DETERMINATION OF BIOMASS AND CHEMICAL COMPOSITION OF BROWSE SPECIES USED FOR FEEDING LIVESTOCK DURINGLATE DRY SEASON IN MARADI ; NIGER REPUBLIC

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A DISSERTATION SUBMITTED TO THE DEPARTMENT OF ANIMAL SCIENCE, FACULTY OF AGRICULTURE, BAYERO UNIVERSITY, KANO. IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF DEGREE OF

MASTER IN ANIMAL SCIENCE

JUNE, 2017

DECLARATION

I hereby declare that this work is a product of my own research efforts undertaken the supervision of ProfessorI.R Muhammad, and has not been presented and will not be presented elsewhere for the award of a degree or certificate. All sources have been duly acknowledged.

……………. …………………

ABOU ALHASSANE ASSAD Date

CERTIFICATION

This to certify that the research work for this dissertation and subsequent preparation of this dissertation by ABOU ALHASSANE ASSAD (SPS/13/MAS/00016) were carried out under our supervision, meets the regulations governing the award of the degree of master of science of Bayero University, Kano, Nigeria, and is approved for its contribution to knowledge.

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APPROVAL

This is to certify that the research work reported here titled DETERMINATION OF BIOMASS AND CHEMICAL COMPOSITION OF BROWSE SPECIES USED FOR LIVESTOCK FEEDING IN THE LATE DRY SEASON IN MARADI; NIGER REPUBLIC)has been examined and approved for the award of the degree of Master of Science in Animal Science of Bayero University, Kano Nigeria

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ABSTRACT

The objective of this work was to assess the browse species fed to animals kept, their yield, nutritive value and antinutritive factors. Two studies were conducted. Study one was questionnaires administered to farmers in Magami (13^0 25' and 7^0 32'E) to identify the browse species used by livestock rearers during the late dry season. In study two, five browse species were sampled for biomass determination by harvesting three medium branches from shrubs and trees. A medium branch of 15±5cm diameter from shrubs of 1m height and 85±45cm diameter from trees of 5m height were harvested. All the harvested branches were defoliated and dried. Biomass was estimated by multiplying the number of branches by the quantity of dry leaves. Samples collected were analysed for proximate composition (Moisture, DM, CF, CP, Ash, and EE), fiber components (NDF and ADF) and antinutritional factors (tannin, oxalate, phytic acid, saponin and hydrogen cyanide. The results showed that 30% of animal combinations (Sheep, Cattle and Goat) were kept followed by Goat and cattle (20%). Major browse species identified were *Piliostigma reticulatum* and *Guiera senegalensis.* Findings from experiment two revealed biomass productivity of dry matter yield for leaves per tree was 129.40Kg *Piliostigma reticulatum,* 128.42Kg *Faidherbia albida*, 69.59Kg *Diospyros mespiliformis*, 21.69Kg *Lannea microcarpa* and 10.58Kg *Guiera senegalensis.* Crude protein contents ranged from 13.36% to 16.61% in *Piliostigma reticulatum* and 14.05% to 15.49% in *Guiera senegalensis*. ADF and NDF ranged between 33.57% and 36.07%, and from 56.20% to 56.77%, respectively. The antinutritional factorsevaluated in both*Piliostigma reticulatum and Guiera senegalensis*werehigher expected in HCN. It is thus, concluded that the major browse species fed to animals kept picket were *Piliostigma reticulatum and Guiera senegalensis.* It is recommended that propagation of more browse species to facilitate livestock rearing and safe guard the environment be a subject of interest.

CHAPTER ONE

1.0 INTRODUCTION

1. 1BACKGROUND OF THE STUDY

Inhabitants of the Sahelian zoneskeep animals which areclosely associated with the social habits and welfare of the rural households. The use of livestock as gifts, for dowry or slaughtering for traditional feasts or religious ceremonies reinforces family and social links. Livestock also represent a mean of saving, a food reserve in times of crop scarcity, and an important asset for investment and insurance. Hence, it contributes to the flexibility and the stability of the food production systems and the total agricultural economy (Bradford, 1999).

Fodder from trees and shrubs represent an enormous potential source of protein for ruminants in the tropics.They represent natural feed resources without which the survival oflivestock would be impossible in the Sahelianzones(Le Houerou, 1980; Attah-krah, 1989).The contribution of browses to ruminant feeding in terms of quantity and quality constitute 35% of total biomass available on rangeland (Breman and Ridder, 1991).Trees and shrubs are increasingly recognized as important components of animal feeding, especially as suppliers of protein. Fodder trees and shrubs have always played a role in feeding livestock. In difficult environmental conditions, where the available grazing is not sufficient to meet the maintenance requirements of animals for part of the year, the contribution from trees and shrubs is significant. Tree fodders contain high levels of crude protein and minerals and many show high levels of digestibility (Seyoum and Zinash, 1998).Tree fodders are important in providing nutrient to grazing ruminants in arid and semi-arid environments, where inadequate feeds are a major constraint to livestock production (Aganga and Tshwenyane, 2003). Tree fodders maintain higher protein and mineral contents during the seasons than do grasses (Shelton, 2004). The productivity ofthese pastures is subjected to high variability between and within years, related to rainfall and seasons. The increase in human population has led to an increase in cropland area, decreasing the area used for grazing and encroaching on better pastures (Hiernaux, 1996). However, livestock production in arid region faces many constraints, the most important being feed shortage (Grouzis, 1988). During the dry season, ruminant diets are limited by shortages in amount and quality of available forage (Shelton, 2004), crop residues or by products (Babayemi *et al*., 2004) which result in reduced livestock productivity in the tropical countries (Odenyo *et al*., 1997). Many tropical tree fodders contain high concentrations of toxic compounds particularly tannins (Salem and Salem, 2006) that can be reacting and with other nutrients (Mangan, 1988) and could have detrimental or beneficrerial effects on animal nutrition (Waghorn and McNabb, 2003).

1.2PROBLEM STATEMENT

The combined effects of fast demographic growth and extensive surface cultivation, have had a negative effect on the natural pastures (Steinfeld *et al.,* 1999; Jamin *et al.,* 2003). There is also an unfavourable seasonal variation, which is characterized by low and irregular rainfall (Grouzis and Albergel, 1989). All these factors have led to a considerable reduction in area and productivity of the pastures.However,browse plants beside grasses constitute one of the cheapest sources of feed for ruminants. The diversity and distribution of the tropical browses have been shown to contain antinutritional substances in their biomass that affect their optimal utilization by animal (Odenyo, 1999). The overexploitation of the woody forage, combined with the harsh climate and very frequent bush fires in semi- arid areas, affect the possibilities of regeneration of some species (Wotto, 2003; Thiombiano, 2005; Ouedraogo, 2006). This causes the disappearance of species of high forage value for the benefit of less palatableof low pastoral interest yet adapted to the environmental conditions.

In any case, there is high recognition of the value of browse plants as livestock feed. However,qualitative data of the contribution is scarce.

1.3JUSTIFICATION OF THE STUDY

Fodder from trees and shrubs provideproteins, minerals and vitamins essential to a balanced diet of livestock (Dicko *et al*., 2006).The use of the woody forage, combined with the harsh climate and very frequent bush fires in semi- arid areas, affect the possibilities of regeneration of some species (Wotto 2003; Thiombiano, 2005; Ouédraogo, 2006).

To deal with this challenge, livestock farmers have tried to find different solutions, one of which is the intensified use of browse species (Gautier *et al*., 2005). As a result, some species are overexploited and threatened (Ouédraogo*et al*., 2006). This situation contributes to the environmental problems in semi-arid region (Fries and Heermans, 1992; Wiegand*et al*., 2006). Consequently, a more sustainable plan for the use of these fodder species has to be developed. However, this cannot be done without sufficient knowledge about the species in question in terms of their qualitative and quantitative potential contribution to livestock feed.

1.4OBJECTIVES

The main objective was to determine the browse species usedand their contribution to livestock feeding at the late dryseason.The specific objectives were to:

1.Identify the different browse species used in feeding animals atstake inthe late dry season in Magami

2. Determine the chemical composition of the browse species fed to animalsat Stake in Magami

3. Estimate the biomass of common plants species used of feeding animals in Magami

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 IMPORTANCE OF LIVESTOCK

Products and services provided by livestock are used by humans to provide a wide range of products and services. Foods derived from animals are an important source of nutrients (Givens, 2010) that provide a critical supplement and diversity to staple plant-based diets (Murphey and Allen, 2003; Randolph *et al.,* 2007). However, there are other reasons for keeping livestock, which include providing manure, fibre for clothes and resources for temporary and permanent shelter, producing power, and serving as financial instruments and enhancing social status. This range of products and services supporting livelihoods especially of the poor is a key feature of livestock. Until recently, a large proportion of livestock in developing countries was not kept solely for food. Due to an on-going trend away from backyard and smallholder livestock production to more intensive and larger-scale systems (FAO, 2010), many purposes for which livestock are kept, are vanishing and being replaced by an almost exclusive focus on generating food.

Animal source foods (ASF), mainly meat, milk and eggs provide concentrated, high quality sources of essential nutrients for optimal protein, energy and micronutrient nutrition (especially iron, zinc and vitamin B_{12}). Access to ASF is believed to have contributed to the evolution of the human species' unusually large and complex brain and its social behaviour (Milton, 2003; Larsen, 2003). Today, ASF contribute a significant proportion to the food intake of Western societies (MacRae*et al*., 2005), but also play an increasingly role in developing countries. Since the early 1960s, ASF consumption has increased in all regions except Sub-Saharan Africa. The greatest increases occurred in East and Southeast Asia, and in Latin America and the Caribbean (FAO, 2010). Structural changes in food consumption patterns occurred in South Asia, with consumer preference shifts towards milk and in East and Southeast Asia towards meat, while no significant changes could be detected in the other developing regions (Pica-Ciamarra and Otte, 2009). The growing demand for livestock products, a development termed the ‘livestock revolution’ (Delgado *et al*., 1999; Pica-Ciamarra and Otte, 2009) has been driven mostly by population growth in developing countries, while economic growth, rising per-capita incomes and urbanization were major determinants for increasing demand in a limited number of highly populated and rapidly growing economies. This has translated into considerable growth in global per capita kilocalorie intake derived from livestock products, but with significant regional differences. World population is projected to surpass 9 billion people by 2050. Most of the additional people will be based in developing countries while the population of developed regions is expected to remain stable (UNDP, 2009). About 3 billion new middle class consumers may emerge in the next 20 years (Mckinsey, 2011). The concomitant ‘nutrition transition’ results in diet changes from staples to higher value foods such as fruit, vegetables and livestock products.

Longer and more complex food chains have increased food diversity available for consumers, but also resulted in more common diets (Nugent, 2011). FAO projects that by 2050, global average per-capita food consumption could rise to 3130 kilocalorie per day. Agricultural production in the next 30 years will therefore present unprecedented challenges; it would need to increase by 60 per cent by 2050, with increases in crop and livestock production. Compared with 2005/07, this requires an additional production of 1 billion tonnes of cereals and 200 million tonnes of meat annually. Approximately half of the total increase in grain demand is predicted to be for animal feed. Globally, meat consumption per capita per year will increase from 41 kg in 2005 to 52 kg in 2050, reaching an average of 44 kg in developing countries and 95 kg in developed countries (OECD-FAO, 2009; Bruinsma, 2011; FAO, 2010). Despite the absolute increase, growth rates in overall agricultural production are expected to decelerate as a consequence of the slowdown in population growth and because a growing share of population will reach medium to high levels of food consumption (Bruinsma, 2011). Although global average production has increased, under- and malnutrition remains a large problem for those without access to animal source food and with food insecurity (Neumann *et al*., 2010) especially for poor children and their mothers. High rates of under nutrition and micronutrient deficiency among the rural poor suggest that, although often keeping livestock, they consume very little ASF. As iron, zinc and other important nutrients are more readily available in ASF than in plant-based foods, increased access to affordable ASF could significantly improve nutritional status, growth, cognitive development and physical activity and health for many poor people (Neumann *et al*., 2003). On the other hand, excessive consumption of livestock products is associated with increased risk of obesity, heart disease and other non-communicable diseases (WHO/FAO, 2003; Popkin and Du, 2003; Nugent, 2011).

2.2SOCIO-ECONOMIC CONTRIBUTION OF LIVESTOCK

Livestock husbandry is an important form of agriculture in the world. It is practiced in various forms, such as mixed farming, nomadic herding, commercial grazing, etc. This activity is very closely related to agricultural activity/production, as cultivation receives input from livestock and, in turn, provides output from livestock in the form of animal feed (Khan *et al;*2006). An important form of diversification of agriculture has recently emerged in the livestock sector in many developing countries like India. Employment generation for millions of poor and small rural landholders is also served by this sector. It provides a significant contribution to the national economy. Approximately 75% of the world's poor live in rural areas. For most of these people, livestock are an important part of their livelihood. In rural India, where over 15- 20% families are landless and about 80% of landholders belong to the category of small and marginal farmers, livestock is their main source of livelihood.

The unaffordability of modern inputs such as tractors and fertilizers for poor farmers is compensated by livestock husbandry (Info resources, 2007).

Livestock constitutes a vital element of food security requirements through provision of meat, milk and eggs. Furthermore, animals provide income from sales of live animals and/or their derived commodities (e.g. milk, meat, eggs, wool, hides and skins). Livestock manure presents a useful source of soil and environment-friendly fertilizer, a crucial ingredient in intensified agriculture. In some countries the utilization of livestock traction power in land tillage is crucial for the resource poor rural farmer. It is estimated that in Sub-Saharan Africa livestock contribute approximately US$ 14 billion per year to the agricultural output (FAO, 2010). About US$ 9 billion of this amount is in the form of meat, milk and leather while US$ 5 billion is inthe form of natural fertilizer and draft power. In addition, livestock provide clothing and shelter. Livestock also provides opportunities for gainful employment to many people either directly or indirectly in livestock dependent industries. It represents the sole source of employment for over 12 million pastoralists from the 160 million people, who own livestock in Africa (FAO, 2010).

Domestic livestock play important roles in socio-cultural values and practices in pastoral communities. Animals also provide opportunities for the utilization of damaged or surplus crops that would otherwise be wasted. The significant role played by livestock farming in rural poverty reduction demands sustained increase in healthy livestock production as an essential tool to poverty alleviation and enhancement of food security in sub-Saharan Africa. At a recent Heads of States Summit, under the auspices of the "New Partnership for Africa's Development" (NEPAD) initiative, African leaders acknowledged the importance of animal resources for the economic development in this sector.

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2. 3. LIVESTOCK MANAGEMENT SYSTEMS

2.3.1 Rotational Grazing Systems

A common goal of rotational grazing systems is to increase forage production by controlling the frequency and intensity of pasture defoliation (Ruane and Raftery, 1964). Rotational grazing is a system where a large pasture is divided into smaller paddocks allowing livestock to be moved from one paddock to the other easily. Using this method cattle are concentrated on a smaller area of the pasture for a few days then moved to another section of pasture.

This movement allows the grazed paddock a rest period that permits forages to initiate regrowth, renew carbohydrate stores, and improve yield and persistency. When utilized properly, rotational grazing can help farmers increase forage productivity. Rotational grazing can help improve productivity, weight gain or milk production per acre, and overall net return to the farm. Rotational grazing allows for better manure distribution that acts as a source of nutrients to the soil. Rotational grazing also has the potential to reduce machinery cost, fuel, supplemental feeding and the amount of forage wasted.

The disadvantages of rotational grazing include the need for more fences to be constructed, time required to move cattle, and the need to have water and access to shade from each smaller paddock. The use of temporary fence is an inexpensive way to divide fields into the smaller paddocks and can be moved based upon the producers' preference.

2.3.2 Continuous Grazing Systems

Continuous grazing is when cattle graze a pasture for an extended amount of time with no, or infrequent rest to the plants from grazing. Advantages of this method are low fencing cost, low daily management requirements, and when stocking rate is correct, acceptable animal gains. This method is most effective where forage availability is plentiful and the manager does not wish to increase livestock numbers. Continuous grazing is more successful when implemented with dry cows, bred heifers, and beef cows of moderate to low milking ability. When implemented with lactating dairy cattle, stocker calves, or other animals that require better quality forages, they may not perform to their potential. One disadvantage of continuous grazing is the difficulty in controlling the timing and intensity of grazing. Another limitation of this system is during slow forage growth periods animal numbers need to be adjusted, or more acreage available for grazing. Continually grazing a pasture with too many animals will lead to reduced forage availability and quality and animal growth(Holechek *et al*., 1987).

A continually grazed pasture will take longer to recover after a drought than a pasture that has been rested because the plants are more stressed. Another disadvantage to continuous grazing is the limited number of forages that can withstand the grazing pressure.

2.3.3Deffered-Rotation

Deferred-rotation grazing was first developed in 1895 and later implemented in the early 20thcentury byArthur Sampson (the “father of range management”) in the Blue Mountains of Oregon. Sampson’s systeminvolved dividing the range into 2 pastures with each pasture receiving deferment until seed set every otheryear. Several modifications of deferred-rotation have been used involving more than 2pastures, however, itskey feature is that each pasture periodically receives deferment (typically every 2 to 4 years, depending onthe number of pastures).In the tallgrass prairie, individual animal performance decreased with deferred-rotation compared to continuous grazing (Owensby *et al.,* 1973), possibly due to lower forage quality (i.e., older, more mature forage) in the deferred pastures.

2.3.4.Rest-Rotation

The rest-rotation system was designed by Gus Hormay of the U. S. Forest Service and was first implementedin the 1950s and 1960s. Although the original system was designed to rotate grazing and rest periods among 5 pastures using 1 to 3 herds over a 5-year cycle (Hormay, 1970), other variations of rest-rotation have used 3 or 4 pastures in a 3 to 4 year cycle. Hence, under rest-rotation, 1 or 2 pastures are rested the entire year while the remaining pastures are grazed seasonally, depending on the number of pastures and herds.

For example, 1pasture in a 3-year, 3-pasture rest-rotation might be managed as follows during a 3-year cycle:

1) Graze the entire year or growing season, 2) Defer, then graze, and 3) Rest. This schedule rests about 1/3 of the range annually.

Rest-rotation has shown superiority over continuous and season-long grazing on mountain ranges where cattle may heavily use riparian areas under all grazing strategies (Platts and Nelson, 1989). Rest provides an opportunity for the vegetation around natural or developed water to recover and helps meet multiple use objectives (e.g., providing hiding cover for birds and mammals, leaving ungrazed areas for public viewing and enjoyment). Hence, rest-rotation provides many of the advantages for riparian habitats discussed under deferred rotation.

Additionally, rested pastures provide forage for emergency use during severe drought years, and provide opportunities to implement relatively long-term rangeland improvement practices (e.g., burning, reseeding, brush control) during scheduled rest periods. However, a disadvantage of all grazing systems that periodically exclude livestock is that elk or other wild herbivores may graze "rested" pastures, negating some of the benefit of rest or deferment from livestock grazing (Halstead, 1998).

Other disadvantages cited for rest-rotation are reduced individual animal performance due to forced animal movements from pasture to pasture, and increased stocking density in grazed pastures, which canreduce dietary selectivity (Gray *et al.,* 1982). However, this criticism may emanate more from failure to properly adjust stocking rates to compensate for resting 20 to 40% of the total grazing areaeach year, rather than a definite failure of rest-rotation. For example, research on mountainous range in northeastern Oregon showed that cattle weight gains per hectare or per animal did not differ among rest-rotation, deferred-rotation, and season-long grazing systems when utilization averaged about 35% for each system over a 5-year period (Holechek *et al.,* 1987). The point to remember is that the benefits of a full year of rest can be nullified if previously rested pastures are overgrazed, particularly in arid regions where frequent drought conditions can impede rangeland recovery (Cook and Child, 1971; Trlia *et al.,* 1977).

2.3.5 Picket or Stake System

The stake or picket is a practice where supplements (crop residues) can be distributed to livestock. In fact, herders consider picking as a flexible and intensive, reasoned and economical for agricultural management tool. This picket practice requires little investment and allows optimal exploitation to reduce or fragment pasture areas. The management of Livestock kept picket have also made possible several occasions to better understanding the relationships between livestock and grass and also allow to identify the intrinsic characteristics to optimize the feeding of the ruminants in true grazing situation (Boval *et al*;2010).

2.4 ESTIMATE OF FORAGE YIELD

2.4.1 Forage Crop Production

Cultivated fodder species are of two types: grasses and legumes. According to Boyer (1986) and Fall *et al.* (2005), their yields vary based on a range of factors (rainfall for rain fed system or quantity and frequency of applied water for irrigated system, soil preparation, sowing date, density, soil fertilization, harvesting, drying and conservation techniques, etc.). In general, grass seeds are difficult to collect and have low germination rates. The annuals include non-cultivated but also cultivated species (sorghum, millet, peanuts and corn grown for forage). The perennials are easy to multiply vegetatively and are more resistant to trampling, grazing and bush fires. The most common local species is *Andropogon gayanus*. When planted, these grass species require fertilization and can yield up to 22 t ha-1 of biomass (Fall *et al.* 2005). Forage maize, sorghum (Sanon and Kanwe, 2004) and millet (Pasternak *et al.* 2012) have also been tried but never reach the large scale adoption in the Sahel as farmers in this area value the grain more than the forage.

Legumes constitute the second group of cultivated fodder species. For this group, many exotic species, mostly Australian herbaceous species and their cultivars (*Stylosantheshamata, Macroptiliumatropurpureus, Mucunaaterrina, Macroptiliumpurpurreum, Stylosanthesgracilis, Vignaunguiculata, Lablab purpereus, Dolichos lablab*, etc.), have been introduced in the Sahel and screened on-station based on their bio-chemical and nutritional composition, fertilizer requirements, persistence, management and use as forage legumes (Birie- Habas and Thirouin 1965; Thomas and Sumberg,1995). In general, they are annuals, germinate well but are less resistant to grazing than grasses and need to be planted annually. Being legumes, most are N-fixers and do not require mineral fertilization except for phosphorus at a rate of 50-200 kg ha-^{1} since most of the Sahelian soils are deficient in this nutrient.

2.4.2 Forage Browses

2.4.2.1**Indigenous Knowledge on the Use of Browse Species in Animal Feeding**

Local people generally recognize the trees and shrubs which are well appreciated by ruminants, and their nutritive importance (Thapa*et al*., 1997; Briggs *et al*., 1999; Thorne *et al*., 1999; Komwihangilo *et al*., 2001). The role of browse during periods of drought has been recognized and has attracted attention from scientists. Thus, important information was collected at the International Conference of Browse in Africa, dealing with various aspects of -browse plants (Le Houérou, 1980). For the improvement of forage production, the screening of browse plants and evaluation of biomass production has concentrated on improved species such as *Leucaena leucocephala and Gliricidia sepium*, for which planting material and information are available from international sources. Hence, some authors have recently focussed on screening indigenous fodder trees and shrubs by involving farmers in the choice of promising species. Indigenous browse species are well adapted to the local environment, are well known by farmers and the planting material can easily be collected in the area.

The methods have consisted of interviews with informants on the diversity of browse species and their knowledge of their palatability by livestock (Scones, 1994; Komwihangilo *et al*., 1995; Roothaert& Frankel, 2001; Okoli *et al*., 2003), the ranking of browse quality coupled with chemical analysis (Bayer, 1990; Scoones, 1994) and the preference of selected animals (Mtengeti&Mhelela, 2006). It appears that local farmers can generate richer data, as the area under consideration will not be limited to direct observation in paddocks as in many studies. Over 160 species were recorded by Okoli *et al.* (2003), working with indigenous farmers in south eastern Nigeria, as used for ruminant feeding, and this list exceeded the previous report in the literature from the area. The ranking of fodder quality revealed that the farmers' knowledge of the quality is well correlated with the chemical composition. The knowledge of the palatability in different animal species was also in accordance with the field observations. Hence, farmers' preference of browse species was related to the availability, palatability and drought resistance.

According to Niamir (1990) local people also have an intimate knowledge of the characteristics and value of different plants e.g. their value in stimulating milk and meat production, the toxicity, saltiness and medicinal value, the ability to indicate the agricultural potential of soil and the prominent characteristics such as prolific fruiters and fast growth. The studies stressed the advantages of a survey of farmers that are quick, compared to direct observations, and give relatively reliable information on the complexity of browse species. In consequence, these surveys are shown to be fundamental in identifying fodder species for further research and development programmes to improve productivity.

2.4.3 Availability of Browse Fodder

2.4.3.1Availability in Space

The relative density of browse plants associated with flora diversity in different pasture types reflects the availability of browse in the area. The inventory of woody flora showed a difference in woody flora diversity according to pasture type. These differences could be explained by varied ecological conditions such as edaphic factors, gradient of humidity, and soil depth. However, human activities could also have some influence, and the physiognomy of shrubby steppe could be the result of cultivation and selective cutting of trees, hence the specific poverty of woody flora and low density of plants. The density observed in sparse woody steppe was higher than the overall density (298 plants/ha) obtained by Couteron & Kokou (1997) in the semi-arid savannah of Burkina Faso.

2.4.3.2 Availability in Time

Phenology is the study of the times of recurring natural phenomena especially in relation to climate. The word is derived from the Greek Phainomai to appear, come into view, and indicates that phenology has been principally concerned with the dates of first occurrence of natural events in their annual cycle (Free Encyclopaedia 2009). According to Le Floch (1969) plant phenology refers to the study of the relations between the morphological and physiological periodicities of the plants and those of active ecological variables, especially climate.

Thus the timing of flushing and shedding of the leaves, the flowering and the fruiting are considered, and give an insight into the availability of forage from trees and shrubs during the different seasons. However, the phenology of plants is variable, depending primarily on the intrinsic factors of the species and the climatic conditions of the area (Poupon, 1979; Piot*et al*., 1980; Grouzis&Sicot, 1980). The species studied flushed as soon as the rainy season started, but the shedding of the leaves was shorter for *Acaciasenegal*than for

Pterocarpuslucens and *Guiera senegalensis*, and allowed them to be classified into two groups: deciduous and semi-deciduous species. Deciduous species lose their leaves, while semi-deciduous species have the ability to use water reservoirs in deep layers or close to a river system and a strategy to reduce water loss in the dry season by the scleromorphic feature of their leaves (de Bie*et al*., 1998). Borchert (1994) stated that the seasonal variations in tree water status are the principal determinant of both phenology and distribution of tree species in tropical dry forest. Tree water status is determined by the availability of subsoil water and a variety of biotic factors, such as structure and life span of leaves, time of leaf shedding, wood density and capacity for stem water storage, and depth and density of the root systems.

The availability of subsoil moisture is shown to vary widely depending on the site, and determines the degree of dessication observed in trees with low stem water storage. *Acaciasenegal* was selected in sparse woody steppe, a site with loamy sands soil and apparently well drained, while *Guiera senegalensis* was selected in lowland with gley loamy sandy soil and *Pterocarpuslucens* in tiger bush with mostly loamy thin soil. The characteristics of these sites could influence the difference in phenology among the three species. If different sites had been considered for each species, one could have had an insight into site effect. The species were, however, selected in the site where they were dominant, which could indicate the area of predilection i.e. the favourable ecological niche.

For *Acacia senegal*, which showed early shedding of leaves, the root system could be the cause, as noted by Gaafar*et al.* (2006), who showed that the concentration of lateral and fine roots of *Acacia senegal* was maximal in the topsoil (0-75 cm), even if the trees was also able to partially utilized water from below 75 cm soil depth, especially during the dry season when the water in the topsoil was depleted.*Guiera senegalensis* has been shown to have deep root system which is extensive enabling the plant to access soil water several meters away both horizontally and vertically (Breman & Kessler, 1995; Seghieri&Simier, 2002). In addition, Seghieri *et al*. (2005) reported *Guiera senegalensis* to be tolerant to drought sétress, due to its ability to open stomata at low water potential. This combination of strategies in *Guiera senegalensis*has been shown to increase the period of photosynthetic activity during the dry season and could contribute to the maintenance of this shrub as a dominant species in the Sahelian landscape (Seghieri *et al.,* 2005). Similar explanation with regard to root system could be valid for *Pterocarpuslucens*. In tiger bush, where it was selected, established trees and shrubs have been shown to exploit soil moisture reserves laterally or by sending roots to deeper, wetter soils.The phenology of *Acaciasenegal*was somewhat different from that reported by Ickowicz*et al.* (2005) and Hiernaux *et al.* (1994).

The difference can be explained by different site conditions and/or rainfall, which determine soil water availability, or maybe the relative air humidity as revealed by Do *et al.* (2005), who noted that interannual variation of canopy phenology is mainly tuned to atmospheric conditions. Indeed some sporadic leaf flush was observed in March 2005, a period not considered in the present study, and can be explained by this phenomenon, as no rain had fallen during this period. Such behaviour is shown to maximize the duration of high photosynthetic activity below a threshold of evaporative demand. This phenological variable in browse plants is fundamental in Sahelian rangeland, as it determines the availability of browse fodder to animals in all season.

2.4.4Role of Browse Plants in the Production Systems

Browse refers to leaves and twigs from shrubs and trees available to ruminants as feed and in a broader sense including also flowers and fruits or pods. The notion of browse is a complex issue, as discussed by Le Houérou (1980), depending on plant species, animal species, forage availability and accessibility and the nutritional state of the animals. Wicken (1980) estimated that the flora of tropical Africa contains more than 7000 species of trees or shrubs of which at least 75% are browsed to a greater or lesser extent, and probably about 50% are useful to man. Apart from being browsed, woody plants have always played a significant role in human lives in South Sahara Africa as demonstrated by their multiple usages. With regard to crop production, farmers in semi-arid West Africa have traditionally spared desired species when establishing their fields by clearing natural vegetation. Species such as *Acacia albida* are valuable because of the ability to improve soil fertility through nitrogen fixation, and also because of the reverse vegetation cycle of this tree, that produces green leaves in the dry season for feeding animals, and they in turn spread manure on the field. In the rainy season the species lose their leaves, resulting in no shading effects on the crop. Other species maintained in the croplands have different socio-economic importance (edible leaves or fruits, ethno- medicinal use or shade) and reduce evaporation from the fields. Overall, the multiple uses of woody plants include soil maintenance and protection against erosion and dune stabilisation (as windbreaks), source of energy (fire wood), construction material and with their shade reduced water loss from the soil and lower temperature. The trees serve as source of income through the sale of leaves, fruits and wood, and ethno medicinal and veterinary uses are common. They are also shown to influence the herbaceous cover in the Sahel, by improving flora diversity and mineral content (Akpo *et al.,* 2003).

2.4.5Potential and Limitations of the Use of Browse Species in Ruminant Feeding

In free ranging systems, browse species constitute an effective insurance against seasonal feed shortage in the dry season, supplementing the quantity and quality of pasture. Trees and shrubs are perennials allowing the provision of permanent fodder compared to herbaceous species, which decrease rapidly in quantity and quality after the rains. Through their deep root system, trees are able to penetrate further into the soil and therefore continue to grow under dry conditions and/or keep green leaves. The regular availability of forage from trees and shrubs depends on the diversity of species and their phenological variation in time and space (Grouzis&Sicot, 1980).

On the other hand, their high feeding quality in terms of protein and content of some minerals such as calcium and phosphorus (Paterson *et al.,* 1998) is well appreciated. Almost all literature on the use of shrub and tree fodders to supplement either natural grasses or crop residues has shown positive responses with respect to the productivity of cattle, sheep and goats (Norton, 1998). Also, stocking rates are shown to increase generally when fodder trees are included in the pastures (Leng, 1997). This author further reported the potential use of browse as bypass protein to increase productivity of ruminants where bypass protein supplements in the form of concentrates such as cottonseed meal have been fed to ruminants, supplementing poor quality forages. This process has been linked to the effect of condensed tannins that are bound to foliage protein, preventing the microbial degradation of leaf protein in the rumen. Then, particles high in protein will move to the lower digestive tract where some of the condensed tannin complex with protein may be hydrolysed, allowing protein to be digested. Condensed tannins under acid or alkaline conditions of the intestines may be split to sugars and organic acids, mostly gallic acid, releasing protein and amino acids that are digested in the lower gut. Anthelmintic proprieties have been reported in many plants that are browsed (Hammond *et al*., 1997), that by improving the nutritional status of the animals, increase their ability to resist the harmful effects of parasites (Hoste*et al.,* 2006).

The utilisation of browse species is limited by the high lignin content and the presence of anti-nutritional factors, which may be toxic to ruminants. Many browse species have chemicals that appear to be produced for the purpose of deterring invasion or consumption of their leaves by microbes, insects and herbivorous animals. The most important cited is tannin, which is shown to decrease the digestibility in browse fodders. Tannins are a group of polyphenol substances with the ability to bind protein in aqueous solution. They are classified into two groups: hydrolysable or condensed tannins, and are considered to have both adverse and beneficial effects depending on their concentration and nature, and also animal species, physiological state of the animal and the composition of the diet (Makkar, 2003). Silanikove*et al.* (1996) concluded that goats have the ability to consume large amounts of tannin rich plants without exhibiting toxic syndromes (due to a detoxifying enzyme in the saliva), which is not the case for other ruminant species. The negative effect of tannin is seen in lowered feed intake, directly due to the astringent properties of tannin rich feed, and indirectly by reducing the digestibility of the feed. Hanley (1992) reported that tannin reduced the digestible crude protein by 44% and digestible organic matter by 14%. However, the level of digestibility reduction varied depending on the level and the activities of tannin (Ebong, 1995). A level of tannin below 5% seems to be tolerable for ruminant animals. While tannins are the best known of the anti-nutritional factors of browse, there is a long list of secondary compounds: cyanide, nitrate, fluoroacetate, cyanogenic glucosides, saponins, oxalates, mimosine and various sterols (Leng, 1997). However, the toxic compounds seem to become of significance nutritionally only when the plant constitutes a high proportion of the diet. Hence, the effects of high protein forage could override the effect of the toxic compounds when used as supplement in the diets.

2.4.6Browse Production in Dry Tropical Africa

Browse production is influenced by many environmental factors such as climatic, edaphic and topographic conditions and management background involving exploitation by animals, lopping and burningforested areas. There is the wide variation in the browse production of the different species particularly in the proportion of fruit which represents 3 to 55% of the deciduous biomass. Browse productivity has been found to be linked to habitat and soil texture (Cisse and Wilson, 1984).

Regarding the effect of management, pruning is found to ensure better browse production than lopping for both, the operation should preferably be carried out during the cold dry season rather than during the hot season period (Le Houerou,1980). Excessive lopping in dry areas often results in the death of trees. Fires have adverse effects on trees and shrubs in arid and semi-arid zones where low soil moisture balance prevails. In sandy soils, however plants with deep root systems are less affected than those on shallow and heavy soils. Also fires at the end of the dry season can be detrimental to trees and shrubs which have already flushed (Walker, 1980).

2.5BIOMASS ESTIMATION METHODS AND APPLICATIONS

Biomass is the weight of organic matter per unit area. The organic matter might include weight of new growth herbage above ground, wild animals, roots, dead organic matter or mature trees. In vegetation studies this is usually done based on unit area measurement, which is square centimetre or square meter. In measuring biomass, the plants are clipped to constant weight in the laboratory and then weighted. The plant biomass for the larger area is then found through multiplication. The relative biomass of animal species and plant species is of primary concern to range managers. However, this is difficult to find as it involves tedious work to find the find the weight of different species clipped together. This requires a timely consuming process of separation by hand of the clipped species (Alemayehu, 2006).

The measurements of biomass are of great value to range managers as it provides a quantitative evaluation of production of organic matter over a period time. Measurements taken over spaced period time, like seasons, allow range managers to know the amount of forage available in the different seasons and the information necessary in estimating the stocking capacity of the area. Measuring biomass also provides insights about forage utilization by animals by taking measurements before and after grazing or by taking measurements in paired plots, where one is important to determine the number of given animal species which can forage in a given area (Alemayehu,2006). Herbaceous above ground biomass is measured to determine the amount of available forage for animals or to assess rangeland condition and or to measure the effects of management on the vegetation (Mannetje, 2000). Moreover, from a grazing point of view production or yield is one of the most important measures used to assess rangeland. Plant dry matter yield is often directly related to animal production while the other parameters are useful to describe and quantity the plant population and the successional trends of the rangeland vegetation and finally to assess the rangeland condition (Foran *et al*; 1978; Amaha, 2006).

Another method to estimate biomass includes its physical parameters such as diameter at breast; heightor branches. The usual way to estimate above ground biomass of a group of trees or a path of a forest is to establish equations that relate tree biomass with easily measurable tree variables like diameter at breast or tree height or both. This is done by measuring representative samples of tree belonging to particular population. These equationsare then used to estimate the biomass that is applicable from where the sample is drawn (Saint-Andre *et al*; 2005). Measuring a tree to estimate its biomass is not easy and straight forward. It requires felling down on tree which is destructive (Cairns *et al* 2003; Saint-Andre *et al* 2005; Xiao and Ceulemans,2004).

Full tree harvest method which uses cutting and weighing or cutting; drying and weighing of whole tree or its parts; is a straight forward procedureto estimate fresh and dry biomass. This method is time consuming; costly and above all destructive. A more efficient method for biomass estimation is tree sub sampling method (de Gier, 2003). This method doesn’t require weighing or drying and weighing the whole tree to estimate its biomass; but estimate the biomass from a small samples collected from the tree (be it wood or leaves) and weighing or drying and weighing only the sample to estimate its biomass. Though this method is efficient in terms of time and cost as compared to whole tree harvest method which is still destructive.

Another method of biomass estimation is showed in Bello (2013) method. The forage production is constituted for about 9/10 by the foliar productionDiop (1989). As a result of this, sheet production has been prioritized. The foliar production of an individual of a given species was obtained by the integral leaf harvesting method. To do this, a medium size branch was cutting, followed by leaves stripping. The leaves were weighedafter drying and the weight was estimated by extrapolation.Thus the dry matteryield was determined by multiplying the quantity of dry leaves by the number of branches.

2.6 CHEMICAL COMPOSITION OF BROWSE PLANTS

2.6.1 Fodder Leaf

Proteins constitute a principal component of the animal body and are continuously needed in the feed for repair and synthetic processes; hence they are vital for animal maintenance, growth, and production (NAP, 1981). For this purpose the CP content of feed has been given special attention in feed evaluation. The high CP content of browse species is well documented and is one of the main distinctive characteristic of browse species compared to mature grasses. Norton (1998) reported a range of CP contents from 12 to 30% for tropical tree legumes, and Le Houérou (1980) found a mean of 12.5% in West African browses, with about 17% for legume species. Generally, the CP content in browse has been shown to be above the minimum level required for microbial activities in the rumen (8% CP according to Norton, 1998).

The species in the Leguminosae family have a higher protein content compared to other species, although species in the Capparidaceae family have on average 25% more protein than legumes (Le Houérou, 1980). Le Houérou (1980) also noted that all browse species are able in all their phenological stages to meet the energy requirements of livestock at maintenance level and often well above, and considered West African browse to be excellent fodder, with very few exceptions. The species used in the present study have CP content within the range mentioned by these authors. *Acaciasenegaland Pterocarpuslucens* being legume trees have higher CP content than *Guiera senegalensis*. A similar level of CP in *Acaciasenegal* leaves was also found by Rittner& Reed (1992). The difference in CP content between species can be explained by inherent characteristics of each species related to the ability to extract and accumulate nutrients from soil and/or to fix atmospheric nitrogen, which is the case of legumes plants. The other factors causing variation in the chemical composition of browse forages include soil type (location), the plant part (leaf, stem, pod), age of leaf and season. With regard to the location, some authors have reported that browse plants in the arid (Sahelian) zone are higher in N compared to plants in the humid zone (Rittner& Reed, 1992). Younger leaves are richer in N than mature leaves, which contain more N than the litter. The fruits are shown to have a N content between young and old leaves, and vary little with stage of maturity (Breman & Kessler, 1995). The leaves of *Acacia senegal and Pterocarpuslucens* had somehigher CP content than the pods. Comparing pods of *Acacia senegal* with pods from other *Acacia* species, the CP content was higher than the value for *Acacia nilotica* (13.5%) and lower than for *Acaciatortilis* (20.5%) obtained by Sawe *et al.* (1998). *Acaciaalbida* pods also had lower CP content (11.4%) according to Fall *et al.* (1997).

With regard to the cell wall content, Rittner& Reed (1992) noted similar means in NDF and lignin content across different ecological zones, 40.1% and 11.7% in the Sahelian zone, 45.7% and 10.5% in the sub-humid zone and 43.6% and 9.3% in the humid zone, respectively. Fall (1993) found a range of 31 to 57% of NDF and 19 to 43% ADF. The values in the present study fall within the range obtained by these authors. NDF and ADF content in *Guiera senegalensis* is similar to the value found by Fall (1993). This species also had high lignin content. Lignin is a component of the cell wall, and deposited as part of the cell wall-thickening process (Boudet, 1998). It is also reported to be important in limiting water loss by reducing the permeability of the cell wall, and in impeding disease organisms, all attributes that are desirable from the perspective of plant function and survival, but limit the nutritional value of the plant for herbivores (Moore & Jung, 2001). Lignin is in general higher in browse than in herbaceous plants. The content varies according to species, age and the plant parts. Positive correlations are reported between content of lignin and soluble or insoluble proanthocyanidins (Rittner& Reed, 1992). Reed (1986) also found a negative correlation between the content of NDF and soluble phenolics, while the correlation with insoluble proanthocyanidins was positive. The content of both soluble and condensed tannins could not be evaluated in this study. However, the relation between fibre and these anti- nutritive compounds could give an idea about their probable level in the species studied. Browse plants have also been shown to develop defensive systems (physical or chemical) that deter utilization by ruminants. The physical defence is related to the development of spines and thorns that are more defensive in juvenile trees and growing parts of the plants. Brooks & Owen-Smith (1994) noted longer and more closely spaced thorns on branches of *Acacianilotica* and smaller leaves in juvenile than adult plants, while Cooper & Owen-Smith (1986) reported fewer spines in many plants as they grow out of reach of browsers. The same phenomenon was found in *Acaciasenegal,* as the younger individuals showed smaller leaves and dense thorns, making browsing difficult.

The chemical defence refers to the concentration of phenolic compounds that could be high in plants exposed to browsing. Ernst *et al.* (1991) found that the concentration of phenolic substances in various *Acacia* and Dichrostachys species was high in young leaves, immature fruits and seeds and low in mature leaves and pods. Although not significant, there was a relatively high lignin content in smaller individuals of *Guiera senegalensis* in the present study, which could be seen as a defensive trait. The chemical composition did not differ within plants due to browsing height, which is in contrast with the findings of Nordengren *et al.* (2003), who related the improvement in quality and quantity of forage to the height of the tree.

2.6.2 Flowers and Fruits

Many flowers of wild plants are consumed in Africa, but Mexico and Central America are probably some of the few areas where flowers are also used as food (Kislinchenko and Velma, 2006; Sotelo, 1997). Hassan *et al*. (2011) reported that, flowers of *Parkiabiglobosa*are used as food in North – Western Nigeria especially by rural dwellers when mixed with groundnut cake and other ingredients to make a delicious salad. *Balanites aegyptiaca* flowers are 5 – 6mmdiameter, greenish white fragrant and axillary in fewflowers cyme or fascicle (Vinod and Tarun, 2012).

Flowering behaviour varies, there is no definite time for flowering in the Sahel, although flowering most likely takes place in the dry season. Flowering in Nigeria varies between November and April with ripe fruits becoming available in December (Orwa*et al.,* 2009). Many parts of the plant are used as famine foods in Africa; flowers can be eaten fresh, when cooked and eaten when incorporated with other ingredients as well as supplementary food in West Africa and an ingredient of 'dawa – dawa' flavouring in Nigeria (Prashant*et al.,* 2011).

The *Balanites aegyptiaca* flower had moisture content which is low when compared to (73.6 -93.2 ± 2.6%) reported for some edible flowers (Richard *et al.,* 1996; Sotelo*et al.,* 2007; Madhumita and Naik, 2010 and Hassan *et al.,* 2011). Hassan *et al.,* (2009) reported that high moisture content is associated with the rise of microbial activities during storage.

The ash content of the flower (6.67 ± 0.29%) compares favorably to 6.50 ± 1.00% in *Parkiabiglobosa* flower (Hassan et al., 2011), but within the range of 5.8 –8.6% reported for some edible flowers (Sotelo*et al.,* 2007).

The crude protein content of *Balanites aegyptiaca* flower (10.8 ± 0.49%) is higher than 6.77% reported for *Parkiabiglobosa*flower (Hassan *et al.,* 2011) and that of the commonly consumed edible flowers (Sotelo*etal.,* 2007). The value is also lower than 14.9% reported for *Colocasiaesculenta*flower (Richard *et al.,* 1996). This result shows that *Balanites aegyptiaca* flower contains appreciable amount of protein content. As expected, the crude lipid was low (4.5 ± 0.50%). The value observed is similar to that of *Aloe vera* (4.2%), *Euphorbia radians* (4.9%) as reported by Sotelo*et al.* (2007) and (4.66%) for *Parkiabiglobosa* flower (Hassan *et al.,* 2011). This indicates that *Balanitesaegyptiaca*flowercontains low level of crude lipid. The crude fibrecontent obtained is the same as that reported for *Parkiabiglobosa* flower (Hassan *et al.,* 2011). This value islower than (17.3%) *Erythrina americana,* (13.8%) *Aloe vera*, (12.7%) *Agave salmiana* (Sotelo*et al.,* 2007) and *Colocasiaesculenta* (20.4%) (Richard *et al.,* 1996).

Fibre plays a role to a reduction in the incidence ofcertain diseases like colon cancer, coronary heartdiseases, diabetes, high blood pressure, obesity andother digestive disorders (Ekpo, 2007). The flower of*Balanitesaegyptiaca* has high carbohydrate content (74.2%).This was in close range with 78.9% reported for *Parkiabiglobosa* flower (Hassan *et al.,* 2011) and 70.4%reported for *Colocasiaesculenta* flower (Richard *et al.,* 1996).

The caloric value (380.5kilocalorie per 100g) is in close range to 388.9kilocalorie per 100g reported in *Colocasiaesculenta*flower (Richard *et al.,* 1996), but higher than 34kilocalorie per 100g in broccoli flower (Bushway and Reuter, 2006) and 111kilocalorie per 100g in *Madhucaindica* flower (Madhumita and Naik, 2010). This result shows that *Balanites aegyptiaca* flower is a good source of energy human populace.

2.7 ANTINUTRITIONAL FACTORS OF BROWSE SPECIES

Feeding value of fodder trees and shrubs is restricted by the presence of secondary compounds or metabolites, which are generally termed as anti-nutritional factors. These compounds are not involved in primary metabolism but may have different roles, such as protecting plants from disease and herbivore intake, toxicity and mimicking hormone actions. Among them, tannins are the most widely occurring components. They are complex phenolic compounds contained in approximately 80% of the woody dicotyledonous plants (Rhoades, 1979). They are often classified into hydrolysable and condensed tannins and are considered to have either adverse or beneficial effects in animal nutrition depending on their concentration, animal species, and physiological state of the animal and composition of the diet (Makkar, 2003). Condensed tannins are usually associated with anti-nutritional effects in ruminants while hydrolysable tannins are more prone to cause toxicity (Kumar and Vaithiyanathan, 1990). High levels of tannins in the diet reduce digestibility and intake (Decandia*et al*., 1999) as well as palatability, probably due to astringency feeling, which is caused by the interaction of tannins with salivary proteins and oral mucosa. However, tannins in low concentrations (2-4%) induce beneficial effects, which are associated with suppression of bloat in ruminants (Jones *et al.,* 1973) and protection of dietary proteins in the rumen. Other compounds such as alkaloids, saponins, etc., present in fodder trees and shrubs, can also limit nutrient utilisation and reduce animal performance or even cause toxic symptoms. Several experiments have shown that the adverse effects of condensed tannins can be overcome by complexing them with the polymer polyethylene-glycol (PEG). For example, the daily administration of PEG to goats grazing on woodlands resulted in increased digestibility and intake (Silanikove*et al*., 1996). Also, PEG-supplemented Sarda goats spent more time foraging on tanniferous than herbaceous plants, ingested more dry matter and digested more proteins than unsupplemented animals (Decandia*et al.,* 2000).

2.8. COMMON FEED RESOURCES

2.8.1 Faba Bean (*Vicia faba*)

These beans contain approximately 23% protein of good quality. There is onlylimited, and slightly conflicting, information on theeffectsof the presence of antinutritional factors. In feeding trials with pigs, Davies (1986) found Faba Beans to be a sound source of protein at inclusion levels of up to 35% of the diet. This is higher than recommendations of 15-20% by Simpson *et al*. (1984). For laying hens (Davidson, 1980) reported the presence of an antinutritional factor in Faba Beans, particularly at inclusion levels greater than 15%. Autoclaving and heat processing gave inconsistent results, and tannins were not implicated. These differences in response possibly reflect variations in the presence of antinutritional factors in the different samples of Faba Bean used in the experiments.

2.8.2 Peanuts(*Arachishypogaea*)

Peanuts, also commonly called groundnuts, are grown as an oilseed crop. The seeds are not normally fed to livestock, as the high unsaturated fatty acid content results in oily fat deposits in animals. The seed is extracted for oil and the meal used as aprotein concentrate. The profile of amino acids for peanut meal differs from the majority of other leguminous seeds in that it is medium to low in lysine content. During processing, the meal is susceptible to processing damage, with an availability of lysine for pigs of 57% (Batterham *et al.* 1984). Chicks, however, are less susceptible to these effects, and the availability of lysine is high (approximately 90%; Major and Batterhamunpubl).

There are no known antinutritional factors in themeal. However, both the seed and the meal aresusceptibleto the presence of aflatoxin-producing moulds, particularly under moist conditions. Caremustbe taken during the harvesting and processingof the crop and during storage of the processed mealto avoid aflatoxin contamination.

2.8.3Crop Residues and by Products as Feed for Ruminants

The harvest index for food legumes varies greatly, both between species and between cultivars within a species. The different plant morphologies result in a range of leaf: stem ratios. The stage of maturity at which harvest is made results in variations in the nature of the residues which may, as for cowpeas picked as immature pods, still be green; or may as for soybeans, be harvested at maturity when the plant stem is drying. The method of harvest, likewise, leaves some food legume straws and stubbles in the field, while for others the whole plant is harvested and the legume seed recovered by whole-vine threshing. The latter procedure can result in stem, leaf and pod/hull residues being separated as different components for subsequentuse as animal feeds. Consequently, the feeding value of the crop residue needs to be described quite specifically not in terms of analysis of samples of bulk material other than edible seed, but in terms of the classes of standing or harvested fractions, and the post-harvest treatments in grain recovery(Khajarern and Khajarern,1986).

As with most crop plants, there is considerable dry matter loss, decreased protein and soluble carbohydrate content and increasing fibre content with approaching maturity of the plant. However, for most of the common food legumes, the stemmaterial is of better digestibility and nitrogen content than cereal straws. Leaf digestibility is high, but for some legume crop residues at maturity may contribute little to the material recoverable by animals grazing stubbles, or hand fed vine-threshed materials. For example, soybean straw is readily accepted by animals, contains 6-7% crude protein, and has an organic matter digestibility of 35-50%. Reported intakes range from 1.4 to 3.0% of liveweight, and as a broad rule, intake decreases with decreasing nitrogen content and digestibility. Furthermore, acceptability and intake is not solely governed by these factors. Ayres *et al* (1986) examined soybean stubbles as feed for sheep, dividing material into three grades depending in part, on extent of weathering. In vitro digestibility of dry matter ranged from 38.4% down to 14.7%, and protein content was 2.6-3.1 %. With a better quality stubble material, consisting of 80.90% stem, 18% pod, 0.9% xseed and 0.2% leaf fragment, organic matter digestibility was about 50% but intake was only 1.0% of liveweight. Since supplementation with urea and molasses did little to improve intake, digestibility or animal performance, simple nitrogen deficiency was not the limiting factor.

CHAPTER THREE

3.0MATERIALS AND METHODS

3.1. DESCRIPTION OF THE STUDY LOCATION

The research wasconducted in Magamilocated(13° 25’ N and 7° 32’ E) insemi-arid region of Maradi(Niger Republic).The climate is characterized by a short rainy season, three to four months (June to September) and a longer dry season (October to May). The average annual rainfall over the last 10 years was 483.74±124.36 mm. Average annual daily temperatures range from 22.4°C in January and 33.8°C in April (INS, 2012).

The vegetation is characterized by dominant tree species of*Guierasenegalensis, Piliostigma reticulatum* and*Faidherbiaalbida.* The local economy isbased mainly on agriculture and livestock rearing. Agriculture isthe main activity withmajor food crops including millet, sorghum, groundnut,cowpea and Livestock (Cattle, sheep, goats and camels) (INS, 2012).

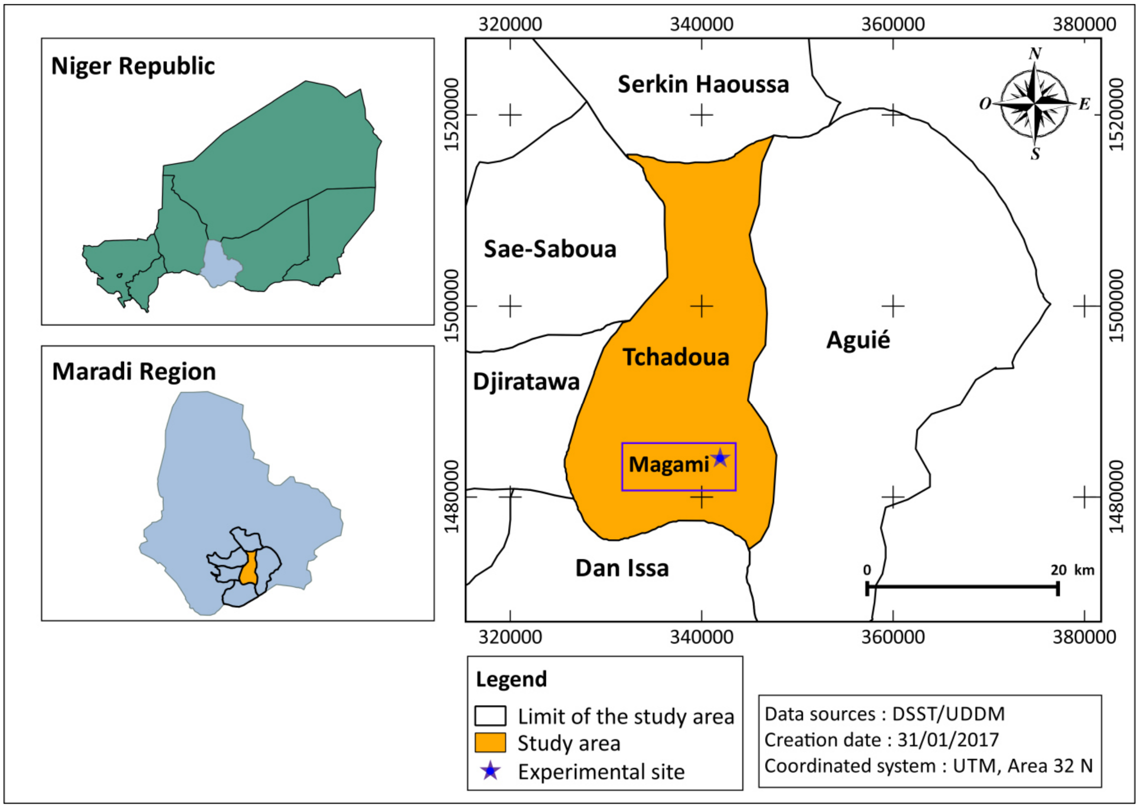

Figure 1: Map of the study Location

Source: University of Dan Dicko Dan KoulodoMaradi /Department of Soil Sciences and teledetection (2013)

STUDY ONE: SURVEY ON IDENTIFICATION OF BROWSE SPECIES FED TO LIVESTOCK DURING THE LATE DRY SEASON

Structured questionnaire was developed and administered to obtain information from farmers in the study area.The questionnaireswere comprised of questions on respondents biodata, educational qualification, occupation, livestock species reared, sources and types of feed and common feeds in the late dry season.Three Hundred (300) livestock rearers were enlisted from which forty(40) farmers involved in crop and livestock farming were randomlyfor administration of questionnaires.

3.2 DETERMINATION OF NUTRITIVE AND ANTINUTRITIVE VALUE OF BROWSE SPECIES FED TO LIVESTOCK KEPT PICKET

From the survey the two browse species (*Guiera senegalensis* and *Piliostigma reticulatum*) used for livestock feeding through questionnaire administrationwere sampled, bagged and carried to Animal Science laboratory of Bayero University Kano. Two samples replicated three times each were oven dried at70$^{\circ C}$ for 48 hours before milling with hammer mill to pass through 2.5mm sieve for nutritivevalue and antinutritive factors analysis.

The two (2) browse species identified that dominated from the survey were analysed for proximate analysis and determination of fiber components.The parameters such as dry matter (DM), Moisture, crude fiber (CF), crude protein (CP), Ash, and Ether extract (EE) were determined using proximate analysis as described by AOAC (1990) while Neutral Detergent Fiber (NDF) and Acid Detergent Fiber (ADF) were determined by Van Soest method *et al* (1991) method.

The antinutritive factors such as tannin, oxalate,phytate and saponinwere determined by the precipitation method (AOAC, 1990) and hydrogencyanide (HCN) by the Knowels and Watkins distillation method as described by Pearson (1976).

3.3 DETERMINATION OF YIELD OF COMMON PLANTS SPECIES

A plot size of 50mx50m was marked in a randomly selected site in four directions (East, West, South, and North) of Magami using a Randomized Complete Block Design RCBD with five (5) browse species serving as treatment and each replicated seven times.Inventory of browse species were taken for determination of the frequency of occurrence. Thereafter (5) Five browse species were sampled in seven replicates for biomass determination. The above ground biomass were determined using non-destructive method by modifying Bello (2013) which consist of harvesting one medium branch ofthe selected woody browse plant of 1m height for shrubs to 5m for tree heightand leaveswere defoliated. The fresh leaves were sun dried and later dried in a constant weight in the oven at $70^{°C}$ for 48 hoursfor two days for dry matter yield determination. The total biomass was estimatedby multiplying the number of branches by the quantity of dry leaves.

3.4 DATA ANALYSIS

Data generated in study one (survey)were subjected to descriptive statistics (frequency and percentages) and Independent T-test was used between the factors and the variables while in study two the general linear model (GLM) of RCBD in SPSS version 16.0 was used for the data analysis where significantly differences means were separated using Least Significant Difference (LSD) at 5% level of significance.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1. RESULTS

4.1.1 Biodata of Respondents who Kept Livestock at Stake in Magami

Biodata of respondents are presented in Table 1. The age groups of respondents varied from 15 to 100 years and with majority being within the range of 26 to45 years constituted (35%). This was followed byage range of 46 to65 years (30%).Respondents within the ages of 65 years and above and within the ages of 15 to 25 yearswere respectively (17.5%).Male respondents constituted 75% while 25% were females. Ninety five(95%) of the respondents were married.Almost all of the respondents had some form of education, 42.5% primary school followed by Qur'anic education and adult education whichhad 22.5%each ;10% and2.5% for none and secondary education respectively.

All the respondents encountered had a household size whichvaried from 1 to 30 persons. Majority of the respondents had 1 to 10 persons (52.5%), followed by 42.5% with 11 to 20 personswhile 5% had 21 to 30 persons; respectively.

Table 1: Biodata ofRespondents who kept Livestock at Stakein Magami

Variables	Frequency	Percentage (%)
Ages		
15 to 25	7	17.50
26 to 45	14	35.00
46 to 65	12	30.00
>65	7	17.50
Total	40	100
Gender		
Male	30	75.00
Female	10	25.00
Total	40	100
Marital Status		
Married	38	95.00
Divorced	2	5.00
Widow		
Total	40	100
Educational Status		
Primary School	17	42.50
Qur'anic	9	22.50
Adult Education	9	22.50
None	4	10.00
Secondary School	1	2.50
Total	40	100
Household Size		
1 to 10	21	52.50
11 to 20	17	42.50
21 to 30	2	5.00
Total	40	100

4.1.2 Flock Size and Livestock Species Kept By the Respondents

Majority of the respondents had a flock size of 1 to 10 (82.5%) followed by 11to20(12.5%) while the least was21 to 30 (5%).

Livestock species kept by the respondents variedwith mixture ofSheep, Goat and Cattle which constituted 30%, followed by Goat and Cattle20%.Those that kept goat alone represented 17.5% followed by Sheep and Cattle 15%.Also,those that kept goat and Cattleconstituted 7.5%. Other mixtures of livestock species such as Sheep and Goat; Sheep, Goat and Donkey;Sheep,Goat,Donkey andCattle;Sheep, Cattle and Donkey were low(2.5%)(Table 2).

Table 2: Flock size and livestock species owned by respondents in Magami

Variables	Respondents	Percentages
Flock Size		
Small(1 to 10)	33	82.50
Medium (11 to 20)	5	12.50
Large (21 to 30)	2	5.00
Total	**40**	**100**
Livestock Species kept		
Sheep, Goat and Cattle	12	30.00
Goat and Cattle	8	20.00
Goat	7	17.50
Sheep and Cattle	6	15.00
Goat and Cattle	3	7.50
Sheep and Goat	1	2.50
Sheep, Goat and Donkey	1	2.50
Sheep, Goat, Donkey and Cattle	1	2.50
Sheep, Cattle and Donkey	1	2.50
Total	**40**	**100**

4.1.3 Feed Resources Used and Supplementation

Feed resource used for feeding ruminants by respondents is presented in Table 3.

Respondents encountered revealed that the most common feed for small ruminantsin Magami were basically*Guiera senegalensis*and *Piliostigma reticulatum.Piliostigma reticulatum* constituted of 57.5% followed by the combination of *Guiera senegalensis and Piliostigma reticulatum*35%; while the least was *Guiera senegalensis*whichconstituted 7.5%.

Supplements varied from grass (*Eragrostis tremula*), millet sorghum bran, millet and sorghum stalks and millet - sorghum bran in water. Majority of the respondents (52.5%) used millet stalks alone only for cattle, followed by millet bran inwater (17.5%); millet bran only(12.5%) followed by grass(*Eragrostistremula*) 7.5 % and others usedhusk of millet 5%. The least were those that used sorghum bran and sorghum bran in water with 2.5% each.

Table 3: Feed resources used by respondents for feeding small ruminants in Magami

Variables	Respondents	Percentages (%)
*Piliostigma reticulatum*only	23	57.50
Piliostigma reticulatum and Guiera senegalensis	14	35.00
*Guiera senegalensis*only	3	7.50
Total	40	100
Supplements		
Millet Stalks	21	52.50
Millet Bran in water	7	17.50
Millet Bran	5	12.50
Grass (*Eragrostistremula*)	3	7.50
Husk	2	5.00
Sorghum Bran in water	1	2.50
Sorghum Bran	1	2.50
Total	40	100

4.1.4 Determination of Nutritive and Fiber Components of Browse Species Used to Feed Animals in Magami

The result showed that crude fibre varied significantly (P< 0.05) between the species (Table 4). Other proximate constituents and fibre fractions were statistically not significant (P> 0.05). With the exception of NDF and DM; all the constituents evaluated were higher in *Piliostigma reticulatum* than in *Guiera senegalensis*as showed in Table below.

Table 4: Chemical Composition of Browse Plants fed to Animals Kept at Stake in Magami

Parameters (%)	*Piliostigma reticulatum*	*Guiera senegalensis*	Means	SEM	P- Value
Proximate Composition					
ASH	12.55	9.88	11.21	2.30	0.229
Moisture	16.27	13.96	15.11	0.929	0.908
EE	3.64	2.63	3.13	0.411	0.948
CP	16.61	13.36	14.98	0.683	0.560
CF	15.49^{a}	14.05^{b}	14.77	0.19	0.029^{*}
DM	83.73	86.04	84.88	0.929	0.908
Fiber Fraction					
ADF	36.07	33.57	34.82	0.499	0.669
NDF	56.20	56.77	56.48	0.705	0.770

ab Means with different superscripts within the same row differed significantly (P<0.05); SEM = Standard error of the mean

4.1.5 Antinutritional Factors of *Piliostigma reticulatum* and *Guiera senegalensis* Browses Fed to Animals at Stake in Magami

The antinutritional factors evaluated were statistically comparable(P<0.05) (Table 5). *Piliostigma reticulatum* had higher levels of tannins while*Guiera senegalensis*had higher levels of Saponins;Phytates and Oxalate as showed in Table below.

Table 5: Concentration of some Antinutritional Factors of Browse Plants Fed to animals

Parameters (mg/g)	*Piliostigma reticulatum*	*Guiera senegalensis*	Means	SEM	P-Value
Tannins	8.26[a]	2.43[b]	5.34	0.154	.000***
Saponins	8.45[b]	19.95[a]	14.20	0.368	.000***
Phytates	18.73[b]	29.84[a]	24.28	0.251	.000***
Oxalate Acid	17.76[b]	30.96[a]	24.36	0.148	.000***
Hydrocyanic Acid	4.94	4.57	4.75	0.237	0.193

ab Means with different superscripts within the same row differ significantly (P<0.05); SEM = Standard error of the mean

4.1.6Determination of Density of Common Browse Species

A total of ten (10) browse species were identified during the inventory which included*Guiera senegalensis, Piliostigma reticulatum*, *Faidherbiaalbida*, *Lanneamicrocarpa*, *Diospyrosmespiliformis*,*Azardirectaindica*,*Balanitesaegyptiaca*,*Annona senegalensis*,*Prosopisafricana* and *Acacia nilotica*.The density of browse plants was higher in *Guiera senegalensis*with 351stands/ha while the least was seen in *Prosopisafricana*and*Acacia nilotica*with 2 stands/ha respectively(Table 6).

Table 6: Density of identified browse species in the study area

Local name	Scientific name	Family	Frequencies	Percentages (%)
Sabara	*Guiera senegalensis*	Combretaceae	351	58.99
Kargo	*Piliostigma reticulatum*	Caesalpinaceae	162	27.22
Gawo	*Faidherbiaalbida*	Mimocaceae	28	7.06
Faru	*Lanneamicrocarpa*	Anacardiaceae	8	1.34
Kanya	*Diospyrosmespiliformis*	Ebenaceae	8	1.34
Maina	*Azardirectaindica*	Meliceae	7	1.17
Aduwa	*Balanitesaegyptiaca*	Balanitaceae	7	1.17
Gonda	*Annona senegalensis*	Annonaceae	6	1
Kirya	*ProsopisAfricana*	Mimocaceae	2	0.33
Bagaruwa	*Acacia nilotica*	Mimocaceae	2	0.33

4.1.7Biomass Productivity of Plants Species

The fresh leaves in *Piliostigma reticulatum;Faidherbiaalbida*and*Diospyrosmespiliformis*were significantly higher (P<0.05) while the least was observed in *Guiera senegalensis* with 18.85Kg.In the dry leaves, similar pattern was observedin *Piliostigma reticulatumFaidherbiaalbida*and*Diospyrosmespiliformis.* The number of branches varied significantly amongst browse species.*Lanneamicrocarpa* had the lowest branches with 16.86 as showed in Table 7.

Table 7: Plants Biomass Productivity of Browse Species Used by Farmers in Magami

Treatments	FL	DL	NB
Piliostigma reticulatum	229.71[a]	129.40[a]	45.86[a]
Guiera senegalensis	18.85[b]	10.58[b]	22.71[ab]
Lannea microcarpa	56.69[b]	21.69[b]	16.86[b]
Faidherbia .albida	271.71[a]	128.42[a]	40.57[a]
Diospyros mespiliformis	122.94[ab]	69.50[ab]	21.14[b]
S.E	81.42	44.20	10.08

Means in the same column with different superscripts differed significantly (P<0.05), SE= standard error

FL: fresh leaves; DL: dry leaves; NB: number of branches

4.2 DISCUSSION

4.2.1Biodata of Respondents who Kept Livestock at Stake in Magami

The younger age group of 15 to 45 years of the respondents was higher than those of 65years.This can be explained by the fact that in most cases older age group disengageitself from livestock husbandry and hands over to younger generation as stated by Garba and Muhammad (2008). However, Ninety five percent of respondents who were married observed in the current study is in agreement with reports of Sodiya (2005), Muhammad (2008), Garba and Muhammad (2008); and Abdurrahman and Muhammad (2012) from reports of different studies. Involvement ofhigher percentage of married farmers than un-married in livestock keeping in the present study was in agreement with Sodiya (2005) and Abdurrahman and Muhammad (2012) who reported that Fulani/Hausa-Fulani culture discourages divorce. It could perhaps be that femalesrespondents were not restricted from keeping livestock even though theywere married, divorced or un-married since livestock keeping is considered as a mobile asset for rural dwellers. Western education level (67%) in the current study was encouraging as compared to early study by Garba and Muhammad (2008). This could beas a result of more awareness by extension workers for better understanding and improvement on new technology in livestock keeping in the region.

4.2.2 Flock Size and Livestock Species kept

As obtained in this study,ownership of livestock combination (sheep, cattle and goat) was higher (30%).This may be attributed to complimentary feeding habits. Smith (2006) reported that sheep grazes lower grasses while goats browse shrubs and trees. It was also revealed that ownership of goat was higher (17.5%) and this may be attributed to the fact that goats are known for browsing (Smith, 2006). Muhammad (2008) reported goats are easier to handle than sheep in terms of nutrition.

4.2.3 Feed Resources Used and Supplementation

This resultshowed thatthe use of *Piliostigma reticulatum*by respondents in the study area was higher than *Guiera senegalensis* and combination of *Piliostigma reticulatum*and *Guiera senegalensis.* This findingis in agreement with the study in Jigawa State on the small ruminant feeding by Abdurrahaman and Muhammad (2012) whoshowed similarities on the use of *Piliostigma reticulatum* and *Guiera senegalensis* use or combination ofboth.Otchere and Nuru (1988) had reported that ruminant animals reared in the Sahel zone are fed primarily on native rangelands, where browse woody vegetation contribute to their nutrition. Several reports have demonstrated the superior nutritive values of browse plants and their acceptability by goatsand sheep (Agishi, 1984; Bibi-Farouk *et al.,* 2006; Garba and Muhammad, 2008).

4.3 DETERMINATION OF NUTRITIVE AND ANTINUTRITIVE FACTORS OF THE BROWSE FED TO ANIMAL

4.3.1 Nutritive Value and Fiber Constituents

The crude protein of the browse species,*Guiera senegalensis*and *Piliostigma reticulatum*ranged respectively from 13.36% to 16.61%, which is above the 7% CPrequirement for ruminants; which will provideammonia required by rumen micro-organisms tosupport optimum microbial activity Norton (2003).

Differences in nutrient contents between and within the browse species could be associated with the inherent nature of the species. There could also be morphological and anatomical differences within the species (Mathur et *al*; 1991). Minson (1980) indicated also that the differencein nutrient contain may be related to variation in certain environmental and edaphic factors in the study area and/or genetic variation of the same plants.

This result of fiber (NDF and ADF) for *Piliostigma reticulatum*and *Guiera senegalensis*was not similar to values reported by Desire (2011) who found higher value in both NDF and ADF.Kamalak (2006) reported that NDF and ADF contents of leaves were significantly increased by advancing maturity. NDF content ranged between 10.1 and 50.5%., depending on the species and harvest stage.Skermen and Riveros (1990) had similarty reported high NDF and ADF values at advanced forage maturity. High ADF and NDF values reflect high extent of cell wall lignification (Van Soest, 1994) that could be associated with decreased cell contents (sugar, minerals) and forage digestibility.

4.3.2 Antinutritive Factors of Common Browse Species in Magami

There is a wide variation in the reported concentration of ANFs (Antinutritive Factors) in the plants (Kumar; 1983). This may be either real because of the changes occurring to the environmental conditions, or may arise because of lack of standardization of methods between laboratories, as well as their destruction in assays (Harbone, 1989).

The antinutritional factors found in both *Guiera senegalensis*and *Piliostigma reticulatum* were lower only in HCN and ranged from 4.57mg/g to 4.97mg/g. Everist (1981) reported that only plants that produce more than 20mg HCN/100g fresh weight are considered deleterious .It would appear that the two browse species analyzed in thisresearch contain tolerable levels of HCN to ruminants. Itcan be deduced that plants (leaves) studied may thus beregarded safe for feeding ruminants.

However, the tannin level in *Piliostigma reticulatum*(8.26mg/g) ; Oxalate acid 17.76mg/g to 30.96mg/g; phytates 8.45mg/g to 19.95mg/g and Saponins18.73mg/g to 29.84mg/g in *Guiera senegalensis*are likelyif consumed in large quantity to have some effects on ruminants such as reduction of blood and liver cholesterol, depression of growth rate, bloat in ruminant, inhibition of smooth muscleactivity, enzyme inhibition and reduction innutrient absorption as stated by Cheeke (1971) and Diagayete and Huss (1981).

4.4. BIOMASS EVALUATION OF COMMON BROWSE SPECIES IN MAGAMI

4.4.1. The Density

Le Houérou (1980) reported that the sudano-sahelian zone of West Africa is dominated by browse species of Mimosaceae family which is similar to the results obtained in the present study. This resulthas shown that the family of *CombretaceaeGuiera senegalensis (*58.99%) was highlyrepresented.The dominance of *Guiera senegalensis*, *Piliostigma reticulatum*, and *Faidherbia albida* were reported by many authors such as (Thiombiano, 1996; Fontes and Guinko, 1995). Similar findings were reported by Achard *et al*(1996)and Olivier (1998) on the dominance in the fallow of *Piliostigma reticulatum* and *Guiera senegalensis*.Through the literature, *Guiera senegalensis*is also abundant on fallow as reported by Piot*et al*., (1980) due it's adaptation to different environmental conditions. In addition, Seghieri *et al*. (2005) reported that *Guiera senegalensis*is tolerant to drought stress, due to its ability to open stomata at low water potential. This combination of strategies in *Guiera senegalensis*has been shown to increase the period of photosynthetic activity during the dry season and could contribute to the maintenance of this shrub as a dominant species in the Sahelian landscape (Seghieri *et al.,* 2005).

4.4.2 The Biomass Productivity of Browse Plants Used By Farmers in Magami

The forage yield was not consistent throughout the period of this study**.** The results of available biomass productivity obtained in the current study were lower and ranged between 18.85Kg to 271.71Kg of fresh fodder and 10.58 Kg to 129.4Kg of dry leaves.Findings by Youssifi (2012) revealed 20.14Kg to 804.68Kg of fresh leavesand 10.20Kg to 342.24Kg of dryleaves. Thevariations found could be due soils properties, or due to the period of harvesting. In the hot dry season, in the Sudan region of Burkina Faso, itwas observedthat there was a decrease inquantity of above ground biomass production due to the phenology of species. Indeed, the phenological stages of species are correlated with climatic parameters and ground textures(Hiernaux*et al*., 1994). Le Houérou (1980) also reported that in semi-arid and arid areas of the world, annual precipitation is linearly related to the above ground production. However, the number of branches 16.86 to 45.86 observed in this study was lower than this finding by Morou(2010) which ranged between 41.4 to 70.9branches.Comparable results were found by Lougbegnon *et al.* (2011) in Benin. The harvest of theseparts (roots, leaves, branches, bark, wood) for various uses sometimes lead to lower productivity and is very often detrimental to the life of the plant. Mahamane*et al*, (2007) also reported that the hot dry season corresponds to a period during which the rural population engages in other income-generating activities (logging, charcoal production, hunting, clearings...) which have consequences on the browse species and productivity.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 SUMMARY

This study was conducted to identify the browse species fed to animals, to determine their nutritive value and antinutritional factors and then evaluate the biomass of some browse plants. Data were collected from April to May 2013/2014. The browse species fed to animals were identified, as well as the nutritive value and antinutritional factors and the quantity of browse biomass was evaluated.

The results obtained showed that 52.5% of the farmers had 1 to 10 persons per family. Large animals combination (Sheep, Cattle and Goat) 30% were dominated followed by Goat and cattle 20%. This survey revealed that male respondents dominated (75%) The browse species identified to be fed to animals were *Piliostigma reticulatum* and *Guiera senegalensis* while respondents (52.5%) fed their animals only with *Piliostigma reticulatum*, (7.5%);*Guiera senegalensis*and (35%) with combination of *Piliostigma reticulatum and Guiera senegalensis.*

For the nutritive value, among all the contents evaluated such as Moisture,DM,EE, ASH and CP, only the CF was significantly higher (P<0.05) in both *Piliostigma reticulatum* and *Guiera senegalensis.*The antinutritional factors such as tannins was significantly higher (P<0.05) in *Piliostigma reticulatum* whilesaponins,phytates,andoxalate acid in *Guiera senegalensis.* The forage yield was not consistent (P<0.05) throughout the period of the study with *Faidherbiaalbida*having 271.71Kg followed by 229.71kg of fresh leaves for*Piliostigma reticulatum*;*Diospyrosmespiliformis* 122.94Kg;*Lanneamicrocarpa*56.69Kg and *Guiera senegalensis* 18.84Kg of fresh leaves.In the dry leaves,*Piliostigma reticulatum*dominated with 129.40kg followed by *Faidherbiaalbida*

*128.42Kg;Diospyrosmespiliformis*69.59kg; *Lanneamicrocarpa* 21.69kg and *Guiera senegalensis*with 10.58Kg, respectively.

5.2 CONCLUSION

It can be concluded from this study that:

Piliostigma reticulatum and *Guiera senegalensis*are the most popular browse species used by farmers to feed livestock during the dry season in Magami.

5.3 RECOMMENDATIONS

- There is therefore the need to broaden the resource base by propagation of more browse species especially *Lanneamicrocarpa* and *Guiera senegalensis*to safe guard the environment and conserve the species.

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DEPARTMENT OF ANIMAL SCIENCE

FACULTY OF AGRICULTURE

BAYERO UNIVERSITY, KANO

Dear Respondent,

I am a postgraduate student in the above named Department. I am conducting a study on the Woody browse species harvested to feed animal at the late dry season.

Kindly respond to questions by ticking the appropriate option and filling-in your responses in spaces provided.

SECTION A: Biodata

Gender: (a) Male [ ] (b) Female [ ]

Age:

Marital status: (a) Single [ ] (b) Married [ ] (c) Divorced [ ] (d) Widowed [ ]

Educational Status: (a) Informal Qur'anic School (b) Primary School (c) Secondary School [ ] (d) tertiary School [ ] (e) Adult Education [ ] (f) None [ ]

Major occupation: (a) Crop and Livestock farming [ ] (b) Livestock farming [ ]

SECTION B: Utilization

1. **Which of the animal species do you rear?**

Goat ☐ ☐ **Sheep** ☐ **Beef** ☐

Camel ☐

2. **How do you obtain your animals?**

Buying ☐ **donation** ☐ **heritage** ☐

3. **How do you do feed your animals?**

Shrubs ☐ **ps residues** ☐ **rs** ☐

4. **How do you obtain this feedstuff?**

Purchase ☐ **crop residues** ☐ **others** ☐

5. **How do you feed your animals?**

Early Dry season ☐ **late dry season** ☐

6. Do you allow your animals feed on browse? Yes No

7. If yes, do you allow them browse on their own or cut and carry?

8. **List the species of woody given to your animals**

Specie	**Shrubs**	**Others**	**Season** **Late dry Season**

9. Which part of the woody your animals take?

Branches [ ] leavesf[ ]s po[ ] [ ]

10. H[ ]w are you drinking your animals?

Stake at home [ ] at the well [ ]

11. List the other feedstuff given to your animals?

a. [ ]b. [ ]c. [ ]

Thank you

<u>SECTION C: Biomass determination</u>

Species	Weight(Kg)		High (m)	Number of Branches	Diameter of medium branch (m)
	fresh	Dry			