EFFECTS OF SUN-DRIED CASSAVA PEELS ON LIVEWEIGHT GAIN AND REPRODUCTIVE PERFORMANCE OF RED SOKOTO DOES

BY

BALOGUN BOSE IBILOYE (MRS)
B.Sc. ZOOLOGY, A.B.U. 1988

A Thesis submitted to the Postgraduate School, Ahmadu Bello University, Zaria, in partial fulfillment of the requirements for the degree of MASTER *OF SCIENCE.*

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

H

JULY, 1997.

DECLARATION

I hereby declare that the work in this thesis was carried out by me in the Farms of the Small Ruminant Research Programme, National Animal Production Research Institute, Ahmadu Bello University, Zaria, under the supervision of Dr. C. A. M. Lakpini and Dr. J. P. Alawa.

No part of this thesis has been presented in any previous application for a higher degree. All sources of information are acknowledged by means of references.

BOSE IBILOYE BALOGUN (MRS.) — DATE 26/7/97

CERTIFICATION

This thesis entitled **"Effects of Sun-Dried Cassava Peels on Liveweight Gain and Reproductive Performance of Red Sokoto Does"**, by *BOSE IBILOYE BALOGUN* meets the regulations governing the award of the degree of Master of Science of the Ahmadu Bello University, Zaria. It is approved for its literary presentation and contribution to scientific knowledge.

Dr. C. A. M. Lakpini,
(Major Supervisor)
Programme Leader, Small Ruminant Research Programme, NAPRI, Shika, Zaria.

Dr. J. P. Alawa
(Supervisor)
Dept. of Animal Science
A.B.U., Zaria.

Dr. J. P. Alawa,
Head, Dept. of Animal Science,
A.B.U., Zaria.

Prof. J. O. Olayemi,
Dean, Postgraduate School,
A.B.U., Zaria.

Prof. I. F. Adu,
(External Examiner).
University of Agriculture, Abeokuta.

DEDICATION

This work is dedicated to my parents, Prince Bisi Isioye and Mrs. Silifat Bola Isioye and my children, Amin and Biodun Balogun.

ACKNOWLEDGEMENT

I would like to express my sincere appreciation and gratitude to my supervisors, Dr. C.A.M. Lakpini, and Dr. J.P. Alawa, for their guidance and encouragement throughout the period of this study.

I am greatly indebted to my major supervisor, Dr. C.A.M. Lakpini for his keen interest and accessibility from initiation of this work to its successful completion. His enthusiasm for this work was a constant source of inspiration for me.

I am grateful to the Director of National Animal Production Research Institute (NAPRI) for allowing me to use NAPRI facilities throughout this study.

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

I acknowldege the valuable support and special contributions of my husband, Dr. G. I. Balogun.

I am very grateful to my parents Prince and Mrs. Bisi Isioye, my brothers, Tunde, Toye and Akeem and my sister, Olaitan as well as my children for their invaluable, special encouragement, support, patience and understanding at all times. I appreciate their contributions to my being able to complete this study.

I am grateful to Mrs. M.A. Lakpini for her sisterly and valuable encouragement. I also wish to thank Mr. Lamidi Owolabi, Bunmi Oladimeji (Miss), Mr. Taiye Olugbemi, Mr. S. Duru, Mr. I.A.

Adeyinka, Mr. Audu for their individual help and encouragement.

Finally, I wish to express my deep appreciation and thanks to Mal. Isa B. Aliyu and Mr. Greg. U. Ititim of NAPRI, Shika who helped in no small way the typing of my thesis work.

Above all, I am grateful to God Almighty for seeing me through this study.

ACRONYMS

DMI	-	Daily dry matter intake (g)/head
DMI/Wkg$^{0.75}$	-	Daily dry matter intake/metabolic weight
CPI	-	Daily crude protein intake (g)/head
CPI/Wkg$^{0.75}$	-	Daily crude protein intake (g)/metabolic weight
EDM	-	Efficiency of dry matter conversion
ECP	-	Efficiency of crude protein utilization
MW	-	Metabolic weight
ADG	-	Average daily gain
PCAS	-	Percentage level of cassava inclusion
BTWT	-	Birthweight
WLDK	-	Weight loss due to kidding
LS	-	Litter size
WBK	-	Weight before kidding
LWT	-	Litter weight
LVWT	-	Live weight (kg)
INLW	-	Initial live weight
CP	-	Crude protein

TABLE OF CONTENTS

CONTENTS	PAGE
TITLE PAGE	i
DECLARATION	ii
CERTIFICATION	iii
DEDICATION	iv
ACKNOWLEDGEMENT	v
ACRONYMS	vii
TABLE OF CONTENTS	viii
LIST OF TABLES	x
LIST OF FIGURES	xii
LIST OF APPENDICES	xiii
ABSTRACT	xiv
INTRODUCTION	**1**
CHAPTER ONE	
2.0 LITERATURE REVIEW	**5**
2.1 Livestock Distribution and Population	5
2.2 Goats	6
2.3 Economic Importance of Goats	11
2.4 Meat Production from Goats	17
2.5 The Red Sokoto Goats	21
2.6 The Potential of Agro-Industrial By-Products and Crop Residues for Goat and Sheep Production in Nigeria	24
2.6.1 By-Products used as Energy Source	26

2.6.2 By-Products used as Protein Source..... 28

2.6.3 By-Products used as Energy and Protein Sources..... 30

2.6.4 Crop Residues..... 32

2.6.5 Cassava and its use..... 34

2.6.6 Animal Wastes..... 45

2.7 Nutrition of Goats..... 46

2.7.1a Dry Matter Intake..... 48

2.7.1b Energy Requirement for Maintenance..... 49

2.7.1c Protein Requirement..... 50

2.7.1d Mineral and Vitamin Requirements..... 51

2.7.1e Water Requirement..... 52

2.7.1f Ratio of Dry Matter to Total Water Intake 53

CHAPTER TWO

MATERIALS AND METHODS..... 55

CHAPTER THREE

RESULTS 61

CHAPTER FOUR

DISCUSSION..... 77

CHAPTER FIVE

CONCLUSION..... 85

REFERENCES..... 86

APPENDICES..... 106

LIST OF TABLES

TABLES		PAGE
3.1	Rations supplemented.....	58
2.1	Estimated livestock population (000) in Nigeria (1965).....	19
2.2	Production of lean meat in Nigeria (1963-1964).	19
4.1	Chemical composition of supplement rations (%).	62
4.2	Chemical composition of grazed forage (%).....	63
4.3	Inventory of plant species in grazed paddock...	64
4.4	Means of dry matter intake (DMI) and crude protein intake (CPI) and efficiency of dry matter conversion (EDM) and efficiency of crude protein utilization (ECP).....	67
4.5	Liveweight response to supplementation.....	68
4.6	*Regression equation table with percent cassava* peel inclusion as independent variable.....	70
4.7	Regression equation table with metabolic weight as independent variable.....	70
4.8	Means of daily dry matter intake and crude protein intake (DMI & CPI) and efficiency of dry matter conversion and efficiency of crude protein utilization (EDM & ECP).....	71
4.9	Liveweight response to supplementation.....	73
4.10	Regression equation table with cassava peel inclusion as independent variable.....	74
4.11	*Regression equation table with metabolic weight* ($W_{kg}^{0.75}$) as independent variable.....	74
4.12	Effect of supplementation on birth weight (BTWT), litter weight (LWT), weight loss due to kidding (WLDK) and litter size (LS).....	75

4.13 Effect of season on birth weight (BTWT), litter weight (LWT), weight loss due to kidding (WLDK) and litter size (LS)..... 76

4.14 Mean cost/kg of ration taken (₦/kg)..... 84

LIST OF FIGURES

FIGURES		PAGE
4.1	Response to percentage level of cassava (PCAS) inclusion (Regression of DMI and CPI/$W_{kg}^{.075}$ on PCAS)	62a
4.2	Response to Metabolic weight (Regression of DMI on Metabolic weight)	62b
4.3	Response to percentage level of cassava (PCAS) inclusion (Regression of CPI/$W_{kg}^{.075}$ and LWT on PCAS)	63a
4.4	Response to Metabolic weight (Regression of DMI and ADG on Metabolic weight)	63b
4.5	Response to Metabolic weight (Regression of EDM and ECP on Metabolic weight)	63c
4.6	Response to Metabolic weight (Regression of DMI/$W_{kg}^{.075}$ and CPI/$W_{kg}^{.075}$ on Metabolic weight)	63d

LIST OF APPENDICES

APPENDICES		PAGE
1	Proximate content of cassava.....	106
2	Mineral content of cassava.....	107
3	Vitamin content of cassava.....	108
4	Distribution of Red Sokoto Goats.....	109
5	Seasons of the year.....	110
6	Prices of ingredient at time of experiment (July 1993).....	110

ABSTRACT

Sun-dried cassava peels were used as an energy source to replace maize offal at levels of 0, (Treatment 1) 18.5, (Treatment 2) 37.0, (Treatment 3) 55.0, (Treatment 4) and 74.0% (Treatment 5) in the ration. A sixth ration (Treatment 6) comprised only cotton seed cake and common salt.

Each of the six rations was fed to five Red Sokoto does prior to breeding at the rate of 1.5% of the live weight daily before being allowed to graze on native pastures in a specific paddock.

In phase 1 of the experiment the daily dry matter intake (DMI)/head was not significantly different for treatments 1, 2, 3, 5 and 6. The highest DM intake was in treatment 4.

The crude protein intake in rations 1 to 5 decreased as the level of cassava peels in the ration increased.

The efficiency of dry matter conversion (EDM) and efficiency of crude protein utilization (ECP) were best in treatment 3.

The highest average daily gain (ADG) (107.1g) was recorded for treatment 4 and the least (40.8) for treatment 5. The overall ADG was 77.Og for this study.

The results in phase 2 of the experiment showed that the lowest DMI of 379.2/head was recorded in treatment 5 while the highest ADG of 67.4g was obtained in treatment 3 and the least liveweight gain of 14.3g was in treatment 4.

The regression equations showed that $CPI/W_{kg}^{0.75}$ had a significantly ($P<0.01$) linear relationship with per cent cassava peels inclusion.

Supplementation had no significant ($P>0.05$) effect on BTWT, LWT, WLDK and LS. Season also had no significant ($P>0.05$) effect on BTWT, LWT and LS of the kids. However, weight loss due to kidding (WLDK) was significantly ($P<0.05$) higher during the cold dry season (October - December).

INTRODUCTION

Goats are among the most important livestock species in Nigeria. Recent demographic studies have shown that Nigeria possesses about 34.5 million goats (FDLPCS, 1991). The Red Sokoto goat is the dominant species in the North while the West African Dwarf goat is the most common in the South.

The major constraint to goat production in Nigeria is the availability of suitable feeds (Adegbola, 1982; Olubajo and Oyenuga, 1974).

One feature of the productivity of ruminants in the tropics is their inherent low level of performance, which is invariably associated with poor nutritional management and inadequate exploitation of the attributes of the individual species, such that their potential productivity is often never realized.

The low productivity is dependent primarily on the inadequacy of nutrients, particularly of energy and protein. Both nutrients are invariably the major constraints to increasing productivity in ruminants of the tropics. In some countries such as those in the Caribbeans, energy rather than protein is the main limiting factor; whereas in others such as those in South east Asia, the reverse is the case. Often, both nutrients are limiting and the situation becomes even more acute when the need for, and dependence on them is accentuated by the use of traditional sources of energy, notably maize. The situation is often compelling enough to explore other

local sources of energy, notably carbohydrates and to lesser extent fats for ruminant feeding.

This approach has led to an examination of the availability and potential value of energy yielding feedstuffs in several countries in the tropics. Perhaps the most significant demonstration of this approach concerns sugarcane and its by - products (Preston and Willis, 1969; Preston, 1974). Similarly, consideration is also being directed at other high energy feedstuffs to alleviate the low level of nutrition and therefore performance of tropical ruminants.

Notable among the potentially very useful energy feedstuffs is Cassava (Manihot esculenta). It is bulky, high in energy, low in protein, and produces relatively high yields per unit area of land. It therefore represents an important supply of energy for feeding livestock. It is becoming increasingly recognized as an attractive substitute for traditional energy sources like maize.

The principal products of the mature cassava plant (12 months old), expressed as a percentage of the whole part, were estimated as leaves 6%, stem 44% and tubers 50%. By - products of tuber processing include; peel 8% and pumace 17% (Devendra, 1977).

Cassava peels are a major by-product of the cassava tuberous root processing industry. In parts of Nigeria where cassava is grown and the tubers processed, the peel is largely underutilized as a livestock feed. In Nigeria, the average annual yield of cassava tuberous roots is 21.1 t/ha (Hahn and Chukwuma, 1986). Since the peel constitutes 20.1 percent of the tuber (Hahn,

Chukwuma and Almazan 1986), it follows that about 4.2 t of cassava peels per ha are available annually for feeding ruminants, especially goats. The following composition has been reported for cassava peels: residual DM 86.5-94.5%, OM 89.0 - 93.9%, CF 10.0 - 31.8%, CP 4.2 - 6.5% (i.e. N 0.7 - 1.0%) Onwuka (1983), Carew (1982), Adegbola (1980) and Oyenuga (1968).

Although the peel contains a higher level of crude protein than the tuber, (Appendix 1) the total protein weight in the peel is low. Like the tuber flesh, the peel is deficient in fat, minerals and vitamins, (Appendices 2 and 3) and would be useful mainly as an energy source. The energy value varies with the amount of flesh retained during the peeling process.

One of the most limiting nutrients in livestock production in Nigeria is energy. The cost of grains and their by products which are conventionally used as energy source are competitively high.

Cassava peels are readily available and there is no competition between man and livestock for this by-product. It is therefore very cheap, costing about ₦180/tonne compared to maize offal which costs about ₦1700/tonne.

With due consideration to the large quantities of this product produced annually and to its relatively lower cost compared to maize offal this study was aimed at using cassava peels as an alternative cheap source of energy to replace maize offal and to

evaluate the effect of cassava peels as energy source for flushing Red Sokoto does prior to breeding and for maintaining the pregnant does during gestation.

CHAPTER ONE

LITERATURE REVIEW

2.1 LIVESTOCK DISTRIBUTION AND POPULATION

The tropics lies between the tropics of cancer and capricorn (Latitudes 23°N and 23°S) and roughly within the 70°F isotherm (Phillips, 1983; Wright, 1954; Joubert, 1954). The climate is not uniform and wide variations are common due to many geographical factors such as altitudes and pressure belts.

Excluding pigs, and in comparison with the world population of 118 million buffaloes, 1,079 million cattle and 1,038 million sheep (F.A.O, 1966), goat population represents about 15% of the total world population of grazing domestic animals. Goats have a wide geographical distribution. They thrive best, however, in the drier tropics and on the lighter sandy soils in preference to the wet and humid tropics. For instance, in Africa, where there are extensive areas of dry, savannah countries, the greatest concentration of goats are found in East - Africa, Northern Nigeria and Morocco. In Nigeria the population of goats is about thrice that of sheep (F.A.O., 1966). Recent demographic studies have shown that Nigeria possesses about 56.6 million small ruminants with 34.5 million of them being goats (FDLPCS, 1991). This made Nigeria to own 33% of all goats in Africa and 52% of goats in the West African subregion.

The world population of goats has increased steadily over the last thirty years from under 300 million in 1950 to over 470 million in 1982. Most of this increase has occurred in those areas of the world where goats are well established as an important domestic animal, and it is most likely that the result of improved management, leading to better herd health and nutrition has contributed.

The goat population in Nigeria is largely concentrated in the North. They are predominantly found in the drier regions 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.

Goats share with chickens the distinction of being well adapted to every ecologic zone in Nigeria and they are so important in the social and ceremonial life to an extent unequalled by other species. Goats are kept in every type of production system, from cut-and-carry confinement, free-range, to migratory system in large pastoral herds. They survive on the islands of Lake Chad, being moved from one settlement to another in canoes.

In Nigeria there are three indigenous breeds of goat; the sahel or desert goat, the Sokoto Red and the West African Dwarf.

2.2 GOATS

Goat, Capra hircus aegagrus, evolved about 7 million years ago, but was probably not domesticated until 10,000 - 8,000 years ago in the Mesolithic period of the Ancient Near East (FDLPCS,

1991). There were no wild sheep or goats in Africa. Long legs and short body are attributes of primitive sheep and goats, prior to their adaptation in the semi-arid zone. The dwarf goat is relatively recent in origin, presumably because dwarfing confers survival advantages in the humid zone. Unlike sheep, goats can revert to the wild state, shown by world wide occurrence of feral goats, compared to scarcely any feral sheep.

From a West African perspective, one important attribute of goats is their feeding adaptations. Though sheep and goats have the same digestive capacity (Montsma, 1986), goats have tougher and more prehensile mouth parts which help them to select the most nutritive and often best defended plant parts. They are much more selective than sheep and are prepared to eat bitter plants which other herbivores dislike (FDLPCS, 1991). Goats may even be able to detoxify plant defence compounds (Lu, 1988).

There is a great deal of evidence that prolificacy increases with age. This is to be seen in the study on Malabar goats which showed that the proportion of twin and triplet births increased from 19% at first kidding to 79% in the second and later kiddings (Shanmugasundaram, 1957). Similar findings have also been reported in Israel, where Negev and Saanen goats, which had an average of 1.1 and 1.5 kids at first kidding, had 1.5 and 2.0 kids per birth respectively at second and subsequent kiddings (Epstein and Herz, 1964).

The dam's weight has been reported to influence litter size, as it does in sheep and other species. In the Philippines, Arriola

(1936) reported a significant correlation of 0.50 between weight of dam and kid. In Egypt, studies on Baladi goats (Tantawy and Ahmed, 1960) showed that does which were heaviest at kidding produced the largest litter. For dams weighing 21.4kg at first kidding 35kg at the sixth or later kidding, the corresponding kidding percentage increased from 121 to 130%. No triplet births were recorded at first kidding but triplets amounted to 39% at six or more kiddings. Payne and Miles (1953) found that dam weight was significantly correlated with birth weight of single kids but not with that of twins.

Since adult weight of the breeding female and age at first kidding both have large effects on the lifetime production of the doe, management should in general be such as to permit the young females to grow as rapidly as possible. Each young female may be mated as soon as she reaches a live weight three-quarters of that required in mature does in the herd. The practice of delaying service until this minimum weight is reached is justified, because small size of the dam, even if entirely environmental in origin, restricts her offspring both in birth weight and number. However, wherever numbers permit, young females not attaining adequate mature weight by 12 months of age should be culled. Where a greater selection intensity is possible, those young does of above average live weight should be favoured. If culling for low-live weight is to be combined with selection for prolificacy, it is essential that allowance be made for the restricting effect of large litter size on the live weight and subsequent growth of litter mates. It is in

such cases that delayed mating of small females may be most valuable, in allowing those born and reared in large litters to reach a satisfactory mature weight. However, it is much more efficient to allow such females to express their full genetic growth potential from birth, either by hand-rearing or by fostering them, or by removing some of their sibs, so that the milk supply available to them is fully adequate for maximal growth.

The adult size of the animal is mainly determined by its birth weight and subsequent growth rate. Birth weight is an important factor affecting productivity (Wilson 1958a and Devendra 1966a & b. There are large variations in the size of adult goats. In general, the birth weights of native or indigenous goats are small compared with those of imported breeds and their crossbreds within the same environment. Males are heavier than females.

The variation in birth weights is due to both genetic and environmental factors. Between-breed differences are primarily due to genetic factors, and where there had been considerable selection as in such breeds as the Anglo Nubian and Jamnapari, birth weights are considerably higher than in the less improved breeds. This is one of the reasons for their use in the improvement of smaller goats in many countries. Variations in feeding and management can affect the efficiency with which nutrients in the feed are converted to meat and milk, and differences in milk production of the does accounts for considerable differences in kid weight within a very short time after birth. It is therefore important to feed the pregnant doe well in order to ensure high birth weights and

adequate milk production to support rapid growth of the kids.

It is essential that in order to get accurate records of birth weights, kids be weighed within the first twelve (12) hours of life. This is recognised in sheep (Starke et al, 1958) and is supported by the findings of Alexander (1956) on weight changes in lambs within the first 36 hours of birth. Weight loss due to coat drying loss averaged 260g and that due to metabolic loss 20g per hour. Where lambs had been suckled immediately, live weight increases averaged 89g in the first twelve (12) hours of life. Since goats are multiparous animals, birth weights are particularly critical in influencing post-natal growth and development, and also survival rates. As with sheep, high birth weights are also desirable in goats, since they are correlated with rate of live weight increase and therefore affect the time taken to reach slaughter weight (Dilwali, 1943 and Datta et al, 1963). Datta et al (1963) have reported a correlation of 0.7 between birth weight and live weight gain during the first month.

On the other hand, lower correlations have been reported between body weights at different ages from birth by Sacker and Trail (1966a) for Mubende goats. Birth weight had little effect upon subsequent body weights (r=0.20 with two-month weight, 0.16 with weaning weight and 0.04 with weight at one year). The correlation between two-month weight and weaning weight was 0.58 and between two month weight and weight at one year was 0.48, indicating that weaning weight may be used as selection criterion for retaining does for further breeding. For South Indian meat

goats introduced into Sri Lanka, the correlation between birth weight and live weight at one year was 0.57, but between weight at six months and at one year of age the correlation was 0.82 (Wijeratne, 1968). Both of these correlations were statistically significant and indicate that selection can be made either at birth or at weaning.

Goats had bigger litter sizes and heavier birth weights in the cold dry season. These was attributed to feed availibility with the onset of rains (Karua, 1989). Although, in the wet season, the reverse was reported; there was abundance of lush forage but this was not available to the goats because of tethering.

It may be safely assumed that in goats, as in sheep, individual birth weight is negatively correlated with litter size, although litter weight of neonates increases with their number.

2.3 ECONOMIC IMPORTANCE OF GOATS

Goats are multipurpose animals, producing milk, meat, skins and hair. Their purpose varies from region to region and depend on their breed. Their main purpose in Nigeria is for meat production, although in temperate regions like Europe where they are intensively managed, they are geared principally to the production of milk, with meat as a by-product or secondary product. Skins are a valuable by-product especially in countries with a large goat population. In Nigeria, goat skins are used for the production of leather goods and goat skin rugs. They are exported to generate revenue for the country. They are used locally for clothing and

furniture. The skin of the Red Sokoto (Maradi) goat in Nigeria is well known for its superior quality and the high value it commands in World markets (F.A.O., 1966).

Chevon is relished in many countries where there is a tradition for meat consumption from both sheep and goats. In parts of Africa, such as Ghana (Jollans, 1959), there is evidence that there is a preference for chevon. Goat milk, like meat, is enjoyed by many people. For the peasant farmers and the average family who are unable to maintain a cow, the goat justifies its designation as "the poor man's cow".

The special attributes of goat milk are that tubercular bacilli are rare; there is a high proportion of smaller fat globules facilitating its easy digestion and that it possesses anti-allergy properties.

Goat milk cheese is commonly made in some European countries and occasionally in tropical countries such as the Republic of Niger, from the milk of Maradi goats (Robinet, 1967). Colostrum, ("dakashi") the thick milky substance produced by ruminant dams immediately after giving birth, is commonly obtained from goats and consumed in the northern parts of Sokoto and Borno States. In some places, it is expressed out and given to children while elsewhere it is fried with spices and eaten as a delicacy. "Wara" is a soft, wet, unripened cheese, usually white and lumpy in appearance. It is often fried or dried to lengthen its shelf life. Another type of "Wara" known as "warankashi", is produced mainly in western Kwara State and to a limited extent around Ilorin. It is very

common in the Republic of Benin where there are also indigenous FulBe and Yoruba and especially in the west "Warankashi" is sun-dried or soaked in vegetable oil as a preservative. Goat milk is also consumed as yoghurt ("Kindirmo" in Hausa) and the fresh milk is mostly preferred as it is popularly known as "Madara" in the North. Nigeria has a wide range of traditional dairy products which have rarely been studied but are widely distributed through the pastoral areas. Most of goat milk and meat are produced in Asia, with China being the principal Asian producer. Europe, with only 3 per cent of the world goat population, produces over 20 per cent of total goat milk but only 4 percent of total chevon. The extensively managed herds of Asia and Africa produce almost 90 per cent of world chevon.

Average yields of milk per head in Europe vary from as little as 100 litres in the Mediterranean region to over 550 litres per lactation in northern and Central Europe. For example, herds recorded in France averaged 583 litres per head per lactation in 1982 (Wilkinson and Stark, 1987).

Statistics for world production of goat fibre are difficult to obtain but it is estimated that 3000 to 4000 tonnes of cashmere and about 15000 tonnes of mohair are produced per year. A high proportion of the total mohair and cashmere produced is imported into the UK for processing and in 1985, 7356 tonnes of mohair and 2188 tonnes of cashmere were imported. The present world supply of mohair is derived mainly from South Africa, Turkey, and Texas in the USA. Cashmere is produced in the Himalayas and other

mountaineous regions from the secondary (very fine) hair follicles of the goats in those areas.

The hair of common goats is used extensively in carpet trade and also in the making of coarse bags and ropes. Goats have varied and numerous miscellaneous values that they serve in the tropics. These include their value as a source of income, investment against the failure of cash crops, conferring prestige on those that own them and their place in custom, religion and festive occasions (Devendra, 1966d).

In India, Joshi (1952) had drawn attention to the keeping of Jamnapari goats mainly for their manure. A modern addition is the value of goats as experimental animals. They are used in physiological and other basic research in the tropics. The knowledge of milk fat synthesis and the physiological mechanisms that are involved, relates to goat on account of its convenience in research.

While it is generally accepted that goats are extremely useful in the tropics, the extent of their destructiveness has been a subject of great controversy. There are two schools of thought on this. On one hand it is contended that goats are the major cause of deforestation and soil erosion (Maher, 1945), while on the other hand it is claimed that goats are of considerable value, not only in providing valuable meat and milk in the rural parts of the tropics, but also in controlling bush encroachment (Staples et al., 1942; Hornby and Van Rensburg, 1948; Oates, 1956; Wilson, 1957; French, 1965 and Knight, 1965).

In the 1965-80 development plan for Nigeria a substantial increase in the goat population was recommended to supply more meat and control rapid regeneration and regrowth of bush. Ecologists have observed that nomads and their animals including goats, are not completely parasitic. In a continuum of symbioses ranging from mutualism to parasitism these animals and their owners sustain each other in an environment that is often harsh, and supply the non-pastoral community with animal products (Krader, 1959).

In Turkey there is evidence that goats have positively contributed to the intensification of sedentary agriculture in those places where soil and water resources were sufficient (Kolars, 1966).

Following browsing during the daytime, goats are often kept in paddocks and corrals at night and their droppings are carefully gathered and sold in bags to local farmers. In this way, goats have contributed towards promoting agricultural development in submarginal areas, particularly with the limited supply and high cost of inorganic fertilizer.

In many countries of the tropics, increasing pressures on the utilisation of land and the lack of available grazing areas have in turn imposed greater limitations on goats. As a result, they have been driven to thrive under conditions where no other ruminant would be able to survive. In addition, the poverty of many farmers often does not allow for proper control in the management of their goats which are left to wander for their food. The destructive habits of goats are the result of a combination of the above

factors but, with better management and the introduction of measures designed to limit the damage, it should be possible to use these same habits to advantage.

In recent years much has been said about the insufficiency of foods of animal origin in a large part of the human race. In Africa, Latin America, the Near and Far East, the consumption of protein foods is particularly low. Proteins of animal origin - meat, milk, cheese, eggs and fish - which provide a concentrated source of readily assimilable amino acids are so limited that such deficiency diseases as marasmus and kwashiorkor remain appallingly common. To reach the targets necessary to overcome this deficit, increased over-all production from the world's fauna in their widely varying environments is required. The campaign to reach this goal recognises two kinds of nutritional deficiencies:

(1) Under-nutrition arising from a deficiency in the quantity of food and

(2) Malnutrition due to a deficiency in the quality of food.

Increased production from tropical goats can contribute towards improvement in both situations, and is particularly important in protein malnutrition. The short generation interval (lambing and Kidding interval respectively) of sheep and goats makes it possible to increase production more rapidly than from cattle, and in the topics, goats have the advantage over sheep of generally higher fertility. Goats are able to thrive on vegetation of no direct value for human nutrition. Their small size and

relatively low individual value bring them within the economic capacity of low - income house-holds both in terms of care (often by children and women) and purchase price.

2.4 MEAT PRODUCTION FROM GOATS

Chevon is very popular in the tropics, but like other kinds of meat, it is often a luxury. Recently in New Zealand about 48,000 feral goats were slaughtered annually for export to Cyprus, Fiji, Ghana, the West Indies and Italy (Kirton, 1969). The special importance of goat meat lies in its suitability for domestic consumption. For the nomads and people of the rural areas the value of goats as a source of meat is far greater than usually appreciated. However, the importance and development potential of chevon in Nigeria is recognised in the FAO Report on Agricultural Development in Nigeria, 1965-1980 (FAO, 1966), which points out that "the long generation interval associated with cattle does not apply to other meat-producing farm livestock in Nigeria. As a result, a substantial increase in goat numbers could be quickly achieved, despite the widespread prejudice in many areas against goats per se. Such a population increase would be possible because of their fertility and reproductive rates, their efficiency in food conversion, the variety of feeds on which they can subsist, and their relative resistance to disease". It is in fact neither an accident nor a deliberate misguided policy of animal production which has led to the present high goat population in proportion to cattle, in Nigeria. By tradition they have been found to fit the

local circumstances while their size makes them especially useful for family consumption and the entertainment of guests in areas where meat cannot be stored for fear of spoiling.

Table 2.1 shows that goats are twice as numerous as sheep in Nigeria. According to the FAO Report on Agricultural Development in Nigeria, 1965-1980 (FAO, 1966), the total goat population of over 21 million provided over 6.38 million carcasses annually, yielding 65,686 tons carcass weight, giving an average carcass weight of nearly 10 Kg. Further analysis shows that the goat carcass yields 44% lean meat, 30% offal, 9.6% fat, 13.4% bone and 3% skin. Goats provide 25.5% of the total lean meat available in Nigeria (Table 2.2), and are second only to cattle in total meat supplied. Yet the annual consumption per head in 1963-1964 was only 0.58kg in Western Nigeria, 1.31kg in Eastern Nigeria and 2.49kg in the North (Devendra and Burns, 1970).

Chevon is preferred to mutton in Sudan and many parts of Africa, the Middle East, Fiji, Malaysia and India. In Malaysia the demand for goat meat is very high indeed, and it fetches the highest price per unit of any meat sold in the market. Wahid (1965) has reported a definite preference for chevon in East and West Pakistan even though the price is almost the same as for mutton. In Fiji, the shortage of goats in many areas, and a high prevailing price for chevon relative to mutton, has put greater emphasis on mutton imports, and it is estimated that up to 60 % savings in imports could be made if more chevon were available (Thompson, 1965).

Table 2.1: Estimated livestock population (in 000), Nigeria (1965)

Region	Cattle	Goats	Sheep	Pigs
North	10,255(94%)	14,317(68%)	4,448(60%)	118
East	434(4%)	4,684(22%)	1,751(24%)	161
West	169(2%)	2,204(10%)	1,036(15%)	401
Total	10,858	21,205	7,235	680

FAO Report on Agricultural Development in Nigeria, 1965 - 1980, (FAO, 1966b).

Table 2.2 Production of lean meat in Nigeria, 1963 - 1964

	Tons	%
Cattle	79,630	47
Goat	43,170	25.5
Sheep	18,891	11
Pigs	4,727	3
Poultry	23,025	13.5
Total	169,443	

FAO Report on Agricultural Development in Nigeria, 1965 - 1980, (FAO, 1966b).

The preference for goat meat is probably related to certain special features which make it quite different from that of mutton. Whereas in sheep the fat is distributed all over the body, in goats the fat is concentrated in the viscera (Villegas et al, 1938; Williamson and Payne, 1965; and Zeuner, 1963b). This in turn affects its succulence and tenderness. Weight for weight, however, goat meat probably has a higher lean meat content. As the meat of males has a very strong taint, it is usual to castrate males that are surplus to breeding requirements.

Although it is recognised that the preference for individual meat differ widely, the actual reasons for the preferences are not clear, and remain speculative. They are probably determined by differences in taste, religion, cost in relation to other types of meat, proportion of lean to fat and the availability of the meat itself. Exactly how chevon compares with other types of meat in consumer preference is not very clear.

Jollans(1959) did an interesting work on the meat preferences of the people in Central Ghana. A carefully planned survey of the preferences of the people was carried out. The most outstanding feature revealed by the survey was the preference by the indigenous Ashanti people for chevon. Chicken was the least important to them, probably because of its higher cost at the time of the survey. The survey also indicated that the parts of the carcass most favoured in the case of sheep, goats and pigs were the chest and the hind-legs. "Chewability" is a special feature of meat consumption in Ghana and this also explains the preference for the chest with its

soft bone content. One other feature which was apparent in the survey was the popular practice of roasting the skin of a goat rather than skinning the animal. It is claimed that it improves the flavour of the meat and it is interesting to note that this is not practised in the case of sheep slaughtered for human consumption.

Despite this obvious importance of chevon, very little work has been done to assess the potential of goats in terms of comformation and component parts of the carcass. This also implies that the value of a number of breeds for meat production has not been completely identified. The reasons for this are many and are probably due to a combination of factors, the most important of which is the lack of adequate differentiation of the specific value of indigenous goats for meat or for milk. Often the dual purpose goat serves as a meat animal after its usefulness for milk ceases, the stage at which this is reached being determined by economic and sociological considerations.

Some studies of meat goats have been made, e.g. the small East African goats (Wilson, 1958a; 1958b and 1960), dwarf goats of lower Congo (Henrotte, 1961) and Ghana goats (Oppong,1965), the last of these providing about 44% of meat from livestock slaughtered in abattoirs. In Nigeria it is known that 30% of Nigeria's meat supply is contributed by goats (Adu et al, 1979).

2.5 THE RED SOKOTO GOAT

The Red Sokoto (Kano Brown or Maradi goat) is probably the most widespread and well-known type in Nigeria. It is the common

village goat in the northern two thirds of the country although it is less common with transhumant pastoralists. It constitutes about 50% of the total 32.50 million population (Osinowo, 1992).

It is uniformly dark red in colour, horned in both sexes (Ngere et al, 1984) and short-haired. The ears are short and carried horizontally. Robinet (1967) presents a very detailed study of this breed. It is relatively small in size (23-30kg) but not dwarfed or achondroplastic. Although physiologically adapted to an arid region, it has shorter legs than typical "desert", goats, and is maintained under sedentry farming conditions. The breed is a good meat animal. In Niger, it is commonly milked giving daily yields of about 0.5kg in the dry season and up to 1.5kg in the wet season (Devendra and Burns, 1970). As kidding normally occurs three or four times in two years, lactation length is usually only about 100 days, with an annual production of around 150kg.

The distribution of Red Sokoto goats in Nigeria is shown in Appendix 4. The Red Sokoto goat is probably the only Nigerian breed for which there is a record of systematic attempts to stabilise a particular type. FDPLCS, 1991, reviewing the work of the veterinary service in Sokoto province, described how in 5 years, 219,688 non-red male goats were castrated resulting in the replacement of non-red skins by the more valuable red in the local markets. Also in an attempt to maintain the purity of the breed in Sokoto province, no other type of goat is permitted, and goats of colours other than dark red are culled. The connection between

coat colour and skin quality is not clear, but at least the typical dark red colour acts as a "trade mark" by which merchants can recognise skins from this breed. Ngere et al (1984) argued that *populations of the Red Sokoto goats spread south and east from* Sokoto through the Savanna belts giving rise to the Kano Brown and the Sahel types of Borno State further east.

The productivity of the Red Sokoto goat has been relatively quite extensively studied, in FulBe husbandry (Otchere et al, 1987), in research institutes in Nigeria (Adu et al, 1979; and Ngere et al, 1984) and in Niger Republic (Haumesser, 1975). Body weight of the female influences the birth weight of the young (Adu *and Ngere, 1979; Ngere et al, 1984).*

Possibly due to the tendency for the heavy newborn kids to demand more milk, or because the milk production is greater in a heavy doe, there is a strong correlation between doe weight and milk yield (Ehoche and Buvanendran, 1983). However, the correlation between milk yield and kid growth is less than might be expected (r=approximately 0.5, Ehoche and Buvanendran, 1983). Red Sokoto goats are not high milkers, giving an average milk yield of 3.8kg per week (Ehoche and Buvanendran, 1983), or 3.28kg per week (Akinsoyinu et al, 1981), though this figure rises in the case of multiple birth, or a heavier doe. The Red Sokoto goat was the source of 'Morocco leather' known in Europe from the medieval period onwards. It was known as 'Morocco' because it was transported across the sahara by caravans controlled by Moroccan Merchants. The Red Sokoto goat is still known for its suitability

for fine leather. Burns (1965) found that the skins have coarse, thinly-spaced outer hairs and small sweat and wax glands and that they lacked fat. Although underfeeding would avoid the problem of cutaneous fat, the result would be a thinner and weaker leather. This was confirmed by Alaku and Moruppa (1983) who found that Red Sokoto goats slaughtered in the driest months suffered a 55% reduction in skin weight, making it 4.9% of the total body weight. The best skin came from young animals fed sufficiently well for them to be full grown by one year of age. Slaughter should be at 12-18 months of age, in the dry season, when insect damage would be minimal (Burns, 1965).

2.6 THE POTENTIAL OF AGRO-INDUSTRIAL BY-PRODUCTS AND CROP RESIDUES FOR GOAT AND SHEEP PRODUCTION IN NIGERIA.

Any excess material produced following the harvest or industrial processing of a target product is a residue. The residue is considered a waste if it is not utilised, but a by-product if it is of some use. Agro-industrial by-products are the residues from food processing industries whereas those from field crops are crop residues. Crop residues and animal excreta would constitute farm wastes if not utilised.

Agro-industrial by-products are usually cheap protein and energy supplements to forage (including the fibrous crop residues). The quality of protein (ARC, 1980) and energy (Preston, 1982) supplements as related to rumen function influences their value.

The supply of protein to the animal (host) through microbial production alone is not sufficient to maintain high levels of production (early growth, late pregnancy and lactation). Preformed protein from dietary sources are required post-ruminally to complement microbial supply. The post-ruminal protein requirement to support high levels of production also applies to glucose precursor requirements of the rumen microbes and the post-ruminal specific nutrient needs of the animal. This fact must be appreciated in the choice of residue combinations for efficient production.

The general constraint associated with the use of these by-products have been presented (Adegbola, 1977b, Chenost and Mayer, 1977) These include:

Ignorance:

The use of a by-product could be hampered by the lack of knowledge on its chemical composition, and optimal feeding level.

Irregular Supply:

This applies especially to those residues whose production depends on the importation of the parent material. Foreign exchange problems largely account for the irregular supply.

Inadequate processing facilities:

This may be due to limited plant capacity or the absence of plant modifications to produce other associated by-products.

Logistic problems:

These are difficulties associated with collection and transportation to sites of utilization.

Nature of by-product:

The physical and chemical composition of the by-product could hamper its use. These adverse compositional characteristics include the presence of too much water, high sugar content leading to rapid fermentation, contamination by mycotoxins in storage and rancidity due to residual oil content of oilseed cakes and brans.

Agro-industrial by-products may be classified into those used as source of energy, supplementary protein, both supplementary energy and protein and miscellaneous by-products from fruit and vegetable processing. Other methods of classification are according to the type of product processed e.g. flour milling by-products, sugar processing by-products etc or classification by plant type e.g. cereals, oilseeds and fruits.

2.6.1 By-products used as Energy Source

These by-products are rich in fermentable carbohydrates but low in nitrogen. They are used in combination with non-protein nitrogen (NPN) sources as food substrates for microbial protein synthesis. The most important by-product in this category in Nigeria is molasses. The reported molasses production in Nigeria for 1980/81 (Barreveld, 1982) was only 16,000 metric tons.

High levels of molasses feeding in the absence of other fermentable energy sources produces low levels of propionic acid (the main glucose precursor) and more of butyric acid (Clark et al, 1972; and Chenost and Mayer, 1977). The low level of propionic acid from high molasses feeding could limit production. This could be overcome by the addition of starchy by-products in the diet. Molasses may be used as a binder in feed pelleting up to 10% level (Chenost and Mayer, 1977). As an energy supplement to poor quality forages, levels of up to 30% have been successfully used in sheep and goats feeding (Alhassan, unpublished).

Oil palm slurry or sludge (OPS) is a by-product from palm oil processing and is a major pollutant in oil producing areas. It is thus largely a waste. There are very few studies on its utilization by ruminant animals. In preliminary trials with West African Dwarf sheep fed rice straw, Alhassan and Akorfur (1982) found no significant depression in straw intake at up to 40% oil palm slurry feeding. The digestibility of all proximate constituents, apart from crude fibre, increased with OPS feeding. Thirty percent OPS was the optimal level. The high water content of OPS renders it too bulky to be transported to areas where sheep and goats are abundant. Its use is therefore site specific.

Fruit cannery by-products like pineapple waste and citrus pulp are good sources of energy but of limited use in Nigeria due to availability and fermentation problems in storage. Like OPS, their use is site specific. Early studies in Nigeria on citrus pulp show that it has 6% CP, 15% crude fibre and 84% water (Mba et al,

1976). Further energy supplemention of these diets was suggested (Mba et al., 1976).

Other energy by-products available in Nigeria are cassava peels, yam peels, oil palm slurry and fruit cannery by-products. Peels of cassava (5.5% CP, 3.03 Mcals/kg DM as ME) and yam (8.7% CP, 2.62 Mcals/kg DM as ME) (Univ. Florida, 1974) are kitchen wastes used by sheep and goats.

The high ME of cassava peels is supported by the high apparent DM digestibility of 70.2% by West African Dwarf (WAD) sheep (Job et al 1976). Grazing WAD sheep receiving urea-molasses supplements containing 78% cassava peels of 3.8% CP and 72.24% CF showed superior intake and growth to their counterparts on rice straw (2.90% CP, 34.53 CF) fortified with urea molasses (Otchere et al, 1977). The large scale feeding of peels of root tubers in feedlots is hampered by availability limitations.

2.6.2 By-products used as Protein Source

The most important agro-industrial by-products used as protein supplements in Nigeria are the oilseed cakes, (Cotton seed Cake (CSC), groundnut cake (GNC) and palm kernel cake (PKC).

Undecorticated CSC is the most widely used oil seed cake for ruminant animal feeding in this country due to its availibility and cost relative to that of its closest competitor, groundnut cake. The CP content is about 26% with DCP of 18.2% in sheep and 16.0% in goats (Alhassan, unpublished). The declining productivity of cotton in Nigeria can seriously affect the availability of CSC in

the near future.

Groundnut cake, another oilseed cake, is much higher in crude protein (over 45% CP) than CSC but is more expensive and scarce. Groundnut cake protein is of high rumen degradibility. Due to the high cost it may be uneconomical to use in ruminant diets at present.

Palm kernel cake is a fibrous low protein (14 - 16% CP) and unpalatable supplement. It should be fed at about 5% level (Adeneye and Oyenuga, 1976) along with more palatable ingredients like molasses and the cereal by-products. The protein is of low rumen degradability. There is very little competition with non-ruminants for this oil seed cake. The factory price of PKC is about half that of CSC.

Copra cake is a by-product of coconut oil extraction. It is less fibrous than PKC and has more protein (24.4% CP) (Alhassan, Unpublished). It is more palatable than PKC but it is less available due to low local production.

Other oilseed cakes (mainly from imported oilseeds) are sunflower (31% CP) and soyabean (50% CP) cakes. These are currently so highly priced that their inclusion in ruminant diets may not be economical.

An agro-industrial by-product of animal origin which is currently a waste but has potential as a protein supplement is dry rumen content mixed with blood (DRCB). Both blood and ruminal content are at the moment, major abattoir pollutants in this country. Dry ruminal content has about 16% CP which can be raised

to 34% by the addition of blood (Alhassan et al., 1985).

2.6.3 By-products used as Energy and Protein Sources

This is an intermediate class between energy and protein supplements. It includes cereal grain by-products (i.e. products of flour milling). The composition and usefulness of these products vary with milling efficiency and level of husk present.

In Nigeria, as in most parts of the tropics, the amount of flour milled by-products from locally produced cereals is very low and thus not quantitatively important as feed sources for ruminants. Competition exists with the monogastrics for their utilization with the monogastrics (especially poultry) given priority. Only the more fibrous of the cereal milled by-products is more readily available to ruminants in commercial operations.

Wheat bran is the most important milled by-product which is locally available. Varying levels have been used in small ruminant diets. Thus 12% (Ehoche et al, 1983), 30% (Adu and Lakpini, 1983) and 100% (Alhassan, unpublished) levels in supplements have been used. No adverse effect was noticed from feeding the all-wheat bran diet in metabolism trials (Alhassan, unpublished).

Apart from wheat bran, the other milled by-products of importance are rice bran, rice polishings and rice husks. Broken rice is not considered a by-product in Nigeria because it is consumed by humans. Rice husk is poorly digested due to the high lignocellulose (45.4% crude fibre) and ash (17.2%) contents. Grinding improves the nutritive value slightly. For instance, the

unground husks has 0.6% digestible crude protein (DCP) for sheep while the ground material has 2.4% DCP (University of Florida, 1974). Five percent (5%) of unground and 10% ground husks are considered optimum in sheep diets (Devendra, 1981). Due to the poor feeding value, rice husks is usually burnt or wasted around rice mills. The nutritive value of the material could be enhanced by alkali treatment (Alhassan, unpublished).

Rice bran with little husk is a good quality feed for sheep and goats. About 15% rice bran of an unknown husk content was successfully fed to sheep in low maize containing (33.5% maize) concentrate supplements in Nigeria (Adeneye and Oyenuga, 1976). Rice polishings is a high energy feed (80.5% TDN in sheep) and of medium crude protein level (15% CP) (University of Florida, 1974). It has low rumen degradability and is an excellent complement to urea-molasses diets (Preston, 1982). It is a source of post-ruminal starch in the small intestine. Due to availability problems rice polishings has not been much studied in small ruminant feeds in Nigeria.

Brewery by-products also belong to the class of by-products considered as intermediate sources of protein and energy. The most important brewery by-product is brewers' grain which is supplied wet (BWG). It is high in fibre (16% crude fibre, 75% NDF) and moderately high in crude protein (22%). The metabolizable energy (ME) content for sheep is 2.3Mcal/kg DM (Univ. Florida, 1974). About 30 % level of Brewers' Dried Grain (BDG) is considered optimum for goats and sheep in Nigeria (Adebowale and Ademosun,

1981). Apart from Guiness brewery most of the breweries in Nigeria do not have drying facilities. This limits widespread use of the material. Brewers' wet grain (BWG) could be ensiled for later use but ensiling could increase costs. BWG has been successfully preserved for 14 days by applying organic acids, namely, propionic and formic acids (1:1 ratio) at 2% level in open containers (Dixon and Combellas, 1983).

2.6.4 Crop Residues

Cereal straws and legume hays (from food crops) constitute the most important field crop residues for sheep and goats in Nigeria. Nutritionally, they are characterised by high content of cellulosic materials and are low in nitrogen except the legume hays. Crop residues are important sources of feed for sheep and goats in the dry season. Due to their limitations in fermentable energy and nitrogen, judicious supplementation (O'Donovan, 1983) and or treatment with alkalis (Sundstol, 1984) have been suggested. The voluntary intake of these residues has been examined (Alhassan, unpublished). The dry matter intake of untreated, unsupplemented cereal straws was 0.93 to 1.5% of body-weight for sheep and 0.7 to 1.5% of body-weight for goats. For cowpea vines (limited leaves), dry matter intake was 1.2% of body weight in sheep and 0.8% of body weight in goats. Intake was highest for groundnut haulms. Both goats and sheep ate 3% of body weight as dry matter. Olayiwole (1976) examined the responses of ruminants to dry, untreated - ensiled and treated ensiled sorghum stover. Treatment of stovers

involved a 6 week ensilage with 0.25% urea and 0.5% molasses. All forms of stover were supplemented with minerals, GNC or urea-molasses. Sheep on urea supplement lost weight, only those on plant proteins maintained their body weights.

Not much has been reported on supplementing cereal straws or dry season forage with cowpea vines or legume haulms. Losses in body-weights of sheep receiving 0.9kg groundnut haulms/animal/day as supplement to grazing was reported by Shaiwoya and de Leeuw (1971). The groundnut haulms used was of an exceptionally low quality (6.1% CP).

The alkali treatment of crop residues to enhance their nutritive value is not yet widely practised in Nigeria. The only place where urea-treated straw is used at the farm level in this country is in Kano State (KNARDA,1983). There, fertilizer grade urea is normally used at the level of 1 kg urea dissolved in 10 litres water and sprinkled on 20kg straw in a pit. The pit was covered for 20 days. Thereafter the straw was fed to goats, sheep and cattle, supplemented with mixtures of molasses and wheat bran. Presently, there are problems associated with obtaining suitable but cheap cover material for the treated straw. The currently recommended polythene sheet is falling out of the reach of farmers due to increasing costs (Alhassan, unpublished).

The use of plant ash, notably palm-bunch ash (Adebowale, 1985) and cocoa pod husk ash (Osafo and Smith, 1985) have been studied. One kilogram sodium hydroxide is equivalent to 4.4kg cocoa pod ash which is in turn equivalent to 7.8kg palm bunch ash for the purpose

of alkali treatment of straw (Adebowale, 1985). These plant ashes, however, do not add extra nitrogen to the treated material. They only enhance digestibility.

2.6.5 Cassava and its use

Cassava is one of the most important staple food crops grown in tropical Africa. Because of its efficient production of cheap food energy, year-round availability, tolerance to extreme ecological stress conditions, and suitability to present farming and food systems in Africa, it plays a major role in efforts to alleviate the African food crisis. It is one of the most drought tolerant crops and can be successfully grown on marginal soils, giving reasonable yields where many other crops cannot do well.

Traditionally, cassava tuberous roots are a major source of carbohydrates in human diets and are processed by various methods into numerous products utilized in diverse ways according to local customs and preferences. In some cultures, the leaves are also consumed as a favorite green vegetable. Many traditional foods are processed from roots and leaves of cassava thus constituting the major part of a family's daily food. However, cassava is frequently denigrated because its roots have a low protein content. But unlike the roots that are essentially carbohydrate, cassava leaves are a good source of protein and vitamins which can provide a valuable supplement to the predominantly starchy diets and feed. Cassava leaves are rich in protein, calcium, iron, and vitamins, comparing favourably with other green vegetables generally regarded

as good sources. According to Rogers and Milner (1983), the amount of protein (dry basis) ranges from 17.8 to 34.8 percent in the leaves of different cultivars. The amino acid profile of cassava leaves indicates that, except for methionine, the essential amino acid values exceed those of the FAO reference protein (Lancaster and Brooks, 1983). The total essential amino acid content is similar to that found in hen's egg and is greater than that in oat and rice grains, spinach and soybean seed (Yeoh and Chew, 1976). However, while the vitamin content of the leaves is high, the processing techniques used can lead to huge losses. Boiling of the leaves especially may reduce vitamin C substantially.

The dried peels are fed to goats and sheep, pigs eat the tubers while the leaves are fed to poultry to increase meat and egg production (Hahn, 1986). As by products, animal wastes are incorportated with household refuse as mulch and used for soil enrichment or are carted directly into fields, especially those close to homes.

Cassava contains the cyanogenic glycosides, linamarin and lotaustralin. After cassava tissue damage, these are hydrolyzed by the endogenous enzyme linamarase to the corresponding cyanohydrins. Further hydrolysis to hydrogen cyanide is responsible for the chronic toxicity associated with inadequately processed cassava products. In small doses, cyanide is detoxified to thiocyanate, a goitrogen, by means of the enzyme rhodanase, making use of methionine as the sulfur donor. This amino acid then becomes a limiting factor in cassava feeds. Since cassava is low in protein,

it necessitates supplementing its diets with animal proteins for the supply of methoionine and lysine. Supplementation with zinc salt prevents parakeratosis. Therefore, processing procedures must seek to reduce the cyanide in cassava before use.

Various processing methods have been used to reduce cyanide quite effectively. For example, grating, sun-drying, boiling and fermenting can reduce cyanide quite effectively. Aerobic fermenting methods which are commonly used in many parts of Africa also increase the protein content of the final product by introducing molds to cassava tuberous roots. The limited supply of raw materials for the livestock feed industry has resulted in a continuous increase in the cost of production causing a phenomenal rise in the unit cost of livestock products. Thus, these products have become too expensive for the majority of the population.

The principal future market for cassava is as livestock feed. Cassava has long been recognized by researchers in Africa as an appropriate animal feed and it has been used as an important and cheap feed in many European countries. Both roots and leaves as well as the dry peels are used as livestock feed. Cassava offers tremendous potentials as a cheap source of feed energy for livestock, provided it is well-balanced with other nutrients. There is a great interest in the supplemental feeding of livestock with cassava in Africa. It is estimated that approximately 4 million tonnes of cassava peelings (useful as livestock feed) are annuallly produced as a by-product in Nigeria alone during processing of cassava roots. Therefore, cassava offers remarkable potentials as

a cheap source of food energy for animals, provided it is well balanced with other nutrients. There is a great deal of current interest in suplementing feeding of animals with cassava in Africa.

Traditionally, cassava is fed to sheep and goats in the tropics and it can constitute 20-40 percent of compound livestock feeds, especially in poultry and pigs, with considerable reduction in production costs. However, there is a need to increase available knowledge of technology of utilization of cassava as livestock feed.

In food crop system, cassava is commonly intercropped with early maturing annuals such as maize, and vegetables like okro, egusi, and bitter leaf. The crops intercropped with cassava in different parts of Africa vary with regions of growth and food preferences. In Zaire, the intercrop may be dominated by grain legumes such as groundnuts and phaseolus beans, while in Sierra Leone, the Gambia, Liberia and Guinea, rice is the dominant intercrop. Soybean may be intercropped with cassava. Cassava is highly compatible as an intercrop with these annuals because of its slow initial growth especially between planting and six to eight weeks of growth. The annuals which grow faster during the initial growth phases rarely compete adversely with cassava and have been shown to smoother weeds. The advantage of soybeans, a relatively new crop in cassava growing areas of Africa, is that it will supply the deficient protein component to a predominantly cassava diet in both human food and animal feeds. Protected trees like Parkia, and non woody perennials such as plantains and bananas, are also

frequently grown in patches or as individual stands in cassava fields. While cassava and associated crops are the main food crops, trees provide fuel-wood and construction materials.

Cassava is capable of providing very high yields of energy/ha. For example it is about 13 times more than maize or guinea corn (Oke, 1978). Out of the estimated 125 million tons of cassava produced yearly (Phillips, 1983), about 90 percent is used as human food while the remainder is used largely as animal feed and for other industrial products. The average yield of cassava in traditionally cultivated varieties is 6.4 tons/ha which is too low to sustain demands for human consumption and for industrial use. However, through the effort of the IITA in Ibadan, varieties have been developed that could yield 15-20 tons/ha which is several times the average yield of local varieties under traditional agricultural system. It will therefore appear that the high agronomic potential of cassava can be fully exploited to drastically increase production and therefore provide enough cassava for use in feeding livestock without adversely affecting the needs of human consumption.

Cassava is a crisis crop. In times of war, drought or low national incomes, cassava consumption increases relative to alternative food staples such as yam, maize, rice and wheat. Cassava in certain forms is a low income consumer's staple. Although an individual may not increase the quantity of cassava consumed in a year, as national income declines, annual average cassava consumption per person increases because more people begin

to substitute cassava for more expensive alternative staple foods.

Even though cassava is regarded as a subsistence crop of low-income families or as a "famine-reserve crop", about 60% of the cassava output of households in the Oyo area of Nigeria is sold for processing (mostly into gari) while the remaining 40% is consumed at home (Ikpi et al, 1986). A high proportion (50 percent) of cassava was sold to food processors in the Western region of Cameroon (Okezie et al, 1988), suggesting a changing status for cassava.

Fresh cassava roots cannot be stored for long because they rot within 3-4 days of harvest. They are bulky with about 70% moisture content, making transportation of the tubers to urban markets difficult and expensive. The raw roots and leaves contain varying amounts of cyanide which is toxic to man and animals, while when uncooked, the raw cassava and leaves are unpalatable.

Traditionally, cassava roots are processed by various methods into numerous products and utilized in various ways according to local customs and preferences. In some countries, the leaves are eaten as vegetables and many traditional or local foods are processed from cassava roots and leaves.

There are a lot of constraints which include environmental, varietal, agronomic and socio-economic in the traditional processing of cassava. Traditional cassava processing methods adopted in Africa, probably originated from tropical America, particularly north eastern Brazil and may have been adapted from indigineous techniques for processing yams (Jones, 1959). The

processing methods include peeling, boiling, steaming, slicing, grating, soaking or seeping, fermenting, pounding, roasting, pressing, drying and milling. These traditional methods give low product yields which are also of low quality.

Utilization incorporates cooking or preparation and consumption. Cooking cassava consists of boiling, steaming, roasting and pounding. The peeled fresh cassava roots are eaten raw, boiled or roasted. The fresh roots are boiled and pounded to obtain "pounded fufu".

Improvement of cassava processing and utilization techniques would greatly increase labour efficiency, incomes and living standards of cassava farmers and the poor urban dwellers. In addition, the shelf life and transportation of the products will be enhanced while market opportunities and human and livestock nutrition will be improved. The nutritional status of cassava can also be improved through fortification with other protein-rich crops such as soybean. Processing reduces food losses and stabilizes seasonal fluctuations in the supply of the crop.

Recent studies at the Obafemi Awolowo University, Nigeria, showed that cassava peel is rapidly and well degraded in the rumen. Asaolu (1988) reported dry matter losses of 70% (dried peel) and 73% (ensiled peel) in 24 hours in the rumen of sheep. Odulami (1988) obtained a $t_{\frac{1}{2}}$ value of 26 hours for dried peel in goats. This value was similar to that obtained from cassava tuberous root meal (26.7 hours), yam peel (28.9 hours), and plantain peel (27.8 hours). Cassava peel dry matter losses in this study were 78% and

88% in 24 and 48 hours respectively.

In another study comparing the rumen degradability of several crop residues in cattle, sheep and goats, Smith et al (1988) reported high dry matter losses for cassava peel in the three ruminant species, with a mean value of 83% in 48 hours. These high rumen degradability values suggest that cassava peel could serve as a useful energy source in ruminant diets.

Larsen and Amaning-Kwarteng (1976) fed grazing cross-bred cattle a supplement made up of molasses and dried or ensiled cassava peel at 0.7 percent of body weight for about 6 months. Weight gains recorded were 0.07kg/day for control (cattle grazed and with no supplement), 0.29kg/day for test (cattle grazed and supplemented with dried peel), and 0.33kg/day for cattle grazed and supplemented with ensiled peel.

In another study, Fomunyan and Meffeja (1987) fed sheep on three levels of dried cassava peel at 0, 35 and 70 percent of diet in combination with *Pennisetum sepium*. Dry matter intake increased linearly with increasing dietary levels of cassava peel. It was concluded that cassava-based diets have great potential as dry season feed stuff for sheep.

Dried cassava peel fortified with urea was compared with rice-straw fortified with urea as a dry season supplement for grazing sheep in Ghana (Otchere et al 1977). The results showed that while sheep supplemented with rice straw and cassava peel gained weight, sheep used as control lost about 15 percent of their body weight during the dry season. The sheep supplemented with cassava peel

gained more weight and maintained this weight gain advantage during the following rainy season when the control animals exhibited a high degree of compensatory growth.

Cassava peel could also be fed dried or as silage. Optimum conditions for making good quality cassava peel silage have been given by Asaolu (1988), who indicated that good quality silage could be obtained when peel is chopped to equal lengths of about 2 cm for easy composition. Moisture content should be reduced from 70-75% to about 40% by wilting (air drying) for 2 days before ensiling. A reduction of moisture content will ensure good fermentation even if the peels are chopped to uniform lengths (Asaolu 1988). Under these conditions, cassava peel silage after 21 days was light brown in colour, firm in texture and had a pleasant odour. The pH was 4.4, and no fungal growth was observed.

Such good quality cassava peel silage and dried peel were fed to West African Dwarf sheep by Asaolu(1988). Two groups of sheep were fed diets made up of 80 percent dried (group 1) or ensiled (group 2) peel, supplemented in each case with 20 percent Gliricidia leaves. The performance of the sheep were compared to a control group fed solely on Gliricidia. The performance of the sheep showed that sheep fed mainly on cassava peel with a small supplement of protein-rich Gliricidia efficiently put on weight during this period.

Another dry season feed formulation based on grass-legume foliage, cassava peel and poultry excreta was evaluated by Okeke and Oji (1988). The three feed materials were ensiled in the ratio

of 60:20:20 on wet basis and fed to West African Dwarf goats. Control goats were fed a maize silage diet, both diets being isonitrogenous (14 percent cassava peel). On the basis of favorable consumption and digestibility of the cassava peel diet, as well as normal rumen and blood metabolites, Okeke and Oji (1988) recommended that in anticipation of dry-season feeding, cassava peel could be used as an energy supplement in an ensiled mixture of grass-legume foliage and poultry excreta.

Cassava peel has also been fed to ruminants after fermentation. Adebowale (1981) substituted fermented cassava peel for maize to feed West African Dwarf sheep at graded levels of 0, 20, 40, and 60 percent over a period of 6 months. It was concluded that fermented cassava peel should not constitute more than 20 percent of a concentrate diet in order to avoid a reduction in performance.

From the foregoing, it is clear that cassava peel could be fed to ruminants either as the main energy source, or as an energy supplement to foliages or poor quality feed. Because of rapid rate of degradability of cassava peel in the rumen, maximum animal response under these two feeding strategies can only be achieved with the provision of protein feed whose rate of rumen degradability is comparable to that of cassava peel for proper synchronization of energy and protein utilization.

A series of experiments was carried out by the Goat Research Group of the Obafemi Awolowo University in Nigeria in 1986 to evaluate the response of goats fed cassava tuberous roots as an

energy supplement to grass-legume foliage basal diets. In the first trial, goats were fed a basal diet of Gliricidia ad libitum, with or without cassava supplement at the rate of 30g dry matter/kg metabolic liveweight. The cassava was fed to the goats three hours before the basal Gliricidia was offered. The results showed an improvement in dry matter digestibility, which was however not reflected in the growth rates. This discrepancy was attributed to a poor energy-nitrogen synchronization in the rumen. Most of the energy supplied by the cassava supplement was already dissipated before the nitrogen from the basal diet was made available.

This was confirmed by the $t_{\frac{1}{2}}$ values (in hours) of the feeds used: cassava 26.7, Gliricidia 53.7, Leucaena 88.9, Guinea grass hay 210.0, and brewers grain 46.2-hours. Taking these into consideration, the feeding pattern was changed in subsequent experiments. In experiment 2, cassava was fed 2 hours after the basal diet. The results showed that the growth rates reflected the digestibility patterns. In the third experiment, cassava supplement fed once a day a few hours after the basal feed was compared with split-feeding three times a day, simulating a steady energy release that matched the slow N release from the basal diet. The results indicated that supplementation improved digestibility and growth rate figures suggested an improved energy-nitrogen utilization. It could be concluded that in order to obtain maximum response from ruminants fed on cassava tuberous roots, two peculiarities of the material need to be recognized - the low nitrogen content and the rapid degradability in the rumen. Appropriate measures such as

fortification with nitrogen, preferably nonprotein nitrogen, and split-feeding several times a day will ensure efficient utilization of nitrogen-poor basal feed by ruminants.

Cassava is frequently denigrated because its roots are low in protein. However, it may be supplemented with protein sources such as legumes as in the case of cassava flour using protein rich soybean. Such fortified products will be nutritionally advantageous.

2.6.6 Animal Wastes

The most important animal waste with a potential for use in ruminant diets is poultry excreta. Large quantities are produced in commercial poultry farms. There are two types of poultry manure, viz., manure from caged layers and the one from deep litter. Variations in poultry manure CP content has been reported by different authors. For instance, 16.5% (Adegbola,1977b) 24.2% (Devendra,1981), 25% (Job et al., 1976) and 31.2% CP (Adu and Lakpini, 1983) have been reported. About 30% of poultry litter is true protein, the remainder being uric acid which is slowly degraded in the rumen (Devendra, 1981). It is thus an ideal protein source for ruminant animals. A serious limitation to its use, however, is the low palatability. A 30% maximum dry poultry waste (DPW) in molasses-based diets was suggested by Devendra (1981). Okorie et al (1981) also suggested 30% DPW as optimal in diets for sheep. However, Adu and Lakpini (1983) suggested a 10% DPW optimum in molasses-based diets for sheep. Cooking or steaming is reported

to overcome the palatability problem of DPW (Devendra, 1981). Fresh litter may be ensiled with grass at 60:40 litter-grass ratio (Devendra, 1981) or with fresh chopped cassava roots (Job et al. 1976). The crude protein content of cassava roots silage was raised from 1.6 to 8.6% due to incoporation with poultry litter at 8:1 cassava-litter ratio. Sheep receiving the cassava-poultry litter supplement grew faster than their counterparts on maize control isonitrogenous diets (Job et al., 1976)

Agro-industrial by-products and farm wastes are the key to economical intensive feeding of sheep and goats in Nigeria. Unfortunately, the economic use of most by-products is site specific, requiring that animal operations be sited nearer to the source of raw materials.

2.7 NUTRITION IN GOATS

Nutrition is one of the major factors affecting livestock productivity. The extensive management system practised by majority of farmers does not make provision for adequate feeding since animals are allowed to scavenge. Thus the necessary adjustments required in the nutrition of the animals when they are pregnant or lactating is missing. In a few instances where the animals may be tethered, especially in the growing season, the supplementation in form of kitchen wastes may not in most cases exceed the maintenance requirement of the animal.

Goats being ruminants feed mainly on roughage (grasses, legumes, browse, plants and crop residues). The time during which

these roughages can meet the requirements of these animals in a year is short especially in the sahelian zone where the growing season is short. Thus it is necessary to give them supplements with rich sources of protein, energy or both. The level of supplementation, however depends on the physical and physiological state of the animal and the quality and quantity of the roughages being fed to the animal. Poor quality roughages can be supplemented with legume hays.

For a large scale commercial operation however, the grazing of well established pasture supplemented with mixed concentrate is recommended. Some of the available supplements that are required on the farm to feed goats include:-

Cotton seed, Cotton seed cake, Yam peels, Cassava peels, Brewers dried grains, Rice bran and Palm kernel cake.

Devendra (1967e) found that estimates of digestive efficiency in goat are comparable to those reported for other ruminants. Gross Efficiency (G.E.) estimates varied from 5.5 to 9.0% and Net efficiency (N.E.) from 14.1 to 15.5%. These are in agreement with estimates for G.E. of 5.1-8.0% and N.E. of 11.8-14.8% for steers in South Africa (Luitingh, 1963). The goats in Devendra's experiments were found to give better live weight responses with improvement in the plane of nutrition.

Despite the above reports on goat's similarity to other livestock in general digestive efficiency, there is considerable evidence that it is exceptionally efficient at digesting crude fibre (cellulose). The apparent ability of goat to digest some

feeds more efficiently has been confirmed by studies in India (Mia et al, 1960a, 1960b; Jang and Majumdar, 1962).

2.7.1a Dry Matter Intake

The dry matter intake of goats is a primary consideration since it indicates their capacity, in terms of voluntary intake, to utilise food. Mackenzie (1967) quoted recommendations from a number of practical goat manuals which provide for a dry matter intake of 5-7% of live weight for dairy goats, and these figures are supported by data quoted from Brody's experiments (1938). Mackenzie concluded that the minimum appetite of the goat is about 2.27kg of dry matter per 45.4kg body weight, and that well bred, productive goats can extend their intake capacity to over 8.5% of body weight. Available evidence also indicate that sheep and goats, showing positive balance of major nutrients would require $58g/W_{kg}^{0.75}$ or 2.8% of their body weight as dry matter (DM) daily.

Available data on sheep and goats (Adu, Olaloku and Oyenuga, 1974; Akinsoyinu, Mba and Olubajo, 1975a; Adu, 1981) showed a high increase in DM intake ($97.5g/day/W_{kg}^{0.75}$) at mid pregnancy, which declined to $71.8g/day/W_{kg}^{0.75}$ during the last one-third of pregnancy. This pattern of feed intake is apparently due to the influence of pregnancy, as a reduction in the volume of abdominal cavity limits the distension of the digestive tract and reduces feed intake.

It is well known that high ambient temperature tends to depress both appetite and productivity, and this adaptive response

occurs in goats as in other species. Since food intake and heat production are inversely related, rising temperature leads to a decreased intake which in turn reduces heat production (Appleman and Delouche, 1958).

Thus, in 30° and 35°C environments heat production was decreased by lower food consumption and by reduced rumination and activity. The practical implication of these findings is that although goats are capable of adapting themselves to tropical temperatures, provision of shelter, particularly during the heat of the day, is very essential.

2.7.1b Energy Requirement for Maintenance

Conventionally the energy for maintenance is that amount required for no gain or loss in body tissues. The nutrients are such that they are just adequate to meet the basic requirements for body function.

Maintenance need could also be calculated by extrapolation of the graph relating energy or DM intake to liveweight changes.

Mean values in literature (Akinsoyinu, 1974; Olatunji, 1974; Adu,1975) show that 100kcal ME/day/$W_{kg}^{0.75}$ is acceptable as the maintenance requirement for sheep and goat, using extrapolation technique. This value agrees with similar estimates recorded for cattle (Moe, Tyrell and Flatt, 1970, Adebowale, 1976).

The average ME for maintenance increases during pregnancy and lactation to 170 for sheep (Adu, 1975) and 174kcal/$W_{kg}^{0.75}$ for goat (Akinsoyinu et al, 1975). Heat production of lactating and pregnant

animals is higher than that in the dry state due to additional energy required for milk and foetus (Ritzan and Benedict, 1938). This may account for an increase of 70% and 74% observed for sheep and goat respectively over the requirement of their non-lactating and non-pregnant counterparts, for maintenance. Hutton(1962) reported an increase of 87% for dairy cattle.

Daily ME needs for growth stands at 599kcal/$W_{kg}^{0.75}$ per kg for goat (Akinsoyinu, 1974) and approximately 857 kcal/$W_{kg}^{0.75}$ for sheep (Olatunji, 1974; Adu and Olaloku, 1976). These values represent 81% and 118% respectively, of the NRC (1975) recommendation.

2.7.1c Protein Requirement

"The maintenance requirement for protein, in terms of digestible crude protein per day, can be calculated from the endogenous urinary nitrogen (E.U.N.), taking account also of the metabolic faecal nitrogen (M.F.N.)" A.R.C. (1980). The maintenance requirement of digestible crude protein (D.C.P.) in g per kg live weight equals 6.25 (E.U.N. x 100 / BV) + M.F.N. (100/BV-1) where E.U.N. and M.F.N. are as g nitrogen per day per kg live weight and BV is the biological value (Devendra and Burns, 1970).

Adegbola (1974) obtained from N-balance experiment, a DCP estimate (g/day/$W_{kg}^{0.75}$) of 0.73 for sheep compared to 0.65 for lamb (Ikhatua and Adu, 1981) and 0.63 to 0.68 for goat (Akinsoyinu, 1974) for maintenance. These results compared favourably with 0.9g DCP per kg liveweight (0.7g/$W_{kg}^{0.75}$) for goat (Mackenzie, 1967) and 0.76 to 0.88, the generally accepted factorial value of 0.51

g/day/$W_{kg}^{0.75}$ was obtained for goats fed browse (cassava leaves, supplemented with cassava peels), Onwuka and Akinsoyinu, 1985.

Evidence (Akinsoyinu, 1974; Akinsoyinu et al., 1976; Onwuka and Akinsoyinu, 1985) showed that a 20kg goat gaining 200 to 270g liveweight daily, would need a DCP intake of 1.8g/day/$W_{kg}^{0.75}$ giving a requirement of 0.06 g DCP/day/$W_{kg}^{0.75}$ per g liveweight gain. Thus a 20 kg goat gaining 270g daily requires 97.2g DCP (9 x 10.8). ARC (1980) recommended 80g available protein (AP) per day for sheep of similar liveweight gain of 300g per day. This AP (80g) amounts to 87.5g DCP, which is in close agreement with 97.2g DCP. Adu and Osinowo (1985) reported 75.4g DCP for 20kg (mean liveweight) Yankasa sheep, gaining 200g liveweight per day. This compares with previous results (Adegbola, 1974), which amount to a mean value of 0.1g DCP/day/$W_{kg}^{0.75}$ for maintenance and growth.

The protein requirement of the indigenous sheep and goat during pregnancy and lactation is yet to receive much attention. Two reports showed that ewes required 10.5g DCP/$W_{kg}^{0.75}$ and does 12.1g/$W_{kg}^{0.75}$ daily (Akinsoyinu, 1974) during pregnancy and lactation. These estimates appear to be reasonable since all the animals were in positive N-balance throughout the experiment.

2.7.1d Mineral and Vitamin Requirements

In West Africa it has been considered that phosphorus is a limiting factor in the nutrition of ruminant livestock (Lansbury, 1962), and evidence of deficiency was supported by beneficial re sponses when it was fed as a supplement. The natural grassland of

West African savannah regions seldom supplies sufficient phosphorus to maintain animals in good health for more than a few weeks at the beginning of the rainy season (Devendra and Burns, 1970). For most of the year levels are extremely low and are frequently below the minimum safety levels. Calcium, as well as phosphorus deficiencies have been reported in parts of Kenya, the coastal regions of Brazil and Argentina. Goats by their wide browsing habits may often avoid mineral deficiencies which afflict other species thus they meet their requirements for good health and productivity.

Various reports and reviews (Lamand, 1981; ARC, 1980;NRC, 1975 and 1981) on deficiency symptoms of trace elements in nutrition suggest that sheep and goat diets should provide (mg/DM) Fe 15.0, Cu 7.0, Co 0.07, Iodine 0.15, Mn 45.0, Zn 45.0, Se 0.1, and Mo 0.2. Lower levels could result into symptoms like anaemia for Fe, Cu, Co, skeletal deformation for Cu, Mn, Zn, ataxia, muscular dystrophy and dyspanes for Se, dermatitis and hoof deformation for Zn, and goitre for Iodine deficiencies.

In general, the majority of vitamins are readily available and goats in the tropics are not known to be handicapped by periodic reduced availability. For instance, in prolonged dry seasons, there is no cause for noticeable deficiency due to shortage of vitamins, under normal feeding practice (Oyenuga and Akinsoyinu, 1976)

2.7.1e Water Requirements

Water is an absolute necessity for all classes of livestock, and lack of access to an adequate supply can be a serious limiting

factor in many parts of the tropics (Payne, 1966). The requirement for water is affected by factors such as the amount of dry matter eaten, the nature of the food, individual variation, physiological condition, temperature of drinking water, ambient temperature and even frequency of drinking. When ambient temperature is high, water is consumed in excess of metabolic needs as it is essential for evaporative cooling.

The demand for water increases in the dry season, which is often the season at which ambient temperatures are highest. The water content of available forage as well as its nutritional value tends to be very low during this period, and there is also depletion in surface water resources.

The cooler weather following the rains reduces the intake of water by the animal. This was reported by Appleman and Delouche (1958).

2.7.1f Ratio of Dry Matter to Total Water Intake

The effects of water on nutrition of goat are generally important. Dry matter and water intakes have been shown to be strongly correlated in sheep (Lloyd et al,1962) and in cattle (French, 1956a). An inadequate supply of water thus reduces intake of dry matter and this restriction has been shown to be more severe at higher ambient temperatures (Bianca et al, 1965). In addition, the low nutritive value of available herbage in the drier parts of the tropics (French, 1957, Whyte, 1967) may further affect the animal by decreasing voluntary food intake (Crampton, 1957; Blaxter

et al., 1961, Payne, 1965). The combined effects of these factors on voluntary food intake can lead to severely lowered productivity.

Mackenzie (1967) suggested that the ratio of dry matter to total water intake required by dairy goats for maximum milk yield under British conditions is 1:4 to 5. In the studies on the water consumption of penned meat-type goats Devendra (1967d) found the ratio to be 1:4.4. As part of adequate feeding, water is important for efficient utilization of the feed nutrients and proper body functioning.

CHAPTER TWO

MATERIALS AND METHODS

LOCATION OF EXPERIMENT

The study was carried out at the National Animal Production Research Institute, (NAPRI) Shika, Zaria, Nigeria, on latitude 11° 12'N, longitude 7° 33'E and 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 to 35°C. Data on climatic variables were obtained from the Institute for Agricultural Research Meteorological station, Samaru, Zaria for the experiments conducted in this study. There are 4 main seasons viz: Hot dry season (January - March), Early wet season (April - June), Late wet season (July - September); and Cold dry season (October - December).

System of Management of Animals

The Red Sokoto goats used in this study were managed semi-intensively and they were individually identified by means of numbered plastic eartags. At 0800 hours each day animals were housed in individual feeding pens for the period of supplementation. The goats were allowed to graze in specified paddocks with natural pastures after the period of pen feeding

under supervision of a herdsman till 18.00 hours before they were returned to their enclosures (pens) at night to drink water and to pass the night.

At the commencement of the experiment, the selected animals were dipped with an acaricide (Stelladone) against ectoparasites and dewormed with an anthelmintic (Banminth F) against endoparasites.

Experimental Procedure

The experiment was carried out in two phases namely:

Phase 1: Effects of sun-dried cassava peels on feed intake and liveweight gains in non-pregnant Red Sokoto does prior to breeding

Sun-dried cassava peels were used as an energy source to replace maize offal at levels of 0, (Treatment 1) 18.5, (Treatment 2) 37.0, (Treatment 3) 55.0, (Treatment 4) and 74.0% (Treatment 5) in the rations. A sixth ration (Treatment 6) comprised only cotton seed cake and common salt.

Thirty non-pregnant Red Sokoto does aged between 1.5 and 2 years were weighed and equally alloted to six treatments (1 to 6) in a Randomized Block Design. Each animal was put into an individual feeding pen at 0800 hours each day and given a weighed amount of appropriate ration (Table 3.1) equivalent to 1.5% of its weekly body weight. They were allowed 2 hours to eat the rations provided and fresh clean drinking water was provided to them ad libitum before being released to graze on natural pasture. The left overs of the rations in the individual pens were weighed so as

to determine the daily intake of the animals before they were sent grazing. Samples of the rations offered and the left overs were separately taken on weekly basis and bulked for proximate analysis while the animals were weighed regularly on weekly basis before feeding so as to determine any liveweight change for the first phase of the experiment which lasted 6 weeks.

Data for animals later discovered to be pregnant were discountenanced and so the experiment became an unbalanced design. Parameters measured were later transcribed for computer analysis.

TABLE 3.1: RATIONS SUPPLEMENTED

Treatment/ Ration	MAIZE OFFAL (%)	CASSAVA PEELS (%)	CSC(%)	COMMON SALT (%)
1	74.0	-	25.0	1.0
2	55.5	18.5	25.0	1.0
3	37.0	37.0	25.0	1.0
4	18.5	55.5	25.0	1.0
5	-	74.0	25.0	1.0
6	-	-	99.0	1.0

Phase 2: Effects of sun-dried cassava peels on feed intake and liveweight gain and reproductive performance of Red Sokoto does during pregnancy

The second phase of the experiment was an offshoot of the first and the animals were maintained in their respective treatments using the same procedures for feeding and grazing on the selected paddock as were used in phase 1.

At the commencement of this phase, a proven breeding buck was introduced and allowed to run with the does. A breeding harness with crayon was fitted ventral to the sternum of the buck. The does were examined at 1800 and 0730 hours of the following day for marks of the crayon on their rump. The day the crayon mark was observed on the does was recorded as the breeding day. The buck was withdrawn after all the does had been bred.

Parameters which include the date of kidding, litter size, type of birth, birth weight, litter weight season of birth and sex

of kid(s) were recorded and later transcribed for computer analysis.

Inventory and abundance of plant species

An inventory (botanical survey) of the plant species in the grazed paddock (5ha) was undertaken at the beginning of the study. In addition, visual estimate to determine the relative abundance of each species was carried out. One hundred guadrats (1m x 1m) were observed per hectare in the paddock. Plant species in each quadrat were rated either as present (rare), common, abundant or most abundant.

The different pasture species identified to be grazed by the animals and rated to be of medium to high acceptability/ palatability were sampled weekly for chemical analysis.

Laboratory analysis

Samples of rations and pastures were chemically analysed. The DM, total N, ether extract and ash were determined by the methods of the Associaton of Official Analytical Chemists (AOAC, 1984). The neutral detergent fibre (NDF) and acid detergent fibre (ADF) were determined by the methods of Van Soest (1965), and Van Soest and Wine (1967).

Statistical analysis

The data collected were analysed for feed and nitrogen intakes and conversion, and reproductive performance using the General Linear Models Procedure and the Duncan's Multiple Range Test of the Systems Analytical Statistics package (SAS, 1987).

Cost Analysis of Rations

The cost of each kilogramme of the rations was evaluated to determine the cheapest ration.

CHAPTER THREE

RESULTS

1. CHEMICAL ANALYSIS OF THE SUPPLEMENT RATION AND GRAZED FORAGES

The results of the chemical analysis of the supplement rations and grazed forages are given in Tables 4.1 and 4.2 respectively. The crude protein (CP) content of the energy-based rations decreased systematically from 18.6 in ration 1 to 11.4% in ration 5. Ration 6 being primarily a protein supplement contained 23.5% CP. The NDF, ADF, EE and ash of the supplements never showed any definite trends.

Table 4.2 shows that generally, the herbaceous and shrub legumes contained more CP than the grasses. While the grasses contained between 4.9 and 7.6% CP, the CP in the other plant species, except for Aspilia africana, ranged from 7.1 to 15.9%.

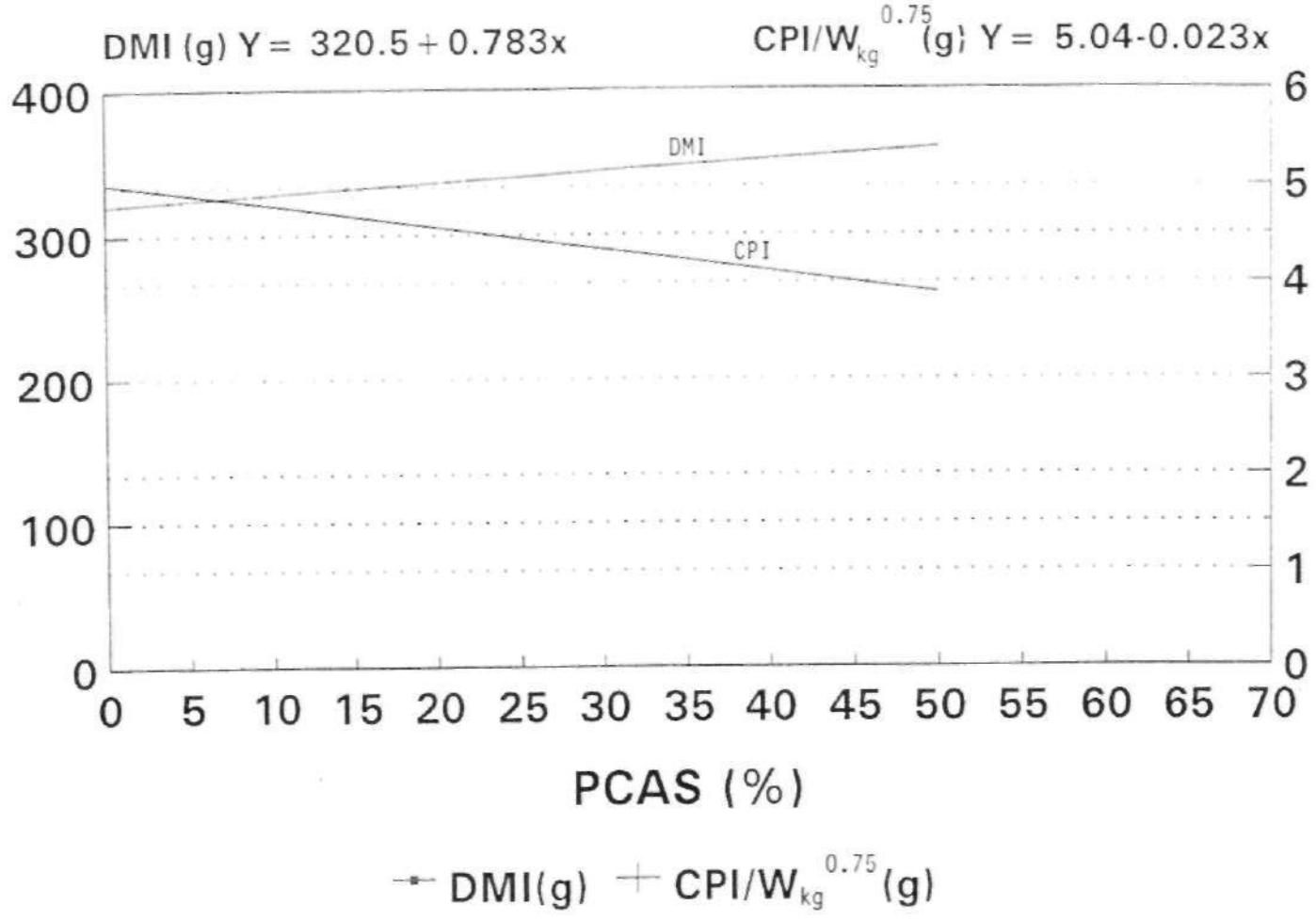
Table 4.3 shows an inventory of the plant species in the grazed paddock. Most of the moderately to highly palatable species were of the family, Papilionaceae. The species in the Compositae, Rubiaceae, Caesalpiniaceae, Tiliaceae, Scrophulariaceae and Sterculiaceae were mostly of low acceptability in the forage value rating.

Table 4.1: Chemical composition of supplement rations (%)

Ration	DM	Ash	EE	NDF	ADF	CP
1.	90.2	4.2	4.5	55.6	21.8	18.6
2.	93.1	10.9	4.1	44.5	23.4	16.5
3.	90.6	6.2	2.9	49.1	29.9	13.6
4.	91.2	7.0	1.4	46.8	31.0	12.8
5.	88.0	7.2	3.3	54.1	35.6	11.3
6.	93.4	5.2	4.6	65.9	41.7	23.5

Fig. 4.1: Response to PCAS

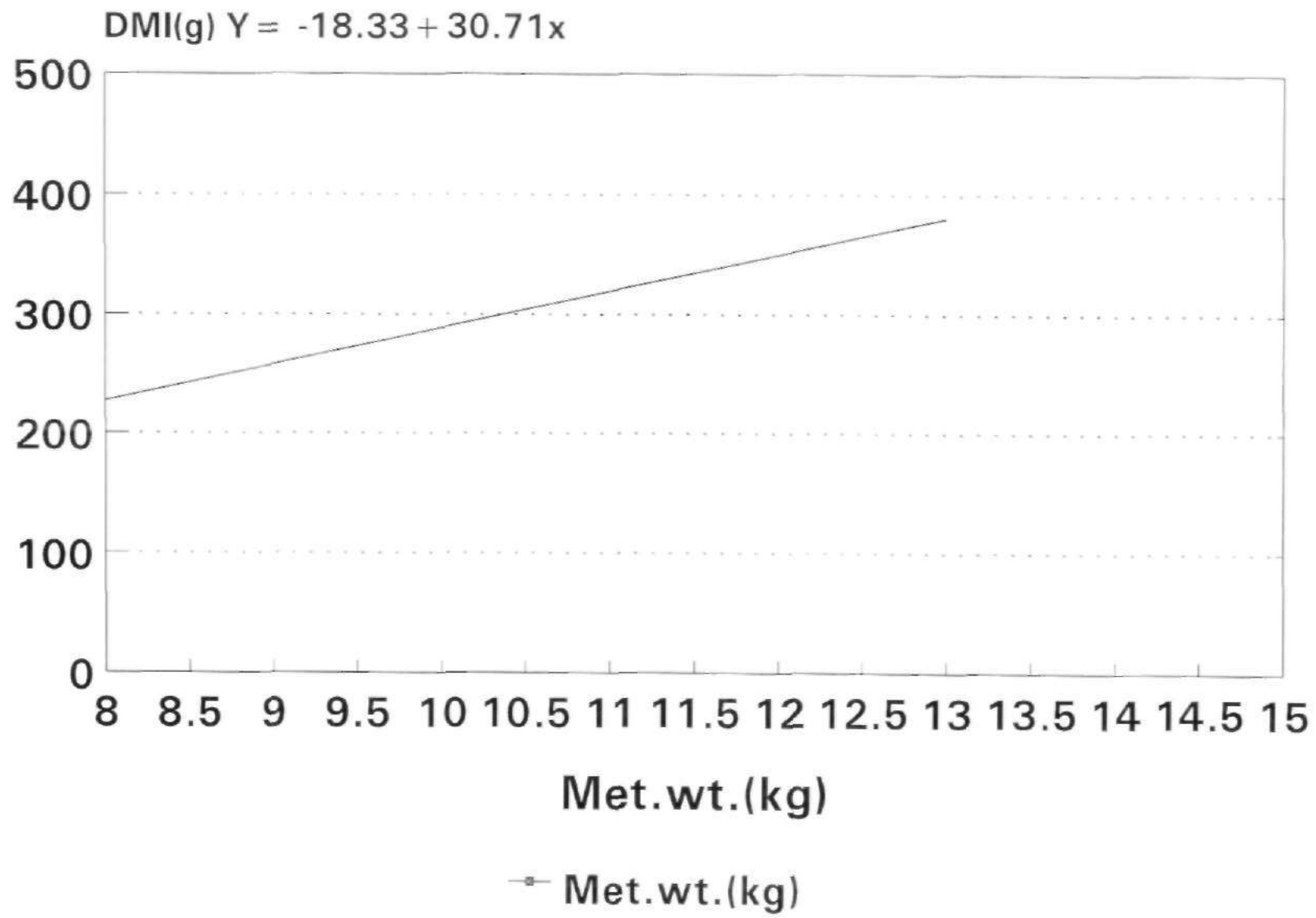
Regression of DMI and CPI/$W_{kg}^{0.75}$ on PCAS



PCAS = %Cassava level
DMI = Daily dry matter intake
CPI = Crude protein intake/Met. wt.

Fig. 4.2: Response to Met. wt.

Regression of DMI on Met. wt.



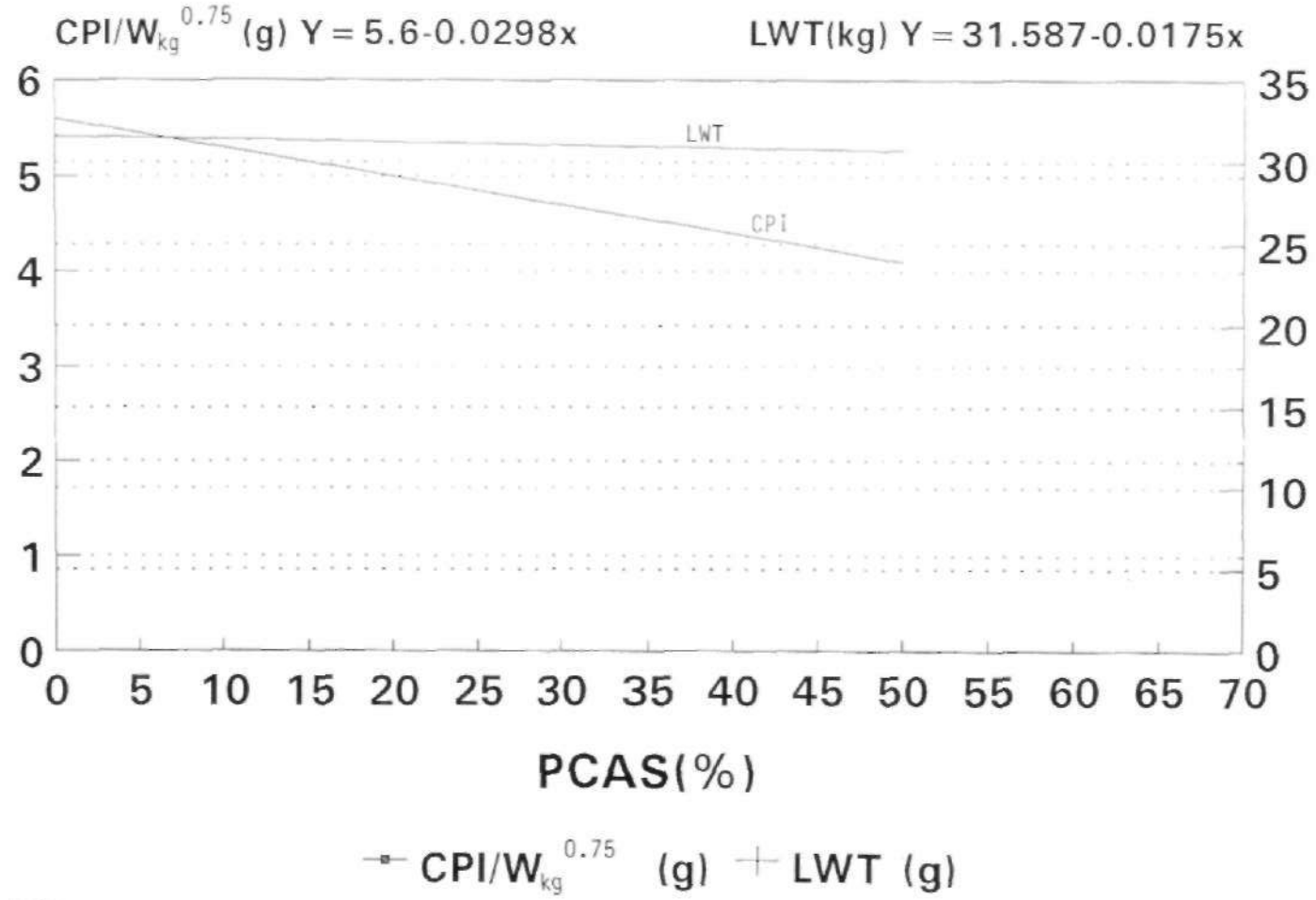
Met.wt. = Metabolic weight
DMI = Daily dry matter intake

TABLE 4.2: Chemical composition of grazed forage (%)

Forage	DM	Ash	NDF	ADF	N	CP
Gramineae:						
Andropogon gayanus	93.2	12.1	73.7	52.8	0.7	4.9
Chloris pilosa	94.2	15.6	71.3	46.4	1.1	6.9
Panicum phragmitoides	94.1	15.7	70.6	39.1	1.1	7.0
Setaria anceps	93.8	4.2	75.1	40.1	0.9	6.0
Urelytrum nuricatum	93.8	15.6	68.7	38.0	1.2	7.5
Caesalpiniaceae:						
Piliostigma thonningii	92.8	7.1	57.7	45.5	1.1	7.1
Compositae:						
Aspilia africana	93.3	20.6	62.7	46.9	0.7	4.3
malvaceae:						
Sida rhombifolia	91.7	4.9	60.3	40.1	1.9	12.3
Urena lobata	92.2	9.6	53.1	37.8	1.7	10.6
Papilionaceae:						
Desmodium velutinum	93.0	7.2	66.3	45.0	1.6	10.3
Indigofera arrecta	92.6	7.1	52.1	43.6	2.5	15.8
Indigofera pulchra	92.9	11.8	54.5	38.6	1.4	9.0
Stylosanthes hamata	93.6	6.6	68.6	52.7	1.2	7.5
Tephrosia linearis	93.2	5.1	80.8	80.7	1.6	10.0
Zornia diphylla	92.1	5.5	59.3	45.1	1.9	11.9

Fig. 4.3: Response to PCAS

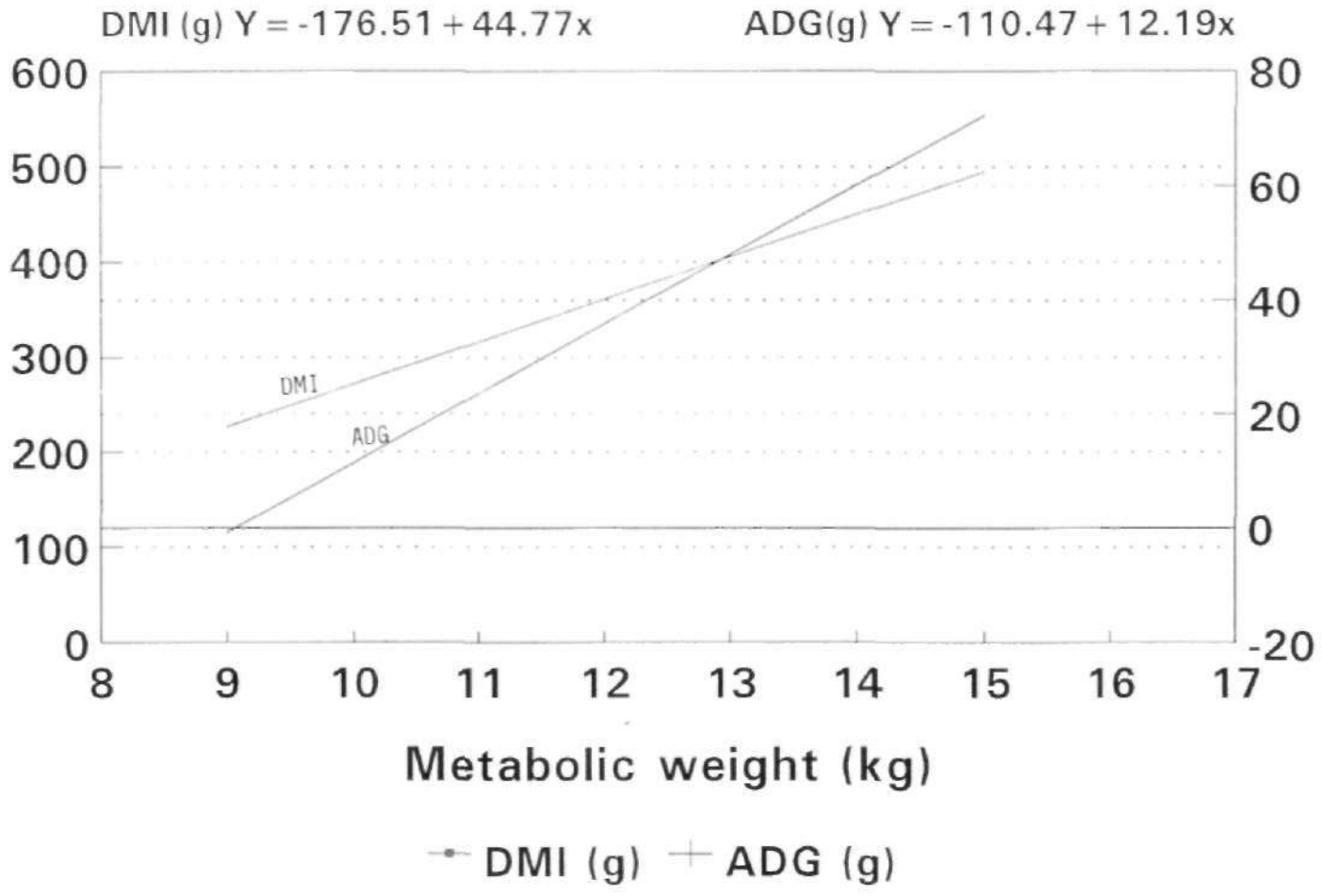
Regression of $CPI/W_{kg}^{0.75}$ and LWT on PCAS



$CPI/W_{kg}^{0.75}$ = Crude protein intake/Met.wt
LWT = Liveweight
PCAS = %Cassava level

Fig.4.4: Response to Met.wt.

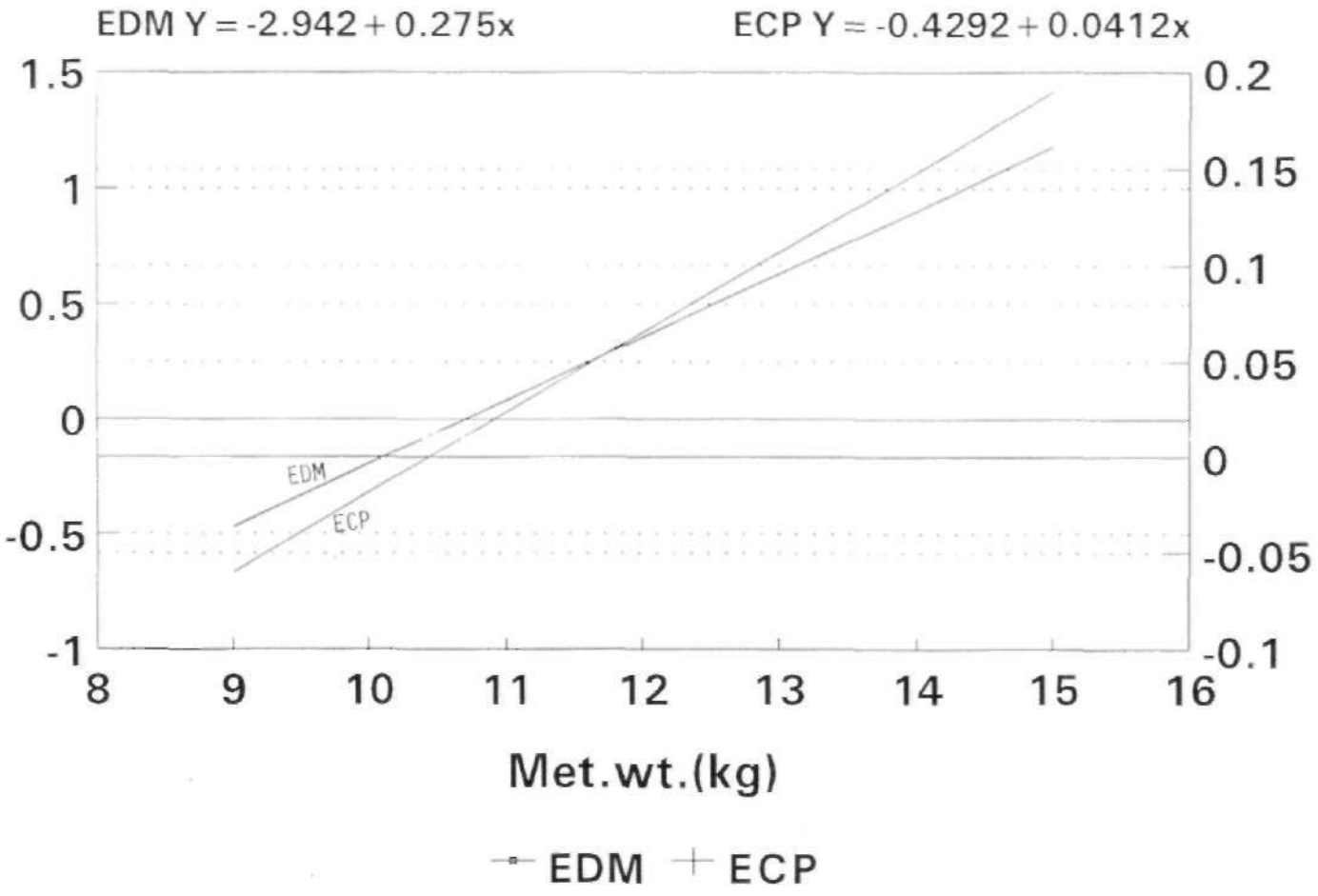
Regression of DMI and ADG
on Metabolic weight



DMI = Daily dry matter intake(g)
ADG = Average daily gain (g)

Fig.4.5: Response to Met.wt.

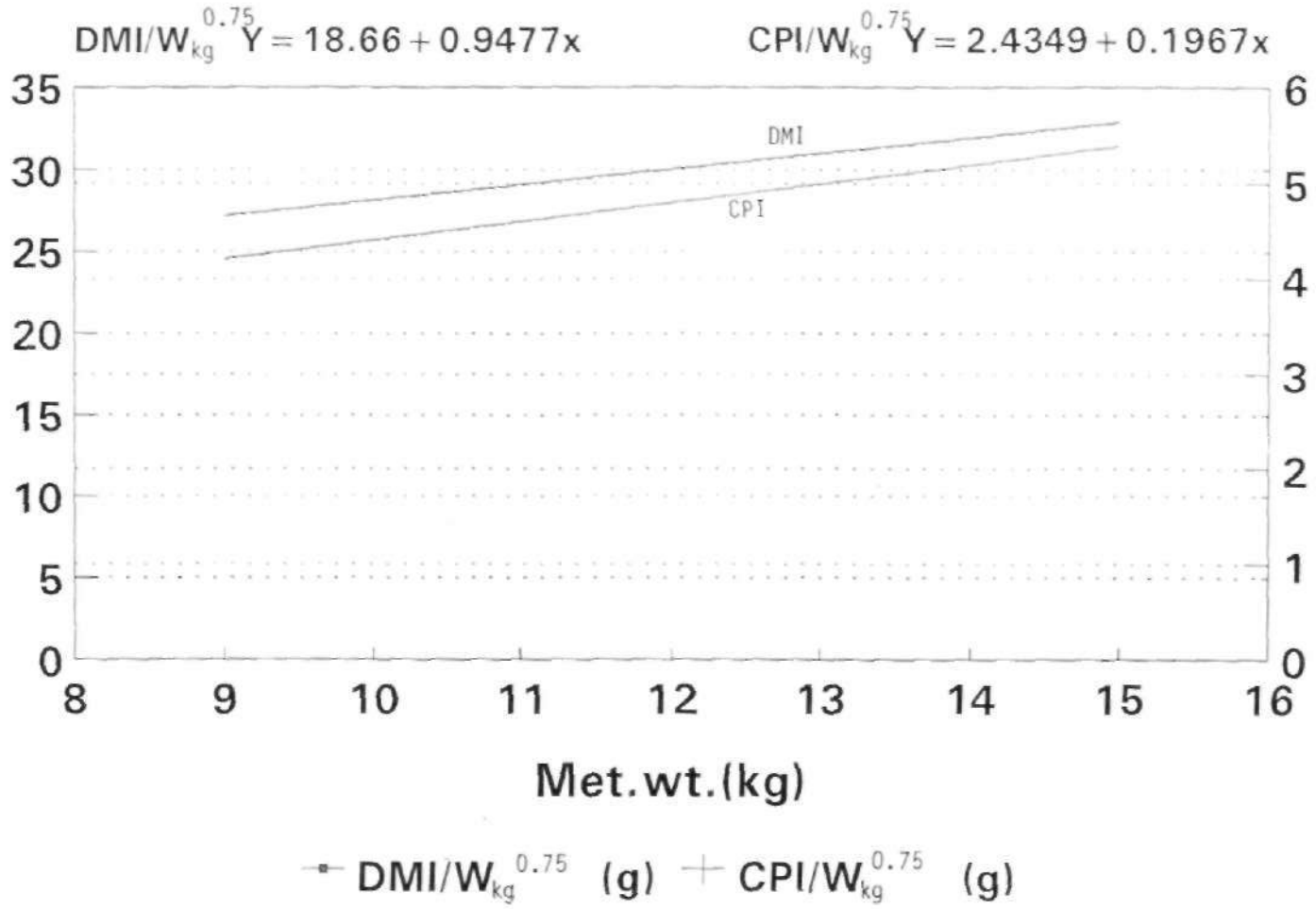
Regression of EDM and ECP on Met.wt.



EDM = Efficiency of feed conversion
ECP = Efficiency of crude protein
Met.wt. = Metabolic weight

Fig.4.6: Response to Met.wt.

Regression of DMI/MWt. and CPI/MWt.



DMI = Feed intake/Met.Wt.
CPI = Crude protein intake/Met.wt.
Met.wt. = Metabolic weight

Table 4.3: Inventory of plant species in the grazed paddock

Family/ Sub-family	Plant Species	RAR	FVR
Gramineae	*Andropogon gayanus*	xx	3
	A. Schirensis	xx	2
	Chloris pilosa	xx	2
	Digitaria tanata	x	3
	Elionurus pobeguinii	xx	1
	Hyparrhenia rufa	x	3
	Loudetia simplex	x	1
	Monocymbium ceresiiforme	x	3
	Panicum phragmitoides	x	3
	Pennisetum pedicellatum	xx	3
	Setaria anceps	xx	3
	Sporobolus pyramidalis	xxx	1
	Urelytrum muricatum	x	2
Caesalpiniaceae	*Cassia nigricans*	xx	1
	C. rotundifolia	x	1
	C. tora	x	1
	Isoberlinia doka	xx	1
	Piliostigma thonnigii	x	2
Compositae	*Ageratum conyzoides*	xx	1
	Aspilia africana	xxx	2
	Blumea aurita	x	1

Table 4.3: (Continued)

Malvaceae:	*Sida rhombifolia*	xx	2
	Urena lobata	xx	3
Papilionaceae:	*Desmodium velutinum*	x	2
	Indigofera arrecta	xx	3
	I. dendroides	x	2
	I. secundiflora	x	1
	Stylosanthes hamata	xx	3
	Tephrosia bracteolata	x	3
	T. Linearis	x	3
	T. pedicellata	x	2
	Zornia diphylla	x	2
Rubiaceae:	*Borreria radiata*	xx	1
	B. verticillata	x	1
Scrophulariaceae:	*Striga species*	x	1
Sterculiaceae:	*Waltheria indica*	xx	1
Tiliaceae:	*Corchorus tridens*	x	1

Key
RAR = Relative Abundance Rating
x = Present/Rare
xx = Common
xxx = Abundant
xxxx = Most abundant
FVR = Forage Value Rating
1. = Low acceptability/palatability
2. = Medium acceptability/palatability
3. = High acceptability/palatability

Phase 1: Effects of sun-dried cassava peels on feed intake and liveweight gain in non-pregnant Red Sokoto does prior to breeding

Table 4.4 shows daily dry matter intake (DMI(g)/head) and crude protein intakes and efficiencies of dry matter (EDM) and crude protein utilization (ECP). The DMI(g)/head of the ration was significantly different for treatments 1, 2, 3, 5 and 6. The highest intake was in treatment 4 with 55.5% cassava peels inclusion in the ration.

The mean daily crude protein intake/head (CPI) was lowest in treatment 5 (39.5g), where the level of cassava peel was highest (74%). The CPI was significantly ($P<0.05$) highest in treatment 6 where supplementation was with cotton seed cake only and this value was 86.0g . The CPI in treatments 1,2,3 and 4 were not significantly ($P>0.05$) different. Treatments 3 and 5 were also statistically similar. The CPI in rations 1 to 3 and 5 decreased as the level of cassava peel increased.

The efficiency of dry matter conversion (EDM) and efficiency of crude protein utilization (ECP) were best in treatment 3 (0.02 and 0.003 respectively Table 4.4). The energy and protein based diets were similar in the EDM and ECP.

Table 4.5 shows the initial liveweight (INWT), mean liveweight (LVWT), and the average daily gain (ADG). The highest ADG was 107.1g obtained in treatment 4 and the least liveweight gain was 40.8g in treatment 5 which did not differ significantly ($P>0.05$). The overall ADG was 77g for this study.

Phase 1: Effects of sun-dried cassava peels on feed intake and liveweight gain in non-pregnant Red Sokoto does prior to breeding

Table 4.4: Means of dry matter intake (DMI) and crude protein intakes (CPI) and efficiencies of dry matter (EDM) and crude protein utilization (ECP)

Treatment	DMI/head (g)	CPI	EDM	ECP
1	311.6[b]	58.0[b]	0.94	0.175
2	335.8[b]	55.4[b]	2.12	0.351
3	352.7[b]	48.0[bc]	0.02	0.003
4	437.0[a]	56.3[b]	2.59	0.334
5	347.6[b]	39.5[c]	1.64	0.187
6	336.1[b]	86.0[a]	0.80	0.189
Overall mean	353.5	57.2	1.35	0.21
SED	±7.86	±2.01	±0.04	±0.07

[a,b,c] Means within column with different superscripts differ significantly ($P<0.05$).

Phase 1: **Effects of sun-dried cassava peels on feed intake and liveweight gain in non-pregnant Red Sokoto does prior to breeding**

Table 4.5 Liveweight response to supplementation

Treatment	INLW (kg)	Mean LVWT (kg)	ADG (g)
1	26.8	27.6[b]	84.4
2	24.8	25.3[b]	84.0
3	28.1	28.6[ab]	63.9
4	28.0	31.1[a]	107.1
5	26.0	27.2[b]	40.8
6	25.7	27.6[b]	81.6
Overall Mean	26.6	27.9	77.0
SED	±0.422	±0.431	±13.79

[a,b] Means within column with different superscripts differ significantly ($P<0.05$).

Table 4.6 shows the regression equations with percent cassava peel inclusion as independent variable. The DMI/head and CPI/$W_{kg}^{0.75}$ were significantly ($P<0.05$ and $P<0.01$ respectively) related with the level of cassava peel inclusion. The relationship with DMI was positive while it was negative for CPI$W_{kg}^{0.75}$ (Fig 4.1). The other dependant variables, i.e. DMI/$W_{kg}^{0.75}$, ADG, EDM and ECP were not linearly related to the level of cassava peel inclusion in the diets.

The regression equations with metabolic weight as independent variabdle are given in table 4.7. The DMI was significantly ($P<0.01$) and postively (Fig. 4.2) related to the metabolic weight. All the other variables were not significantly related to the metabolic weight.

Phase 2: Effects of sun-dried cassava peels on liveweight gains and reproductive performance of Red Sokoto does during pregnancy

Table 4.8 gives the daily dry matter intake (DMI), daily crude protein intake (CPI) and efficiencies of dry matter conversion and crude protien utilization. (EDM and ECP) respectively. The DMI in treatment 6 did not differ significantly from others except treatments 1 and 5. Although treatments 1 and 5 did not differ significantly, the lowest DMI of 379.17g/head was recorded in treatment 5 which had the highest cassava peel content. The EDM and ECP were not significantly ($P>0.05$) different for all the treatments.

TABLE 4.6 Regression equation table with percent cassava peel inclusion as independent variable

Dependent variable (y)	a	b	Probability	R-Square
Daily dry matter intake(g)	320.50	0.783	0.03	0.057246
Dry matter intake/$W_{kg}^{0.75}$	27.66	0.037	0.16	0.024613
Daily Crude protein intake/ $W_{kg}^{0.75}$	5.04	-0.023	0.0001	0.278071
Average daily gain (g)	87.23	-0.393	0.58	0.005205
Efficiency of dry matter conversion	1.13	0.003	0.88	0.000394
Efficiency of Crude protein utilization	0.22	-0.00099	0.75	0.001811

Phase 1: **Effects of sun-dried cassava peels on feed intake and liveweight gain in non-pregnant Red Sokoto does prior to breeding**

TABLE 4.7 Regression equation table with Metabolic weight as independent variable

Dependent variable (y)	a	b	Probability	R-Square
Daily dry matter intake (g)	-18.33	30.71	0.0001	0.315
Dry matter intake/$W_{kg}^{0.75}$	27.19	0.16	0.65	0.002052
Crude protein intake/ $W_{kg}^{0.75}$	5.45	-0.04	0.69	0.001459
Average daily gain (g)	-57.11	11.13	0.23	0.018531
Efficiency of dry matter conversion	-.51112	0.14	0.61	0.003338
Efficiency of Crude protein utilization	-.13868	0.03	0.55	0.0044

Phase 2: Effects of sun-dried cassava peels on feed intake, liveweight gain and reproductive performance of Red Sokoto does during pregnancy

Table 4.8: Means of daily dry matter and crude protein intakes (DMI & CPI) and efficiencies 0f dry matter and crude protein utilization (EDM & ECP)

Treatment	DMI/head (g)	CPI (g)	EDM	ECP
1	393.95^{bc}	72.83^{b}	0.360	0.067
2	415.39^{ab}	68.54^{c}	0.761	0.126
3	426.32^{a}	58.09^{d}	0.599	0.002
4	418.66^{ab}	53.90^{d}	0.293	0.038
5	379.17^{c}	43.13^{e}	1.138	0.129
6	438.71^{a}	103.10^{a}	1.057	0.248
Overall Mean	412.0	66.59	0.70	0.10
SED	±4.00	±0.948	±0.198	±0.033

^{a,b,c,d,e} Means within column with different superscripts differ significantly ($P<0.05$).

Table 4.9 shows the effects of supplementation on liveweight, and the average daily gain. The highest average daily gain of 67.4g was obtained in treatment 3 and the least liveweight gain of 14.3g was in treatment 4. Treatment 3 was significantly higher than only treatment 4 ($P<0.05$).

The highest final mean liveweight of 32.2kg was obtained for treatments 3 and 6. Treatments 1, 2, 4 and 5 were not significantly ($P>0.05$) different.

The regression equations on the percent of cassava peel inclusion in Table 4.10 showed that $CPI/W_{kg}^{0.75}$ had a significantly ($P<0.01$) linear and negative relationship (Fig 4.3). Although the final liveweight was significantly ($P<0.05$) but negatively related to the percent level of cassava peel inclusion (Fig. 4.3) DMI, $DMI/W_{kg}^{0.75}$, ADG, EDM, and ECP did not show any linear relationship.

Table 4.11 gives the regression equations on metabolic weight as independent variable. The DMI, EDM, $DMI/W_{kg}^{0.75}$ and $CPI/W_{kg}^{0.75}$ were significantly ($P<0.01$) and positively related to metabolic weight. The ECP and ADG were also significantly ($P<0.05$) and positively related to metabolic weight (Figs. 4.4, 4.5 and 4.6).

Table 4.12 shows the effect of supplementation on birth weight (BTWT), litter weight (LWT) weight loss due to kidding (WLDK) and litter size (LS). The difference between treatments was not significant ($P>0.05$) for BTWT, LWT, WLDK and LS.

Table 4.13 gives the effect of season on BTWT, LWT, WLDK and LS. Season had no significant ($P>0.05$) effect on BTWT, LWT and LS of the kids. However, weight loss due to kidding was significantly

(P<0.05) higher during the cold dry season (October - December).

No mortality was reported in this study. The twinning estimate was 42% while the single births was 54% and triplets was 4%.

Phase 2: Effects of sun-dried cassava peels on feed intake, liveweight gain and reproductive performance of Red Sokoto does during pregnancy

Table 4.9: Liveweight response to supplementation

Treatment	Mean LVWT (kg)	ADG (g)
1	31.35[ab]	37.68[ab]
2	30.80[ab]	60.63[ab]
3	32.17[a]	67.37[a]
4	30.16[b]	14.29[b]
5	30.15[b]	60.30[ab]
6	32.17[a]	60.37[ab]
Overall Mean	31.13	50.10
SED	±0.216	±6.30

[a,b,c] Means within column with different superscripts differ significantly (P<0.05).

TABLE 4.10: Regression equation table with cassava peel inclusion as independent variable

Dependent variable (y)	a	b	Probability	R-Square
DMI	411.886	-0.142	0.40	0.00123
$DMI/W_{kg}^{0.75}$	31.071	-0.0063	0.475	0.00090
$CPI/W_{kg}^{0.75}$	5.600	-0.0298	0.0001	0.48197
ADG	48.226	0.0119	0.96	0.000005
ECP	0.0810	0.00021	0.87	0.0007
LVWT	31.587	-0.0175	0.05	0.0067
EDM	0.416	0.0059	0.48	0.0012

Phase 2: Effects of sun-dried cassava peels on feed intake, liveweight gain and reproductive performance of Red Sokoto does during pregnancy

TABLE 4.11: Regression equation table with metabolic weight ($W_{kg}^{0.75}$) as independent variable

Dependent Variable (y)	a	b	Probability	R-Square
DMI	-176.51	44.77	0.0001	0.587
ADG	-110.47	12.19	0.0005	0.0243
EDM	-2.492	0.275	0.0122	0.0125
ECP	0.4292	0.0412	0.0256	0.0099
$DMI/W_{kg}^{0.75}$	18.66	0.9477	0.0001	0.1000
$CPI/W_{kg}^{0.75}$	2.435	0.1967	0.0001	0.0476

Phase 2: Effects of sun-dried cassava peels on feed intake, liveweight gain and reproductive performance of Red Sokoto does during pregnancy

Table 4.12: Effect of supplementation on Birth weight (BTWT), Litter weight (LWT), Weight loss due to kidding (WLDK) and Litter size (LS)

Treatment	BTWT (kg)	LWT (kg)	WLDK (kg	LS (g)
1	1.64	2.90	-4.88	1.75
2	1.54	2.24	-3.60	1.40
3	1.48	2.17	-4.33	1.40
4	1.50	2.10	-5.70	1.40
5	1.60	2.63	-4.50	1.60
6	1.75	2.25	-4.00	1.33
Overall Mean	1.59	2.38	-4.50	1.48
SED	±0.062	±0.201	±0.504	±0.112

Phase 2: Effects of sun-dried cassava peels on feed intake, liveweight gain and reproductive performance of Red Sokoto does during pregnancy

Table 4.13: Effect of season on Birth weight (BTWT), litter weight (LWT), weight loss due to kidding (WLDK), litter size (LS)

SEASON	BTWT (kg)	LWT (kg)	WLDK (kg	LS (g)
1 Hot dry season (Jan-Mar)	1.52	2.11	-2.75[a]	1.33
3 Late wet season (July-Sept)	1.73	2.29	-4.58[a]	1.33
4 Cold dry season (Oct-Dec)	1.52	2.79	-6.75[b]	1.88
Overall Mean	1.59	2.39	-4.69	1.51
SED	±0.062	±0.201	±0.504	±0.114

a,b Means within column with different superscript differ significantly ($P<0.05$)

CHAPTER FOUR

DISCUSSION

1. CHEMICAL ANALYSIS OF THE SUPPLEMENT RATION AND GRAZED FORAGES

The grazed natural pastures were relatively high in CP content because most of the species were in the vegetative stage. Higher CP contents and digestibility have been associated with pasture species during this stage compared with the flowering/seedling stage. Furthermore, the growth of the species was enhanced by the amount of rainfall (742.7mm) during the experimental period.

Preference for the leaf by grazing animals is higher than the stem part (Weir and Torrell, 1959). This was attributed partly to the higher CP content of the leaf over other parts of the whole plant (Henzell and Oxenham, 1964; Mears and Humphreys, 1974). In this study, the mean CP content of the whole plant of most species was above 7.0%, thus it could be inferred that the performance of the goats were not limited by the protein content of the herbage.

The ADF of the grass species except, *A. gayanus* and *C.pilosa*, were close to 39.2% recorded for most tropical grasses (Coward-Lord et al., 1974), in cutting experiments. On the other hand, the NDF values were within the range of 69.1 - 77.5% reported by Coward-Lord et al (1974). The exceptionally high NDF and ADF values of T.linearis cannot be explained. The NDF values for the grasses in this study were generally higher than other plant species.

Phase 1: Effects of sun-dried cassava peels on feed intake and liveweight gains in non-pregnant Red Sokoto does prior to breeding

The CPI in rations 1 to 5 decreased as the level of cassava peel increased because the proportion of the maize offal which contained higher CP than the peels decreased in the same direction. Even though the CP content in ration 6 was twice that of ration 5, this did not influence the DMI. This result doesn't agree with the findings of Rajpoot et al., 1981, Malachek and Provenza, 1981, Preston and Leng, 1986 who reported that decrease in crude protein content of feeds significantly inhibited the daily dry matter intake by the animals. this may be because none of the animals suffered dietary protein as deficiency none of the grazed pastures had CP less than 7.0%.

The energy and protein based diets were similar in the EDM and ECP indicating that the diet containing equal amounts (37% of maize offals and 37% of cassava peels) was the most efficient diet probably because the ration contained optimum protien: energy ratio for efficient utilization of nutrients.

The overall ADG for this study (77g) agrees with 55 - 80g and 35 - 65g reported by Nuru (1985) for Red Sokoto goats and West African dwarf goats respectively. From the study of Fomunyan and Meffeja (1987), sheep on diet containing either 70% or 30% sun-dried cassava peels in combination with 35% *Gliricidia sepium*, 35% *Panicum maximum* or both in varying proportions (w/w) were better than those solely on cassava peels which significantly ($P<0.05$) lost weight (-54.8g/day). Animals fed the best diet which was a

combination of 30% cassava peels with 35% *Gliricidia sepium* and 35% *Panicium maximum* gained 66.3g daily.

The difference in average daily gain (ADG) in sheep obtained by Fomunyan and Meffeja when compared with the present study must have been due to species differences and level of feeding.

The CPI/$W_{kg}^{0.75}$ decreased significantly (P>0.05) because the proportion of the maize offal which contained higher CP than the peels decreased in the same direction. This result also indicated that the replacement of maize offal with up to 74% cassava peels in the ration did not depress intake (DMI) which makes cassava peels acceptable to goats up to that level.

The metabolic weight had no effects on DMI which invariably shows that cassava peels can be used to totally replace maize offals which constituted up to 74% of the ration as supplement to does prior to breeding without having adverse effects on the liveweight changes in the does and it also indicated that metabolic weight did not depress intake of cassava peels.

Phase 2: **Effects of sun-dried cassava peels on liveweight gains and reproductive performance of Red Sokoto does during pregnancy**

Akinsoyinu, et al., 1976; showed that a 20kg goat gaining 200 to 270g liveweight daily would need a digestible crude protein (DCP) intake of 1.8g/day $W_{kg}^{0.75}$ giving a requirment of 0.06g DCP/day/$W_{kg}^{0.75}$ per (g) liveweight gain. This study showed much higher crude protein intake/$W_{kg}^{0.75}$/day (43.13 to 103.10g/head/day) for a daily weight gain of not more than 67.37g after conversion.

However Akinsoyinu (1974) made a recommendation of 12.1g/$W_{kg}^{0.75}$/day DCP for pregnant and lactating goats. This shows that pregnant does used in this study were more efficient than the recommendation made by Akinsoyinu for pregnant and lactating goats. This may be due to breed and ecologic differences.

The EDM was not significantly ($P>0.05$) different for all the treatments. Diet 4 was apparently the most efficiently utilized.

The ECP also did not differ significantly ($P>0.05$) but was apparently more efficient in the energy based diets probably because their higher energy to protein ratio enhanced better utilization than for ration 6. This result confirms the report of Boorman (1980) which stated that insufficient dietary energy prevents full utilization of dietary nitrogen and imposes a threshold on nitrogen retention which is lower than the maximum determined.

The overall ADG (50g) for the treatments was slightly lower than the 55 - 80g but within that reported by Nuru (1985) for Red Sokoto goats and West African Dwarf goats (35-65g). Fomunyan and Meffeja (1987), worked with sheep fed on diet containing 70% sun-dried cassava peels and 30% cotton seed cake which gained 227.1g daily. Ifut (1988) fed West African Dwarf goats with diets containing either 100 or 30% cassava peels in combination with *Gliricidia sepium,* Panicum maximum or both in varying proportions (w/w) and those entirely on cassava peels significantly ($P<0.05$) lost weight (-54.8g/day) while animals feels the best diet which contained a combination of cassava peels and 35% each of *Gliricidia*

sepium and *Panicum maximum* gained 66.3g daily. The weight gain obtained in this study compared well with those reported by Nuru (1985) and Ifut (1988). The higher weight gain in sheep obtained by Fomunyan and Meffeja (1987) than observed in this experiment must have been due to level of feeding and species differences.

The results have shown an increase in DMI when the pregnant animals used in phase 2 were compared to the non pregnant animals used in phase 1. The result is at variance with reports on sheep and goats (Adu, Olaloku and Oyenuga, 1974, Akinsoyinu, Mba and Olubajo, 1975, Adu, 1981) showing an increase in DM intake (97.8g daily/$W_{kg}^{0.75}$ at mid pregnancy, which declined to 71.8g daily $W_{kg}^{0.75}$ during the last third of pregnancy. The difference in the pattern of feed intake was probably due to the influence of pregnancy compared. The average daily dry matter intake which was 412g/head/day in this experiment was much lower than in the report cited above after conversion and this may have been due to breed differences and type of feed offered.

The results obtained in phases 1 and 2 have indicated that maize offal can be totally replaced with sun-dried cassava peels which constituted up to 74% of the ration as supplement to pregnant and non-pregnant Red Sokoto does without having adverse effects on the pregnancy or liveweight changes in the does.

The level of cassava peels in the diet did not significantly affect the BTWT, LWT, WLDK and LS. This could be because the cassava peels provided adequate energy for foetal growth and development as it replaced the maize offal in the diet. It may

also imply that cassava peels did not contain any component that was deleterious to the growth and development of the foeti.

Since the ration did not affect BTWT, LWT, WLDK and LS it indicates that cassava peels can successfully replace maize offals without affecting them adversely.

Cassava peels can be used to replace maize offal prior to kidding during the Hot dry season, Late wet season and Cold dry season without having any adverse effects on BTWT, LWT and LS. However, season of kidding had significant ($P<0.05$) effect on WLDK. This was more pronounced during the Cold dry season probably because of the more abundant feed resources during the preceeding late wet season which promoted the physiologic changes during pregnancy which may have led to retention of more body fluids in the cold dry season than in the hot dry season.

Goats had bigger litter sizes and birth weights in the cold - dry season. This was attributed to feed availability during the rainy season (Karua, 1989). This observation was not well confirmed with this result which indicated that goats had bigger litter sizes and smaller birth weights though not significantly different ($P>0.05$) in the cold dry season. This disparity could be attributed to breed differences and ecologic and seasonal variations as well as feeding management.

No mortality was reported in this study which indicates that cassava peels can be used totally to replace maize offal without causing any reproductive wastage such as abortion, stillbirth and preweaning mortality which have been identified as one of the major

constraints in small ruminant production, (Denis, 1974; Wilson 1976; Matthewman, 1977).

Adu et al. (1979) obtained an average of 32.6, 58.8, 7.2 and 1.8% of single, twin, triplet and quadruplet kiddings respectively in Red Sokoto goats. In this study, a higher percentage of singles (54%) and lower for twins (42%) and triplets (4%) were obtained than reported by Adu et al. (1979). The difference may have been because Adu et al. (1979) used the kidding records of 3 consecutive years and it is known that litter size is positively related to parity in goats (Shanmugasundaram, 1957, Adu et al., 1979).

This results show that goats are highly prolific and the inclusion of cassava peel in the diet has no deleterious effect on the birth type.

Cost analysis of rations

The present study showed that the cost of the ration decreased significantly ($P<0.05$) Table 4.14 as the level of cassava peels in the diet increased.

The cheapest ration (In terms of cost per kilogramme of ration) was ration 5 which had the highest cassava peel inclusion (74%). The most expensive ration was the protein-rich ration, Table 4.14.

Cassava peels (₦0.18) were considerably cheaper than maize offal (₦1.70) which cost nine times more, (Appendix 7).

Table 4.14: Mean cost/kg of rations taken (₦/kg)

Treatment	Phase 1	Phase 2
1	4.34[a]	5.38[a]
2	3.99[ab]	4.92[b]
3	3.51[b]	4.24[c]
4	3.49[b]	3.29[d]
5	2.09[c]	2.22[e]
6	5.73[d]	8.22[f]
Overall Mean	3.89	4.71
SED	±0.12	±0.06

a, b, c, d, e, f

Means within column with different superscripts differ significantly (P<0.05)

CHAPTER FIVE

CONCLUSION

The results obtained from this study show that cassava peels can successfully replace maize offal without adverse effects on feed intake, liveweight gains and reproductive performance of Red Sokoto does prior to breeding and during pregancy.

The results showed that without adjusting for energy, cassava peels can be used to replace maize offal in the ration for goats up to 74% level without adverse effects on the animals.

It was found that cassava peels offer a tremendous potential as a cheap source of energy for ruminants. It promotes liveweight gains and reproductive performance in goats. It was also discovered that as the level of cassava peels increased in the diet the cost of feeding the goats decreased.

Due to the high degree of competition for maize and its by-products by both man and livestock especially poultry without a concomitant increase in production of the grain, cassava peels would serve as a cheap alternative source of energy.

REFERENCES

Adebowale, E.A. 1976. Studies on dry matter, energy and protein Utilization of three breeds of dairy cow in Ibadan. Ph.D. Thesis, University of Ibadan, Ibadan, Nigeria.

Adebowale, E.A. 1981. The maize replacement value of fermented cassava peels (Manihot Utilissima Pohl) in rations for sheep. Tropical Animal Production 6: 66 - 72.

Adebowale, E.A. and Ademosun, A.A. 1981. Studies on the utilization of brewers dried grains by sheep and goats. 1. Growth studies. Bull. Anim. Hlth. Prod. Afr. 29: 365 - 370.

Adebowale, E.A. 1985. The performance of goats fed maize straws treated with organic waste ashes 10th Annual Conference, Nigerian Society for Animal Production. Univ. of Ife. Ile-Ife, Nigeria. Abstr. Pp. 6.

Adegbola, A.A. 1974. Digestion and utilization of protein in the West African Dwarf sheep. Ph.D. Thesis, University of Ibadan, Ibadan, Nigeria.

Adegbola, A.A. 1977a. Methionine as an additive to cassava - based diets. In: Proceedings, Cassava as Animal Feed Workshop, University of Guelph, 13-20 April 1977, Ontario, Canada, Pp. 9-17.

Adegbola, A.A. 1977b. Utilization of agro - industrial by products in Africa. In: New Feed Resources. Proceedings Technical Consultation, Rome, 22 - 24 Nov. 1976. F.A.O. Anim. Prod. Hlth Paper. Pp. 147 - 161.

Adegbola, A.A. 1980. New feed resources for Nigerian livestock. Discourses of Nigerian Academy of Science 2 (2) : 50 - 63.

Adegbola, A.A. 1982. Forage resources and beef production in Nigeria. In: Proceedings, National Conference on Beef Production 27 - 30 July 1982, Kaduna, Nigeria. Pp. 137-165 National animal Production Research Institute, Shika, Zaria, Nigeria.

Ademosun, A.A., Jansen, A.J. and Van Houtert, V. 1984. Research on goat management at the University of Ife. Paper Presented at Workshop on Small ruminant production systems in the humid zone of West Africa, ILCA, Ibadan, Nigeria.

Adeneye, J.A. and Oyenuga, V.A. 1976. Energy and Protein requirements of West African Dwarf Sheep. I. Effects of feeding four levels of dietary energy to Sheep. E. Afr. Agric. For. J. 42 (1): 89 - 97.

Adu, I.F. 1975. The effects of "steaming up" on the birth weight, lactation and growth of West African Dwarf sheep. Ph.D. Thesis. University of Ibadan.

Adu, I.F. 1981. Water intake of Yankasa ewes during late pregnancy. J. Anim. Prod. Res. 3: 49 - 56.

Adu, I.F. and Olaloku, E.A. 1976. Studies on Feed intake of the West African Dwarf sheep. E. Afri. Agr. For J. 42: 224 - 230.

Adu, I.F. and Ngere, L.O. 1979. The indigenous sheep of Nigeria. World Review of Animal Production 15: 3, 51 - 62.

Adu, I.F. and Lakpini, C.A.M. 1983. The utilization of dried Poultry waste a protein supplement for growing Yankasa sheep. J. Anim. Prod. Res. 3: 49 - 56.

Adu, I.F. and Osinowo, O.A. 1985. The effects of dietary protein concentration and feeding level on the performance of weaned lambs. J. Anim. Prod. Res. 5(1): 45-46.

Adu, I.F., Olaloku, E.A. and Oyenuga, V.A. 1974. Effects of energy intake during late pregnancy on lamb birth weight and lactation of Nigerian Dwarf sheep Niger. J. Anim. Prod. 1: 151 - 161.

Adu, I.F., Buvanendran, V. and Lakpini, C.A.M. 1979. The reproductive performance of Red Sokoto goats in Nigeria. J. Agric. Sc. Camb. 93: 563 - 566.

Ahmad, M.D. 1966. Genetic Aspects of Growth Rate and feed Utilization in Beef Cattle. Ph.D. Thesis, lowa state University, U.S.A.

Akinsoyinu, A.O. 1974. Studies on protein and energy utilization by the West African Dwarf goats. Ph.D. Thesis, University of Ibadan, Nigeria.

Akinsoyinu, A.O. and Akinyele, I.O. 1979. Major elements in milk of the West African Dwarf goats as affected by state of lactation J. Dairy Sci. 62: 921 - 924.

Akinsoyinu, A.O., Mba, A.U. and Olubajo, F.O. 1975a. Studies on energy and protein Utilization for pregnancy and lactation by the West African Dwarf goats in Nigeria, E. Afr. Agric. For. J. 4: 167 - 176.

Akinsoyinu, A.O., Mba, A.U. and Olubajo, F.O. 1975b. Studies on Comparative Utilization of Urea and groundnut cake rations by young growing West African Dwarf goats. II. Effects on Carcass quality and chemical Composition of the organs and

muscles. Nig. J. Anim. Prod. 2: 81 - 88.

Akinsoyinu, A.O., Mba, A.U. and Olubajo, F.O. 1976. Crude Protein requirements of West African Dwarf goats for maintenance and gain. J. Ass. Sci. Africa. 3: 75 - 80.

Akinsoyinu, A.O., Tewe, O.O., Ngere, L.O. and Mba, A.U. 1981. Milk Composition and Yield of the Red Sokoto (Maradi) goats in Nigeria Tropical Animal Production 6(2): 186.

Akinrele, I.A. Cook, A.S. and Holgate, R.A. 1962. The manufacture of gari from Cassava in Nigeria pages 633 - 644 in proceedings, First international Congress on Food Technology, London.

Alaku, O. and Moruppa, S.M. 1983. Dry Season weight losses in Red Sokoto (Maradi) goats reared in the sahel region of north eastern Nigeria. International Journal of Biometeorology 27, 143 - 156.

Alexander, G. 1956. Changes in weight of lambs during the first thirty six hours of life. Aust. Vet. J., 32: 321 - 325.

Alhassan, W.S. and Akorfur, V.A. 1982. Influences of oil Palm slurry on the digestibility of rice straw by sheep. J. Anim. Prod. Res. 2 (2): 81 - 89.

Alhassan, W.S., Lufadeju, E.A. and Bello, S.A. 1985. The potential of a dry ruminal content - blood mixture as feed for ruminant animals 10th Annual Conference. Nigerian Society for animal Production. Univ. of Ife, Ile - Ife, Nigeria. Abstr. Pp. 61.

Amble, V.N., Khandekar, N.C. and Garg, J.N. 1964. Statistical studies on breeding data of Beetal goats. I.C.A.R. Res. Ser., No. 38. New Delhi: Indian Council of Agricultural Research. 70 pp.

Amegee, Y. 1984 b. Milk study with the West African Dwarf sheep (Djallonke) and its relation to the growth of lambs. Revue d'Elevage et de Medicin Veterinaire des Pays Tropicales 37, 331 - 335.

Anonymous, 1972. Committee on bovine reproduction nomenclature. Recommendations for standardizing bovine reproductive terms. Cornell Vet. 62, 216 - 237.

Anonymous, 1985. Highlights of Research Achievements on animal production, small ruminant production PP. 17 - 26 (National Animal Production Research Institute Ahmadu Bello University, Zaria).

AOAC (Association of Official Analytical Chemists). 1972. Official methods of analysis. Washington, DC, USA.

AOAC (Association of Official Analytical Chemists). 1984. Official methods of analysis. Washington, DC, USA.

Appleman, R.D. and Delouche, J.C. 1958. Behavioral, Physiological and biochemical responses of goats to temperature, O° to 40 °C. J. Anim. Sci., 17: 326 - 335.

ARC, 1980. Agricultural Research Council. The nutrient requirements of farm livestock No. 2. Ruminants. London.

ARC, 1980. The nutrient requirement of ruminant livestock. Agricultural Research Council. Tech. Rev. Commonwealth Agric. Bureau, London.

Arriola, G.C. 1936. A study on the breeding habits of goats. Philipp. Agric., 25: 11 - 29.

Asaolu, V.O. 1988. Utilization of Cassava peels and Gliricidia Sepium in the diet of West African Dwarf Sheep. M. Phil. thesis. Obafemi Awolowo University, Nigeria.

Barreveld, W.H. 1982. Alternative end - uses of agricultural and agro-industrial residues. *In; Crop Residues and Agro-*industrial by - products in animal feeding. Procs. FAO/ILCA Workshop. Dakar, Senegal, 21 - 25 Sept. 1982. Pp. 127-138.

Barrios, E.A., and R. Bressani, 1967. Composicion quimica de la raiz y de la hojas de algunas variedades de yuca (Manihot esculenta Crantz. Turrialba 17(3): 314-320.

Bianca, W., Findlay, J.D. and Mclean, J.A. 1965. Response of steers to water restriction. Res. Vet. Sci., 6: 38 - 55.

Blaxter, K.L., Wainman, F.W. and Wilson, R.S. 1961. The regulation of food intake by sheep. Anim. Prod., 3: 51 - 61.

Boorman, K.N., 1980. Dietary constraints on nitrogen retention. In: Buttery, P.J. and Lindsay, D.B. (eds.) Protein deposition in animals. Butterworths London-Boston.

Brody, S. 1938. Growth, milk production, energy metablison and energetic efficiency of milk production in goats. Res. Bull. *Mo. Agric. Exp. Stn, No. 291: 64Pp.*

Burns, M. 1965. The Skin histology of some Nigeria goats. Tropical Agriculture (Trinidad) 42, 243 - 259.

Carew, B.A.R. 1982. Free choice response of extensively managed goats in tropical environment. Humid zone Program Document Number 8, ILCA, Ibadan, Nigeria.

Carew, B.A.R. 1983. Gliricidia Sepium as sole feed for Small ruminants. Tropical Grassland 17: 181 - 183.

Chadha, Y.R. 1961. Sources of starch in Commonwealth territories. III: Cassava. Tropical Science 3: 101-113.

Chadhokar, P.A. and Sivasupiramanian 1983. Gliricidia leaves as a protein supplement to paddy straw in growing crossbred heifers. Indian Journal of Animal Science 53 (2): 120 - 125.

Chenost, M. and Mayer L. 1977. Potential contribution and use of agro-industrial by - products in animal feeding. In: New Feed Resources. Proceedings Technical Consultation. Rome 22 - 24 Nov. 1976. FAO Anim. Prod. Hlth paper. Pp. 87 - 110.

Chiboka, O. 1980. Semen characteristics of West African Dwarf rams. Anim. Reprod. Sci. 3: 247 - 259.

Clark, J., Preston, T.R. and Zamora, A. 1972. Molasses as an energy source in low fibre diets for milk production. 2, Effect of varing the level of Cereal grain Rev. Cubana *Cience. Agric.* 6: 27 - 32.

Coward-Lord, J., Arroyo-Auilu, J.A. and Garcia-Molinari, O., 1974. Fibrous carbohdrate fraction and in vitro true and apparent digestibility of 10 tropical forage grasses. J. Agric. Univ. Puerto-Rico 58(3): 293-304.

Crampton, E.W. 1957. Interrelations between digestible nutrient and energy Content, Voluntary dry matter intake, and the overall feeding value of forages. J. Anim. Sci. 16: 546 - 552.

Da Rosa E Silva Neto, J.M. 1948. Primeira contribuicao Parao estudo do caprino - nacional Moxoto. Reprinted from Bolm Secr. Agric. Ind. Com. Est. Pernambuco, 15 (1 and 2): 48PP.

Datta, I.C., Sahani, K.L. and Roy, A. 1963. Studies on certain aspects of sheep and goat husbandry II. Birthweight, liveweight growth and rearing lambs and kids. Indian J. Vet. Sci. 33: 71 - 77.

De Brochard, P., Rickard, J.R. and Triaca, H. 1957. Table internationale de composition des aliments. Marseilles.

Dennis, S.M. 1969. Laboratory diagnosis of infectious bovine abortion. J.A.V.M.A. 155: 1913 - 1922.

Dennis, S.M. 1974. Perinatal lamb mortality in Western Australia. I. General procedures and results. Aust. Vet. J. 50: 443 - 449.

Devendra, C. 1962. Upgrading of local goats by the Anglo - Nubian at the Federal Experiment Station, Serdang. Malay. agric. J., 43: 265 - 280. *Anim. Breed. Abstr* 32: 313.

Devendra, C. 1966a. Goat breeds of Malaysia. Malays. Agric. J., 45: 268-274.

Devendra, C. 1966b. Studies in the nutrition of the indigenous goat of Malaya. I. The body measurements, composition of sample joints and their relationship to carcass composition. Malays. Agric. J., 45: 345-369.

Devendra, C. 1966c. Goat improvement in Malaysia Malays. Vet. J., 4: 18-22.

Devendra, C. 1966d. The importance of goats in Malaya. Z. Tierzucht. Zucht-Biol., 83: 72-79.

Devendra, C. 1967e. Studies in the nutrition of the indigenous goat of Malaya. V. Food conversion efficiency, economic efficiency and feeding standards for goats Malays. Agric. J., 46: 204 - 216.

Devendra, C. and Burns, M. 1970. Goat production in the tropics. Tech. Comm. No. 19 Commonwealth Agric. Bureaux Bucks, England.

Devendra, C. 1977. Cassava as a feed source for ruminants. In: Nestel, B. and Graham, M. (eds.) Cassava as Animal Feed. Proceedings, Cassava as Animal Feed Workshop. University of Guelph, Ontario, Canada. IDRC: Ottawa. 18th-20th April, 1977. Pp. 107-119.

Devendra, C. 1981. Non-conventional feed resources in Asia and the Far East. Health Commission for Asia (APHCA) Publication 2.

Dilwali, C.K. 1943. Analysis of weight records of Etah goats. Indian J. Vet. Sci., 13. 155 - 120.

Dixon, R. and Combellas, J. 1983. A note on the preservation of Wet brewers grains. Trop. Anim. Prod. 8:151 - 152.

Ehoche, O.W and Buvanendran, V. 1983. The yield and composition of milk and preweaning growth rate of Red Sokoto goats in Nigeria. World Review of Animal Production. 19 (2), 19 - 24.

Ehoche, O.W., Theresa, Y.M., Buvanendran, V. and Adu, I.F. 1983. The nutritive value of tannin - treated Cotton seed Cake for growing lambs. J. Anim. Prod., Res. 3 (1): 15 - 25.

Epstein, H. 1969. Domestic animals of China. With a foreward by Boerma, A.H. Tech. Commun. Commonw. Bur. Anim. Breed. Genet., No. 18. Farnham Royal, Bucks: Commonwealth Agricultural Bureaux. xvii + 166PP + 205 illustrations.

Epstein, H. and Herz, A. 1964. Fertility and birth weights of goats in a sub - tropical environment. J. Agric. Sci., Camb., 62: 237 - 244.

Falade, S. and Sellers, K.C. 1976. Reproductive losses in Female goats. Niger. J. Anim. Prod. 3: 131-133.

Falade, S., Seller, K.C. and Ojo, M.O. 1975. A Serological Survey of caprine brucellosis in Nigeria. Bull. Epiz. Dis. Afr. 22: 335 - 339.

FAO, 1966. Agricultural development in Nigeria 1965 - 1980. Rome: F.A.O. P. 215.

FAO, 1967. Report of the fourth FAO, Far East regional Conference on animal Production held in Nuwara Eliya, Ceylon, 7 - 16 October 1966. Meeting Report. No. An 1966/7. Rome: F.A.O. 59Pp.

FAO, 1979. Production year book. United Nations Food and Agricultural organisation, Rome.

FAO, 1986. African agriculture, the next 25 years. Food and Agriculture Organization of the United Nations, Rome, Italy.

FDLPCS, 1991. Nigerian National Livestock survey. Federal Department of Livestock and Pest Control Services Abuja. Vol. 2. 289 PP.

Fomunyan, R.T. and Meffeja, F. 1987. Cassava by - products in rabbit and sheep diets. In: Proceedings, Workshop on Utilization of Agricultural By - products as Livestock Feeds in Africa. little, D. A. and Said, A.N., (eds.) African Research Network for Agricultural By - products. (ARNAB), September 1986, Blantyre, Malawi. ILCA, Addis Ababa, Ethiopia. Pp. 103 - 107.

Fowler, V.R. 1968. Cited by Butterfield, R.M. and Berg, R.T. 1976. New concepts of cattle growth. Sydney University Press, Australia Page 15.

French, M.H. 1956a. The effect of infrequent water intake on the consumption and digestibility of hay by Zebu cattle. Emp. J. Exp. Agric., 24: 128 - 136.

French, M.H. 1956b. The importance of water in the management of cattle. E. Afr. Agric. J., 21: 171-181.

French, M.H. 1957. Nutritional value of tropical grasses and fodders. Herb Abstr., 27: 1 - 9.

French, M.H. 1965. Animal production and the work of FAO. Wld. Rev. Anim. Prod., 1965(1): 7-27.

Goldstone, P. 1963. The Boer goat is making money. Anim. Breed. Abstr. 31: 1307.

Guha, S., Kohli, M.L. and Bhattacharya, P. 1951. Artificial insemination in sheep and goats at Izatnagar. Indian J. Vet. Sci., 2: 171 - 176. Anim. Breed. Abstr. 21: 1341.

Hahn, S.K. and Chukwuma, E.M. 1986. Uniform Yield trials. Root and Tuber Improvement Programme annual report, 1985. IITA, Ibadan, Nigeria.

Hahn, S.K., Chukwuma, E.M. and Almazan, A.M. 1986. Losses of cassava tuberous roots during processing into gari. Root and Tuber Improvement programmme annual report, 1985. IITA, Ibadan, Nigeria.

Haumesser, J.B. 1975. Some aspects of reproduction in the Red Sokoto goat. Comparison with other tropical and subtropical breeds. Revue d' Elevage et de Medicin Veterinaire des Pays Tropicales 28, 225 - 233.

Henrotte, A. 1961. Etude du cheptel Caprin dans le Bas - Congo. Bull. Agric. Congo, 52: 1279 - 1293.

Henzell, E.F. and Oxenham, D.J., 1964. Seasonal changes in the nitrogen content of three warm-climate pasture grasses. Aut. J. Exp. Agric. Anim. Husb. 4: 336-344.

Hofmeyr, H.S., Joubert, D.M., Badenhorst, F.J.G., and Steyn, G.J., Van, D. 1965. Adaptability of sheep and goats to a South African tropical environment. Proc. S. Afr. Soc. Anim. Prod.,1965, 4: 191 - 195.

Hofs, P., Montsma, G. and Nabuurs, S. 1984. Growth and Reproduction rates of West African Dwarf Goats under high levels of feeding and management. Paper presented at the Workshop on small ruminant production systems in the humid zone of West Africa, ILCA and FLD, Nigeria.

Hornby, H.E. and Van Rensburg, H.J. 1948. The place of goats in Tanganyika farming systems: 1. In deciduous bushland formation. E. Afri. Agric. J., 14: 94-98.

Hutagalung, R.I. 1977. Additives other than methionine in cassava diets. In: Cassava as animal feed. Proceedings, Cassava as Animal Feed Workshop. Nestel, B. and Graham, M. (eds.) 18-20

April, 1977, University of Guelph, Ontario, Canada. IDRC: Ottawa. Pp. 18-32

Hutton, J.B. 1962. The maintenance requirement of New Zealand dairy cattle. N.Z. Anim. Prod. Proc. 22: 12 - 15.

ICAR (Indian Council of Agricultural Research) 1962. Research in animal husbandry. A review of work done during 1929 - 1954. Raghavan, D. and Kachroo, P. (eds) New Delhi: Indian council of Agricultural Research 4733PP.

Ifut, O.J., 1988. The Potential of Cassava Peel for Feeding Goats in Nigeria. In: Hahn, S.K., Reynolds, L. and Egbunike, G.N. (eds). Cassava as Livestock Feed in Africa. Proceeding of the IITA/ILCA/ University of Ibadan Workshop on Potential Utilization of Cassava as Livestock Feed in Africa. 14-18th November, 1988, Ibadan, Nigeria. Pp. 72-81.

Ikhatua, U.J. and Adu, I.F. 1981. Protein requirement of weaned Yankasa lambs for maintenance and growth. J. Anim. Prod. Res. 1: 13 - 22.

Ikpi, A.T., Gebremeskel, N.D., Hahn,S.K., Ezumah, H. and Ekpere, J.A. 1986. Cassava Crop for household food security. IITA - UNICEF Collaborative Programme Report, IITA, Ibadan, Nigeria.

ILCA, 1980. Livestock production in Africa the Challange pages 7 - 14 in ILCA: the first year. Addis Ababa, Ethiopia.

Jang, S. and Majumdar, B.N. 1962. A study of comparative digestibilities in different species of ruminants. Anim. Biochem. Exp. Med., 22: 303 - 308.

Job, T.A., Tewe, O.O., Loosli, J.K. and Oyenuga, V.A. 1976. The value of cassava for growth of sheep: Nig. J. Anim. Prod. 3 (2): 147 - 155.

Jollans, J.L. 1959. Meat preferences of people in the Central region of Ghana. J. W. Afr. Sci. Ass., 5: 64 - 78.

Jones, W.O. 1959. Manioc in Africa Stanford University press. Stanford, U.S.A. 315PP.

Joshi, H.C. 1952. Jamnapari goats. Indian Vet. J., 29: 101 - 104.

Joubert, D.M. 1954. Breeding for beef in tropical and sub-tropical climates. Colon. Pl. Anim. Prod., 4(1): 1-13.

Karua, S.K. 1989. Some Performance Indicators of Malawi Indigenous Goats under Village and Ranch Condition. In: Wilson, R.T. and Melaku, A. (Eds). African Small Ruminant Research and Development. Proceedings of Conference held at

Bamenda, Cameroon. 18 - 25 January, 1989. Pp. 23 - 36. African Small Ruminant Research Network. International Livestock Centre for Africa, Addis Ababa, Ethiopia March, 1989.

Kaura, R.L. 1943. some common breeds of goats in India. Anim. Breed. Abstr. 12: 145.

Khajaren, S., Khajarern, J.M., Kitpanit, N. and Muller, Z.O. 1977. Cassava in the nutrition of swine. In: Cassava as animal feed. Proceedings, Cassava As Animal Feed Workshop, Nestel, B. and Graham, M. (eds). 18-20 April, 1977. University of Guelph, Ontario, Canada. IDRC: Ottawa. Pp. 56-64.

Kirton, A.H. 1969. Goats cannot be written off as producers of meat. N.Z. J. Agric., 118 (4): 50 - 55.

KNARDA, 1983. (Kano State Agricultural and Rural Development Authority). Cruprocess. Dry season feeding for cattle and sheep KNARDA Handbook for field staff.

Knight, J. 1965. Some observations on the feeding habits of goats in the South Baringo district of Kenya. E. Afr. Agric. For. J., 30: 182-188.

Kolars, J. 1966. Locational aspects of cultural ecology: The case of the goat in non - western agriculture. Geogrl Rev., 56: 577 - 584.

Krader, L. 1959. The ecology of nomadic pastoralism. Int. Soc. Sci. J., 11: 499 - 510.

Kurian, N.I. and Raja C.K.S.V. 1965. Studies on the semen characteristics of Malabari bucks. Anim. Breed. Abstr. 34: 2211.

Lamand, M. 1981. Trace elements metabolism and requrements of goats. In. Int. Symp. on Nutr. systems of goat feeding. Ed. P. Morand - Fehr. et al I.T.O.V.I.C., France, Vol. 1: 210 - 217.

Lancaster, P.A and Brooks, J.E. 1983. Cassava leaves as human food. Economic Botany 37 (3): 331 - 348.

Lansbury, T.J. 1962. Livestock production with particular *reference to the nutritional problems of West Africa. Proc.* Nutr. Soc., 21: 106 - 113.

Larsen, R.E and Amaning - Kwarteng, K. 1976. Cassava peels with urea and molasses as dry season supplementary feed in cattle. Ghana Journal of Agricultural Science 9: 43 - 47.

Lebbie, S.H.B. and Manzini, A.T. 1989. The productivity of indigenous goats under traditional Management in Swaziland. In: Wilson, R.T. and Melaku, A. (Eds). African Small Ruminant Research and Development. Proceedings of a Conference Held at Bamenda, Cameroon. 18 - 25th January, 1989. PP 39 - 50. African Small Ruminant Research Network, International Livestock Centre for Africa, Addis Ababa, Ethiopia. March 1989.

Leach, F.B. and Sellers, K.C. 1959. A Secondary survey of losses associated with pregnancy and parturition in Yorkshire sheep. J. Agric. Sci. 52: 117 - 124.

Lloyd, L.E., Donefer, E., Bowman, A.L. and Crampton, E.W. 1962. Effect of certain forage characteristics on water intake by sheep. Abstr. in J. Anim. Sci. 21: 1036.

Lowe, H.J. 1943. Goats as a source of milk in tsetse areas. E. Afr. Afric. J., 8: 238 - 240.

LU, C.D. 1988. Grazing behaviour and diet selection of goats. Small Ruminant Research 1, 205 - 216.

Luitingh, H.C. 1963. The efficiency of beef production in terms of carcase weight increase as influenced by the ration concentration and the age of steers. J. Agric. Sci, Camb., 61: 127 - 134.

Mackenzie, D. 1967. Goat husbandry. London: Faber and Faber Ltd. 2nd edn. 368 PP.

Maher, C. 1945. The goat friend or foe? E. Afri. Agric. J., 11: 115 - 121.

Malachek, J.C. and Provenza, F.D. 1981. Feeding behaviour and nutrition of goats on rangelands. In: Morand-Fehr, P., Bourbouze, A. and De Simiame, M. (eds). Proceedings, International Symposium on Nutrition and Systems of Goat Feeding. Pp. 411-428. 12-15 May, 1981, Tours, France.

Mason, I.L. and Maule J.P. 1960. The indigenous livestock of Eastern and Southern African. Tech. Commun. Commonw. Bur. Anim. Breed Genet., Edinb., No. 14. Farnham Royal, Bucks.: Commonwealth Agricultural Bureaux XV + 151 PP + 48 plates.

Masud, M. 1964. Black Bengal goat in East Pakistan. Anim. Breed. Abstr. 33: 2536.

Matthewman, R.W. 1977. Small livestock production in two villages in the forest and derived savanna Zones of South Western Nigeria. AES Res. Bull. No. 1, Department of Agric. Extension services, University of Ibadan.

Maule, J.P. 1949. Breeding for milk in Mediterranean environment. Pt II: Goats. Emp. J. exp. Agric., 17: 37 - 47. Anim. Breed. Abstr. 17: 532.

Maule, J.P. 1966. A note on dairy goats in the tropics. Anim. Breed Abstr. 34: 153 - 158.

Mazumdar, N.K., Mazumdar, A. and Goswani, K.K. 1980. Studies of some factors affecting mortality and survival rates in Pashmina Kids. Indian J. Anim. Sci. 50: 251 - 255.

Mba, A.U., Ovuru, E.A. and Oyenuga, V.A. 1976. Digestion and Utilization of citrus by - products by two breeds of West African Dwarf goats. Nig. J. Anim. Prod. 3 (1): 162 - 171.

Mears, P.T. and Humphreys, L.R. 1974. Nitrogen response and stocking rate of *Pennisetum clandestium* pastures. 1. Pasture nitrogen requirement and concentration, distribution of dry matter and botanical composition. J. Agric. Sci., Cam. 451-467.

Mia, W.H., Sahai, B., Majumdar, B.N. and Kehar, N.D. 1960a. Studies on tree leaves as cattle fodder. 111. The nutritive value of Bargad leaves (Ficus bengalensis). Indian J. Dairy Sci., 13: 1 - 8.

Mia, W.H., Majumdar, B.N. Sahai, B. and Kehar, N.D. 1960b. Studies on tree leaves as cattle fodder. IV. The nutritive value of Pipal leaves (Ficus religosa). Indian, J. Dairy Sci., 13: 9 - 15.

Minett, F.C. 1950. Mortality in sheep and goats in India. Indian J. Vet. Sci., 20: 69 - 103. Anim. Breed. Abstr. 20: 1667.

Mishra, H.R. and Biswas, S.C. 1966. A study on distribution of oestrus in Deshi goats. Indian J. Dairy Sci., 19: 132 - 134. Anim. Breed. Abstr. 36: 525.

Moe, P.W., Tyrell, H.F. and Flatt, W.P. 1970. Partial efficiency of energy use for maintenance, lactation, body gain and gestation in dairy cow. European Ass. Anim. Prod. Pub., 13: 65.

Molokwu, E.C.I and Igono, M.O. 1978. Reproductive performance and Pattern in the Brown goat of Nigeria Savana Zone. Proceedings of the 4th World Conference of Animal Production.

Montaldo, A. 1977. Whole plant utilization of cassava for animal feed. In: Cassava as animal feed. Proceedings, Cassava As Animal Feed Workshop, Nestel, B. and Graham, M. (eds). 18-20 April, 1977, University of Guelph, Ontario, Canada. IDRC: Ottawa. Pp. 95-106.

Montsma, G. 1986. Meat Production in West African Dwarf goats. Netherlands Journal of Agricultural Research 34, 413 - 420.

Montsma, G., Luiting, P., Verstegen, M.W.A., Van der Hel, W., Hofs, P. and Zijlker, J.W. (1985). Effects of high ambient temperatures on the Metabolism of West African Dwarf goats. II. International Journal of Biometeorology 29, 23 - 35.

Moulick, S. K., Guha, H., Gupta, S., Mitra, D.K. and Bhattacharya, S. 1966. Factors affecting multiple birth in Black Bengal goats. Indian J. Vet. Sci., 36: 154 - 163.

Mukherjee, D.P., Jawa, S.S. and Bhattacharya, P. 1953a. The effect of feeding thyroprotein on semen quality and on some physiological conditions of goats. III. Effect on pulse rate of respiration, body temperature and body weights. Indian J. Vet. Sci. 23: 15 - 24.

Mukherjee, D.P., Roy, A. and Bhattacharya, P. 1953b. The effect of feeding thyroprotein on semen quality and some physiological conditions of goats. I. Effect on reaction time and semen characteristics. Indian J. Vet. Sci., 23: 1 - 7.

Muller, Z., Chou, K.C. and Nah, K.C. 1975. Cassava as a total substitute for cereals in livestock and poultry rations. In *proceedings of the 1974 Tropical Products Institute* Conference. Pp. 85-95. 1-5 April, 1975.

Nasim, M. Amjad Ali, M., Wahiduzzaman, M. and Shamsuddin, M. 1964. Study on conception rate by first, second and third insemination among East Paksitan cows with semen extended in egg - Yolk- Sodium citrate diluent. Agriculture Pakist., 15: 439 - 441. Anim. Breed. Abstr. 34 No. 1208.

Ngere, L.O,. Adu, I.F. and Okubanjo, I.O. 1984. The indigenous goats of Nigeria. Animal Genetic Resources. Information 3, 1 - 9.

Njoku, C.O. 1972. Field guide to diagnosis of bacterial and mycotic abortions of sheep and cattle. Niger Vet. J. 1: 37 - 41.

NRC, 1975. (National Research Council) Nutrient requirements of domestic animals No. 5. Nutrient requirements of sheep 5th ed.. NRC, Washington, D.C.

NRC, 1981. Nutrient requirements of goats. National Academy Press, Washington D.C. No. 15, P. 21.

Nuru, S. 1985. Trends in Small Ruminant Production in Nigeria. In: Adu, I.F., Osinowo, O.A., Taiwo, B.B.A. and Alhassan, W.S. (eds). Small Ruminant Production in Nigeria.

Proceedings of National Conference on Small Ruminant Production. Zaria, Nigeria, October 6th - 10th, 1985. Pp. 35-48.

Oates, A.V. 1956. Goats as a possible weapon in the control of the thorn bush. Rhodesia Agric. J., 53: 68-85.

O'Donovan, P.B. 1983. Untreated straw as a livestock feed. A Review Nutr. Abstr. Rev. Series B. 53: 441-455.

Odunlami, M.O. 1988. Energy Supplementation of forage - and browse - based diets for West African Dwarf goats. M. Phil. Thesis Obafemi Awolowo University, Nigeria.

Ojo, S.A. 1980. The merits of the indigenous goats as a competitive meat producer in meeting Nigeria's protein requirement. Paper presented at the 18th Annual Conference of the Nigerian Veterinary Medical Association, Ibadan, Nigeria.

Oke, O.L. 1978. Problems in the use of cassava ss animal feed. Animal feed science and Technology. 35: 345 - 380.

Okeke, G.C. and Oji, V. 1988. The nutritive value of grass emsiled with cassava peel and poultry excreta for goats. Pages 101 - 106 in Proceedings, Workshop on Goat Production in the Humid Tropics. Smith, O.B. and Bosman, H.G. (eds). 20 - 24 July 1987, Obafemi Awolowo University, Ile - Ife, Nigeria.

Okezie, B.O., Proctor, C.M. and Numfor, F. 1988. Tropical root and tuber Crops storage, processing and utilization in Cameroon - a diagnostic survey report. Tropical Roots and Tubers Research Project. USAID contract No. 631 - 605. Pp. 117.

Okoh, A.E. J. 1980. An Investigation of abortion in sheep in Rano L.I.B.C near Kano, Nigeria. Bull. Anim. Hlth. Afr. 28: 135 - 138.

Okorie, A.U., Obioha, F.C., Anyaechie, A.A. and Ahamefule, H.C. 1981. Dried poultry waste versus groundnut cake as protein supplement for grazing West African Dwarf Goats and Sheep. *Nig. J. Anim. Prod.* 8: 140 - 147.

Olatunji, O. 1974. Digestion and utilization of carbohydrate and energy in West African Dwarf sheep. Ph.D Thesis, University of Ibadan, Nigeria.

Olayiwole, M.B. 1976. Effects of different treatments on utilization of dry, high - fibre sorghum stover by ruminants. Ph.D. Theis. Dept. Anim. Sci., A.B.U., Zaria, Nigeria.

Olubajo, F.O., and Oyenuga, V.A. 1974. The yield, intake and animal production of four tropical grass species grown at Ibadan, Nigerian Journal of Animal Science Production 1(2): 217-224.

Onwuka, C.F.I. 1983. *Nutritional evaluation of some Nigerian* browse plants in the humid tropics Ph.D. Thesis, Department of Animal Science, University of Ibadan, Ibadan, Nigeria.

Oppong, E.N.W. 1965. A note on goats in Ghana with reference to the need to develop goat husbandry to improve the nation's diet. Anim. Breed. Abstr. 35: 505.

Osafo, E.L. and Smith, O.B. 1985. Effectiveness of cocoa - pod ash solutions for treating fibrous Crop residues. 10th Annual Conference. Nigerian Society for Animal Production University of Ife, Ile - Ife, Nigeria Abstr. Pp. 65.

Osinowo, O.A. 1992. Problems and prospects for the development of small ruminants in Nigeria. Proc. Wkshp on the Nig. Livestock Industry: Problems and Prospects. 26th - 27th February 1992, Jos. LIMECU, FDLPCS Abuja.

Osuagwuh, A. I.A. 1984. Studies on the protein, energy and mineral utilization by the pregnant West African Dwarf (Fouta Djallon) *goat in humid Tropical Zone of Ibadan. Ph.D Thesis,* University of Ibadan.

Osuagwuh, A. I.A. and Akpokodje, J.U. 1981. West African Dwarf (Fouta Djallon) Goat. I causes of early mortality. Int. Goat and Sheep Res. 1: 303 - 309.

Osuagwuh, A. I.A. and Akpokodje, J.U. 1984. The reproductive performance of West African Dwarf (Fouta Djallon) goat. Tropical Animal Production. 9: 231-238.

Otchere, E.O., Dadzie, C.B.M., Erbynn, K.G. and Ayebo, D.A. 1977. Response of sheep to rice straw or cassava peels fortified with urea and molasses as supplemental feeds to grazing. Ghana J. Agric. Sci. 10: 61 - 66.

Otchere, E.O., Ahmed, H.U., Adenowo, T.K., Kallah, M.S., Bawa, E.L.K., Olorunju, S.A. and Voh Jr., A.A. 1987. Northern Nigeria: Sheep and goat production in the traditional Fulani agropastoralist sector. World Animal Review 64, 50 - 55.

Oyenuga, V.A. 1968. Nigeria's foods and feeding stuffs, their chemistry and nutritive value. Ibadan University press, Ibadan, Nigeria. Pp. 99.

Oyenuga, V.A. and Akinsoyinu, A.O. 1976. Nutrition requirements of sheep and goats of tropical breeds. Proc. First Int. Symp. Feed. Comp. Anim. Nutr. Requirements and Computerization of Diets. Utah State University, Logan, Utah, U.S.A. 505-511.

Patel, J.K. 1967. Artificial insemination in goats. Indian Vet. J., 44: 509 - 511.

Payne, W.J.A. 1965. Specific problems of semi - arid environments. Qualitas Pl. Mater. Veg., 12: 269 - 294. Abstr. in Nutr. Abstr. Rev., 1966, 36, No. 3386.

Payne, W.J.A. 1966. Nutrition of ruminants in the tropics. Nutr. Abstr. Rev., 36: 653 - 670.

Payne, W.J.A. and Miles, N.S. 1953. Goat husbandry in Fiji. A report on the results from the Goat Breeding Project at Sigatoka for the period June 1950 - January 1953. Anim. Breed. Abstr. 22: 1024.

Phillips, P.T. 1983. An overview of Cassava consumption and production. Pages 83 - 88 in cassava toxicity and thyroid: research and public health issues. Proceedings, International Workshop on Cassava Toxicity. Delange, F. and Ahluwalia, R. (eds). 31 May - 2 June 1982, Ottawa, Canada. IDRC - 207 e: Ottawa. Pp. 83-88.

Preston, T.R. 1974. Sugar cane as the basis for intensive animal production in the tropics. London, Proc. T.P.I. Conf. on animal feeds of tropical and sub-tropical origin, 1 - 5 April 1974. Pp. 69 - 84.

Preston, T.R. 1982. Nutritional limitations associated with the feeding of tropical forages. J. Anim. Sci. 54: 877 - 884.

Preston, T.R. and Willis, M.B. 1969. Sugarcane as energy source for the production of meat. Outlook Agric. 6, 29 - 35.

Preston, T.R. and Leng, R.A. 1986. Matching livestock systems to available feed resources. ILCA, Addis Ababa, Ethiopia. Pp. 200.

Rajpoot, R.L., Sengar, O.P.S. and Singh, S.N. 1981. Energy and protein in goat nutrition. In: Morand-Fehr, P., Bourbouze, A. and De Simiane, M. (eds). Proceedings, International Symposium on Nutrition and Systems of Goat Feeding: Vol. 1. Pp. 101-124. 12-15 May, 1981, Tours, France. ITOVIC-INRA.

Ritzan, E.G. and Benedict, F.G. 1938. Nutritional physiology of the adult ruminant. Carnegie Institution of Washington. Pub. 494, Washington, D.C.

463195

Robinet, A.H. 1967. La Che'vre Rousse de Maradi. Son exploitation et sa place dans I' economie et I'elevage de la Republique du Niger. Revue Elev. Med. Vet. Pays trop., N.S., 20: 129 - 186.

Rogers, D.J. and Milner, M. 1983. Amino acid profile of manioc: leaf protein in relation to nutritive values. Economic Botany 17: 211 - 216.

Roy, A. and Bishop, M.W.H. 1954. Effect of glycine on the survival of bull spermatozoa in vitro. Anim. Breed. Abstr. 23: 184.

Roy, A. and Gupta, D.N. 1959. Studies on the reproductive physiology of goat. II. Fertility of Spermatozoa preserved in vitro and certain preliminary observations on female fertility. Indian J. Vet. Sci., 29 (2/3): 55 - 57.

Roy, A., Datta, I.C., Sahani, K.L., Singh, B. and Sengupta, B.P. 1962. Studies on certain aspects of sheep and goat husbandry. Artificial breeding, telescoping the breeding season and certain reproductive phenomena in sheep and goats. Indian J. Vet. Sci., 32: 269 - 275.

Sacker, G.D. and Trail, J.C.M. 1966a. Production characteristics of a herd of East Africa Mubende goats. Trop. Agric., Trin., 43: 43 - 51.

Sahni, K.L. and Roy, A. 1967. A study of the Sexual activity of Barbari goat (Capra hircus) and conception rate through artificial insemenation. Indian J. Vet. Sci., 37: 269 - 276.

Seerley, R.W. 1972. Utilization of cassava as livestock feed. In: Literature review and research recommendations on cassava. Hendershott et al. (eds). AID Contract no. Csd/2497. University of Georgia, Athens, U.S.A. Pp. 99-130.

Sellers, K.C. and Leech, F.B. 1955. Surveys of losses associated with pregnancy and parturition in Yorkshire sheep. J. Agric. Sci. 46: 90 - 96.

Shaiwoya, E.L. and de LeeuW, P.N. 1971. Feeding sheep for mutton: Some preliminary Feeding trials at Shika Agricultural Research station. Samaru, Agric. Newsletter 13: 120 - 122.

Shanmugasundaram, K.S. 1957. Birth rate among goats. Indian Vet. J., 34: 107 - 117.

Sharma, G.P., Suri, K.R. and Vali, K.N. 1957. A study on the "reaction time" and some of the semen characteristics of the beetal breed of goat. Res. Bull. Panjab Univ. Zool., No. 101: 217 - 227. Anim. Breed. Abstr. 26 283.

Shelton, M. 1961. Factors affecting kid production of Angora does. Anim. Breed. Abstr. 30: 2641.

Smith, O.B., Idowu, O.A., Asaolu, V.O. and Odunlami, M.O. 1988. Comparative rumen degradability of forages, browses crop residues and by-products. In: African Small Ruminant Research and Development. Wilson, R.T. and Azeb, M. (eds). ILCA, Addis Ababa, Ethiopia. Pp. 204-208.

Staples, R.R., Hornby, H.E., and Hornby, R.M. 1942. A study of the comparative effects of goats and cattle on a mixed grass-bush pasture. E. Afr. agric. J., 8: 62 - 70.

Starke, J.S., Smith, J.B., and Joubert, D.M. 1958. The birthweight of lambs. Sci. Bull. Dep. Agric. S. Afr., No. 382: 28 Pp.

Sundstol, F. 1984. Recent advances in development and utilization of chemically treated low quality roughages. Int. Workshop on Relevance of Crop Residue Utilization as Animal Feeds in Developing Countries. Khon Kaen Univ. Thailand, University of Florida 1974. Latin American Tables of Feed Composition. Grainsville, Florida, U.S.A.

SAS, 1987. (System of Analytical Statistics). SAS Institute Inc., Cary, NC 27512-8000 U.S.A.

Tantawy, A.O. and Ahmed, I.A. 1960. Studies on Egyptian Baladi goats. II. Some factors affecting mrotality rate. Anim. Breed. Abstr. 28: 2058.

Tewe, O.O., Job, T.A., Loosli, J.K. and Oyenuga V.T. 1976. Composition of local cassava varieties and the effect of processing on their hydrocyanic content and nutrient utilization by the rat. Nigerian Journal of Animal Production 3(2): 60 - 66.

Thompson, P.G. 1965. Goat breeding in Fiji, S. Pacif. Bull., 15: 28 -30.

University of Florida, 1974. Latin American Tables of Feed Composition. Gainsville, Florida, U.S.A.

Van Rensburg, S.J. 1971. Malnutrition of the foetus as a cause of abortion. J.S. Afri. Vet. Med. Assoc. 42: 305 - 308.

Van Soest, P.J., 1965. Use of detergents in the analysis of fibrous feeds. II: A rapid method for the determination of fibre and lignin. J. Assoc. Off. Agric. Chem., 46: 829-835.

Van Soest, P.J. and Wine, R.H., 1967. Use of detergents in the analysis of fibrous feeds. IV: Determination of plant cell-wall constituents. J. Assoc. Off. Agric. Chem., 50: 50-55.

Vigo, A.H.S. 1946. A note on the managment of milk goats in Nigeria. Anim. Breed. Abstr. 16: 161.

Villegas, V. 1932 - 3. Goat raising. Anim. Breed. Abstr. 2: 125. Villegas, V., Ynalves, L.A. and Gatan, A.M. 1938. A comparative study of the nutritive value of the carcasses of sheep and goats. Philipp. Agric. 27: 52 et seq.

Wahid, A. 1965. Goat raising in Pakistan. Anim. Breed. Abstr. 35: 2700.

Weir, W.C. and Torrell, D.T., 1959. Selective grazing by sheep as shown by a comparison of the chemical composition range and pasture forage obtained by hand clipping and that collected by esophageal fistulated sheep. J. Agric. Sci. 18: 641-648.

Wentzel, D., Morgenthal, J.C., Van Niekerk, C.H. and Roelofse, C.S. 1974. The habitually aborting Angora doe: 11. The effect of energy deficiency on the incidence of abortion. Agroanimalia 6: 129 - 132.

Whyte, R.O. 1967. Milk production in developing countries. London: Faber and Faber Ltd. P. 58.

Wiljeratne, W.V.S. 1968. The production traits of a nondescript breed of South Indian meat goats. Anim. Breed. Abstr. 36: 2764.

Wilkinson, J.M. and Stark, B.A. 1987. Commercial goat production. BSP professional Books. Billing and Ltd. Worcester Great Britain.

Williamson, G. and Payne, W.J.A. 1965. An introduction to animal husbandry in the tropics. London: Longmans Green and Co. Ltd. 2nd edn. P. 281.

Wilson, P.N. 1957, Studies of the browsing and reproductive behaviour of the East African Dwarf goat. E. Afr. Agric. J., 23: 138 - 147.

Wilson, P.N. 1958a. The effect of plane of nutrition the growth and developmment of the East African Dwarf goat. I. Effect of plane of nutrition on the liveweight gains and the external measurements of kids. J. agric. Sci., Camb., 50: 198 - 210.

Wilson, P,N. 1958b. The effect of plane of nutrition on the growth and development of the East African Dwarf goat. II. Age changes in the Carcass compostion of female kids. J.l Agric. Sci. Camb., 51: 4 - 21. anim. Breed. Abstr. 26: 2022

Wilson, P.N. 1960. The effect of plane of nutrition on the growth and development of the East African Dwarf goat. III. The effect of plane of nutrition and sex on the carcass composition of the kid at two stages of growth, 161b weight and 301b weight J. Agric. Sci., Camb., 54: 105 - 130.

Wilson, R.T. 1976. Studies on the livestock of Southern Darfur, Sudan III. Production traits in sheep. Trop. Anim. Hlth. Prod. 8: 103 - 114.

Wilson, R.T. 1986. Livestock production in Central Mali: Long term studies on cattle and small ruminants in the Agropastoral system ILCA Research Report No. 14.

Wright, N.C. 1954. The ecology of domesticated animals. In: Progress in the physiology of farm animals. J. Hammond. Vol. 1. London: Butterworths Scientific Publications. Pp. 191-251.

Yarkin, I. and Eker, M. 1961. A native dairy goat in Turkey. Summ. in Viiith int. Congr. Anim. Prod. (Hamburg, 1961), I (Gen. Rep.): 187 - 189 (English, German and French text.) Anim. Breed. Abstr. 29: 2200.

Yeoh, H.H. and Chew, M.Y. 1976. Protein content and amino acid composition of cassava leaf. Phytochemistry 15: 1597 - 1599.

Zeuner, F.E. 1963a. A history of domesticated animals. London: Hutchinson & Co. Publishers.

Zeuner, F.E. 1963b. The origins of domesticated animals. Span, 6: 54 - 58.

APPENDICES

APPENDIX 1 Proximate content of Cassava

Constituents (%)	Leaves (foliage)		Peel		Tuber	
	Range	Mean	Range	Mean	Range	Mean
Dry Matter	19.5-33.0	(25.3)	27.3-33.5	(29.6)	13.0-43.3	(30.8)
Crude protein	14.7-36.4	(25.1)	2.8-6.5	(4.9)	1.5-3.5	(2.3)
Crude fibre	4.8-15.4	(11.4)	10.0-22.0	(16.6)	1.3-7.7	(3.4)
Ether extract	4.0-15.2	(12.7)	0.5-2.2	(1.3)	0.8-3.2	(1.4)
NFE[d]	37.3-51.9	(46.1)	62.5-72.9	(68.5)	88.0-94.1	(88.9)
Ash	5.5-16.1	(9.0)	3.5-10.4	(5.9)	1.6-4.1	(2.5)

Sources:- Rogers and Milner 1963, Oyenuga 1968, Seerley 1972, Devendra 1977, Khajaren et. al., 1977, Montaldo 1977, and Asaolu 1988

Note:- NFE = nitrogen free extracts

APPENDIX 2 Mineral content of cassava

Mineral (mg/kg)	Leaves	Peel	Tuber
Calcium	1.1-1.4	0.31	0.02-0.35
Phosphorus	0.25-0.30	0.13	0.07-0.46
Magnesium	nd	0.22	1.10
Copper	8.0	nd	nd
Iron	450	904	8-65
Manganese	46.0	nd	18.0
Zinc	28.0	nd	nd

Source:- Chadha 1961, Barrios and Bressant 1967, Devendra 1977 and Hutagalung 1977

Note:- nd = not determined

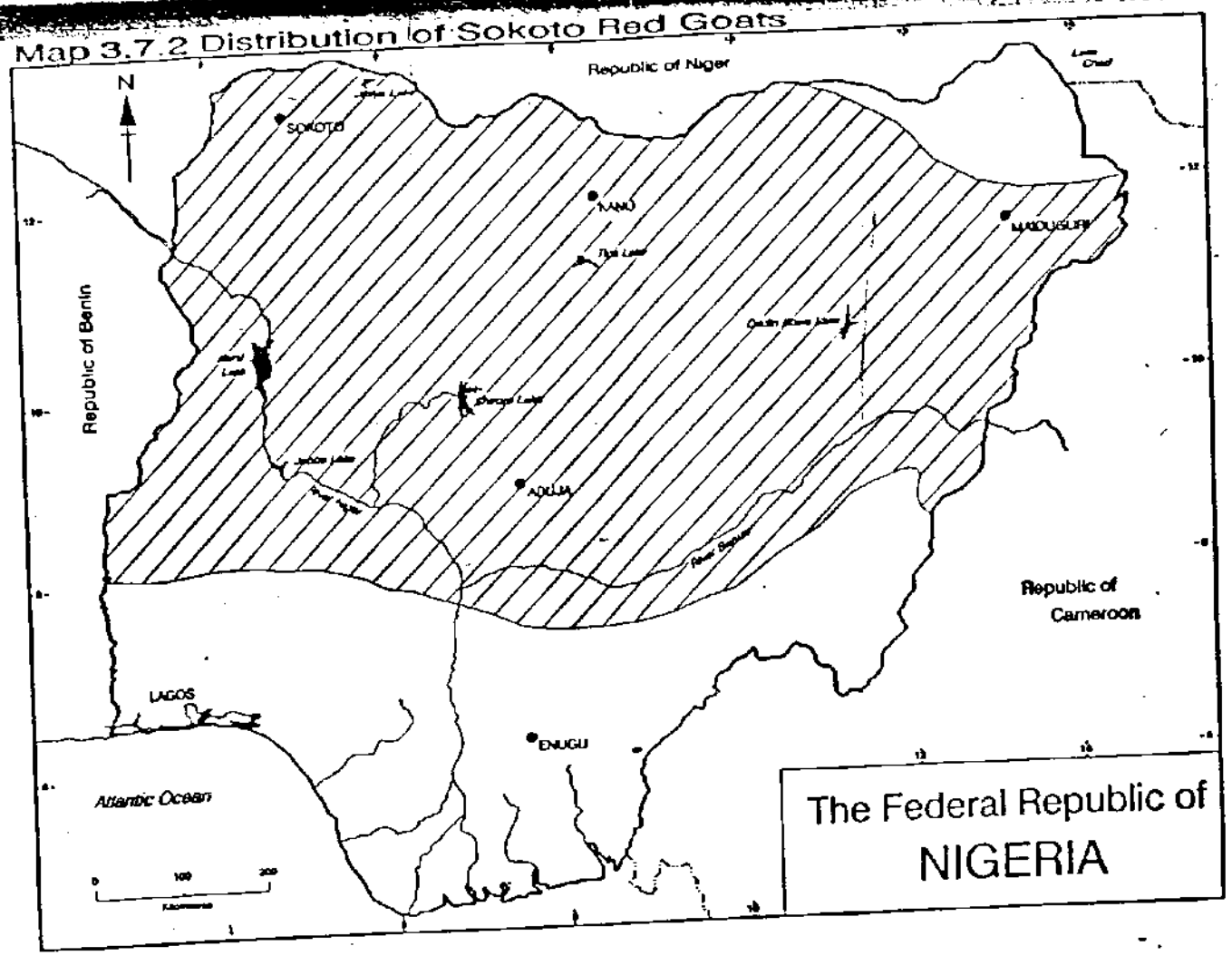
APPENDIX 3:- Vitamin content of cassava

Vitamin	Leaf content	Tuber Content
Vitamin A (I.U)	100 000-300 000	550
Riboflavin (mg)	2.5-4.3	0.3-0.8
Thiamine (mg)	0.3-2.7	0.4-1.6
Niacin (mg)	8.5-35.3	0.6-1.6
Vitamin C (I.U)	520-1800	5-360

Source:- De Brochard et. al., 1957, Jones, 1959, Chadha 1961, Muller et. al., 1975, Hutagalung 1977 and Montaldo 1977

APPENDIX 4

Map 3.7.2 Distribution of Sokoto Red Goats



Appendix 5

SEASONS OF THE YEAR

1. January to March - Hot dry season
2. April to June - Early wet season
3. July to September - Late wet season
4. October to December - Cold dry season

SEX OF KIDS

Male - 1

Female - 2

BIRTH TYPES

Single - 1

Multiple - 2