COMPARATIVE FEEDING VALUE OF *CYNODON DACTYLON* AND *DIGITARIA SMUTSII* FORAGES SUPPLEMENTED WITH CONCENTRATE FOR WEANED FEMALE YANKASA LAMBS

BY

HASSAN FATIMAH BUKAR DR. (MRS)
DVM (UNIVERSITY OF MAIDUGURI) 1994

A Thesis Submitted to the Post Graduate School, Ahmadu Bello University, Zaria.

In Partial Fulfillment of the Requirements for the Award of Masters Degree

Department of Animal Science, Faculty of Agriculture
Ahmadu Bello University, Zaria.

OCTOBER, 2007.

DECLARATION

I hereby declare that the work in this thesis entitled "Comparative feeding values of *Cynodon dactylon* and *Digitaria smutsii* forages for weaned Yankasa female lambs'' was carried out by me in the Experimental Unit of Small Ruminant Research Programme, National Animal Production Research Institute, Ahmadu Bello University, Zaria under the supervision of Prof. C. A. M. Lakpini and Prof. W.O. Ehoche. The information derived from the literature has been duly acknowledged in the text and a list of references provided.

No part of this thesis was previously presented for another degree or diploma at any University.

Dr. (Mrs.) HASSAN Fatimah Bukar …… …….

Signature Date

CERTIFICATION

This thesis entitled comparative feeding values of *Cynodon dactylon* and *Digitaria smutsii* forages for weaned Yankasa female lambs by Fatimah Bukar HASSAN meets the regulation governing the award of the degree of Masters of Science (Animal Science) of the Ahmadu Bello University, Zaria. It is approved for its literary presentation and contribution to scientific knowledge.

Name and Signature

…… Date:……
Prof. C.A.M Lakpini
Chairman, Supervisory Committee

Name and Signature

…… Date:……
Prof. W.O. Ehoche
Member, Supervisory Committee

Name and Signature

…… Date:……
DR. (Mrs.) G.E Joktan
Head of Dept.,

Name and Signature

…… Date:……
Prof. S.A. Nkom
Dean, Post Graduate School.

DEDICATION

I dedicate this thesis to the following;

My Mother, Hajiya Maryam Bukar Biu for bringing me to this world.

My Sister, Hajiya Aisha I. Abdullahi, my Brother, Mallam Adamu .A. Biu for being there for me at the time I needed them most.

And to my only son, Sadiq Adamu Zoaka for been the source of my joy and inspiration.

ACKNOWLEDGEMENT

Praise be to Almighty Allah for His Divine guidance during the research work.

I would like to express my profound gratitude to my Major Supervisor, Prof. C.A.M Lakpini for his sincere commitment by being meticulous while I was conducting the research as well as while going through the write up, Sir I have learnt so much from you, not only the academic work but also the ethics of life. Thank you sir.

I am also indebted to my second supervisor Prof. W.O Ehoche for his academic guidance while going to this write-up.

I am grateful to the Director of National Animal Production (NAPRI) for allowing me to use the facilities of the institute for this study. I also wish to thank the director of Division of Agricultural Colleges Dr Salihu Dadare and the provost of college of Agriculture and animal science, Mando Kaduna Prof. M. Mamman for their support and encouragement.

I wish to also thank the field and technical staff of Small Ruminant Research Programme for helping with the care of the experimental animals.

I acknowledge strongly the valuable support and special contribution of my husband (DEE) Dr. A.Z Hassan toward my academic pursuit in particular and my life in general

I am grateful to members of my household Sadiq, Hassan Yusra, Kulu and Hashimu for their understanding and endurance while I was away to Zaria for this research work. .

I remain grateful to my students for allowing to scheduled my timetable to suit my postgraduate programme

TABLE OF CONTENTS

Contents		pages
Title page		i
Declaration		ii
Certification		iii
Dedication		iv
Acknowledgement		v
Table of Contents		vi
List of Tables		vii
List of Appendices		viii
Abstract		xi
CHAPTER ONE: Introduction		1
CHAPTER TWO: Literature Review		5
2.1	Livestock Distribution	5
2.1.1	World Distribution	5
2.1.2	Distribution in Nigeria	6
2.2	Breeds of Sheep	7
2.2.1	Uda	7
2.2.2	Balami	8
2.2.3	Yankasa	8
2.2.4	West African Dwarf	
2.3.1	Primary Products	9
2.3.2	Sheep by-product	11
2.3.3	Secondary Products	11
2.4	Sheep Production in Nigeria	12
2.4.1	Protein Requirement	15
2.4.2	Energy Requirement of Ruminant	16

2.4.3 Minerals 17
2.4.4 Water 17
2.4.5 Feeding Sheep 17
2.4.5.1 Concentrate 17
2.4.5.2 Forages or Roughages 18
2.4.5.3 Feed intake 22
2.4.5.4 Digestibility 23
2.4.5.5 Animal Factor 24
2.4.5.6 Quality of Feed 25
2.4.6 Weight gain and Supplementation 26
2.4.6.1 Efficiency of Feed Conversion 28
2.5.1 Experimental Forages 29
2.5.2 *Digitaria Smutsii* 38

CHAPTER THREE: Materials and Method

3.1 Location of Experiment 42
3.2 Experimental Procedures 42
4.1 Feeding trial 46
4.1.1 Composition of Diets 46
4.1.2 Digestibility of Nutrients 46
4.1.3 Blood Protein Level 48
4.2 Feed intake, Body weight gain and
Feed Conversion Efficiency 48

CHAPTER FOUR: Results

CHAPTER FIVE: Discussion

5.1 Discussion 52
5.2 Conclusion 57
References 58

LIST OF TABLES

TABLES	PAGES
Table 1 Average Water Requirement of Stock.	35
Table 2 Nutritional contents (% dry matter) of Bermuda grass stems and leaves.	55
Table 3 Botanical Characteristics of *Digitaria* spp.	62
Table 4 Chemical Composition of some *Digitaria* Specie	41
Table 5 Ingredient Composition of Concentrate	66
Table 6 Treatment Grouping for Feeding Trials	66
Table 7 Feed intake (g/W $^{0.75}$ kg – on DM basis), body gain and Efficiency of Feed Conversion	70
Table 7 Chemical Composition of Feeds	69
Table 8 Digestibility Values of Feed Nutrient	69
Table 9 Blood Protein Values	71

LIST OF APPENDICES

APPENDICES		PAGES
Appendix 1:	Harvested *Digitaria Smutsii* plant	92
Appendix 2:	Harvested *Cynodon dactylon* plant	93

ABSTRACT

The study was conducted to compare the feeding values of *Cynodon dactylon* or *Digitaria smutsii* as basal diet on growth and some blood metabolites in weaned female Yankasa lambs. Twenty weaned female Yankasa lambs with an average body weight of 10± 2kg were randomly assigned to four treatments with five lambs per treatment in a randomized complete block design.

They were fed with either *Cynodon dactylon* (treatments A and B) or *Digitaria smutsii* (treatments C and D) ad labium. Animals in treatments A and C were supplemented at 1.0% of body weight (BW) while those in treatments B and D were supplemented at 1.5% BW. The concentrate was a mixture of maize (75.2%), cottonseed cake (23.8%), common salt (0.5%), and bone meal (0.5%). The chemical composition of the feed ingredients showed that *Digitaria smutsii* comprised DM 97; Ash 7.3; EE 4.1; CP 6.3: NDF 73 and ADF 46%. *Cynodon dactylon* on the other hand had a composition of; DM 97.1; Ash 7.2; EE 3.5; CP 6.1; NDF 76.4 and ADF 47.0%. The concentrate had a composition of DM 98; Ash 19.4; EE 5.2; CP 18.8; NDF 34.1 and ADF 25.0%.

The result showed that there was no difference in the nutrient content of *Digitaria* and *Cynodon*, but the analysis of concentrate revealed a higher level of crude protein and lower levels of neutral and acid detergent fibers.

The forage intake was higher in *Digitaria* but not significantly ($P>0.05$) different from *Cynodon*. There was an increase in concentrate intake as the level of supplementation

increased. The same trend was observed with the total intake. Supplementation at 1.5% gave higher ($P>0.05$) total intake than at 1.0% supplementation. Daily weight gain was higher ($P>0.05$) with *Cynodon* supplemented at 1.5% BW than with *Digitaria* supplemented at 1.5% BW.

Cynodon supplemented at 1.5% BW was found to be the most efficient and was significantly ($P<0.05$) different from Digitaria supplemented at 1.5% BW. The digestibility result also showed no differences between the two forages. Supplementation was found to increase the level of blood protein, albumin, and globulin. It was concluded from the study that *Cynodon dactylon* is a good forage substitute for *Digitaria smutsii* at a high supplementation level of 1.5%. It is hence recommended as good forage for small ruminants. This is because it has almost the same chemical composition as *Digitaria smutsii*, hence almost the same nutritive values. Also the body weight gain was higher for animals on *Cynodon* than *Digitaria* at the same level of supplementation. It is therefore recommended that *Cynodon dactylon* which is a native pasture available as weed in all the ecological zones of the country can be effectively produced and used as forage for small ruminant production.

CHAPTER 1

INTRODUCTION

Small ruminant production in Nigeria has been characterized by low productivity. Several factors have been adduced to this; among them is the low reproductive characteristic of small ruminants found in the country. Others include the management system practiced as well as high morbidity and mortality especially during the rainy season (Gefu, 2002).

The low productivity of livestock in Nigeria is associated with genetic, nutritional, management and disease factor (Isiyaku, 1988). However, nutrition appears to be the most important factor since with poor nutrition, disease becomes a dominant constraint. The low plane of animal nutrition in the country results from the seasonality and growth of natural herbage especially within the Sahel and Sudan savannah zones. These zones have the largest population of ruminant livestock in the country and are characterized by long dry season (6-8 months) which causes a decline in both quantity and quality of available grazing forage. (Agishi, 1986; Olayiwole, 1986). In spite of the importance of sheep in Nigeria, their productivity is low(David-West, 1983) and poor nutrition has remained one major factor limiting productivity of the indigenous sheep in Nigeria (Ogundipe ,2002). However, grasses are the most abundant basal feed for small ruminants and livestock generally their palatability and digestibility vary with the species and stage of maturity (Lakpini 2002). Consequently, animals fed on mature forage have lowered intake of digestible energy for maintenance hence their poor performance (Olubajo and Oyenuga, 1971). Since ruminants in Africa are traditionally raised on natural pasture that declines rapidly in quality during the dry season (Ademosun, 1973), changes in nutritional status results in a very irregular growth, marked with fluctuation in

seasonal weight gain (Wilson, 1987). This poor animal performance has given rise to low animal protein intake by the average Nigerian. Therefore, the use of pastures on a large scale will rapidly develop the Nigerian livestock industry as it is regarded as a low feed base for ruminants especially sheep. Fresh forage is often the sole diet of ruminants in the humid tropics whereas the indigestible organic matter is the main factor of variation in their nutritive value (Achimede *et. al.,* 2002).

To improve ruminant productivity, farmers are increasingly relying on weeds as a potential feed source; notable among these weeds is *Cynodon dactylon (C dactylon* or bermuda grass*)*. Bermuda grass originally came from the savannah of Africa and is the common name for all the East African species of *Cynodon*. It grows in open areas where there are frequent disturbances such as grazing, flooding and fire. Although most of the specie have remained in Africa today, *C. dactylon* is found growing in pastures and the under stories of open woodland and orchards. It is called bermuda grass in United States of America because it was introduced from the Bermuda Island. It is a creeping grass and will creep along the ground and root while *Digitaria smutsii* on the other hand, is a pasture imported from Australia. It is a robust hefted perennial growing to about 1.5m and with an oblique rhizome. Its lowest leaf sheathes are densely hairy at the base but higher ones have few hairs (Anon[1], 2003). Although the use of improved pasture such as *D. smutsii* is an established practice in institutional research farms, this is not feasible in traditional husbandry. Furthermore the importation, growing and cultivation of this pasture is both labour and capital intensive which is sufficient reason to search for alternatives. Small scale farmers cannot afford the investment required to establish

improved pasture and to feed concentrate supplement to alleviate dry season growth checks .

JUSTIFICATION

According to the Food and Agricultural Organization (F.A.O. 1986), the Nigerian average intake of animal protein is 15 g per day, which is far below the recommended minimum level of 56 g per day. The main reason for the poor intake of animal protein is poor livestock productivity, which is due to poor nutrition, diseases, bad breeding practices and management. Of these factors, nutrition appears to be the most important because the gain of selective breeding, good management and disease control can only be realized with adequate plane of nutrition.

This project was hence conceived to evaluate the effects of *C. dactylon* which is a common weed in this part of the country (North Central) on growth of weaned Yankasa female lambs as well as to compare this with those of improved pastures such as *D. smutsii*. It is envisaged that a positive outcome of this research will present the livestock farmer with a suitable feeding substitute for both intensive and semi intensive sheep farming.

OBJECTIVE OF THE STUDY

The broad objective of this study was to evaluate the effects of feeding *C. dactylon* or *Digitaria smutsii* supplemented with concentrate at 1.0 or 1.5% BW on growth and some blood metabolites .The specific objectives of this study were to evaluate:

1 The effect of feeding *C. dactylon* or *Digitaria smutsii* on growth in weaned female Yankasa lambs.

2. The total protein, albumin and globulin profiles in the animals fed *C. dactylon* or D. *smutsii*.

CHAPTER 2

LITERATURE REVIEW

2.1 LIVESTOCK DISTRIBUTION

2.1.1 World Distribution

Sheep (*Ovis aries)* have been domesticated for over 10,000 years and figure prominently in the story of civilization and human survival, as evidenced by numerous biblical references, religious practices and symbols and cultural rituals that involve this species, not to mention their importance to agriculture over several millennia. Sheep are widespread across the world, having adapted to many different climate conditions and econiches {Adams and Mckinley (1995). During this century, sheep have also been the subject of considerable research from the viewpoint of physiological function and animal production. After humans, dogs and cats, it has been one of the more studied mammalian species (Adams and Mckinley 1995). An estimate by the Food and Agricultural Organization (FAO) of the United Nations puts the world sheep population at 1,158 million (FAO, 1983) which makes sheep the third most numerous species of farm animals after chicken and cattle.

The summary of world animal statistics shows that Asia has the largest sheep population representing 30% of the world population. Oceania i.e. Australia, New Zealand and the Pacific Island have the next largest population, 18% of world total. This is followed by Africa (16%), U.S.S.R 13%, Europe 12%, South America 9% and North and Central America 2% (Croston and Pollot, 1985). When the density of sheep per unit area is

considered however, Europe with 12% of world population is reported to have the highest density of sheep (Croston and Pollot, 1985).

2.1.2 Distribution in Nigeria

The population of sheep in Nigeria has been estimated at 22.1 million (FDLPCS 1992; Bourn *et al* 1994). The sheep population in Nigeria is largely centralized in the north. They are predominantly found in the drier region of the north. These areas contain a wide variety of plants, shrubs and trees which provide a varied supply of feed for animals at different times of the year. The most common breed of sheep in North Central, Nigeria is the Yankasa. They are shorthaired; the coat color is white with black patches around eyes and the body (Okorie, 1978).

Many different breeds of sheep have evolved and intensive breeding for particular purpose has resulted in many strains. The size of different breeds of sheep varies, with typical body weights of ewes ranging from 30kg for Welsh Mountain sheep, 45kg for Merinos, 55kg for Clun Forest breeds, 65kg for Cheviots, 75kg for Domestic Horns and 90kg for Lincolns (Hecker, 1983). It is worthwhile understanding some of the background of the various breeds of sheep and the specialization which they may posses. For example, the ancestors of the Merino, famous throughout Australia as a producer of fine wool, were derived from Spain and North Africa and are highly adapted to a hot arid environment. As such they have kidneys capable of concentrating urine and therefore conserving water to a much greater degree than strains that evolved in colder climate of

Northern Europe (McFarlane, 1968). Another well-known feature of the Merino is the copious folds of skin around its neck.

Domestic sheep vary in size, shape of the body and nature of coat cover, productivity, reproductive capacity and adaptability to different environments. A utilization classification of sheep can be made on the basis of chief function or body type. Although sheep are naturally multi-purpose animals, most traditional sheep in the tropics are maintained as subsistence animals supplying meat, skin, hair, manure and to some extent wool whereas selectively bred animals are more often narrowly specialized (Devendra and Mclerory, 1982).

2.2 BREEDS OF SHEEP

There are four main breeds of sheep indigenous to Nigeria. They are; Balami Uda, Yankasa and West African Dwarf sheep. These differ considerably in size, coat colour and other characteristics. Based on these characteristics, they can be grouped into large long legged types found in the northern part of the country and the dwarf found in the hot humid coastal areas (Adu and Ngere, 1979; Oni, 2002).

2.2.1 Uda

This is also called the Fulani sheep and is found in the southern fringes of the Niger Republic and in the Sudan and Sahel savanna zones of Nigeria, where it is kept mainly by the nomadic Fulani. It has a characteristic color, which is either black or brown at the fore-half and white at the hind. Horns are large wide and spiral in the rams but absent in

the ewe. Ears are long and pendulous. The mean birth weight is 3.5kg, while mature weight for ewes' ranges between 35 and 45kg; and between 45 and 55kg for rams. Height at withers ranges between 74-89cm for rams and 71-83 for ewes (Devendra and Mclerory, 1982).

2.2.2 Balami

This breed is found mainly in Borno state. It is a big, white and hairy sheep possessing large droopy ears with horns usually absent in the ewes but present in rams. Recorded birth weight averages 2.5kg for twins and 3.5 kg for singles. The mature weight ranges between 45-60kg for ewes while rams weigh 50-75kg. Height at withers ranges between 79cm-89cm for rams and 76-89cm for ewes (Oyeyeola, 1989).

2.2.3 Yankasa

The Yankasa, also known as Hausa sheep, is the most numerous and widely distributed breed of sheep in Nigeria. It is found in the sub–humid and semi–arid zones of the country but it has also been found to thrive in the humid zone. It is of medium body size, hairy and has a predominantly white colour with black patches around the eyes muzzle and hooves (Osinowo, 1990). The Yankasa is kept mainly by the town dwellers and also by the nomads in small flocks. Rams have curved horns which are short or absent in the ewes. Recorded adult weight varies from 30 to 45kg for ewes and 40 to 50kg for a ram while height at withers ranges between 75 and 94cm for rams and 65 and 88cm for ewes (Devendra and Mclerory, 1982).

2.2.4 West African dwarf

The breed is found predominantly in the southern part of the country. It is small and short- legged. The coat colour varies from all white, all blacks or brown to a spotted black or brown on a white coat. Many of the sheep have wattles. Males carry horns mature live weight varies from 15-25kg in ewes and 20-30kg in rams. The West African dwarf sheep is a hardy animal with a compact body, the breed is believed to be tolerant to trypanosomosis because they survive in the tsetse infested forest areas of southern Nigeria (. Oni, 2002)

2.3 SIGNIFICANCE OF SHEEP

Sheep have been used as experimental animals in such diverse fields of study as endocrinology and reproductive physiology, cardiovascular physiology, fluid and electrolyte homeostasis, immunology, neurophysiology and neuroanatomy, thermoregulation, haematology, ingestive behaviour, nutrition and gastro-intestinal physiology (Adams and Mckinley, 1995) with regard to the last, being ruminants with specialized four chambered stomachs, sheep have been studied extensively in their own right, with much knowledge accruing in ruminant nutrition and animal production. The study of the sheep foetus has also been extensive, and much of our knowledge of foetal physiology derives from these studies. Another aspect of sheep is the availability of post-mortem sheep tissues from abattoirs. This has enabled the collection (in vast numbers) of organs such as the pituitary from the sheep, enabling the discovery and characterization of a number of new hormones, e.g. the various hypothalamic releasing hormones which

control the secretion of growth hormone, luteinising hormone and adrenocorticotropin (Adams and Mckinley 1995).

2.3.1 Significance of Sheep Production

Sheep and goats play an important role in the socio-economic life of the people of Nigeria and make a significant contribution to the national economy. They constitute about 35 % meat supply (Oni, 2002). They also feature prominently in socio-cultural function , like ceremonies and religious festivals. The rams in particular are favorite slaughter animals during sallah festivals at which time rams command very high market prices (Oni, 2002).

In addition to the numerous advantages which sheep have over cattle and other livestock species, such as ease of acquisition, rapid growth, prolificacy, management and disposal for cash and household food protein source, among other characteristics, sheep have continued to fulfill household needs (Gefu, 2002).

2.3.2 Sheep as an Experimental Animal

There are several reasons why sheep make excellent experimental animals for physiological studies. Their body weight and size is said to approximate that of a human and adapt rapidly and extremely well to laboratory situation (Adams and Mckinley, 1995). In general, they have a placid nature and relate positively to handlers and experimenters, a possible result of their adaptation to domestication which has occurred over many generations. After introducing a sheep to the laboratory pen or metabolism

crate for one or two weeks and regular handling, patting and food rewards, together with the company of other sheep, there results a confident, unstressed, healthy animal with a strong bond often developing between the sheep and experimenters (Adams and Mckinley,1995). This enables experiments investigating physiological function in conscious, unstressed animals to be performed successfully. The size of sheep enables ease of introduction of catheters or cannulas (using either local or general anaesthesia) into various blood vessels, bladder lumen, salivary duct or cerebral ventricles for the purpose of obtaining samples of blood or other body fluids for chemical analysis. Their size also enables sufficient blood to be withdrawn for chemical and hormonal analyses with minimal effects on cardiovascular function, which is not always possible in small rodents. Sheep recover robustly from anaesthesia and experimental surgery and provided appropriate care is taken, are not usually troubled by post-operative or post-experimentation infection (Hecker, 1974). Great care is necessary in preserving asepsis when the brain or foetus is involved in order to avoid life-threatening infections. Compared to rodents, sheep are long-lived and in this country are relatively inexpensive for their size. With the provision of adequate food and water, well-maintained and well-cleaned facilities and sympathetic handlers and experimenters, sheep can thrive in a laboratory where thoughtful, well executed experiments can yield a wealth of physiological information relevant to human and animal physiology and medicine (Adams and Mckinley,1995). Sheep and goat contributed about 35% (about 700 million naira) to the capital value of Nigeria's livestock (Adu, 1980). Sheep population represents about 15% of the total grazing domestic animals (Adu, 1975). Sheep also have an annual off take rate of 25% (Adu, 1980).

They are multipurpose animals producing; meat, milk, skin, wool and manure. The majority of sheep owe their existence to the fact that, they thrive as meat producers under conditions in which it is difficult for other species of domestic livestock to survive (Ngosle, 1989). They are a major source of livelihood in many parts of the country. Unlike cattle, the farmers of the community own them and an attempt to increase the production of sheep is an important way of improving the living standard for both the rural and urban populace which will go a long way towards improving the economy of the country.

There are many reasons why more effort and funds should be directed towards improving sheep production. Unlike cattle, sheep and goats are closely associated with rural family units and form part of livelihood of the peasant and subsistent agriculturalists in many less developed countries of Africa (Adu and Ngere, 1980). Small ruminants also have higher fecundity, a shorter gestation period and faster growth rate requiring less maintenance and space than cattle (Ngosle, 1989).

Sheep is an important animal in the agricultural life of the rural people in Nigeria. They play an important role in the livestock enterprise in both temperate and tropical regions of the world. In Africa, the system of management is essentially traditional. Peasant farmers who keep them mainly as a source of manure to improve crop yield, own most of the sheep. They constitute an assurance for the farmer against crop failure (Ngosle, 1989). In addition, their small size, early maturity and short reproductive cycles make them especially suitable for farmers with relatively small capital.

Small ruminants have other qualities, which render them more attractive to the small producer. They have a low input requirement in terms of concentrate; they have low investment costs, dry season feeding, veterinary service cost and housing as compared to cattle. Small ruminant's increase in the level of input could theoretically improve production and increase supply of meat (ILCA, 1984).

The major breed of sheep in Nigeria is the Yankasa, which are kept predominantly by Fulani pastoralists who manage them fairly extensively (ILCA, 1984). Sheep play an important role in the economy and culture of Nigeria as a whole. They play a major role in religious festivals being the favorite animal for slaughter. In addition, sheep serve as a good source of periodic income and play a role in dowry payment in some communities. To the small-scale farmer, they are a source of livelihood investment, security and insurance against crop failure. Sheep are looked upon as liquid asset and for immediate sale in case of disaster. More wealthy farmers keep sheep as a way of accumulating wealth (Ngosle, 1989).

In the past, sheep were maintained in the tropical regions of Africa and Asia mainly for the production of meat. Other secondary purpose, were the production of wool, hair, skin, milk and manure (Williamson and Payne, 1978). Sheep are also a source of foreign exchange earning. The relative importance of the primary and by-products varies in different areas of the world. Economic conditions, social customs and trading conditions are among the factors that account for the wide variation in the relative importance of the products (Owen, 1976).

2.3.3 Primary products

Sheep are found extensively throughout the world from arid desert to the region of the northern and southern poles. It is multipurpose specie providing a diversity of product from a wide range of environment. In global terms, sheep farming is predominantly aimed at wool production particularly in the southern hemisphere. However, meat production is the major product in Africa and Europe

Meat (mutton)

Adu and Ngere (1979) reported that 11% of the meat supplied from slaughterhouses in Nigeria came from sheep. ILCA (1984) reported that in Nigeria, small ruminants contribute an estimated 39% to the total meat supply. The importance of this source would be greater if rural unregistered slaughters are taken into account. Despite the significance of sheep as a source of food, raw materials for industries and foreign exchange, there has been little attention paid to their improvement through research until recently.

Milk production

The large quantities of milk produced in Africa and Asia are mainly for home consumption and it is only in the Mediterranean area that milk is regarded as a major product of ewes. The largest share of this milk is used for manufacturing cheese and soft cream (Croston and Pollot, 1985).

The main differences in lamb growth arising from lactations are due to differences in the yield of milk by the ewe in early lactation and this affects several aspects of the composition of the ewe's milk. The first secretion or colostrum differs markedly from the milk produced after the first few days although changes in composition continue during the course of lactation in common with many other characteristics. Milk yield increases with age, up to 5-6 years and then declines. Lactation performance improves rapidly in the first two to three lactations depending on whether the ewe is mated to a ram at one or at 2 years of age. Milk quality also changes with age and the evidence from dairy ewes showed that milk quality particularly the content of fat and protein was more in the second than the first lactation (Owen, 1976).

2.3.4 Sheep by-products

Sheep skin

Skin from lambs provides a valuable product and feature significantly in world trade (Croston and Pollot, 1985). Processing, without removal of the wool gives a dressed skin suitable for manufacture into clothing and rugs while wool removal and subsequent tanning provides valuable leather (Croston and Pollot, 1985).

Skins coming from haired or only lightly woolen animals are much thicker than those from temperate type fine-woolen breeds. In particular, the skin of the larger breeds of sheep raised by pastoralists in low-rainfall areas are sought after for use as glove leather and in the manufacture of handbags. Sheep skins have many other local uses as

containers for water, milk and other liquids as well as for making beddings (Devendra and Mclerory, 1982).

2.3.5 Secondary products manure

The integration of an ewe flock into an intensive farm structure provides a high level of soil fertility and this is considered by many to out weigh the major products of meat or wool (Croston and Pollot, 1985).

Hair and wool

Most indigenous tropical sheep possess a completely hairy coat; others have a hair/wool coat possessing few of the desirable characteristics. A limited amount of hair-wool is collected and processed locally into natural coloured rugs, floor mats, bags and various other items for home use or for sale or barter to other near-by people lacking the processing skill (Devendra and Mclerory, 1982).

2.4 SHEEP PRODUCTION IN NIGERIA

The productivity of ruminants in the tropics is inherently low. The level of performance, which is associated with poor nutritional management, diseases and inadequate exploitation of the attributes of the individual species, are such that its potential productivity is often never realized. Livestock production in Nigeria is an expensive venture due largely to the high cost of feeds, which are mostly formulated using expensive ingredients which could also be utilized for human consumption. Where the

duration of the rainy season is only about 5-6 months as in large areas of Africa, the decline in availability of feed due to seasonal rainfall, coupled with land shortages and existing agricultural practices make livestock feeding an acute problem.. Adnan (1985) also refers to the most significant limiting factors in livestock production.It is settling the traditional rearer as that of feed supply during the dry season as well as the acquisition of sufficient land to set up such ventures.

Good feeding is important during pregnancy or at least during the latter half. After such treatment, ewes produce strong lambs and more milk (Williamson and Payne, 1978). Feeds, disease and housing problems totaled 54% of responses when farmers were asked about difficulties encountered when keeping livestock (ILCA, 1998). Lack of veterinary care, crop destruction and theft were the next most frequently cited problem. There are varieties between climatic zones in the types of problems cited. Feed was apparently a less serious problem in humid climatic zone than in the drier zones (ILCA, 1998).

According to Devendra and Mclerory (1982), in the more humid areas, the sheep industry is characterized by smallholder farmers or landless peasant who raised sheep in association with agriculture. During the relatively long rainy season and time of lush crops, grazing is usually restricted in order to protect crops from being eaten up. Feeding conditions are at their best during early and mid-dry seasons when sheep have free access to farm residues and marginal grazing land. Bridging the feed gap depends on feed preservation, effective use of various by-products and production of forages.

Unfortunately increasing population pressure is dictating cropping of suitable land and with improved pastures or forage crops.

Sheep production is either of a scavenging nature or pursued as a way of life on a subsistence basis. The system is rather self-limiting since total animal numbers cannot be significantly increased under existing management practices and socio-economic condition. The industry needs to become more commercially oriented with production inputs designed to improve feed supplies. The solution to the problem of feed supplies will depend on the production system and the ecological zone (Devendra and Mclerory, 1982). The extensive production systems common to the arid tropics require some degree of transhumance or migration to carry animals through the long dry season of 7-10 months. Livestock feed may be defined as any substance that nourishes the animal's body for maintenance, production and reproduction (Devendra and Mclerory, 1982). The most complex and limiting production factors for tropical and semi-tropical sheep are those concerning nutrition and feed supplies. The traditional concept that natural pastures is free and of no value and can therefore be put to grazing at a no production cost, with all returns being net profit is erroneous and contributes to these problems of production. In addition, most land is government-owned but communally utilized.

Sheep are superior to cattle in utilizing grasses and other forages and can obtain 80 – 90% of their yearly nutrients from forages alone (McDonald *et. al.,* 1972). For this reason, they should be limited in the amount of cereal grains and other concentrates consumed.

Mature sheep have a low glucose tolerance. Their blood contains only 40 – 50 mg/litre of glucose (McDonald *et. al.,* 1972). They also prefer to graze in the early morning and late evening. They consume the shorter grasses, so pasture with more than 6 – 8 inches of growth are unpalatable to them.

The essential nutrients are protein, carbohydrates, fats, minerals and vitamins. Water is also an essential nutrient. In the more arid tropics and dry season in general, water is often a factor in sheep production.

2.5 SHEEP NUTRITION

Apart from being adequate in amount and composition to meet requirements for protein and energy, feed for sheep must also satisfy a set of interrelated behavioural and physiological factors (Adams and Mckinley,1995). Ruminants have cyclical activities which are geared to demands for water and food and the repose necessary for the processes of rumination and digestion. Sheep apply an impressive array of behavioural adaptations to their herbivorous mode of life. For example, their exploration of feed and their learned innate preferences and selectivity are being investigated only now but should be borne in mind in the laboratory environment (Adams and Mckinley,1995).

Sheep possess a complex digestive system to deal with their mixed diet of digestible plant components and relatively indigestible cellulose. Feed takes 25-35 hours to pass through the gut and is exposed to microbial fermentation in the rumen during this time, which provides micro-organisms and the products of cellulose breakdown for digestion. Sieving

processes are involved, with large particles being regurgitated for re-mastication by the process of ruminating (or 'chewing the curd') and smaller particles of less than one to two mm passing into the stomach. Sheep ruminate for six to seven hours per day and this readily observable activity is a guide to health and wellbeing. Side benefits of ruminal fermentation include accessory food factors such as water soluble vitamins and protein elaborated by microbes from simple nitrogen compound (Adams and Mckinley, 1995).

According to Robbison, (2002) the nature of sheep production system is such that it is difficult to achieve the desired degree of precision in the animal's nutrient supply. Nutrient recommendations therefore merely provide guidelines for the development of improved feeding strategies. It is thus more important to ensure that requirements are based on a sound understanding of the animal's physiology and how this influences net nutrient requirements and the absorption and utilization of nutrients, than the arrival at a value for the requirement that is too precise to be of practical use. A good example of a 'too precise to be practical' recommendation for nutrients was the ARC (1965), available protein system, abandoned utilization, and in so doing, has had a major impact on improving feeding strategies for sheep.

2.5.1 Protein Requirement

AFRC (1993) assumes that dietary MP is used with 100% efficiency in meeting basal endogenous nitrogen requirements, thus understanding MP requirement in animals held at maintenance by ~20%. This has practical implications for the formation of re-alimentation diets for growing lambs and early/mid gestation of ewes kept at, or slightly

below maintenance. It may also be important in maintaining the animal's contemporary and subsequent immune function.

Understandably in view of their novelty, none of the current recommendations for protein takes into consideration the recent observations that MP intakes during late pregnancy which are in excess of current recommendations are highly effective in the development of immunity to gastro-intestinal nematodes (Donaldson *et al*., 2001). They estimate that current MP recommendations would have to be increased by 20% in twin-bearing ewes during late pregnancy for the acquisition of maximum immunity. On the basis of theoretical calculations involving information on the differences between infected and non-infected animals in circulating lymphocytes, immunoglobulin, mucosal mast cells, mast cell proteases and plasma loss, Houndijk *et al.,* (2001) estimated that the additional MP requirements are 5% but conceded that they could be as high as 10%. Estimates of the demands for other nutrients to mount an immune response to gastro-intestinal parasites during late pregnancy are not available, although it is generally accepted that nematode infections increase the dietary requirements for many micronutrients (reviewed by Lee *et al.,* 2002).

Younger growing animals have a higher protein requirement than more mature animals hence a finishing diet for weaned prime lambs should contain between 14.0 – 16.0 percent crude proteins (Kirby, 2003)re should be a minimum amount of protein or nitrogen in the diet to enable the animal to replace losses due to damage to muscle tissues, hoofs, horns, hair and skin. Moreover, according to Dyer and Hafez (1969), the subjection of animal tissue to constant wear and tear requires constant replacement. Due

to geo-climatological variations, Nigerian breeds of ruminants have maintenance requirement different from those of their temperate counterparts (Oyenuga, 1958).

About one-half of the dietary intake is required for maintenance, which gives the sheep a low productive efficiency. This is adequate when animals must be carried for extended periods to reach market weight or when non-breeding, non-woolen ewes remain in the flock for a year or more. The digestible protein content of the feed should range from 9-15% with the lower rate suitable for maintenance of adults and the higher for moderate to optimal supplies of protein for pregnant and lactating ewes or young animals.

Sheep production can be assessed by an increase in number, body size and weight and increase in milk and wool production (Osuhor, 1988). With respect to weaner lambs, the initial emphasis is on increase in body weight and size. Size is important where eye judgment is the major criterion for market price as it is the case in most local markets. In Nigeria, protein requirement for maintenance is the protein required in the diet which will give the maximum and the most efficient protein retention (Church, 1971). The protein requirement for maintenance for tropical ruminants also differs from the temperate breeds Ademosun e*t al.,* (1975) stated that the Nigerian breed of ruminants have low protein requirement for production compared with the temperate breeds and the efficiency of production per unit dry matter consumed is low. Adu and Brinckman (1981) working with Uda and Yankasa breeds reported that a daily crude protein intake of 11.5g $W^{0.75}$ kg was sufficient to fatten the animals. Uda was superior to Yankasa. Uda gained weight faster than Yankasa under identical rations. At 3.0 Mcal ME and 8.0-10.0 per cent crude

protein, Osuhor (1988) discovered that there was no significant difference in live weight gains. He reported that the rations were adequate to maintain the animals in good condition but not enough for production.

2.5.2 Energy Requirement of Ruminants

Energy is necessary to maintain body temperature, drive essential body processes, fuel physical activity and promote growth, (Kirby, 2003). Energy for maintenance is defined as amount of energy required to keep an animal in a state of energy equilibrium (Maynard and Loosli, 1973). Energy for maintenance is used to support the functions of lungs, heart, intestine and also help in maintaining body temperature. Maintenance requirement depends on age and body size of animals. Blaxter *et. al.,* (1961) stated that the maintenance requirement of adult animals is usually considered to be a function of body size ("W" or metabolic body size $W^{0.75\ kg}$). One of the procedures involved in assessment of the amount of feed required to obtain constant weight of animal is by feeding trial (Osuhor, 1988).

For animals to effectively utilize protein, sufficient energy must be provided. When the energy is low, animals tend to metabolize their protein and fat to meet their energy requirement (Maynard and Loosli, 1973) and this can lead to loss of condition and decrease in body immunity.

For a 20kg lamb growing at 200g/day, the ME requirements is 25% higher in the Australian (SCA, 1990) feeding standards than in AFRC (1993) and NRC (1985). This

reflects the higher fasting metabolism and higher net energy value for gain used by the Australians. For pregnancy and lactation, the only major difference between the Australian and UK standards is a higher maintenance value in the Australian system. For each physiological state (maintenance, growth and lactation) both systems use the same relationships between efficiency of ME utilization and the ME concentration of the diet but neither allows for the effects of dietary ME concentration on the efficiency of ME utilization for conceptus growth (Robinson et al 1981; Hutchings, 1997). For prolific ewes this has a significant effect on ME requirements, there is also lack of clarity in AFRC (1993) regarding what value (pregnant or non-pregnant) to use for body weight when calculating the maintenance energy component in the factorial method used to estimate the total energy requirements of pregnant ewes.

2.5.3 Minerals and Vitamins

The essential minerals and vitamins generally occur in sufficient amounts in green feed, while some supplements may be necessary when the feed 'hays off'. Production targets (i.e. desired carcass weight and time of marketing) will influence the nutrient requirements and feeding strategies used (Kirby, 2003).

A large increase in the assumed values for Ca and P availability by ARC (1980) has led to a major reduction in recommended dietary amounts. Tests by Wan Zahari *et al*., (1990) indicate that the new 'low' levels for Ca and P are more than adequate for growing lambs and, in the case of P, appears satisfactory for pregnant and lactating ewes (Perkins *et al.,*

1998). Although hypocalcaemia during late pregnancy in ewes is still a practical problem all the evidences indicate that it is the result of too high an intake of calcium followed by a sudden deficit and, as a result of the initial high intake of Ca, an associated delay in the initiation of the endocrine changes (parathyroid hormone, PTH) that promote Ca absorption, rather than an inadequate Ca intake *per se.* The recent evidences presented by Sykes and Russel (2000) of an intermediate optimum concentration of plasma magnesium (~0.9mM) for stimulating the activities of 1, 25-dihydroxy-cholecalciferol and PTH), thereby stimulating calcium absorption, merits further investigation.

Hypomagnesaemia is also practical problem which in many cases is triggered by dietary factors (high K and CP) that reduce absorption. Its prevention is matter of applying existing knowledge of requirements.

For many of the trace elements and vitamins, the critical factor is availability, which for example, in the case of copper can result in a four-fold difference in the ability of feeds to provide absorbable copper (Underwood and Suttle, 2000), depending on the concentrations of other mineral elements. Coupled with breed differences in copper requirements, copper toxicity and deficiency still result in significant losses to the industry yet these losses are avoidable with existing knowledge on availability and requirements.

In the case of selenium, little is known about its dietary availability and whether its shared absorption pathway with molybdate and sulphate make these anions absorptive antagonists (Underwood and Suttle, 2000). Cobalt is another element in which the

availability of its functional entity, vitamin B12, may be impaired by the formation of analogues that disrupt the vitamin's biological activity (Price, personal communications) leading to high concentrations of branched-chain fatty acids and soft fat in concentrate-fed lambs.

The necessity for the addition of minerals to ration is determined by the character of the feed and water consumed. Special demands for certain mineral may arise as a result of function or activity especially with reference to growth, pregnancy and lactation. Minerals needed in relatively large amounts include Na, Ca, P, K, S and Mg. A simple mixture of 2 parts ground limestone or seashell and 1 part steamed bone meal when fed free choice will usually meet all requirements for these minerals i.e. 2-3 % of ration (Greg, 2007)

Minerals required in minute amounts include Fe, Cu^{2+} , Co, Mn, Mo, Se and Fl. Most salt blocks contain the trace minerals. It is expected that grazing animals in the region of saline and low calcerous salt shall receive an adequate supply of salt and Ca^{2+} but P is usually low in most deserts. In general, mineral deficiencies tend to be localized in nature, due to the soils producing the forage lacking these minerals in a given area.

2.5.4 Water

Water is an essential nutrient for all animals. It is important for both animal welfare and business profitability that sheep and cattle have an adequate supply of good quality water. Amount and quality of water required vary between species of livestock, between classes

of stock within the species, and in response to the environment in which the stock are running (Greg, , 2007).

The suitability of water for stock use is determined by the following factors;

- water quality, which includes salinity, acidity, toxic elements and compounds, and algae growth;
- environmental factors such as air, temperature and feed quality;
- animal factors, which include breed differences and age and condition of stock.

Water quality

Quality of water is broadly defined as its fitness for consumption by livestock to maintain satisfactory production. The principal factors affecting water quality are as follows;

Salinity

The main factor which determines the suitability of water for stock is the proportion of dissolved salts in the water. Dissolved salts in water are expressed in milligrams per litre (equivalent to parts per million –ppm) or in terms of the electrical conductivity of the water, measured in decisiements per metre (dS/m) or microsiements per centimeter (uS/cm). Generally, surface waters are low in salts compared with artesian or underground water. Many factors influence the concentration of salts that animals can tolerate in their drinking water. Salinity increases the intake of water by animals, partly through the taste and partly to allow greater water turnover so that the body can regulate the salt balance (Greg , 2007).

Acidity or alkalinity (pH)

Water with a pH value below 6.5 (acid) or above 8.5 (alkaline) can cause digestive upsets in stock, resulting in rejection of the water, depressed appetite and consequent loss of production. If this problem is present, animals may perish, even when they apparently have adequate water. Adding alum can correct high pH, but this should be undertaken with care as alum is highly acidic. Likewise, water with a pH below 6.5 can be treated by adding lime (Greg, 2007).

Toxic elements and compounds

Water is a potential source of important minerals and other compounds. However, the concentration of these substances can reach toxic levels particularly in underground water.

There are a number of elements which, if presenting high enough concentrations, can lower livestock productivity. These include iron, magnesium, arsenic, lead, mercury, selenium and the fluorides. Where productivity losses are suspected, the problem can be investigated by a veterinarian or livestock adviser. Such an investigation would include a detailed water analysis, combined with an examination of affected stock. (Greg, 2007).

Algae growth or bloom

Algae occur naturally in both fresh and brackish waters. They respond to sunlight and fertilizers, and when environmental conditions are right, algal growth may occur that can make water unpalatable to stock. Algal blooms are excessive growth of particular algal

species. Blooms are most likely to occur when the water is still, warm and contains high nutrient levels. All algal blooms can cause water use problems. However, of most concern are those caused by blue-green algae, as a number of these are toxic (Greg, 2007)

Coptrol Aquatic Algicide, Cupricide Algicide and Cupricide 110 Algicide are approved for the control of blue-green algae and some other algae types. They must be used in strict accordance with their label conditions and directions. These products are registered for use in systems. They must not be used in rivers, streams, creeks, wetlands, lakes or billabongs, and water treated with these products must not be allowed to spill into these water bodies.

Watering Points

The consumption of water can be affected by the cleanliness of the watering point. Where the water level in an earth tank is low, animals may be forced to wade through mud to get to the water. Due to the boggy surroundings, the water becomes heavily contaminated with suspended soil and faeces, which can make stock reject the water. Also, animals in weak condition may become bogged and die.

Feral pigs can create the same effect by wallowing along the water's edge. Such dams should be fenced off and the water pumped or gravitated to temporary troughing. This will ensure maximum use of the available water by avoiding fouling, and will remove the risk of stock losses from bogging.

Troughs used in watering systems should be drained and cleaned regularly. Algae grow in troughs, producing unpleasant odours in the water which can repel stock. Salinity also builds up due to evaporation if troughs are not drained. The frequency of cleaning depends mainly on the temperature, which affects intake and the rates of evaporation and algae growth. The type of stock will also have some influence on the frequency of cleaning, as tolerance of contamination varies according to the requirements of the particular class of stock. Contamination of trough water need only be very slight to cause problems with some stock. Instances have been recorded of weaner sheep refusing water because of a thin layer of dust on the surface of an otherwise clean trough.

Care should be taken when introducing stock to extensive paddocks or unfamiliar watering systems. When introducing stock to a new paddock, make sure they are familiar with the location of the watering point and are drinking the water, particularly in pastoral areas. If water quality is marginal or unknown, check newly introduced stock during the first week to ensure that there is no problem. (Greg, 2007).

Watering Radius

In pastoral areas, sheep normally graze within a radius of about 2.5km of a watering point, and cattle within a radius of about 5km.If stock requires more water due to lactation, salinity or dry feed, they may need to drink more than once a day. This will reduce their foraging radius and the area of the paddock being used. (Greg, 2007

2.5.5 Environmental Factors

Temperature

In hot weather, animals use more water for evaporative cooling. For example, shearing increases the heat load on sheep in summer because the insulation formerly provided by the fleece is lost. The sheep adjust to this heat load by increasing evaporative cooling through panting. Water consumption can increase by 78 percent under extreme conditions. The provision of shade will largely relieve this situation. In normal conditions with good quality water, consumption in summer will be about 40 percent higher than in winter. However, with salty water, the summer intake may be 50 to 80 percent higher than consumption in the cooler months (Greg 2007)

The amount of water that stock drinks also depends on the temperature of the water. Generally, animals prefer water at or below body temperature and avoid warmer water. Cool water is preferred in hot conditions.

Marginal quality water may become unsatisfactory during summer because animals drink more because of high temperatures and drier pasture. The salinity of some water may also increase because of evaporation from troughs, bore drains and shallow tanks (Greg, 2007).

Drought

During drought, stocks require more water as they are forced to select more fibrous and less digestible feed. This extra water is used to maintain the movement of the coarse feed

in the gut. As drought worsens and stocks become weaker, marginal waters may become unsuitable as the animals' tolerance of the salt decreases. Feeding salt or salt-based licks or blocks during dry period increases water intake. If water quality is marginal, this added salt intake may depress appetite and cause digestive upsets, the opposite of the supplement's purpose (Greg, 2007).

Pasture composition

The diet of stock has a large influence on their water requirement. Good green pasture can supply all of an animal's water need. Sheep under these conditions may not need to drink for many weeks. Good pasture allows stock to use water which would normally be unsuitable at higher levels of consumption (Greg, 2007).

Stock on dry pasture need increased water consumption to utilize the less digestible fodder. In pastoral areas, stock grazing saltbush or other chenopod plants require large quantities of relatively low-salinity water. This is because of the high level of salt in the diet and the need for a high water turnover to maintain the salt balance in the body

2.5.6 Animal factors

Age and condition of stock

Young animals, heavily pregnant or lactating females and aged or weak stock are less tolerant of saline water. In weaner sheep, high salinity depresses growth rate, wool production and causes scouring (Greg, 2007).

Breed Differences

British breed sheep need about 20 percent more water than do Merino sheep in hot weather. Cattle of the *Bos indicus* or *Bos indicus-infused* breeds drink more water under hot conditions than do *Bos taurus* breeds (British or European breeds).

2.6 FEEDING SHEEP

Feeding sheep adequately entails meeting its nutrient requirements. The basal feeding comprises mainly roughages but often times do not meet the basic requirements for maintenance and production. This warrants supplementation with forage legumes or/and concentrate.

2.6.1 Concentrates

Supplements are defined as special concentrated feeds that are fed to supply nutrients, which are deficient in ration i.e. to balance the ration for essential nutrients. Among the more relevant supplements most often needed in the tropics are salt and minerals such as calcium, phosphorus and protein from by-product feeds e.g. oil cakes and cereal milling residue. Molasses is available in many tropical countries and can be used to increase palatability in low quality ration. Molasses is also a perfect 'carrier' of non-protein nitrogen substance such as urea. Included in this category of feed are the cereal grain, numerous other seed oil cakes and meals as well as agro-industrial by-products. Concentrates are expensive, highly digestible, possess low fiber content and are rich in protein.

On the basis of protein content, concentrates may be further divided into carbonaceous feed such as cereal grains with relatively low protein content and nitrogenous feed that are rich in protein such as the various oil seed cakes and animal by-products (Devendra and Mclerory, 1982).

2.6.2 Forages or Roughages

These include pastures, both native and improved, hay, straw, silage, roots, herbs, bushes, trees and a number of by-product materials used as feed, relatively low in protein and fat but tend to be high in fiber and are usually of low digestibility. They are especially suitable for ruminant feeding and provide sheep with the nutrient required.

The most common sheep feed throughout the world is grass and grass like species which are either grazed or fed as cut and conserved products. The digestive tract of the sheep can utilize a wide range of feeds such as: cereals, forages, crops and low quality roughages. This is one reason why sheep are found in such a wide range of environment. However, it is the ability to utilize the poorer quality feed stuff, which has led to the importance of sheep in world agriculture. The feeding of cereal and other high quality feed is an uneconomic proposition and in many cases leads to competition with single-stomached animals including humans for feed resources.

Fresh forage is often the sole diet of ruminants in the humid tropics. Digestible organic matter intake from tropical grass forage is the main factor of variation of their nutritive value (Aumomt, *et. al.,* 1995). Intake and digestibility of tropical grass are relatively low

at early stages of growth (28 days) compared to temperate grass (Minson, 1990). This is due to differences in grass physiology with an early maturity for tropical grasses (Wilson, 1994). Consequently, compared to temperate areas, low animal performance is observed when ruminants are fed relatively young (28 days) tropical forages grasses (Humphrey, 1991).

Naturally grown grasses available in fallow land, playgrounds and waysides are the main source of green forages for most ruminants. Most of the farmers are small landholders and landless sharecroppers and it is not possible for them to earmark any land exclusively for fodder cultivation. Therefore, any attempt to improve qualitative and quantitative availability of natural pasture has to be based on existing resources for improving forage and livestock productivity. There is a variation in the nutritional quality of grass at different times of the year .In the majority of the studies, type of grass species, stage of maturity, method of cultivation and time of harvesting have not been reported which make the comparism difficult since it is assumed that the yield as well as quality of native grasses might be influenced by season (Castellanos, *et. al.,* 1990). A negative correlation has also been observed between daily temperature and dry matter digestibility of grasses (Minson and Mcleod, 1970).

Intake and digestibility of tropical grasses are relatively low in comparison to temperate grasses, hence low animal performance are observed when ruminants are fed exclusively on forage (Achimede *et. al*., 2002).

2.6.3 Feed Intake

Although feed intake can be controlled at the metabolic level in ruminants, the signals are likely to be different from those in monogastric animals. Ruminants are adapted to the utilization of "bulky" food but may nevertheless have difficulty in processing such food (Wilson, 1961). It has long been recognized that in ruminants there is a possible relationship between digestibility of food and intake. This has shown that intake is actually more closely related to the rate of digestion of diet than digestibility *per se*, although the latter measures are generally related to one another. In other words, food that is digested rapidly is also of high digestibility. The more rapidly the digestive tract is emptied, the more space made available for the next meal (Blaxter *et. al.,* 1961).

Tait (1972) showed that with increase intake of dry grass ration by lambs there was a significant effect of level of feed intake on protein digestibility. Osuhor (1988) reported that the presence of adequate amount of feed is not enough reason to suggest that an animal will maximally consume the feed, digest it and utilize it efficiently for maintenance as well as productive purposes. There are factors which influence intake, digestibility and utilization.

Adu (1975) noted that feed intake by ruminants was controlled by the animal's dietary and environmental factors. Weston (1966) reported that feed intake was greatly influenced by the environment and physiological status of the animal but Owen (1976) asserted that feed intake by sheep was controlled by physiological and physical factors.

According to Cornard (1966) feed intake was attributed to intrinsic and extrinsic factors. The intrinsic factors are those factors inherent within the feed, which determine the voluntary intake when fed *ad libitum*. The extrinsic factors being those dependent on the method of feed preparation, preservation and environment.

2.6.4 Animal Factor

If the capacity of the rumen is a critical factor in determining the food intake of ruminants, the circumstances that change the relationship between size of rumen and the size of the whole animal are likely to affect feed intake. Dulphy, *et al (1980)* reported that as ruminants of a given species grow, their food intake follows approximately the proportionality of metabolic body weight. However, cattle have a greater intake per unit of body weight than sheep

The presence of adequate amount of feed is not enough. It has been suggested that an animal will maximally consume the feed, digest it and utilize it efficiently for maintenance as well as production purposes. There are various interconnected factors which influence feed intake, digestibility and utilization.

Breed, metabolic size and physiological status of animals are some of the animal factors that influence feed intake, digestibility and utilization. Rogers (1970) reported that the higher protein requirement of the exotic temperate animal was due to breed difference.

Generally, grinding, flaking and chopping may be expected to increase intake, digestibility and utilization of feeds. Oyenuga, (1958) reported that supplementing the diets of the indigenous ruminant with well processed concentrate result in increased feed intake.

2.6.5 Digestibility

McDonald *et. al.,* (1973) stated that the digestibility of a feed or forage constituent is the difference between intake and faecal output of the constituent expressed as a percentage of intake. Minson and Mcleod (1970) have shown that in general, tropical grasses are on average 13% less digestible than temperate grasses. The low digestibility of most tropical grasses limits their voluntary intake by ruminants and reduces animal productivity (Hodgson *et. al.,* 1972; Stobbs, 1975a, 1975b).

Studies with ruminants grazed on pastures have shown that the level of animal production is proportional to both intake and digestibility of the herbage on offer (Holmes, 1966; Balch and Campling, 1969). That is to say, animal production from pastures depends on both the quality of herbage eaten and its digestibility. The chemical component that determines rate of digestion is neutral detergent fibre (NDF), which is itself the measure of cell wall content. Thus, there is a negative relationship between NDF content and the rate at which they are digested (Blaxter, 1961).

Digestibility of any of these constituents can be readily determined with high degree of accuracy (Raymond, 1964). With the application of high technology to ruminant nutrition, the digestibility of virtually all constituent that makes up herbage can be easily determined. The more conventional laboratory methods used on dry forage digestibility have been listed by Tsutsumi and Abe (1977).

2.6.6 Quality of Feeds

Quality of feed as a factor affecting voluntary intake has since been recognized. Grass silage for example as a sole ration is inadequate for fattening lamb because voluntary intake is usually low(Sheehan and Fitzgerald, 1977) . Hawkins et al (1971) in a study with legumes silage observed a high intake value in relation to their digestibility. Intake was also increased considerably by wilting (Hawkins, *et al.,* 1970).

2.6.7 Weight Gain and Supplementation

Levy (1974) has also shown that increasing the quantity of concentrate significantly increased the body weight gain of British Friesian calves with all types of roughages but the mean body weight gain was generally greater where the roughage was of a high digestibility.

Adu and Brickman (1981) working with six levels of concentrate to roughage rations in Yankasa rams obtained the highest daily weight gain of 150g on the treatment with 47:53 concentrate to roughage ratio which was significantly different from all other treatments. Fattening of sheep on high quality roughages has been advocated (Brickman, 1974). Playne and Haydock (1972) stated that cattle digest feed with less than 55% dry matter digestibility better than sheep. It has also been reported (Oyenuga, 1957) that tropical pastures are known for rapid decline in nutritional quality with increased fibre and decrease crude protein resulting in decreased digestibility and the need for concentrate supplementation. Levy, *et. al.,* (1975) in an experiment with Israeli Friesian bulls

reported that animals fed 15% hay in the diet gained significantly faster than those fed 35% hay.

Crabtree and Williams (1971) and Marsh (1975) demonstrated positive relationship between initial body weight and voluntary intake and between intake and weight gain. McCullough (1974) also reported increase in weight gain from a lighter to heavier stage of growth. It was also reported that bulls that were initially heavier made significantly faster gains and took less time than lighter bulls to reach market weight (Gaili, 1979).

The range of temperature may vary from 30^0C in the temperate to less than 10^0C during winter in Scotland and Wales. The average body temperature of sheep is 39^0C $\pm$ 1.5^0C (Grell, 1977). Day length, temperature and humidity generally affect ruminant performance. The temperature effects however are more important in the temperate. Forbes, et. al., (1979) showed that lambs kept in 16 hours light per day grew significantly faster than those on short day length.

The feeding level has influence on weight gain. *Ad libitum* feeding resulted in much fatter carcasses that restricted feeding. The stimulated growth and gut fill as a result of long day length was attributed to some central control mechanism and not merely by encouraging more feeding (Forbes, *et. al.,* 1979).

Heavier animals tend to have higher weight gain than lighter animals. In an experiment conducted by Maurogenus and Louca (1979) with lambs weaned at 35 days of age, it was found that male lambs were heavier than female lambs at weaning and at 10, 15 and 20

weeks of age. Male lambs also grew at a much faster rate from weaning to 20 weeks. Similar findings have been reported for 42 days weight and for post weaning growth rate (Mavrogenis, *et. al.,* 1973).

Tait (1972) also showed the average daily weight gain of entire male lambs to be significantly greater than that of females. Growth is of greater practical importance in all classes of livestock particularly in meat producing animals such as beef cattle, swine, sheep and goat (Cole, 1966).

Animals on high concentrate (*ad lib* feeding and 85%) had higher carcass weight than those on the other treatments (Levy *et. al.,* 1974). showed that daily gain of cattle was reduced by the replacement of 2kg of concentrate by an equal weight of air-dry matter with roughages though the reduction was only significant when the replacing roughages was straw. Levy *et. al*., (1974) in a study with Israeli Friesian male cattle also showed that there was a better utilization of metabolizable energy from concentrate.

Diets containing low quality hay had a higher feed conversion ratio. An increasing level of hay in the diet significantly increased the total dry matter conversion ratio (McCullough 1970).

2.8 EXPERIMENTAL FORAGES

2.8.1 *Cynodon dactylon -C. dactylon* (Bermuda Grass, Bahamas Grass, Dhoob, Kirikiri , Devil Grass, African Couch, Star Grass)

Classification and Distribution

The currently accepted scientific name for Bermuda grass is *Cynodon dactylon* (L.) Pers (Poacease) [Gleason *et al*., 1991, Hickman et al 1993]. Two varieties are recognized [USDA, 1994] Cynodon dactylon var. dactylon (L.) Pers. & *Cynodon dactylon var. aridus* Harlan and De Wet.

Bermuda grass, native to Africa, occurs throughout the world in tropical to warm temperate climates between 45 degrees north and 45 degrees south latitude (Northham *et al.,* 1991). in the United States, Bermuda grass is most common in the subtropical regions from southern California east to the Gulf Coast and southeastern states. It is found north to Washington, Idaho, Utah, Colorado, Iowa, Michigan, New York, Massachusetts, and New Hampshire (Gleason 1991). Populations occurring in cool temperate climates may be winter hardy cultivars (Belesky *et al.,* 1991).

The genus *Cynodon* comprises of nine species and 10 varieties. *Cynodon* is a small but important genus of the tribe Chloridae, which contains some of the world's most important grasses. These warm-seasoned, sod-farming, perennial grasses are widely used in tropical and warmer temperate regions of the world for soil stabilization. The most widely distributed and best-known taxon of the genus is *Cynodon dactylon.* By virtue of its wide geographical distribution and enormous variability, the dactylon is economically the most important species of the genus (Taliaferro 1995). *C. dactylon* (poacea) is a hardy

perennial grass and is one of the most common weed in India (Sastry and Kauathekar, 1990).

Cynodon dactylon (Appendix 1) is a highly variable perennial with stems up to 120 cm tall that forms dense turf. It grows almost anywhere with more than 600mm of rainfall a year and mean daily noon temperature of 24ºC. It is found on many soils particularly where the pH is above 5.5 and fertility is moderate to high. It withstands temporary water logging and prolonged drought, but is unproductive. It responds well to fertilizers and has a variable palatability. It should not be used in temporary pastures, for it is difficult to eradicate from arable land. It tolerates saline soils and high grazing pressure.

C. dactylon belongs to the family *Poecea*. It is a much-branched glabrous perennial grass with spreading rhizomes and vigorous mat-forming stolons. The flowering stems are up to 20cm high. It reproduces from seed and vegetatively by rhizomes and stolons. It is a common weed in field crops and it is also used as lawn grass.

*Cynodon dactylon (*bermuda grass) is found throughout the tropical and sub-tropical parts of the world. Most early writers expressed the opinion that it probably originated in India (Glen, 1962). Perhaps the fact that it grows “everywhere” in India and has been used there for centuries was the basis for this assertion.

Although most of the species have remained in Africa, today, *Cynodon dactylon* is found in warm climates all over the world between 45º South and 45º North latitude. It can be found growing in pastures and under stones of open woodlands.

Harlan *et. al.,* (1970) also discussed the geographical distribution of *Cynodon arcuantus* which is distributed through South Asia, Indian and South Pacific Oceanic Islands. The distribution includes Madagascar, the Seychelles, Comoros, Ceylon, South India, lowland Nepal and East across Southeast Asia, the Philippines, Taiwan, Indonesia, Timor, Australia and other islands in the region. *C barberi* is endemic to Southern India. Plants of these two species are typically found in wet areas and in the case of *C. barberi* are sufficiently abundant to produce a turf only in much localized areas. *Cynodon dactylon* var. *dactylon* is cosmopolitan occurring almost continuously across all continents and islands between latitudes 45°N and 45°S Cold-hardy (-12 ± 3ºC) forms are also found to extend to approximately 53ºN latitude in Europe and Asia and are found at 400m elevation in the Himalayas. It is found on remote atolls and islands in the Pacific, Atlantic and Indian oceans. It is one of the most widely distributed of all plant species.

Cynodon imcompletus, C transvaalensis and *C magennisii* are endemic to South Africa. Both *Cynodon imcompletus* and *C imcompletus* var. hirsutus are distributed in South Africa from Transvaal to the Cape. The former occurs predominantly in the high veld and the latter in both the high and low veldt but generally in somewhat higher rainfall areas. The varieties are distinguished primarily on the basis of pubescence and plume size.

C. transvaalensis is endemic to the south western Transvaal, Orange Free State and the northern part of the Central Cape Province of South Africa. It is typically found in wet areas near ponds and along waterways. Bermuda grass originally came from the savanna of Africa and is the common name for all the East African species of *Cynodon* (Anon[1]2002).

Description

Bermuda grass is an introduced, perennial, mat-forming, warm season grass. It is both rhizomatous and stoloniferous. Erect or ascending culms grow 0.3 to 1.3 feet (0.1-0.4 m) tall. The panicle has seven digitate branches (Hickman *et al* 1993). Rhizomes are hard, scaly, and 0.06 to 0.13 inch (1.5-3.3 mm) in diameter. Stolons are flattened and 1.3 feet long, rooting at nodes (Hamiton *et al.,* 1960). Main root length per cultivar range from 2.3 to 37.1 feet (0.7-11.3 m) while length range from 43 to 4,854 feet 13.0-1, 480 m). Root hairs contributed 64 to 95 percent of the total root length [Green *et al* 1991]

Bermuda grass is a creeping grass that creeps along the ground and root wherever a node touches the ground. It also reproduces from root under the ground. It has a deep root system and in drought situations, the root system can grow 49 to 59 inches (120 – 150cm) deep. Most of the root mass lies under the surface. Its blades are grey-green color and are short, usually 1 – 4 inches (3 – 10 cm) long with rough edges. The erect stems can grow 0.3 to 1.3 feet (0.1 to 0.4 m) tall. The stems are slightly flattened. (Anon[1], 2002).

Several species of bermuda grass are important sod forming warm-season grasses that are widespread throughout the southern region of the USA. The initial introduction from Africa occurred in 1751 (Beard, 1973). The coarser textured common-type-bermuda grass *C. dactylon* are generally tetraploids with a few exceptions e.g. giant bermuda grass var. aridus Harlan and the lalet a diploid. Fine textured types are also well distributed throughout the southern region and represent the African bermuda grass species which have been introduced into the American south east. These includes *C. incompletes, C. hirsatus, C. bradleyi* and *C. plectostacylus* but have not gained prominence. Whereas common and African types are seeded grasses, the inter specie crosses between these two species C *dactylon* and *C. transvaaleisis* have produced a number of clonally propagated sterile triploids.

A detailed study of genetic relationship between established bermuda grass cultivars determined the level of genetic variation within and between selected species and inter specific crosses that exhibited a wide variety of leaf blade textural characteristic have been reported (Caetano-Anollés, *et. al.,* 1995).

Growth Requirement

A principal goal in pasture management is production of a reliable supply of high quality available forage throughout the growing season. Pastures in the Appalachian region are dominated by cool-season forage species, but periodic drought and elevated temperatures in midsummer often depress productivity. Warm season forages might help buffer variation in available herbage (Jung, *et. al.,* 1985; Poster, *et. al.,* 1993; George *et. al.,*

1995; Madakadze, *et. al.,* 1998) because of greater water, light and N-use efficiencies (Belesky and Feddes, 1995a.) and higher temperature optimal compared with cool season forages.

Nutritive Value

Nutritional contents (% dry matter) of Bermuda grass stems and leaves sampled from the Edwards Plateau region of Texas are presented in Table 2 (Huston, 1981):

Table 2: Nutritional contents (% dry matter) of Bermuda grass stems and leaves.

	Phosphorus	crude protein	digestible organic matter
May 24	0.22%	12%	58%
June 28	0.21%	12%	56%

Crude protein was measured for four Bermuda grass cultivars in New Mexico. Coastal Bermuda grass had the highest crude protein values: 5.5, 7.5, and 7.4 percent for July, August and October respectively (Lugg, 1983).

Bermuda grass is eaten by livestock (Stubbendieck, 1986). No information was found discussing beneficial or detrimental effects of Bermuda grass on wildlife. Bermuda grass is highly preferred and has good forage value for cattle (Stubbendieck, 1986). It is acceptable to sheep (O'reagain and Peter, 1993). Bermuda grass sampled in September in Oklahoma contained 8.1 to 10.2 percent crude protein and was 41.6 to 44.4 percent digestible (Bogle *et al.,* 1989).

Intake and or digestion of warm-season grasses such as bermuda grass are typically lower than that of cool season grasses. Thus energy and amino acid supplies are more limiting to performance of growing ruminants ingesting warm season rather than cool –season grass (Minson, 1990).

Most soils in the southwestern USA are sandy, acidic and have low nutrient-holding capacity (Ball *et. al.,* 1991). Broiler litter has been found to be a desirable alternative to commercial fertilizer.

In a review of nutrient utilization of forage crops, Robinson (1996) reported that the N, P and K uptake of coastal bermuda grass needed to reach 90% of maximum yield was 440, 48 and 300kg ha^{-1} respectively, with an approximate ratio of 9:1:6.

High temperature adversely affects forage quality by increasing plant maturity and lignification (Henderson and Robinson, 1982a). Hill, *et. al.,* (2001) concluded that reduction of Average Daily Gain (ADG) on bermuda grass pasture in the late grazing

season is related to higher energy requirements for maintenance as body weight increase over the grazing season and to lower forage quality in the late season. Lower weight gain during the summer with warm season perennial grasses has been associated with lower organic matter digestibility (Duble, *et. al.,* 1971; Pitman and Holt 1982; Henderson and Robinson 1982a). Aiken and Brown (1996) found in a 2-year-grazing experiment in west central Arkansas that *in-vitro* digestible organic matter of common bermuda grass was greater than 600g/kg organic matter (OM) by the middle of July. Hill *et. al.,* (2001) also reported that the *in-vitro* digestibility will vary among bermuda grass cultivars and is typically lower for common bermuda grass than for the hybrids. Maturity will reduce the digestibility of bermuda grass, but the decline does not appear to be directly related to increase in neutral detergent fibre (Hill, *et. al.,* 2001, Mandebvu *et al* 1998 and 1999). Mandebvu, *et. al.,* (1999) compared neutral detergent fibre and digestibility between Tifton 85'and coastal bermuda grass hays. Although Tifton 85 was 5.9% higher in neutral detergent fiber, it also had *in vivo* digestibility that were 9% higher for organic matter and 13.3% higher for neutral detergent fiber. It was concluded that the higher quality of Tifton 85 compared with the coastal hybrid was associated with Tifton 85 having lower concentration of acid insoluble lignin and ether ferulic acid.

Concentrations of moisture if greater than 200g kg^{-1} in alfalfa (*Medicago sativa*) and bermuda grass hays produce spontaneous heating, mould growth and deleterious changes in forage nutritive value (Collins *et al*, 1987; Coblentz *et al.,* 1996, 2000). Microbial activity and the subsequent production of heat reduce the nutritive value of hay. Oblentz, *et. al.,* (1997) found that microbes preferentially oxidize non-structural carbohydrates in

alfalfa hay. Robert (1995) associated the mould growth and production of associated toxins with increased spontaneous heating in hay bales during storage. Rotz and Muck (1994) indicated that increased microbial activity and their associated heating result in greater concentrations of fiber components and heat damaged N in hay.

Grain type and form affect the pattern of ruminal starch digestion, thereby influencing condition in the pH and availability of starch for microbial utilization (Orskov and Ryle, 1990), which modifies fibre digestion. Small difference in forage intake and digestion occur with low levels of supplement grains e.g. $\leq$ 0.5% BW DM; (Vanzant *et al.,* 1990:). However, effects of different grains at $\geq$ 30% of the diet may be dissimilar. Bermuda grass is generally high in NDF and low in soluble carbohydrates (Mandebuu *et al.,* 1998).

Uses of *Cynodon dactylon*

A. Feed.

Bermuda grass forms a dependable perennial base for pasture and hay production enterprises in the southeastern USA (Williams *et. al.,* (1996). Bermuda grass hay is an important feed source (Loosli *et al*, 1973) for cattle (*Bos taurus* and *B. indicus*) and horses (*Equus caballus*) in the southern USA.

B .Alternative/traditional Medicine

Although problem for farmers, dhoob grass is a valuable herbal medicinal plant and has been used as first aid for minor injuries (Oudhia, 1999a, and b).

Farmers have traditionally applied crushed leaves to minor wounds to stop bleeding similar to *Tridax procumbens*, *Achyranless aspera* and *Blumea lacera* (Oudhia and Paul, 2000). *Cynodon* has a renowned position in Indian systems of medicine and many parts of the plants are assumed to have medicinal properties. A traditional use of *Cynodon* is for treatment of eye disorders and weak vision. The affected are advised to walk barefooted on dewdrops spread over *Cynodon* plant each morning, according to Ayurveda, India's traditional pharmacopoeia. *Cynodon* plant has also been credited to be pungent, bitter fragrant eating appetizer, vulnerary anthelmintic, antipyretic, and alexiteric which is said to destroy foulness of breath. It is useful in the treatment leucoderma, bronchitis, piles, asthma, tumor and enlargement of spleen.

According to" Unani" system of medicine, *Cynodon* plant has bitter, sharp hot taste, good odor, laxative, brain and heart tonic effects. It is an aphrodisiac, alexipharmic, emetic, emmemagogue, expectorant carminatives and useful against grippe in children and for pains, inflammation and toothache (Agharkan, 1991).

Virus-affected discolored leaves of *Cynodon* have also been used for the treatment of liver complaints. In homoeopathic systems of medicine, it is used to treat all types of bleeding and pain troubles (Ghosh, 1988; Oudhia *et. al.*, 1998).

2.8.2 Digitaria smutsii

Distribution

Digitaria smutsii (D. smutsii) (Appendix 2) belongs to the family Poecea and is commonly referred to as digitaria grass or crab grass. It is however said to be native to Southern Africa (Hacker et. al., 1993).

Digitaria smutsii is indigenous to Africa and grows well in dry part of tropical and sub-tropical climates. The grass was first introduced into Nigeria from South Africa in 1956. *Digitaria* performs well in areas with annual rainfall ranging from 600-1800mm, but best rainfall optimum is 900mm/year. Well-drained sandy-1oam soil is preferable for the successful establishment of *D. smutsii*, which is by means of stem cuttings or stolons because no viable seeds are produced. *D. smutsii* is tolerant to acidic or alkaline soil and withstands limited-water logging.

The genus *Digitaria* belongs to the family Poecea and had world-wide distribution in tropical areas (Hanard 1950). It is found in area characterized by fertile soil, seasonal rainfall and generally high temperature (Osbourn, 1969). It has been introduced into tropical countries including west-African since 1953 (Nestel *et al.,* 1962). Successful introduction is due to the fact that it is easily established, it is vigorous and adaptable, it persists under intensive grazing and it is palatable to livestock (Osbourn, 1969). Its stoconiferous habits make vegetative propagation relatively easy in that both stolons and mature stems will produce. Adventitious roots in humid atmosphere and the plants cover the ground within 6-8 weeks, even when only 3 plants take root per square yard. (Ronney, 1961)

Description

Digitaria is a tropical grass. It has better growth and water use efficiency (Tow, 1993) at the higher temperature, its optimum temperature may be lower than for some other tropical grasses (Fitzpatrick and Nix, 1970). *Digitaria* spp. is being favoured by summer temperature, it requires a summer rainfall of 400-1000mm annually (Oram 1990). The botanical characteristics and chemical composition of some *Digitaria* species are shown in Tables 4 and 5.

The dry-matter digestibility (DMD) of the 25 cuts ranged from 42.0-65.9%; organic matter digestibility (OMD) from 43.5-68% and energy digestibility (ED) from 39.7-64% depending as specie and stage growth. (Minson, 1990).

The level of Neutral Detergent Solution (NDS) varied from 13.0 to 26.9% according to pasture types and stage of growth. *D setivalva* had the highest mean level of 20.5%. (Minson, 1984). Hemicellulose levels in dry matter ranged from 26.5 to 33.2% with a means of 30.1%. *D. setivalva* had the lowest (28.7%) and *D smutsii* the highest (31.1%). mean hemicellulose level.

Cellulose level in the dry matter varied from 26.3 to 35.4% with a mean of 32.4%. The digestibility of cellulose varied from 43.4 to 75.7% with a mean of 61.6%. *Digitaria setivalva* had the higher mean digestibility of 65.9% which was higher than that for other specie. Increase in maturity led to a reduction in cellulose digestibility ($P<0.05$) (Minson, 1984). The lignin content varied from 4.4-9.7% with a mean value of 6.7%. The lowest mean level was found in *D. setivalva* (6.4%) The apparent digestibility of lignin varied from 16.6– 23.4%. The ME content of *Digitaria setivalva* had a mean content of 7.8l0kg dry matter more than other specie (Minson, 1984).

Table 3: Botanical characters of the *Digitaria* specie.

Specie	Introduction	Origin	Form	Fertility	Dry matter
D. settivalva	CP128996	South Africa	Tufted Stolaniferous	fertile	64.4
D. polevansii	CPI41191	Botswana	Tufted/SNION	fertile	56.8
D. smutsii	CPI38869	South Africa	Tufted Stockuifeous	fertile	56.8
D. pentzssii	CPT18578	South Africa	SNknief	Sterile	63.4
D. decumbers	CP1 18578	South African	SNKuiferous	Sterile	63.4

Source: Minson D.J. (1984)

Table 4: Chemical Composition of Some *Digitaria Species*

Attribute	Neutral Detergent	Hemicellulose	Cellulose	Lignin Soluble
D. settivalva	53.6[a]	66.4[a]	65.9[a]	11.7[a]
D. polevansii	43.8[b]	63.6[ab]	61.2[b]	0.3[c]
D. smutsii	44.6[b]	62.7[ab]	59.0[ab]	0.6[b]
D. peitzii	43.5[b]	65.1[a]	61.2[b]	6.2[a]
D. decumbers	54.6[a]	59.6[b]	59.7[ab]	10.19[a]

[a,bc] means on the same column with different superscript are significantly ($P<0.05$) different.

Source: Minson D .J. (1984)

The voluntary intake of *Digitaria spp* declines with increasing maturity and this is common to most temperate grasses (Osborn, 1969). The voluntary intake of dry matter ranged from 38.7 to 70.0g/ kg $W^{0.75}$ d according to specie, month of cutting and stage of growth.

CHAPTER 3

MATERIALS AND METHODS

3.1 LOCATION OF EXPERIMENT

The study was carried out at the National Animal Production Research Institute (NAPRI) Shika, Zaria, Nigeria on latitude 11^{o} 12'N and longitude, 7^{o}33'E on the altitude of 610 M above sea level. Shika is within the Northern Guinea Savanna zone and has a sub-humid tropical climate with average annual rainfall of 1092 mm, which fall mainly between April and October. The mean maximum temperature ranges from 27-35^{o}C. Data on climatic variable were obtained from the Institute for Agricultural Research meteorological station, Samaru, Zaria. The climate in Shika is characterized by 4 main seasons viz.; early wet season (April-June), late wet season (July –September), early dry season (October-December) and late dry season (January – March) (Ibiloye, 1997)

3.2. EXPERIMENTAL PROCEDURES

3.2.1 Feeding trial

Twenty weaned female Yankassa lambs of an average weight of 10kg were used for this study. The animals were dewormed with levamisol (leva jet) intramuscularly at 1ml/10kg body weight at the commencement of the study. Ivax veterinary Suspension® was administered orally at 2ml/1kg, whenever indicated

The lambs were weighed and equally allotted to four treatment groups (Table 7): (Cynodon + 1% BW Conc.); B (Cynodon + 1.5% BW Conc.); C (Digitaria + 1% BW

Conc.) and D (Digitaria + 1.5 % BW Conc.) in a randomized design. The body weight was used for blocking before random allotment to treatment groups.

Each animal was put into an individual feeding pen and at 08:00 hours each day given a weighed amount of the appropriate concentrate equivalent to 1% of its body weight for treatment groups A and C and 1.5% of body weight for treatment groups B and D. They were allowed 1 hour to eat the concentrate provided and fresh drinking water was provided to them *ad-libitum*. The concentrate was a mixture of maize offal (75.2%), cotton seed cake (23.8%) common salt (0.5%) and bone meal (0.5%) (Table 5).

After one hour, *Cynodon dactylon* pasture was offered to animals on treatments A and B, while *Digitaria smutsii* was fed to sheep on treatments C and D at the rate of 6% body weight. The leftovers of both the concentrate and the pastures were weighed the following morning to determine the daily intake of the animals. The animals were weighed regularly on a weekly basis before feeding to determine body weight changes in the course of the experiment. The feeding trial lasted 180 days to monitor the growth of the lambs.

Table 5: Ingredient composition of the concentrate.

Ingredient/nutrient	Composition (%)
Maize offal	75.2
Cotton seed cake	23.8
Common salt	0.5
Bone meal	0.5

Table 6: *T*reatment groupings for feeding trials.

Group	Forage offered (6%)	% Concentrate offered
A	*C. dactylon*	1.0%
B	*C. dactylon*	1.5%
C	*D. smutsii*	1.0%
D	*D. smutsii*	1.5%

3.2.2 Digestibility Trial

Two animals from each treatment were weighed on the first day of the digestibility trial and placed in individual metabolism crates . They were fed their respective rations for the first 14 days adjustment period. During the subsequent 7 days, feed and water offered, feed refusal, fecal output and urine output collected in 5 ml 0.1M H_2SO_4 were measured.

Samples of the feed, urine and feces were taken for laboratory analysis to determine their proximate compositions (AOAC, 1984). Neutral Detergent Fiber (NDF) and acid detergent fiber (ADF) were determined by the method of Van Soest (1965).

3.2.3 Blood Collection and Analysis

Blood samples (5mls) from individual animals were collected from the jugular vein at the commencement of the study to determine baseline values of the serum protein as well as at the end of the study. The determination of serum protein was undertaken in the Clinical Chemistry Laboratory of the Ahmadu Bello University Teaching Hospital, Zaria.

3.2.4 Computation, Presentation and Analysis of Result

The data collected were analyzed using GLM of SAS package (1987) to determine treatment mean values, which were compared using Schaffer test for significance.

CHAPTER 4

RESULTS

4.1 FEED COMPOSITION

4.1.1 Composition of the Diets

The chemical composition of the concentrate , *Digitaria* and *Cynodon* is presented in Table 7 .The crude protein, ash and ether extract in Digitaria were marginally higher than Those of Cynodon Spp.However , the neutral detergent fibre and acid detergent fibre were marginally higher in Cynodon compared to those in Digitaria

4.2.1 FEED INTAKE, WEIGHT CHANGE, FEED CONVERSION EFFECIENCY AND DIGESTIBILITY.

Table 8 shows the feed intake, weight changes and feed conversion efficiency while the digestibility of the feeds is given in table 9. It was observed that the intake was slightly higher in Digitaria but not significantly different ($P>0.05$) from Cynodon.

The intake of concentrate was higher ($P < 0.05$) in treatments with supplementation at 1.5% BW than in supplementation at 1.0% BW. It was observed that the higher the level of supplementation the higher the intake.

The total feed intake by animals is the same for all the treatments. The highest ($P < 0.05$) daily weight gain was recorded in animals on *Cynodon* supplemented at 1.5%BW, followed by those on *Digitaria* supplemented at 1.5% BW. The least daily weight gain was recorded for the other two treatment groups.

From Table 8, *Cynodon* supplemented at 1.5% BW was found to be the most efficient ($P < 0.05$). Followed by *Digitaria* supplemented at 1.5% BW. . The least efficient ($P < 0.05$) was found to be that of *Digitaria smutsii* supplemented at 1.0% BW.

4.2.2. Digestibility of Nutrients

The digestibility result as presented in Table 9 showed that the dry matter digestibility in treatments C and D was marginally higher than in treatments A and B and this was the trend with all the other nutrients - ash, NDF and ADF. Except for EE which tend to be lowest in treatment C (Table 9).

Table 7: Chemical Composition of Feed (%)

	DM	ASH	EE	CP	NDF	ADF
Cynodon dactylon	97.1	7.2	3.5	5.1	76.4	47
Digitaria smutsii	97.0	7.3	4.1	6.3	73	46
Concentrate	98	19.4	5.2	18.8	34.1	25

KEY

DM - Dry matter
EE - Ether extract.
CP - Crude Protein
NDF - Neutral detergent fiber
ADF - Acid detergent fiber

Table 8: Feed intake (g/W $^{0.75}$ kg - on DM basis), body weight gain and efficiency of feed conversion

Treatment.	Forage Intake	Conc. Intake	Total Intake	Weight gain g/day	Eff. feed Conv(fd/Bwt gain)
Cynodon dactylon +1.0% BW. Conc	98	21^{b}	119	22^{c}	28^{b}
Cynodon dactylon 1.5% BW conc.	97	27^{a}	123	49^{a}	15^{c}
Digitaria smutsii 1.0% B W concentrate	102	21^{b}	123	17^{c}	42^{a}
Digitaria smutsii + 1.5% B W concentrate	99	25^{c}	123	36^{b}	21^{bc}
SEM	2.4	`1.4	2.7	4.3	4.4

^{abc} means on the same column with different superscripts are significantly P<0.05) different.

4.3 BLOOD PROTEIN LEVEL

Table 10 presents the blood protein levels obtained in the experimental animals. From the table, the total proteins level increased ($p<0.05$) and almost doubled with an increased level of supplementation. Treatments B and D which had 1.5% level of supplementation had twice the total protein content than treatments A and C. Similarly, the albumen level also increased ($P<0.05$) with increased level of supplementation as treatments B and D with 1.5% level of supplementation had values higher than treatments A and C

The globulin level also showed a similar pattern. Those treatments with high level of supplementation had higher ($P<0.05$) values of globulins than treatments A and C.

TABLE 9: Digestibility Values of the Feed Nutrients (%)

	DM	ASH	EE	CP	NDF	ADF
Cynodon dactylon + 1% B.W. of concentrate	39.2	47.1	30.3	35.4	42.1	42.2
Cynodon dactylon + 1.5%B.W .concentrat	44.8	59.1	32..2	39.4	49 .3	53.1
Digitaria smutsii +1% BW concentrate	45.7	60.9	27 .3	47 .4	47 .3	44.4
Digitaria smutsii +1.5% B.W concentrate	49	60 .3	32 .1	48 .2	57 .3	56.3

KEY

DM - Dry matter
EE - Ether extract.
CP - Crude Protein
NDF - Neutral detergent fiber
ADF - Acid detergent fiber

Table 10: Blood protein values (mg/ml)

Treatment	**Total Protein**	**Albumin**	**Globulin**
Cynodon dactylon + 1.0% B.W concentrate	12^{b}	8^{b}	13^{c}
Cynodon dactylon + 1.5% B.W concentrate	26^{a}	11^{b}	19^{b}
Digitaria smutsii + 1.0% B.W concentrate	11^{b}	10^{b}	15^{bc}
Digitaria smutsii +1.5% B .W concentrate	24^{a}	16^{a}	26^{a}
SEM	2.9	1.9	2.5

N.B: Means with different superscript are significantly different ($p< 0.05$).

CHAPTER 5

DISCUSSION

The level of nutrient. in both forages was because the study was conducted during the rainy season when pastures are of highest quality in the sub humid climatic zone. The growth of the specie was enhanced by the amount of rainfall (742.7mm) during the experimental period.

The ADF of the grass specie was 46.5% which compares to most tropical grasses while the NDF values were within the range of 73-76% as reported by Coward – lord *et. al.,* (1974).

In all the treatments, the lambs consumed between 90 and 99% of the forages and concentrate offered respectively. The ratio of concentrate to forage offered to lambs was 1:2 as recommended by Ruttle and Should (1968) and Levy *et. al.,* (1974).

The intake of *Digitaria* was slightly higher than *Cynodon dactylon.* This is in line with the report of Chilliard et al (1995,) which showed that for a given diet when intake increases, the retention time of particles in the rumen decreases. Stobbs (1975 and 1975[a]) and Hogson *et. al*., (1977) in their various works showed that the low digestibility of most tropical grasses limit the voluntary intake and this reduces animal productivity. The slightly higher intake of *Digitaria* as compared to *Cynodon* can further be explained by the studies conducted by Horn *et. al*., (1979), which shows that in young animals, forage

intake tends to be selected. Forages with more crude protein and less acid detergent fiber and cellulose are preferred.

It was observed from the results in Table 8, that increasing the level of supplementation in *Cynodon dactylon* fed groups increased the intake. This agrees with the work of Wielderma *et al* (1983). Dovonon (1975) also reported that supplementation of low quality roughages including cereal crop residues, with nitrogen concentrate enhances voluntary intake by ruminants. Similarly, the work of Okeagu (1981) showed that feeding of concentrate to grazing animals not only add directly to the total feed intake but also stimulates the intake of low quality forage

The low intake of *Cynodon dactylon* is also in line with the work of Bosch *et al.,* (1992) who reported that the capacity of ruminants for mechanically reducing feed particles size can be a limiting factor for feed intake

The concentrate intake was higher in the treatments B supplemented at 1.5% BW. This shows that the higher the level of supplementation the higher the intake. This is in line with the work of Ademosun (1970) which states that ruminants tend to consume feed that are high in crude protein than feed that have lower levels. He also stated that differences in crude protein and crude fiber influence intake.

The result revealed that animals in all treatments except those on Cynodon +1% BW supplementation had similar total feed intake. A similar finding had been reported by

Milford (1960) who also stated that digestibility was higher when crude protein content of feed was high, which also agrees with Andrew and Orskov (1970); Krepton and Levy (1979).

Daily weight gain was highest in *Cynodon* + 1.5% BW supplementation. The weight gain in these treatments indicated that feeding was above maintenance level (Osuhor, 1988). The result also explained the fact that supplementing *Cynodon dactylon* with concentrate can result in weight gain better than with *Digitaria smutsii*. This is in line with the work of Mc Collough (1970 a, b) who reported that diets containing low quality hay had a higher feed conversion ration.

Supplementation in both pastures plays a role in weight gain. Significant ($P<0.05$) weight gain was recorded in treatments given 1.5% of body weight concentrate as compared to those given 1% concentrate. This finding is also supported by the work of Leaver (1973) whose study shows that increasing the quantity of concentrate significantly increases live weight gain of British Friesian calves with all types of roughages. Similarly, Adu and Brickman (1981) working with six levels of concentrate to roughages ratio in Yankasa rams obtained the highest daily weight gain of 150g on treatment with 47 to 53 concentrate to forage ratio. The higher weight gain in *Cynodon dactylon* plus 1.5% concentrate supplement as compared to *Digitaria smutsii* plus 1.5% body weight concentrate can further be explained by studies conducted by Levy *et al*., (1975) in Israel with Friesian bulls who reported that both daily live weight gain and Carcass gain were significantly higher on low roughages ration than a high one. Similarly, Mc Dowell *et*

al., (1975) stated that daily intake would increase up to 10-12% of body weight when forage digestibility is 50-60 %. Oyenuga (1957) also reported that tropical pastures are notorious for rapid decline in nutritional quality with increased fiber and thus the need for supplementation.

The work of Grabtee and William (1977) also shows a similar pattern where the highest daily gain was recorded for sheep given the highest concentrate supplementation of 400g/day.

From Table 7, treatments Cynodon + 1.5% BW supplementation was found to be most efficient. This agrees with the work of McDowell (1975) which shows that animals on low roughages diet were approximately 11% CP more efficient than those on high levels in converting metabolizable energy into live weight.

Supplementation also plays a role in feed utilization as animals on Digitaria + 1.5% BW concentrate were more efficient than in treatments supplemented at 1%. This finding agrees with the work of Levy *et. al.,* (1974) which shows that there was a better utilization of metabolizable energy from concentrates. Orskov (1987) similarly reported that feeding the right combination of feed in the correct manner can easily cause improvement in feed utilization.

The digestibility within treatments on 1.5% supplementation also followed a similar pattern. Animals with high level of supplementation had higher levels of digestible

nutrient values than those on 1% supplementation (A and C). This also agrees with the work of Orskov (1994,) who stated that digestibility of diets tended to be increased by supplementation. Santra *et al* (1980) in an experiment with cross calves with 60% and 30% concentrate supplement reported that the total protein albumin and globulins remained unchanged in all the groups. This was further supported by Lebengard (1986) who reported that the serum total protein albumin and globulin concentration were not affected due to the iso-nitrogenous diets. This is in contrast to our findings, as we observed that with increased level of supplementation there was an increase in the total protein, albumin and globulins.

CONCLUSIONS AND RECOMMENDATIONS

It was concluded from the study that *Cynodon dactylon* is a good forage substitute for *Digitaria smuttsii* at a high concentrate supplementation level of 1.5%. It is hence recommended as good forage for small ruminants. This is because it has almost the same chemical composition as *Digitaria smutsii*, hence almost the same nutritive values. Also the body weight gain is higher for animals on *Cynodon* than *Digitaria* at the same level of supplementation. It is therefore recommended that *Cynodon dactylon* which is a native pasture available as weed in all the ecological zones of the country can be effectively produced and used as forage for small ruminant production.

REFERENCES

Anon (2003) Digitaria smutsii Better pasture for the tropics and subtropics .Better Pasture home page.

Anon 2004):Bermuda Grass. In:http/www:hearirgpier3cydahtm.

Achimede H, Boval M, Alexandre G. , Xande A . , Aumount G. and Ponect A. : (2002); Effect of Regrowth, age, and intake and digestion of *Digitaria decumbens* consumed by black belly sheep. Animal Feed Science and Technology. 87:153-162.

Adams D. and Mckinley .M. (1995): The sheep In; Aczccart News Vol. 8 no 2.: 1-3

Ademosun , A.A (1970); Nutritive evaluation of Nigeria forages (I) digestibility of *Penniselum purpereum* by sheep and goats. Nigeria Agricultural Jounal.7: 19-26.

Ademosun A.A. (1973) :The development of the livestock industry in Nigeria: Ruminants. Paper presented at the 9th conference of the Agricultural Society of Nigeria. Ilorin pp1-5.

Adnan M. .M (1985):NewNigerian Newspaper Tuesday 21 may 1985, No 5962 :importance of commercial livestock production.

Adu . I.F. and Brickman, W.L (1981): Feedlot performance and carcass characteristics of sheep fed varying concentrate levels. Journal Animal. Production and Research. 1 (1): 1-12.

Adu I.F. and Ngere H.O (1979) : The indigenous sheep of Nigeria. World Review of Animal Production 15 (3): 5-62.

Adu I.F. (1975); The effects of steaming up on the birth weight, lactation and growth of West African Dwarf Sheep. PhD. Theses. Department of Animal Science

University of Ibadan. Ibadan, Nigeria.

Adu I.F. (1980); Investigation into Nigeria's future with sheep and goat production. West African farming and Food processing May –June: 16-18

Adu I.T. amd Osinowo O.A (1985); The effects of dietary protein concentration and feeding levels on the performance of weaned lambs. Journal of. Animal Production. Research 5 (1): 45- 46.

AFRC Technical Committee on Response to Nutrients , Report Number 5, Nutritive Requirements of Ruminant Animals: Energy .Nutrition Abstracts and Reviews Series B, 60:729-804 (1990) CAB International.

Agharkar S.P (1991) : Meadicinal plants of Bombay. Presidentcy – Scientific publication Jodhrpur India Pp 80-87.

Agishi E. (1986) : The improvement of cattle production through pasture and range Development. In: Livestock and Poultry management (For Livestock and Veterinary Officers). AERLS Ahmadu Bello University Zaria., Pp Q1 – Q18.

Aiken G.E and M .A Brown (1996): Steer responses to protein supplementation and lasalocid on Bermuda pasture. Proceedings of Animal .Science 22 :109 -113

AOAC (Association of Official Analytic Chemists)1984. Official methods of analysis, Washington ,D. C. U.S.A.

ARC (1965) : The Nutrient Requirement of farm Livestock. No 2 Ruminants .ARC London.

ARC (1980): The nutrient Requirements of Ruminant Livestock. Common wealth Agricultural Bureax, Farnham Royal Slough.

Andrew R.P and Orskov E.R (1970a) : The nutrition of the early weaned lambs. The

influences of protein concentrate and feeding level on rate of gain in body weight Journal of Agricultural Science. Cambridge. 75 :11-18.

Andrew R.P and Orskov E.R (1970b): The nutrition of early weaned lambs; (2) the effect of dietary protein concentrate feeding level and sex on body composition at two live weights. Journal of Agricultural Science Cambridge 75: 19-26

Aumount G.., Caudron I., Samandiri G. Xande A (1995): Sources of variations of nutritive values of tropical forages from the Carribean Animal. Feed Science Technology. 51:1-3.

Balch C.C. , Freer M. and Balch C.C .(1969) :Factors influencing the voluntary intake of food by cows 3-the effect of urea on voluntary intake of roughages by cows Journal of Dairy Research. 33:1-11.

Ball. H.T (1950) : Breeds of sheep in the Indian Union. Misc Publ. Ind. Cannah Agricultural Research. No 75, KAR New Delhi.

Ball D.M., Hoveland C .S and Lacefield G.D (1991); Southern forage. Potash and phosphate Inst. Norccoss G.A**.**

Beard J.B.(1973) .Turfgrass:Science and culture.prentice-Hall Inc., Englewood Cliffs, New jersey.

Belesky. D ..P and J..M. Feddes (1995a); Comparative growth analysis of cool and warm season grasses in a cool temperature environment. Agronomy Journal. 87:974-980. Bioresour. Techno 65:1-12.

Belesky. D.P.; Perry, H. D. and Windham, W. R (1991): Productivity and quality of Bermuda grass in a cool temperate environment.
Agronomy Journal. 83(5): 810-813. [25225].

Blaxter K . L . , Wanmann F .W and Wilson R .S. (1961); The regulation of food intake by sheep. Animal. Production. 3:51-61

Blatter K .L . (1964) : Utilization of the metabolizable energy of grass. Journal. British GrassLand Society. 19: 90-9.

Boer, S., William J. Schmidly, N., David J. (1977): Terrestrial mammals of the riparian corridor in Big Bend National Park. In: Johnson, R. Roy; Jones, Dale A. (Tech Eds.). In: Proceedings; of the Importance, preservation and management of riparian habitat.July 1997. Tucson, Az. U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station: 212-217. [5349]

Bogle, T, Laurie A., Engle, David M., McCollum, F. Ted. (1989); Nutritive Value of range plants is the Cross Timbers. Report P-908. Stillwater, : Oklahoma Agricultural Experiment Station. 29 p. [9293]

Bosch, M.W.,S C.W. Lammers-Wienhoven, G.A. Bangma, H. Boer,and P.W.M.. van Adrichem (.1992): Influence of stage of maturity of grass silage on digestion processes in dairy cows. 2.Rumen contents, passage rates , distribution of faecal particles andmastication activity.Livesock Production Science 32:265-281.

Bourn , D., Wint W., Blench .R . and Woolley E. (1994); Nigeria Livestock Resources Survey. World Animal Review,78:49-58.

Brickman ,W. L .(1974) .The feeding of five hay as fed to sheep. Nigerian Journal of Animal Production : 225-230.

Brown David E.; Lowe, Charles H.; Hausler and Janet F. (1976) : Importance of Merino ewes and lamb at 13 stocking rate Australian Journal of Agricultural Research ,28.947

Burton G .W. and W.W. Hanna ,(1985): :Bermudagrass.p247-254.In M.E. Health et al (.ed) Forages:.The Science of grassland agriculture.IOWA State University press, Ames.

Caetano – Annolles G. B, J Bassan and Gresshoff P.M . (1991) DNA Printing Using very short arbitary oligonucleotide primers BioTechnology 9;553-557.

Caetano-Annolles ,G., L.M.callahan, P.E. Williams ,K.R.Weaver and P.M.Gresshoff, (1995).DNA amplification fingerprinting analysis of bermudagrass(Cynodon):genetic relationships between species and interspecific crosses.Theor Appl Genet 91:228-235 (errata in 92:498,1996)

Campling R. C., Freer ,M. and Balch. C. C.(1962): Factors influencing The voluntary intake of food by cows 3,.The effect of urea on voluntary intake of roughages by cows .jounal of Dairy Research.33:1-11.

Chilliard, Y., Doreau, M., Bocquier, F. and Lobley, G.E.(1995) : Digestive and metabolic adaptations of ruminants to variations in food supply. In: Recent Developments in the Nutrition of Herbivores, INRA Editions, Paris, France, pp 329-360.

Church D ..C. (1971): Digestive physiology, a nutrition of ruminants. Convallis Oregon O.S.U. Book store 2 Pp. 407.

Coblentz W .K .Fritz J .O, Bolsen K .K and Cochran R .C (1996): Quality changes in Alfalfa hay during storage in bales. Journal of. Dairy Science. 79:873-885

Coblentz W.K. ,J.E. Turner , D.A Scarbrough, ,K.E. Lesmeister , Z.B. Johson , D W.Kellogg K. P Coffey ,L.J MC Beth , and J.S Weyes (2000) :Storage characteristics and nutritive value changes in Bermudagrass Hay as affected by moisture content and density of rectangular Bales .Crop Science 40:1375-1383.

Cole H.H (1966): Introduction to livestock production. 2nd edn. W.H Freeman and Co. San Fransisco and London.

Collins M, W .H. , Paulson, M .F , . Finner, N .A , .Jourgensen and C .R . Keuler (1987): Moisture and storage effect on dry matter and quality losses of alfalfa in round Bales. Trans ASAE 30:1.913.

Conard H .R (1966): Symposium on factors influencing the voluntary intake of herbage by runminants. Physiological and Physical factors limiting intake. Jounal of. Animal. Science. (Cambridge). 57:419-425

Coward—Lord J, Arroyo-Auilu J.A and Garcia, Molinaria O (1974): Fibrous carbohydrate fraction and invitro true and apprarent digestibility of 10 tropical grasses. Journal of. Agriculture. University of. Puerto—Rico 58(3): 293—304.

Crabtree ,J.R. and Williams G.L. (1971): Voluntary intake and utilization of roughages – concentrate diet by sheep .I. concentrate supplements for hay and straw. Animal Production. 13: 71-82

Croston B. and Pollot G .E (1985): Planned sheep production, world trade produce. Collins Proff and Techn. Books. Britain.

David-West,K.B.(1983): Problems and Prospects of livestock development in Nigeria.Nigeria journal of veterinary Medicine series B, 2:417-427

Devendra C and G .B. Mclerory (1982): Reproduction in Small ruminants. Goat and sheep Production Manual. NAPRI ABU Zaria. Pp 51-54

Duble R.L. J.A Lancaster and E.C. Holt (1971): Forage characteristics limiting animal performance in warn- season perennial grasses. Agronomy. journal. 63: 795-788.

Donaldson ,J., Van Houter, M.F.J. and Sykes ,A.R ..(.2001)The effect of dietary fish meal supplementation on parasite status burdens of periparturient sheep .Animal Science 72:149-158.

Dulphy ,J P. , B.Remond and M. Therieez ,(1980):Ingestive behaviour and related activities in ruminants in:Y. Ruckebusch and P .Thivend (Edl) Digestive Physiology and Metabolism in Ruminants p 103.AVI Publ . Co., Westport, CT.

Dovon P.B(. 1975) :Potential by product feeding in tropical areas World Animal Review

Dyer E.S.C and Hafez I.A. (1969): Animal growth and nutrition. Lea and Febiger, Philadelphia U.S.A.

Evers, G .W. (1998): Comparison of broiler poultry litter and commercial fertilizer for costal Bermuda grass production I the South eastern USA.
Journal. Sustainable Agriculture. 12:55-77

FAO. (1983): Integrating crop and livestock in West Africa. FAO Animal production and paper No 41 Rome pp 112.

FAO (1984): Balance sheet, 1975-77. FAO. Rome Italy.

FAO (1986): African Agriculture, the next 25 years Food and Agriculture Organization of the United Nation, Rome Italy.

FDLPCS – (1992): Nigeria National Livestock Survey. Federal Department of Livestock and Pest Control Service

Fitzpatrick E.A and Nix H.A (1970): The climatic factors in Australian grass land ecology. In: Australian grassland (Ed RM Moore). Australian National University press Canberra. Pp 3—26

Forbes T.T and Robinson J .J . (1979): Energy requirement of weaned lambs. Animal. Production. 11 (3): 389-397.

Gaili E .S .E . (1979): Effect of initial feedlot weight on the finishing performance and body composition of western Sudan Baggara cattle. Tropical. Agriculture (Trinidad) 56 (1):69—74.

Gefu (2002): Socioeconomic consideration in small ruminant production. In; Small Ruminant Production Training Workshop Manual. C.A.M. Lakpini et al (editors) pp 8-11

George J. R. K ..M. Blanchet, R.M. Gettle, D.R. Buxton and K. .J Moore (1995): Yield and botanical composition of legume inter seed versus nitrogen fertilized switch grass. Agronomy. J. 87: 1147-1153

Gleason, Henry A. Cronquist, Arthur1 (1991) : Manual of vascular plants of northeastern United States and adjacent Canada. 2nd ed. New York: New York Botanical Garden 910 p. [20329]

Grell H.,: Sheep rearing in the Tropics and SubTropics. Animal Research and development 5:36-59.

Harlan, J, M .J de Wet, K.M Rawal. M. R Feider and W.L Richardson (1970): Cytogenetic studies in *Cynodon* L.C. Rich (Graminae) Crop Science. 10:288-291.

Hawkins D.R., Henderson H .E and Purser D.(1970): Effect of dry matter levels of

Alfalfa silage on intake and metabolis in the ruminant. Journal of. Animal. Science. 31:617-625

Henderson M.S. and D.L Robinson (1982a): Environmental influences on yield and in vitro true digestibility of warm-season perennial grasses. Agronomy.. Journal. 74:573-579

Hill G.M, R.N. Gates and J.W. West (2001): Advances in Bermuda grass research involving new cultivar for beef and dairy production Journal. Animal. Science. 79 (E. Suppl.) E48-E58.

Hecker J .F.(1983): The sheep as an experimental animal Academic Press London as cited David Adams and Michael Mckinley (1995): The sheep ,Anzccart news vol 8 No 2 . (1).

Houdijk, J.G.M., Jessop, N.S. and Kyriazakis, I.(2001).Nutrient partitioning between reproductive and immune functions in animals Proceedings Nutrition Sociology .60:515

Humphreys. L.R (1991): Tropical pasture utilization. Cambridge University press. Meibourne. A ustralia

Hutchings, . N. J . .(.1997) :Estimating the metabolizable energy requirement for pregnancy in sheep. Animal Science 64:463-467

Ibiloye, B . (1997); Effect of Feeding Cassava peels on the reproductive performance of Red Sokoto goat. Msc thesis. Department of Animal Science Ahmadu Bello University Zaria.

ILCA 1984 Traditional Small ruminants production in the sub-humid zone of Nigeria sub-humid zone.

Isiyaku Y .M (1988): The effect of different levels of palm kennel meal on the performance of growing and fattening yankasa rams. MSc Thesis. Department of Animal.Science Ahmadu Bello University Zaria

Jung G .A .G. , J.L. Griffin, E.R Kocher, J.A Shaffer and C.F Gross (1985): Performance of switch grasses and bluestem cultivars mixed with cool-season species. Agronomy.Journal. 77:846-850.

Kirby Rachel(2003):Feeding prime lambs for slaughter in Sheep updates bulletin 4473.Department of Agriculture, Western Australia, Perth.

Kempton, T.J., and R.A. Leng (1979):Protein nitrition of growing lambs.,British Journal of nutrition,42-289..

Lakpini(2002):Feed and feeding strategies for small Ruminant in varios physiological stage in:Small ruminant Production training workshop manual. C.A.M. Lakpini pp 40-47

Lee, J., Knowles, S.O. and Judson ,G.J.(2002). Tr ace element and vitamin nutrition of grazing sheep.In:Sheep Nutrition[Eds. M.Freer and H. Dove .CABI Publishing Wallingford, UK(In Pres)

Lerbengard Z (1986): Change metabolism and Immune response in cross bred heifers reared on low concentrate diet. Veterinary, Moscow. USSR. 8:66-67. In: Nutri. Abstracts Rev. (B) 1986 56:Abstr 6676J.

Levy D, Holzer Z ; Neumark ,H and Anim .S. (1974): The effect of dietary energy content and level of feeding on the growth of Israeli – friesian intact male cattle Animal production 18 : 67- 73

Madakadze I.C. B.E Coulman, A.R. McLeroy, K.A Steward and D.G. Smith (1998): Evaluation of selected warm-season grasseos for biomass production in urea with a short growing season. Bioresource Technology. 73:281-290.

Magnard L.A and Loosli J.K (1973): Animal nutrition. Tata McGran Hill pubcamp LATD.

Mandebvu .P.J.W. west R.N. Gates and G .M. Hill (1998); effect of hay maturity, forage and corn silage. Animal feed Science Technology 73:281-290.

Mandebvu P .J. W. West, G.M. Hill, R.N. Gates R.D Hatfield B.G. Mullunix, A .H. Parts and A.B. Caudle (1999): Comparison of Tifton 85 and costal Ber journal. Animal Science. 77:1572-1586

Marsh .R. (1975): Intake and live weight gain by British Friesian calves offered different ratios of dried grass and concentrates. Anima l prouction. 20 : 345 - 353

Marvogenis , A .P and . Louca A.(1973): A note on some factors influencing post weaning performance of pure breed and cross breeds of lambs. Animal production. 29: 415-418

Maynard, L.A. and Loosli , j .k (.1973): Animal Nutrition.Tata McGraw Hill Publication .Company Limited Bombay New Delhi.

Mc Cullough .T.A. (1974): The effect of different proportion of dried grass and concentrate in the diet on voluntary intake and performance of calves. Animal prodroduction 18 : 49- 58

McFarlane(1968) ,as cited by Adam David and Michael Mckinley (1995) :The Sheep, Anzccart News vol 8 No2 (1)

Mc Donald P. Edward R.A and Greenhalgh F. E (1973) :. Animal Nutrition Longman , London and New York

Milford ,R (.1960): Criteria for expressing nutritional values of tropical grasses Australian .Journal of Agricultural Science Research.11:121-127.

Minson, D. J. and Mecleod ,M. N.(1970) The digestibility of temperate and tropical grasses.Proceedings 11^{t} International Grass Land Congrress. Surfers Paradise Queensland, Australia pp719-722.

Minson D .J. Stobbs T . H. Hegarty, M .P. and Playne M J (1976): Measuring the nutritive value of pasture plant. Tropical Pasture Research: Principles and methods Bulletin 51 Pp 308

Minson D .J (1990); Forage in ruminant Nutrition. Academic Press. New York

Ngosle. A.B. (1989): Goat product in manufarm. Borno State. A HND project. College of Animal. Health and husbandry. Vom Plateaus State.

Northam, F. E.; Callihan, R. H.; Olad, R. R. 1991. Range extensions of four introduced grasses in Idaho. Journal of the Idaho Academy of Science. 27 (1): 19-21. [17409]

NRC (1985):Nutrient Requirement of sheep. 6th Edition National Academic press Washington DC.

Ogundipe S. O. (20002) :Ration formulations and least cost rations for small ruminant in small ruminant production workshop manual.C.A.M. Lakpini et al editors pp 49-62.

Okeagu M.U. (1981) :Evaluation of Nitrogen Fertilised signal Grass (Brachiaria decumbens Stapf) pastures under cattle grazing. M .sc. thesis Animal Science. Ahmadu Bello University.

Okorie I.T . H.V.D Miclroy R. J (1978): The productivity and nutritive value of tropical grass/legume pasture rotationally grazed by Ndama cattle at Ibadan. Nigeria Jounal of Agricultural . Agriculture Science(Canb) 64 235-245.

Olayiwole M.B. (1986): Cattle industry in Nigeria, prospects and problems. In livestock and Poultry Management Course for Livestock and Veterinary Officers. Ahmadu Bello University Zaria PP k_1-K_{10}

Olubajo F .O. and Oyenuga V .A. (1971): The measurement of yield, voluntary intake and animal production, production of tropical pasture. Journal. of Agricultural Sci.ence 771-774

Oni.O.O .(.2000): Breed and genetic improvement of Small Ruminant; in Small Ruminant production training workshop manual pp 1-7.

Oram R.N. (1990): Regiiste of Australian Herbage plant cultivars 3rd edition. CSIRO, East Melbourne Australia. Pp 105-106.

O'Reagain, Petter J(1993) : Plant structure and the acceptability of different grasses to sheep. Journal of Range Management 46: 232-236. [21277]

Orskov E.R and F. L.Mould((93)ulation ofrumen fluid ce on cellulolysis insacco, Dry matter degradation and the rumen microflora of sheep offered either hay or concentrate ..Animal nd Technology 10:1-14

Orskov E.R.1994 Recent advances in understanding of microbial transformation in ruminant.Livestock Production Science 39:53-60

Orskov E.R.and M. Ryle, (1990) Energy nutrient in ruminants. Elsevier Science Publications. New York.

Osbourn D.F. (1971): Biological and husbandry aspect of supplementary feeding of cows during the grazing season. Diary Science .Abstrast. Vol 33: 748

Osinowo A .O . (1990): April publication. NAPRI Ahmadu Bello University Shika.

Osuhor C.U (1988); Effect of Level of Feeding on the performance and carcass characteristics of 'Yan kasa rams Msc thesis 1988. Department of Animal Science Ahmadu Bello University Zaria.

Oudhia P (1999a) Medicinal weeds in rice field of chhahis ga-h (India). Int. Rice Res. Note 24 (1): 40.

Oudhia P and AR. Pal . (2000): Rainy season medicinal weed flora in wastelands of Ohanra nallam watersled area at Bagbahera. J. Medicinal Aromatic plant Science 2z /4A and 23/1A :44-449.

Oudhia P .B, S Joshi and V .K. Kosta (1998): The possibilities of preparing homeopathic drugs from the obnoxious weed of chhatitisgarh. Bhartiya Krishi. Ausandlan Patrika. 13(1/2): 53-57

Oudhia P. (1999b) :Medicinal weeds in groundnuts field of chhaHisgarh (India) Int. Arachis Newslett 19:62-64.

Owen J.B. and Rideman W.J. (1968): The design and integration of experiments to study Animal Production from grazed pasture. Journal. of Agricultural Science

Owen J.B. (1976) Sheep production. Cassel and callier Mc Millan publishers Ltd Camb 71:- 327-335.

Oyenuga ,V.A. (1957): The composition and agricultural values of some grass specie in Nigeria.

Oyenuga ,V.A. (1958): Problem of Livestock Nutrition in Nigeria. Nutrition. Abstr.ast

Rev.28: 285 – 293.

Oyeyilola L.A. (1989): Sheep and Goat Production Lecture Notes. CAAS/ABU

Paul A.F. (1988): Some aspects of sheep and goat management in South Eastern Nigeria. ILCA Bulletin No 30-April 1988

Playne, M.J and Haydock J. (1972): Nutrive value of Townsville stylo (*Stylosanthes humilis*) and spear grass (*Heteropogan contortis*) dominant pasture fed to sheep. The effect of maturity. Australian. Journal. Experimental. Agriculture. Animal. Husbandary. 12:365-372

Posler, G.L.A. W Lerssen and G.L Fine (1993): Forage yield, quality, compatibility and persistences of warm- season grass- legume mixture. Agronomy. Journal. 85: 554-560.

Raymond, N.F. (1964); The utilization of grass by ruminants; the efficient use of grass. Journal British. GrassLand Society. 19,81-89.

Roberts C.A (1995): Microbiology of stored forages P21. In: K.J. moore and M.A Pertersen (ed.) Post – harvest physiology and preservation of forage. CSSA spec public 22 ASA. and CSSA Madison W.I.

Robinson D.L. (1996): Fertilization and nutrient utilization in harvested forage system-Southern forage crops P. 65-92. In: R.E Joost and C.A Roberts (ed) Nutrient cycling in forages systems potash and phosphate. Inst. Norcross, GA.

Robinson , J. J . ,Rooke , J. A. , McEvoy , T .G. (2002).: Nutrition for conception and pregnancy. In Sheep Nutrition [. Eds. M. Freer and H Dove]. CABI Publishing Wallingford , U. K.[in press] Nat caution forage quality evaluate and utilization Univ. of Neubraska Unicoln 3-15 April 1994. ASA CSSA Maidism W.I.

Robinson, J . J., McDonard, I., Fraser, C. and Gordon J. G.(1980) :Studies on reproduction in prolific ewes.6.The efficiency of energy utilization for conceptus growth. Journal of Agricultural Science Cambridge 94:331-338.

Ruttle J.L. and Shount C.N.(1968): Effect of ration, energy level, vaccination and antibiotic feed lot performance of range lambs. Nutrition Abstrast Review 41:278.

Santra A. Agarwal N. D .N. Kamra and N .N Pai hak (1999): Effect of level of concentrate supplement on blood biochemical changes and testosterone level in cross bred Bos indicus calves. Australian. Journal. of Animal. Science.

Sheehan, W . and Fritzgerald, J.J (1977): Effects of method of herbage conservation on performance of store lambs Journal .Agricultural Research 16:83--94

Sastry C .S .T and Kauthekar K .Y. (1990): Plant for reclamation of wastelands. Publications and Information Directorate Council of Scientific and Industrial Research. New Delhi. Pp 219-220.

S.C.A (1990) Feeding Standards for Australian Livestock, Ruminants.Standing Committee on Agricultuure, CSIRO Publication, Melibounrne, Australia pp 266.

Stubbendieck, J.; Hatch, Stephan L.; Hirsch, Kathie J. 1986. North American rnage plants. 3rd ed. Lincoln, NE: University of Nebraska Press. 465 p. [2270]

Stobbs T.H (1975): Sward structure and grazing behavior in management of improved tropical pasture. Australian Institute of Agricultural Science .Queen s land Branch. pp 39—55

Tait R.M (1972): The utilization of dried grass by early weaned lambs Journal.British .Grassland Soc 27:217—220

Taliaferro, C.M (1995) .: Diversity and Vulnerability of Bermuda Turfgrass species Journal of Crop Science 35:327-332.

Tow, P.G(.1993):Persistence and water use efficiency of a tropical grass and Lucerne on a solodic soil on the Far North- West Slopes of New South Wales. Australian Journal of Experimental Agriulture 33, 245-52.

Tsutsumi,,M. and Abe , A (.1977): A comparasion of result using five method for prediction of forage digestibility. Journal. Japanese Soc. Grassld Science ,23(3):252—255.

Underwood, E.J. and Suttle, N.F.(2000).The Mineral Nutrition of Livestock, 3rd Edition.CAB International.

Vanzant E.S R.C. Cochran, K. A.Jacques A.A Boharka T. Delcurto and T.B Avery (1990).influence of level of supplementation and type of grains in supplement on intake and utilization of harvested early growing season bluestem range forage by beef steer. J. Anim. Sci.68:14-57

Van soaest P.J. (1965): Symposium on factors influencing voluntary intake in relation to chemical composition and digestibility. Journal. Animal Science. 24:834-843.

Wan Zahari, M., Thompson, j. k., Scott, D. and Buchan, W.(1990) ; The dietary requirement of calcium and phosphorus for growing lambs .Animal Production 50 :301-308.

Weston R.H. (1966): Factor affecting the digestive tract to handle digesta and the supply of glucogenic substrate Australian. Journal. Agronomy. Research. 17-939-954.

Wielderma *et al.,* 1983

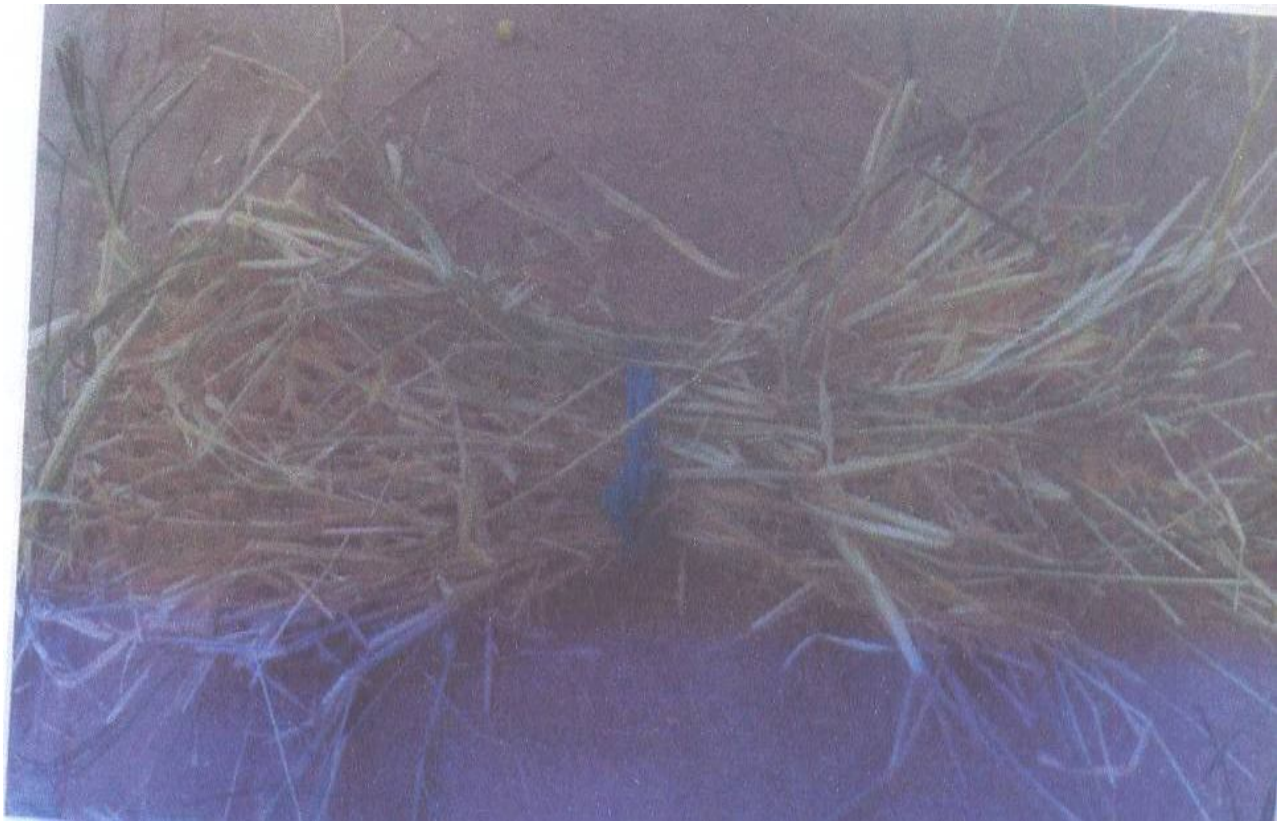
Williamson, G., and Payne W .J .A. (1978): An introduction to Animal husbandry in the tropics 3rd edition. Longman. Pp 437-463.

Wilson J.R (1994): Cell wall characteristics in relation to forage digestion by ruminants. Journal.of Agricultural. Science. (Cambridge.)122; 173-182.

Wilson, Robert E. 1989. The vegetation of a pine-oak forest in Franklin country, Texas, and its comparison with a similar forest in Lamar County, Texas. Texas Journal of Sciences. 41 (2): 167-176. [8771].



Appendix 1: Havested *Digitaria smuttsii* plant.



Appendix 2: Harvested Cynodon *dactylon* plant