KWAME NKRUMAH UNIVERSITY OF SCIENCE ANDTECHNOLOGY, KUMASI

COLLEGE OF SCIENCE

DEPARTMENT OF THEORETICAL AND APPLIED BIOLOGY

THE IMPACT OF GRAZING ON RANGELAND ECOSYSTEM: A STUDY OF THE CHANGE OF THE GUINEA SAVANNA VEGETATION IN THE TOLON-KUMBUNGU DISTRICT IN THE NORTHERN REGION

By

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A thesis submitted to the Department of Theoretical and Applied Biology in partial fulfillment of the requirement of the Degree of Master of Science (Environmental science)

By

Nyamekye Edward K. Prosper

September 2010

DECLARATION

CANDIDATES DECLARATION

I hereby declare that this project work is the result of my own efforts and that no part of it has been presented for another certificate in this university or elsewhere.

………………………………………….. ………………………

Candidate's Signature Date

SUPERVISOR'SDECLARATION

I hereby declare that his preparation and presentation of this project work was supervised in accordance with the guidelines on supervision of project work laid down by the Kwame NkrumahUniversity of Science and Technology – Kumasi.

....

Supervisor's Signature Date

(Prof. K. Yeboah - Gyan)

……………………………. …………………………

Head of Department Date

(Dr. Philip K. Baidoo)

DEDICATION

This work is dedicated to my wife Mrs. Priscilla Nyamekye, my children Raymond Nana Nyamekye, Kelvin Nyamekye, Desmond Nyamekye and Rosmond Nyamekye, my cousin Mr. Michael Boamey, my parents as well my brothers and sisters, for their support, contributions and prayers.

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ABSTRACT

Factors such as rapid increases in population growth, the desire on the part of government to confine and sedentrarize nomads which discourages free movement of people and livestock are rapidly reducing the proportion of climax woody species in savanna vegetation. This situation sets the succession to begin at the serial stage, sometimes dominated by invasive weeds. These plants are not palatable to grazing animals and their prevalence in an area, may therefore affect the use of the area for grazing.

A study was conducted in an area commonly known as the Jaagbo grove cluster of villages near Tolon, the administrative capital of the Tolon-Kumbungu District of the Northern Region. The vegetation of the area is Guinea Savanna. The aim of the study was to determine the impact of using the Guinea Savanna for grazing. The study consisted of field and questionnaire surveys. The study area (the experimental area) was used for grazing domestic animals including cattle. The control was an area which has been designated as fetish grove and has been protected from all forms of exploitation over the years. The two areas were adjacent to each other. In each area an area of $640m^2$ was delimited and divided into 64 square plots, within each of which four $5m^2$ quadrats were randomly placed. In each quadrat the relative abundance of the various plant species was quantified. The environmental data were also collected to correspond with each quadrat.

In the questionnaire survey the local knowledge of the field study clearly revealed that grazing has had a lot of influence on the vegetating of the area. Whereas the vegetation of the control area was a typical Guinea Savanna type with a greater proportion of the vegetation being tree species, the experimental area vegetation was predominantly grasses.

It was also observed that some tree species such as *combretum molle*, *Gardeniaerubescens, Mitragyna enermis* and *Bombax* which were common in the control area had disappeared in the experimental area. Almost all the plant species identified as weeds were found mostly in the experimental area, which was also relatively poor in nutrient status. The respondents in the questionnaire survey were however, of the view that bush fires are the major cause of change in the vegetation of the area.

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the project

Rangeland is a type of land that supports different vegetation types including shrub-land such as deserts, grass lands, steppes, wood lands, and temporarily treeless areas in forests. Rangeland vegetation may be naturally stable, temporarily derived from other types of vegetation, especially following fire, timber harvest, bush clearing or abandonment from cultivation (Harold and Denis, 1994).

Savannas represent a type of grassland found in the tropics. It is a term applied to a range of vegetation types consisting predominantly of grasses but also varying in amount of forb (Alhassan *et al*., 1993). Greater parts of West Africa (about 2/3) are covered by savanna vegetation (Alhassan and Barnes, 1993). In Ghana two of the three savanna types are represented: these are Guinea savanna and Sudan savanna. The Guinea savanna, which occupies 148, 542km^{2}consists mostly of broad-leafed trees some of which are found in the forest. It is relatively moist with rainfall of between 1500 and 900mm/year, nearly all of which falls from 7-8 months of the year.

The Sudan savanna vegetation zone lies north of the guinea savanna and covers a greater part of Burkina-Faso and Mali. In Ghana the Sudan savanna is limited to Navorongo Bolgatanga Bawku corridor. It covers an area of about 1955m^2 and has an approximate annual rainfall of about 600-900mm, but in spite of this the area endures a severe and prolonged dry season of approximately 7 months, from October -April. The natural vegetation here is characterized by short grasses, interspersed with low-density woodland of draught and fire resistant tree species.

The savanna rangelands make at least 65.7% (156,000km) of Ghana's 238, 537km^2 land area and about 41% of the total land area occurs in the North, consisting of the three political regions, viz., Northern, Upper East and Upper West (World Bank, 1992, LPIU, 1997; NRI, 1996).

1.2Problem statement

The erratic national rainfall pattern, particularly around the guinea savanna ecological zone and as a result of several decades of abuse through over grazing, improper land clearing practices, bush fires, deforestation practices as well as the impact of invasive weeds, has given rise to a visible decline in the quantity and quality of rangeland forage and a consequent threat to the carrying capacity of such range.

Research conducted over the years in Ghana on rangelands are centered on aspects of overgrazing, bush fires, improper land use practices, etc, with very little regard on the impact of invasive weeds in the rangeland ecosystem.

Over grazing as indicated above reduces the proportion of climax woody species and sets the succession to begin at the seral stage, sometimes dominated by invasive weeds. These plants are normally not palatable to grazing animals. Their prevalence in an area, may therefore affect the use of the area for grazing.

Grazing animals affect plant communities in several interrelated ways including plant defoliation, nutrient removal and redistribution through excreta, and mechanical impacts on soil and plant material through trampling. However, grazing in most natural ecosystems is as much a part of the system as is the need for forage by grazing animals. Removal of grazing in such ecosystems often results in the development of plant communities greatly different from that which originally developed under grazing. Lack of grazing in a community that has evolved under grazing should thus be considered a disturbance factor.

Grazing by large herbivores in the short run often is of little importance in the process of vegetation change, unless grazing is so excessive that the grazed plants cannot restore themselves. The long-term effects of grazing will largely depend not only on the adaptation of the plant to local environmental factors but also on the relative effects of grazing on associated plants and plant species. Most plants can withstand some loss of foliage and still maintain their position in the plant community.

These and many more problems bedevil the savanna rangelands and attempts were made in this research to assess the level of damage in this ecological zone.

1.3 Main objective of the research

The main objective of the research was to assess the impact of grazing on the rangeland ecosystem around the Tolon-Kumbumgu District in the Northern Region.

1.4 Specific objectives

The specific objectives were:

(i) Identification of the floristic composition of the grazed and ungrazed rangelands.

(ii) Identification of relative abundance of the various plant species in the grazed and ungrazed areas.

(iii) Identification of the diversity and relative abundance of the invasive weeds in the grazed and ungrazed areas.

(v) The impact of the weed species on the rangeland ecosystem.

1.5 Significance of the project

The importance of this research to policy makers, range managers and farmers cannot be over emphasized. These benefits among others include:

(i) establish the state of knowledge on the savanna rangelands

(ii) provide information to assist policy decision for sustainable development of the savanna rangeland

(iii) propose rangeland improvement strategies

(iv) highlight gaps in the knowledge of productivity and management of savanna rangeland

(v) sensitize government and policy makers to critically take interest in the activities of alien herdsmen on Ghana's savanna rangelands

1.6 Scope of the Research

The study was focused on cattle farmers around the Jaagbo grove cluster of villages in the Tolon-Kumbungu District in the Northern Region of Ghana.

CHAPTER 2

2.0 LITERITURE REVIEW

2.1 Rangeland ecosystem

A report submitted by UNESCO and FAO to the Economic and Social Council of the United Nations in 1968 has stated that in many areas of the world, including both developed and developing nations, semi-arid grazing lands are being effectively destroyed at a rate that appears to be accelerating.

The report attributes this destruction to mismanagement of either domestic or wild animals, which results in over stocking, over grazing, destruction of the vegetation, loss of soil and interference with the hydrologic cycle.

According to Evans (1990) most grassland have evolved under the impact of grazing animals and the vegetation is as much in balance with their presence as it is with the climate, soil and other factors of the environment. In the absence of grazing different vegetation would prevail, in the same way that, in the presence of excessive grazing, the vegetation alters its general state and composition in a less desirable direction. Most if not all plants can tolerate some degree of animal use. Their response varies with the intensity, and timing of that use.

Range grasses usually have three periods in each year when they are most vulnerable to grazing pressure. The first is at the start of the growing season when the plant is dependent upon reserves of nutrients stored in the roots or root crown. Grazing of the newly sprouting vegetation can prevent the plant from establishing enough photosynthetic surface to manufacture the food materials it requires (Evans, 1990).

When resources are exhausted the plant will die. A second period is after the main growth of the year is completed, when the plant is developing and maturing to a seed crop. Use at this time can prevent seed from being set or cast and this endangers reproduction. A final period is at the end of the growing season when the plant is storing reserves for next year's growth. Heavy use of the grasses at any of these three stages is more likely to be injurious than at other times of the year, and various systems of rotational and deferred grazing have been devised to provide protection accordingly.

The growing buds of grasses are located near the base of the plant. Grazing of the top leafage is therefore seldom injurious, except the times noted above. Close grazing, however, which removes or exposes the growing tissues, is generally injurious. Nevertheless there are great differences in the ability of various species to withstand grazing. Grasses with an open, loose growth habit are more likely to be injured by grazing than a compact bunch or tussock type. Grasses which form a sod

(upper lowers of grassland including grass with its roots and earth), reproducing by rhizomes or stolons, can usually better withstand grazing than the taller gasses.

Certain types of grassland, dominated for example by sod – formers e.g. *Cynodon* or *Boutelova* in the presence of moderately heavy grazing disappear through replacement by other species in the absence of grazing.

Annual grasses, after their seeds are matured are not injured by any amount of grazing since they die back completely in any event. But conditions for the formation of seeds and growth of seedlings are improved if grazing is not too close and a cover of dry stems and litter is left on the ground.

Wild grazing animals, when on confined, are inclined to graze selectively and keep on the move, thus not exerting continuous pressure in any one area. A variety of different species of grazing animals for example as found in the savannas of East Africa will make use of a wide range of different plants, each species tending to have a different preference. The presence of a great number of wild species, each adapted to its own place in the savanna results in a relatively uniform use on the entire range of plants in the vegetation. Selective pressure thus does not favour the less desirable rangeland plants and range vegetation holds up well under what amounts to very heavy total grazing pressure. An equal number of any one species of grazing animal would do far more damage than the combination of many species.

Many wild species are adopted to go for long periods without drinking water, and in consequence, do not confine their use to areas within easy reach of watering points. *Eland*, *Oryx* and *addox* are three African species, which can occupy rangelands far removed from permanent water sources. By contrast, most domestic species need water much more regularly and their grazing is confined to areas that are not so far from watering points.

Traditional nomadic grazing of steppe and savanna lands was based on a grazing system that most closely resembled that of wild grazing animals. Nomads kept their animals on the move, permitting selective grazing, but usually not allowing a heavy concentration of animals to remain in any one place.

Although routes of movement were determined by the location of suitable watering points, livestock were not kept for prolonged periods in the vicinity of any one water hole. Local concentrations did not take place during the cold season of Mediterranean or Sub- tropical lands and the dry season in the tropics, but these were periods when the vegetation was less vulnerable to the affects of heavy grazing. In general therefore, nomadism was well adapted ecologically to the conditions prevailing in areas occupied by nomadic peoples.

The impact of development on such areas has tended to be unfavorable. Initially, the effects of introducing better provision for maintaining the health of people and animals removed constraints that had previously prevented great increases in numbers. The elimination of inter-tribal warfare removed another limitation to population growth. The desire on the part of governments to confine and sedentrarize nomads discourages free movement of peoples and their livestock and contribute to the concentration of grazing animals where they would be most likely to damage the vegetation on which they depended.

The education and training needed to permit the nomads to adopt to a different way of living has not accompanied the constraints on their former way of life. The result has been the semi-nomadic and sedentrarized patterns of land use, which contribute most strongly to the destruction of rangeland and the spread of deserts.

Rangelands represent an important resource in many countries around the world. About 30-40 million people in arid and semiarid regions have " animal-based'' economies (Stanford, 1983). Over 50% of these people live on the continent of Africa and they are commonly referred to as "pastoralists''. They derive most of their income and sustenance from livestock grazing in the arid and sub arid areas. In developing countries pastoralists are more dependent on rangelands than in other countries because there are seldom other employment opportunities such as industry (Stanford, 1983).

2.2 Invasive weeds.

Deway and Torel (1991) defined invasive weed as a plant that is extremely prolific, noxious, competitive, harmful and non-indigenous plant species.

Zimmerman (1976) also suggested that the term ‘‘invasive’’ should be used as a synthetic concept that implies a series of interrelated attributes common to that form of plant life. He believes that an invasive plant is a plant that colonizes disturbed habitats, is not a regular member of the original natural community of the geographical area in which it is found, is abundant at least locally, is noxious, destructive or troublesome and is economically of little value.

He argued that the process of invasion of an unoccupied region by a new species may be divided into the introduction phase, the colonization phase and the naturalization phase, where the species establishes new self-perpetuating populations, undergoes widespread dispersal and becomes incorporated within the resident flora.

Weed invasions began a few centuries ago but primarily in the mid- 1800's when seeds began to arrive from other countries without their natural enemies. Most of the weeds invading most rangeland of the United States originated in Europe and Asia. Many were introduced to western rangelands during the nineteenth century and are rapidly spreading (Roger *et al.*, 1997). Indigenous weeds do not normally pose many problems in their ecosystem of origin, because they evolved with natural controls such as insect predators, plant pathogens, fungi and other competing plants (Roger *et al.*, 1997).

Where intensive agriculture is practiced through out the world it is common for species not endemic to the region to be present as weeds (Salisbury, 1961). Agricultural practices are constantly changing, and new techniques are likely to affect the success of different weeds by affecting habitat characteristics and opportunities for dispersal. The introduction of seed cleaning is thought to have led to the virtual disappearance of *Agrostemma githago* in British cereal cropping (Salisbury, 1961). Again the introduction of reduced tillage system and the reduction of crop rotation have allowed species with little dormancy, such as *Bromus sterilis* to persist and become major problem (Froud-Wulliams, 1983).

Weeds prefer highly disturbed sites such as rivers, stream banks, and roadsides, building sites, trails wildlife bed grounds, overgrazed areas and campgrounds. Well-managed land is the best defence against the spread of weeds. However, even well managed land in good condition is susceptible when natural disturbances (such as wind, water and a wide variety of wild-life including birds) open niches in the plant community and distribute plant parts and seeds. Once established weeds are spread by many vectors, including vehicles, wind, recreationists, waterways, animals and weeds contaminated hay (Roger *et al.*, 1997 and Harris, 1991).

Over-grazing by cattle changes the rangeland habitats, offering new opportunities for invading exotic annuals (Mark, 1981).

Across the vast rangelands of the world, many ecosystems are changing because of the rapid invasion by alien plants. These invasive species have mostly in the last 150 years competed well with native plants, increased soil erosion and can transform wetlands, grassland, and hillsides into stands of unwanted plants (Antognini *et al.*, 1995). The simplest effect of some invasions is the displacement of native plants, species by simply crowding, by competing for resources, or by other mechanisms (Mack, 1981).

Many invasive plants form broad-leaved rosettes or in some other way shade out neighbours (Huenneth, 1996). Some plants produce chemicals that reduce the germination of other plants. This effect on other plants is called allelopathy and studies indicate that the Russian Knapweed is allelophatic (Rocte, 1989). Also, the leaf litter of salt cedar increases soil salinity so that large areas are unfit for native vegetation and the livestock or wildlife that depends on that vegetation (Rocte, 1989).

According to Platt (1959), the kinds of invasive plants and the problems they cause are as diverse as the soils and climates they inhabit. The invasion of land by weeds and brush in the 1960s resulted in plant poisoning, physical injury, and increased cost of management, estimated at $ 250 million annually on western United States rangelands (United States Department of Agriculture, 1965). Frandsen and Beo (1991) estimated the 1989 loss in the 17 western State at $ 340 million because of noxious weeds.

Livestock production is an important feature of the country's agriculture, contributing power, manure and cash income. The livestock sub-sector contributes in direct products an estimated 9% of agricultural GDP (Alhassan and Barnes, 1993). Coupled with this, the sub-sector is a major source of income for farmers in the three Northern regions of the country, and it makes an indirect contribution to reduction of rural poverty. About half of the farmers in Upper East and West regions use bullock for ploughing, with 49% of them renting the animals. Bullock owing households cultivate 60% more land than those who don't (World Bank, 1992).

De Wet and Harland (1975) have suggested that plant species react in different ways when humans disturb their habitats. Some species flourish because of the disturbance, where as others migrate or die and are replaced. They described three classes of vegetation based on the degree of association with human caused disturbance. According to them, wild plants grow naturally out side of human-disturbed habitats. They are aggressive colonizers and when the habitat is frequently disturbed, successive waves of different species invade until dynamic, but eventually stable population balances are achieved when the habitat is continuously disturbed by human, a much different set of species becomes established. Weeds may invade newly disturbed habitat, but they are usually replaced by wild colonizers if the habitat is not disturbed further.

2.3 Soil Factors

The types of soil may influence the composition of the pasture especially its mineral content. Plants normally react to a mineral deficiency in the soil either by limiting their growth or by reducing the concentration of the elements in their tissues or more usually both (McDonald *et al.*, 1987).

The acidity of a soil is an important factor which influences in particular the uptake of many trace elements, by plants. The soil that develops under natural woodland or forest, the classic brown earth of the temperate regions or red earth of the tropics, is fertile. It is well structured, has good moisture holding capacity, is resistant to erosion and possesses a store of fertility in the nutrients bound-up organic molecules. The cycles of carbon and the major nutrients under natural vegetation has been demonstrated, most notably in rainforest but also in savanna and semi arid ecosystems. (Anthony, 1991).

Further evidence of the effects of trees on soils comes from comparing soil properties under the canopy of individual trees with those in the surrounds without a tree cover. For *Acacia albino*, cases of 50 – 100% increases in organic matter and nitrogen under the canopy are known as well as its effects on water-holing capacity. In semi-arid climates it is common to find higher soil organic matter and nutrients like Nitrogen, phosphorus, potassium, sodium and calcium under tree canopy than in adjacent opened land (Felker, 1978).

In the Northern Ghana Guinea savanna, the soils have low accumulation of organic matter in the surface horizon owing to high temperatures, which results in rapid rate of decomposition. Thus the soils are notoriously low in nutrient status with phosphorus and nitrogen being particularly deficient in almost all soils (Jones and Wild, 1975). The poor fertility status of the soils coupled with low amount of rainfall received per annum often results in slow plant growth rate (Jones and Wild, 1975).

2.3.1 Soil reaction (pH)

The pH is perhaps the most commonly measured soil characteristic. It is the most widely used criterion for judging whether a soil is acidic, and if so, how acidic (Seatz and Peterson, 1964). The pH range for acid soils ordinarily is from around 4 -7. Values much below 4 are obtained only when free acids are presents (e.g. H_2SO_4 in cation clays and mine spoils) (Seatz and Peterson, 1964).

Although soil pH is a very useful index, it is not completely understood and perhaps should be regarded as more empirical than otherwise. The pH of a soil is usually measured in slurry of soil and water. In routine procedures as those used in soil testing laboratories, one part of soil is mixed with one or two parts of water and the electrodes are immersed in the stirred suspension (Seatz and Peterson, 1964).

2.3.2 Soil organic carbon and organic matter

Greenland *et al.*, (1992) have suggested that the difficulty of sustaining productivity of plants in tropical soils is due to the effects of higher temperature. This has led to the belief that organic matter in tropical soils is somehow of lower quality than in temperate zones, however, increasing research has shown that there is no difference in the quality of organic matter in comparable soils of temperate and tropical soils.

The quality of organic matter in tropical soils varies enormously. Its amount in the soil at any one time is a reflection of the quality of inputs and the rate of decomposition. For example, the equilibrium rate of organic matter in tropical soils under forest cover is high. This high equilibrium occurs despite the high decomposition rates under tropical conditions because the rate of organic matter input to the soil is also high (Greenland *et al*., 1992).

Organic matter "influences physical and chemical properties of the soils far out of proportion to the small quantities present. It commonly accounts for as much as one third of cation exchange capacity of surface soils and is responsible, perhaps more than any other single factor, for the stability of soil aggregates" (Brady, 1990). Brady (1990) suggests that the optimum level of organic matter in the soil is about 5%.

Organic carbon percentage in the soil is often used as a proxy measure of soil organic matter (Brady, 1990). Using a conversion factor of 1.729 the ideal levels of organic carbon in the soil may be about 2.9%. In sandy Southern African soils 1-1.5% organic carbon was recommended as the long-term agro-ecologically viable minimum. Research from Western African countries suggests that where organic carbon levels falls below 1%, severe physical soil degradation can be expected to take place (Brady, 1990).

2.3.3 Soil Nitrogen

Soil nitrogen is of special importance because plants need it in large amount. It is also fairly expensive to supply and easily lost from the soil. The inert gas or elemental nitrogen is the ultimate source of Nitrogen for growing plants (Russel, 1980).

The Nitrogen content of soils shows very great variation caused by differences in drainage, topography, soil texture and management practices adopted on the soil (Russel, 1980). It has been found that under tropical climates the nitrate levels slowly increase during the dry season. An intensive increase is observed particularly at the beginning of the rainy season. Few weeks later the level of nitrogen falls and remains fairly constant until the next dry season (Russel, 1980). The total nitrogen content of the soil is determined by the kjeldahi method (Bremner and Mulvaney, 1982).

2.3.4 Soil Phosphorus

Soil phosphorus is one of the nutrient elements with the complex chemistry in the soil. This is because the phosphate ion can form many different compounds of different composition and of variable solubility (Bray, 1963).

The total phosphorus content of a soil varies depending on the organic matter content, parent material and degree of weathering (Russel, 1980). Determination of the total phosphorus content of a soil is of little agronomic value in the valuation of the fertility potential of a soil (Olsen and Sommers, 1982).

Soil Phosphorus is determined in solution by the Chlorostannous acid-Hydrochloric acid-Molybdate Blue method of Dickman and Bray (Bray, 1963).

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 The study area

The study was conducted in an area commonly known as the Jaagbo grove cluster of villages near Tolon, the administrative capital of the Tolon-Kumbungu District of the Northern Region, which lies in the Guinea Savanna ecological zone. It is about 33km west of Tamale-the Northern Regional capital (fig. 1).

Like other West African climatic conditions, rainfall patterns and amounts are the principal factors determining the range of the savanna vegetation zone. Hence, the savanna regions are generally characterized by short raining seasons of less than 6 months per year and low amounts of average annual precipitation of less than 1,000mm per year. It decreases from the south to the north and occurs largely in a single season from April/May to September/October (fig. 2). This is followed by a 5-6 months period of dry season when moisture stress is more intense. This period is characterized by dry harmattan winds from the Sahara (Rose-Innes, 1977).

Temperatures around these areas are quite high, registering a mean monthly minimum temperature of about 22^{o}C and a mean monthly maximum of 35^{o}C.

FIG. 1: MAIN SETTLEMENTS IN THE STUDY AREA TOLON-KUMBUNGU DISTRICT

(SOURCE: DEPARTMENT OF GEOGRAPHY AND RESOURCE DEVELOPMENT)

The vegetation of this zone has been described as a secondary fire climax, semi-deciduous woodland, shrub and coarse grass (Rose-Innes, 1977). The area supports a fire controlled tree savanna of broad-leaved trees, densely distributed in a continuous ground cover of perennial bunch grasses and associated forbs. However the height and density of trees vary from place to place.

Woody trees commonly seen and of interest for their economic value and use as fodder include *Butyrospernum*species, *Parkia biglobosa, Afzelia sp., Danielle sp., Gardenia sp., Lannea sp., Isoberline sp.*, *Drterum macocapa,* and *Pterocarpus sp.*

The common grasses include *Andropogon* species, *Hyparhenia* species, *Panicum* species, *Paspalumsp, Pennisetum sp,* and *Heteropogon sp* (Alhassan *et al.*, 1993).

Ernest and Tolsma, (1989), and Jordan, (1985), emphasized that the savanna species composition in this area is being changed by several types of disturbances, which includes, over grazing by cattle, frequent burning, intensive firewood harvesting among others. As a result of this the existing vegetation has been destroyed, damaged or changed. In areas where the vegetation has been destroyed soils have been exposed to external influences and this has created barren landscapes. The changes in species composition and diversity influenced the nutrient cycle and this also influenced the productivity of the ecosystems, since nutrients, water and energy are the important factors, which control productivity.

However in this area of study there still exists a small patch of relic climax vegetation, commonly referred to as sacred grove (Fetish Grove). This was the area selected as the control for the research. The close canopy woodlands to a height of 18m and a shrubby groundcover is almost free of grass. Such community indicates that the prevailing Northern Ghana Guinea Savanna will support woodland if disturbance factors were excluded.

The sacred Grove, as the name connotes, is an area regarded by the local people as the residence of their ancestral spirits and gods. Since time immemorial this sacred grove has been jealously protected and traditionally kept by the indigenous people in its pristine condition through certain traditional means, religious and cultural beliefs and taboos. Some of these traditional, religious beliefs, taboos and unwritten local laws serve as regulatory mechanisms and spell out the dos and don’ts pertaining to the use of the resources contained in the sacred grove. It has been found to be consistent with modern biodiversity conservation practice on environmental protection (Telly, 1997).

Based on this philosophy of traditional conservation a horizontal projection of this concept is being extended to other parts of the ecosystem to reduce environmental degradation. In this regard villages, which have direct influence in the conservation of the grove, were chosen for the study. These bonafide villages included, Tali, Botinli, Gbonjon, Gbambaya (Jaagbo grove of cluster villages)(fig. 1).

The inhabitants of the grove cluster of villages perceive the grove to be extremely important to their survival and therefore intend to preserve it for posterity.

3.2 Field survey of floristic composition and relative abundance

The field study of floristic composition of the vegetation was conducted from July-October, 2001 in two different habitats in the study area; namely a grazing area (the experimental site) and a sacred grove (the control).

In each of these sites an area of 640m^2 was delimited and divided into 64 square plots, within each of which four 5m^2 quadrats were placed at random (with the use of random numbers). In each of these quadrats the relative abundance of the various species was quantified by counting and recording the plants in the randomly distributed quadrats. Plants, which could not be identified on the field, were collected for identification in the herbarium.

Since dominant plant species in both the experimental and control areas were grasses, their relative abundance in both areas was compared in order to assess the status and change in the vegetation as a result of grazing.

3.3 Physio – chemical studies

The environmental data were collected to correspond with each quadrat. In each quadrat, soil core samples were taken at depths of 0-10cm with the use of a core sampler. The core sampler used is a hollow piece of metal pipe 5cm in diameter and 12cm in depth, used to enclose a column of soil when pressed into the soil and extracted.

In all a total of 10 cores were taken within each quadrat at random and bulked. The soils were air dried, sieved through a 2mm sieve and stored in polythene bags, scaled and labeled according to the location in the field. These samples were analyzed in the soil chemistry laboratory of the Savanna Agricultural Research Institute (SARI).

Sub samples of the sieved soils were analyzed to determine pH (McLean, 1982), estimate organic carbon content by the modified Walkley-Black procedure (Nelson and Summers, 1982), Total nitrogen content by the kjeldahi method (Bremner and Mulvaney, 1982), Available phosphorus (Olsen and Sommers, 1982) and exchangeable K, Ca, Mg, Na, content using neutral ammonium oxalate solution (Thomas, 1982). The soil organic carbon and total Nitrogen content figures were used to calculate the carbon, nitrogen ratio (C/N ratio).

3.3.1 Total Nitrogen

Total Nitrogen in the soil sample was determined by the Macro-Kjeldahl method. I g of soil was weighed and passed through a 0.5 mm sieve into a digestion tube. A 5ml digestion mixture (a mixture of selenium powder and concentrated sulphuric acid) was added and heated cautiously at a low temperature on a digestion block.

One ml of 36% H_2O_2 was added and the heating temperature gradually increased to 350 ^{0}C. Digestion was complete when the mixture turned white. The tube was allowed to cool slowly after which about 100ml of distil water was added to the digest and carefully transferred into a clean macro-Kjeldahl flask (750ml). A 50ml H_3B0_3 indicator solution was added into a 500ml Erlenmeyer flask and placed under the condenser of the distillation apparatus. The 750ml Kjeldahl flask was attached to the distillation apparatus and about 150ml of 10N NaOH was poured into the flask and distilled.150ml of the distillate was collected and the NH4-N in the

distillate determined by titrating with 0.0IN HCl. The colour change at the end point was from green to pink. The percentage Nitrogen in the soil was then calculated.

3.3.2 Soil pH

The soil pH was determined in 0.01m Calcium chloride solution in a ratio of 1:2.10g of air-dry soil was weighed and passed through a 2mm sieve into a beaker after which a 20ml of 0.0lm of $CaCl_2$solution was added and allow to stand for 30 minutes and stirred occasionally with a glass rod.

The electrodes of a pH meter were inserted into the suspension and the pH measured.

3.3.3 Soil Organic Carbon and Organic Matter

A sample of grind soil was passed through a 0.5mm sieve and 2g of it weighed into a 250 ml Erlenmeyer flask. 10ml of 1N $K_2C_{r2}O_7$ solution was pipetted into a flask and stirred gently to disperse the soil after which 20ml concentrated H_2SO_4 was rapidly added and swirled gently for 1 minute and the flask allowed standing for about 30 minutes. After adding 100ml of distilled water, 3-4 drops of diphenylamine indicator was added and titrated with 0.5N ferrous sulphate solution. ($FeSO_4$) At the end point colour changes from pink to greenish cast, then to dark green. The blank titration was made in the same manner but without soil and the results was calculated from the formula:

$$\% \text{ Organic C in soil} = \frac{[\text{Conc. } K_2Cr2O_1 - \text{Conc. } FeSO_4] \times 0.003 \times 100 \times (f)}{\text{Weight (g) of air-dry soil}}$$

f = 1.33 correction factor.

The % Organic Matter in soil = % Organic Carbon x 1.729

3.3.4 Exchangeable Ca, K, Mg and Na

A 30ml of 1N $NH_4\ OA_C$ was added to 5g of air-dry soil (passed through 2mm sieve) and shaked on a mechanical shaker for 2 hours.

The soil solution was filtered through a whatman No 42 filter paper and the Ca, K and Na in the filtrate was determined using a flame photometer.

3.3.5 "Available" Phosphorus

Using the Bray No. 1 Method, 5g of air-dried soil sample (passed 2mm sieve) was weighed into a tube and 35ml of the extracting solution added. It was shaked for 5 minutes on a mechanical shaker and filtered through whatman N0, 42 filter paper.*2 ml of the filtrate was pipetted into a*

20ml test tube and 5ml distilled water and 2ml ammonium molybdate solution added. The content was properly mixed and allowed to stand for 5 minutes to develop a blue colour. Transmittance or concentration was measured on UV/Vis.Spectrophotometer at

λ = 660µm.

3.4 Questionnaire Survey

Local knowledge of the biota was assessed in questionnaire survey. The questionnaire was administered to 90 individuals (30 in each site). 45 were administered to females and 45 to males. Each respondent was selected from a different household, thus ensuring a wide representation of each community. All respondents were interviewed individually on a one to one basis and answers recorded by the researcher. The questionnaire composed of closed and open-endedquestions

Amongst other questions, farmers were asked to give the local names of grass and plant species, which were common in the area, and name the invasive weeds, which have colonized the area.

CHAPTER FOUR

4.0 RESULTS

4.1 Floristic composition

The plant species identified in the study areas have been indicated in Tables 1(a and b). The control (fetish groove), expectedly had more plant species than the grazing area.

The area was dominated by the following plant species:

Aristida verstingii, Euciasta candylotricha, Sporobolus suloglobolus, Sida acuta, Parohyparrhenia annua, Arundinellapumila, Tripogon minimus, Cassiaobtusfolia, P*ennisetum pedicellatum, Fiurer umbrellata, Panicum* sp., *Iperata cylindrica, Afzelia africana and Parkia clappertonia.*

The dominant plant species observed in the experimental area were:

Aristida verstingii, Euciasta candylotricha, Sida acuta, Tephrosia elegans, Parohyparrhenia annua, Adropogon gayanus, Vigna pubigera, Parohyparrhenia annua, Pannasetum hordeoides, Tripogon minimus, Ctenium newtonii, Tephrosia purpurea, Acanthospermum hispid, Iperata cylindrica, Seteria pallindefusca, Pennisetum pedicellatum, Azadirachta indica, Butysrospermum parkii, and *Terminalia glaucescens.*

Table 1a Grass species identified in the study area

FAMILY NAME	SCIENTIFIC NAME	LOCAL NAME(Dagbani)	USES
Graminaceae	*Iperata cylindrical*	Kundungpeim	Pasture
Graminaceae	*Pennisetum pedicellatum*	Chimli	Medicine
Graminaceae	*Andropogon gayanus*	Perinpelgu	Fencing
Graminaceae	*Imperata cylindrical*	Biyoli simle	Pasture
Graminaceae	*Andropogon pteropholis*	Fookagile	Sweeping
Graminaceae	*Sporobolus pyramidalis*	Banglari	Pasture
Graminaceae	*Sporobolus suloglobosus*	Nahasaa	Sweeping

Table 1a (cont'd)

FAMILY NAME	SCIENTIFIC NAME	LOCAL NAME	USES
Graminaceae	*Arundinella pumila*	Sapachahaligu	Medicine
Graminaceae	*Commelina erecta*	Peigu-nyemeri	-
Graminaceae	*Bulbostylis metrailis*	Kapakoju-nyuli	-
Icacinaceae	*Impomoea eriopcarpa*	Linteringa pealli	Rope
Malvaceae	*Hibiscus surattensis*	Saabera	Medicine
Malvaceae	*Sida acuta*	Nahalar sabrinli	Fencing
Nyctaginaceae	*Asilia helianthiodes*	Budinni	Medicine
Nyctaginaceae	*Boerhavia coccinea*	Jangkuno-nyoli	Medicine
Nyctaginaceae	*Boerhavia difusa*	Kansikogiyidi	Medicine
Papilionaceae	*Tephrosia elegans*	Banglori	Medicine
Papilionaceae	*Tephrosia purpurea*	Banglari	Medicine
Rubiaceae	*Mitracarpus villosus*	Kansikogiyidi	Medicine
Rubiaceae	*Anchomones Sp.*	Zaa	-
Scrophulariaceae	*Striga hermontrica*	Wubluri	Medicine
Solanaceae	*Acanthospermum hispidum*	Gotaba	-
Sterculiaceae	*Euciasta candylotricha*	Suein	Pasture
Sterculiaceae	*Lepidagathis anabrya*	Wubluri	Medicine
Tiliaceae	*Triumfetta dubia*	Peagu nyemeri	Medicine
Tiliaceae	*Corchorus aestuans*	Selingvohu-mochoo	Edible

TREE SPECIES

FAMILY NAME	SCIENTIFIC NAME	LOCAL NAME	USES
Bombacaceae	*Adansonia digitata*	Tua	Medicine/Edible
Combretaceae	*Annogeissus leiocarpus*	Shia	Medicine/Rafters
Mimosaceae	*Parkia clappertoniana*	Dawadawa	Medicine/Edible
Moraceae	*Afzelia Africana*	Kpalaga	Medicine/Fuelwood
Rubiaceae	*Azadirachta indica*	Nyinsigba	Medicine/Rafters
Sapotaceae	*Butyrospermum parkii*	Tanga	Edible

SHRUB SPECIES

FAMILY NAME	SCIENTIFIC NAME	LOCAL NAME	USES
Annonaceae	*Annona senegalensis*	Bulinbougo	Edible/Medicine
Combretaceae	*Combretum molle*	Gboriga	Medicinal/Fuelwood
Combretaceae	Anogensus leiocarpus	Shia	Medicinal/Fuelwood
Mimosaceae	*Dichrostachys cinerea*	Vapga	Medicinal/Fuelwood
Mimosaceae	*Dichrostachys glomerata*	Kpaliga	Fuelwood
Mimosaceae	*Acacia dudgeon*	Gozie	Medicinal/Fuelwood

FORB/HERB PLANT SPECIES

FAMILY NAME	SCIENTIFIC NAME	LOCAL NAME	USES
Mimosaceae	*Mimosa pudica*	Langyem	-
Nyctaginaceae	*Boerhavia diffusa*	Kansikogiyidi	Medicine
Rubiaceae	*Borreria verticillata*	Yihim zei	Pasture
Solanaceae	*Solanum nigrum*	Nahsaa	Medicine
Sterculiaceae	*Waltheria indica*	Chima	Medicine
Tiliaceae	*Corchorus olitorius*	Selingoohu	Edible

Table 1b :

PLANT SPECIES IDENTIFIED IN THE GRAZING AREA
(EXPERIMENTAL SITE)

FAMILY NAME	SCIENTIFIC NAME	LOCAL NAME	USES
-	*Commelina erecta*	Peigu-nyemeri	-
-	*Indigofera hisuta*	Zalinzahi	-
-	*Cassia obtusfolia*	Tukulaakum	Medicine
-	*Echinochloa obtusifiora*	Punkpung	-
Amaranthaceae	*Boraria scabia*	Belongbeng	Pasture
Cyperaceae	*Fiurera umbrellata*	Sowen	-
Cyperaceae	*Cyperus rotundus*	Satilga	Medicine
Euphorbiaceae	*Euphobia Sp.*	Janimabihili	Medicine
Euphorbiaceae	*Euphorbia hirta*	Gwani-mabihili	Medicine
Graminaceae	*Aristida verstingii*	Barzum	-
Graminaceae	*Pennisetum polystachyon*	Chimli	Pasture
Graminaceae	*Sporobolus suloglobosus*	Nahasaa	Sweeping
Graminaceae	*Tephrosia platicarpa*	Gbongagubachari	Pasture
Graminaceae	*Vigna pubigera*	Lileringi sabinli	Medicine
Graminaceae	*Desmodium Sp.*	Worikpaligu	Pasture
Graminaceae	*Parohyparrhenia annua*	Dazamam	Pasture
Graminaceae	*Arundinella pumila*	Sapachahaligu	Medicine
Graminaceae	*Stylochiton lanceafolius*	Buhu	-
Graminaceae	*Biophytum petersianum*	Naa-makpabsong	Medicine
Graminaceae	*Andropogon gayanus*	Perinpelgu	Fencing
Graminaceae	*Andropogon Sp.*	Fookagile	Pasture
Graminaceae	*Pennisetum hordeoides*	Bisigora	Pasture
Graminaceae	*Tripogon minimus*	Tantee	Pasture
Graminaceae	*Indigofera tetrosperma*	Zalinzanli	Medicine

Table 1b (cont'd)

FAMILY NAME	SCIENTIFIC NAME	LOCAL NAME	USES
Graminaceae	*Andropogon pteropholis*	Fookagile	Sweeping
Graminaceae	*Rottboelia exaltata*	Sugura	Pasture
Graminaceae	*Asparagus africanus*	Jenkpekigu-goo	prepare gun powder
Graminaceae	*Rottboellia cochinchinensis*	Besigoho	Pasture
Graminaceae	*Iperata cylindrica*	Kundungpeim	Pasture
Graminaceae	*Setaria pallindefusca*	Noblinini	-
Graminaceae	*Pennisetum pedicellatum*	Chimli	Medicine
Graminaceae	*Panicum Sp.*	Sakeni	Pasture
Graminaceae	*Pannisetum purpureum*	Buntibli	Pasture
Graminaceae	*Sporobolus pyramidalis*	Banglari	Pasture
Graminaceae	*Heteropogon contortus*	Bugu	Pasture
Graminaceae	*Imperata cylindrica*	Biyoli simle	Pasture

FAMILY NAME	SCIENTIFIC NAME	LOCAL NAME	USES
Graminaceae	*Eleusine indica*	Chima	Medicine
Icacinaceae	*Impomoea eriopcarpa*	Linteringa pealli	Rope
Malvaceae	*Sida acuta*	Nahalar sabrinli	Fencing
Malvaceae	*Hibiscus surattensis*	Saabera	Medicine
Nyctaginaceae	*Asilia helianthiodes*	Budinni	Medicine
Nyctaginaceae	*Boerhavia coccinea*	Jangkuno-nyoli	Medicine
Nyctaginaceae	*Boerhavia difusa*	Kansikogiyidi	Medicine
Papilionaceae	*Tephrosia elegans*	Banglori	Medicine
Papilionaceae	*Tephrosia purpurea*	Banglari	Medicine
Rubiaceae	*Anchomanes Sp.*	Zaa	-
Rubiaceae	*Mitracarpus villosus*	Kansikogiyidi	Medicine
Sterculiaceae	*Euciasta candylotricha*	Suein	Pasture
	TREE SPECIES		
Annonaceae	*Annona senegalensis*	Bulinbougo	Edible/Medicine
Annonaceae	*Annona glaucescens*	Langyem	Medicine
Bombacaceae	*Adansonia digitata*	Tua	Medicine/Edible
Combretaceae	*Annogeissus leiocarpus*	Shia	Medicine/Rafters
Mimosaceae	*Parkia clappertoniana*	Dawadawa	Medicine/Edible
Moraceae	*Afzelia Africana*	Kpalaga	Medicine/Fuelwood
Rubiaceae	*Azadirachta indica*	Nyinsigba	Medicine/Rafters
Rubiaceae	*Gardenia erubescens*	Dawle	Medicine/Fodder
Sapotaceae	*Butyrospermum parkii*	*Tanga*	Edible

SHRUB SPECIES

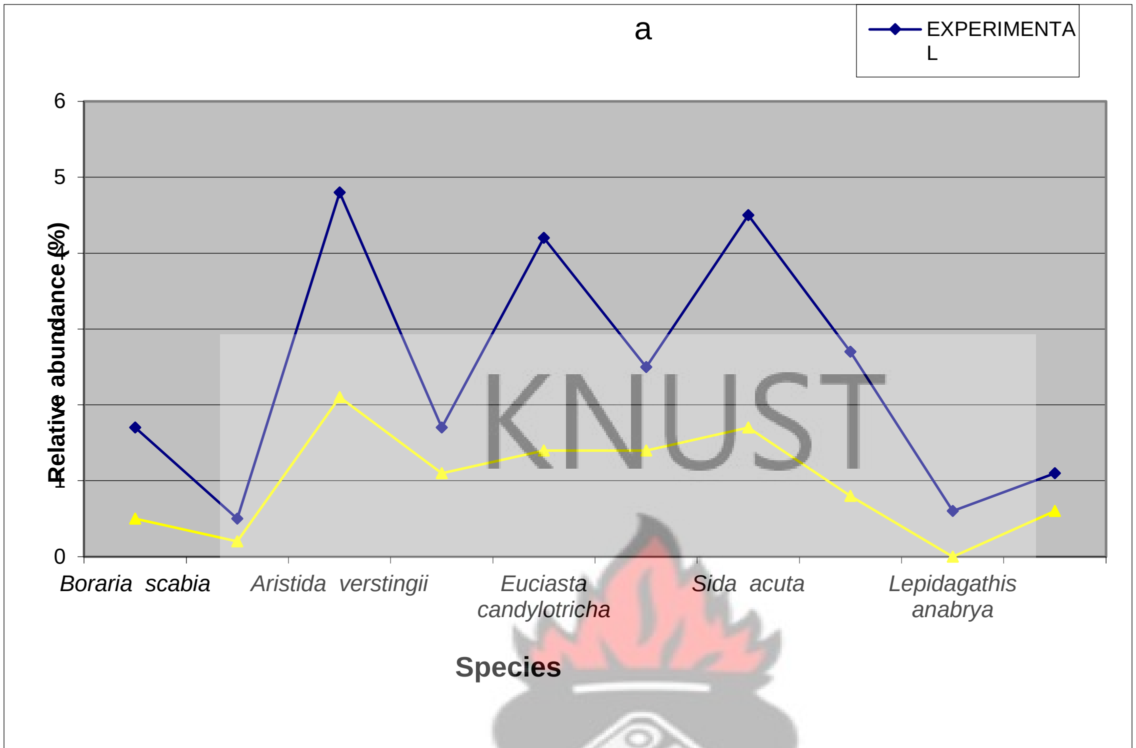
FAMILY NAME	SCIENTIFIC NAME	LOCAL NAME	USES
Annonaceae	*Annona senegalensis*	Bulinbougo	
Caesalpiniceae	*Bauhinia rufescens*	-	Fuelwood
Combretaceae	*Combretum molle*	Gboriga	Medicinal
Combretaceae	*Anogeissus leiocarpus*	Shia	Fuelwood
Ebenaceae	*Diospyrus mespiliformis*	Gaa	Medicinal/Edible
Mimosaceae	*Dichrostachys cinerea*	Vapga	Medicinal/Fuelwood
Mimosaceae	*Dichrostachys glomerata*	Kpaliga	Fuelwood
Mimosaceae	*Acacia dudgeoni*		
Rubiaceae	*Mitragyna inermis*		

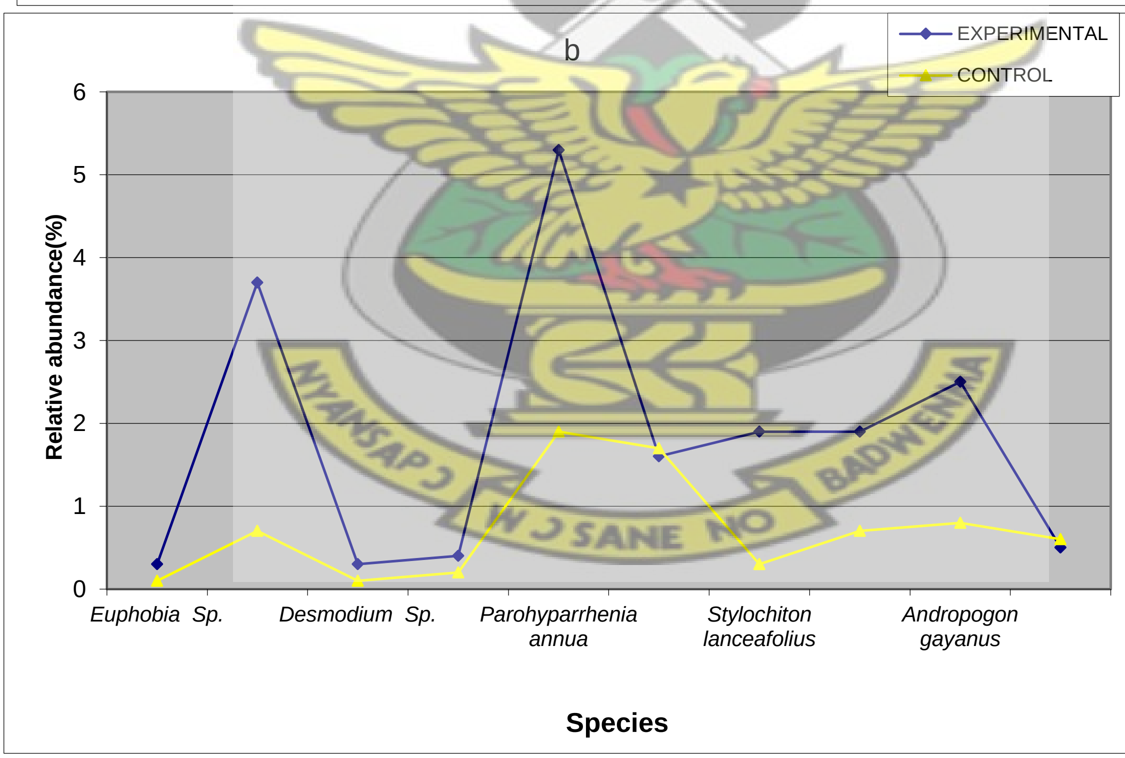
FORB/HERB PLANT SPECIES

FAMILY NAME	SCIENTIFIC NAME	LOCAL NAME	USES
Amaranthaceae	*Achyranthes aspera*	Narenga	Pasture
Amaranthaceae	*Alternanthera pungens*	Kpalsoo	Pasture
Mimosaceae	*Mimosa pudica*	Langyem	-
Nyctaginaceae	*Boerhavia diffusa*	Kansikogiyidi	Medicine
Solanaceae	*Solanum nigrum*	-	Medicine

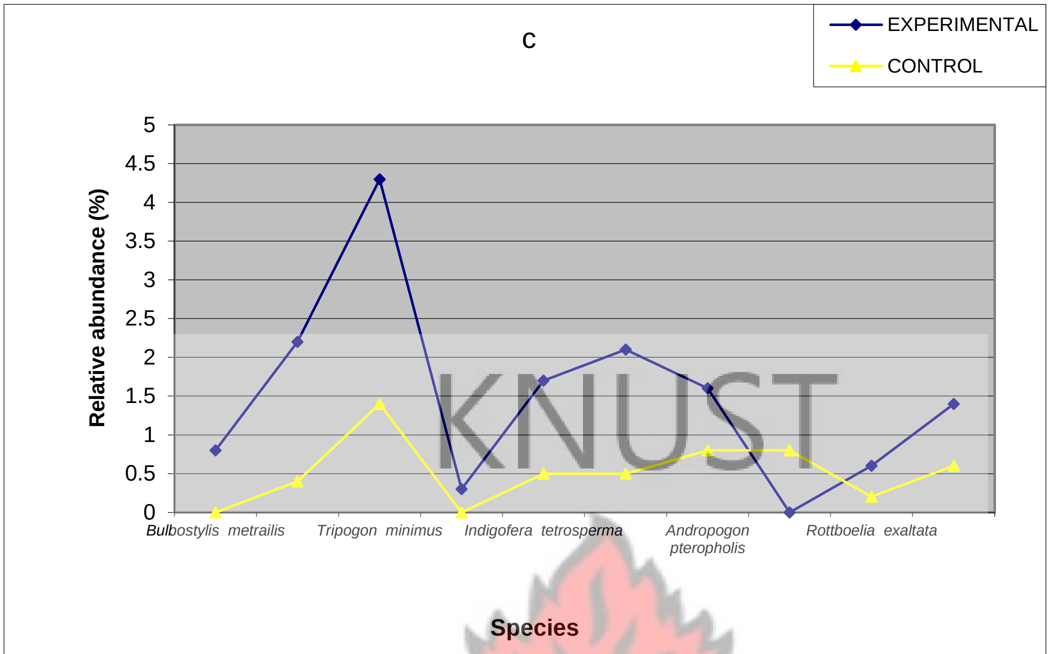
4.2 Relative abundance of plant species

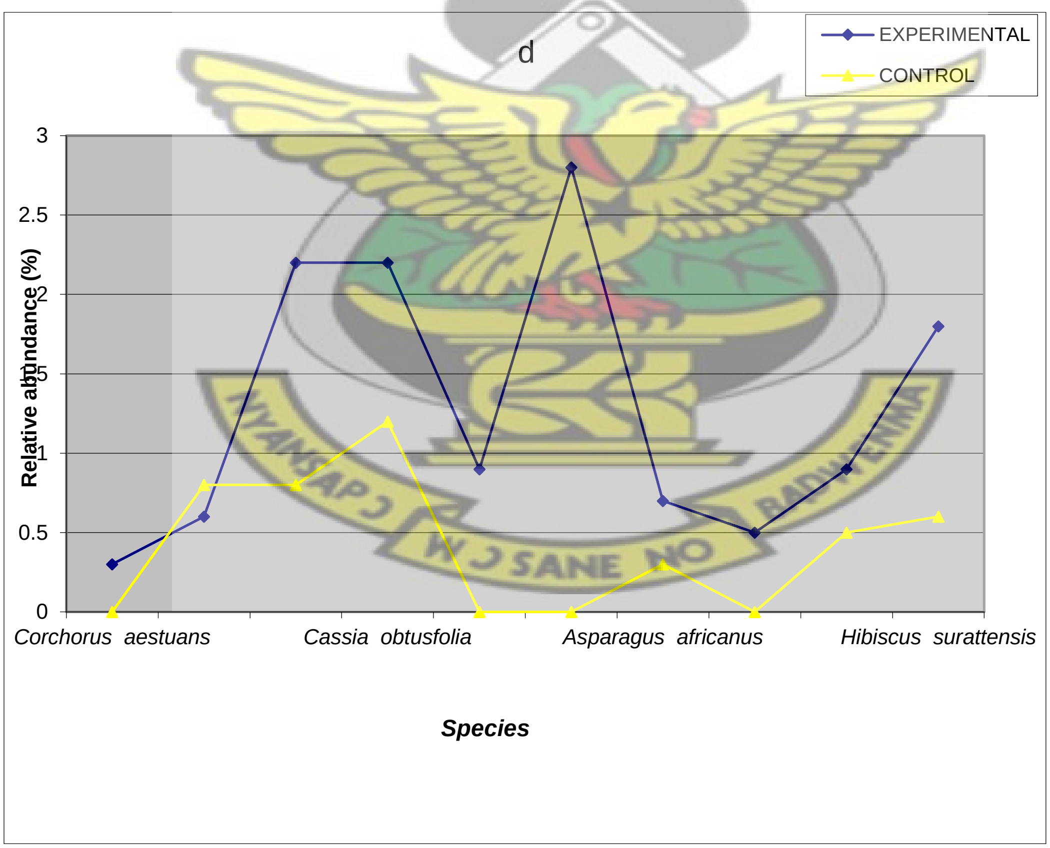
In the determination of the relative abundance of the plant species in the study areas the amount of ground in a quadrat covered by the various types of vegetation (e.g. trees, shrubs, perennial, grasses, annual grasses, forbs etc.) was calculated. Since dominant plant species in both the experimental and control areas were grasses, their relative abundance in both areas was compared in order to assess the status and change in the vegetation as a result of grazing (figure 4a,b,c,d,e and f).The relative abundance was quantified using the cover method. The value was obtained by a visual estimate; a certain percentage of the total area of a quadrat being covered by a given species.

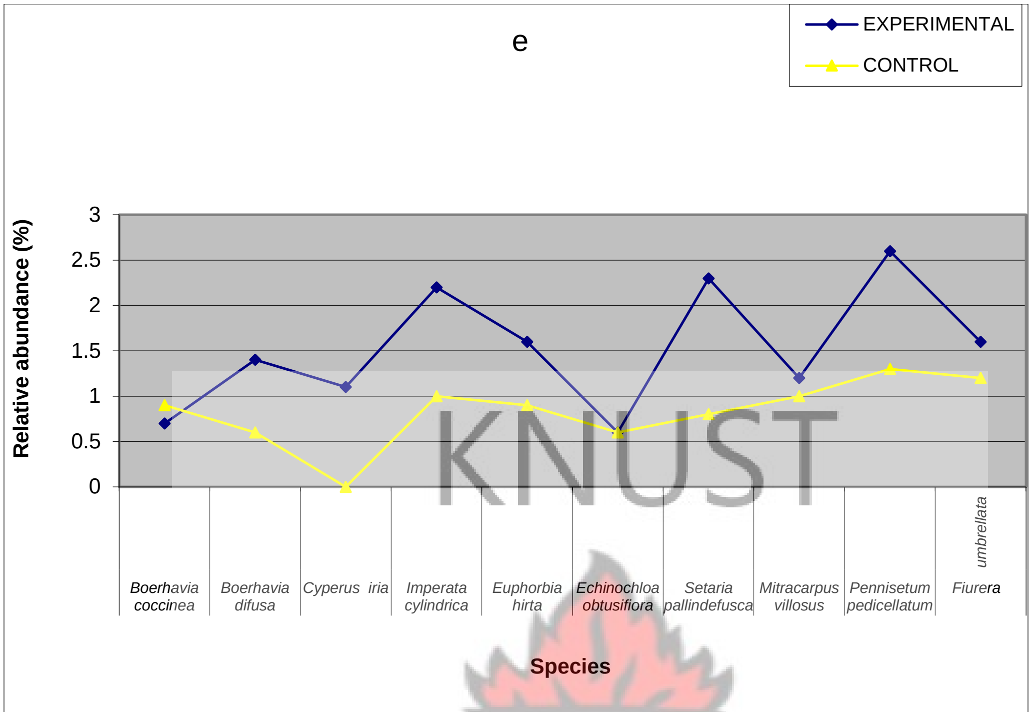


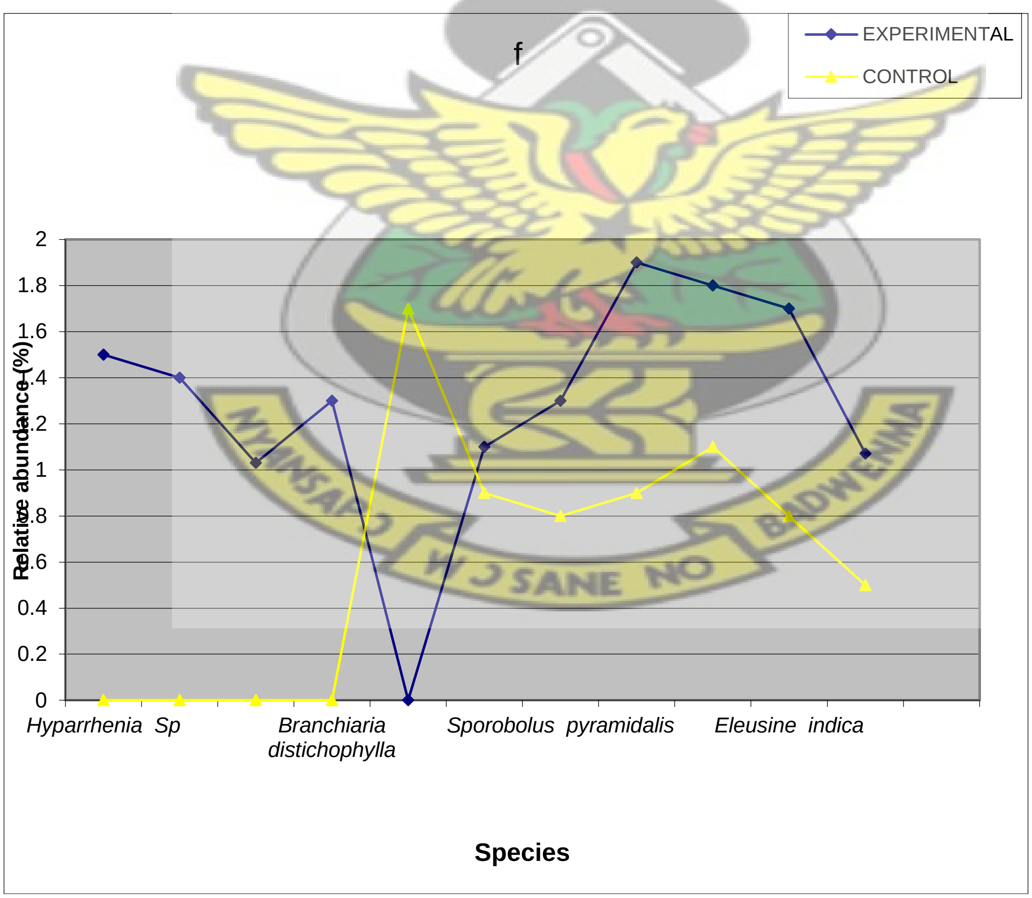


Figures 4 a, b, c, d, e and f. The relative abundance of some key plant species identified in the study areas


c
EXPERIMENTAL
CONTROL
Relative abundance (%)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
Bulbostylis metrailis
Tripogon minimus
Indigofera tetrosperma
Andropogon pteropholis
Rottboelia exaltata
Species


d
EXPERIMENTAL
CONTROL
Relative abundance (%)
3
2.5
2
1.5
1
0.5
0
Corchorus aestuans
Cassia obtusfolia
Asparagus africanus
Hibiscus surattensis
Species


e
EXPERIMENTAL
CONTROL
Relative abundance (%)
3
2.5
2
1.5
1
0.5
0
Boerhavia coccinea
Boerhavia difusa
Cyperus iria
Imperata cylindrica
Euphorbia hirta
Echinochloa obtusifiora
Setaria pallindefusca
Mitracarpus villosus
Pennisetum pedicellatum
Fiurera umbrellata
Species


f
EXPERIMENTAL
CONTROL
Relative abundance (%)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
Hyparrhenia Sp
Branchiaria distichophylla
Sporobolus pyramidalis
Eleusine indica
Species

4.3 Invasive weeds

The invasive weeds identified and their relative abundance in both the experimental and control sites are indicated in Table 2.

Table 2 Relative abundance of invasive weeds in the study area

Invasive weed species	**Relative abundance (%)**	
	Experimental Area	**Control**
Lepidagathis helianthiodis	7.2	15.2
Bulbostylis metrailis	15.1	16.1
Jasminum berstingii	6.9	0
Corchorus aistuans	2.5	0
Striga hermetic	6.2	0
Acanthospermum hispidum	11.2	22.8
Triumfetta dubia	5.2	0
Hyparrhnia Sp.	8.4	0
Paspalum orbiculares	6.8	0
Paspalum conjugatum	13.2	14
Branchiaria deflexa	9.2	13.2
Branchiaria distichophyllla	9.1	17.9

4.4 Distribution pattern

In the experimental area all the grasses occurred in patches, the patch size ranging from 1-5m. The grasses in the control area were however dominated by tall grasses.

4.5 Soil characteristics

Concentrations of inorganic nitrogenous compounds (or nutrients) in the experimental and control sites are presented in Table 2.

Table 3:

Comparison of physical characteristiics of soils collected from the Experimental and Control areas

Soil Characteristics	**Experimental Area**	**Control Area**
Soil pH	4.8	6.7
Organic matter (%)	0.98	2.38
Organic Carbon (%)	0.52	1.12
Total Nitrogen (%)	0.038	0.06
C: N Ration (%)	13.7	18.7
Phosphorus (mg/kg)	2.6	6.2
Exchangeable Calcium (mg/kg)	135.3	830.9
Exchangeable Magnesium (mg/kg)	95.0	176.0
Exchangeable Sodium (mg/kg)	67.1	98.3
Exchangeable Potassium (mg/kg)	43.8	103.2

4.5.1 Soil fertility

In terms of soil fertility as indicated by percentage organic carbon, nitrogen and organic matter, C : N ratio, the soil from the protected areas was more fertile than the grazed area. The values for the above soil characteristics were higher for the control than those for the grazed area.

Concentration of mineral elements also varied with soil from the protected area recording higher values for major elements such as Ca, Mg, Na, and K.

4.5.2 Soil pH

The pH of the soil of the control area ranged from 6.6 to 6.9, whereas it was 4.7 to 4.9 in the experimental area. The soil of the experimental area was therefore acidic while that of the control area was slightly alkaline.

4.6 Survey data

The data obtained from the questionnaire administered to find some aspects of grazing which affect the rangeland are indicated in Figures (4 – 9) .The data obtained included the number of years the farmers have kept grazing animals, the range condition, factors responsible for change in range condition, management constraints, indigenous range management practices and the type of invasive weeds found in the range vegetation.

4.6.1 Grazing activities

About 60% of the respondents have keep cattle for over 15 years (fig. 4) giving an indication that a fairly reasonable number of farmers have a fair idea about the range condition over the years.

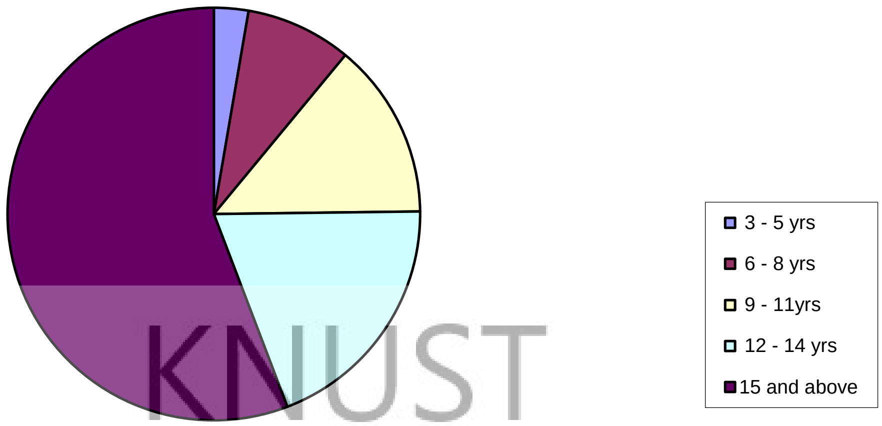


Fig. 4 Number of years of keeping animals

4.6.2 Range condition

Majority of the farmers (over 80%) were of the view that there was a decline in the range condition (fig. 5).

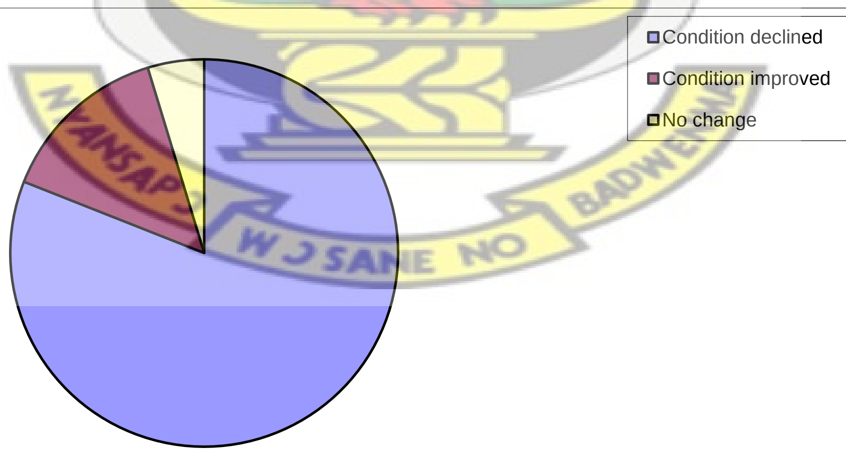


Fig. 5 Perception of respondents about range condition.

The decline was seen in loss of plant and wildlife species, the seasonality and dry-out of most streams and rivers. These changes were however nit significant in the control site.

4.6.3 Changes in range condition

The changes in the range conditions in this part of the savanna zone were attributed to an array of factors with varying degree of influence. Bush burning attributed to the greatest of change, followed closely by by over-grazing and human population Pressure (fig. 6).

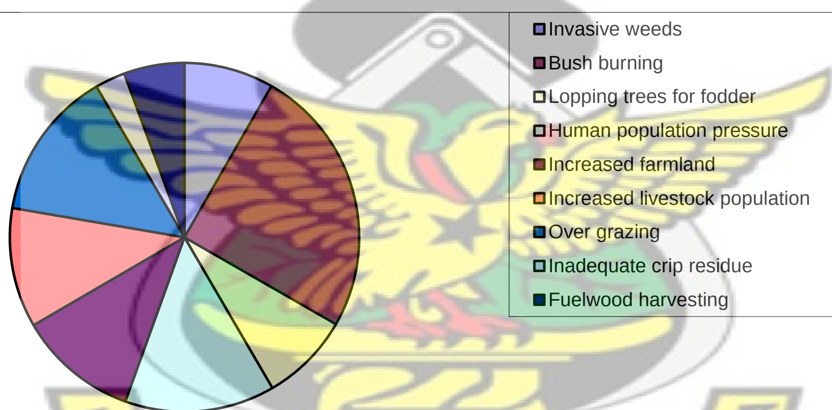


Fig. 6 Some factors causing change on the rangeland in the study area

Farmers did not however have any idea of the type of grass species lost over the period due to the above factors. However, it was indicated that urban and peri-urban rearing of animals has put pressure on palatable species such as *Afzelia sp*. *Ficus sp*. and *Ptericarpus sp*.which are often lopped for feeding livestock.

4.6.4 Range management constraints

In view of the fact that grazing lands are communally owned for grazing purposes, where no permission is needed before grazing, farmers are faced with a variety of constraints with regards to range management in the area (fig. 7). Bush burning and over grazing again accounted for over 80% of the constraints, and were perceived as the major constraints to their range management efforts.

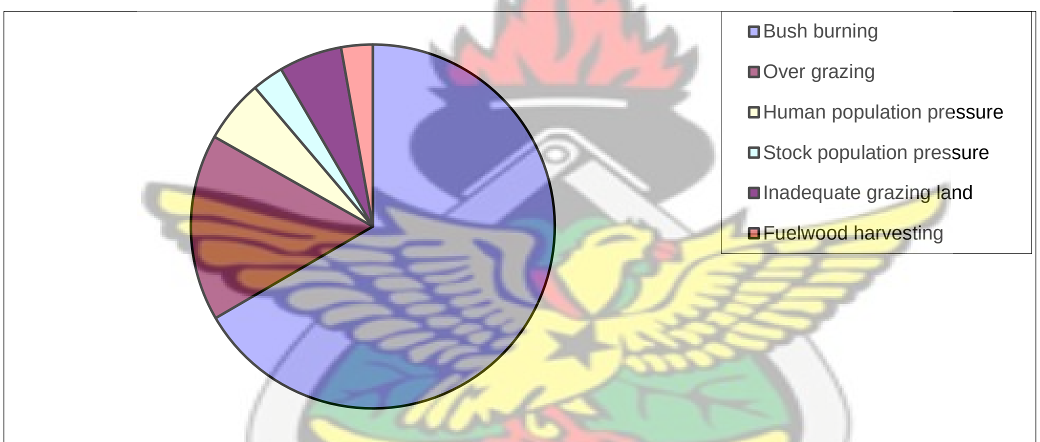


Fig. 7 Range management constraints

4.6.5 Range management

The results of the survey suggested that farmers appeared to be making strenuous efforts to manage the rangeland. The results also revealed that early burning was the main indigenous method of range management practiced by farmers (fig. 8).

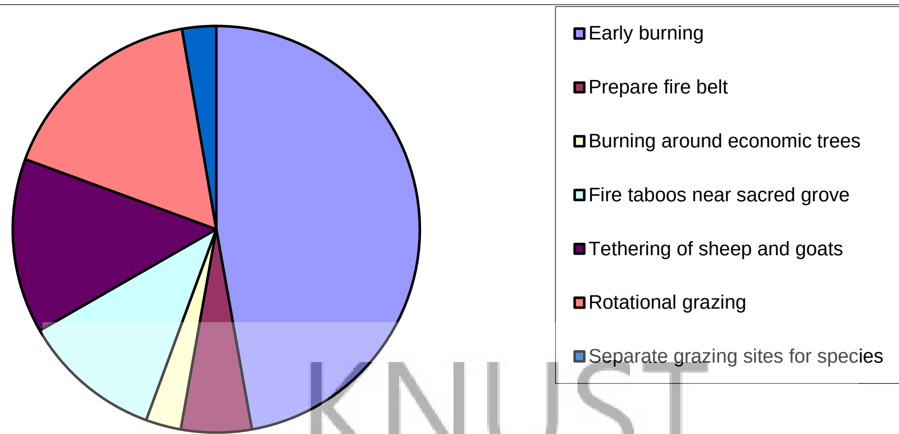


Fig. 8 Indigenous rangeland management practice.

4.6.6 Invasive weeds

The study revealed that farmers were not knowledgeable about invasive weeds. About 15% of them knew *Lepigadathis* and *Bulbostylis* sp. And only between 3 and 12% knew about the other weed species (fig. 9).

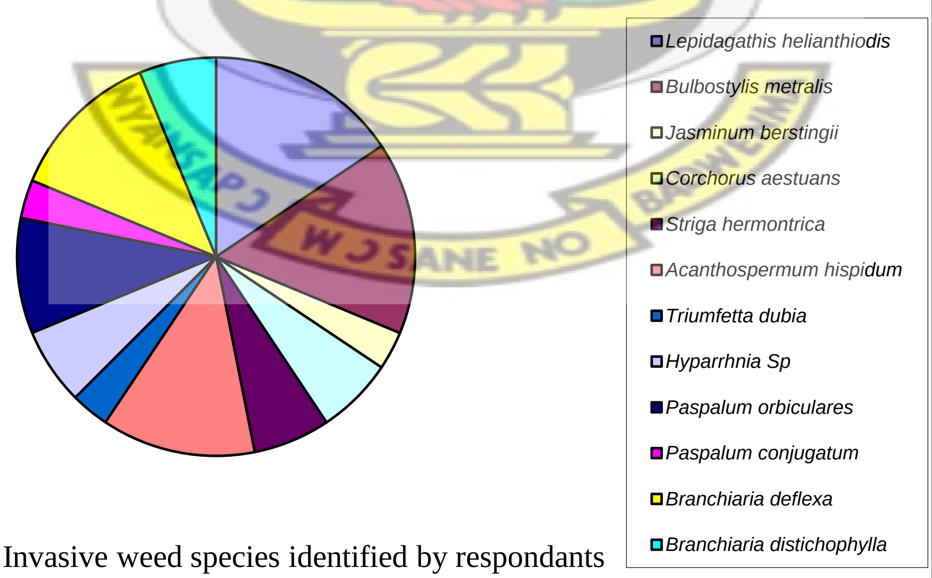


Fig.9. Invasive weed species identified by respondants

CHAPTER FIVE

5.0 DISCUSSION

It has been found that a decline in the condition of a rangeland is commonly reflected in less diversity of plants over any extensive area (Dasmann *et al.*, 1979). In the present study it was found that the area set aside as a fetish grove and from which all forms of occupation and exploitation have been excluded was far richer in species than the adjacent experimental site used for grazing cattle.

The vegetation of the protected area was typical Guinea Savanna vegetation with mostly broad-leaved tree species while that of the experimental area was dominated by perennial grasses of tussock or bunch grass forms, growing in compact clumps. It has been stated that the greatest single factor contributing to rangeland deterioration tends to the mismanagement of livestock (Dasmann *et al.*, 1979).

From the survey response, it was observed that about 70% of farmers have kept cattle for over 12 years (fig.4), giving an indication that the rangeland has been subjected to some intense grazing pressure all these years.The problem is compounded by intruding alien herdsmen from neighbouring countries who allow their poorly managed animals, overgraze the rangelands causing deterioration of vegetation (Baako, Per. Comm.).

Over grazing reduces the vigor of palatable species, decreases desirable vegetation whilst less desirable species become dominant and finally leads to accelerated erosion (Dyksterhius, 1949).

Bush fires often occurred as a result of illegal and uncontrolled burning of bush after harvest for the purpose of removing rank vegetation, or hunting or just having fun (survey response).

Damage done by bush fire to the rangeland was very significant. This make bush fire a major contributing factor to the decline in rangeland condition (fig. 6), as well as the greatest constraint to the success of the rangeland management exercise (fig. 7).

Perhaps fire which is the second important factor in influencing vegetation of the Savanna (Lawson, 1985) may have contributed to the decline in floristic composition of the experimental area. The following plant species, which were identified by the participants in the survey and are of medicinal value, were not found in the experimental area: *Lepidagathis helianthiodis, Bulbostylis metrailis, Striga hermontrica, Acanthospermum hispidium, Indigofera tetrosperma, Boerhavia coccinea, Boerhavia difusa* and *Euphorbia hirti.*

The people in Savanna and arid regions in Africa depend for their survival on knowledge and location of wild crop and medicinal plants (Kabuye, 1986). The results of the field studies conducted from 1970-82 in Eastern Kenya by Begon and Mortimes (1986), showed dramatic changes in the incidence and uses of plants. They observed that the main causes are rapid increase in population, a change from communal to individual land tenure and new values brought about by modernization.

They found that large hardwoods have all but disappeared, many having been cut down to make charcoal. This situation, according to them, is more serious in the relatively bare and arid areas where factors such as overgrazing and the use of plant as a fuel wood are rapidly accelerating the desertification of these areas.

The disappearance of these plants would be an irretrievable germplasm loss and also threaten the very survival of many pastoralist people in this country.

From the results it was observed that two grass species namely *Andropogon* and *Panicum* species were completely absent from the experimental site. This could be due to the fact that these species might have been faced out by heavy grazing activities since they appear quite palatable to ruminants (Cattle, sheep and goats) (Dyksterhuis, 1949). It can however be concluded that the experimental site has suffered considerable grazing pressure because it has been exposed to grazing (Alhssan and Barnes, 1993). Jerry *et al*., (1998) have reported that most ranges, which are subjected to random or intermittent burning, do not have vegetation uniformity. My observation about the distribution pattern of grasses in my study areas may be in keeping with the above finding. While the grasses in the grazing area occurred in patches the control area was dominated by uniformly occurring and relatively tall grasses.

The level of disturbance found in such an agricultural or rangeland ecosystem has a confounding impact on the species distribution pattern of the plant community (Whittaker, 1970). The relatively higher nutrient status recorded in the control site (Table 3) can be attributed to several factors. The tree plant species are said to have accumulated nutrients over the years, which are then released into the soil through regular litter-fall; decomposition and mineralisation, which result in the improved soil nutrient status beneath the tree canopy.

Thus recycling of nutrients has contributed to the higher nutrient within the control site (Ernest and Tolsma, 1989).

Young (1991) stated that, soils, which develop under natural woodland and forest, are always fertile, well structured, has good moisture-holding capacity, are resistant to erosion and possess a store of fertility in the nutrient bound up inorganic molecules. Increases in organic matter and nitrogen under the canopy are known, as compared to the adjacent open land (Felker, 1978). Again the tree cover in the control site tends to moderate the effects of leaching through addition of bases to the soil surface.

However, Grewal and Abrol (1986) have raised doubts as to whether tree litter can be a significant means of raising pH on acid soils, owing to the order of magnitude involved, except through the release of bases that have accumulated during many years of tree growth.

Other processes by which trees maintain or improve soil include, the protection from erosion and thereby from loss of organic matter and nutrients; nutrients retrieval by trapping and recycling of nutrients which would otherwise have been lost by leaching, including through the action of mycorrhisal systems associated with tree roots and the root exudation (Atkinson *et al*., 1983). The trees also reduce the rate of organic matter decomposition by shading (Parker, 1983).

The factors responsible for the relatively higher C: N ratio registered in the control site is not immediately clear, but it could be due to wetter or poor drainage conditions which are reported to lead to higher C:N ration of up to 18.7 (Russel, 1973).The lower soil nutrient levels sampled from the experimental site is possibly due to the regular harvesting of plants including twigs which are higher in nutrients.

Harvesting of tree biomass leads to the export of nutrients outside the ecosystem and when this continues for a long time it gradually leads to decreases in nutrient content of that particular ecosystem (Ernest and Tolsma, 1989).

In the Northern Ghana savanna, the soil has low accumulation of organic matter in the surface horizons owing to high temperatures, which results in rapid rate of decomposition. Thus the soils are very low in nutrients, with phosphorus, Nitrogen and Potassium being particularly deficient in almost all soils (Jones and Wild, 1975). Again a rising trend in population has led to the land in the experimental site being subjected to pressure to increase food production. Farmers continuously cultivate land, which has led to the depletion of soil nutrients around this area.

CHAPTER SIX

6.1 CONCLUSION AND RECOMMENDATION

6.1.1 Floristic composition

The results of the field study clearly revealed that the vegetation of the control area which had been protected from all forms of occupation and exploitation including grazing, was typical Guinea Savanna vegetation type. A greater proportion of the vegetation was tree species as compared with the experimental area, which were predominantly grasses.

It was also observed that some tree species such as *Combretum molle, Gardenia erubescens, Mitragynaenermis* and *Bombax,* which were common in the control area had disappeared from the experimental area. These species have important uses such as medicinal, fodder or fuel wood for the communities. The current trend of rising population growth coupled with corresponding increase in population of livestock could put a greater pressure on grazing land.

6.1.2 Invasive weeds

For the farmer, weeds are plant species that grow where they are not wanted, competing with crops for moisture, sunlight and nutrients. They have been called plants that are out of place (Ochse, 1961). Weeds have been found to be well adapted to temperature extremes on bare soil of planted fields prior to the emergence of the crop, and the tolerance of some specie to low nutrient status is greeter than that of crops. In the present study almost all the weed species were found in the experimental area, which was also relatively poor in nutrient status.

The vigorous colonization by weeds on degraded agricultural lands in the tropics is one of the major technical problems of agricultural production. Perhaps the farmers low knowledge about the weed species could possibly be attributed to the fact that the weeds may be “allien“ plants in the area.

6.1.3 Views of the community

In the study, pastoralist stated bush fires as the major cause of change in the range condition. This response was not surprising because most range managers have also been emphasizing on the need to control bush fires. The question therefore is, how urgent is it to control weeds, especially the thousands of new or small infestations currently growing out of control in relatively infested areas. I wish to consider the priority in relation to fire. Nature often helps put out fires, nature does not help put out weeds. Fires are often very beneficial, weeds are not beneficial. If and when there are negative impacts from fire, they are usually short term, whereas impacts from weeds are long term and often permanent. Therefore, the thousands of small new infestations that are currently growing out of control on relatively uninfected land, truly constitute a state of biological emergency.

6.1.4 Concluding remarks

The respondents in the questionnaire survey were of the view that bush fires are the major course of change in range condition. The view may be true because in the savannas of Ghana farmers and pastoralists often set fires in attempts to open of rangeland, remove shrubs and make new grass growth more readily accessible to grazing animals. Burning may also have an immediate fertilizing effect upon the surface soil so that the vegetation which springs up after a burn is more palatable, more nutritious, and consequently, more attractive to grazing animals. It has been suggested that ecosystems that contain abundant forage resources as well as grazing animals are subject to burning (Harold and Chub, 1994). It has been argued that if plant species have developed mechanisms for surviving fire and grazing, they may also depend on fire and grazing forsuccessful regeneration. They may possess characteristics thatenhance flammability andattractiveness to grazing animals.

However some researchers caution that frequent fires could destroy grassland and encourage the invasion of shrubs and trees. They admonish that fire should be used with great care. In the present study the symptoms of overgrazing were apparent in the experimentalarea with perennial grasses beingrecognized as the dominantand major climax species. This type of vegetation may be more prone to fires thanthe vegetation in the protected area, which was dominated by woody plants.

6.2 Recommendations

6.2.1 Rangeland monitoring

The first major rangeland monitoring was undertaken in 1994/1995 by a team of scientists from the Animal Research Institute (CSIR), University of Ghana and Animal Production Directorate (Duku, 1993). Rangeland monitoring should be carried out to monitor seasonalchanges in plantbiomass, botanical and chemical composition of rangelands. It should also be done to estimate the carrying capacity for the rangelands and assess the year round herbage consumption in the rangeland ecological zone.

6.2.2 Monitoring Alien Herd encroachment

It is known that the country's rangeland utilization for grazing is left in the hands of children who drive the animals to the bush. Grazing movements do not normally travel distances beyond 4-5 km radius. Beyond the estimated 4-5km radius, people of the Fulani ethnic group navigate. This is to the extent that cattle herds from neighbouring countries from the north invade the country to graze.

There is the need to conduct studies to establish the routes, movement pattern, and impact of such herds on the savanna rangelands of the country.

Such studies could also suggest the relevant community-based interventions to address the seemingly annual alien herd encroachment issue, which appears to plague the ECOWAS sub-region with tension of conflicts.

6.2.3 Annual bush burning

Bush burning is now being discussed nationally. However, the talk itself is like the bush fire. It appears no concrete steps are being taken to address the situation. Location wise, one could identify two types of burning; that which is done within the immediate environs of villages and of town settlements (2-3km radius), and that which is further away. The first category looks promising to be controlled if backed by education.

.There is a saying that the Savanna is a product of fire, meaning fire will always be needed. In spite of the benefits fire has, so far as rangelands are concern the question that need to be answered is; what has been the short term and long term changes in vegetation and grass species due to fire in our Savannas? This probably has to be monitored on a continuous basis.

Burning cannot repair the damage done by overgrazing and I recommend that appropriate authorities such as the Environmental Protection Agency should embark on serious environmental education campaign about the dangers inherent in the use of fire in the grasslands. Also a legislation to give effect to the call for a ban or judicious application of bush fires should be enacted. The role of traditional rulers should be recognised in legislation enforcement.

The Ghana National Fire Service should be adequately resourced to give training to Anti-Bush Fife Volunteers. Volunteer fire fighters should also be adequately resourced.

6.2.4 Land ownership for grazing

Around this part of the country land is communally owned, thus making grazing control and pasture improvement rather difficult. I will like to suggest the system of individual or family land ownership. The traditional authorities or rulers could be involved in drawing out strategies such that there will be an individual ownership of pasture, and the owners take full responsibility for its improvement.

6.2.5 Provision of community stock water

Drinking water supply for range animals is a critical factor in the dry season when streams are dry. The shortage of water causes livestock owners to trek cattle over long distances, causing hardship to both herders and livestock. It is estimated that a total of 104.65 million litters of water were required per day for 18.3 million herd of cattle, sheep, goats, pigs, horses, donkeys, poultry and rabbits in the country in 1994 (Wiafe, 1997). It is therefore important that easily accessibly water is provided all years round.

District Assemblies should be called upon to assist in financing the constraction of dams and dugouts within their districts. Ruminant livestock should be levied as contribution to the construction of new dams and the maintenance of existing ones. An aggressive policy to supply stock water from dams or boreholes should be pursued. Data bases extablished by the CSIR-Water Research Institute should help in locating dams and boreholes.

6.3 POSSIBLE INTERVENTIONS

The farmer's management strategies as observed appear fully inadequate for the effective management of the Savanna rangelands for grazing.These lands as at present have very short or no rest period at all. Lands within the vicinity of the village settlements are grazed, farmed and burnt yearly. The distant lands (above 5-7 km) are also either farmed by the indigenous people and or burnt by alien Fulani herders annually. Known traditional interventions which could enhance the efficient utilisation of the Savanna rangelands in the given crop-livestock farming systeminclude measures such as, planting of fodder trees, fodder conservation (crop residues and hay preparation), non or controlled burning, stock water development and range monitoring and surveillance.

REFERENCES

Alhassan, W.S. and Barnes, P. (1993). Problems and prospects for forage improvement and utilization in Ghana. Procs.XVII Int. Grassland Congress. New Zealand and Australia pp 499-500.

Anthony, Y. (1991). Agroforestry for soil conservation. P. 93-94.

Antognini, J., Quimbly Jr., P. C., Turner, C. E. and Young, J. A. (1995). Implementing effective noxious range weed control on Rangelands.Rangelands 17: 158 –163.

Atkinson, D., Bhatt, K. K. S., Mason, P. A., Coutts, M. P. and Read, D. J. (1983).Tree root system and their mycorrhizas. The Hague : Nijholf, 525 pp.

Baumgartner, D. M., Breuer, D. W., Zamora, B. A., Neuenschwander, L. F. and Wakimoto, R. H. (Eds), (1989). Prescribed fire in the intermountain region: Forest site preparation and range improvement.Washington State Ext. Serv., Pullman, WA.

Begon, M. and Mortimes, M. (1986). Population Ecology : A unified Study of Animals and Plants. 2nd ed. Blackwell Scientific Publications, Oxford.

Boateng, E. (1998). Proceedings of workshop on land use planning. FAO Land Planning Project.TCP/GHA/6715/A.

Brady R. N. C. (1990). Methods of soil Analyses, Two, Vol 1.Agronomy No 9 Am. Soc.of Agron. Madison, Wisconsin.

Bray, S. R. (1963). Chemical tests for avail. P. Soil Sc. 94, 87-95

Bremmer, J. M. and Mulvaney, C. S. (1982). Nitrogen-Total. In: page AL (Ed). of soil analysis. Part 2, Chemical and Microbiological properties.Agronomy Monograph No.9 2nd Edition. American Society of Agronomy – Soil Science Society of America, Madison, Wisconsin, U.S.A. p 395-625.

Dasmann, R. F., Mutan, J. P., and freeman, P. H. (1979).**Ecological Principles for Economic Development.I.V.C.N, Morges, Switzerland and the Conservation Foundation, Washington D. C. U.S.A.**

De Wet, J. M. J. and Harland, J. R. (1975). Weeds and domesticates evolution in the Man-made habitat. Econ. Bot. 29: 99-107.

Deway, S. A. and Torel, J. M. (1991). What is a noxious weed? Pp. 1-4. In: Noxious range weeds. West view Press, Boulder, Co.

Duku, S. (1993). Rangeland herbage accumulation, quality and off-take by grazing livestock in Ghana. Range monitoring project proposal. Animal Research Institute, CSIR, Accra, Ghana 12pp.

Dyksterhuis, E. J. (1949). Conditions and Management of Rangeland based on quantitative ecology. Rangeland Management, 2.

Ernest, W. H. O. and Tolsma, D. J. (1989). Mineral nutrients in some Botswana Savanna types. In: Proctor, J. (ed). Mineral Nutrient in Tropical forest and Savanna Ecosystem.Blackwell Scientific Publication.

Evans, K. E. (1990). Rangeland research: Past, Present, and Future. USDA-FS. Washington, DC. 26pp.

Food and Agricultural Organization, (1990). Soil map of the world.Revised Legend.FAO, Rome, Italy.

Felker, P. (1978). State of the Art, *Acacia albida* as a complementary permanent intercrop with annual crops.Report of USAID. Riverside California USA. University of California 133 pp.

Frandsen, E. And Boe, D. (1991) Economics of noxious weeds and poisonous plants. Pp. 442 – 458. In Noxious range weeds. West view Press, Boulden, Co.

Froud-Williams, R. J. (1984). The influence of straw disposal and cultivation regime on the population dynamics of *Bromus sterilis*.Annals of Applied Biology; 103, 139-48.

Greenland, M.B. (1992). Factors of plant nutrient availability relevant to soil testing.Plant and soil 64.129-138.

Greg, O. H. (1984). Soil, Vegetation, Ecosystems; Conceptual frameworks in geography.

Grewel, S. S. and Abrol, J. P. (1986).Agro forestry on alkaline soils; effect of some management practice on initial growth biomass accumulation and chemical composition of selected tree species.Agro forestry systems. 4: 221-32.

Harold, F. N. and Denis, R. C. (1994).Rangeland Ecology and Management.West view press, Boulder, Co.

Harris, G. A. (1991). Grazing lands of Washington State Rangelands 13: 222-227.

Huenneth, L. (1996). Ecological impacts of invasive plants in natural areas. Proceedings: Western Society of weed science 49: 119-121.

Jerry, L. H., Rex, D. P. and Carlton, H. H. (1998). Range management principles and practices 3rd Edition, p.460.

Jones, M. J. and Wild, A. (1975). Soils of the West Africa Savanna.Technical Communication No. 55. Commonwealth Bureaux of soils. Commonwealth Agricultural Bureaux, U.K. pp. 246

Jordan, G. L. (1985). Range seeding and brush management for Arizona rangelands. Univ. Ariz. Bull. T 81121.

Kabuye, P. S. (1986). Productivity of vegetation in arid countries, the savanna problem and bush encroachment after grazing. In African Pasture land Ecology p118.

Lawson, G. W. (1985). Plant life in West Africa.Ghana Publishing Corporation Ghana.

LPIU.(1997). 1996 livestock census.Ministry of Food and Agriculture, Accra. 55pp.

Mack, R. N. (1981). Invasion of *Bromus tectorum* into western North America: an Ecological Chronicle. Agro-Ecosystems, 7, 145-165.

Mc Donald, P., Edwards, R. S. and Greenhalgh, J. J. D. (1987). Animal Nutrition.4th Edition. Longman group (FE Ltd. U.K.).

McLean, E. O. (1982). Soil pH and lime requirement In: page, A. L. (ed.) Methods of soil Analysis part 2. Chemical and Microbiological properties.Agronomy Monograph No.9.2nd edition.Pp199-224.

Miller, D., Karbo, N., Bruce, J. and Otchere, E. O. (1998). Group formation and West African Shorthorn cattle development among the konkombas and Chokosi of the Saboba-Cheriponi District of the Northern Region. Technical Report, Animal Research Institute. March 1998. 28pp.

Ministry of Food and Agriculture, (1998). National soil fertility management action Plan.Directorate of Crop Services. Accra 159pp.

Nelson, D. W. and Sammers, L. E. (1982). Total Carbon, Organic Carbon and Organic matter. In: page A.L. (ed.), Methods of Soil Analysis part 2. Chemical and Microbiological properties.Agronomy Monograph No.9.2nd edition. PP, 539-579.

NRI.(1996). Ghana renewable natural resources profile, Cathom, UK.

Ochse, J.J., (1961). Tropical and sub tropical Agriculture. Macmillan, London. Two Volumes.

Olsen, S. R. and Sommers, L. E. (1982). Phosphorus In: page AL (ed.), Methods of Soil Analysis part 2. Chemical and Microbiological properties. AgronomMonograph No.9. 2nd edition. American Society of Agronomy, Soil Sc. Soxiety of American, Madison, Wisconsin, USA pp. 403-430.

Parker, C. (1983). Factors influencing Striga seed germination and host-parasite specificity. Proceedings of second international workshop on Striga, 5th –8th October 1981, IDRC/ICRISAT, Ouagadougou, Upper Volta pp31-38.

Pimentel, W. (1999). Invasive species. GOV: The Nation's Invasive Species Information System.

Platt, K. B. (1995). Plant control – some possibilities and limitations. 1. The challenge to management. J. Range Mgt. 12: 64-68..

Rocte, B. (1989). Knapweed Newsletter 3(4): 1

Roger, L.S., Janet, K.P. and Michael, M.B. (1997). Biology and Management of Noxious Rangeland Weeds.Island Press, Washington, D.C.

Rose-Innes, R. (1977). A manual of Ghana grasses. Resources Division, Ministry of Overseas Development. Polwarth Tower, Surbiton, Surrey, England.KTC TOY. 265pp.

Russel, E.W. (1973). Soil conditions and plant growth. 10th ed. Longman, London Pp849.

Salisbury, E.J. (1961). Weeds and Aliens. London: Collins.

Sampson, A.W. and Schultz, A.M. (1957). Control of brush and undesirable trees.FAO Forestry Division Rome.

Seatz, L. F. And Peterson, H. B. (1964).**Acid, alkaline, saline and sodic soils. P 292 – 319. In F. E. Bear (ed) – Chem. Of the soil. 2nded. Var Nostrand Reinhold Co., New York.**

Stanford, T. (1983).Cited by Rex, D.P., Jerry, L.H. and Carlton, H.H. (1998). Range Management Principles and Practices. 3rd edition.

Telly, E.M. (1997). Some traditional mechanism for protecting the environment. In Biodiversity conservation: Traditional knowledge and modern concepts (ed. Amlalo, D.S., Atsiatorme, L.D. and

Fatis, C.). Proc. 2nd UNESCO MAB Regional seminar on biosphere resources for biodiversity conservation and sustainable development in Anglophone Africa (BRAAF). Cape Coast EPA. Accra, Ghana. Pp. 48-50.

Terry, P.J. (1983). Some common crop weeds and their control, UDSID, Senegal.

Thomas, G.W. (1982). Exchangeable cations. In: page AL (ed.), Methods of Soil Analysis part 2. Chemical and Microbiological properties. AgronomMonograph No.9. 2nd edition. American Society of Agronomy, Soil Sc. Society of American, Madison, Wisconsin, USA pp. 159-165.

United State Department of Agriculture, (1965).**Losses in Agriculture.U.S.D. A – A.R S. Handbook No. 291**

Whittaker, R.H. (1970). Communities and Ecosystems. Macmillan, London.

Whittaker, R.H. (1977). Communities and Ecosystems, 2nd ed. Macmillan, New York.

Wiafe, K. (1997). Information binding block.Volume 1.Volta basin system.Irrigation, Annex 2.Ghana water resources management study.10pp.

World Bank (1992). Staff appraisal report.Republic of Ghana.National Livestock Services Project. Report No. 11058-GH. Western Africa Department.Agricultural Operations Division IV. 131pp.

World Resources Institute (1986). The Western range.Senate Document 199. Basic Books Inc., NY. 353pp.

Young, A. (1991). Agroforestry for soil conservation P93-94.

Zimmerman, C.A. (1976). Growth Characteristics of Weediness in *Portulacaalerocea*. L. Ecology 57: 964-974.

Appendix 1

Relative Abundance of plant species identified in the Experimental and Control sites

	RELATIVE ABUNDANCE (%)	
NAME OF SPECIES	EXPERIMENTAL	CONTROL
Acanthospermum hispidum	2.8	0
Anchomanes Sp.	0.4	0.2
Andropogon gayanus	2.5	0.8
Andropogon pteropholis	1.6	0.8
Andropogon Sp.	0	0.8
Aristida verstingii	4.8	2.1
Arundinella pumila	1.6	1.7
Asilia helianthiodes	0.5	0.2
Asparagus africanus	0.7	0.3
Biophytum petersianum	1.9	0.7
Boerhavia coccinea	0.7	0.9
Boerhavia difusa	1.4	0.6
Boraria scabia	1.7	0.5
Branchiaria distichophylla	1.3	0
Bulbostylis metrailis	0.8	0
Cassia obtusfolia	2.2	1.2
Commelina erecta	0.5	0.6
Corchorus aestuans	0.3	0
Ctenium newtonii	2.1	0.5
Cyperus iria	1.1	0
Cyperus rotundus	1.0	0.5
Desmodium Sp.	0.3	0.1
Echinochloa obtusifiora	0.6	0.6
Eleusine indica	1.7	0.8
Euciasta candylotricha	4.2	1.4
Euphobia Sp.	0.3	0.1
Euphorbia hirta	1.6	0.9
Fiurera umbrellata	1.6	1.2
Heteropogon contortus	1.9	0.9
Hibiscus surattensis	1.8	0.6
Hyparrhenia Sp	1.5	0
Imperata cylindrica	2.2	1
Imperata cylindrica	1.8	1.1
Impomoea eriopcarpa	0.6	0.8

Appendix 1 (con'd)

	Experimental	Control
Indigofera hisuta	1.4	0.6
Indigofera tetrosperma	1.7	0.5
Jasminum berstingii	0.3	0
Lepidagathis anabrya	0.6	0
Mitracarpus villosus	1.2	1
Panicum Sp	0	1.7
Pannisetum purpureum	1.1	0.9
Parohyparrhenia annua	5.3	1.9
Paspalum conjugatum	1.03	0
Paspalum orbiculares	1.4	0
Pennisetum hordeoides	2.2	0.4
Pennisetum pedicellatum	2.6	1.3
Pennisetum polystachyon	1.7	1.1
Rottboelia exaltata	0.6	0.2
Rottboellia cochinchinensis	0.9	0.5
Setaria pallindefusca	2.3	0.8
Sida acuta	4.5	1.7
Sporobolus pyramidalis	1.3	0.8
Sporobolus suloglobosus	2.5	1.4
Striga hermontrica	0.9	0
Stylochiton lanceafolius	1.9	0.3
Tephrosia elegans	2.7	0.8
Tephrosia platicarpa	1.1	0.6
Tephrosia purpurea	2.2	0.8
Tripogon minimus	4.3	1.4
Triumfetta dubia	0.5	0
Vigna pubigera	3.7	0.7

Appendix 2

QUESTIONNAIRE SURVEY

Questionnaire survey prepared for Pastoralists in the Tolon –Kumbungu District (Grove cluster of villages), in the Northern Region.

This questionnaire is for academic purposes only, and all information obtained will be treated as confidential and private. Appreciation is attached to your co-operation.

1.What is your name sir? …………………………………………………………………………

2.How long have you lived in this area? ……………………………….

3.How many animals (ruminants) do you have? (Cattle( ) Sheep( ) Goats( )

4.When did you start rearing cattle?…………………………

5.How do you feed your cattle?………………………………

6.Can you name the plants (Grasses) on which your cattle feed?……………………

7. What are the sources of water for your animals?

□ Dams □ Dug out □ Bore hole□ River/Stream □ Pipe-borne

8.What is your perception about the range condition now?

□Condition decline □ Condition improved □ No change in condition

9.What causes the change in range condition?………………………………

10.Do you have any idea of the type of grass species lost over the period? □Yes: □No

If yes list them:……………………………………………………

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11. Have you observed any strange (invasive) grass species in the grazing area?
□Yes: □No

If yes list them:…………………………………………………………

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12 .Do these strange species pose any problems to you or your animals? □Yes: □No

If yes specify some of these problems:…………………………

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13.How do you manage these weeds (invasive species)?

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14.What are the constraints you face when managing these weeds?
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