EFFECT OF NPK 15:15:15 RATES ON FORAGE YIELD, QUALITY OF *Brachiaria ruziziensis* AND PERFORMANCE OF YANKASA RAMS FED *Brachiaria:* Concentrate RATION

BY

AHMED Safiyanu Abdullahi

DEPARTMENT OF ANIMAL SCIENCE,
FACULTY OF AGRICULTURE,
AHMADU BELLO UNIVERSITY,
ZARIA, NIGERIA

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Brachiaria: **Concentrate RATION**

BY

AHMED Safiyanu Abdullahi
B. AGRIC (HONS) ANIMAL SCIENCE, UNIMAID [2011]
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DEPARTMENT OF ANIMAL SCIENCE,
FACULTY OF AGRICULTURE,
AHMADU BELLO UNIVERSITY,
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APRIL, 2019

DECLARATION

I hereby declare that the work in this dissertation entitled "**Effect of NPK 15:15:15 Rates on Forage Yield, Qualityof *Brachiaria ruziziensis* andPerformance of Yankasa Rams Fed *Brachiaria* : Concentrate Ration"**was carried out by me at the National Animal Production Research Institute, Shika, Zaria, under the supervision of Professor J. T. Amodu and Dr. S. B. Abdu. The information derived from the literature has been duly acknowledged in the text and list of references was provided and no part of this dissertation was previously presented for another degree or diploma at any university.

_____	_____	_____
Name of student	Signature	Date

CERTIFICATION

This dissertation entitled "**EFFECT OFNPK 15:15:15 RATES ON FORAGE YIELD, QUALITYOF *Brachiaria ruziziensis* ANDPERFORMANCE OF YANKASA RAMS FED *Brachiaria*:CONCENTRATE RATION"** byAhmed Safiyanu Abdullahi, meets the regulations governing the award of the degree of Master of Science (MSc.) of Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

_____ _____

Prof. J. T. Amodu, **Date**
Chairman, Supervisory Committee,
National Animal Production Research Institute, Shika,
Ahmadu Bello University, Zaria.

_____ _____

Dr. S. B. Abdu, **Date**
Member, Supervisory Committee,
Department of Animal Science,
Faculty of Agriculture,
Ahmadu Bello University, Zaria.

_____ _____

Dr. M. Kabir, **Date**
Head of Department,
Department of Animal Science,
Faculty of Agriculture,
Ahmadu Bello University, Zaria.

_____ _____

Prof. S. Z. Abubakar, **Date**
Dean, School of Postgraduate Studies
Ahmadu Bello University, Zaria.

DEDICATION

This dissertation is dedicated to the entire family of Alhaji Ahmed Abdullahi Jibril.

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In the name of Allah, the most beneficent, the most merciful. I express my gratitude to Almighty Allah, the creator of everything. May his peace and blessing continue to shower on our beloved prophet Muhammad (SAW), his household, his companions and the generality of his Ummah until the final day (Amin). I wish to express my immense gratitude to my able supervisors, Prof. J. T. Amodu and Dr. S. B. Abdu, under whose expert supervision and meticulous guidance this dissertation was produced. I say thank you so much to for your tireless effort in making this research work a success. May God Almighty continue to bless and reward you abundantly. My appreciation will not be complete without mentioning the role played by my lecturers from Department of Animal Science, National Animal Production Research Instutute, National Agriculture Extension Research and Liason Services and Institute for Agricultural Research of Ahmadu Bello University Zaria, in shaping my future.

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ABSTRACT

The study was conducted to evaluate the effect of varying NPK 15;15:15 levels on the forage yield and quality of *Brachiaria ruziziensis and* performance of Yankasa rams fed different ration of the forage and Concentrate in a total mixed ratioin the Northern Guinea Savanna of Nigeria. The experiment was laid in a randomized complete block design (RCBD) in a 4x3 factorial arrangement comprising of four rates (0,20,40 and 60 kg/ha) of NPK 15:15:15 replicated three times and age of harvest were 10,12 and 14weeks after sowing. The growth components showed that plant height (74.9 cm) and leaf length (33.3 cm) were significantly (P<0.05) higher at 60kg/ha and 40kg/ha, respectively.Number of tillers (23) weremore (P<0.05) at 12 weeks after sowing (WAS). Varying fertilizer levels significantly (P<0.05) affected fresh forage yield with the highest value (15.8t/ha) recorded at 60kg/ha. Age of cutting also had significant (P<0.05) effect on both fresh forage and dry matter yields. The highest fresh weight yield (16.3t/ha) was recorded at 12 weeks after sowing (WAS) where as dry weight (4.3t/ha) was recorded at 14 weeks after sowing (WAS).Proximate compositions ofcrude protein, crude fiber and nitrogen free extract were significantly (P<0.05) affected by the varying levels of fertilizer, whereas Dry matter, crude protein, crude fibre, ether extract, andnitrogen free extract were significantly (P<0.05) affected by age of cutting. The highest DM (94.3%), CP (8.99%) and CF (39.39%) were recorded at 10, 12 and 12 weeks after sowing (WAS), respectively. ether extract (7.88%) and ash (7.67%) were significantly (P<0.05) higher at 12 weeks after sowing. Calcium content of the forage and Calcium (Ca): Phosphorus (P) ratio were significantly (P<0.05) affected as the level of fertilizer application varied with 60kg/ha rate recording the highest percentage (1.62%) and ratio (6.23:1), respectively. Calcium (Ca), Phosphorus (P) and Ca: P ratio were similar (P>0.05) at different cutting intervals. It can be concluded from the result of this study that NPK 15:15:15 compound fertilizer rate 60 kg/ha on *Brachiaria ruziziensis* gave the better forage yield, Crude protein was higher when harvested at 12 weeks after sowing, mineral composition (Ca and P) was also optimum. Therefore, NPK 15:15:15 rate of 60 kg/ha is recommended for higher*Brachiaria ruziziensis* forage yield and nutrient composition for smallholder farmers and livestock owners. In the Second experiment a feeding trial which lasted for (12) weeks was carried out to determine feed intake, nutrient digestibility and nitrogen balance of growing Yankasa rams fed different mixture of *Brachiaria ruziziensis*/concentrate in a total mixed ration. Sixteen healthy Yankasa rams with an average live weight of 21.75kg±1kg were randomly allocated to four treatments with four replicates in a Complete Randomized Design (CRD). The treatment diets were ratio of *Brachiaria ruziziensis* to concentrate: (90:10), (80:20), (70:30) and (60:40)mixtures. Feed intake (57.19kg), Daily feed intake (635.48g/day), Average daily gain (61.11g/day), and feed conversion ratio (10.47) were significantly higher (P<0.05) in animals' fed (60:40) ratio of *B.ruzizienss* to concentrate mixture and showed a decline across the treatments as the quantity of concentrate inclusion in the mixture decreased. Feed conversion ratio (10.47) was significantly (P<0.05) lower in animals fed (60:40) ratio of *B.ruziziensis* to concentrate mixture. The DM, OM, CP, CF, EE NFE and ADF digestibility showed significant variation (P<0.05) across the treatments. The Crude protein digestibility (CPD) was significantly (P<0.05) higher (84.25%) in (60:40) ratio *B.ruziziensis* to concentrate mixture while the least value of 76.12% was recorded in rams fed

*B.ruziziensis*to concentrate mixture (90:10) ratio. Nitrogen intake, nitrogen absorbed, nitrogen retained and absorbed as percentage of intake (61.28%, 59.16%, 57.58%, 93.75% and 96.48%) respectively were significantly higher ($P<0.05$) in animals fed (60:40) ration. Rumen pH (6.80), TVFA (Total volatile fatty acid) (44.87 Mmol/100ml), Rumen Ammonia nitrogen (NH_4-N) (16.18 mg/100ml) significantly ($P<0.05$) differed across the treatments and animals fed (60:40) ratio of *B.ruziziensis* to concentrate mixture ratio recorded the highest value. It can be concluded from this work that feeding Yankasa rams with 60:40 ratio of *B.ruziziensis* to concentrate mixture in a total mixed ration improved digestibility, utilization resulted in the highest weight gain (5.5kg) and highest revenue (₦4887.7). Feeding of *B.ruziziensis* to concentrate at a ratio of 60:40 in a total mixed ration is hereby recommended for smallholder farmers and livestock owners in the Northern Guinea Savanna of Nigeria.

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ACRONYMS AND ABBREVIATIONS

ADF = Acid Detergent fire

ANOVA=Analysis of Variance

AOAC = Association of Official Analytical Chemists

Ca= Calcium

CEC = Cation Exchange Capacity

CF =Crude Fibre

CIAT = International Centre for Tropical Agriculture

CIRAD = French Agricultural Research Centre for International Development

CP = Crude Protein

RCBD = Randomized Complete Block Design

CRD = Complete Randomized Design

D = Diets

DM = Dry Matter

DMD = Dry Matter Digestibility

DRP = Dairy Research Programme

EE = Ether Extract

FAO = Food and Agriculture Organization

FGN = Federal Government of Nigeria

G.E = Gross energy

IAR = Institute for Agricultural Research

ILRI = International Livestock Research Institute

IVDMD = *In vitro* Dry Matter Digestibility

IVOMD =*In vitro* Organic Matter Digestibility

Kcal = Kilo Calorie

LAI = Leaf area index

LWG = Live Weight Gain

ME = Metabolizable Energy

Mg/100ml = milligram /100 milliliter

mmol/100ml = Millimole/100 milliliter

N = Nitrogen

NAPRI = National Animal Production Research Institute

NASS = National Agricultural Sample Survey

NDF = Neutral Detergent Fibre

NFE = Nitrogen Free Extract

NPK = Nitrogen Phosphorus Potassium

OM = Organic Matter

OMD = Organic Matter Digestibility

SEM = Standard Error of Means

TMR = Total Mixed Ration

TVFA = Total Volatile Fatty Acid

CHAPTER ONE

1.1 INTRODUCTION

Small ruminants play a key role in bridging the wide gap in the supply of animal protein for human consumption (Osinowo *et al.*, 1991) because of their special features with relatively short generation interval as compared to cattle and they have high reproductive rate and low production cost. Given the estimated population of 34.5 million goats and 22.1 million sheep and specifically about 70 percent of the sheep and goat populations are concentrated in the northern region of the country(FDLPCS, 1992). Concentration of Nigeria's livestock-base in the northern region is mostly influenced by the climate of the region, which is characterized by low rainfall duration, lighter sandy soils and longer dry season. Therefore, the importance and advantages of small ruminants in northern Nigeria cannot be over looked.

Feed scarcity is one of the major constraints to livestock production in the West African Sub-region (Glatzle, 1992). The poor quality of feed resources available to ruminants results into a low plane of nutrition (Doma *et al.,* 1999)and low productivity of our indigenous animals (Otchere *et al.,* 1987). Similarly,a major constraint to livestock production in developing countries such as Nigeria is the scarcity and fluctuating quantity and quality of all year-round feed supply. The hope of feeding the rapidly growing human population will depend on the enhanced and efficient utilization of unconventional resources that cannot be used as food for humans or for livestock (Ørskov,1999). The major challenge to livestock production is ensuring adequate feed supply throughout the year in terms of quality and quantity (Kallah. *et al*.,1997).Ruminants depend largely on crop residues during the long dry periods of the year for maintenance as well as production of

meat, milk, skin and fibre. Ruminants are fed mainly on agro-industrial by- products containing a large portion of ligno-cellulose feeds such as cereal crop residues, straws,stovers and native pastures and other related feeds. These feeds are usually poor in protein, energy, minerals and vitamins (Kapu, 1975; Bogoro, 1997).Ruminants in the tropics are raised predominantly on grasses which are inherently poor in digestibility, nutritive value and unavailable in the dry-season (Babayemi, 2009).

Feeding grains to ruminants is unrealistic, because of the stiff competition from man, industrial raw materialsand monogastric animals. On the other hand, ruminants are characterized by their ability to convert low quality roughage to products that are useful to man e.g. meat, milk natural fibers, leather and manure. Ideally, ruminants should graze on arable areas, utilize crop residues when crops are harvested, Crops such as maize, sugarcane, grains, sorghum, wheat, millet, rice, cowpea and vegetables are usually utilized in animal feeding.

The main feed resources for ruminant animals are pastures, crop residues and other agro-industrial by-products. In the dry season and post-harvest periods, these feed resources become the main sources of energy for ruminants when poor quality forages from the range land prevail (Kibon and Ørskov, 1993). The quantity and quality of available feedstuffs are the major factors influencing productivity of ruminants in many parts of the world, especially in regions with high animal numbers.Cropresidues are potential feed resources especially during the dry season. However, cereals cropresidues are generally low in digestibility, because of their high fibre content and are deficient in nitrogen, minerals and vitamins. The cell walls of low-quality roughages are generally high in indigestible

fractions of lignin and silica (Jayasuriya, 1986).However, animal performance with such feedstuffs may be poor due to low voluntary intake and digestibility, which result from low protein concentrations and high levels of indigestible or slowly degradable fibre (Abdel-Hameed *et al.,* 2013).The feeding value of a grass particularly if related to percentage of crude protein (CP), acid detergent fibre (ADF) and neutral detergent fibre (NDF), as well as invitro dry matter digestibility (IVDMD), depend on the age and the part of the plant that is analysed, the time of the year it is harvested and the soil fertility conditions.

Importantly,one of the major constraints of small ruminant production in Nigeria is nutrition, in which feeding constitutes about 85% of total cost of production (Alawa and Umunna, 1993). Therefore, feeding strategies are needed to increase animal performance using tropical grasses (Eugene *et al.,* 2010). The feed shortage for ruminants can be alleviated by deliberately cultivating forages. Availability of high-quality sown forages is important in the sense that their potential values lie in the provision of protein, vitamins and also the mineral elements that are lacking in natural pastures during the dry season (Bamikole *et al.,* 2004).Similarly, ruminants in the tropical and sub-tropical countries are likely to depend almost entirely on pasture and agricultural by-products of relatively poor nutritional status. Improvement in ruminant production will therefore require increased effort in investigating the different possible ways and means of upgrading poor roughages through increasing their digestibility and voluntary intake (Fadel, 2004).

Brachiaria is one of the most important forage grass for pastures in the tropics (Singh, 2009).*Brachiaria* is a genus of grass originating from the savannas of Eastern Africa and several species are widely used as livestock feed. *Brachiaria* species are either annual or

perennial grasses, with most of the species lacking rhizomes. The inflorescence has panicle branches composed of racemes and the entire plant usually do not grow higher than 1m. *Brachiaria* is a C4 plant which tolerates drier conditions and more light exposure than many other plants (Watson and Dallwitz, 2008).

(Silva *et al*. 2004) reported that species of the genus *Brachiaria* are frequently used in no-till systems because these plants are highly adaptable and tolerant to limiting conditions that would affect other forage species negatively. *B. ruziziensi*s has a good nutritive value and is more palatable than most other *Brachiaria* spp. Its crude protein (CP) content commonly ranged from 7–13% and up to 20% with dry matter digestibility of 55–75%. A *B. ruziziensis*grasshay cut 45 days after seeding in northeast Thailand, hadIVDMD, crude fibre, NDF and ME concentrations of 61%, 80.5%, 72.8% and 7.9 MJ/kg, respectively. Selective grazing, heavy grazing pressure and low soil fertility can result in the loss of *B. ruziziensis*grass(Schultze-Kraft and Teitzel, 1992).

*Brachiaria*species have been known since the 1950's inBrazil, but the actual acreage expansion occurred in the '70s and '80s, mainly in tropical regions. Of the genus *Brachiaria*, the species *B. brizantha*, *B.ruziziensis* and *B. decumbens* are the most widely used in Brazil (Zimer *et al*., 1995).*Brachiaria* cultivars have impacted the economy of various countries in the tropics because of their ability to grow so well in low fertility acid soils and still able to produce highly nutritious forage for many ruminants. In the past 25-30 years,*Brachiaria* cultivation and export has become a major component of sown pastures (Singh*et al.*, 2009). In South America, Brazil represents the leading user of *Brachiaria* forage. *Brachiaria* grass has a rapid growth especially in the wet season. Its compatibility

with *Stylosanthes humilis* and *S. hamata* is highly noted and also its ease of establishment (Miles *et al.*, 1996). *Brachiaria ruziziensis* combines well with other grasses and legumes.

1.2 Justification for the Study.

The feed shortage and quality are the main problems of ruminant animals and this often leads to clashes between farmers and herders as a result of encroachment into the farmlands. Ruminants in such areas depend largely on availability of crop residues most especially during the long dry season of the year. This can be met by deliberately cultivatingforage plants to feed animals which may offer solution. Availability of high-quality sown forages is important in the sense that their potential values lie in the provision of protein, vitamins and also the mineral elements that are inadequate in natural grassland pastures during the dry season (Bamikole *et al.*, 2004). *Brachiaria* cultivars have impacted the economy of Brazil and Zaire, because the plant has the ability to grow so well in low fertility acid soils of the countries and is also able to produce highly nutritious forage for many ruminants. Its crude protein (CP) content commonly ranged from 7-13% and sometimes to 20%, with dry matter digestibility of 55-75%. In the past 25-30 years, *Brachiaria* cultivation and export has become a major component of sown pastures in the tropics (Singh, 2009).

1.3 Objectives of the study

The general objective of this study was to determine the effect of varying levels of NPK 15:15:15 fertilizer on the forage yield, quality and nutrient digestibility of *B.ruziziensis* in the provision of protein, vitamins and mineral elements that are inadequate in natural grazing lands of the semi-arid zone of Nigeria.

The Specific objectives include:

- ✓ To determine the growth components, dry matter yields and chemical composition of *Brachiaria ruziziensis* as affected by different levels of NPK 15:15:15.
- ✓ To determine the feed intake, performance and nutrient digestibility of Yankasa sheep fed mixture ratios of *Brachiaria ruziziensis* and concentrate in a total mixed ration.

1.4 Hypothesis:

Experiment 1:*Effect of fertilizer rates on the agronomic characteristics of *Brachiaria ruziziensis.

$H_{O:}$ Varying levels of NPK 15:15:15 have no effect on forage yield and quality of *Brachiaria ruziziensis*.

H_A: Varying levels of a NPK 15:15:15 havean effect on forage yield and quality of *Brachiaria ruziziensis*.

***Experiment 2:*Performance of Yankasa rams fed varied ratios of *Brachiaria ruziziensis*: concentrate in a total mixed ration.**

H_O: Feed ratios of *Brachiaria ruziziensis*to concentrate mixture in a total mixed ration have no effect on performance and Nutrient digestibility of Yankasa rams.

H_A: Feed ratios of *Brachiaria ruziziensis*to concentrate mixture in a total mixed ration have effect on performance and nutrient digestibility of Yankasa rams.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 History of Brachiaria

The genus *Brachiaria* and its species originated from Africa but found their way to the sub tropical and tropical regions of Australia and South America (Parsons, 1972). In Brazil, introduction of *Brachiaria spp* date back to 500 years ago, when *B. mutica* was introduced through African slaves. The new forage grasses were favoured by stock owners due to their persistence under grazing and higher nutrient value compared to indigenous grasses. *Brachiaria* species are common constituents of the natural vegetation in East Africa. Ndikumana and De Leeuw (1996) observed that sown pastures still play no role in livestock production in East Africa except in small holder dairies in the highland regions. Within those areas cut and carry or extensive grazed pasture is more often practiced. Miles *et al*. (1996) found that the forage potential of these grasses was first recognized about 40 years ago in restricted niches in tropical Australia. The major impact of the genus was however realizedbetween 1976-1981 when a handful of germplasm was sown in Tropical America where numerous cultivars have been developed to date.

2.2 Adaptation and distribution of *Brachiaria ruziziensis*

Brachiaria species are mainly found in Lake Edward and Lake Kivu districts of Congo, Rwanda, Burundi, and the Ruzizi plains in Zaire, but are now widely distributed in the tropics. They occur in grasslands, disturbed areas and are naturalised throughout the humid tropics and also cultivated and grown in Queensland (Australia), Srilanka, Thailand and

tropical America in places like Korovinia (Fiji), Quilichao (Colombia), French Guyana, Honduras and Costa rica (McGregor, 1988).

Several commercially grown *Brachiaria* species are well adapted to low-fertility, acid soils of the tropics. Research to identify plant attributes that contribute to efficient acquisition and use of nutrients for plant growth is recent. Several root and shoot attributes were shown to contribute to the adaptation of *Brachiaria* species to acid soils, These include their ability to change the partitioning of fixed carbon to favour root growth, to acquire nitrogen (N) through associative fixation, to acquire phosphorus (P) through extensive root systems and mycorrhizal association and to acquire calcium (Ca) through highly branched root systems. Differences in adaptation to acid soils among *Brachiaria* species cannot be attributed to aluminum (Al) toxicity (Singh, 2009).

2.3 Morphological description of *Brachiaria ruziziensis*

Brachiaria forages are annual or perennial grasses,lacking rhizomesexcept for *B. ruziziensis, B. brizantha* and *B. decumbens* having short rhizomes. The inflorescence has panicle branches composed of racemes,dense and spikelike racemes, the spikelets are all sessile and close together while the rachis of the racemes is winged, broad and over 3 mm wide (Watson and Dallwitz, 2008).the entire plant usually does not grow taller than 1 m. The flowers are fleshy with 3 anthers and the plants are bisexual. Some members of the genus have a prominent vein in the center of the leaf whereas others do not. Brachiaria are C_4 plants able to tolerate drier conditions, are spreading perennials with short rhizomes similar in habit to Para grass.A tufted, creeping perennial with short rhizomes forming a dense leafy cover. Culms arise from many-noded creeping shoots and short rhizomes,

growing to a height of 1.5 m when flowering. Leaves are soft but hairy and up to 25 cm long and 15 mm wide. Inflorescence consists of 3–9 relatively long racemes (4–10 cm), bearing spikelets in 1 or 2 rows on one side of a broad, flattened and winged rachis. Spikelet'sare hairy, 5 mm long with an average seed weight of 250,000/kg. *B. ruziziensis*is very closely related to *B. decumbens*, being differentiated morphologically on rachis shape, which is sub-foliolate and 2–3.5 mm wide and flat in *B. ruziziensis* and 1–1.7 mm wide in *B. decumbens* and on the position of the lower glume, which is 0.5–1 mm distant from the rest of the spikelet in the former and very close to the upper glume in the latter (Rao *et al*., 1996).

2.3.1 Genetics and breeding

Brachiaria species have a diploid number of chromosome, reproduction is sexual with a high degree of cross-pollination. Breeding programs are related to the ability of a tetraploid form of *B.ruziziensis* to confer sexual reproduction ability to interspecific *Brachiaria* hybrids involving the tetraploid , apomictic *B. decumbens* /*B.brizantha* complex Typical chromosome number, 2*n* = 18. Also tetraploid, 2*n* = 4*x* = 38.The genus *Brachiaria*, tribe *Paniceae*, includes about 100 species, which occur in the tropical and subtropical regions of both eastern and western hemispheres, but mostly in Africa. Seven perennial species of African origin: *B. arrecta, B. brizantha, B. decumbens, B. dictyoneura, B. shumidicola, B. mutica,* and *B. ruziziensis* have been used as fodder plants, particularly in tropical America, and less so in Asia, the South Pacific, and Australia (Keller-Grein et al. 1996). Bogdan (1977) stated that *B. ruziziensis* and *B. decumbens* were regarded as closely related and not easily differentiated. At the Kitale Research Station, Kenya, *B. ruziziensis* and *B. brizantha* were not distinguished from each other for a long time. Maas (1996) suggested that the

widely used cv. *Basilisk*, commonly identified as *B. decumbens* (Oram, 1990), is in fact *B. brizantha* because much of the *B. brizantha* germplasm overlaps morphologically with accessions of *B. decumbens*. Maas (1996) suggested that we continue identifying cv. Basilisk as *B. decumbens*, until the taxonomic status of the whole agamic complex, including *B. brizantha*, *B. decumbens*, and *B. ruziziensis*, is clarified. Keller-Grein *et al.* (1996) reported that while *Brachiaria brizantha* is widespread in tropical Africa, occurring in open and wooded grasslands, along margins of woodlands and thickets and in upland grasslands, *Brachiaria decumbens* has a narrow natural distribution. However, except for cv. Basilisk no germplasm is available from Uganda where the species is very common and where numerous herbarium specimens were collected. In addition, no germplasm has been collected from westem Tanzania or Zaire, where the species also occurs naturally. It is found in deciduous bush land, grasslands, and at forest edges. Four major and three minor collections of *Brachiaria* exist *ex situ*, holding a total of 987 distinct accessions of 33 known species. About 40% of existing accessions are of *B. brizantha*, and another 39% are of *B. humidicola, B. decumbens, B. nigropedata, B. jubata*, or *B. ruziziensis* (Keller-Grein *et al*., 1996). To minimize genetic drift, shift or erosion, proper maintenance of germplasm is essential. But conservation of *Brachiaria* germplasm as seed is extremely difficult because of problems in seed production and processing. Hence, most major genetic resource centers maintain live field collections (Keller-Grein *et al*. 1996). Because most *Brachiaria* species are apomictic, problems of contamination of accessions by out-crossing during rejuvenation are limited. Current practices to avoid mechanical mixtures are adequate. Sexually reproducing biotypes would be better conserved *in vitro*. However, no conservation method has yet been developed for this (Keller-Grein *et al*., 1996).

2.3.2 Varieties and cultivars

Brachiaria decumbens and *B. brizantha* are tetraploid (2n = 4x = 36) and apomictic, that is the embryo is produced without fusion of male and female gametes. Sexuality has been found at the diploid level in these species and in *B. ruziziensis*, and is generally associated with regular chromosome pairing and division. As a breeding tool, apomixis offers several advantages, because it associates fixation of hybrid vigour with seed propagation. Apomictic hybrids breed true and superior genotypes can be rapidly increased by seed (Valle do and Savidan, 1996). Until 10 years ago, genetic improvement of *Brachiaria* species depended entirely on selection among naturally existing genotypes, genetic recombination being impossible because of prevailing apomictic reproduction. However, recent advances in understanding the genetics and cytogenetics of *Brachiaria* have opened the way for controlled genetic manipulation. Genetic recombination is now possible in the *B. ruziziensis/B. brizantha/B. decumbens* pool. Present breeding initiatives aim to create apomictic genotypes combining spittlebug resistance and edaphic adaptation with other desirable attributes (Miles and Valle do, 1996). Probably the best known and most widely used *Brachiaria* cultivar is *B. decumbens* cv. Basilisk (Signal grass). It derives from seed (CPI 1694) introduced into Australia from the Ugandan Department of Agriculture in 1930. It was approved for commercial release in Australia in 1966 and registered in 1973 (Oram, 1990). This cultivar is well adapted to infertile acid soils and forms an aggressive, high-yielding sward that withstands heavy grazing and trampling. It is a palatable grass of good forage quality and gives good animal performance. However, its susceptibility to spittlebugs reduces its value as a pasture plant in areas where this pest is a major constraint, for example, in the neo-tropical savannas (Keller-Grein *et al*., 1996). Improvement of

protein concentration in *Brachiaria* seems feasible, as indicated by the variation in crude protein (CP) among accessions of some important *Brachiaria* species grown at different sites. However, based on results with other grass species, genotype and environment (GxE) variance for CP in *Brachiaria* is likely to be greater than genetic variance (Vogel and Sleper, 1994). But, the large variation in IVDMD and the stability of this attribute across environments suggest that digestibility of *Brachiaria* species can be improved. Even small changes in digestibility in *B. decumbens* or *B. brizantha* could have a significant impact on animal performance, as was shown with bermuda grass (Hill *et al*., 1993.Lascano and Euclides, 1996).Identifying the best association between annual crops and different species of Brachiaria allows the exploitation of seed and biomass. After harvesting the seed, the area will be used as a standard pasture. The use of more productive forages during the dry season is important because they minimize the effect of the seasonality of production. In this way, the forage is suitable for intercropping in addition to promoting grain production of annual crops, and it must have good establishment and growth when intercropped, as well as major forage production

2.3.3 *Brachiaria ruziziensis* as a forage crop

Brachiaria brizantha has been found to have similar characteristics with *B. ruziziensis* and can be heavily grazed if used as a monospecific sward and regularly fertilized with nitrogen. *Brachiaria brizantha* alone or in combination with Congo grass *(Brachiaria ruziziensis*) are considered as improved forages and recommended to farmers in South America (Payan, 2007). Other grasses such as *Brachiaria humidicola* or *Brachiaria dictyoneura* under more intensive grazing systems, creeping legumes such as *Arachis* spp.,

Desmodium heterocarpon sub spp. ovalifolium, *Stylosanthes spp.*, *Alysicarpus vaginalis*, *Leucaena leucocephala*, *Pueraria phaseoloides*, *Desmodium intortum*can be mixed with *Brachiaria brizantha* (Cook *et al.,* 2005).Dry matter (DM) yields range from 8–20 t/ha/year, depending on soil moisture and fertilization. Pastures can be permanent (up to 20 years without replanting) or planted under crops such as rubber and coconut. Both *Brachiaria brizantha* and *B. ruziziensis* are well accepted by grazing animals. They are considered to be slightly more palatable than *Brachiaria decumbens* (Signal grass) though slightly less digestible. Most of the trials involving the species were carried out in Brazil.

2.4 Environmental requirements

2.4.1 Soil requirements

*B. ruziziensis*grass requires loam soils of moderately high fertility with pH range of 5.0–6.8 and cannot tolerate strongly acid conditions. Rao *et al.* (1996), in their reviews suggested that *Brachiaria* species can adapt to a wide range of soil types, from Oxisols and Ultisols (low-fertility acid soils) to Alfisols and Mollisols which are high-fertility neutral soils. They perform, much better on acid soils than other grasses, such as *Panicum* species, and also perform well on moderately fertile to very fertile soils. Requirements for phosphorus, calcium, and potassium for growth of *B. humidicola* are much lower than those for other species. Greenhouse and field studies have demonstrated stricking responses in forage yield to phosphorus, but no response to lime or micronutrient applications. Rapid and reliable screening procedures are urgently needed to improve the efficiency of evaluation and genetic improvement of *Brachiaria* germ plasm (Rao *et al.* 1996).

2.4.2 Temperature requirement

Temperature for optimal growth of *B. decumbens* is 30-35°C.It is not frost tolerant (Dienum and Dirven, 1972). It is readily frosted, but its winter production is better than *Digitaria decumbens* in frost free areas. Low temperature depresses growth and hence, *Brachiaria* in general performs poorly at altitudes above 1,800m above sea level (Ndikumana and de Leeuw, 1996). The optimum temperature for growth of *B. ruziziensis* is 33°C during the day and 28°C at night, with a minimum night temperature of 19^{o}C. Low yields resulted from a 24^{o}C temperature during the day and 19°C temperature at night. Ludlow (1976) found *Brachiaria* species among several tropical grasses to be the most affected by low temperatures. It is highly affected by heavy frosts, and spring re-growth is very slow after light frosts.

2.4.3 Light requirement

Fisher and Kerridge (1996) reported that *Brachiaria* species are used as soil covers in many plantation crops, such as rubber and coconut, in Southeast Asia and the Pacific Islands. Their tolerance of shade is therefore of interest. In one experiment, thirty-five (35) forage grass accessions were grown under coconut on fertile soils in North Sulawesi and Bali, Indonesia, with light transmissions of 73% or 58%, respectively. Rainfall (amount and distribution) was confounded with light transmission, higher total rainfall and more even distribution occurred at the site with greater light transmission. *Brachiaria decumbens* cv. *Basilisk* was the top performer at the site with higher rainfall, less shade, and a 12-month growing season (Kaligis and Sumolang, 1991). It was also one of the best species that

performed very well at the site with lower rainfall, more shade, and a more marked dry season (Rika *et al.*, 1991).

2.4.4 Moisture requirement

*B. ruziziensis*tolerate rainfall of up to 2,000mm in the humid tropics with a minimum of 1,200 mm average annual rainfall. However, it can tolerate a dry season of 4 months but will die out in extended dry conditions. Having poor tolerance to flooding, it thrives best on well-drained soils. *B. decumbens* is essentially a grass of the wet tropics, but it has good drought tolerance and is adapted to a dry season of four or five months. However, it prefers 1,500 mm or more of rain. It does not do well where the dry season is more than five months, but is more productive than *Digitaria decumbens, Panicum maximum* and *Brachiaria mutica* in the late dry season. In Australia, Loch (1977) assessed *B. decumbens* as better adapted to the humid tropics, with a dry season of less than 4 months and an annual rainfall of more than 1,400 mm. However, in strongly seasonal climate of the isothermic savannas of the Brazilian Cerrados, *B. decumbens* cv. *Basilisk* is grown in areas where the dry season is as long as 7 months and rainfall as low as 1,300 mm. It extends further into drier zones than *B.humidicola. Brachiaria brizantha* is reputed to tolerate drought better than either *B. decumbens* or *B. humidicola* (Thomas and Grof, 1986). All three species grow well throughout the year in the piedmont of the eastern Cordillera of the Andes in Colombia, where rainfall is more than 4,000 mm (Fisher *et al*., 1996).

Gayalin (1994) compared the performance of *B. decumbens* with *Panicum maximum, Pennisetum purpeureum,* and *Tripsacum laxum* as forages for deferred grazing in the dry season. Although *B. decumbens* is widely grown by farmers for its drought resistance, it

was out yielded by *T. laxum*, which retained three to seven times more green leaf *P. purpeureum* yielded two to three times more total forage than *B. decumbens* and had between one and three times as much green leaf dry matter (DM).

2.5.0 Land preparation, establishment and management

A well-prepared seed-bed is recommended, but light disc-harrowing gives good results. Drill the seed into a well-prepared seed-bed. In Zaire it has been sown in rows 60 cm apart, or broadcasted over the land after scarification of the soil with a disc harrow or brushcutter, without burning the native pastures and grazed as soon as it is ready (Risopoulos, 1966). It will establish in rough seeds-beds but gives better results on a well-prepared seed-bed. Minimum tillage systems should be used andthe work of Boddey *et al*. (1996) also suggested that the environmental impact of a vigorously growing *Brachiaria* pasture is only positive. The grass provides good soil cover, facilitating water infiltration, preventing erosion and leaching of soluble nutrients is minimal. Nitrogen fixation associated with some *Brachiaria* genotypes may slow down pasture decline and the grass's deep, dense rooting system also sequesters much more atmospheric Carbon than native pasture. The large area occupied by *Brachiaria* pastures suggests that this may be an area of global significance for atmospheric carbondioxide (CO_2) sequestration. Sustaining the productivity of pastures while improving animal production requires strategies for maintaining or even improving soil fertility and one effective strategy is to introduce forage legumes into standing *Brachiaria* pastures. Surface sowing in moist soil is feasible but sowing should not be deeper than 2 cm in dry soil (Bogdan, 1964). In Zaire it is recommended to sow*Brachiaria ruziziensis* seed at a depth of 1-2 cm. Under humid conditions seeds lose their vitality after one year (Risopoulos, 1966).

2.5.1 Method of sowing

B. ruziziensis will establish in rough seed-beds but gives better results on a well prepared seed-bed cleared of weeds, stones and dirts. Within three months a complete ground cover should be obtained. It has a long growing season with productive active growth from spring to late autumn. In Zaire, seed is sown into soil not deeper than 1 cm at a recommended seed rate of 30 kg/ha and rolling is only recommended after sowing. After seed ripening, it takes 10 to 12 months to break dormancy.

2.5.2 Sowing of *Brachiaria ruziziensis*

B. ruziziensis will establish in rough seed-beds but gives better results on a well prepared seed-bed cleared of weeds, stones and dirts. Within three months a complete ground cover may be obtained. In Zaire, seed is sown into soil not deeper than 1 cm at a recommended seed rate of 30 kg/ha and rolling is recommended after sowing. After seed ripening, it takes 10 to 12 months to break dormancy. Treating the seeds for 10 to 15 minutes with commercial Sulphuric acid will improve germination of harvested seed by 33% and seedling vigour is excellent (Grof, 1969).

2.5.3 Establishment of *Brachiaria ruziziensis*

B. ruziziensis can be established from seed, which is often cheap but needs to be stored for at least 6 months after harvest to break its seed dormancy. Broadcast seed at 2.5–10 kg/ha (depending on seed quality) onto a well-prepared seedbed and lightly cover and seed should be sown not deeper than 2 cm. Infertile soils should be fertilised with NPK fertilizer to supply nitrogen, phosphorus and potassium prior to sowing and seedling growth is

vigorous. *B. ruziziensis*grass can be established vegetatively from stem cuttings with rooting nodes and by seed sowing. Initially planted from vegetative material, it is now established mostly from seed after dormancy has been broken (Hare and Phaikew, 1997; Burke *et al*., 2003).

2.5.4 Growth vigour of *Brachiaria ruziziensis*

B. ruziziensis gives a good early wet season growth up to eight weeks after the onset of rain and it seeds heavily in April at Australia. (lat. 17°36'S) (Falvey, 1976).It forms a dense mat under grazing which withstands grazing well (Davidson, 1966). The yields of dry matter did not vary very significantly in Sri Lanka with monthly cutting at 2.5 cm or 7.6 cm height but bi-monthly cuts yielded a little higher dry matter yield (Appadurai and Goonawardene, 1973). Within three months a complete ground cover can be obtained.

2.5.5 Weeding and fertility management of *Brachiaria ruziziensis*

B. ruziziensis can tolerate pre-emergence application of atrazine herbicide at 2.5 kg of 80% product per hectare which will give good control of a wide range of weeds when it is established in the red latosolic soils of Atherton Tableland, Queensland (Loch, 1978)*Unlike B. ruziziensis, Brachiaria brizantha* responds well to nitrogen (N) fertilization and may require repeated moderate applications. In cut-and-carry systems, nitrogen fertilizer should be applied after each cut for maximum production. If grown with a legume, the grazing system must favour the legume and adequate phosphorus (P) must be maintained (Fredericksen *et al*., 1980).*B. ruziziensis* demands high fertility soils and adequate fertiliser to persist under grazing or cutting. It needs high phosphorus in the early growth on a wide range of soils. It responds well to nitrogen, either inorganic or from legumes, but its

nitrogen requirement exceeds that of Guinea grass, which makes the latter more attractive (Mellor *et al*., 1973a). Risopoulos (1966) recorded an increased yield of 10.74t/ha from nitrogen application in Zaire. Added nitrogen is required to keep *B. decumbens* in active leafy growth. Frequent applications of nitrogen, up to six times per season, keep the grass in a very nutritious condition and improve live weight gain in animals especially under high rainfall conditions. On an oxisol at Carimagua, Colombia, it gave maximum yields at 50 kg P_2O_5/ha, responding much more to phosphorus than *Panicum maximum* and *Andropogon gayanus* while on an ultisol at Quilichao, Colombia, it gave a linear response to more than 400 kg N/ha (CIAT, 1978).

2.6 Cropping system and crop management practices of *Brachiaria species*

Brachiaria needs to be stocked heavily and added nitrogen is required to keep it in active leafy growth. Frequent applications of nitrogen-up to six times per season-keep the grass in a very nutritious condition and improve live weight gain especially under high rainfall conditions. At 56-day rotations, the *Brachiaria* seeded and new seedlings dominated the *Pueraria* while at 28-day rotations the *Brachiaria* maintained good stands. It is compatible with legumes such as *Stylosanthes spp., Centrosema spp. and Pueraria spp*. Hetero (*Desmodium heterophyllum*) has similar tolerance (Loch, 1978; Gutteridge and Whiteman, 1978) and*B. ruziziensis* withstands heavy grazing and trampling. CIAT (1978) recommend waiting for a month after the opening rains before establishing rainy-season stoking rates.

2.6.1 Compatibility of *Brachiaria ruziziensis* with other grasses and legumes

Under light grazing, ruzi forms a dense cover and competes with weeds. The sward opens under heavier grazing, allowing broad-leaf weeds to establish and legumes to persist. It will combine with a range of twining, erect and shrub legumes. The advantages of using this genus in integrated system are because these species have abundant roots which contribute to the collection of water, soil aggregation and aeration. Furthermore, these forages have good adaptability, tolerance and resistance to biotic factors and show high dry matter production with good nutritional value, capable of meeting the requirements of animals, especially in the dry season. Identifying the best association between annual crops and different species of *Brachiaria* allows the exploitation of grain and biomass. After harvesting the grain, the area will be used as a standard pasture. The use of more productive forages during the dry season is important because they minimize the effect of the seasonality of production. In this way, the forage is suitable for intercropping in addition to promoting grain production of annual crops, and it must have good establishment and growth when intercropped, as well as major forage productionunder light grazing, *B. ruziziensis* forms a dense cover and competes with weeds. Fisher and Kerridge,(1996) reported that *Brachiaria* species are very aggressive and there have been difficulties in them forming long-term, stable associations with legumes. *Desmodium heterophyllum* and *D. ovalifolium* were reported to be more compatible with *Brachiaria* than species of *Centrosema* and *Pueraria*, which in turn were more compatible than *Stylosanthes guianensis*. Of the common cultivars of *Brachiaria, B. humidicola* is assumed to be the most aggressive, followed by *B. dictyoneura* CIAT 6133 and then*B. decumbens*. Usually, few weeds invade a *Brachiaria* pasture unless it is grossly mismanaged through

overgrazing. Some legumes, grown in association with *B. decumbens*, have persisted over the long term, for example, at Carimagua, associations of *B. decumbens/Stylosanthes capitata* on a sandy soil. *Brachiaria decumbens/Pueraria phaseoloides* persisted for more than 10 years on a clay loam, even though in some years the vigor of *B. decumbens* was reduced by spittlebug infestation. At Pucallpa, Peru, associations of *B. decumbens/D. ovalifolium* have persisted for 8 years under lenient grazing (Fisher and Kerridge, 1996). Research in Costa Rica confirmed that *A. pintoi* is more persistent than other legumes in associations with *Brachiaria*. The proportion of *A. pintoi* increased with heavy grazing pressure, and fewer weeds grew in these than in the other *Brachiaria*-legume associations. One mechanism for greater persistence was the greater half-life of *A. pintoi* plants (Fisher and Kerridge, 1996). In summary, it is difficult to assess whether the poor persistence of legumes (other than *A. pintoi*) with *Brachiaria* species results from competition with the grass or from inherent characteristics of the legumes. Most other legumes have characteristics that do not favour persistence under heavy defoliation i.e easily removed growing points and low seed production. *Brachiaria decumbens* tolerates heavier grazing than other grasses and thus tends to be grazed more heavily which in turn puts greater pressure on the legumes. On the contrary, where growing points are not removed as with *A. pintoi*, the proportion of legume can increase under heavy defoliation (Fisher *et al*. 1996).

2.6.2 Pests and diseases of *Brachiaria ruziziensis*species

B. ruziziensis is attacked by spittlebug (*Aeneolamia* spp., *Deois* spp. and *Zulia* spp.) in tropical America. The leaves are attacked by foliar blight (*Rhizoctonia solani*) in tropical America. Seed heads are attacked by a fungus (*Sphacelia* spp.) in Zaire. But generally,

incidence of disease and pest are not common in *Brachiaria* and they are very resistant species (Lenne and Trutmann, 1994).

2.6.3 Nutritive value and digestibility of *Brachiaria ruziziensis*species

Identifying the best association between annual crops and different species of *Brachiaria* allows the exploitationof grain and biomass. After harvesting the grain, the area will be used as a standard pasture. The use ofmore productive forages during the dry season is important because they minimize the effect of the seasonalityof production. In this way, the forage is suitable for intercropping in addition to promoting grain production ofannual crops.It must have good establishmen growth and forage production when intercropped.*B. ruziziensi*s has a good nutritive value and is more palatable than most other *Brachiaria* spp. Its crude protein (CP) content commonly ranged from 7–13% and up to 20% with dry matter digestibility of 55–75%. For *B. ruziziensis*grasshay cut 45 days after seeding in northeast Thailand, the IVDMD, crude fibre, NDF and ME concentrations were 61%, 80.5%, 72.8% and 7.9 MJ/kg, respectively. Selective grazing, heavy grazing pressure and the need for high soil fertility can result in the loss of *B. ruziziensis*grass(Schultze-Kraft and Teitzel, 1992). Photosensitization may occur and Abas and Sharif (1986) suggest that *B. ruziziensis*grass should not be fed to sheep, goats or young cattle. The quality of *B. decumbens* (Signal grass) has been measured in many cutting experiments and feeding trials, together with other well-known grass species. Studies have shown that the *in vitro* (IVDMD) and *in vivo* digestibility of young leaf and mature (whole plant) Signal grass is similar or higher than that of the other tropical grass such as *Panicum maximum*. The IVDMD of Signal grass ranged from 60% to 70% in young forage and 50% to 60% in mature forage, which is higher than the average (55%) for tropical forage grasses found by

Minson (1990),Lascano and Euclides, (1996). High temperatures have an adverse effect on digestibility that decreased in 18-day material from 78.4 percent at day/night temperatures of 24/18°C to 72.7 percent at 29/30°C and 69.5 percent at 34/30°C (Dienum and Dirven, 1972). Feeding value declined when it seeded heavily at South Johnstone, Queensland, in April (Mellor *et al*., 1973b). Scaut (1959) in Zaire, found fresh grass to contain 13.9 percent crude protein, 27.2 percent crude fibre, 9.0 percent ash, 2.3 percent ether extract and 47.6 percent nitrogen-free extract in the dry matter.

2.7.0 Production potential of *Brachiaria ruziziensis*

2.7.1 Fresh and dry-matter yields

In Sri Lanka, DM yields of 16.8, 22.0 and 25.6 t/ha/year were achieved with N applications of 112, 224 and 366 kg/ha, respectively.In Tanzania, *B. ruziziensis* grass yielded 21.16t DM/ ha (Naveh and Anderson, 1967). At South Johnstone, north Queensland it yielded 19.5t DM/ha under a six-week cutting interval and an input of 220 kg N/ha/year (Grof and Harding, 1970).In French Guyana the yield was 20.58t DM/ha and 1.18 t/ha crude protein (Borget, 1966) and in Zaire yields of 31.35t/ha and 21.47t/ha green matter per hectare per year were obtained in successive years from 1958 to 1959, with 100 kg nitrogen and 100 kg superphosphate per hectare per year (Risopoulos, 1966). At Gualaca, Panama, it produced 11t DM/ha without fertilizer and 27tDM/ha when fertilized with 600 kg N/ha per year in a rainfall area of 3997 mm per year (Holmann *et al*., 2004). A selection of *Brachiaria decumbens* yielded over 4 tonnes of DM/ha without nitrogen but with adequate phosphorus at Quilichao, Colombia (CIAT, 1978). In Honduras, mean annual production was 23 tonnes DM/ha with 450 kg sulphate of ammonia per hectare (Romney, 1961). At Korovinia, in

Fiji's wet zone, it yielded 34 tonnes DM/ha over an 11month period, while in Solomon Islands it produced up to 30 tonnes DM/ha per year under coconuts.

2.7.2 Tillering and seed production (Seed yield, processing and storage)

The patterns of tillering and tiller development have been documented in well fertilized seed crops covering eight tropical grass species by Loch (1985). Results showed that maximum tillering occurred during early vegetative growth and then declined before inflorescences emerged because some tillers dried without completing reproductive development.Production management emphasis should focus on how to encourage high tiller numbers during the vegetative stage and how to maintain a high proportion of tiller survival and reproductive development.Seed crop management is mostly conventional, whereas vigorous synchronized tillering is stimulated by use of nitrogenous fertilizer at times when rainfall, temperature, and sunshine are expected to favour unrestricted development. Ripe seed sheds readily and coupled with imperfect synchronization of crop ripening, tends to make conventional direct harvesting inefficient and its timing critical. Where possible, seeds are allowed to fall and accumulate, and then recovered. Seed yields range from more than 1,000 kg/ha of pure seed to less than 100 kg/ha(Grof, 1969).Seed quality is heavily influenced by vitality and dormancy. Vitality depends mostly on maturity of seed at harvest, which is higher in accumulated fallen seed and much lower in directly harvested seeds. Dormancy is strongly developed in the genus and persists in most taxa at least into the season after harvest. This creates problems for germination testing and in the field use of fresh seed. Yields of 125–200 kg/ha pure seed have been achieved by combine harvesting and up to 700 kg/ha seed has been harvested by ground sweeping. Head emergence is relatively uniform, supporting combine harvesting or sweating. In Thailand,

hand-harvested seed heads are stacked about 1 m deep and allowed to sweat for about 3 days. The heads are turned daily to facilitate the separation of seed from the head and to prevent overheating. Alternatively, the "living sheath" method is used, where heads are tied together in groups and effectively sweated in the field for 1–2 weeks before harvest. The grouped seed heads are shaken into a large net every 2–3 days until all seed is collected. Main countries of seed production are Brazil and Thailand. Seed has a high percentage of dormancy following harvest (<20% germination). Primary dormancy is physiological, while long-term dormancy is mechanical, caused by a restriction of the seed coat. Dormancy may be broken by 6–9 months storage or by acid scarification (Phaikaew *et al*., 1993).Fresh seed shows post-harvest dormancy and delayed germination. Fresh seed gave 20 percent germination in Queensland and after 12 months' storage this increased to 40 percent (Davidson, 1966). Dormancy can also be broken by treating the seed with concentrated Sulphuric acid for 15 minutes (Barnard, 1969) or mechanical scarification (Jones, 1973). All seed recovered directly from the crop must be dried after harvest because moisture contents can be as high as 60% and the usual target for storage is about 10%. The minimum germination and quality required for commercial sale are 15% germinable seeds with 50% purity (Phaikaew and Pholsen, 1993).

2.8 Utilization of *Brachiaria ruziziensis*

2.8.1 Animal production on *Brachiaria ruziziensis*

Brahman steers grazing *B. ruziziensis* grass at Utchee Creek, north Queensland, gave a poor winter performance on grass in association with legumes compared with the performance on Guinea grass, but nearly equalled Guinea grass when 27 kg N/ha was applied. *B. ruziziensis* grass/legume pastures produced 1157 kg/ha live- weight gain while *B.*

ruziziensis grass plus 200 kg N/ha per year gave 1 513 kg/ha live-weight gain (Mellor *et al.*, 1973a). Live-weight gains exceeded 1,000 kg/ha/year on pastures of *B. ruziziensis* with legumes, and over 1,500 kg/ha/yr with 200 kg/ha N fertilizer and steers grazing *B. ruziziensis*on Brazilian savannas at 2 head/ha gained 285 kg/ha/year.

2.8.2 Grazing management of *Brachiaria ruziziensis*

Brachiaria species in combination with *Stylosanthes humilis* in northern Australia had to be grazed heavily to maintain the legume in the sward (Falvey, 1976). *Brachiaria*needs to be stocked heavily, grazing at 42-day rotations gave the best balance with *Brachiaria decumbens* and *Pueraria phaseoloides* at Carimaqua, Colombia. At 56-day rotations, the *Brachiaria* seeded and new seedlings invaded the *Pueraria*. At 28-day rotations the *Brachiaria* also maintained good stands. (Rika *et al*., 1991) also reported that *Brachiaria* species show rapid re-growth and good persistence under heavy or frequent defoliation. Under grazing, *B. decumbens* persisted longer than *Panicum maximum* and *Digitaria setivalva* (now *D. milanjiana*) under increasing stocking rates and heavy grazing pressure (Chen *et al*., 1981). As grazing pressure increased, the pasture of *P. maximum* was gradually invaded by *Paspalum conjugatum.*unlike that of *B. decumbens* pasture, which maintained high ground cover that diminished under prolonged and heavy grazing at a stocking rate of 10 head/ha (Fisher *et al*., 1996). Lascano and Euclides (1996) summarized results from experiments designed to measure live weight gain (LWG) of steers grazing signal grass under different types of management. In the humid environment of South Johnstone, Australia, live weight gain/ha/year on unfertilized signal grass was 50% higher than that recorded earlier at the same location with unfertilized common *P. maximum* (Grof and Harding, 1970), whereas on fertilized signal grass, live weight gain was almost 1000

kg/ha (Harding and Grof, 1978). In a drier environment (Cape York Peninsula, Australia), signal grass in association with legumes, produced more live weight gain in heavily stocked pastures than a common *P. maximum* association (Winter *et al*., 1977). In southeastern Queensland, Australia, signal grass fertilized with nitrogen and the improved *P. maximum* cv. Hamil produced similar live weight gain at both medium and high stocking rates (Whiteman *et al*., 1985). However, in Campo Grande, Brazil, animal gains on unfertilized signal grass were 20% to 30% lower than on improved *P. maximum* cultivars (Lascano and Euclides, 1996). The low live weight gains in 1986 coincided with a season of unusually heavy rains (over 3,000 mm) and a severe spittlebug attack on the grass. Maximum live weight gain was recorded in a year with abnormal dry season rainfall (300 mm) (Lascano and Euclides 1996). An analysis of the 16-year live weight gain data indicatedsignal grass was not regarded despite periodic spittlebug attacks. The annual live weight gain recorded in 1994 (140 kg/hd) was similar to that recorded in the first year after establishment. However, this should not be interpreted to mean that spittlebug is not a problem in *B. decumbens*.Nevertheless, signal grass has been persistent in this long-term grazing experiment, probably because of careful management, seasonal stocking rate adjustment and maintenance fertilizer which is not practiced for most commercial pastures (Lascano and Euclides, 1996). Over grazing and lack of fertilization coupled with spittlebug infestation are probably responsible for the degradation and consequent low animal production of large areas of the Cerrados. Live-weight gains on signal grass increase with improved management. Results from Mato Grosso do Sul, Brazil, showed that live weight gain on signal grass could be doubled (from 120 to 250 kg/ha/year) with phosphorus fertilization (44 kg/ha) (Schultze-kraft and Teitzel, 1992). On less fertile soils in the

Cerrados, live weight gain on signal grass increased only by 60 kg/ha per year when the amount of phosphorus applied to the pasture was doubled (29 to 58 kg/ha) but animal performance was probably limited by low nitrogen levels in the soil (Lascano and Euclides, 1996). One effective way to increase the quality of *Brachiaria* pastures is through grass-legume associations. However, because of the inherent aggressiveness of most *Brachiaria* species, few associated legumes have persisted. Results from a short-term grazing study in Campo Grande, Brazil, showed an 18% advantage in live weight gain from the association of signal grass with the legume *Calopogonium mucunoides*. In a long-term grazing trial in the Colombian Llanos, signal grass associated with *Pueraria phaseoloides* (Tropical kudzu) produced, on average, 40% more live weight gain than the grass alone over the first 9 years of grazing (Lascano and Estrada, 1989). Over a longer period (16 years), the signal grass-kudzu pasture has produced an average of 34% more live weight gain than the grass alone. The grass-legume pasture has shown a clear advantage over pure grass, giving a 67% higher live weight gain in the dry season and a 24% higher live weight gain in the wet season indicating both a direct (i.e., animal selection) and an indirect (i.e., nitrogen cycling) contribution of the legume to animal performance (Lascano and Euclides 1996).

The excellent compatibility and persistence of *A. pintoi* cv. Amarillo with *Brachiaria* was documented in the Colombian Llanos by Grof (1970). Following these initial results, grazing experiments were established in the Llanos and in the humid tropics of Costa Rica to measure live weight gain on *Brachiaria* with and without *A. pintoi*. Associations gave substantially higher live weight gain than the pure grass pastures: 67% higher for *B. humidicola* and 52% higher for *B. dictyoneura*. In the more favourable environment of a humid forest site at Guapiles, Costa Rica, live weight gain on heavily stocked pastures of *B.*

brizantha cv. Marandu/*A. pintoi* has been exceptionally high, producing 30% more live weight gain over a 3-year period than the pure grass. Another legume compatible with *Brachiaria* is *Desmodium ovalifolium* (now *D. heterocarpon* subsp. *ovalifolium*). In a humid environment of Bahia, Brazil, pastures of *B. humidicola* and *D. ovalifolium* were relatively stable over time with adequate grazing management (Pereira *et al*., 1992). However, because of the low quality of this legume (i.e. high tannins content), live weight gains on the grass-legume association did not differ from that on the pure grass (Lascano and Euclides, 1996).

2.8.3 Utilization of *Bracharia species* for silage and hay

Although *Bracharia brizantha* silage may result in low nutrient intake and thus lower animal performance, it may be a valuable alternative as a forage source in beef cattle diets. Its optimal use depends on the appropriate integration of pasture management and conversion of surplus forage into hay (Pereira *et al*., 2008). *Bracharia brizantha* grass/sorghum silage ratio of 67:33 fed to Nelore steers produce similar intake and body weight gain compared to a diet containing only sorghum silage (Chizzotti *et al*., 2005). *Brachiaria* hay can be combined with tree foliage. Moringa (*Moringa oleifera*) foliage included as a protein supplement to *Bracharia brizantha* (Bread grass) hay-based diet fed to dairy cattle increased DM intake and digestibility of the diet as well as milk production without affecting milk composition (Sanchez *et al*., 2006).

2.8.4 Poisonous aspects of *Brachiaria*

Brachiaria have been known to cause hepatogenous photosensitization in livestock (Riet-Correa et al., 2011). The poisoning is due to lithogenic steroidal saponin with protodioscin

being the main saponin found in different species (Brum *et al*., 2009). According to Riet-(Correa *et al.*, 2011) *Brachiaria* poisoning has been reported among sheep, cattle and goats with sheep being more susceptible than cattle. He further states that there exist differences in susceptibility between animals of the same species and this difference has been suggested to be genetic. Sheep raised on *Brachiaria* pastures are less susceptible to poisoning than sheep grazing them for the first time having been raised on other pasture species (Castro *et al*., 2009). In Brazil most outbreaks of poisoning are caused by *B. decumbens* (Souza *et al.*, 2010), whereas outbreaks caused by *B. brizantha* are less frequent (Brum *et al*, 2007). Control measures include removing cattle from toxic pastures, keeping animals in the shade and providing other feed and water. Future preventive measures could incude selection of resilient or resistant animals and cultivars with low saponin content (Riet-Correa *et al.*, 2011).

CHAPTER THREE

3.0 MATERIALS AND METHOD

Experiment 1: Effect of NPK 15:15:15 rates on the agronomic characteristics of *Brachiariaruziziensis*.

3.1 Experimental Siteand Climate

This study was carried out at the Feeds and Nutrition Research Programme of National Animal Production Research Institute,Ahmadu Bello University,Shika-Zaria,Nigeria.Shika is geographically located between latitude 11^0 12"N and longitude 7^0 33"E at an altitute of 660m above sea level, 22km North West of Zaria in the Northern Guinea Savannah zone of Nigeria. Wet season starts from April to Early-May and ends in Late-September to early October. Long- term annual rainfall ranges from 1110 to 1580 mm with maximum temperature of 30^OC and relative humidity of approximately 70% ((*I.A.R*,MS 2016).

3.2 Meteorological data of the experimental site

Weather observations at Shika and environs during the experimental period in 2017 are presented in Table 3.1. Mean maximum and minimum air temperatures (32.27^{o}C and 22.65^{o}C, respectively) were recorded for the months of May to October during the rainy days which were similar to the previous records. A total annual rainfall of 1049.90mm with a mean of 209.18mm was recorded in 2016. Total number of rainy days in Shika and environs was 61 days for 2016. A mean relative humidity of 73.33% and mean sunshine of 7 hours was recorded.

Table 3.1. Weather observations,temperatures, relative humidity and rainfall distribution at Shika during the experimental period in 2016

Months	Max.Air Temp (^{0}C)	Min.Air Temp (^{0}C)	Rainfall (mm)	Relative humidity (%)	Sunshine (Hours)
May	35.16	24.16	81.30(6)	66.39	7.83
June	31.40	23.20	133.30(14)	75.50	7.12
July	30.84	22.94	218.40(10)	80.39	5.90
August	30.55	21.90	268.80(16)	81.94	6.68
September	32.46	25.45	344.10(15)	77.28	6.31
October	33.23	18.23	-	58.45	8.16
Mean	32.27	22.65	209.18(12)	73.33	7.00

A number of rainy days is in parenthesis.

Source: IARMS, 2016

3.3Soil sampling and analysis.

A composite soil sample was collected from the experimental plots using a soil auger to a depth of 15-20cm. The soil samples were analysed for physical and chemical properties such as texture, particle size, nitrogen, phosphorus, soil pH, total carbon, and cations exchange capacity (CEC) as described by A.E.S (1998).The analysis was carried out at the Department of Soil Science, Faculty of Agriculture, Ahmadu Bello University Zaria. The result obtained is presented in Table 4.1

3.4Experimental plot, land preparation and experimental design.

A total area of 120 m^2 was used for the experiment. The land was ploughed and harrowed to provide a good seedbed to enhance faster germination. The experimental field measuring 8m x 15m was divided into three (3) replicates with four (4) treatments each. The main plot was divided into twelve (12) sub-plots of (2m x 3m). The selected forage grass *B.ruziziensis* was established on different fertilizer rate using R.C.B.D (RandomizedComplete Block Design) on a sole using drilling method with 50cm distance in between the rows. A seeding rate of 20kg/ha was used and normal agronomic practices were adopted. The levels of fertilizer NPK 15:15:15 were 0, 20, 40 and 60 kg/ha.

3.5Data collection.

Growth component was recorded on phenological stages of the crop which include plant height, number of leaves, number of tillers, and plant yield using a quadrate, data were taken at 6, 8,10, 12 and 14 weeks after sowing. Sampling of the forage materials was done at different stages of growth (10, 12 and 14) to determine dry matter production. Samples were weighed,recorded, prepared in the laboratory, labeled and put into polythene bags until required for analysis. About one kilogram (1.0kg) of fresh sample weight of each sample was collected.

Experiment 2: Performance of Yankasa rams fed mixture ratios of *Brachiaria ruziziensis* to Concentrate in a total mixed ration.

3.6Location of study

This Experiment was carried out at the Old Calf Pens of Dairy Research Programme of National Animal Production Research Institute (NAPRI), Ahmadu Bello University,Shika-Zaria,Shika is geographically located between latitude 11^0 12"N and longitude 7^0 33"E at an altitute of 660m above sea level, 22km North West of Zaria in the Northern Guinea Savannah zone of Nigeria (Ovimaps 2015). Wet season starts from April to early May and ends in late September to early October. Long- term annual rainfall ranges from 1110 to 1580 mm with maximum temperature of 30^OC and relative humidity of approximately 70% (*I.A.R.*MS 2015).

3.7Curing and preparation of hay

At the end of the agronomic evaluation, forage material was harvested at the point of seed harvest and air dried. The forage material was properly dried chopped and grounded with a forage chopper to smaller particles and stored in bags in a well-ventilated store room until ready for the feeding trial with growing Yankasa rams. At the commencement of the feeding triala standard concentrate was used. The diet mixture ratios were prepared at 90:10,80:20,70:30 and 60:40 *B.ruziziensis* hay and Concentrate mixture in a total mixed ration as presented in table 3.2

TABLE 3.2. Ratios of experimental Diet *Brachiaria ruziziensis* and Concentrate mixtures fed to Yankasa Rams

Total mixed ration	*B.ruziziensis*	Concentrate
D1	90	10
D2	80	20
D3	70	30
D4	60	40

D1= 90:10, D2= 80:20, D3= 70:30, D4= 60:40 ratios

Table 3.3: Composition of Concentrate Diet

Ingredient	Percentage (%)
Maize	31.2
Maize offal	15.6
Wheat offal	15.6
Cotton seed cake	34.6
Bone meal	2
Salt	1
Total	100.0

Table 3.4 Composition of proximate analysis of concentrate and hay

Proximate analysis(%)	Concentrate	Hay
O.M	89.70	89.55
C.P	12.63	8.25
E.E	7.68	4.35
C.F	7.30	26.41
Ash	4.03	2.88
NFE	68.36	58.11
ADF	22.31	35.15
NDF	39.95	61.58
M.E (kcal/kg)	3934.34	2104.75
Cost/kg	₦72.24/kg	₦39.28/kg

3.8Management of experimental animals

Sixteen (16) healthy rams of about 12 months old, weighingabout 21.75kg±1kgwere used for the trial. Before the commencement of the study, the experimental animals were given prophylactic treatment against an endo- andecto- parasites using (Sambezole) *Albendazole* (Oral Suspension) 20 ml/10 kg, *Amiticks* spray (200 ml/ 20 ltr), *Ivermectin* (subcute) 0.1ml/10kg and Long Acting 10ml/10kg (antibiotics) against bacterial infection.The pen was washed with detergent and disinfectant against microorganisms. The animals were housed in their individual pen and fed the experimental diet to adjust before the commencement of the study.

3.9Experimental design, treatments and feeding

Prior to the commencement of the experiment the animals were balanced for weight and Sixteen rams were randomlyallocated to thevarious treatmentssuch that there were 4 rams pertreatment in a Completely Randomized Design (CRD). The animals were fed *ad-libitum* on experimental dietat about 8am in the morning in their individual pens.The first group of experimental animals were fed diet *Brachiaria ruziziensis* – concentrate mixture ratio of 90:10. Group Two aniamls were fed *B.ruziziensis* and Concentrate ratio of 80:20 while Group three animals were fed 70:30 and Group Four animals received a diet of 60:40 ratiosof grass to concentrate and each served as a treatment.The experimental animals were fed ad-libitum and the left-over(ort) was weighedand recorded before the nextday'sfeeding. Clean waterand mineral lick werealso offered *ad-libitum*to the animals.

3.10Live weight changes

The initial weights of the animal were taken at the onset of experiment and subsequentlyanimals were weighed on fortnightly basis to measure their live weight changes. The live weight changes were determined by the difference (final – initial), The daily record of feed intake was obtained by subtracting the quantity of leftoverfeed weight (Ort weight) from the feed offered the previous feeding.

3.11Digestibility trial

After the 90 days feeding trial, three (3) rams were randomly selected from each group and housed in individual metabolic cages as described by (Osuji *et.al.*, 1993). Urine and faeces were collected for a period of 5 days after an adjustment period of 14 days. The daily faecal output per animal per treatment was weighed, sub sampled and oven dried at 60 ^{O}C for 6 hours for determination of dry matter then Bulked feacal, sub-sampledwas stored in polythene bags until when required for chemical analysis to determine dry matter and proximate composition. The daily urine output was collected in plastic container, acidified with 10mls of 0.1M H_2SO_4 to prevent nitrogen loss through volatilization. Thereafter 10% of the total urine collected was sub sampledand analyzed to determine nitrogen (Osuji *et al*., 1993).

3.12Chemical analysis

Samples from the bulked experimental diets and faecal sample were obtained, dried and milled for the determination of crude protein, crude fiber (CF), ether extract (EE), and ash contentwhile soluble carbohydrates (NFE) was calculated by the sum of % ash, % crude fiber, % crude fat and % crude protein from 100. That is: NFE = 100 − (%ash + %crude

fiber + % crude fat + % crude protein).N-content was determined using the Micro Kjeldahl procedureof A.O.A.C. (2005).Neutral detergent fibre (NDF), and acid detergent fibre (ADF), were determined by the method of Van-Soest *et, al*. (1999). Mineral contents (calcium and phosphorus) were determined by AOAC (2005).methods using an Atomic Absorption Spectrophotometer.The Metabolizable energy of the diet was determine using a Bomb Calorimeter at the central laboratory of the National Animal Production Research Institute/ABU, Shika.

3.13 Cost benefit analysis of feeding *Brachiaria ruzizienisis* to the yankasa rams

The value of gain (gross margin) for each treatment was calculated based on the value of live weight gain by each ram and the cost of managing the ram during the 90 days feeding trial. The cost of feed per kilogramme (kg) was determined by addition of the cost of concentrate and hay mixture per kg. Total feed consumed was recorded as the total feed intake from each treatment for the diet. Cost of feeding each ram was calculated as total cost of feed multiply by total feed consumed for each ram. The value of gain was determined as cost of live animal minus the total cost of production for each ram.

3.14Statistical analysis

All data collected were subjected to ANOVA using SAS package (SAS, 2002) and the means were separated using Duncan Multiple Range Test (Duncan, 1955).

Statistical model for experiment I:

$$\mathbf{Y_{ijk} = \mu + I_i + C_j + (I \times C)_{ij} + E_{ijk}}$$

Where:

Y_{ij} = Dependent variable

μ = Population mean

I_j = Effect of Treatment (NPK 15:15:15) (j = 0, 20, 40, 60 kg/ha)

C_k= Effect of Cutting age (10, 12 and 14 weeks after sowing)

(I x C) = Interactions between fertilizer rates and cutting age.

E_{ij} = Random error.

Statistical model for experiment II:

$$\mathbf{Y_{ij} = \mu_i + I_j + E_{ij}}$$

Where:

Y_{ij} = Dependent variable

μ = Population mean

I_j = Effect of Diet (j = 90:10, 80:20, 70:30 and 60:40 ratios of *B.ruziziensis* to concentrate).

E_{ij} = Random error.

CHAPTER FOUR

4.0 RESULTS

4.1 Experiment 1: Effect of Fertilizer rates on Forage Yield and Quality of (*Brachiaria ruziziensis*).

4.1.1 Soil characteristics of the experimental Site

The physical and chemical characteristics of the composite soil samples taken from 0 to 15 cm and 15 to 30 cm depths of the experimental site are shown in Table 4.1. The soil consists of (54% and 54.20%) sand, (16% and 16.20%) clay and (30% and 29.60%) silt giving rise to sandy loam while the organic carbon was (0.67% and 0.62%). The pH value recorded was (4.8 and 4.7) 0.01M $Cacl_2$ respectively which shows that the soil is slightly acidic in reaction. Typically, with tropical soils, the soil of the experimental site is low in both total nitrogen (0.175% and 0.190%) and available phosphorus (23.28 and 22.01mg/kg). The exchangeable cations present in the soil samples are Ca^{2+}, Mg^{2+}, K^{+} and Na^{+} which are needed for growth and development of plants and cations exchange capacity (CEC) of 8.20 and 8.00, respectively.

Table 4.1: Physical and chemical properties of soil in the study area

Physical properties	Soil depth	
Particle size (%)	0-15cm	15-30cm
Clay	16.00	16.20
Silt	30.00	29.60
Sand	54.00	54.20
Textural class	Sandy Loam	Sandy Loam
Chemical properties		
pH (0.01M$CaCl_2$)	4.80	4.70
Total nitrogen (%)	0.175	0.190
Organic carbon (%)	0.67	0.62
Phosphorus (ppm)	23.28	22.01
Exchangeable bases(cmol/kg):		
Ca^{++}	4.00	3.91
Mg^{++}	1.50	1.43
K^{+}	0.64	0.62
Na^{+}	0.32	0.31
Cation Exchange Capacity: (CEC)	8.20	8.00

4.1.2 Effect of fertilizer rates on growth and yield components of *Brachiaria ruziziensis.*

The result of forage yield component is presented in Table 4.2.Plant height increases significantly (P<0.05) with an increase in the level of fertilizer rate. Fertilizer ratesof 60kg/ha and 40kg/ha had significantly (P<0.05) higherbut similar plant height of 74.90cm and 73.40 cm, respectively. Leaf length was significantly (P<0.05) affected by fertilizer rate in the same manner. However, leaf width, number of leaves and number of tillers were not affected significantly by the rate of fertilizer application. Age of plant had an effect on the growth parameters.Plant height at 14 weeks (105.56cm) differed significantly (P<0.05) from the other weeks being at 10 weeks (75.13cm) and 12weeks (91.37cm), respectively. Leaf length at 14weeks,12weeks and 10weeks after sowing (WAS) were not significantly different from each other (P>0.05). Leaf width at 10 weeks (2.0cm),12 weeks (2.2cm) and 14 weeks (1.9cm) were similar (P<0.05) to each other. Numbers of Leaf at different age differed significantly (P<0.05) at 12weeks (11) and 14weeks (10) compared to 10weeks (8) after sowing, Number of tillers statistically similar with age, at 10 weeks, 12 week and 14 weeksafter sowing (21, 23 and 22,),respectively. Leaf area index (LAI) showed a significant (P<0.05)difference at 0 and 40 kg/ha rate of fertilizer application (0.56 and 0.44, respectively) while the least LAI was recorded at 20kg/ha rate of fertilizer application (0.35). Age also hada significant (P<0.05) effect on the LAI. It washighest at 12weeks of age (0.60) and lowest at 14 weeks (0.04) (WAS).The interaction between fertilizer and age of cutting was not significant (P>0.05) for any measured variables.

Table 4.2: Effect of fertilizer rates and age of cutting on yield component of *Brachiaria ruziziensis.*

Fertilizer rate(kg/ha)	Plant height	Leaf length	Leaf width	No. of leaves	No.of tillers	Leaf Area Index
0	65.7[b]	27.2[b]	2.04	7	18	0.56[a]
20	70.6[b]	28.7[b]	2.1	8	19	0.35[c]
40	73.4[a]	33.3[a]	1.9	8	19	0.44[ab]
60	74.9[a]	31.7[a]	1.8	7	20	0.42[b]
SEM	2.280	0.900	0.200	0.630	1.690	0.060
LOS	*	*	NS	NS	NS	*
Age of plant: (weeks)						
10	75.13[c]	30.6[ab]	2.0[a]	8[b]	21[ab]	0.46[a]
12	91.4[b]	33.5[a]	2.2[a]	11[a]	23[a]	0.60[a]
14	105.6[a]	31.4[ab]	1.9[a]	10[ab]	22[a]	0.45[b]
SEM	1.830	0.720	0.160	0.500	1.350	0.040
LOS	**	*	*	*	**	*
Interactions (p-value)						
FxC	0.920	0.770	0.460	0.580	0.780	0.990

PH= plant height, LAI=leaf area index. LL= leaf length, LW = leaf width, F= fertilizer rate, C = age of plant.a, b, c: Means with different superscript within column differ significantly (P<0.05).SEM=Standard error of the mean, LOS= level of significance**,**

4.1.3 Effect of fertilizer rates and age of cutting on fresh and dry forage yield.

The results of fertilizer rate and age of cutting on the yield of *B.ruziziensis* grass are presented in Table 4.3. Fresh forage yield was significantly (P>0.05) higher but similar at 20,40 and 60 kg/ha fertilizer rates(14.222, 15.778, and 15.889 t/ha respectively) but significantly (p<0.05) higher than 0kg/ha fertilizer rate (13.222 t/ha). Dry matter yields as affected by fertilizer rate was significantly higher at 40 and 60 kg/ha (3.580and 3.534 t/ha)which were similar but differed significantly from 0 and 20 kg/ha fertilizer rates (2.579 and 3.1945 t/ha) which were similar. Age of cutting had a significant effect on both fresh and dry matter yields, the highest fresh forage yields of (16.333 and 15.333 t/ha) and dry matter yield of (3.240 and 4.275 t/ha) were recorded at 12 and 14 weeks after sowing (WAS) respectively. The lowest fresh forage yield and dry matter yield (12.667 and 2.150 t/ha, respectively) were recorded at 10 WAS. The interaction between fertilizer and age of cutting was not significant (P>0.05) for fresh and dry forage weight.

TABLE 4.3: **Effect of fertilizer rates and cutting age on the yield of *Brachiaria ruziziensis.***

Fertilizer rate ($kgha^{-1}$)	Freshforage weight($kgha^{-1}$)	Dry weight ($kgha^{-1}$)
	13.222^{b}	2.579^{b}
20	14.222^{a}	3.195^{b}
40	15.778^{a}	3.534^{a}
60	15.889^{a}	3.580^{a}
SEM	1171.120	301.120
LOS	*	*
Ages of Cutting (weeks)		
10	12.667^{b}	2.150^{b}
12	16.333^{a}	3.240^{a}
14	15.333^{a}	4.275^{a}
SEM	1561.5	401.5
LOS	*	*
Interactions		
P- value		
FxC	0.900	0.600

a, b, c: Means with different superscript within column differ significantly ($P<0.05$). SEM= Standard error of mean, F= fertilizer rate, C = age of cutting.

4.1.4 Proximate Composition of *Brachiaria ruziziensis*hay.

The result of the proximate composition of *B.ruziziensis* is presented in Table 4.4.The result showed that the dry matter and ash content were not significantly (P>0.05) affected by fertilizer rate but crude protein (7.94,8.25,8.32,8.12) etherextract(7.99,7.94,6.87,6.75) crudefibre(36.72,37.93,37.18,35.53) and nitrogen free extract(40.35,39.34,40.80,42.90) differed significantly (P<0.05) at varying levels of fertilizer rate (0, 20, 40 and 60kg/ha), respectively. Age of cutting significantly (P<0.05) affect the proximate fractions at 10, 12, and 14 weeks after sowing. The higherdry matter was recorded at 10 and 14 weeks (94.30% and 94.12%) and highest crude protein (8.99%) was recorded 12 WAS.Crude fiber, ether extract,andash were higher at 12 WAS(39.39%, 7.88%, and 7.67%),respectively.The lowest crude protein, ash, andether extract were recorded at 14 WAS(7.06%, 5.89% and 6.80%) respectively. crude fibre lower was at 10 WAS also nitrogen free extract was highest at 10 (44.36) WAS.

Table 4.4: Proximate composition of *Brachiaria ruziziensis*as affected by fertilizer rate and age of cutting.

Fertilizer Rates ($kgha^{-1}$)	Dry Matter	Crude protein	Crude fibre	Ash	Ether Extract	Nitrogen Free Extract
0	93.84	7.94^{c}	36.72^{a}	6.99	7.99^{a}	40.35^{b}
20	93.76	8.25^{a}	37.93^{a}	6.82	7.94^{a}	39.34^{c}
40	93.93	8.32^{a}	37.18^{a}	6.70	6.87^{b}	40.80^{b}
60	94.03	8.12^{b}	35.53^{b}	6.54	6.75^{b}	42.90^{a}
SEM	0.151	0.26	0.89	0.25	0.27	1.12
LOS	NS	*	*	NS	*	*
Ages of Cutting (weeks)						
10	94.30^{a}	8.42^{b}	33.00^{b}	6.73^{b}	7.49^{a}	44.36^{a}
12	93.24^{b}	8.99^{a}	39.39^{a}	7.67^{a}	7.88^{a}	36.07^{b}
14	94.12^{a}	7.06^{c}	38.13^{a}	5.89^{c}	6.80^{b}	42.12^{ab}
SEM	0.08	0.13	0.48	0.15	0.36	1.04
LOS	*	*	*	*	*	*
Interactions						
FxC	0.0002	0.0002	0.0004	0.0013	0.4075	0.012

a, b, c: Means with different superscript within column differ significantly (P<0.05).SEM=Standard error of mean, LOS= level of significance,F= fertilizer rate, C = age of cutting.

4.1.5 Effect of NPK fertilizer rates on mineral composition of *Brachiaria ruziziensis*.

There was no significant (P>0.05) difference among the varying levels of NPK 15:15:15 fertilizer application (0, 20,40 and 60 kg/ha) for ash and phosphorus at 10weeks,12 weeks and 14 weeks WAS as shown in Table 4.5. The ash content differed significantly (P>0.05), depending on ages of cutting, the highest value 7.67% recorded at 12 weeks and the lowest value of 5.89% at 14 weeks after sowing. Calcium content of the forage and Ca:P ratio differed significantly (P>0.05) as the levels of fertilizer application varied, with 60kg/ha rate recording the highest percentage (6.23:1) and the lowest was recorded at 20kg/ha rate (3.85:1), but P level was not significantly different (P>0.05). Calcium, Phosphorus and Calcium: Phosphorus ratio were similar (P>0.05) at different cutting intervals.

Table 4.5: Effect of NPK fertilizer rates and age of cutting on mineral composition of *Brachairia ruziziensis*

Fertilizer rates ($kgha^{-1}$)	Ash	Ca	P	Ca:P ratio
0	6.99	1.05^{b}	0.19	$5.01:1^{b}$
20	6.82	0.83^{d}	0.25	$3.85:1^{d}$
40	6.70	0.99^{c}	0.23	$4.96:1^{c}$
60	6.54	1.62^{a}	0.28	$6.23:1^{a}$
SEM	0.25	0.17	0.023	0.80
LOS	NS	*	NS	*
Ages of Cutting (weeks)				
10	6.73^{b}	1.11	0.24	4.50:1
12	7.67^{a}	0.95	0.24	4.75:1
14	5.89^{c}	1.31	0.24	5.80:1
SEM	0.15	0.23	0.03	1.03
LOS	*****	NS	NS	NS
Interaction				
FxC	0.0013	NS	NS	NS

a, b, c: means with different superscript within a row differ significantly ($P<0.05$). SEM=Standard error of mean, LOS= level of significance, F= fertilizer rate, C = age of cutting. * significant at 5%

4.2 Experiment 2: Performance of Yankasa rams fed *Brachiaria Ruziziensis* to concentrate ratios in a total mixed ration

4.2.1 Chemical composition and energy content of *Brachiaria ruziziensis* and concentrate ratio in a total mixed ration.

Table 4.6 presents the chemical composition of the experimental diet organic matter (89.70%) of the concentrate diet was similar to (89.55%) of the *Brachiaria ruziziensis*hay. Crude protein content of the concentrate diet (12.63%) was higher ($P<0.05$) than the hay (8.25%) The dry matter of the different experimental diet mixtures was similar across the treatments 90:10, 80:20, 70:30 and 60:40, (92.21,92.01,91.39 and 92.60%) respectively. The crude protein content of the mixture ratios was within the range of (6-8%) crude protein in 90:10 and 80:20 but higher (8.13 and 11.75%) in 70:30 and 60:40, respectively. Metabolizable energywere similar (3807.75,3876.30 and 3893.26%) in 80:20, 70:30 and 60:40, respectively and the lowestvalue of 2292.9 kcal/kg was in 90:10diet.

TABLE 4.6: Chemical composition and energy content of*Brachiariaruziziensis* and concentrate mixture ratios

	Brachiaria ruziziensis: Concentrate ratio			
Components (%)	90:10	80:20	70:30	60:40
DM	92.21	92.01	91.39	92.60
OM	87.55	85.14	87.22	86.86
CP	7.56	7.88	8.13	11.75
EE	9.49	7.26	8.26	8.04
NFE	56.96	49.59	62.36	57.10
ASH	4.66	6.87	4.17	5.74
ADF	32.01	32.56	25.13	22.95
NDF	53.14	48.85	49.97	40.42
Hemicellulose	21.13	16.29	24.84	17.47
M.E(Kcal/kg)	2292.96	3807.75	3876.30	3893.26

ME=metabolizable energy,OM= organic matter,DM=dry matter,CP= crude protein,EE=ether extract,NFE=nitrogen free extract,Ash, ADF= acid detergent fibre,NDF=neutral detergent fibre

4.2.2 Growth performance of Yankasa rams fed *Brachiaria ruziziensis* and concentrate mixture ratios in a total mixed ration.

The results obtained from growth performance of yankasa rams areshown in Table 4.7 below Weight gain shows significant (P<0.05) difference among the treatments with the highest recorded in animals fed (60:40) ratio *Brachiaria ruziziensis* andconcentrate mixture (5.5kg). The result of this study showed a trendthat weight gain increases with increased levels of the concentrate because 60:40 ratio had the highest level of inclusion recorded the highest values of mean weight gain.There was a linear trend for the live weight gain with a significant improvement along the treatments as a result of inclusion level of concentrate, feed intake (57.19kg), Daily feed intake (635.48g/day), Average daily gain (61.11g/day), and feed conversion ratio (10.47) were significantly higher (P<0.05) with animals' place on (60:40) ratio*B.ruziziensis*and concentrate mixtures and showed a decline across as the quantity of concentrate inclusion in the mixtures decrease as in (90:10) ratio*B.ruziziensis* grass to concentrate mixture. Feed conversion ratio, the lower the better and in this study the feed conversion ratio was significantly (P<0.05) lower in animals on (60:40) ratio*B.ruziziensis*andconcentrate mixture (10.47).

TABLE 4.7: Growth performance of Yankasa rams fed *Brachiaria ruziziensis* and concentrate mixture ratios in a total mixed ration.

Brachiaria ruziziensis: Concentrate ratio					
Parameters	(90:10)	(80:20)	(70:30)	(60:40)	SEM
Initial body weight (Kg)	21.75	22.0	21.75	21.75	
Final body weight (kg)	24.0^{b}	24.88^{ab}	25.25^{ab}	27.25^{a}	0.96*
Weight gain (kg)	2.25^{c}	2.88^{bc}	3.50^{b}	5.5^{a}	0.25*
Average daily weight gain (g/day)	25.00^{c}	31.94^{bc}	38.89^{b}	61.11^{a}	2.74*
Total Feed intake (kg)	40.11^{b}	50.18^{ab}	54.21^{ab}	57.19^{a}	3.54*
Daily feed intake (g/day)	445.69^{c}	557.58^{b}	602.29^{ab}	635.48^{a}	39.5*
Feed Conversion ratio	18.31^{c}	17.73^{c}	15.88^{b}	10.47^{a}	2.00*

[a b c:] Means with different superscript within a row differed significantly (P<0.05). SEM: Standard error of mean, *****significant.

4.2.3 Nutrient digestibility of *Brachiaria ruziziensis* andconcentrate mixture ratio diet fed to Yankasa rams.

Table 4.8 presents nutrient digestibility, pattern of *B.ruziziensis*and concentrate mixture fed to Yankasa rams. In this study, highest($P<0.05$)digestibility of the feed was recorded with (60:40) ratio*B.ruziziensis* to concentrate mixture with DMD, OMD, C.P, C.F and E.E (84.90%,85.43%,84.25% 89.07% and 88.20%).There was a decline across the diet with the lowest digestibility indices recorded in animals fed 90:10 ratio (80.57,81.40 and 76.12%),respectively for dry matter, organic matter and crude protein TheNFEwas not significantly ($P>0.05$) different across the treatments. NDFand ADF digestibility showed less variation ($P<0.05$) across the treatments. The high digestibility recorded could be due to a higher quantity of Concentrate ratio in the total mixed ration diets which influenced microbial protein synthesis and facilitated fermentation and consequently improved intake and digestibility.The crude protein digestibility (CPD) were significantly ($P<0.05$) different and the values range from 76.12 - 84.25% with the highest at (60:40) ratio *B.ruziziensis* andconcentrate mixture (84.25%) while the least value of 76.12% was recorded in rams fed (90:10) ratio*B.ruziziensis* and concentrate mixture. The crude fiber digestibility (CFD) was significantly ($P<0.05$) different among the treatments and that the values 89.07% with rams fed (60:40) ratio*B.ruziziensis* to concentrate mixture recorded the highest CFD while the least CFD value of 73.90% was recorded in rams fed (90:10) ratio*B.ruziziensis* and concentrate mixture. The Nitrogen Free Extract digestibility (NFED) of the rams was not significantly ($P>0.05$) different among treatments.

TABLE 4.8: Nutrient digestibility of *Brachiaria ruziziensis* and Concentrate mixture ratios fed to yankasa rams.

Nutrient digestibility (%)					
B.ruziziensis : Concentrate					
Parameters	90:10	80:20	70:30	60:40	SEM
Dry Matter	80.57^{c}	82.62^{b}	82.30^{b}	84.90^{a}	1.06*
Organic matter	81.40^{b}	82.47^{b}	82.76^{b}	85.43^{a}	1.04*
Crude protein	76.12^{b}	78.44^{b}	77.14^{b}	84.25^{a}	2.26*
Crude Fibre	73.90^{c}	87.53^{b}	85.05^{b}	89.07^{a}	1.36*
Nitrogen Free Extract	83.10	83.38	85.75	84.97	0.96^{NS}
ADF	50.43^{a}	51.11^{a}	51.76^{a}	44.31^{b}	3.19*
NDF	59.82^{a}	46.70^{c}	55.77^{a}	51.33^{b}	2.48*
Ether Extract	84.94^{b}	78.78^{d}	82.38^{c}	88.20^{a}	1.01*

[a b c:] Means with different superscript within a row differed significantly (P<0.05). SEM: Standard error of mean, ADF =Acid detergent fibre,NDF = Neutral Detergent Fibre

4.2.4 Nitrogen balance in Yankasa rams fed *Brachiaria ruziziensis* and concentrate mixture ratios in a total mixed ration.

Table 4.9 showed the result of nitrogen balance in Yankasa rams fed *Brachiaria ruziziensis*and concentrate mixture ratios.nitrogen intake was significantly (P<0.05) higher (61.28g) with animals on treatment four (60:40) ratio *Brachiaria ruziziensis*andconcentrate mixture than the other treatments. Faecal nitrogen output was also higher (P<0.05) with animals on 60:40 mixture (2.13) which is similar to animals on 90:10 ratio mixture (1.80). Urinary nitrogen output(1.59), total nitrogen output (3.29) were higher (P<0.05) with animals on 80:20 mixture but similar to animals on 60:40 mixture being (1.55) and(3.75), respectively. Nitrogen absorbed, nitrogen retained and nitrogen retained and absorbed as a percentage of intake (59.16,57.58,93.75 and 96.48, respectively) were significantly higher (P<0.05) in animals fed 60:40 ratio mixture.

TABL 4.9: Nitrogen balance in Yankasa rams fed *Brachiaria ruziziensis* and concentrate mixture ratios in a total mixed ration.

B.ruziziensis : concentrate					
Parameters	(90:10)	(80:20)	(70:30)	(60:40)	SEM
N intake (g)	28.49^{c}	32.57^{b}	33.92^{b}	61.28^{a}	0.99^{*}
Feacal N output	1.80^{a}	1.70^{b}	1.48^{b}	2.13^{a}	0.12^{*}
Urine N output	1.04^{b}	1.59^{a}	1.02^{b}	1.55^{a}	0.02^{*}
Total N output	2.84^{b}	3.29^{a}	2.49^{c}	3.70^{a}	0.25^{*}
Nitrogen absorbed	26.69^{c}	30.87^{b}	32.44^{b}	59.16^{a}	1.04^{*}
Nitrogen Retained	25.65^{c}	29.26^{b}	31.42^{b}	57.58^{a}	1.16^{*}
N retained as % of intake	89.84^{b}	89.80^{b}	92.62^{a}	93.75^{a}	0.77^{*}
N absorbed as % of Intake	93.51^{c}	94.75^{b}	95.62^{b}	96.48^{a}	0.45^{*}

[a, b, c:] Means with different superscript within a row differed significantly ($P<0.05$). SEM= Standard Error of Means**.**

4.2.5 Effects of feeding *Brachiaria ruziziensis* to concentrate mixture ratios in a total mixed ration on some rumen metabolites of Yankasa rams.

The result of rumen pH, presented in Table4.10 below indicates that animals fed diet with 60:40 ratio recorded the highest (6.80) that was similar to 90:10 ratio (6.64) which was followed with those fed diet 70:30 ratio (6.63) and least was recorded on animals fed 80:20 ratio (6.20). This may be attributed to the high concentrate inclusion in the total mixed ration, higher ruminal NH_3-N which may be produced due to feeding high level of CP. TVFA (Total volatile fatty acid), obtained in this study indicated that rams fed 60:40 ratio recorded the highest ($P<0.05$) value 44.87 mmol/100ml and the least was in animals fed 90:10 ratio 33.05 Mmol/100ml. Volatile fatty acids are the main energy sources for ruminants feeding solely on roughages. The increase in rumen TVFA in this study is possibly due to increased digestibility of the feed material. Rumen ammonia (NH_3-N) significantly ($P<0.05$) differedalong the treatments with animalsfed (60:40) ratio recorded the highest value (16.18mg/100ml) and the least was recorded in animals on 90:10 ratio (12.30mg/100ml). This can be attributed to lower fermentation process due to low concentrate inclusion in the ration mixture.

Table 4.10: Effect of feeding *Brachiaria ruziziensis*and Concentrate mixture ratios on some rumen metabolites of Yankasa rams

Parameters	*B.ruziziensis* : Concentrate (90:10)	(80:20)	(70:30)	(60:40)	SEM	Normal range
Rumen Ph	6.64^{ab}	6.20^{c}	6.63^{b}	6.80^{a}	0.05^{*}	6.4-6.8
TVFA (Mmol/100ml)	33.05^{c}	42.45^{b}	42.59^{b}	44.87^{a}	0.36^{*}	70-150Mm/100ml
RumenNH_{3}-N(mg/100ml)	12.30^{b}	12.92^{b}	12.77^{b}	16.18^{a}	0.29^{*}	8.5-30mg/100ml

[a, b, c:] Means with different superscript within a row differed significantly ($P<0.05$). SEM: standard error of means. TVFA= total volatile fatty acids

4.2.6 Cost benefit analysis of feeding *Brachiaria ruziziensis*andconcentrate mixture ratio diets to Yankasa rams

The cost of production increases across the treatments as the cost of concentrate increases and vice versa.The increase in the cost is as a result of increase in the level of concentrate which was made from agro-industrial by-products which are known to be expensive. The revenue generated was highest with animals fed 60:40 ratio (₦17,500) was recovered and the least value was on 90:10 ratio (₦11,125) and total cost of fattening followed the same trend with highest value (₦12,612.3) obtain with 60:40 diet the lowest (₦10,444.7) recorded with 90:10. High quality feed associated with increase in intake, performance and weight gain by the animals was observed with 60:40 ratio diet. Gross margin at the end of keeping the animals also differed ($P<0.05$) significantly across the treatments Animals on 60:40 ratio gave the highest (₦4887.7) and the least (₦680) was obtained from animals on 90:10 ratio.This can also be attributed to the quantity of concentrate inclusion and weight gain by the animals fed 60:40 ratio, the cost of production increases across the treatments as the cost of concentrate increases and vice versa.

Table 4.11: Cost analysis of feeding *Brachiaria ruziziensis*and concentrate ratio diets to yankasa rams

B.ruziziensis : Concentrate					
Parameters	90:10	80:20	70:30	60:40	SEM
Cost of Rams (₦/ram)	8500[d]	9750[a]	9250[c]	9375[b]	193.48*
Cost of feed / kg	42.58[d]	45.87[c]	49.17[b]	52.46[a]	4.94*
Cost of feed Con. (₦/kg)	18.98[d]	25.57[c]	29.61[b]	33.34[a]	0.89*
Total cost of feed consumed (₦/ram)	1707.8[d]	2301.9[c]	2665.2[b]	3000.5[a]	80.84*
Total cost of Fattening ram (₦/ ram)	10444.7[d]	12288.8[b]	12152.0[c]	12612.3[a]	213.56*
Total revenue ((₦/ ram)	11125[d]	13500[c]	15000[b]	17500[a]	172.11*
Gross Margin (₦/ram)	680[d]	1211.2[c]	2848[b]	4887.7[a]	143.74*

[a, b, c]: Means with different superscript within a row differed significantly (P<0.05). SEM: standard error of means, Cost of fattening =Total cost of production, Total revenue = Cost of production – sales, Gross margin = profit. Con. = consume.

CHAPTER FIVE

5.0 DISCUSSION

Experiment 1: Effect of Fertilizer rates on Forage Yield and Quality of (*Brachiaria ruziziensis*).

5.1.1 Effect of fertilizer rates on yield components

Plant heightwas significantly affected with increase in the quantity of fertilizer application whereas leaf width, leaf number,LAI andnumber of tillers were significantly affected by age of cutting (WAS). Leaf number is another important growth component that has a great influence on biomass yield production. This study reveals that leaf number of *Brachiaria ruziziensis* was significantly influenced by level of fertilizer application.Hazrat *et al*. (2004) found that plant height generally depends on internode expansion which caused an increase in height with an increase in water depth resulting in the taller plant. In the current study of *B. ruziziensis* grass, tiller development in both spaced-plant and miniature swards showed a substantial increase over time after the appropriate cuttingmanagement had been applied. In fact, both frequency and intensity of defoliation management had a profound influence on tiller development. This was particularly apparent when different cutting treatments were compared.Narongrit (1999) reported that the numbers of tillers in plants usually show a general increase at the initial growth stage and then declines at the final growth stage.

5.1.2 Effect offertilizer rates and age of cutting on fresh and dry forage yield.

The result obtained for the fresh and dry matter yield was lower than that obtained by Sani *etal.* (2015) at 12 weeks after sowing but similar to what was obtained by Ezenwa *et al.*

(1996) for *B.ruziziensis* grown as asolecrop with nitrogen fertilizer and harvested at 24 WAS. This indicates that the stage of growth influenced the yield of the plant (Mickan, 2006) and hence, dry matter yield increases as the plant age increases. Cook *et al.* (2005), also reported that DM production is strongly influenced by soil fertility and ranges from 7–34 t/ha/year. The above authors also reported that in Fiji, unfertilized *humidicola*grass produced an annual DM yield of 11 t/ha DM, whereas DM increased to 34 t/ha with the application of 452 kg/ha N and in humid-tropical Vanuatu, annual yield declined from 28 t/ha DM to 17 t/ha DM as fertility declined. Annual DM yields of 7 t/ha and 5–9 t/ha were reported from Paraguay and Brazil, respectively. The principal effect of nitrogen fertilizer on tropical grasses is to increase forage yield, usually through the production of more photosynthetic apparatus (Loch, 1980).

5.1.3 Proximatecomposition of *Brachiaria ruziziensis*hay

The CP content must be equal to or higher than 7.0% to be valuable to ruminants.Crude protein content of all the plant materials analyzed met the minimum requirements for ruminants (>7%), i.e., 6.9 % for maintenance, 10.0 % for beef production and 11.9 % for milk productionSingh *et al.* (2009).Similar contents were also obtained by (Villela,2008), who found that the *Brachiaria decumbens* had CP content of 11.69%,11.08%, 9.43% and 8.93% in spring, summer, autumn,and winter, respectively, showing a reduction of CP content during the winter period due to retarded growth and less photosynthesis. These nutrients in forages vary according to many factors such as forage species and climate (Baron and Belanger, 2007). This trend of lesser CP content has been reported by other workers such as by Kidunda *et al.* (1990), Seyoum *et al*. (1998) and Tessema *et al*. (2002)

and is mainly attributable to dilution of the CP contents of the forage crops by the rapid accumulation of cell wall carbohydrates at the latter stages of growth (Van Soest, 1994). Vega *et al.* (2006) stated that other factors like the maturity of the grass can be the source of declining CP and Whitehead (2000), found that the CP content of grasses depends on soil N availability and that N fertilization increases it.

5.1.4 Effect of fertilizer rates and age of cutting on mineral composition.

The Ca content in the tested grass was high, and was similar to the results of Collins and Fritz (2003) who reported that the Ca content in Orchard grass*(Dactylis glomerata L)* was 2.3%. In addition, researchers on tropical grasses also found that Ca content in the grasses was sufficient to meet cattle and sheep's requirement for Ca(Youssef and Braithwaite, 1987). However, according to McDowell and Valle (2000), some forage grasses and legumes collected from different regions of Latin America and Africa showed low concentrations of Ca (< 0.3%). Also Nguku *et al.* (2015) reported that *B. brizantha*cultivars showed higher calcium (0.104-0.267%)DM content than other *Brachiaria* cultivars (with an exception of *Brachiaria* hybrid Mulato II) as the production phase progressed. Calcium concentration obtained in this study werehigher than those reported by the aforementioned authors. It is likely that *Brachiariaruziziensis* willbe able to meet the Ca and P requirements of most ruminantanimals.

5.2 Experiment 2: Performance of Yankasa rams fed *Brachiaria ruziziensis* to concentrateratios in a total mixed ration

5.2.1 Chemical composition and energy content of *Brachiaria ruziziensis* to concentrate ratio in a total mixed ration.

The chemical composition of the experimental diet showed that the organic matter (89.70) of the concentrate diet was similar to that of the *Brachiaria ruziziensis*hay. (89.55). C.P content of the concentrate diet (12.63) was higher than of the hay (8.25) which is above the minimum requirement for maintenance of a ruminant animal as reported by NRC (2007) and Van Soest (1994) that CP ranges of 6-8% CP is required for efficient rumen function and maintenance.

5.2.2 Growth performance of Yankasa rams fed *Brachiaria ruziziensis* to concentrate mixture ratio diet in a total mixed ration.

Better weight gain indicates the good efficiency of converting feed to flesh and adipose tissue.Sani *et al.*(2014) reported a lower weight gain compared to this study when they fed *B.ruziziensis* with different protein supplements. However, basal diet in itself alone is not sufficient to meet the animal's maintenance and production requirements.The improvement in feed conversion efficiency at 60:40 ratio mixture meant there was efficiency of absorbed amino acids and energy. VFA available from digestion corresponded to the animals' requirement needed for efficient utilization of poor-quality resources (Preston and Leng, 1987). Average daily gain (g/day) was within the range of 33.56 – 62.89g/day as reported by Abdullahi *et* al. (2016) but lower than the value 109.32 – 160.67g/day reported by Alabi *et al.* (2010) when the authors fed *Brachiaria decumbens* as basal diet supplemented with sorrel seed (*Hibiscus sabdariffa)* to Yankasa rams. On the other hand, the value of 61.11

g/day obtained was higher than the values (49.04g) and (52.98g) as reported Ajayi *et al.* (2014) who fed concentrate diets with corn cob at varying inclusion levels. Ferdous *et al.*(2011) who reported that higher levels of concentrate supplementation increase live weight gain.The growth rate in ruminant is highly correlated with the energy and protein intake; with energy intake being the major limiting factor affecting tissues deposition (Leng, 1990).

5.2.3 Nutrient digestibility of *Brachiaria ruziziensis* to concentrate mixtures ratios fed to Yankasa rams.

FAO, (1995) classified digestibility of feed as high (>60%), medium (40 - 60%) and low (<40%). This is also in agreement with the report of Quala *et al.* (2011) that the activity of ruminant microbes is improved by the presence of nitrogen. The DMD values obtained in the present study was in agreement with the result obtained by Usman *et al.* (2008) whose value ranged between 61.39% and 84.37% when fore stomach digesta and poultry waste was fed to Uda lambs. The crude protein digestibility (CPD) values range from 76.12 - 84.25% while the least value of 76.12% were obtained, the result of this study was similar to the findings of Fajemisin *et al.*(2012) who reported digestibility values of 84.92 to 86.02%, and in conformity with the values reported by Maigandi and Wasagu (2002) whose value ranged between 75.5% and 81.06% when *Ficus sycomorus* leaves were fed to Yankasa rams. The crude fiber digestibility (CFD) was significantly ($P<0.05$) different among the treatments and the value of 89.07% for rams fed (60:40) ratio*B.ruziziensis* to concentrate mixture recorded the highest CFD while the least CFD value of 73.90% was recorded in rams fed (90:10) ratio*B.ruziziensis* to concentrate mixture. The values recorded were higher than the values 52.70% to 53.7% reported by Nyako *et al.*(2012).The lower

digestibility values recorded in (90:10) ratio could be attributed to the lower CP content of the *B.ruziziensis* to concentrate mixture diet. McDonald *et al.*(2011) reported that digestibility is much reduced when a ration contains little protein in proportion to the amount of readily digestible carbohydrate, also Nsinamwa *et al*. (2005) ageed with the report that the higher the fibre fractions, the lower the digestibility. The Nitrogen Free Extract digestibility (NFED) of the rams was not significantly (P>0.05) different among treatments but higher than the range of 51.39 - 67.00% reported by Fajemisin *et al.*(2012) when the authors fed cassava peels substituted with *Cajanuscajan* hay.

5.2.4 Nitrogen balance in Yankasa rams fed *Brachiaria ruziziensis* to concentrate mixture ratios in a total mixed ration.

Nitrogen absorbed, nitrogen retained and nitrogen retained and absorbed as a percentage of intake 59.16,57.58,93.75 and 96.48, respectively were significantly higher (P<0.05) in animals fed 60:40 ratio mixture.This provides the fermentable nitrogen for efficient synthesis of essential amino acids and positive nitrogen balance (Trinh *et al*., 2009; Hassan *et al*., 2016). The nitrogen retened and absorbed as percentage intake were above 68.0 % and higher than 47.98 % reported by Yashim *et al*. (2014) who fed *Digitaria smutsii* hay supplemented with *Ficus sycomorus* leaf meal but in line with 95.84 % and 74.24 % reported by Wada *et al*. (2016) who fed total mixed rations containing *Parkia biglobosa*forage included at graded levels. Nitrogen retention is the major indicator for assessing the protein nutritional status of ruminant livestock (Abdu *et al*., 2012; Hassan *et al*., 2016). It is also the proportion of nitrogen utilized by animals from the total nitrogen

intake for the body processes, hence the more nitrogen consumed and digested the more nitrogen retained and vice versa (Okeniyi *et al*., 2010).

5.2.5 Effects of feeding *Brachiaria ruziziensis* to concentrate mixtures ratios in a total mixed ration on some rumen metabolites of Yankasa rams.

Adamu (2015) reported a normal pH range of 6.2-6.9. The slightly alkaline rumen condition in this study was probably due to increased concentration of ammonia in the rumen. Jokthan (2007) obtained a pH of 7.1-7.31 when pigeon pea forage-based diets were fed to sheep on rice straw basal diets. Differences in ruminal pH may also result from variations of VFA concentrations, because ruminal pH reflects the rate of fermentation of carbohydrate (Galip, 2006). This can be attributed to the high concentrate inclusion in the total mixed ration and Fievez *et al.* (2001) reported that the levels of CP significantly alter ruminal pH. This may also be attributed to higher ruminal NH_3-N that may result when feeding high level of CP. TVFA (Total volatile fatty acid), concentration obtained in this study indicated that rams fed 60:40 ratio recorded the highest ($p<0.05$) value of 44.87 mmol/100ml and the least value was by animals fed 90:10 ratio (33.05 Mmol/100ml). Volatile fatty acids are the main energy sources for ruminants feeding solely on roughages,thus their concentration in the diet gave indication of their energy values. The value ranged between 33.05 – 44.87 mmol/100ml in this study which was above 28.8- 56.8 Mmol/100 ml reported by Adamu (2015) when groundnut haulm was fed to Yankasa rams and 19.57-36.57mmol/l reported by Jokthan (2007) when pigeon pea forage was supplemented in sheep diet. The increase in rumen TVFA in this study is possibly due to increased digestibility of the feed material. Rumen Ammonia (NH_4)-N significantly ($p<0.05$) differ along the treatments with animal fed (60:40) ratio recorded the highest value

(16.18mg/100ml) and the least was recorded in animals on 90/10 ratio (12.30mg/100ml). This can be attributed to lower fermentation process due to low concentrate inclusion in the ration mixture. The increased concentration of NH_3-N with increasing CP content was observed by Gaafar *et al.* (2009). The rumen NH_3-N concentration of 12.30 mg/100ml in this study was within the range of 11.42-14.43mg/100ml recorded by Jonas and Vilma (2007) and was lower than 19-25mg/100ml observed by Mehrez *et al.* (1977) needed to be adequate for forage digestion. Powel *et al.* (1981) reported that between 3.6-17mg/100ml NH_3-N concentration promotes microbial protein production which is an important factor in determining the utilisation of nitrogen in the rumen (Jokthan,2007). Also, the increased concentrations of NH_3-N may be attributed to the ruminal degradation of CP Mathieu*et al*.(1998). Higher ruminal NH_3-N concentration is accompanied with an increase in the level of dietary CP; Similar results were observed by Al-Malah (2007). Shamoon*et al*. (2009) and Chen*et al*. (2010) who observed that NH_3-N level increased with increasing CP level, the increased concentration of NH_3-N was mainly explained by a higher production of ammonia from the degradation of proteins in the rumen (Mathieu*et. al*., 1996).

5.2.6 Cost analysis of feeding *Brachiaria ruziziensis* to concentrate mixtures ratios to Yankasa rams under small holder system.

The cost of production increases across the treatments as the cost of concentrate increases and vice versa.The increase in the cost is as a result of increase in the level of concentrate which was made from agro-industrial by-products which are known to be expensive. The revenue generated was highest with animals fed 60:40 ratio (₦17,500) was recovered and the least value was on 90:10 ratio (₦11,125) and total cost of fattening followed the same

trend with highest value (₦12,612.3)obtain with 60:40 diet the lowest (₦10,444.7) recorded with 90:10. High quality feed associated with increase in intake, performance and weight gain by the animals was observed with 60:40 ratiodiet.This can also be attributed to the quantity of concentrate inclusion and weight gain by the animals fed 60:40 ratio, the cost of production increases across the treatments as the cost of concentrate increases and vice versa. Bello *et,al.,* (2016) reported a similar total revenue of (₦7565.40), and Net farm income (₦2005.42). Gross margin followed similar trend as was observed for total revenue and net farm in-come in which highest values were recorded for supplemented treatment group (₦3272.42). When he fed dried poultry droppings as supplement to rams as profitable and it is similar with the findings of this study.

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 SUMMARY

Experiment 1: The study was conducted to evaluate the effect of varying fertilizer levels (Compound fertilizer NPK 15:15:15) on the forage yield and quality of *Brachiaria ruziziensis and* performance of Yankasa rams fed *Brachiaria ruziziensis*and Concentrate ratios in a total mixed rationin the Northern Guinea Savanna of Nigeria. The experiment was laid in a randomized complete block design (RCBD) in a 4x3 factorial arrangement comprising of four fertilizer doses (0,20,40 and 60 kg/ha NPK 15:15:15) and three age of cutting (10,12 and 14 weeks) replicated three times.The growth components showed that plant height (74.9 cm) and leaf length (33.3 cm) were significantly ($P<0.05$) higher at 60kg/ha and 40kg/ha, respectively. Number of tillers (23) were higher ($P<0.05$) at 12 weeks after sowing (WAS). Varying fertilizer levels significantly ($P<0.05$) affected fresh forage yield with the highest value recorded at 60kg/ha (15.8t/ha). Age of cutting also had significant ($P<0.05$) effect on both fresh forage and dry matter yield. The highest fresh weight yield (16.3t/ha) was recorded at 12weeks after sowing (WAS) while dry weight (4.3t/ha) was recorded at 14 weeks after sowing (WAS). The proximate compositions: crude protein, crude fiber and nitrogen free extract were significantly ($P<0.05$) affected by fertilizer application, whereas dry matter, crude protein.,crude fibre, ether extract, ashandnitrogen free extract were also significantly ($P<0.05$) affected by different age of cutting. The highest DM (94.3%), CP (8.99%) and CF (39.39%) were recorded at 10, 12and

12 weeks after sowing (WAS), respectively. EE (7.88%) and Ash (7.67%) were higher at 12 weeks (WAS). Calcium content of the forage material and Calcium (Ca): Phosphorus (P) ratio were significantly (P<0.05) affected as the level of fertilizer application varied with 60kg/ha rate recording the highest Ca percentage (1.62%) and Ca:P (6.23:1), respectively. Calcium (Ca), Phosphorus (P) and Ca: P ratio were similar (P>0.05) at different cutting intervals. It can be concluded from the result of this study that the use of NPK 15:15:15 compound fertilizer at 60 kg/ha on *Brachiaria ruziziensis* gave a better forage yield, Crude protein was higher when harvested at 12 weeks after sowing, mineral composition (Ca and P) was also optimum. Therefore, NPK 15:15:15 at 60 kg/ha is hereby recommended on *Brachiaria ruziziensis* for forage yieldand nutrient composition for smallholder farmers and livestock owners.

Experiment2. A feeding trial which lasted for (12) weeks was carried out to determine feed intake, nutrient digestibility and nitrogen balance by growing Yankasa rams fed different mixture of *Brachiaria ruziziensis*/concentrate in a total mixed ration. Sixteen healthy Yankasa rams with an average live weight of 21.75kg±1kg were randomly allocated to four treatments with four replicates in a Completelyrandomized design (CRD).The treatment diets were ratio of *Brachiaria ruziziensis* andconcentrate:(90:10), (80:20), (70:30) and (60:40)mixtures. Feed intake (57.19kg), daily feed intake (635.48g/day), Average daily gain (61.11g/day), and feed conversion ratio (10.47) were significantly higher (P<0.05) in animals' fed (60:40) ratio *B.ruziziensis* andconcentrate mixture and showed a decline across the treatments as the quantity of concentrate inclusion in the mixture decreased. Feed conversion ratio (10.47)was significantly (P<0.05) lower in animals fed (60:40) ratio of *B.ruziziensis*and concentrate mixture. The DM, OM, CP, CF, EE NFE and ADF

digestibility showed significant variation (P<0.05) across the treatments. The Crude protein digestibility (CPD) was significantly (P<0.05) higher(84.25%) in (60:40) ratio *B.ruziziensis* andconcentrate mixture while the least value of 76.12% was recorded in rams fed*B.ruziziensis* and concentrate mixture (90:10) ratio. nitrogen intake, nitrogen absorbed, nitrogen retained, nitrogen retained as percentage of intake and absorbed as percentage of intake (61.28%, 59.16%,57.58%,93.75% and 96.48%) respectively was significantly higher (P<0.05) in animals fed (60:40) mixture ratio. Rumen pH (6.80), TVFA (Total volatile fatty acid) (44.87mmol/100ml), Rumen Ammonia nitrogen (NH_3-N) (16.18 mg/100ml) differed significantly (P<0.05) across the treatments with animal fed (60:40) ratio of *B.ruziziensis* andconcentrate mixture recorded the highest value. It can be concluded from this work that feeding Yankasa rams with 60:40 ratio*B.ruziziensis* and concentrate mixture ratio in a total mixed ration improved digestibility, utilization,highest weight gain (5.5kg) and highest revenue (₦4,887.7). Feedingof *B.ruziziensis*and concentrate at a ratio of 60:40in a total mixed ration is hereby recommended for smallholder farmers and livestock owners in the Northern Guinea Savanna of Nigeria.

6.2 CONCLUSION

I. Application of NPK 15:15:15 at 60kg/ha rate on*Brachiaria ruziziensis* gave a higher fresh forage yield of 15.9t/ha and dry matter yield of 3.6t/ha.

II. Harvesting at 12 weeks after sowing gave a higher fresh forage yield 16.3t/ha, dry matter yield 3.2t/ha yield, a crude protein of 8.99%and mineral composition ratio (Ca:P) 4.75:1%.

III. It is possible to mix *B.ruziziensis*forage and Concentrate to feed small ruminants at 60:40 ratio for better performance.

IV. Feeding a 60:40 ratio of *B.ruziziensis*forage and Concentrate gave a higher level of feed intake by 28.35%, increased nutrient digestibility of dry matter to 84.90% and crude protein to 84.25%.

V. Feeding 60:40 ratio *B.ruziziensis*forage and Concentrate in a total mixed ration improvedweight gain by 38.92% and resulted in higher revenue of ₦ 4887.7.

6.3 RECOMMENDATION

I. It is recommended that pasture producers and livestock farmers can use up to 60kg/ha of NPK 15:15:15 on *Brachiaria ruziziensis*and harvest foragefor ruminant feeding at 12 weeks after sowing for higher forage yield and quality.

II. Further findings on the use of NPK 15:15:15 on the production of *Brachiaria ruziziensis* is hereby recommended in the Northern Guinea Savannah of Nigeria.

III. It is recommended that farmers can feed total mixed ration to ruminants with up to 60% of *B.ruziziensis*forageinclusion for improved performance and productivity.

REFERENCES

Abas, M. and Sharif, H. (1986).Deleterious effects of *Brachiaria decumbens* (Signal grass) on ruminants.*MARDI Repor*t, 112, p.20.

Abas, M. and Sharif, H. (1988).Hepatotoxicity in indigenous sheep of Malaysia stall-fed with different forms of *Brachiaria decumbens. Pertanika Journal of Tropical Agricultural Science*, 11, 57-61.

Abas, M., Sharif, H., Khusahry, M. Y. and Vance, H. N. (1985). Photosensitisation in goats grazed on *Brachiaria decumbens*. *MARDI Research Bulletin*, 13, 203-206.

Abdel Hameed, A. A., Fedel Elseed, A. M. and Salih, A. M. (2013). Growth Performance and Rumen Fermentation of Lambs Fed Untreated or Urea Treated Groundnut Hull with Different Protein Sources. *Journal of Animal Production Advances*, 3(3): 86–96.

Abdu, S. B., Hasan, M. R., Adamu, H. Y., Yashimi, S. M., and Abdullahi, M. J. (2012). Intake, Nutrient Digestibility and Nitrogen Balance of *Acacia auriculate, Gmelina arborea, Albizia lebbeck and Butryospermum parkii* by Yankasa Bucks. *Iranian Journal of Applied Animal Science, 2*(2): 121–125.

Abdullahi, S,Nyako, H.D., Malgwi, I.H., Yahya, M.M., Mohammed I.D., Tijani, I., Aminu, I. M., Shehu, I.T. (2016,)Performance of Yankasa Rams Fed Urea Treated Sorghum Chaff as a Basal Diet Supplemented with maize offals in semi - arid environment of Nigeria. 4, (1), 15-21. Available at: www.researchpublish.com.

Abou-Donia, M. B. (1989). In: P. R. Cheeke (Ed.) Toxicants of Plant Origin. Volume IV: Phenolics. CRC Press, Boca Raton, Florida. Pp. 1-22.

Abubakar, M., Kibon, A. and Ibrahim, T. (1998).The effect of graded level of cotton seed cake supplementation on the performance of lactating does (goats) in the semi-arid region of Nigeria. In: O. O. Oduguwa, A. O. Fanimond O. A. Osinowo (Eds). *Proceeding of Silver Anniversary of the Nigerian Society of Animal Production* Pp: 361-362.

Adamu.H.Y. (2015).Assessment of two Groundnut (*Arachis Hypogaea L*) Varieties for Forage,Pod Yield Characteristics and Effect of Feeding the Haulm to Yankasa Rams. Ph.D Thesis Pp 72-82.

Aduku, A. O. (1992). *In:* Practical Livestock Feed Production in the Tropics. Asekome and Company Publishers, Zaria, Nigeria.*Advances.* 9: 2396-2400.

Afzal, J. and Ullah, M. A. (2007)**.**Assessment of productive potential and utilization of rangelands and sown pastures in Peshawar Plateau.Annual Report of the National Agriculture Research Centre, Islamabad. Pp10.

Agricultural Research Council (ARC, 1984). The nutrient requirements of ruminant's livestock, supplement No. 1. Common Wealth Agricultural Bureau, Famham Royal, U.K. P.45.

Ajayi, F.I., Ogunleke, F.O., Odejide, J.O., Tiamiyu, A.K., and Morankinyo, O.A. (2014). Feed Intake and Weight Changes of West African Dwarf Goats Fed Concentrate Diet with Corn cobinvaryinglevels.Proc. 39th Conference Nigerian Society for Animal Production. 16-19 March, 2014. Babcock Univ. Ilishan-Remo, Ogun State, Nigeria. Pp 262-264.

Akinola, J. O. (1981). Growth of Signal grass (*Brachiari*a *decumbens*) alone and with legumes in Northern Nigeria. *Journal of Tropical Grassland Society of Australia.*15:3. Pp 1-5.

Alabi, J.B., Yahaya, M.S., and Julius, N. (2010). Effect of Sorrel seed (Hibiscus sabdariffa) supplementation on the performance of Yankasa rams fed Brachiaria decumbens as basal diets. *Journal of Agriculture and Veterinary Science.* Pp: 7: 12-13.

Alawa, J. P. and Umunna, N. N. (1993). Alternative feed formulation in developing countries: Prospects for utilization of agro-industrial by-product. *Journal of Animal Production Resource*, 13 (2): 63-98.

Al-Mallah, O.D.M., (2007). Effect of protein levels in formaldehyde treated rations on coefficient of digestion and performance in Awassi lambs. PhD. Thesis, University of Mosul.

Alokan, J. A. (1998). Intakes and digestibility by Yankasa sheep of diets containing different proportion of legumes and grass (*Cynodon nlemfuensis*). In: O. O. Oduguwa, A. O. Fanimond O. A. Osinowo (Eds). *Proceeding of The Silver Anniversary of Nigerian Society Animal Production*. Pp: 333-338 and Utilization by West Africa Dwarf Goat.Fed Cassava Peels Substituted with Cassava.

Andrade, S. O., Lopes H. O., Barros M. A., Leite, G. G., Dias, S. M., Saueressing M., Nobre, D.and Temperini, J. A. (1978).Aspectos da fotosenzilibizacâo em bovinos em pastagens de *Brachiaria decumbens* Stapf infestadas por Phitomyces chartarum (Berk and Curt) M.B. Ellis.1978 Arq. Inst. Biol. São Paulo 45: 117-136.

AOAC, (2005). Official Method of Analysis, 17thedition.Association of Analytical Chemists, 24th edition Washington, DC. USA. 200-210.

Appadurai, R. R. (1975). Pasture development and management on marginal plantations in central Sri lanka. *Proceedings of The Third World Conference Animal Production*. p.333-338.

Appadurai, R. R. and Goonewardene, L. A. (1973). Performance of three fodder grasses under high nitrogen applications in the mid-country wet zone of Sri Lanka. *Journal of The National Agricultural Society of Ceylon*, 8: 31 -37.

Argel, P. J. and Keller-Grein, G. (1994). Regional Expertise with *Brachiaria*: Tropical America - Humid Lowlands. 1994 *Brachiaria*: Biology, Agronomy, and Improvement. (CIAT & Embrapa).Pp.205-224.

Arigbede, O. M., Olatunji, J. E. N., Isah, O. A., Bawala, T. O. and Oseni, K. A. (2006). Performance of West African Dwarf goats fed *Panicum maximum* basal diets with different protein supplements. *Journal of Animal and Veterinary Advances*. 5 (10):795-799.

Babayemi, O. J. (2009). Silage quality, dry matter intake and digestibility by West African dwarf sheep of Guinea grass (*Panicum maximum cv Ntchisi*) harvested at 4 and 12 week regrowths. *African Journal of Biotechnology,* 8 (16): 3983-3988.Babcock Univ. Ilishan-Remo, Ogun State, Nigeria. Pp 262-264.

Bamikole, M. A., Akinsoyinu, A. O., Ezenwa, I., Babayemi, O. J., Akinlade, J. and Adewuni, M. K. (2004).Effect of six- weekly harvests on the yield, chemical composition and dry matter degradability of *Panicum maximum and Stylosanthese hamata* in Nigeria, *Grass and Forage Science*, 59:357-370.

Barnard, C. (1969). Herbage plant species.Australian Herbage Plant Registration Authority; Canberra, CSIRO Australian Division of Plant Industries.

Baron, V.S., Belanger, G. (2007).Climate and forage adaptation. In R. J. Barnes, (ed) *Forages The science of grassland agriculture. 6th edition,* (pp. 83-104). Iowa State Press, USA 2: Blackwell publishing.

Bello.A.A (2016).Economics of feeding sun-dried poultry dropping based diets on growing rams consuming sorghum stover. *Iranian Journal of Applied Animal Science*. 6(3), 595-598.

Bernardi, L. C. and Goldblatt, L. A. (1969).Gossypol.*In*: Liener, I.E. (Ed). Toxic Constituents of plant Foodstuffs. Academic Press, New York, Pp. 158-266.

blood Metabolites of Yankasa sheep. A seminar paper presented at the Department of Animal Science ABU Zaria, 18th May 2006.Pp 1-15.

Boddey, R.M., Macedo, R., Tarré, R.M., Ferreira, E., de Oliveira, O.C., Rezende, de P, Cantarutti, R. B., Pereira, J. M., Alves, B. J. R., Urquiaga, S. (2004). Nitrogen cycling in

Brachiaria pastures: the key to understanding the process of pasture decline. *Agriculture, Ecosystems and Environment Journal*.103:389-403.

Boddey, R.M., Rao, I. M. and Thomas, R.J. (1996).Nutrient Cycling and Environmental Impact of Brachiaria Pastures.*Brachiaria*: Biology, Agronomy, and Improvement. (CIAT & Embrapa).Pp.72-86.

Bogdan, A. V. (1964). A study of the depth of germination of tropical grasses: a new approach. *Journal of Britain Grasslands Society*. 19:251-254.

Bogdan, A. V. (1977). Tropical pasture and fodder plants (Grasses and legumes.), Longman, *Tropical Agriculture Series*, London and New York: Longman; 1977. Pp. 111–126.

Bogoro, S. E., (1997). Effect of protein energy supplementation on rumen kinetics, metabolites profile and growth performance of rams fed high fiber diets. Ph.D thesis, Abubakar Tafawa Balewa University, Bauchi, Nigeria.

Boonman, J.G. (1971). East Africa's grasses and fodders: their ecology and husbandry. Kluwer Academic Publishers, Dordrecht, Netherlands, Pp-343.

Borget, M. (1966). Rendements et characteristics de graminees four rageres sursables cotiers a cayemme. *Agronomie Tropicale*, Paris 2L: 250-259.

Brewer, D., Russel, D. W., Amaral, R. A. M. and Aycardi, E. R. (1989). An examination of North and South American isolates of *Pithomyces chartarum* for production sporidesmin and sporidesmolides. *Proceeding of New Zealand Institute for Science.* 38:73-81.

Burke, I. C., Thomas, W. E., Spears, J. F. and Wilcut, J. W. (2003). Influence of environmental factors on broad leaf signal grass (*Brachiaria platypylla*) germination. *Weed Science*, 51: 683-689.

Canesin, R. C., Berchielli, T. T., Andrade, P. and Reis, R. A. (2007). Performance of beef steers grazing ***Brachiaria brizantha*** cv. Marandu and receiving different supplementation strategies during the rainy and dry seasons. *Revise Brasilia Zootec.*, 36 (2): 411-420.

Centro Internacional de Agricultura Tropical (CIAT, 1978) Beef program Report at International Institute for Tropical Agriculture centre, Pp35.

Chen, C. P., Ajit, S. S. and Evans, T. R. (1981). Beef production from three nitrogen fertilized grasses in peninsula Malaysia. MARDI Research Bulletin. 9:207-224.

Chizzotti, F. H. M., Pereira, O. G., Valadares Filho, S. de C.,Garcia, R., Chizzotti, M. L., Leao, M. I., Pereira, D. H. (2005). Intake, apparent total tract digestibility and production of Nellore steers fed diets containing different proportions of *Brachiaria brizantha* cv. Marandu and sorghum silages. Revise Brasilia. Zootec, 34 (6, Suplemento): 2427-2436

CIAT (Centro Internacional de Agricultura Tropical) (2006). Annual report 2005 project I.P-5 Tropical Grasses and legumes. Optimizing genetic diversity for multipurpose use: Pp 266.

CIRAD. French Agricultural Research Centre for International Development (2004). Fonio: An African cereal crop. Available at: www.cirad.fr/en. Retieved 28 October, 2006.

Clayton, W.D. (1986). Renvoize S.A. Genera Graminum.Her Majesty's Stationery Office, London, UK.Pp389.

Collins M, Fritz J.O (2003). Forage quality. In: Barnes RF, Jerry CN, Collins M, Moore KJ (eds) Forages*an introduction to grassland agriculture.*Volume 1, 6th edition, Iowa Sate Press, USA. pp 363–390.

Cook, B. G., Pengelly, B. C., Brown, S. D., Donnelly, J. L., Eagles, D. A., Franco, M. A., Hanson, J., Mullen, B. F., Partridge, I. J., Peters, M. and Schultze-Kraft, R. (2005). Tropical Forages. CSIRO, DPI and F(Qld), CIAT and ILRI, Brisbane, Australia.

Corn cobinvaryinglevels. Proc. 39th Conf.Nig.Soc.For Animal Prod. 16-19 March, 2014.

Davidson, D.E. (1966). Five pasture plants for Queensland. *Queensland Agricultural Journal*degradable nitrogen on rumen microbial growth and nitrogen utilization efficiency of animals fed maize silage at maintenance. *Reproduction Nutrition Development*.,41:349–364.

Dias-filho, Moacyr Bernardino. Photosynthetic light response of the C4 grasses Brachiaria brizantha and B. humidicola under shade. Sci. agric. (Piracicaba, Braz.) [online]. (2002), vol.59, n.1, pp. 65-68.ISSN 0103-9016.http://dx.doi.org . 23/2/2014.

Dienum, B. and Dirven, J. G. P (1972).Climate, nitrogen and grass 5. Influences of age, light intensity and temperature on the production and chemical composition of Congo grass (*Brachiaria ruziziensis* German et Everard). *Netherlands Journal of Agricultural Science.* 20:125–132.

Dobereiner, J., Torkarnia, C. H., Monteiro, M. C. C., Cruz, L. C. H., Carvalho, E. G. and Primo, A. T. (1976). Intoxicacao de bovinas e ovinas em pastos de *Brachiaria decumbens* contaminados por pithomyces chartarum.*Pesqui Agro peculic Brasilia. Ser. Veterinale.* 11:87-94.

Doma, U.D., Adegbola T.A., Bamgbose, A.M. and Umeh,P.A. (1999). Utilization of Cowpea Shell and Maize Cobs in Diet of Rabbit.*Tropical Journal of Animal Science*, 2(1):27-32. (a)

Doma, U. D., Mohammed, L. K., and Umeh, A. P. (1999). Observation on the characteristics of small holder sheep and goat management practice in old Bauchi State. *Tropical Journal of Animal Science, 2*: 125–130.(b)

Duncan, D.B. (1955). Multiple range and multiple F-test. *Biometrics.*11**,** 1-42.

Eugène, M. Sauvant, D. Weisbecker, J.L and Archimède, H. (2010).Effects of defaunation on digestion of fresh *Digitaria decumbens* grass and growth of lambs.*Animal Science journal*.4: 439–455. doi: 10.1017/S1751731109991194.

Ezenwa, O., Aribisale, A. and Aken'ova, M. E. (1996). Dry matter yields of *Panicum maximum* and *Brachiaria* with nitrogen fertilization or *Pueraria* in an oil palm plantation. *Tropical Grassland Journal*.30: 414-417.

Fadel Elseed, A. M. A. (2004). Effect of supplemental protein feeding on ruminal characteristics and microbial N production in sheep fed treated rice straw. *Small Ruminants Research*.57:11-17. http://www.elsevier.com/locate/smailrurnes. 3/1/2014.

Fadel Elseed, A. M. A. (2005). Effect of supplemental protein feeding frequency on ruminal characteristics and microbial N production in sheep fed treated rice straw. *Small Ruminant Research*, *57*(1): 11–17.

Fadel. R., Rosa B., Oliveira,I.P.de: Orsine,G.F. and Dias, I.D.(2004). Nutirtive value of rice straw aminniated for sheep Cie^ncia *Animal Brasileira.* 5(1):19-25.

Fagliari, J. J., Kuchembuck, M. R. G., Curi, P. R. and Oleiveira, J. A. (1991).Desenvolvimento ponderal de bovinos intoxicados naturalmente pela micotoxina esporodesmina.*Cieric Veterinale Journale.* 5:6-8.

Ferdous, M. R., Khan, M. J., Rashid, M. A. and Kamruzzaman, M. (2011).Effect of different levels of concentrate supplementation on the performance of Black Bengal goat.*Bangladesh Journal of Animal Science.*40 (1-2): *40-45.*

Fajemisin, A.N., Omotoso, O.B., Fadiyimu,A.A. and Shuaibu.Y.A. (2012). Nutrients Intake and Utilization by West Africa Dwarf Goat.Fed Cassava Peels Substituted with Cassava Cajan hay. Proceeding 17th Annual Conference, Animal Science Association, Nigeria, 9-13, 2012, Abuja. Pp 636 - 639.

FAO (1995).Food and Agriculture Organization of United Nations.*Food and Nutrition Series*, No.27.

Fievez, V., De Fauw, K., Notteboom, K. Demeyer, D., (2001). Effect of level and origin of rumendegradable nitrogen on rumen microbial growth and nitrogen utilization efficiency of animals fed maize silage at maintenance. *Reproduction Nutrition Development*.,41: 349–364.

Fasae, O. A., Alokan, A. and Onibi, G. E. (2005). Feed intakes and digestibility in Yankasa sheep fed diets containing varying levels of *Leucaena leucocephala* leaf residues. *Nigerian Journal of Animal Production.* 32:88-93.

FDLPCS (1992): Federal Department of Livestock and Pest Control Services.National Livestock National Synthesis. *Federal Ministry of Agriculture Abuja.*

Ferdous, M. R., Khan, M. J., Rashid, M. A. and Kamruzzaman, M. (2011).Effect of different levels of concentrate supplementation on the performance of Black Bengal goat.*Bangladesh Journal of Animal Science*.40 (1-2): *40-45.*

Fernandes, L. O., Reis, R. A. and Paes, J. M. V. (2010). Supplementation effect on the performance of beef cattle steers maintained in *Brachiaria brizantha* cv. Marandu pasture. *Ciencia e Agrotecnologia*, 34 (1): 240-248.

Fisher, M.J. and Kerridge, P.C. (1996).The Agronomy and Physiology of Brachiaria Species.*Brac iaria*: Biology, Agronomy, and Improvement. (CIAT & Embrapa).P.43-52.

Food and Agricultural Organization (FAO, 2006). FAO, Statistics on ruminant animal livestock population in Nigeria. Rome, Italy. Pp. 61.

Food and Agricultural Organization (FAO, 2006). FAO, Statistics on ruminant animal livestock population in Nigeria. Rome, Italy. Pp. 61.

Fredericksen, J. H. and Kategile, J. A. (1980**)**.The effect of nitrogen fertilization and time of cutting in first growth in *Brachiaria brizantha* on yield, crude protein content and in vitro digestibility.*Tropical Animal Production*, 5:136-143.

Gaafar, H.M.A., Mohi El-Din, A.M. A., Basiuoni, M.I., El-Riedy.K.F.A.(2009). Effect of concentrate to roughage ratio and baker's yeast supplementation during hot season on performance of lactating buffaloes. Slovakia,*Journal of Animal Science.* 42, (4): 188 – 195.

Galip, N.(2006). Effects of dietary *Saccharomyces cerevisiae* live yeast culture supplementation onruminal digestion and protozoa count in rams fedwith diets with low or high ratio forage/concentrate. *Revue de Médecine Véterinaire.* 157 (12): 609-613.

Gayalin, I. (1994). Stockpiling of tropical forage for the dry season in Martinique. In: *Proceedings of the XVII International Grassland Congress*, 8-21, February, 1993, Vol. 1. NZGA, TGSA, NZSAP, ASAP-Qld and NZIAS, Palmerston North, New Zealand. P. 518-519.

Glatzle, A. (1992). Feed Resources in the Sahel. Animal Research and Development, 35. 43–58.

Goes, R. H., Mancio, A. B., Alves, D. D. and Lana, R. P. (2005). The effect of level of supplementation on the performance of growing steers fed on *Brachiaria brizantha* pasture in the Amazonian region. Acta Scientiarum.*Animal Sciences Journal.* 27 (4): 491-496

Göhl, B. (1982). Les aliments du bétail sous les tropiques. FAO, Division de Production et Santé Animale, Roma, Italy.http://www.fastonline.org/CD3WD_40/JF/414/05-222.pdf . 13/04/2014.

Graydon, R. J., Hamid, H., Zaha, R. I. P. and Gardiner, C. (1991).Photosensitisation and crystal-associated cholangiohepatopathy in sheep grazing *Brachiaria decumbens. Australian Veterinary Journal*, 68, 234-236.

Grof, B. (1969). Viability of para grass (*Brachiaria mutica*) seed and the effect of nitrogenfertilizer on seed yield. *Queensland Journal of Agricultural and Animal Sciences.*26:271 -276.

Glatzle, A. (1992). Feed Resources in the Sahel. *Animal Research and Development*,35. 43–58.

Gutteridge, R.C., Whiteman, P.C. (1978). Pastures species evaluation in the Solomon Islands.*Tropica Grasslands Journal*, 12: 113-128.

Hale, F., Lyman, C. M. and Smith, H. A. (1958). Use of cottonseed meal in swine rations.*Texas Agricultural Experiment Station.Bulletin* 898.

Hall, M.B. (2003). Challenges with non-fiber carbohydrate methods.*Journal of Animal Science* 81:3226-3232.

Harding, W. A. T. and Grof, B. (1978).Effect of fertilizer nitrogen on yield, nitrogen content and animal productivity of *Brachiaria decumbens cv. Basilisk* on the West Tropical coast of North Queensland.*Queensland Journal of Agriculture and Animal Science*. 35:11-21.

Hare, M.D. and Phaikew, C. (1997).Forage Seed production in northeast Thailand. In: Loch, D.S. and Ferguson, J.E. (eds) *Forage seed production 2, Tropical and subtropical species*. (CABI Publishing).Pp. 435–443.

Hassan M. R., Muhammad, I. R., Amodu, J. T., Jokthan, G. E., Abdul, S. B., Adamu, H. Y., Yashim, S. M., Taofik, I., Tamburawa, M.S. and Musa, A. (2016). Growth performance of Red Sokoto bucks fed graded levels of Lablab (*Lablab purpureus* L. Sweet) hay as supplement to maize (*Zea mays*) stover basal diet. *Journal of Animal Production research*, 28(1): 283-298.

Hawton, D. (1979). Temperature effects on *Eleusine indica* and *Setaria anceps* grown in association (I). *Weed Research Journal*. 19:279-284.

Hazrat, M. A., Mahmuda, K. M., Lun, G. M. (2004). Influences of various level of water depth on rice growth in Rice-Fish culture under Wetland Rice Eco-systems.*Journal of Geo-Environment* 4: 23-30.

Hicks, R. B., Owens, F. N., Gill, D. R., Martin, J. J. and Strasia, C. A. (1998). Water intake by feedlot steers. *Animal Science Research Report.* 12:45-52.

Hill, G. M., Burton, G. W. and Utley, P. R. (1993). Forage quality and steer performance on Tifton 78 and coastal Bermuda grass pastures. In: *Proceedings of the XVII International Grassland Congress*, 8-21, February, 1993. Vol. 1.NZGA, TGSA, NZSAP, ASAP-Qld and NZIAS, Palmerston North, New Zealand. P. 870-872.

Holechek, J. L., Pieper, R. D. and Herbal, C. H. (2004). Range Management, Principles and Practices. Pearson Prentice Hall Publishers.Pp. 133.

Holmann, F., Rivas L., Argel, P. J. and Pérez E. (2004): Impact of the adoption of Brachiaria grasses: Central America and Mexico. *Livestock Research for Rural Development*.16: 98.Retrieved November 7, 111, from http://www.lrrd.org/lrrd16/12/16098.htm.

Hopkinson, J.M., De Souza, F.H., Diulgheroff, S., Ortiz, A., Sanchez, M. (1996).Reproductive Physiology, Seed production, and Seed Quality of Brachiaria. Brachiaria: Biology, Agronomy, and Improvement. (CIAT & Embrapa).P.124-140.

Humphreys, L. H. (1999). Tropical pasture and fodder crops. *International Tropical Agricultural Series*.Longman Publishers Pp.18.

IAR (2017). Institute for Agricultural Research, Ahmadu Bello University, Zaria. Meteorological Data Information of Samaru and its Environs.

Jayasuriya, M. C. N. (1986). Agro-industrial by-products as ruminants feed. In nuclear and related techniques for improving animals in harsh environments.IAEA, Vienna, Austria.

John, T., McGregor, Jr., Roy J. S. and Ronald E. T. (1988).Broadleaf Signal grass (*Brachiaria platyphylla*) Duration of Interference in Rice (Oryza sativa).*Weed Science Journal*. 36: 747-750.

Jokhtan, G.E. (2007). Effect of supplementing Rice straw with pigeon pea forages on rumen and blood Metabolites of Yankasa sheep. A seminar paper presented at the Department of Animal Science ABU Zaria, 18th May 2006.Pp 1-15.

Jonas, J. and Vilma, V. (2007).Effect of l.planetarium, pediococus Acdilactici,Enterococcus faectum and l. Lactis microbial supplementation of grass silage on the fermentation characteristics in rumen of dairy cows. V*eterinary Journal of Zootechnika*, 40(62) 29 pts@Igi.It

Jones, L. A. (1981). Nutritional values for cotton seed meal. *Feedstuffs*. 53: 19-8

Jones, R. J. (1973). Some seed problems associated with the use of tropical pasture species and methods of overcoming them. *International Training Course on Seed Improvement and Certification*.Canberra, Dept. Foreign Affairs.

Kaligis, D.A., Sumolang, C.(1991). Forages for plantation crops: proceedings of a workshop, Sanur Beach, Bali, Indonesia, 27-29 June 1991. *ACIAR proceedings no. 32.ACIAR*, Canberra, A.C.T. Australia.Pp.45-48.

Kallah, M. S., Baba, M., Alawa, J. P., Muhammad, I. R. and Tanko, R. J. (1997).Ensiling quality of Columbus grass (*Sorghum almum*) growth in northern Nigeria.*Animal Science and Technology*, 68: 153 – 163.

Keller-Grein, G. Maass, B.L. and Hanson, J. (1996).Natural variation in *Brachiaria* and existing germplasm collections. In: J.W. Miles, B. L. Maass and C. B. do Valle (Eds.). *Brachiaria*: Biology, agronomy and improvement (CIAT & Embrapa). Pp. 16-42.

Kellerman, T. S., Erasmus, G. L., Coetzer, J. A. W., Brown, J. M. N and Maartens, B. P. (1991). Photosensitivity in South Africa VI.The experimental induction of geeldikkop in sheep with crude steroidal saponins from *Tribulus terrestris* onderstepoort *Journal of Veterinary Resource*. 58:47-53.

Kibon, A. and. Ørskov, E. R. (1993).The use of degradation characteristics of browse plant to predict intake and digestibility of goats.*Animal Production,* 57: 247-251.

Kidunda, R.S, Lowga, A.B, and Mtengeti E.J (1990). Utilization of research results on forage and agricultural by-products as animal feed resources in Africa. PANESA/ARNAB (Pasture Network for Eastern and Southern Africa/African Research Network for Agriculture By-products), pp. 36 - 56. Proceedings of the first joint workshop held in Lilongwe, Malawi, 5-9 December 1988, PANESA/ARNAB, Addis Ababa, Ethiopia.

Kopu, M. M. (1975). The natural forage for Northern Nigeria 2.Nitrogen and mineral composition of grasses and browse from northern Guinea savannah and standing hay from different savannah zones. *Nigerian Journal of Animal Production,* 2: 235-246.

Lajis, N. H., Abdullah, S. A., Salim, J. S., Bremmer, J. B. and Khan, M. N. (1993). Episarsasapo-genin and epismilagenin isolated from the rumen content of sheep intoxicated by *Brachiaria decumbens. Handbook of plant and fungal toxicants.*58: 387-389.

Lascano, C. and Estrada, J. (1989). Long term productivity of legume- based and pure grass pastures in the Eastern plains of Colombia. *Proceedings of the 16th International Grassland Congress*, Nice, France, 1989.Pp1179-1180.

Lascano, C. E. and Euclides, V. P. (1996).Nutritional Quality and Animal Production of Brachiaria Pastures.*Brachiaria*: Biology, Agronomy, and Improvement. (CIAT & Embrapa).Pp.106-123.

Leao, M. M., Andrade, I. F., Baiao, A. A., Baiao, E. A., Baiao, L. A., Perez, J. R. and Freitas, R. T. (2005). Supplementation levels of crossbred steers on pasture. *Ciencia e Agrotecnologia,* 29 (5): 1069-1074.

Leng, R.A (1990) Factors affecting the utilization of poor-quality forage by ruminants particularly under tropical conditions *Nutritional Research Review* 3:277-303.

Lenné, J. M. and Trutmann, P. (eds) (1994) *Diseases of Tropical Pasture Plants*. (CABI, Wallingford, UK).

Linn, J.G. and Martin, N.P. (1999). Forage quality tests and interpretations. College of Agricultural, Food and Environmental Sciences. University of Minnesota, USA.

Loch D.S., Rethman N.F.G. and Van Niekerk W.A. (2004). Rhodes Grass. In B. G. Cook, *Warm-Season (C4) Grasses, Agronomy Monograph Vol. 45* (pp. 833-871). Madison, Wisconsin:

Loch, D. S. (1977).*Brachiaria decumben*s (Signal grass) - A review with particular reference to Australia.*Tropical Grasslands Journal.*11:141-157.

Loch, D. S. (1978).*Basilisk* signal grass - a productive pasture plant for the humid tropics.*Queensland Agricultural Journal*. 104(5): 402-406.

Loch, D.S. (1985). Tiller development in relation to seed production of tropical grasses.

Ludlow, M. M. (1976). Physiology of growth and chemical composition. In Shaw, N.H. and Bryan, W. W. (eds). Tropical pasture research, principles and methods.*Commercial Agricultural BureauBulletin*. 5- 11.

Maigandi. S. A. and Wasagu. A. A. (2002). Nutrient intake and digestibility by Yankasa rams fed varying levels of *Ficus sycomorous* leaves, *proceeding of the 27th conference Nigerian Society for Animal Production* (NSAP) held at Federal University of Technology. Akure Pp.182-184.

Mathieu, F., Jouany, J.P., Sénaud, J. Ohatier, J.B. Bertin, G. Mercier, M. (1996). The effect of Saccharomyces cerevisiae and Aspergillus oryzae on fermentations in the rumen of faunated and defaunated sheep;protozoal and probiotic interactions.*Reproduction Nutrition Development*, 36,271-287.

Mehrez, A.z, Orkskov, E.R. andMcdonald, I. (1977) Rates of rumen fermentation in relation to ammonia concentration.*British Journal Nutrition.*38: 437-443

McDonald, P., Edward, R. A., Greenhalgh, J. F. D., Morgan, C. A., Sinclair, L.A.and Wilkinson, (2011). *Animal Nutrition*. 7th Edn., Prentice Hall/Pearson Education Ltd., Harlow, UK.

Magalhaes, J. A., Townsend, C. R., Costa, N. L. and Pereira, R. G. (2005).Utilization of *Desmodium ovalifolium* hay as a feed supplement for woolless sheep during the dry Amazon season.*Pasturas Tropicales Journal*, 27 (2): 62-64.

Mass, L. (1996). Identifying and naming Brachiaria species. *Brachiaria*: Biology, Agronomy, and Improvement. (CIAT & Embrapa).P.ix-xiii.

Mathias, E. I., Benneth, O. I.and Lundberg, P. E. (1973). Effect of rates of nitrogen use and winter survival of midland Bermuda grass *(Cynodon dactylon (L.) pers.)* in Appalachia.*Agronomy Journal*. 65:67-68.

McDowell RL, Valle G (2000). Major minerals in forages. In: Givens DI, Owen E, Axford RFE and Omed HM (eds) Forage evaluation in ruminant nutrition. CAB International Publishing. Pp. 373–397.

McGregor, J. T. Jr., Smith, R. J. Jr. and Talbert, R. E. (1988).Broadleaf Signal grass (*Brachiaria platyphylla*) Duration of Interference in Rice (*Oryza sativa*). *Weed Science Journal.* 36: 747-750.

Mckell, C. M., Youngner, B. B., Nudge, F. J. and Chatterton, J. J. (1969). Carbohydrate accumulation of coastal Bermuda grass and Kenlucky blue grass in relation to temperature regimes.*Crop Science Journal*. 12: 534-537

Meek, D. M., Wiedmeier, R. D., Schmidt, P. R., Young, A. J. and Snyder, D. L. (2004).Cow-Calf production on irrigated pastures composed of monoculture versus a mixture of forages *Proceeding of Western Section of American Society of Animal Science*.55:269-272.

Mehrez, A.Z, Orkskov, E.R. andMcdonald, I. (1977) Rates of rumen fermentation in relation to ammonia concentration.*British Journal Nutrition.*38: 437-443

MelIor, W., Hibberd, M. J. and Grof, B. (1973a). Beef cattle live weight gains from mixed pastures of some Guinea grasses and legumes on the wet tropical coast of Queensland. *Queensland Journal of Agriculture and Animal Science*, 30: 259-266.

Mellor, W., Hibberd, M. l. and Grof, B. (1973b).Performance of Kennedy Ruzi grass on the wet tropical coast of Queensland.*Queensland Journal of Agriculture and Animal Science*. 30: 53-56.

Mickan, F. (2006). Forage cereals: harvest and storage. When to cut for whole-crop cereal silage. Department of Primary Industry, Victoria Gov., Ag, Note 1243.

Miles, J. W. and Do Valle, C. B. (1996). Manipulation of apomixis in *Brachiari*a breeding. In: J. Miles, B. L. Maass and C. B. do Valle (Eds.). *Brachiaria*: *Biology, Agronomy and Improvement.*(CIAT publication No 259).Pp 164-177.

Miles, J. W., Do Valle, C. B., Rao, I. M. and Euclides, V. P. B. (2004). Brachiaria grasses In.L.E Moser B.L Burson Y.L.E Sollenberger (eds). Warm – season (C4) grasses. Agronomy of grasses 45, ASA, CSSA, SSSA, Madison WI, USA 2004.745-783.

Miles, J. W., Maass, B. L., Kumble, V**.** and do Valle, C.B. (1996) *Brachiaria* : Biology, Agronomy and Improvement. Joint publication by Centro Internacional de Agricultura Tropical (CIAT), Cali-Colombia and Embrapa/CNPGC, Campo Grande, MS, Brazil. Pp 161-162.

Minson, D. J. (1982).Effects of chemical and physical composition of herbage eaten upon intake. In: J. B. Hacker, C. A. B. Farnham.(ed.) Nutritional limits to animal production from pastures. Royal. Pp 28-32.

Minson, D. J. (1990).Forage in Ruminant Nutrition.Academic press Inc. Harcourt Brace Jovanovich, Publishers, San Diego, pp9-59.

Morais, J. A. da S., Berchielli, T. T., Queiroz, M. F. S., Keli, A., Reis, R. A. and Souza, S. F. de (2009). Influence of supplementation frequency on intake, digestibility and ruminal fermentation in beef cattle steers grazing palisade grass. *Revise Brasilia Zootec.*38(9): 1824-1834.

Narongrit, W. (1999).Effect of cutting, nitrogen, closing date and water on herbage and seed production in Ruzi grass (*Brachiaria ruziziensis* Germain and Everard).Plant Science (Seed echnology) at Massey University, New Zealand.

NASS, (2011). National Agricultural Sample Survey Census on Nigerian livestock. Ministry of Agriculture and Rural Development.

National Research Council *(2007).Nutrient Requirements for various classes of sheep and goat, Update 2007.National Academy Press, Washington, DC.*

Ndikumana, J. and De Leeuw, P. (1996). Regional Experience with Brachiaria: Sub-Saharan Africa.In: J. Miles, B. L. Maass and C. B. do Valle (Eds.).*Brachiaria:* Biology, Agronomy, and Improvement. (CIAT & Embrapa), (CIAT Publication No.259) Pp.247-257.

Nguku, S.A (2015). An evaluation of Brachiaria grass cultivars productivity in semi-arid Kenya. MSc research thesis southeastern Kenya University.

Niinemets, U. (2004). Adaptive adjustment to light in foliage and whole plant characteristics depend on relative age in the perennial herb *Leontodan hispidus*. New phytologist 162:683-696

Nsinamwa, M., Moleele, N.M. and Sebego, R. J. (2005).Vegetation patterns and nutrients in relation to grazing pressure and soils in the sandveld and hardveld communal grazing areas of Botswana.*African Journal of Range Forage Science*. 22: 17–28.

Nyako, H. D., Kibon, A. and Yahaya, M. S. (2012). Effect of different supplement on the performance of Yankasa rams fed Pangola grass in Adamawa State, Nigeria. *Proceeding of the 17th Annual Conference of Animal Science Association of Nigeria* (ASAN), Abuja, Nigeria.9-13.

Nsinamwa, M., Moleele, N.M. and Sebego, R. J. (2005).Vegetation patterns and nutrients in relation to grazing pressure and soils in the sandveld and hardveld communal grazing areas of Botswana.*African Journal of Range Forage Science*. 22: 17–28.

Okeniyi, F. A., Aina, A. B. J., Onwuka, C. F. I. and Suwande, S. O. (2010). Nutrient digestibility of urea maize stover-based diets as dry season feed in West African Dwarf Goats. *Proceedings of the 15th Animal Science Conference Association of Nigeria*, University of Uyo, Nigeria. Pp 663-665.

Okojie, J. A. (1999). The role of government and Universities of Agriculture improving animal production and consumption in Nigeria, *Tropical Journal of Animal Science*,2: 1-7

Omokanye, A. T., Amodu, J. T. and Onifade O.S. (2004). Influence of intra row plant spacing, phosphorus application and growth stage on the forage yields and quality of Phasey bean (*Macroptilium lathyroides)* in sub-humid area of Nigeria, *Nigerian Journal of Animal Production.* 31:45-50.

Onifade O. S. (1992). *Brachiaria decumbens* and *Leucaena leucocephala* as promising pasture species. Pasture and Range Management Workshop for Extension Workers held at NAERLS, A.B.U, Zaria. 18th -22nd May, 1992.

Oram, R. N. (ed) (1990). Register of Australian herbage plant cultivars. 16. *Brachiaria* a. *Brachiaria decumbens*, 3rd Edition, CSIRO, Melbourne, Australia. Pp. 89-90

Ørskov, E. R. (1998): Feed Evaluation with emphasis on fibrous roughages and fluctuating supply of nutrients. 1. A review. *Small ruminant Research*, 28: 1-8.

Ørskov, E. R. (1999). How can agricultural scientist contribute to rural poverty alleviation? In: Promoting Sustainable Small-Scale Livestock Production towards Reduction of Malnutrition and Poverty in Rural and Sub-Urban Families in Nigeria Eds. FACE PAM/ATBU Publications, Nigeria, Pp: 13-23.

Ørskov, E. R. and Hovell, D. F (1978).Rumen digestion of hay (measures with Dacron bags) by cattle grain sugar cane or pangola hay.*Tropical Animal Production* 3: 9-11.

Ørskov, E. R., and McDonald, I. (1979). The estimation of protein degradability in the rumen from incubation measurements weighted according to rate of passage. *Journal of Agriculture Science (Cambridge),*92(2): 499–503.

Ørskov, E.R., Hovell, D. F. and Mould, F. (1980). The use of nylon bag technique for the evaluation of feed stuffs. Rowett Institute Buksburn, Aberdeen, Scotland. *Tropical Animal Health and Production*, 5: 195-213.

Osinowo, O. A., Abubakar, B. Y., Adewuyi, A. A., Onifade, O. S. and Dennar, P. O. (1991). Estimates of genetic and phenotypic parameters of birth weight, weaning weight and pre-weaning gain in Yankasa sheep. *Presented at the 16th Annual Conference of the Nigerian Society for Animal Production, Usmanu Danfodio University*. Sokoto, Nigeria.

Osuji, P. O., Nsahlai, I. V, and Khalili, H. (1993). *Feed Evaluation* (ILCA Manual.,N_O 5). Addis Ababa, Ethiopia: ILCA (International Livestock Centre for Africa) 40.

Otchere, E.D., Ahmed H.H., Adenowo, T.K., Kallah.M.S., Bawa.E.L.K., Olurunju.S.A., and Voh. A.A.Jr.(1987).Sheep and Goat Production in the Traditional Fulani Agropastoral Sector.*Wold Animal Review*, 64:50-55

Ovimaps, (2015). Ovi location map: Ovi Earth Imagery Data.

Payan, A., Jimenez, F., Ibrahim, M., Casanoves, F. (2007). Improved pastures for cattle rising in the Jucuapa river sub-watershed, Nicaragua. Recursos Naturales y Ambiente. 51/52: 167-174

Pereira, J. M., Junior, D. do Nascimento, Cantarutti, R. B. and Regazzi, A. J. (1992). Consumo e ganho de peso de bovinos em pastagens de capim.*Brachiaria humidicola* (Rendle) Schweickt, em monocultivo ou consorciado com leguminosas submetidas a differentes taxas de latacao *Rev. Soc. Bras.Zootec.* 21:118-131.

Pereira, J. R. A., Reis, R. A., Berchielli, T. T., Bertipaglia, L. M. A. and Melo, G. M. (2008). Supplementation of cattle kept in *Brachiaria brizantha* (cv. Marandu) pasture: ruminal parameters and degradability. Acta Scientiarum - *Animal Science Journal*, 30 (3): 317-325.

Phaikaew, C and Pholsen, P. (1993). Ruzi grass (*Brachiaria ruziziensis*) seed production and research in Thailand. *Paper presented at the 13th FAO Regional Forage Working Group of South East Asia on Strategies for Suitable Forage-Based Livestock Production*, p316 Feb. 1993, KhonKaen, Thailand.

Pizarro, E. A., Hare, M. D., Mutimura, M. and Changjun, B. (2013). Potential forage use and seed yield. A *Brachiaria Breeding Program* initiated by CIAT, Cali, Colombia. A research conducted on growth, quality, persistence and seed yields of *Brachiaria* hybrids in Asia, Central America and Africa from 2003-2013. Pp13

Porto, M. O., Paulino, M. F., Valadares Filho, S. de C., Sales, M. F. L., Leao, M. I. and Couto, V. R. M. (2009). Protein sources in multiple supplements for finishing crossbred steers on Brachiaria pasture, in the wet season: productive and economic performance. *Revise Brasilia Zootec.* 38 (8): 1553-1560.

Powel, M.P., Okorie, A. O, Okorie, A. U, Peter, J.B. Wilhain, H.Dyfed, L (1981) Amonia Concentration and protein Synthesis in the rumen. *Journal of science food Agriculture,* 32:759-763.

Preston, T.R., and R.A., Leng, (1987). Matching Ruminant production system with Available Resources in the tropics and subtropics. Penambul Books Ltd, Arnidale NSW Australia. Pp 245.

Promkot, C., Wanapat, M. and Rowlinson, P. (2007).Estimation of ruminal degradation and intestinal digestion of tropical protein resources using the nylon bag technique and the three-step ***in vitro*** procedure in dairy cattle on rice straw diets.*Asian-Australian Journal of Animal Science.,* 20 (12): 1849-1857.

Quala, I.D. Yahaya,M.S. Midau,A. Aji,S.B. Muktar,Y.M. and Nyako, H.D. (2011). Assessment of the Digestibility of intercropped sorghum stover with legume(Groundnuts). *Global Journal of Science FrontierResearch.*11(3):45-54

Rao, I. M., Kerridge, P. C. and Macedo, M. (1996). Nutritional requirements of Brachiaria and adaptation to acid soils. In: J.W. Miles, B.L. Maass and C.B. do Valle (Eds.). *Brachiaria*: Biology, Agronomy, and Improvement. Pp. 53-71.

Renvoize, S. A., Clayton, W. D., Kabuye, C.H. (1996). Morphology, Taxonomy, and Natural Distribution of Brachiaria (Trin.) Gries. *Brachiaria*: Biology, Agronomy, and Improvement. (CIAT & Embrapa). Pp.1-12.

Risopoulos, S. A. (1966).Management and use of grasslands, Democratic Republic of the Congo. 1st edition, Published1966 by Food and Agriculture Organization of the United Nations in Rome.

Roberts, O. T. (1971). Research abstract: "Pasture improvement and research in Fiji (South Pacific Bull). *Agricultural Journal*. 20(4): 35-38.

Romney, D. H. (1961). Productivity of pasture in British Honduras. II. Pangola pasture. *Tropical. Agriculture. Journal.* (Trinidad), 38: 39-47.

Sani I. (2012). Effect of Different protein supplementation on the performance of Yankasa sheep fed Congo grass (*Brachiaria ruziziensis*), (MSc Dissertation, Ahmadu Bello University, Zaria).Pp 64-69.

Salam A. A., Noordin, M. M. and Rajion, M. A. (1988). Signal grass (*Brachiaria decumbens*) toxicity in sheep: changes in motility and pH of reticulo-rumen. *Veterinary and Human Toxicology Journal*, 30: 256-258.

Salam A. A., Noordin, M. M. and Rajion, M. A. (1989). Neurological disorders in sheep during Signal grass (*Brachiaria decumbens*) toxicity. *Veterinary and Human Toxicology Journal*, 31: 128-129.

Salam A. A., Nordin, L., Bremner, J.B., Davies, N.W., Mustapha, W. and Rajion, M.A. (1992). Hepatotoxic constituents in the rumen of *Brachiaria decumbens* intoxicated sheep. *Veterinary and Human Toxicology Journal*, 34(2): 154-155.

Sampaio, A. A., Fernandes, A. R., Henrique, W., Ribeiro, G. M., Oliveira, E. A. and Silva, T. M. (2010). Effect of supplementation on nutrient digestibility and performance of lactating calves fed with *Brachiaria brizantha* pastures. Acta Scientiarum. *Animal Sciences Journal,* 32 (1): 63-68.

Sanchez, N. R., Sporndly, E., Ledin, I. (2006). Effect of feeding different levels of foliage of Moringa oleifera to creole dairy cows on intake, digestibility, milk production and composition. *Livestock Science Journal,* 101 (1/3): 24-31.

SAS, (Statistical Analysis Systems). (2002). Procedures Guide. North Carolina, USA: Statistical Analysis Systems Institute, Cary.

Schoenian, S. (2009). Copper toxicity in sheep. Small Ruminant Information Sheet, University of Maryland, USA.12: 45.

Schultze-Kraft, R. and Teitzel, J. K. (1992) *Brachiaria ruziziensis*Germain & Evrard. In't Mannetje, L., and Jones, R.M. (eds) *Plant Resources of South-East Asia No. 4. Forages* (Pudoc Scientific Publishers, Wageningen, the Netherlands). Pp. 65–67

Seyouma, E.T. Batteseb, G.E. and Fleming, E.M. (1998). Technical efficiency and productivity of maize producersin eastern Ethiopia: a study of farmers within andoutside the Sasakawa-Global 2000 project 19: 341-348.

Shahjalal, M. E., Khan, M. J. and Bhuiyan, A. A. (2003). Effect of dietary energy Supplementation on feed intake, growth and reproductive performance of sheep under grazing condition. Asian Network for Scientific Information. *Pakistan Journal of Nutrion* 2(3). 148-152.

Shamoon, M., Saleh N., Abbo N.Y. (2009). Effects of different levels of protein treated with formaldehydeon nutrients digestibility and some rumen and blood parameters in Awassi sheep. Iraqi *Journal of Veterinary Science.* 23, Supplement II, 169-173.

Silva, H. G. de O., Pires, A. J. V., Cunha Neto, P. A. da, Carvalho, G. G. P. de, Veloso, C. M. and Silva, F. F. da (2007). Digestibility of nutrients in diets containing ammoniated elephant grass and cocoa meal or palm kernel cake fed to sheep. Revise Brasilia Zootec., 36 (2): 499-506.

Singh, R. J. (2009). *Genetic resources, chromosome engineering and crop improvement: Forage crops*. CRC Press, Florida, U. S. A. Pp 8-12.

Smith, B. L., and Miles, C. O. (1993). A role for *Brachiaria decumbens* in hepatogenous photosensitization of ruminants. *Veterinary and Human ToxicologyJournal*, 35: 256-257. Society for Animal Production (NSAP) held at Federal University of Technology. Akure

Stur, W. W., Hopkinson, J. M. and Chan, C. P. (1996). Regional Expertice with *Brachiaria*: Asia, the South Pacific, and Australia. *Brachiaria*: Biology, Agronomy, and Improvement. (CIAT & Embrapa). Pp.258-277.

Tarawali, S. A., Tarawali, G., Larbi A., and Hanson, J. (1995). Initial Screening Methods. In G. T. S. A. Tarawali, (eds) *Methods for the Evaluation of Forage Legumes, Grasses and Fodder Trees for Use as Livestock Feeds* (pp. 10-11). Nairobi Kenya: International Livestock Research Institute.Thesis Pp 72-82.

Thomas, D. and Grof, B. (1986). Some pasture species for the tropical savannas of South America III. *Andropogon gayanus, Brachiaria* species and *Panicum maximum*. *Herbage Abstracts*, 56: 557-565.

Tohme, J., Palacios, N., Lenis, S., Roca, W. (1996). Applicatios of Biotechnology to *Brachiaria*. *Brachiaria*: Biology, Agronomy, and Improvement. (CIAT & Embrapa) Pp.196-204.

Tolera, A. and Abebe, A. (2007). Livestock production in pastoral and agro-pastoral production systems of Southern Ethiopia. *Livestock Research and Rural Development.* 19:177. http://www.irrd.org/Irrd19/12/tole9177.htm. 13/12/2013.

Trinh, P. H., Ho, Q. D., Preston, T. R. and Leng, R. A. (2009). Nitrate as a fermentable supplement for goats fed forage basal diet low in protein. *Livestock Research for Rural Development*, 21(10). Retrieved August, 10th June 2016, from www.Irrd22/5/sing22093.htm*Tropical Agriculture*. (Trinidad*)*, 64: 122-128.

Umunna, N. N., Nshalai., I.V. and. Osuji, P.O. (1995). Degradability of protein forage supplement and their effects on kinetics of digestion and passage, *Small Ruminant Research*. 17: 145-152.

Usman H. B., Maigandi, S. A., Hassan, W. A. and Daneji, A. I (2008). Growth performances and Nutrient Utilization by Sokoto red goat Kids fed fore stomach digesta as replacement for cowpea husk. *Nigerian Journal of Basic and Applied Science*.16(1):62-70.

Valerio, J. R., Lapointe, S. L., Kelemu, S., Fernandes, C. D. and Morales, F. J. (1996). Pest and Diseases of *Brachiaria Species*. *Brachiaria*: Biology, Agronomy, and Improvement. (CIAT & Embrapa) Pp.87-105.

Valle do, C. B. and Savidan, Y. H. (1996). Genetics, Cytogenetics, and Reproductive Biology of *Brachiaria. Brachiaria*: Biology, Agronomy, and Improvement. (CIAT & Embrapa). Pp.16-35 and Pp.147-163.

Van Soest, P. J., Robertson, J. B. and Lewis, B. A (1991). Method for directory Neutral detergent fibre and Non- Starch polysaccharides in relation to Animal Nutrition, *Journal of Dairy Science*, 74: 3583-3597.

Vega, E.M., Ramírez de la Ribera, J., Leonard Acosta I. and Igarza, A. ((2006).). Dry matter yield, chemical characterization and digestibility of Brachiaria decumbens in the edapho-climatic conditions of the valley of Cauto. *Revista Electrónica de Veterinaria REDVET*,http://www.veterinaria.org/revistas/redvet/n050506.html

Wada, N. I., Njidda, A. A. Olafadehon, O. A. and Bello, B. (2016). Effect of graded level of *Parkia biglobosa* in concentrate diets on growth performance, digestibility and nitrogen utilization of Yankasa rams. *Nigerian Journal for Animal Production*, 43(1): 231-238.

Walli, T.K. (2008a). Densified TMR – A newer nutrient delivery system for feeding dairy animals in tropics. *In Proc. XXXVI dairy industry conference,* BHU, Varanasi, India, Pp. 74–79.

Walli, T.K. (2008b). Complete feed block – An effective feeding technology for efficient utilization of our limited feed resources. *In Proceedings of the regional animal nutrition conference,* Animal Nutrition Society of India, Tirupati. Pp.1–3.

Walli, T.K. (2009a). Nutritional strategies for ruminant production in Afro-Asian tropics. *In Proceedings of the World Animal Nutrition Conference,* Animal Nutrition Association,NASC Complex, New Delhi. Pp. 294–300.

Watson, L. and Dallwitz, M. J. (2008). The grass genera of the world: Descriptions, illustrations, identification and information retrieval; including synonyms, morphology, anatomy, physiology, phytochemistry, cytology, classification, pathogens, world and local distribution and references. *The Grass Genera of the World. Retrieved from* http://www.tropicalforages.info/key/Forages/Media/Html/glossary.html. 2011-11-07

Whitehead, D.C. (2000) Nutrient Elements in Grasslands. Soil-Plant-Animal relationships. CABI. Wallingford, UK. Pp 135.

Whiteman, P. C., Halim, N. R., Norton, B. W.and Hales, J. W. (1985). Beef production from three tropical grasses in south eastern Queensland. *Australian Journal for Experimental Agriculture and Animal Husbandry*, 25 (3): 481-488.

Winter, W. H., Cameron, A. G., Reid, R., Stockwell, T. G. and Page, M. C. (1985). Improved pasture plants. In: Muchow, R. C. (ed.). Agro-Research for the Semi-Arid Tropics, North-west Australia. University of Queensland Press, St-Lucia, Qld. Pp227-269.

Winter, W. H., Edye, L. A., Megarrity, R. G. and William, W. T. (1977). Effects of fertilizer and stocking rate on pasture and beef production from sown pastures in Northern Cape York Peninsula. 1. Botanical and chemical composition of the pasture. *Australian Journal of Experimental Agriculture and Animal Husbandry* 17:66-74

Woods, V. B., Moloney, A. P. and O'Mara, F. P. (2003a). The nutritive value of concentrate feedstuffs for ruminant animals. Part II: In-situ ruminal degradability of crude protein. *Animal Feed Science Technology*, 110 (1/4): 131-143.

Yashim, S. M., Jokthan, G. E., Lamidi, O. S., Yakubu, R. L. Hassan, M. R., Ibrahim, T. A. and Abdu, S. B. (2014). Performance, nutrient digestibility and nitrogen balance of growing Yankasa rams fed *Digitaria smutsii* hay supplemented with *Ficussycomorus* leaf meal. *Nigerian Journal for Animal Science*, 16(1): 85-93.

PLATES

PICTURES TAKEN DURING THE EXPERIMENT



Plate 1: ***Brachiaria ruziziensis*** **seed**



Plate 2: Experimental plot



Plate 3: Drilling of *Brachiaria ruziziensis* seed



Plate 4: A well-established *Brachiaria ruziziensis* forage crop



Plate 5: Grounded *Brachiaria ruziziensis* forage hay



Plate 6: Feeding Trial



Plate 7: Digestibility Trial



Plate 8: Urine Collection



Plate 9: Collection of Rumen fluid