosia spp* in dry season had percentage frequencies of 10, 5 and 25 while in wet season the percentage frequencies of occurrences were 15, 12 and 25 in Kaloleni, Matuli and Vigwaza villages respectively. The *Neorautanenia specie* during dry season had the percentage frequency of 12.5, 2.5 and 7.5 while in wet season had the percentage frequency of 12.5, 12 and 15 in Kaloleni, Matuli and Vigwaza villages respectively.

4.2.3 Weed plants species

The weed plants are summarized in Table 5. The most frequently occurring weed species were; *Amaranthas, Cyperus, Oxigonum, Cacia, Solanum*, and *Sida* species both in dry and wet season in all villages. The percentage frequencies of occurrence of *Amaranthas* specie in dry season were 42.5, 25 and 35 while in wet season the weed had percentage frequencies of 45, 35 and 35 in Kaloleni, Matuli and Vigwaza villages respectively. In dry season *Solanum* specie had the percentage frequencies of 45, 30 and 32.5 while in wet season the weed had percentage frequencies of 55, 35 and 35 in Kaloleni, Matuli and Vigwaza villages respectively.

Sida specie had percentage frequencies of 30, 22 and 45 during dry season while in wet season the percentage frequencies of occurrences were 35, 25 and 35 in Kaloleni, Matuli and Vigwaza villages respectively. In the dry season the *Commelina* specie had percentage frequencies of 35, 25 and 37.5 while in wet season the percentage frequencies of occurrences were 45, 45 and 55 in Kaloleni, Matuli and Vigwaza villages respectively. In the dry season the *Oxigonum* specie had percentage frequencies of 35, 20 and 40 while in wet season the percentage frequencies of occurrences were 37, 25 and 45 in Kaloleni, Matuli and Vigwaza villages respectively.

4.2.4 Woody vegetation

The assessment of woody plant *spp* was done once during the dry season. A total of 16 woody *spp* were identified in the study villages as show in Table 5. Of the identified woody *spp*, the largest proportion of woody vegetation was contributed by *Acacia spp*, *Dichrostachys cinerea*, *Pterocarpus angolensis* and *combretum molle*. The percentage frequencies of occurrence of *Acacia* specie were 40, 67.6 and 48.75 while *Combretum spp* was 3.75, 5 and 32.5. *Dichrostachys* had the percentage frequencies of 6.25, 2.5 and 1.25 and *Pterocarpus* spp percentage frequencies of occurrences was 7.5, 5 and 1.25 in Kaloleni, Matuli and Vigwaza villages respectively. Generally, the dominant woody plant species at Kaloleni village were *Acacia*, *Combretum* and *Pterocarpus spp*. In Matuli village the dominated woody species were; *Acacia, Combretum, Borassus* and *Pterocarpus spp* and in Vigwaza village the dominant woody plant *spp* were; *Acacia, Combretum* and *Grewia spp*.

Table 5: The percentage frequency of occurrence of herbage plant species of grass, legume, weed and woody plant species during dry and wet season

Plant spp	Dry season	Total observation (N=80)		Wet season			
Grass	**Kaloleni**	**Matuli**	**Vigwaza**	**Grass**	**Kaloleni**	**Matuli**	**Vigwaza**
Chloris spp	2.5	2.5	5.0	*Chloris spp*	5.0	2.5	7.5
Cynodon spp	5.0	5.0	5.0	*Cynodon spp*	7.5	2.5	5.0
Urochloa spp	27.5	27.5	12.5	*Urochloa spp*	25	37.5	22.5
Digitaria spp	2.5	7.5	2.5	*Digitaria spp*	5.0	2.5	5.0
Panicum spp	20	20	15	*Panicum spp*	35	22.5	25.5
Heteropogon spp	7.5	10	7.5	*Heteropogon spp*	2.5	7.5	7.5
Hyperrhenia spp	7.5	10	7.5	*Hyperrhenia spp*	5.0	2.5	5.0
Bothrochloa spp	7.5	2.5	7.5	*Sporobolus spp*	2.5	5.0	5.0
Eragrostis spp	15	12	15	*Eragrosts spp*	17	20	18.5
Echinochloa spp	7.5	7.5	12.5	*Themeda spp*	2.5	2.5	2.5
				Bothrochloa spp	2.5	7.5	5
				Echinochloa spp	10	5.0	5.0
Legume							
Crotalaria spp	5.0	12.5	10	*Neorautanenia spp*	12.5	2.5	15
Rynchosia spp	10	5.0	25	*Crotalaria spp*	15	15	25
Neorautanenia spp	12.5	2.5	7.5	*Rynchosia spp*	15	12	25
Aristida spp	2.5	2.5	7.5	*Aristida spp*	5.0	3.5	8.5
Weed							
Solanum spp	45	30	32.5	*Solanum spp*	55	35	35
Amaranthas spp	42.5	25	35	*Amarantha spp*	45	35	35
Sida spp	30	22	45	*Sida spp*	35	25	35
Cyperus spp	30	27	35	*Cyperus spp*	33	37	45
Oxigonum spp	35	20	40	*Oxigonum spp*	37	25	45
Commelina spp	35	25	37.5	*Commelina spp*	45	45	55
Woody							
Acacia spp	40	67.6	48.75				
Combretum spp	3.75	5	32.5				
Grewia spp	0	0	12.5				
Borassus spp	0	6.25	0				
Strychnos spp	0	0	2.5				
Dalbergia spp	0	25	0				
Osyris spp	0	2.5	0				
Euclea spp	5.0	0	0				
Lannea spps	2.5	0	0				
Julbernardia spp	2.5	0	0				
Dombeya spp	2.5	0	0				
Flacourtia spp	3	0	0				
Dichrostachys spp	6.25	2.5	1.25				
Sterculia spp	1.0	0	0				
Brachystegia spp	3.5	0	0				
Pterocarpus spp	7.5	5.0	1.25				

The mean tree canopy areas, tree density and tree height are summarized in Table 6. Results showed that canopy areas, tree height, and tree densities differed from one grazing area to another. Kaloleni grazing areas had significantly higher ($P < 0.05$) tree canopy area (6.61 m^2) than Matuli (5.3 m^2) and Vigwaza (4.5 m^2) grazing areas. Kaloleni grazing areas had taller trees (7.5 m) than Matuli (3.5 m) and Vigwaza (3.5 m). Moreover, Vigwaza communal grazing areas had higher mean tree density (2 308 tree/ha) than Matuli (1 026 tree/ha) and Kaloleni (1 312 tree/ha) grazing areas.

Table 6: Least Square Means of crown diameter, Canopy area, and tree height effect of different grazing sites of the study villages

Variable	**Kaloleni**	**Matuli**	**Vigwaza**
Crown diameter (M)	4.73^b	2.4^b	2.1^b
Canopy area (m^2)	6.61^a	5.35^b	4.59^b
Tree height (m^2)	7.56^a	3.49^b	3.48^b
Tree density (tree./ha)	1 026	1 312	2 308

Means with the same superscript in the same row are not significant ($P < 0.05$)

4.4 Soil Properties in the Grazing Areas of the Study Villages

Soil properties results are summarized in Table 7. The results revealed that soils from Matuli grazing areas had relatively high bulk density, pH, silt, clay, organic carbon, nitrogen, calcium, magnesium and sodium as compared to other grazing areas. Soils of Kaloleni grazing areas had more potassium, CEC as compared to other study grazing areas. Soils of Vigwaza grazing areas were richer in phosphorous and higher in sand percentage as compared to other grazing areas.

Table 7: Soil characteristics of the grazing areas of the study villages

Variable	Kaloleni	Matuli	Vigwaza
BD gm/cm3	1.4	1.5	1.4
pH	6.7	7.2	6.0
Clay	20	22	14
Silt %	5.0	6.0	4.0
Sandy %	75.0	72.0	82.0
Texture Class	Scl	Scl	Scl
OC %	1.07	1.10	0.25
N %	0.0875	0.112	0.0525
P –(Ppm)	1.643	1.675	2.115
Ca m.e/100g	6.555	20.64	2.855
Mg m.e /100g	2.135	3.095	1.375
K m.e /100g	1.3	0.42	0.3
Na m.e /100g	0.155	0.260	0.185
CEC m.e /100g	17.50	15.55	16.70

Key: PPM= part per million, CEC= cation exchange capacity, OC%= Organic carbon, BD=Bulk density, Scl=Sandy Clay Loam

4.5 The Common Plant Species and Their Main Uses

The common herbaceous plant species, their main uses and grazing preference by different types of ruminant livestock in the study areas are summarized in Table 8. According to the livestock keeper views, the highly desirable grasses were *Chloris*, *Cynodon*, *Hyperrhenia* and *Bothirochloa* species, while the undesirable grasses were *Urochloa* and *Echnochloa* species. Majority of leguminous plant species observed were desirable while the weed plant species observed were undesirable. Majority of woody plant species observed were desirable except *Dichrostachys spp* which was less desirable. The results revealed that majority of the observed herbaceous species were grazed. The main plant parts of grasses, forbs and legumes used by the ruminant animals were leaves and stems while in woody plant species the plant parts browsed were leaves, twigs and barks.

Table 8: Plant species their main uses, parts used and grazing preferences by different ruminant livestock species in study villages

Plant sp	Main uses	Part of plant eaten	Palatability (Desirability)	Grazing reference Cattle	Goat	Sheep
Grass						
Chloris spp	Fodder	Leaves and stem	HD	C	G	S
Cynodon spp	Fodder	Leaves and stem	HD	C	G	S
Urochloa spp	Fodder	Leaves and stem	LD	C	G	S
Digitaria spp	Fodder	Leaves and stem	D	C	G	S
Panicum spp	Fodder	Leaves and stem	D	C	G	S
Heteropogon sp	Fodder	Leaves and stem	D	C	G	S
Hyperrhenia spp	Fodder	Leaves and stem	HD	C	G	S
Bothrochloa spp	Fodder	Leaves and stem	HD	C	G	S
Echinochloa spp	Fodder	Leaves and stem	LD	C	G	S
Aristida spp	Fodder	Leaves and stem	D	C	G	S
Legume						
Neorautanenia sp	Fodder	Leaves and stem	D	C	G	S
Crotalaria spp	Fodder	Leaves and stem	D	C	G	S
Rynchosia spp	Fodder	Leaves and stem	D	C	G	S
Weed						
Solanum spp	Fodder	Leaves and stem	LD	C	G	S
Amaranthas spp	Fodder	Leaves and stem	D	C	G	S
Sida spp	Fodder	Leaves and stem	D	C	G	S
Cyperus spp	Fodder	Leaves and stem	LD	C	G	S
Oxigonum spp	Fodder	Leaves and stem	LD	C	G	S
Borhavia difusa	Fodder	Leaves and stem	D	C	G	S
Woody plants						
Acacia spp	Fodder, Fuel	Leaves and stem	D	C	G	S
Combretum sp	Fodder, Fuel	Leaves and twigs	D	C	G	S
Grewia spp	Fodder, Fuel	Leaves and twigs	D	C	G	S
Strychnos spp	Fodder, Fuel	Leaves and twigs	D	C	G	S
Dalbergia spp	Fodder, Fuel	Leaves and twigs	D	C	G	S
Borassus spp	Fodder, Fuel	Leaves and twigs	D	C	G	S
Euclea spp	Fodder, Fuel	Leaves and twigs	D	C	G	S
Lannea spps	Fodder, Fuel	Leaves and twigs	D	C	G	S
Julbernardia sp	Fodder, Fuel	Leaves and twigs	D	C	G	S
Dombeya spp	Fodder, Fuel	Leaves and twigs	D	C	G	S
Flacourtia sp	Fodder, Fuel	Leaves and twigs	D	C	G	S
Sterculia spp	Fodder, Fuel	Leaves and twigs	D	C	G	S
Dichrostachys sp	Fodder, Fuel	Leaves and twigs	LD	C	G	S
Brachystegia spp	Fodder, Fuel	Leaves and twigs	D	C	G	S
Pterocarpus spp	Fodder, Fuel	Leaves and twigs	HD	C	G	S

Key: C= Cattle, G= Goat, S= sheep, D= desirable species, LD= Less desirable, HD=highly desirable

4.6 The Acceptability of Dominant Browse Plant Species

The results of acceptability test of some dominant browse plant species observed in the study villages are summarized in Table 9 and Appendix 2. Present results revealed that *Pterocarpus angolensis* was highly preferred (89.75%) compared to *Acacia polyacantha* (71.5%), *Acacia tortilis* (68.98%), *Combretum molle* (64.73%) and *Dichrostachys cinerea* (53.57%).

Table 9: The acceptability test of the dominant browse plant species as animal feed in the study village

Woody plant	Amount eaten per min (g DM/min)	% accepted by goats	Livestock keepers ranking
AP	35.7	71.5	2
Cm	32.4	64.7	4
Dc	26.8	53.6	5
Pa	44.9	89.8	1
At	34.5	69.0	3

Key: Ap = *Acacia polyacantha*, Cm = *Combretum molle*, Dc = Dichrostachys *cinerea*, Pa = *Pterocarpus angolensis*, At = *Acacia tortilis*, Min = Minute

4.7 Nutritive Value of the Herbaceous Forage Plants in Different Grazing Sites of the Study Villages

4.7.1 Chemical composition of herbaceous forage in grazing sites

Mean chemical composition during the dry and wet season are summarized in Table 10. Results showed that chemical composition of herbaceous species were significantly different (P<0.05) between villages and seasons. The dry matter (DMC) content of the herbaceous plants differed from one grazing area to another. The DM content of the herbaceous plants during the dry season was higher in Vigwaza village (89.6%) followed by Kaloleni (88.0%) and Matuli (85.6%) villages. In wet season Vigwaza village had slightly higher percentage of DM content (38.3 ± 2.9) followed by Matuli (38.1 ± 2.5) and Kaloleni (38.0 ± 3.5) villages. The percentage CP content of herbaceous plants during the wet season was more less the same in all three villages, i.e. in Matuli village (6.7 ± 0.1) compared to Kaloleni (6.6 ± 0.1) and Vigwaza (6.3 ± 0.1) villages. In the dry season Matuli village had slightly higher (4.7 ± 0.4) crude protein percentage compared to Vigwaza (4.2 ± 0.4) and Kaloleni (3.2 ± 0.4) villages.

Table 10: Least square means of chemical composition of composite herbaceous plant species sampled during dry and wet season in the study villages

	Dry season			Wet season		
Parameter	**Kaloleni**	**Matuli**	**Vigwaza**	**Kaloleni**	**Matuli**	**Vigwaza**
DM	88.05^{bc}	85.62^{bc}	89.63^{bc}	38.07±3.56	38.19±2.52	38.37±2.91
CP	3.29 ± 0.42^{cd}	4.72 ± 0.42^{bd}	4.23 ± 0.42^{bd}	6.63 ± 0.19^{ac}	6.70 ± 0.14^{ac}	6.38 ± 0.16^{bc}
INVIDMD	33.1 ± 1.14^{bf}	36.86 ± 1.14^{bg}	32.6 ± 1.14^{bf}	47.99 ± 1.55^{be}	47.49 ± 1.10^{be}	46.80 ± 1.27^{be}
INVOMD	33.37±1.88	27.36±1.88	32.60±1.88	47.43 ± 1.67^{bh}	51.72 ± 1.18^{bj}	50.67 ± 1.37^{bj}
NDF	67.22 ± 1.10^{ab}	71.54 ± 1.10^{bs}	73.17 ± 1.10^{bs}	54.66 ± 0.77^{bb}	50.83 ± 0.54^{ba}	53.87 ± 0.63^{bb}
ADL	7.35 ± 0.84^{b}	10.54 ± 0.84^{a}	9.60 ± 0.84^{a}	8.75 ± 0.62^{a}	5.51 ± 0.44^{b}	5.61 ± 0.51^{b}
ADF	46.52 ± 0.72^{a}	42.32 ± 0.72^{b}	45.74 ± 0.72^{a}	25.60 ± 1.54^{c}	25.69 ± 1.09^{c}	25.91 ± 1.26^{c}
Ash	17.54^{a}	14.95^{b}	12.83^{c}	12.89^{a}	9.54^{b}	9.1^{b}
Ca	0.22 ± 0.01^{b}	0.23 ± 0.01^{b}	0.25 ± 0.01^{a}	0.25 ± 0.01^{b}	0.24 ± 0.01^{b}	0.26 ± 0.01^{a}
P	0.16 ± 0.01^{b}	0.22 ± 0.02^{a}	0.20 ± 0.02^{a}	0.17 ± 0.01^{b}	0.17 ± 0.01^{b}	0.22 ± 0.02^{a}

Means with different superscript along the same row within the season are significantly different at (P<0.05). DMC = Dry matter content of the herbage, CP = crude protein, INVIDMD = in vitro dry matter digestibility, INVOMD = in vitro dry matter digestibility, NDF = neutral detergent fibre, ADL= Acid detergent lignin, ADF = Acid detergent fiber, Ca = calcium, P = Phosphorous

The results in *in vitro* DM digestibility (INVDMD) of the herbaceous plants varied considerable with seasons. INVDMD contents was significantly (P < 0.05) higher in the wet than in the dry season. In wet season the percentage INVDMD of the herbaceous plant was slightly higher in Kaloleni village (47.9 ± 1.5) followed by Matuli (47.4 ± 1.1) and Vigwaza (46.8 ± 1.2) villages. During the dry season Matuli village had higher percentage INVDMD (36.8 ± 1.1) compared to that of Kaloleni (33.6 ± 1.1) and Vigwaza village (32.6 ± 1.1). Therefore, Matuli village had more digestible herbaceous plant during the dry season as compared to other study villages. In wet season almost all villages had herbage of similar digestibility. However in wet season they were more digestible as compared to the dry season.

The mean proportion of INVOMD of the herbage in this study showed that there was significant difference (P<0.05) between seasons. In wet season Kaloleni village had higher percentage INVOMD of 51.7 ± 1.1 compared to Vigwaza village (50.6 ± 1.3) and

Matuli (47.4 ± 1.6). Similar trend was observed in dry season in all villages. Herbage in the wet season was observed to have significantly higher (P < 0.05) INVOMD as compared to dry season. There was a significant difference (P > 0.05) between seasons in terms of neutral detergent fibre. The neutral detergent fibre (NDF) of herbaceous plants in wet season was similar in all villages. Kaloleni village had lower percentage NDF (67.2 ± 1.1) compared to Matuli (71.5 ± 1.1) and Vigwaza (73.1 ± 1.1) villages during the dry season.

There was a significant difference (P < 0.05) in acid detergent lignin between seasons. Dry season forages had higher percentage ADL as compared to those of the wet season. Matuli village has higher percentage ADL content (10.5 ± 0.8) during dry season compared to other villages of Kaloleni (7.3 ± 0.8) and Vigwaza village (9.6 ± 0.8).

The Acid detergent fibre (ADF) of the herbage was significantly different (P < 0.05) between seasons. The herbaceous plant fibre content was higher in dry season than in wet season. In the dry season, the herbaceous plants of Kaloleni village had higher percentage fibre content of 46.5 ± 0.7 compared to Vigwaza (45.7 ± 0.7) and Matuli villages (42.3 ± 0.72). In wet season the percentage fibre contents of the herbages were similar in all study villages, (i.e. 25.6 ± 1.5 in Kaloleni village, 25.6 ± 1.0 in Matuli village and 25.9 ± 1.2 in Vigwaza village).

There was no significant difference (P > 0.05) between seasons and villages in terms of Calcium and Phosphorous content. Calcium content ranged from 0.22 ± 0.01% in Kaloleni village to 0.25 ± 0.01% at Vigwaza during dry season, while in wet season calcium content ranged from 0.24 ± 0.01% in Matuli village to 0.26 ± 0.01% in Vigwaza village. Phosphorous content of herbaceous plants during the wet season ranged from

0.17 ± 0.01% in Matuli village to 0.22 ± 0.02% at Vigwaza village. In dry season Phosphorous content ranged from 0.16 ± 0.01% at Kaloleni village to 0.22 ± 0.02% in Vigwaza village. Generally, Kaloleni village had herbaceous plants of lower calcium content as compared to other study villages.

4.7.2 Chemical composition of dominant browse tree/shrubs foliage and grasses.

The chemical composition of dominant browse and grass species are summarized in Table 11. The comparison of the five major browse plant species (*Acacia polyacantha*, *Combretum molle*, *Dichrostachys cinerea*, *Pterocarpus angolensis and Acacia tortilis)* and three grasses species (*Eragrostis superba*, *Panicum maximum* and *Urochloa mosambiensis)* during dry season indicated that there is difference in nutrient concentration between the species.

The mean proportion of DM and NDF contents in grass species was significantly ($P < 0.05$) higher than that of browse plant species. Similarly, the mean proportion of *in vitro* dry matter digestibility and crude protein content in browse plant species was significantly ($P < 0.05$) higher than that of grass plant species. Mean Calcium and Phosphorous contents of browse plant species was significantly ($P < 0.05$) higher than those of the grass species.

Table 11: Least Square mean of chemical composition and in vitro digestibility of some dominant browse and grass plant species in the study grazing areas during the dry season

VR	Ap	C m	Dc	Pa	At	ES	PM	UR
% Dm	51±0.8[b]	47±0.4[b]	49±0.3[b]	48±0.15[b]	48.9±0.6[b]	92.5±1.5[a]	90.8±1.4[a]	91.9±3.26[a]
CP	18±0.3[a]	9.8±0.6 [b]	16±0.9[a]	15.1±0.3[b]	14.32 ±0.1[b]	2.67±0.7[c]	6.2±0.95 [c]	4.73±0.32 [c]
NDF	47±0.5 [b]	46±0.6[b]	49.±0.1[b]	47.2±1.0 [a]	45.7±2.3[b]	68.67±13.1[a]	70±2.26[a]	66.7±30[a]
ADF	24±0.4 [b]	20±0.1[b]	32±0.4[b]	23±19 [b]	13.4±0.3[bd]	43.67±6.7[ba]	38.13±2.53[ba]	44.00±1.7[ba]
INVDMD	59±1.01[a]	41±1.5[b]	40±34[b]	48±2.01[b]	60.3±0.45[be]	32.77±3.5[bc]	38.67±2.5[bc]	39.90±7.04[bc]
Ca	1.2±0.1 [b]	1.3±0.3[b]	0.89±0.1[b]	1.4±0.2[b]	1.2±0.12[b]	0.24±0.05[b]	0.33±0.06[b]	0.35±0.05[b]
P	0.8±01 [a]	0.5±0.3 [b]	0.4±0.2 [b]	0.7±0.4[a]	0.6±0.2[b]	0.40±0.4[b]	0.21±0.01[b]	0.20±0.10[b]

Note: *Means with the different superscript along the same row are significantly different at (P < 0.05), Ap = Acacia polyacantha, Cm = Combretum molle, Dc = Dichrostachys cinerea, Pa = Pterocarpus angolensis, A t= Acacia tortilis, DM = dry matter, CP = Crude protein, DF = Neutral detergent fiber, ADF = Acid detergent fiber, INV= in vitro dry matter digestibility, ES = Eragrostis superba, PM = Panicum maximum, UR = Urochloa mosambiensis, Ca = calcium, and P = Phosphorous*

CHAPTER FIVE

5.0 DISCUSSION

5.1 Vegetative Ground Cover and Contribution of Individual Grass Species to Ground Cover and DM Yield

5.1.1 Vegetative ground cover

The result from this study revealed that there was a relative low vegetative cover in the grazing sites during the dry season. The reasons are due to the high grazing pressure and low soil fertility of the grazing areas as indicated from soil chemical analysis. High livestock population in the study villages resulted into overgrazing which led into high percentage of bare soil and increased tree density, as well as low dry matter yield of herbaceous species in the study villages.

Vigwaza village had a grazing land of 118.8 ha which accommodate livestock population of 4000 cattle, 2500 goats and 1050 sheep. It had also a mean tree density of 2308 tree/ha which was higher as compared to the other two villages. Matuli village had grazing area of 1000 ha which accommodated a livestock population of 1850 cattle, 800 goats and 500 sheep and had tree density of 1312 tree/ha. Kaloleni village had a communal grazing land of 5010 ha which accommodated a livestock population of 15 805 cattle, 2015 goats and 3060 sheep and a mean tree density of 1026 tree/ha. The higher livestock population reported in relation to the available grazing land resulted into high percentage of the bare ground soil. The condition can be interpreted as a typical signs of overgrazing which resulted to relative low dry matter yield during the dry season.

In similar way Herlocker (1999) reported that overgrazing reduces ground cover, plant height, forage quality and productivity. Also changes are induced in the dominant growth forms of herbaceous plants as tall perennial bunch grass species that gives way to shorter rhizomatous and stoloniferous perennial grasses which are replaced by annual grass and forbs species. Moreover, overgrazing tends to reduce perennial grassland vegetation types and allow invasion by annual forbs and grasses and shrubs (Holechek *et al.,* 1995).

Bharahenda (2001) on his study on feed resource assessment, knowledge and practices under a traditional ruminant production system in semi-arid areas of Tanzania, at Gairo division in Kilosa district reported the mean vegetative cover of 27.1% in dry season. The study findings also implies that drought and overgrazing over a long period of time might have been the main factors that caused decline in the botanical composition of plant species.

5.1.2 The contribution of individual grass species in vegetative ground cover and DM yield

The results showed that the contribution differs from one grazing site to the other both in dry and wet season. Grass species such as *Urochloa*, *Panicum*, *Eragrostis* and *Hyperrenia* species contributed heavily both to the total ground vegetative cover and yield in dry and wet seasons. Vegetative covers in Kaloleni and Vigwaza grazing areas were heavily contributed by *Urochloa* and *Panicum* grass species. Frequent burning practices of forage by charcoal makers during the dry season made favourable condition for these grass species seeds to germinate very quickly as their seeds were scarified by fire. More over their stools have growing points which are better protected from fire and tend to sprout earlier after burning.

The dry matter yield in the wet season was significantly higher than that of dry season. The findings concurs with those reported by Maskini (2000) who found forage yield in dry and wet season to range from 896 to 2790 kg DM/ha and 1872 to 3520 kg DM/ha respectively in the Ngorongoro Conservation Area. The result also was in agreement with the findings reported by Kimambo (2002) who conducted research at Mikumi National Park during the wet season and found that the dry matter yield ranged from 2869 Kg DM/ha to 4909 Kg DM/ha. Kakengi (1998) in his study conducted in Shinyanga, reported similar results. The author found dry matter yields ranging from 0.32tonnes/ha to 1.97 tonnes/ha during the dry season. However, contrasting results were reported by (Otysina *et al.,* 1995) who reported higher forage dry matter yields during the dry season (1.5 tonnes/ha) from conserved fodder banks in Shinyanga. The possible reason for this difference could be that, forage in Shinyanga fodder banks were over sown with leguminous plant species while communal grazing areas of Chalinze division, were not over sown with pasture species.

5.2 Botanical Composition and Vegetation Structure

5.2.1 Botanical composition of tree plant species

The result revealed that *Acacia* species was the most dominant tree species in all grazing areas of the study villages. The woody vegetations serve as most important sources of supplementary feed to the grazing ruminant animals in shortage of herbaceous plants during the dry season. Mtengeti and Mhelela (2006) reported that most of the browse plants had several other uses. In general the ranking of the browse species by livestock keepers was close to the preference by local goats.

According to livestock keeper's views, woody vegetations were mostly valued as livestock feed source during the dry season when there was shortage of forage and water. About 57% of livestock keepers reported that *Pterocarpus angolensis* and *Acacia polyacantha* were the most important fodder trees to young ruminant stock during dry season. The scientific test in acceptability in this study showed that; these multipurpose trees were highly preferred by goats and scored higher percentage of acceptance by goats.

5.2.2 Canopy area, tree density and height in different grazing sites of the study villages

There were significant differences in tree canopy size between the villages and Kaloleni village had significantly higher ($P < 0.05$) woody canopy area (6.6 m^2 / tree). Matuli and Vigwaza villages were not significant different in terms of woody canopy areas (2.4 and 2.1 m/tree respectively). High canopy prevent understory plant growth. According to Kuchar (1995) tree canopy that covers more than 50% of the sunlight will shade out most understory plants rendering the site unproductive for grazing while decreasing the amount of forest canopy cover to less than 50% results in a proportional increase in forage production. Kaloleni village had significantly taller ($P < 0.05$) trees (7.56 m / tree) as compared to other study villages. However, there were no significant differences between Matuli and Vigwaza villages in terms of tree height which had mean tree height of 3.5m/tree each.

Generally canopy cover area and tree height in grazing sites were found to be significantly higher ($P < 0.05$) in Kaloleni village compared to other study villages. However, there was no effect on growth of understory herbage plant species due to the fact that the canopy cover observed were less than 50% of the grazing area so sun light was enough for the understory forage hence make them to establish well.

Though the tree density was higher in Vigwaza grazing areas still there was no effect on fodder availability due to the fact that the tree size were in affordable height for browsing by livestock and thus not too shady to reduce undergrowth. Cutting practices of woody plants by livestock keepers to feed animals during dry season might have contributed to lower canopy cover and tree height in Matuli and Vigwaza villages. Large number and high concentration of livestock potentially favors woody plants in numerous ways.

Among the major resisting behaviors of woody species that increase in grazing areas are high seed production, deeper and strong roots, the ability to disperse their seeds over long distances, the ability to sprout following top removal, also to spread by sprouting roots much as *D. cenera*, tolerance to low levels of water and nutrients and low palatability (Archer, 1989). Hence, the browsable heights of these different browse tree species in the grazing areas could make more favorable for browsing animals such as goats and maintain the balance between the woody and herbaceous species.

This Study suggested that integrating grazers and browser having different feeding habitats enables more efficient use of vegetations. Taylor (1985) reported that when cattle were replaced by goats and/or sheep, individual cattle performance increased because forage demand for the grass component was reduced due to lower grazing pressure. Again, diversification of herds through increasing the number of browsers enhances efficient resource utilization and decreases woody plant encroachments (Gemedo, 2004).

The woody plants are useful feed resources during the dry season and multipurpose trees have multiple uses that sometimes result into resource use conflicts. The conflicts occur between pastoralists and charcoal producers because the trees are also valued for good quality charcoal. Therefore, the livestock keepers gave more protections for the trees against destruction. These showed the fact that woody plants are of higher significance as sources of livestock feed in the study villages. The woody species importance as source of food, fodder, fuel, wood, medicine, fiber and gums has been reported by Herlocker *et al.*

(1999). Generally the canopy cover, tree height and tree density did not have an effect on dry matter yield and stocking rate. This concurs with the criteria described by Kuchar (1995).

5.2.3 Botanical composition of weed plant species

The grazing areas of the study villages were heavily invaded by weed plants species. The most frequently occurring invader plant species were; *Amaranthas, Cyperus, Oxigonum, Solanum*, and *Sida* species. The condition might be contributed by overgrazing of the communal grazing areas. Gartner (1976) reported that when the grazing areas are excessively overused, usually invaders or undesirable plants increase. The invader plants were found to be absent in the original vegetation, but with increasing grazing pressure, they replaced the decreaser and increaser plants. In favourable years, invaders can provide considerable forage for a short period of time, but sound range management cannot be based on this uncertain forage production.

The four classes of range condition are based on percentage of the production of the decreasers and increasers when compared to the original vegetation. A site composed of decreasers and increasers indicates high range condition value. Replacement of decreasers on the site with increasers and invaders means that the site needs improvement. This probably indicates over utilization levels of desirable species in the grazing sites.

However, Skerman and Riveros (1990) reported invader species to grow well in soils of poor structure, low in lime, phosphorous and potash. It is also adapted to loose sandy soils, alluvial silts, and a wide range of other soils. The number of species generally varied within and between grazing sites and villages. This might be contributed by grazing pattern. The proportions of desirable and undesirable species of grasses increased when compared to the proportion of the species identified as highly desirable which were observed in low frequency during dry and wet season. This might be due to the gradual disappearance of desirable species through overuse and disturbance by livestock and human beings.

The major factors that caused decline in the abundance of desirable species were drought, overgrazing and human being disturbance. In similar way, Herlocker (1999) suggested that overgrazing reduces ground cover, plant height, forage quality and productivity, and changes are induced in the dominant growth forms of herbaceous plants as tall perennial bunch grass species give away to shorter rhizomatous and sotoloniferous 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 (Holechek *et al.*, 1995). Bharahenda (2001) observed similar results in Gairo division in Kilosa district, that most of palatable herbaceous species were over utilized during the dry season.

5.2.4 Botanical composition of legume plant species

There were few leguminous plants species found in the study villages. The legume plant species with higher frequency in the grazing areas were; *Rynchosia, Crotalaria* and *Neorautanenia* species. According to the respondents, the leguminous plant species are among the highly desirable species which were highly preferred by the animals. The reduction in the proportion of highly desirable species might be due to their gradual disappearance through overuse and disturbance by livestock and human beings. The results were in agreement with those of Hovel (1996) who reported that highly desirable species were highly palatable and preferred by livestock which resulted into decline in number with increasing grazing pressure.

5.3 Soil Properties

The results revealed that Matuli grazing areas had soils with relative higher bulk density, pH, Silt, Clay, Organic carbon, nitrogen, calcium, magnesium and sodium content as compared to other villages grazing area. The soils of Kaloleni grazing areas were significantly higher ($P < 0.05$) in potassium, cation exchange capacity and pH value of 6.71, while soils in grazing areas of Vigwaza, were richer in Phosphorous and sandy percentage and with pH value of 6.07. These soils are related to the forage dry matter yield produced by these grazing areas. Matuli grazing areas had higher dry matter yield as compared to other grazing areas.

Redmann (2001) reported that soils with high adequate amounts of soil nutrients produce forage with high nutritive values. The findings observed in this study are in agreement with that reported by Kidunda (1996) who noted that tropical rangeland soils are deficient in phosphorous and nitrogen. Soil which had relatively higher nitrogen content like that of grazing areas of Matuli and Kaloleni villages were found to have forage of higher crude protein content in both seasons compared to other grazing areas of the study villages although it was below the critical level required. There was a strong relationship between nutrients found in the soil and those found in the forage.

5.4 Stocking Rate Estimation of the Grazing Areas

The grazing areas of Vigwaza village had lower stocking rate as compared to other grazing areas. This might be contributed by small area of grazing land as compared to higher number of livestock. Stocking rate was greatly affected by season. Higher stocking rate was observed during the wet season as compared to the dry season. This agrees with the report by Kidunda (1996) that tropical herbage available for grazing ruminants fluctuates with season. There was a strong relationship between stocking rate and the dry matter yield of the grazing area. The grazing areas of Matuli village and that of Kaloleni village were found to have relative higher dry matter yields as compared to Vigwaza grazing areas which resulted into relative high stocking capacity. Tacheba and Mphinyane (1989) working in eastern Botswana indicated that 6-8 ha/LSU was appropriate stocking rate on rangeland under good condition and on degraded rangeland stocking rate needed was 12 ha/LSU following two to three years of complete rest.

The type and distribution of tropical grasslands are largely determined by climate and its interaction with soil properties. High yield of forage occurs in the areas with high rainfall and where soil moisture is not a limiting factor (Crowder and Chheda, 1982). Kidunda (1996) observed that increased stocking rate had a negative effect in availability and consequent forage intake resulting in increased body weight fluctuations. Therefore, correct stocking rate is important for the perpetuation of the range, well being of the animals and economic stability of the producer. Gammon (1984) noted important principles of rangeland management as appropriate stocking rate, and rest and the frequency of grazing.

In communally grazed rangelands, high stocking rates, few rest periods and frequent close grazing, and fire are factors that weaken the rangelands. Seasonal fluctuations of feed resources in the tropics follow the pattern of vegetation growth that is affected by the availability of rainfall. This resulted in a seasonal pattern of wet season gain and dry season loss of live weight. Seasonal fluctuations in the availability and the poor quality of feeds are considered to be the main constraints on sheep production in arid regions (Guada, 1989).

5.5 Dry Matter Content of the Herbage in Different Grazing Sites

The lowest dry matter content of the herbage was experienced in Matuli grazing areas. The reason leading to a low DM content might be due to high moisture content in the soil that made the herbage to be succulent throughout the year. The dry matter content of the herbage was in agreement with those reported by Bharahenda (2001) who found dry matter content ranging from 89.02% in Rubeho village to 92.2% in Kitaita villages in Gairo division. Kimambo (2002) reported similar results of DM content ranging from 32.69 ± 2% in the savanna zone in Mikumi National Park, Morogoro during the wet season while Manangwa (2003) reported the DM content of 45.28% in ecotone and shrub zone in Mikumi National Park.

5.6 Chemical Compositions of the Natural Forages in Different Grazing Sites

5.6.1 Crude protein in different grazing sites

The mean CP content of the herbage in the grazing areas during wet season was 6.57%. The grazing areas of Matuli village had herbage with relative as higher crude protein content of 6.7% as compared to other grazing areas during the wet season. However during the dry season the mean CP content of the herbage was 4.0%. Very low CP content was recorded in Kaloleni grazing areas which recorded 3.3%. The higher CP content in the grazing areas of Matuli village could probably be attributed by the higher moisture content and relative higher nitrogen content of the soils compared to other grazing sites.

In this study results in CP contents during the dry season were in agreement with those reported by Gohl (1981) who observed crude protein to be 2.7% in *Dicanthium annalatum*, 3.5% in *Heteropogon contortus*, and 4.4% in *Themeda triandra* at mature stages of growth. Amina and Cheni (1989) reported that tropical pastures have CP contents ranging from 3.0 to 8% for grasses and 5.6 to 30% for legumes. Result of this study was also in agreement with those of Kimambo (2002) who observed a crude protein contents ranging from 4.8 to 6.7% in Mikumi National Park and Bharahenda (2001) who found the CP content of the herbage during wet season ranged from 6.4 to 9.6% in Gairo division and Manangwa (2003) who reported the CP content ranged from 4.61 to 5.6% during wet season in her study at Mikumi National Park. Similar observation were reported by (Gohl, 1981) who found higher protein content of 6.9% in *Themeda triandra* and 12.9% in *Sporobolus hevous* during the wet season. The disparity might be accounted by the differences in soils, ecological zones, climatic factors, species difference and the stage when the forage was harvested.

Generally CP content for both wet and dry seasons reported in this study were insufficient to nutrient requirement of grazing ruminants. For proper functioning of rumen microbes a minimum crude protein of 70-80 g/Kg DM is required (Mc Dowel, 1972; Van Soest, 1994). Based on the CP content of the forage in this study, they were far below the minimum requirements of rumen microbes in the dry season. Lannell (1984) observed that feed with CP lower than 6% were found to reduce digestibility and consequently affect animal performance. Thus, incorporation of suitable legumes into the natural grasslands is important for improvement of the nutritive values.

5.6.2 Neutral detergent fibre of the herbage in different grazing sites

The results of this study showed that wet season herbage had low NDF content in all grazing areas of the study villages compared to that of dry season. The reason for lower NDF might be attributed by low proportion of the stem to leaf during the wet season. This reflects the degree of cell wall build up with maturity in the dry season. Results reported in this study support the results reported by Kakengi (1998) who found NDF ranging from 512 g/DM at Kambarage village to 762 g/DM for Ndala village in Shinyanga grazing lands. The results are also in agreement with those reported by Bharahenda (2001) who found NDF ranging from 50.5 to 81% in Gairo division during the wet season. However, Kimambo (2002) observed different results at Mikumi National Park especially during the wet season. The observed difference could probably be attributed to species differences and stage of growth when herbage was harvested. Advancing maturity is accompanied by increase in dry matter that is reflected in the increase in cell wall content and a decrease in cell contents (Crowder and Chheda, 1982; Van Soest, 1994).

5.6.3 Acid detergent fibre of the herbage in different grazing sites

The lower ADF content during wet season could be attributed to high levels of the cell soluble content e.g. CP and Phosphorous, which declines during the dry season. Thus, plants are more nutritious during the wet season than in the dry season.

These results are similar to those reported by Bharahenda (2001) who found ADF content ranging from 21.42% in Nguyami village and 23.79% at Rubeho in Gairo division during the wet season. The result are in agreement with the result observed by Manangwa (2003) who observed that the ADF was 25 ± 0.75% in the grassland zone and 27.78 ± 0.84% in the ecotone zone during the wet season. The results of this study are also in agreement with those reported by McDonald *et al*. (1985) who found ADF of 452 g/Kg DM, for poor quality grass hay.

5.6.4 Acid detergent lignin of the herbage of different range sites

The result of this study shows that there was no significance difference ($P > 0.05$) in ADL in the grazing areas in both seasons. Matuli grazing areas had relative higher ADL compared to other study village grazing areas. The results of this study was in support of the results reported by Kimambo (2002) who found lignin content of herbage ranging from 3.23% in the ecotone zone to 4.65% in the shrub land zone in Mikumi National Park during the wet season.

Nearly the same results were also reported by Asfaw (2000) who found ADL of 6.64% during the wet season in Shinyanga. Similarly Van Soest (1994) reported that ADL range of 60 to 80 g/Kg for hay grass. Higher NDF, ADF, and ADL content obtained in this study had negative implication on nutritive value of the forage. Increase in plant structural carbohydrate and lignin was found to depress digestibility (Van Soest, 1994). Rapid plant physiological growth exhibited in tropical countries results on rapid maturation, which is characterized, by synthesis and accumulation of highly lignified tissues (Butterworth, 1985).

5.6.5 In vitro dry matter digestibility of herbaceous plants at different grazing sites

In wet season all villages had similar digestibility. Wet season herbage was more digestible than those of the dry season. The higher digestible herbage in Kaloleni and Matuli grazing areas was probably attributed to high crude protein content in the herbage. The results of soil test revealed that the grazing sites of Matuli village had relative higher nitrogen content than other grazing areas of the study village.

Generally, seasons were found to have a significant effect on the digestibility of the herbage. Kidunda (1996) reported variation of nutritional quality of pasture within seasons. The author found that forage plants are more nutritious during the wet season than the dry season. Crowder and Chheda (1982) found that low CP in animal feeds interferes with microbial activity in the rumen, which causes an incomplete utilization of structural carbohydrate and slow rate of passage of the digesta leading to reduced forage digestibility and voluntary intake.

Skerman and Rivores (1990) reported that tropical grasses have dry matter digestibility ranging from 30% to 75%. The results was in agreement with those reported by Asfaw (2000) who observed that IVDMD of 23.15% during the dry season and 41.99% during the wet season in Shinyanga. The results also were in agreement with that noted by Bharahenda (2001) who found IVDMD ranging from 36.8% in Misingisi village to 45.7% in Kitaita village during the dry season. During the wet season it ranged from 39.24% in misingisi village to 52.7% in kitaita village in Gairo division. Kimambo (2002) reported contrasting results during the wet season in Mikumi National Park. The author found IVDMD ranging from 24 ±1% in the grassland zone to 39.1% in the ecotone zone. This difference was probably caused by the difference in cellulose content and the stage when the forage was harvested.

5.6.6 The chemical composition of dominant browse species and most dominant grass species

The comparisons of five major browse species i.e. *Acacia polyacantha*, *Combretum molle*, *Dichrostachys cinerea*, *Pterocarpus angolensis*, *Acacia tortilis* and three most dominant grass spp, *Eragrostis superb*, *Panicum maximum* and *Urochloa mosambiensis* in nutrient content during dry season indicated that there were differences in nutrient contents between the species. The mean proportion of DM and NDF contents in grass species were significantly ($P < 0.05$) larger than the mean in browsers plant species leaves. Similarly, the mean proportion of in vitro dry matter digestibility and crude protein in browser plant species was significantly ($P < 0.05$) higher than that of grass species and vice versa.

The mean proportion of the Calcium and Phosphorous contents of browsers plant species leaves were significantly ($P < 0.05$) higher than the mean proportion of the grass species. Normally the differences in nutrient content between and within the species types could be associated with the inherent nature of the species. In other words, the fodder trees leaves contain more protein content than grass species. Of course, there could be morphological and anatomical differences within the same species. Van Soest (1994) observed that most grasses and tree leaves in tropical environments are low in nutritive values mainly because of the high contents of lignin and relatively high indigestible cellulose and hemi-cellulose.

Generally range forage varies in quality from time to time and from place to place. It is during the growth stages that plants are most nutritious. Once mature, plants are subjected to leaching and dilution of nutrients. Reduction in the nutritional values, declines in nutrient composition and leaching are especially serious in the case of herbaceous plants (Kidunda, 1996). As plants mature, crude protein, the more readily digested carbohydrates, and phosphorus decrease. In contrast, fiber, lignin and cellulose increase (Stoddart *et al*., 1975).

Most grasses and tree leaves in arid environments are low in nutritional values because of high contents of lignin and relatively indigestible cellulose and hemi-cellulose because of encrustation by lignin. The plants require such substances to protect themselves from herbivores grazing and browsing activities. Unfortunately, they lower their nutritional contents and digestibility (Bharahenda, 2001). The stage of growth and maturity of grasses in general and taste influence the nutritional values of these sources of feed.

CHAPTER SIX

6.0 CONCLUSIONS AND RECOMMENDATIONS

6.1 Conclusions

i. The results of this study are in agreement with the proposed null hypothesis which hypothesised that grazing land condition differs between villages and season.

ii. The results of this study revealed that the range condition differs significantly ($P<0.05$) with respect to soil properties, botanical composition, yield and woody plant species density both in villages and grazing areas.

iii. Generally the condition of communal grazing areas is declining due to increased number of ruminant livestock resulted into over grazing. Therefore, should be revamped through rangeland rehabilitation, proper management and delineation of the natural grazing lands.

6.2 Recommendations

i. The principles of rangeland management in the study villages were scantly adhered. Provision of integrated extension services regarding rangeland resources management and training on basic principles of forage establishments, conservation, storage, proper grazing pattern systems and amounts of supplementation of the feed resources should be made.

ii. The observed useful herbaceous leguminous plant species in this study were few. Attention should therefore be given to improve the legume and grass mixtures in the district through introducing legume species that are appropriate to the area and through putting in place effective grazing management.

iii. 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 of these grazing areas.

iv. Attention should be given to conservation and development of the fodder species like *Pterocarpus angolensis* and *Acacia polyacantha* due to their sensitivity in providing feed resource during the dry season.

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

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APPENDICES

Appendix 1: Criteria for scoring of the different factors determining range conditions

Parameters	Value	Total point	*Description*
Hedging	3	5	Highly palatable and palatable shrubs share dominance Most hedge able plants are lightly to moderately hedged Few or no decadent plants.
	2	3	Palatable plants dominant. Hedge able plants moderately to Heavily hedged. Some shrubs decadent due to hedging.
	1	2	Palatable and less palatable plants dominant. Hedge able plants heavily to very heavily hedged. Considerable numbers of decadents' shrubs present. Some may be dead due to hedging.
	0	1	Less palatable and unpalatable shrubs dominant. Some normally un hedge able shrubs are hedged. Hedge able shrubs very heavily hedged the crowns often reduced to:
Canopy cover	3	5	>45%cover
	2	4	36-45%cover
	1.5	3	26-35%
	1	2	15-25%
	0	1	<15%cover
Density		5	0-1000/h
		4	>1000-2000/ha
		3	>2000-3000/ha
		2	>3000- 4000/ha
		1	>4000/ha

Source: Kuchar (1995)

Appendix 2: Woody plant species and their acceptability by goats in the study villages

		Total weight offered to the experimental goats, in 1000g/goat/20min/day														
		Kaloleni					Matuli					Vigwaza				
		G1	G2	G3	G4	G5	G1	G2	G3	G4	G5	G1	G2	G3	G4	G5
		Ap	Cm	D c	Pa	At	Ap	Cm	Dc	Pa	At	Ap	Cm	D c	Pa	At
	Acacia polyacantha	200					120					64				
	Combretum molle		300					453					342			
Day 1	*Dichrostachys cinerea*			400					432					321		
	P. angolensis				100					67					28	
	Acacia tortili					200					768					450
		Cm	D c	Pa	At	Ap	Cm	Dc	Pa	At	Ap	Cm	Dc	Pa	At	Ap
	Combretum molle	300					333					457				
	Dichrostachys cinerea		400					643					378			
Day 2	*P. angolensis*			500					74					87		
	Acacia tortilis				200					245					293	
	Acacia polyacantha					650					33					321
		Dc	Pa	At	Ap	Cm	Dc	Pa	At	Ap	Cm	Dc	Pa	At	Ap	Cm
	Dichrostachys cinerea	550					457					543				
	P. angolensis		368					130					95			
Day 3	*Acacia tortilis*			98					216					432		
	Acacia polyacantha				180					123					569	
	Combretum molle					112					127					187
		Pa	At	Ap	Cm	Dc	Pa	At	Ap	Cm	Dc	Pa	At	Ap	Cm	Dc
	P. angolensis	30					75					12				
	Acacia tortilis		245					212					431			

		Total weight offered to the experimental goats, in 1000g/goat/20min/day																
		Kaloleni					Matuli					Vigwaza						
Day 4	*Acacia polyacantha*			352					37					345				
	Combretum molle				542					367					674			
	Dichrostachys cinerea					652					468					392		
		At	Ap	Cm	Dc	Pa	At	Ap	Cm	Dc	Pa	At	Ap	Cm	Dc	Pa		
	Acacia tortilis	255					76					532						
	Acacia polyacantha		350					68					782					
Day 5	*Combretum molle*			320					214					563				
	Dichrostachys cinerea				675					312					231			
	P. angolensis					45					95					61		
		Total weight of twigs and leaves remaining after feeding, (in g/goat/day)																
		Kaloleni					Matuli					Vigwaza						
Ranks		G1	G2	G3	G4	G5	G1	G2	G3	G4	G5	G1	G2	G3	G4	G5	Total	%
2	*Acacia polyacantha*	200	650	180	352	350	120	33	123	37	68	64	321	569	431	782	4280	28.5
4	*Combretum molle*	300	300	112	542	320	453	333	127	367	214	342	457	187	674	563	5291	35.2
5	*Dichrostachys cinerea*	400	400	550	652	675	432	643	457	468	312	432	378	543	392	231	6965	46.4
1	*P.angolensis*	100	68	500	100	45	67	74	130	75	95	28	87	95	12	61	1537	10.2
3	*Acacia tortili*	200	200	98	245	255	768	245	216	212	76	450	293	432	431	532	4653	31.0

Whereby; G1, G2, G3, G4, and G5= Goat number 1,2,3,4, and 5. At=*Acacia tortilis*, AP= *Acacia polyacantha*, Cm= *Combretum molle*, D m=*Dalbergia melanoxylon* and Pt= *Pterocarpus angolensi*