NUTRITIONAL ASSESSMENT OF *Panicum maximum* (Jacq.) ENSILED WITH TWO CULTIVARS OF *Lablab purpureus* (*Lablab purpureus* L.) FOR WEST AFRICAN DWARF RAM

BY

Modupe Christiana ALASA

Matriculation No.: 41483

B.Sc, M.Sc, (Animal Science) Ibadan.

A Thesis in the department of Animal Science submitted to the Faculty of Agriculture and Forestry in partial fulfillment of the requirement for the degree of Doctor of Philosophy of the University of Ibadan.

APRIL, 2014.

ABSTRACT

Panicum maximum, a grass which is low in Crude Protein (CP), high in fibre and scarce in dry periods. Common legumes are used to improve the quality of *P. maximum* and preserved as hay and silage for dry season feeding. *Lablab purpureus* is a legume though rich in protein but not commonly used. Information on *P. maximum/Lablab purpureus* mixtures as silage for West African Dwarf (WAD) ram production is scanty. The nutritive value of intercropping *P. maximum* with *L. purpureus* as well as ensiled mixtures of *P. maximum* and *L. purpureus* for WAD ram was evaluated.

Panicum maximum was intercropped with two cultivars of *L. purpureus* (Highworth and Rongai) in a completely randomised block design to determine the effect of grass, grass/legume mixtures on CP contents of grass. Sole grass and grass/legume mixtures: 100% *P. maximum* (Pm-100), 75% *P. maximum*+25% Highworth (Pm-75/H-25), 50% *P. maximum*+50% Highworth (Pm-50/H-50), 25% *P. maximum*+75% Highworth (Pm-25/H-75), 75% *P. maximum*+25% Rongai (Pm-75/R-25), 50% *P. maximum*+50% Rongai (Pm-50/R-50) and 25% *P. maximum*+75% Rongai (Pm-25/R-75) were ensiled. Silage characteristics were determined. Total Gas Volume (TGV), Metabolizable Energy (ME), Organic Matter Digestibility (OMD), Short Chain Fatty Acid (SCFA) and methane of silages were determined using *in vitro* Fermentation Technique (ivFT). Twenty-one rams were allotted to seven treatments on ensiled grass and grass- legume mixtures in triplicate for 98 days to assess Feed Intake (FI), Body Weight Gain (BWG), Dry Matter Digestibility (DMD), and nitrogen retention. Blood was sampled for haematology and serum parameters. Data were analysed using descriptive statistics and ANOVA at p=0.05

The CP of *P. maximum* from *P. maximum* intercropped with Highworth (8.0%) or Rongai (8.1%) was significantly higher than CP of sole *P. maximum* (6.5%). Colour of silages was olive green with pleasant odour, firm texture, normal temperature (23-25°C) and pH range of 4.1-4.5. Least CP value was observed in Pm-100 (9.0%) and highest in Pm-25/H-75 (16.8%). Highest neutral detergent fibre, acid detergent fibre, acid detergent lignin were 56.1%, 39.4% and 9.4% respectively observed for Pm-100.The TGV (24.7-34.0 mL), ME (6.1-7.5 MJ/KgDM), OMD (48.0-57.1%) SCFA (0.53-0.75 µmol), and methane (10.0-15.0 mL) varied significantly among treatments. The least FI (573.87g) and BWG (23.81g) occurred in rams fed Pm-100, while the highest FI (715.47g) and BWG (47.62g) was reported for rams fed Pm-25/R-75 and Pm-25/H-75 respectively. Least DMD (40.4%) was obtained for rams fed Pm-75/R-25, while highest (56.9 %) was for rams on Pm-25/R-75 while animals fed Pm-25/R-75 had the highest FI. Nitrogen retention varied such that rams fed Pm-75/H-25 had the least (30.7%) while those fed Pm-25/R-75 had the highest (56.7%). Highest packed cell volume (37.0%) and total protein (6.46g/dL) occurred in Pm-25/H-75, red blood cell ($11.60X10^{6}$µL) in Pm-25/R-75, while highest blood urea (29.00mg/dL) was obtained in Pm-100.

Intercropping of *Panicum maximum* with *Lablab purpureus* cultivars improved crude protein content of the grass. Ensiling *Panicum maximum* with 75% Highworth or Rongai enhanced feed intake, weight gain and could serve as a good substitute dry season feed for ram.

Keywords: *Panicum maximum-Lablab purpureus* mixtures, Silage quality, West African dwarf ram

Word Count: 494

ACKNOWLEDGEMENT

I give glory to the Most High God for He is the only one worthy of my praise for the successful completion of this research work. I want to thank God for He is my God, my guide, my guardian, my helper, my sustenance, my pillar, my shield and fortress throughout the period of this programme. The God of signs and wonders, I say a resounding thank you Sir.

I, so much appreciate my Supervisor, Prof. O. J Babayemi for the immense contribution and effective role he played concerning this work. I appreciate you for all you did in imparting me positively in the area of academic. I have ever known you to be a very hard working, selfless and caring boss. May the good Lord continue to energise, increase and comfort you on every side (Amen). I also appreciate Dr. (Mrs) Babayemi, thank you Ma.

My profound appreciation goes to the H.O.D, Department of Animal Science, Prof. A.D Ologhobo, all my lecturers, most especially the immediate past H.O.D Prof. E.A Iyayi, Drs O.Abu, O. O Olusola,T. Ososanya, A.E Salako, Olorunnisomo, O. Ajewole, A. Ladokun a.k.a 'Ladoks' (UNAAB) and Mr Ayo Odufuye for their support during the years of executing this project.

I sincerely thank and appreciate my husband who is my brother and baby, Mr kolawole Alasa for all his selfless support spiritually, emotionally and financially towards my academic pursuit. Big thanks to my children, Susan, Tope, Zion and Joshua for loving and understanding me. May God support and take you to the greatest height in life (Amen). I appreciate my elder sister, Mrs Bisi Alalade. I am greatly indebted to my mother, Mrs Comfort Mojoyinolu Ogunmokun (JP). Maami you brought me to life, nurtured and catered for me. Even, in the course of this programme your words of encouragement, advice and prayers pushed me forward. You always admonished me to endure, that I will finish well and your words came to pass. I thank you my dear mum.

My gratitude goes to my bosom friend Dr (Mrs) Adebomi Moradeun Oyewumi of Special Education Department, University of Ibadan. Words are not enough to express myself to you from our undergraduate days till now for the positive impart you made in my life.

Special thanks go to my brother, Mr.Taiwo Akano of the Dean's Office, Post Graduate School, University of Ibadan.

I sincerely appreciate all my senior, junior colleagues and friends at Federal College of Education (Special), Oyo. Drs T.A.G Oladimeji, R.A Oyeyinka (UNAAB), B.A Adebiyi, J. Durojaiye, S. Agbato, A. Bello; Messers- Muibi, R. Bello, F. Alaka, O. J Olabode, Ibitoye Adebola, A. Sanusi, A. Akinsola, Ibitoye Olayinka, S. Oloso, R. Tiamiyu. Mrs. B.O. Akanbi and Pastor (Mrs) Oso, I appreciate you. Deji Odubunmi, and all others in Agricultural Education Department and School of Vocational and Technical Education, I thank you all for your immense contributions to the success of this work.

A special appreciation goes to my colleagues in the same struggle; Dr. T. Binuomote, S. Akinsola a. k a. 'Nigeria', Falola , Bamigbose, Ty , Dr. Amuda, Dr. Dupe Ogunbosoye, Priscila, Bro. James, Onyenkwereh, Odu, Ajetumobi, Adenekan and Kenneth-Obosi.

I would like to appreciate my Pastors (Mama) Dina Doyin (R.C.C.G), Pastor P.O Oriola (R.C.C.G), Mrs Titilayo Akerele (R.C.C.G), Pastor Sunday Alaba (R.C.C.G), Pastor Ade Adeleye (R.C.C.G) and Daddy, Zion Adeola Oke (Mt. Zion Glorious Temple, Oyo) for their spiritual assistance all the time.

DEDICATION

This project work is dedicated to GOD ALMIGHTY, the Beginning and the Ending.

CERTIFICATION

I certify that this work was carried out by, Modupe Christianah ALASA in the Department of Animal Science, University of I badan, Ibadan, Nigeria.

……

Prof.O.J. Babayemi

B.Agric. (Benin), M.Sc, Ph. D (Ibadan)

Senior Lecturer (Ruminant Nutrition)

TABLE OF CONTENTS

CHAPTER FIVE

CHAPTER SIX

LIST OF TABLES

Table **Page**

LIST OF FIGURES

APPENDIX

Page

List of plates of the grass / herbaceous legumes and WADrams used in the study

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background to the study

Ruminant animals are cattle, sheep and goats. They consume large quantities of humanly inedible roughages such as straw, bean husk and corn stalks etc for production and reproduction.They are animals with complicated stomach and because of this, the rumen microbes perform best on roughages which they can digest. Ruminant animals are physiologically adapted to obtain their nutrients from grass and they convert this low quality, high fiber feedstuffs to meat and milk that are important sources of protein, mineral, fat and vitamins.Sheep are ruminant species that occupies a very important position in livestock production in Nigeria. The West African dwarf sheep at maturity have a body weight of 20-35kg. Although, they thrive on local grazing either browsing or scavenging, as this tend to limit their production and they can not meet the rapidly increasing human population. Low productivity of sheep in tropical/sub tropical region is associated with low digestibility and low nitrogen contents of available feed resources. One of the ways of improving their nutritional status and under nutrition is by supplementation (Ismartoyo *et al.*, 1993).

Nutrition is one of the important management practices in ruminant production and it is the bed rock of performance in animal; but if there are limited forages; and reduction in nutrient composition of the available forage grasses and legumes during dry season, this poses a problem (Amole *et al.*, 2011). However, available evidences indicate that small ruminant industry would benefit if the animals received optimal nutrition. In Tropical Africa, majority of ruminant animals are reared on natural pastures which decline in quality during the dry season (Bamikole, 1998). Ruminants in recent times have also been reared on fodder tree and herbaceous legume foliages because they supply nutrients, particularly Nitrogen (N), during the dry season when nutrients from grazing become qualitatively and quantitatively limited for grazing livestock. These fodder trees and herbaceous legume foliages serve as supplements depending on the capacity to provide essential nutrients to the rumen microbial population and also satisfy the animal's requirement, both of which may increase the efficiency of feed utilization (Elliot and McMeniman, 1987). In this regard, foliages from fodder legumes qualify as supplements to poor quality forages.

One major problem of ruminant production in Nigeria is the scarcity of these fodder grasses and legumes (forages) throughout the year (Babayemi *et al.*, 2006). Odedire and Babayemi (2007) opined that due to seasonal changes in climate, there used to be unavailability of year round grazeable forages for livestock. In the same vein, Onyeonagu and Asiegbu (2006) reported that the supply of grass herbage for livestock during the dry months of the year declines substantially.

Forages are the cheapest feed resources for small ruminants but due to low pasture quality and availability they become low during the dry season (Njoya *et al*, 2005). According to Bamikole *et al.,* (2003) stressed that the bulk of the feed available to ruminants in the tropics is the grass forage, as this can be sourced cheaply. Smallholder producers of ruminants particularly sheep and goats in Nigeria rely on unimproved natural pasture as the main feed source, backed up with crop residues after harvest (Bamikole *et al.,* 2004). In an effort to alleviate ruminant feed supply problem, due to the fact that grasses are low in crude protein and insufficiently available in dry season, farmers need not depend solely on natural pastures but needs to practise improved pasture management (Bamikole 1998). Makembe and Ndlovu (1996) advocated that the weight of high yielding tropical legumes in establishing an improved pasture will eventually result into achieving year round quality forage.

Greater research efforts have been made focusing on ways to improve the nutritive value of forage/legumes, thereby enhancing productivity of the animal. Ezenwa and Akenóra, 1998; Bamikole and Ezenwa (1999) reported the methods which include fertilization of pure grass stands as well as the incorporation of adapted herbaceous legumes into grass pastures for good quality forage production. Tropical grasses have been reported to respond well to inorganic fertilization, high doses of these fertilization at up to 200kgN/ha^{-1} to achieve optimum yields is unlikely to be of practical importance to the low-input farmers in Southern Nigeria. However, good results have been obtained with forages of herbaceous legumes as supplements for ruminants on low quality diets (Said and Tolera, 1993; Abule *et al.,* 1995; Kariuki *et al.,* 1999).

The *in vitro* gas production technique developed by Menke *et al.*, (1979) remains a useful tool for rapid screening of feeds to assess their potential as energy sources for ruminant animals. Blummel and Becker (1997), assumed that the volume of gas produced reflect the end result of fermentation of the substrate to short chain fatty acid (SCFA), microbial biomass and the neutralization of the SCFA. Blummel and Orskov (1993) used this technique of determining gas production at several incubation times and values obtained to describe the pattern of fermentation of feeds; also with application which permits fermentation kinetics of the soluble and readily degradable fraction of the feed and the more slowly degradable fraction to be described (Getachew *et al.*, 1998). *In vitro* gas production ascertains feeds nutritive value.

In Nigeria, one of the major sustainable pastures is *Panicum maximum*. *Panicum maximum* grows naturally in many parts of Nigeria. *Panicum maximum* is a high yielding grass commonly used to improve pasture in Southern Nigeria (Ademosun, 1973). It is well eaten by all classes of grazing livestock with particularly high intakes of young leafy growth. The major challenge of *Panicum maximum* which is similar to other tropical grasses is the rapid decline in the crude protein and soluble carbohydrate with age. This is coupled with a progressive increase in the crude fibre and lignin (Agishi, 1985; de Leeuw, 1979). It grows well in the humid tropical part of Nigeria but low in crude protein and insufficiently available in the dry season, thereby needs to be intercropped with a forage legume (Bamikole and Babayemi 2004). Bamikole (1997) reported the nutritional quality of *Panicum maximum* becoming low with advancing age thereby suggesting cutting interval. Adegbola (1985) reported that ruminant animals cannot meet their maintenance needs on grass alone; their feeding could be augmented with forage legumes. Elliot and McMeniman (1987) reported forage legumes such as *Lablab purpureus*, species of Leucaena, Sesbania and Gliricidia etcetera qualify as supplements to poor quality forage grasses due to high N and relatively low fibre content. Ezenwa and Akenova (1988) recorded the use of grass-legume mixtures which are as productive as N fertilized grass stands.

Cattle like any other ruminant depend too much on forages with nitrogen especially during the dry season to support production performances and maintenance. The availability of nitrogen in forages has a major influence on feed consumption, live weight and ecology of stock which graze extensively on pastures. Siebert and Kennedy, (1972) reported that low Nitrogen levels

in forages results into reduction in feed intake, so ruminants need to consume the much needed nitrogen in order to maintain their weight and production performances. Livestock production systems are associated with mixed crop-livestock farming systems. Inadequate quantity and poor quality of feeds available year-round is a major constraint to livestock production in such systems. Mainly natural pastures and crop residues provide dietary energy for dairy cattle but are generally unable to meet the nutrient requirement for milk production and reproduction (Topps, 1997).

Grass with legume compatibility studies involve some of the legumes being incorporated into grass pastures such as *Lablab purpureus*, *Centrosema pubescens*, *Aeschynomene histrix* and *Stylosanthes*. In order to improve the grass yield, nutritional status and enhance performance in animal, growth compatibility involving *Panicum maximum* with *Pueraria phaseoloides*, *Vigna* species, *Calopogonium mucunoides* and *Centrosema* has been reported (Kanava *et al.*, 2005).

Lablab purpureus was previously known as *Dolichus lablab* and in different parts of the World, lablab, being palatable to livestock, is an adequate source for the much needed protein and can be utilized in several different ways. It can be grazed in a pasture setting or as a companion crop to maize, cut as hay or mixed with corn silage (Murphy and Colucci, 1999).
It is an important forage legume that could be included in the feeding of animals (Rogers, 2002). It has been observed that it increases livestock weight and production during the dry season (Murphy and Colucci, (1999). Ajayi (2007) incorporated lablab leaves to feed goat successessfully. Ismartoyo *et al.*, (1993) reported the suitability of *Lablab purpureus* seed as a supplement for young goats. Lablab is a climbing/trailing or erect annual or short lived perennial (Evans, 2002).In some tropical and sub-tropical countries (South and Central America, East) the seeds and immature seed were used for human and to control erosion while it is used as a feed supplement for cattle grazing mature pasture in the dry season (Aganga and Tshwenyane, 2003).

1.2 Justification

Earlier research on fodder conservation in Shika, Northern Guinea Savanna of Nigeria showed that there are inherent problems in conservation of forages as hay. The right climatic conditions suited for hay making coincide with the time when forages are low in nutritive value while the making of good quality hay during the rainy season when they are of good quality, is practically imposible due to humid weather conditions (Amodu and Abubakar, 2004). Ensilage offers alternative means of fodder preservation during the rainy season while retaining nutrient quality of the forage without recourse to the use of fuel or solar energy for artificial hay making under wet, humid conditions (Kallah *et al.*, 1997). Muhammad *et al.* (2008) suggested the need for development of feed conservation strategies during period of abundant supply so as to redistribute the feed supply over the year to meet the requirement of livestock resources. He further supported among other methods employed in the problem associated with feeding ruminant forage conservation which is silage adequately in quantity and quality during the dry season calls for an alternative means of feeding. One of such technology of feeding forage grasses and forage legumes after ensiling (silage) is made during the wet season and which could be fed to livestock during the dry season (Dube, 1995).

Ensilage involves utilization of forages, crop residues or Agricultural and Industrial by products preserved by acids either added or produced by natural fermentation (Babayemi, 2009).Cowan (2000) also reported that silage had played an uneven role by improvements in pasture and forage crop conservation. He stressed that harvesting and storage of excess growth in the growing season for feeding during the dry season is necessary.Silage technology is preferred in the tropics because it is less dependent on weather condition, sun drying and artificial drying than hay. Silage can be kept for months or years, Wong, (1999) and can be used at any time when required especially during the periods of drought (Koon, 1993).Purposes of incorporating silage in ruminant feeding are highlighted as drought feeding, production increases, an aid to pasture or crop management, utilization of excess growth, balancing nutrient in diet and the storage of wet seed products. Thus, this research option for improving sheep productivity via improving nutrient value of ensiled forage grass and forage legume fed as basal diet, as forage quality and overall potential are best measured in terms of animal productivity (Bamikole *et al.*, 2001).

1.3 The broad objective

The broad objective of this study is to evaluate: The performance of West African dwarf ram fed improved *Panicum maximum*.

1.3.1 The specific objectives

The specific objectives are to determine the:

i. Effect of grass and legume mixture on the chemical composition and *in vitro* degradation of the forages
ii. Effect of silage quality and the nutritive value from *Panicum maximum* and *Lablab purpureus* mixture.
iii. Shell life and quality of silages made from *Panicum maximum* and legume
iv. Performance of growing West African dwarf ram fed ensiled *Panicum maximum* and legume mixture.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 SUSTAINABLE PASTURES

Pastures are areas of land on which forage plants are growing or are being grown. Forages are grasses and legumes which are consumed by livestock e .g. Cattle, Sheep, Goat, Rabbit etcetera. Pasture or grasslands is a farming system which emphasizes the importance of grasses and legumes in ruminant production and land management. Pasture grasses and legumes are the cheapest and major feed to ruminant despite the indispensability of forages; livestock farmers still face the problem of its scarcity during the dry season (Babayemi *et al.*, 2006). Pastures can be natural or improved. They are referred to as natural when they are growing on their own; while they are referred to as improved pastures when a man deliberately attempt to establish them (Onwueme, 1979). Sustainable pastures are the forage plants that will continue to grow even after being cut and being available as feed resources to livestock irrespective of whether they are natural or improved pastures. Aganga and Tshwenyane (2003) stated a need for improved pastures with the increasing demand for meat and milk and also increasing productivity of grass on land without degrading the natural resources.

Bamikole *et al.*, (2004) observed that in Southern Nigeria, constraints imposed on small ruminant production are predominantly by disease or poor nutrition especially with animals subjected to intensive system of management. Adeloye (2001) also stressed that the apparent inefficiency of ruminant livestock production in Africa was attributed to unfavourable climate, disease prsevalence and feed shortage during dry seasons. The first two factors tend to encourage adoption of intensive ruminant farming system which can further aggravate the problem of inadequate feed supply. Cost of feeds and feeding under intensive production systems account for about 60% of the total production cost when compared to 40% value under extensive production system (Atteh, 2002). A substantial reduction in cost of feeds is achievable through the use of improved pastures. Also, in order to address the problem of low nutritive value of grasses fed to ruminant, improved pasture can be practised.Bamikole *et al.*, (2001) reported the use of nitrogenous fertilizer to improve grassland which is uneconomical and could increase environmentally related problems. Pasture can be grazed; cut and fed fresh

or later fed as either hay or silage. Legumes are normally of better nutritive values than grasses because they have higher contents of protein, calcium, phosphorus and lower contents of fibres and they have ability to influence the nutritive value of the intercropped grasses (Alabi and Alausa, 2006). Forage *Pennisetum* crops have been successfully intercropped with legumes (Gill and Tripathi; 1991 and Bhagat, Prassad and Singh 1992, Mhere *et al*,1999); and ensiled with and without legumes (Mhere *et al.*, 1999, Crowder and Chheda,1982 and Bareeba, 1992). Mhere *et al.*, (1999) found that soil type, planting pattern and weather had significant effects on proportion of legume in both forage sorghum and forage *Pennisetum* crops.

Tainton (2000) stated that, it is important to appreciate that veld and pastures can play complementary roles in providing fodder to livestock. He further suggested that before pastures are introduced into any system, an assessment should be made of the extent to which productivity is likely to be increased, the amount of capital needed, the livestock system which is envisaged, the availability of labour and management expertise, and perhaps most important of all, the attitude of each individual farmer to pasture development.

2.2 *Panicum maximum* (Guinea Grass cv Ntchisi)

Panicum is derived from Latin name for millet which is used in bread making while *maximum* refers to the greatest height this plant attains (GubbR *et al.*, 1990). *Panicum maximum var Ntchisi* is an introduced variety and earlier studies on it (Ezenwa, 1995; Olanite, 2003; Olanite *et al.*, 2006) reported its superiority over the naturalized and widely distributed local variety in terms of yield, quality and persistence.A sustainable forage grass which can support ruminant feeding system in Nigeria is *Panicum maximum*. *Panicum maximum* is indigenous to Africa, widely distributed in West Africa and grows naturally in many parts of Nigeria. Like any other tropical grasses, the major limiting factor to the use of *Panicum maximum* is rapid decline in crude protein and soluble carbohydrate with age. *Panicum maximum* is a tall, vigorous, tufted perennial with stems up to 3.5m in height and short creeping rhizome. *Panicum maximum* can tolerate fire and shade. It grows in sugar cane fields due to its ability to grow under shaded conditions. It can be fed green at manger, or fed as hay or as silage. It is reported that it has played an important role in grasslands improvement and livestock feeding (Bamikole *et al.*, 2001). When very young and well fertilized, there is an improvement in the

intakes and digestibility of livestock (Ademosun, 1985). Bamikole and Babayemi (2004) reported intakes (g/ kgLWd) of DM (65.24), CP (6.11), NDF (47.72) and OM (60.66) from nitrogen fertilized *Panicum maximum* were not different from that of *Panicum maximum*-Verano stylosanthes mixture which had respective values of 69.65, 6.71, 47.19, 65.20. The intake values from unfertilized grass were lower having corresponding values of 50.43, 4.35, 37.04 and 46.84g/ kg LWd. The digestibility of DM, CP, and OM were not different in all the three supplemented forages, while digestibility of NDF was higher in UFG than NFG but not GVSM. It is therefore a grass that can contribute a great deal to livestock improvement in Nigeria (Ademosun, 1977). Dry matter (DM) is the weight of feed left after all the moisture has been removed by heating. Oyenuga (1960) recorded annual DM yield figure of 12.0, 16.1, 15.2 and 23.4 ton/ha in grass plots at Ibadan when the grass was harvested at 3, 6, 8 and 12 weekly interval respectively. Chemical composition of the grass varies with increasing maturing, the most consistent of which is declined in the crude protein. The protein content declines rapidly during the first 30 days. Thereafter, it is gradual; conversely the crude fibre content increases with age (Oyenuga, 1968). Johnson *et al.*, (1967) also reported that total carbohydrate fraction (crude fibre and Nitrogen free extract) increase slightly with maturity in all seasons.

2.2.1 Chemical Composition of *Panicum maximum*

Crowder in Alokan (1998) recorded yields of 70,000kg Dm/ha. Dry matter (DM) is the weight of the feeds left after all the moisture has been removed by heat.Oyenuga (1960) recorded annual dry matter yield figures of 12.0, 16.1, 15.2 and 23.4 ton/ha in grass plots at Ibadan when the grass was harvested at 3, 6, 8 and 2 weekly interval respectively. When leafy and young, it has a high nutritive value but declines with advancing maturity especially in the crude protein content. Conversely, the crude fibre content increased with age. (Ademosun,1973). Adeneye and Sunmonu (1994) recorded the crude protein of *Panicum maximum* to be 11.9% and crude fibre of 31.7%. Aribido (1990) reported values of proximate analysis of dried *Panicum maximum* to be (MC) 21.68%, Crude protein of 0.05%, (EE) 2.60%, (CF) 36.6%, ADF 33.30%, NDF 46.07 and Ash 6.79%.

2.2.2 Compatibility with other Species

Panicum maximum combines very well with twinning legumes like *Lablab purpureus Stylosanthes*, and *Centrocema*. Ajayi *et al.*, (2007) reported its compatibility when intercropped with two different types of legumes, (*Stylosanthes* and *Aeschynomene histrix).* Also, Bamikole *et al.*, (1999) had a mixture of *Panicum maximum* with *Stylosanthes hamata* to supply organic nutrients to the soil for use of grass component. Furthermore, Bamikole *et al.*, (2004) reported increased dry matter yield of *Panicum maximum* (2 kg/ha) intercropped with *Stylosanthes hamata.* The grass alone when planted depletes the soil nitrogen relatively having low protein and minerals but rich in carbohydrates. The grass-legume mixture in which the growing legume supplies N to itself as well as to the grass, thereby reducing the cost of fertilizer. Bamikole *et al.*, (2001) reported *Panicum maximum*/*Verano Stylosanthes* mixture resulted in feed with a balanced carbohydrate, proteins and minerals, when livestock are fed with the mixtures, livestock assessment indicates a significant improvement. Muhammad *et al.*, (2008) reported compatibility on the field grown Columbus grass (Sorghum *almum parodi*) and fortified with forage legumes from centurion (*Centrocema pascourum* L); Lablab bean (*Lablab purpureus* L); and Groundnut (*Arachis hypogea* L).

2.2.3 Cultivation

Panicum maximum cv *Ntchisi* is presently found and cultivated in almost tropical parts of the world. It is the giant type having hairless stems with panicle distinctive dark brown colour often propagated vegetatively (rooted tillers). *Panicum maximum* can be established vegitatively by the use of crown splits. Bamikole *et al.* (2004) reported vegetative propagation of *Panicum maximum* using 3 crown split per stand. *Panicum maximum* thrives well on well drained, highly textured soils and does not tolerate heavy clayey soils (Bodgan, 1977). *Ntchisi* are often propagated vegitatively (Chen *et al.*, 1992). *Panicum maximum* can also be established by seed drilling or broadcasting at 2-3kg/ha and planted at no more than 1cm deep; rolling after sowing improves germination and establishment (Whiteman, 1980). Akinola (1974) reported that drilling green panic (*Panicum maximum var trichoglume*) seed to a 2.5cm depth under the imperfectly drained, cracking sandy clay conditions of the northern guinea Savanna zones of Nigeria have been recommended to yield good results. According to Edwards and Bodgan, (1951) *Panicum maximum* can flourish from sea level up to1950m above sea level. Ademosun (1973) stated *Panicum maximum* is a constituent of

natural grasslands. In the savannah area of Northern Nigeria, he further stressed that the grass serves as a reserve crops for feeding during dry season with nutritive value being highest when harvesting is over a short interval of about 6 weeks. The more fibrous the grass the lower it's digestibility by livestock.Gibbs, (1990) also reported *Panicum maximum* can easily be cultivated from seed that is obtained from seed distribution. Whiteman (1980) reported that *Panicum maximum* can be established by seeds drilled in holes at the rate of 1-10kg/ha depending on the variety soil type and climate condition.

2.2.4 Cutting Frequency

One of the major limitations of *Panicum maximum* is the fact that they become stemmy if not cut frequently (Chen *et al.,*1992). Nutritive value of grasses and legumes species grown in Nigeria depends on the species and season of growth at which the grasses are cut or grazed (Aina and Onwukwa, 2002). *Panicum maximum* cuttings with a single node and a mature bud gives a good result having higher percentage emergence than cutting containing 2 – 3 nodes or a single node with immature bud: a limiting factor in the use of *Panicum maximum* is the cutting frequency. Cutting becomes a limitation, if not cut or grazed frequently *Panicum maximum* becomes stemming. Cut and carry should be done as frequently as possible, even though, cutting frequency has its own advantage of increasing the herbage yield of *Panicum maximum*. Cutting should not be done at the age less than 4 weeks and at 4 weeks intervals. Cutting frequency increases herbage yield of *Panicum maximum*, however, cutting should not be done too frequently. Ademosun (1973) reported that four weekly cutting frequencies produced optimum yields of high digestible leafy herbage, an indication that the digestibility of grasses decreases with delayed period of harvest. Increasing the age at first cutting also increased the dry matter yield of *Pennisetum purpureum, Pannicum maximum* and *Cynodon nlemfuensis*. He further observed a decline in the leaf: stem ratio from 4 to 7 when harvest was differed from 4 to 7 weeks and reported that the nutritive value of grass decline with increasing maturity.Grof *et al.,* (1970) reported four-weekly cut intervals for *Panicum maximum*. This is done to obtain the best balance between quality and quantity. *Panicum maximum* is also susceptible to frequent low cutting, not below about 30cm. Bamikole *et al.,* (2004) reported a six- week old harvesting *Panicum maximum*. He also reported a six weekly cutting frequency of *Panicum maximum* and *Stylosanthes hamata* with 4 harvests during the growing season.The dry matter yields of the forages differed significantly ($P < 0.001$) and

showed a significant reduction (P <0.01) across the season. Babayemi, (2009) reported cutting of *Panicum maximum* (*Panicum maximum cv Ntchisi*) at 4 and 12 week re-growth and then fed to West African Dwarf sheep. Familade and Babayemi (2010) reported harvesting of *Panicum maximum* at 4 weeks with crude protein of 7.40g/100gDM and 12 weeks re-growth with lower crude protein of 5.20g/100gDM.

Mineral content in the soil for example, Phosphorus often determines the establishment and persistence of Legume (Haque *et al.*, 2008) and the importance of good re-growth, cutting height and age of pasture to its nutritive value and overall biomass production has been reported by several workers (Adjei and Gentry, 1996; Aina and Onwukwe, 2002; Odion and Singh, 2005; Ahmadi *et al.*, 2009; Smithson and Giller 2002).

2.3.0 *Lablab purpureus* (*Lablab purpureus* L.) *sweet*

Lablab purpureus is synonymous to *Dolochos lablab*. Lablab combines a great number of qualities that can be used successfully under various conditions. Its first advantage is its adaptability, not only is it drought resistant but is able to grow in a diverse range of environmental conditions world wide (Murphy and Colucci, 1999). Ogundipe *et al*., (2003) reported that *Lablab purpureus* remains green far into the dry season. Murphy and Colucci (1999) identified twenty various names of lablab such as Dolichos bean, Hyacinth bean, Country bean, Lablab vulgaris, Hierbade conejo, Lablab garbanzo, Frijol dolicos, Caballero, Lubia bean, India butter bean, Egyptian bean, frijol jacinto, Siem bean, poronto japones, Bonavista bean, Tonga bean, Poor man's bean, Chimbolo bean, Gallinita, Caroata chwata (Venezuela). Lablab is widely grown in Africa. The bean is used as seed for human consumption and livestock consumption (Pulsegra, 1968). Aganga and Tshwenyane (2003) reported it performs well on new ground and on acid soils. Lablab has been distributed to many tropical and subtropical countries where it has been naturalised with two main cultivars, Lablab cultivar Rongai"; was introduced from Rongai region of Kenya to subtropical and tropical Australia (Evans, 2002). Lablab cultivar Highworth originated from Coimbatore, South India and is morphologically similar to Rongai. Lablab is used as forage for livestock (Herndrickson and Myles, 1980). Lablab is a short–lived perennial or growing annual with vigorously trailing twinning herbaceous plant (Agishi, 1991). Lablab has the ability to out-yield conventional crops, especially during the dry season and it enhances the nutritive value

(Murphy and Colucci, 1999). It is a fodder crop of great importance for the tropics. It can be used advantageously as a cover crop. Its dense green colour during the dry season protects the soil against the action of sun's rays and decreases erosion by wind and rain. As green manure it provides organic manure, minerals and as legume lablab provides biological nitrogen fixation, with its natural action of converting atmospheric N into forms available for plant-animals-soil system which improves productivity in an inexpensive and environmentally friendly manner. (Murphy and Colluci, 1999). Humphreys (1995); Schaaffhausen (1963a,b) firstly, reported that as a leguminous cover it conserves soil, improve organic matter and compete with weeds and secondly that the legume-rhizobial symbiosis provides farmers with an inexpensive sources of Nitrogen whose production is environmentally clean. Lablab is a legume well suited to most tropical environments, as it is adaptable to a wide range of rainfall, temperature and altitude. *Lablab purpureus* with its ability to out-yield conventional crops, especially during the dry season, and its enhanced nutritive value, is a fodder crop of great importance in the Tropics. Several authors have reported that lablab grows well under warm and humid conditions at temperature ranging from 18°C to 30°C and is fairly tolerant to high temperatures (Hendricksen and Minson 1985; Kay 1979; Cameron 1988). Below 20°C, the plant reduces growth; leaves begin to drop at minus 2°C, but the plant can survive in frost for a limited period (Kay 1979; Mayer *et al.*, 1986). The average daily maximum temperature during the two growing seasons ranged from 28°C to 31°C and 24°C to 29°C in the 2002/2003 and 2003 growing seasons. Winter period in this region is fairly mild and this can allow favourable growth of lablab. Average rainfall in this region is 600mm. Lablab is drought hardy and has been grown in arid, semi-arid and humid regions with rainfalls between 200 and 250m (Hendricksen and Minson 1985; Cameron 1988). Lablab is one of the major leguminous forages and green manure crops in Australia (Cameron,1988). Lablab can be fed as fresh foliage, hay or silage. Lablab has the potential of alleviating nutrient deficiencies in poor quality diets especially during the dry season (ASARECA REPORTS). Murphy *et al.*,(1999) reported that based on the high protein content of leaf fractions and the digestibility values of all botanical fractions, it may be concluded that lablab is nutritionally valuable legume resource which should be employed more often in Tropical Agricultural Production Systems.The supplementation of oat hay with lablab for Ethiopian Menz sheep (Umunna *et al.*, 1995). It was combined with maize stover for goats in Zimbabwe (Makembe and Ndlovu,1996). It has been used as supplement in feeding Tswana sheep and goats (Aganga

and Autlwetse,1999). Lablab can be mixed with Napier grass to feed dairy animals. Researchers in Uganda reported that dairy cows were fed on their farms a combination of diets of Napier grass –forage and legume mixture with 3Kg per cow per day of lablab hay and increased milk production by 1-2litres per cow per, per day (ASARECA).

2.3.1 Chemical Composition of *Lablab purpureus* L.

Summaries of Crude Protein (CP), Crude Fibre (CF), Neutral Detergent Fibre (NDF), Acid Detergent Fibre (ADF), Acid Detergent Lignin (ADL), Dry Matter Digestibility (DMD) and Digestibility Crude Protein (DCP) values for lablab plant and various fractions have been reported by several authors. Aganga and Autlwetse (2000) reported the whole plant of lablab contains 42.4% NDF, 31.8% ADF, 4.74% ADF. Cameron (1988) and Karachi (1997) reported that lablab leaf contains 21-38% CP, 41.8%CF, 29.6% NDF, 10.8% ADF and in vitro DMD 64.4%. Cameron (1988) and Karachi (1997) reported that lablab stem contains 7-20% CP, 61.8% CF, 49.3% NDF, 10.8% ADF and 44.2% in vitro DMD. Aganga and Autlwetse (2000); Umunna (1995) reported that whole plant of lablab hay contains 16.4% CP and 43% CF. Cameron (1988) reported 55.7% DCP and 64% *in vitro* DMD. Herndrickson and Myles (1980) reported that dried seeds of Hyacinth bean contains 20-28% crude protein like other beans, their amino acid is moderately well balanced while is high in lysine content. Lablab foliage analysis result suggests that it has high protein content (15-30%) as well as high levels of lysine and digestibility (Valenzuela and Smith, 2002).

2.3.2 Uses and application

Lablab purpureus is a dual purpose legume. Lablab has the potential to enhance the nutritive feed source for livestock. Among the many introduced legumes that have so far been evaluated in Nigeria, lablab has been reported to be a promising crop for the Northern Guinea savanna (Thomas and sunberg, 1995; Iwuafor and Odunze, 1999; Ewansiha *et al.*, 2007). In the feed regimes, it helps to rectify some of the problems associated with low protein and high fibre diet (Murphy and Colucci, 1999). Lablab was used as a supplement to oat hay, and average daily gain in sheep fed the supplement was almost double than that of sheep fed solely the basal diet (Ummuna *et al.*, 1995). Lablab has been known for its use as a green manure, adding organic matter as well as Nitrogen and mineral to the soil. Lablab is a main

fodder crop in Kenya, Zambia and milk production from animals fed lablab was higher than from those fed grasses. A feedy favour in milk is reported with lablab feed (Evans, 2002).

It is traditionally grown as a pulse crop for human consumption in the South and South East Asia and Eastern Africa. Flower and mature pods are used as vegetable. It is used as a fodder legume sown in grazing and conservation in broad-acre agricultural systems in tropical environment (Cameron, 1988).

2.3.3 Soil Requirement and Reproductive Development

Lablab grows well in a wide range of soil types from deep sands to heavy black clay sand, can tolerate pH ranges of 5-7.5 (Murphy and Colucci, 1999). The soil should be well drained. It is a short-day flowering response with early ('Highworth') and late ('Rongai', 'Endurance') flowering types available. Flowering can be early at 55 days after sowing. Lablab being an annual or weak perennial, lablab flowers and sets seed in the first season of growth (Cameron, 1988).

2.3.4 Defoliation and Companion Specie

Three harvests are possible per year from the annual types but lablab will not stand heavy grazing of stems. As forage, the crops should be utilized before flowering. When used in green manure, the lablab should be cut before flower initiation. Lablab is more tolerant of grazing than cowpea and more harvests possible. (Agishi,1991). Companion species are grasses such as annual forage sorghum (*Sorghum spp*) and millets (*Pennisetum glaucum*) summer cereal crops, maize (*Zea mays*) and Sorghum (*Sorghum bicolour*). Lablab can be over sown into *Panicum maximum* pastures (Ayisi *et al.*, 2004).

2.3.5 Feeding Value and Palatability/Acceptability

The leaf of *Lablab purpureus* has crude protein content of 21-38% average of 26%. The stem of lablab has much lower crude protein of 7-20%. Grains contain 20-28% crude protein. Grains have high content of vitamin K, B and D. Digestibility ranges from 55-76%. The leaf is highly palatable but the stem has low palatability. The palatability of grain is low to moderate depending on variety (Cameron, 1988).

2.3.6 Seed Production and Production Potential

Lablab gives high grain yields of 1-2.5t/ha which can be obtained depending on cultivar. Lablab gives seasonal yields of 2t/ha leaf or 4t/ha stem in the tropics. Dry matter yield of lablab is usually higher than for cowpea. Lablab consistently produced more than 2.2 t/ha^{-1} of biomass in both the growing season.

2.3.7 Animal Production

Cameron (1988) reported Zebu cattle grazing maize stalks, dry grasses and green lablab gained 350g/head/day over a 3 month period, while cattle without lablab lost weight in Brazil. In sub tropical Australia, cattle gains have ranged from 0.09-1.04kg/head/day depending on the feeding conditions (Ayisi *et al.,* 2004). Murungweni *et al.*, (2004) reported trials in Zimbabwe have demonstrated that the use of a lablab hay supplement resulted in milk yield increases slightly less than those obtained through the use of velvet bean (*Mucuna pruriens*). Milk quality was also slightly less than that achieved with velvet bean but still very acceptable. Supplementing the diet of goats with lablab in Zimbabwe has been shown to yield better condition for does, higher kid birth weights and growth rates, and higher milk yields.

2.4.0 FORAGE LEGUMES

Generally, legumes are pod producing crops mostly, they are herbaceous plants. Melaku (2004) reported herbaceous legumes foliages and food trees are important sources of nutrients especially nitrogen (N) during the dry season, when nutrients for grazing become qualitatively and quantitatively limited for livestock production in the tropics. Forage grasses which are deficient in organic matter nitrogen finds forage legumes relevant in improving the nitrogen content because they have ability thereby increasing productivity of crops, forage grasses and animals. Forage legumes can be grazed, fed fresh or stored as hay or silage (Harricharan, 1988). Forage legumes have the potential to ameliorate feed constraints, especially for cattle and other ruminants, during the dry seasosn through their higher nutritive value relative to natural fallows (Minson, 1990).

Forage legumes played major role in improving pasture production and animal performance (Adeoye *et al.,* 2011). This is one of the cheapest means of increasing soil Nitrogen by biological nitrogen fixation. This biologically fixed nitrogen is transformed into legume protein which may eventually be consumed directly by animals to meet their protein needs.

Forage legumes support animal production adequately and their nutritive values remain higher as plant matures (Gutterridge and Shelton, 1994). It has been reported that the most economic way to improve energy intake and performance of animals eating crop residues is to supplement them with good quality forage, including forage legumes (Topps 1997). Small holder farmers have also shown increasing interest in the use of forage legumes as a sustainable source of limiting nutrients (proteins, minerals and vitamins) in roughage based feeding systems (Butterworth and Mosi, 1985). Herbaceous forage legumes have been identified as potential supplements for ruminants .They contain crude protein (150-300g/100g DM), minerals and vitamins needed for the growth of ruminal microbes (Norton and Poppi,1995). Legumes are important sources of proteins, carbohydrates, dietary fiber and minerals consumed world wide. Forage legumes are kwown to have an important role in the nutrition of ruminants in terms of providing energy, protein, minerals element for ruminant (Ahmad *et al.*,2000;Ranibar,2007). Ogedegbe *et al.,* (2012) reported the critical importance of herbage quality and danger of poor mineral content of forage legumes that affect livestock feeds and evaluated the response of mineral composition of lablab herbage to phosphorus and cutting regime. The potential of legumes might be of great importance in many zones of developing countries where there is a pressing need for food sources of high energy and protein quality (Osman, 2007). Ruminant production has been reported low because of poor nutrition, which is primarily derived from natural pastures and limited amount of crop residues (Tessemia,1988). While the production of natural pastures is low, the roughage also have low nutritive values, but it can be improved by supplementing them with a forage legume (Van Eys *et al.*,1986). Forage legumes enhance efficient rumen fermentation which optimizes microbial growth for increased digestibility of feedstuffs. A forage legume such as *Lablab purpureus*, species of *leucaena, sesbania*, centrosema, gliricida, stylosanthes, acacia, et ce te.ra qualify as supplement to poor quality forages due to high Nitrogen and relatively low fibre contents.

However, most tropical herbaceous and fodder tree foliages contain different types and levels of phonetics that can have either beneficial or negative effects on Nitrogen metabolism in ruminants (Reed and soller 1987; Reed *et al.,* 1990; Mc Sweeney *et al.,* 2001) with forage legumes. Odhiambo (2004) reported legumes have great potential for improving soil fertility. He reported five legumes species. *Mucuna pruriens, Lablab purpureus* cultivar Rongai,

Clitoria ternatea (*butterfly pea, var. Milgara*) and *vigna unguiculate* (two varieties) were planted. Forage legumes can be harvested and fed fresh or stored as hay or silage (Harrichara *et al.,* 1998).

2.5.0 FORAGE GRASSES AND LEGUME PRODUCTION SYSTEM

2.5.1 Cereal Monoculture Farming System

Cereal crop is one of the arable crops such as maize, sorghum, millet especially maize plays an important role in the livestock industry in the Tropical Countries. When planted alone, it yields amounts up to 1.37 million tonnes per year (F.M.A.W.R, 1988). It gives such high yield in a single harvest. Maize is very important as feeds because of its high energy value, but its major shortcoming is undoubtedly its low crude protein content, which on dry matter basis is usually of the order of 70 to 80 g/kg (Topps and Oliver, 1993). Maize residues such as maize stover can be utilised by ruminants by converting maize Stover into edible human foods. Maize stover is low in crude protein to meet the requirement of small ruminants and hence needs for supplementation. Lablab monoculture yields 1-2.5t/ha depending on the cultivar. Lablab consistently produced more than 2.2 t/ha^{-1} of biomass in both the growing season legume nitrogen concentration and accumulation ranged between 12 to 40 g Kg^{-1} and 4 to 106 $kgha^{-1}$, respectively, over the two growing season lablab biomass production was consistent in the growing season indicating that it has potential to be incorporated into cereal monoculture systems in the region when planted in summer or can be used as a green manure when planted in the winter and incorporated before the summer planting season.

2.5.2 Cereal Crops Intercropped with Legumes

Lablab can be intercropped with maize. The lablab should be sown about 28 days after the maize to avoid severe cereal crop yield depression from competition (Ayisi *et al.,* 2004). Forage research has also focused on intercropping legumes with cereal crops to increase grain yields of crops while improving soil fertility in farming systems in the semi- arid tropics (Willey, 1979). Willey (1979) reported the benefits of intercropping cereal and legume for the production of high quality role in the livestock industry and has high energy value as feed maize remains the preferred cereal crop for silage (Titterton, 1997). Ensiled maize produces higher yields and higher energy content than grain, sorghum, forage sorghum or *pennisetums*. Maasdorp and Titterton (1997), reported the effect of inter cropping (in-row of fifteen tropical

legumes with a variety of long-season maize) the grain legumes which are soil beans lablab (dolichus bean), Velvet bean sunn hemp and cowpea. Sunn hemp and cowpea prove the most promoting but in row intercropping with the maize which was at a density of 65,000 plants/ ha did not prove to be viable.

2.5.3 Alley farming with grasses

This is a system where by grasses are planted between legume tree rows rather than planting food crops. This gives rise to cheap means of forage production system that provides a balanced feed ration on a single plot of land. Alley farming with grasses forms a two storey system that allows more efficient use of light, space and soil resources. The system provides continuous supply of energy and protein sources for animal production and productivity. Some grasses species which have been found compatible with Leucaena (*Leucaena leucocephala*, hedge rows include African giant star grass (*Cenchrus aliaris*), Elephant grass (*Pennisetum purpureum*), Guinea grass (*Panicum maximum*), Pangola grass (*Digitaria decumbens*), Signal grass (*Bracharia decumbens*), among others (Reynolds and cobbuna 1992). *Panicum maximum* have been found compatible with *Tephrosia candida*, a perennial shrub very high in biomass production suitable as forage for ruminants, the leaf is a source of protein to ruminants (Babayemi *et al.*, 2003a)

2.6.0. CULTIVATED SOWN PASTURES

Alokan (1988) stated three major types of cultivated sown pastures: Permanent or perennial pastures, which consist of perennial grasses with or without legumes and herbs that are grazed year after year or cut and carry season after season to feed animals. This consists of perennial grasses with or without legumes and herbs that are grazed year after year. They are characterised by high productivity per unit area land and possess a high productivity per unit area land and possess a high annual stocking capacity. They are reseeded at intervals or renovated using number of techniques (Fream, 1989). Grasses that have been identified to be palatable to ruminant livestock, and are known to be available, in abundance only during the months of March-November each year (Babayemi *et al.*, 2004), and this is why they are in dispensable in the ruminant Nutrition and in the semi humid and humid Africa. Grasses generally are typically known to have crude protein that cannot solely sustain ruminant animals throughout the year hence the need for intercropping with forage legumes (Ojo *et al.*,

2009). In recent times, the use of forage legumes in livestock production systems for ruminants has increased with the benefits such as serving as cover against erosion, conversion of atmospheric nitrogen to form of nitrogen which plants can take up and cycled within the plant-animal-soil system (Tarawali, 1991). Humphrey, (1995) opined that a better way to improve the feeding value of these tropical pasture especially for the poor resource small holders is through intercropping the grasses with forage legumes. *Panicum maximum* species are well known and important grass that could be used as feed because they serve as natural vegetation that serves as the grazing resource to ruminants (Onayinka and Akinyemi, 1976). Alasa and Babayemi (2009) reported a system of cultivation where *Panicum maximum* was intercropped with two cultivars of *Lablab purpureus* with the aim of improving the nutritive value of the grass. Ezenwa, (1995) reported *Panicum maximum* var Ntchisi as an introduced variety and its superiority over the naturalised and widely distributed local variety in term of yield quality and persistence. Macharia,(2003) also reported one of the ways of increasing the grazing resources of natural pastures is to integrate forage legumes into the pastures, with the aim of diversifying the sources of forage and at the same time increasing the amount of protein available for the grazing animals and as the Nitrogen uptake of associated forage grass . *Lablab purpureus* is an example of forage legumes intercropped with *Panicum maximum* and there is a true effect on the growth herbage yield and nutritive quality of *Panicum maximum* in the humid zone of Nigeria (Ojo *et al.*, 2009). *Panicum maximum* can be intercropped with *Centrosema puberienes*: it gives 550-650 kg ha/ year $LW^{0.75}$ gain possible in humid queens land (Grof *et al.*,1970). Grasses such as *Andropogon gayannus*, *Melinus minutiflora*, *Panicum maximum* and *Pennisetum purpureus* are intercropped with *Pueraria phaseoloides* (Halim, 1992). In the SouthWest Nigeria, unfertilized mixture of *Pueraria phaseoloides* intercropped with *Panicum maximum* or *Pennisetum purpureum* produced 13.6 l/ha /year DM and transferred approximately 40kg/ ha N the grasses (Muhr *et al*, 1999).

2.6.1 Short Term Pastures or Leys

These consist of association of perennial grasses and or legumes and other forage plants that are grown in rotation with cultivated crops. They can be grazed for 2 to 5 years before they are ploughed and replaced by a crop. These grasses and legumes improve the texture and fertility of the soil thereby making the crops planted more productive (Fream, 1989).

2.6.2 Temporary or Annual Pastures

These are usually single-specie grass, legume or other plants grown specifically as forage within a crop rotation. They are usually characterized by a high yield per unit area of land and a high cost per unit weight of forage compared with that produced from perennial pastures. (Humphreys,1987).

2.7.0 SILAGE TECHNOLOGY

Silage technology is another management practice employed for conservation of forages in an intensive animal production system. Muhammad *et al.*, (2007) reported the sporadic year round shortage in the supply of pasture both in quantity and quality despite the abundant supply of feeds during the late rainy season, and that there are increasing indices towards intensification of livestock in Nigeria. Thus, there is need for conservation of forages through silage making. At this time, forages are surplus and at the growing season when hay making is mired by humid condition. Silage is the product of fermentation of grasses and legumes, which has been compressed and stored under anaerobic condition. The primary goal of silage making is to ensure maximum preservation of original nutrients in the forage crop for feeding in future or at a later date (Bolsen, 1995; Muck and Kung, 1997). Silage is forage crop residues or agricultural and industrial by-products preserved by acids either added or produced by natural fermentation (Mannetje, 1999). He further opined three conservation methods namely sun drying (hay), artificial drying (meal) and addition of acids or fermentation (silage). Lactic acid bacteria ferment the plant sugars (water soluble carbohydrates) in the crop to lactic acid to a lesser extent to acetic acid.

In the temperate regions silage making is practised in intensive animal production system mainly for the following reasons:

* During winter, there is no high quality feed available in the field
* In order to feed high quality conserved supplement e.g. maizeis used at any time of the year to complement grass to improve milk products and nitrogen utilization (Andrade *et al.*, 1998).

Silage making is also adopted in the tropics depending on the type of farm system. It is not all weather dependants as hay. Changes in climate can make forages to be available for about 4-5

months only in a year which makes for abundant forages at that time and scarcity for all other months of the year (Catchpole and Henzell 1971).

Catchpole and Henzell (1971) reported conditions which are useful for silage making:

* The ensiling product must be of good quality i.e. be well preserved and of high digestibility and protein concentration.
* Ensiling forages must be harvested when in excess and at a young stage of growth with high feeding value (Babayemi, 2009). Harvesting of grass and legumes is preferable because of high nutritional quality at the early stage of growth and in fact while the rains are still prevalent (Titterton and Bareeba, 1999).
* Ensiling forages must be wilted to 30% Dry Matter (DM). Tropical grasses and legumes need to be cut early in the vegetative stage for ensilage while protein and digestibility are high and at this stage there is relatively high moisture content of the plants which can adversely affect fermentation quality of the silage. (McDonald *et al.*, 1991).
* Wilting involves laying the cut forage on racks or against walls to allow the sun's heat to evaporate some moisture content from the forages (Mannetje, 1999; Cowan, 2000). High forage moisture content at ensiling may cause silage effluent to be produced and favour undesirable (Clostridial bacteria). Silage dominated by this type of bacteria has a strong rancid odour and poorly consumed by ruminants.
* Ensiling forages must be chopped into short lengths from1-3cm. Chopping is necessary to obtain good compaction to exclude air in order to promote a rapid initiation of the microbiological processes and to take optimum advantage of the storage system capacity (FAO, 2000). Chopping should be between 2-5cm in lengths which has the additional benefit of ease ingestion, regurgitation and posterior rumination.Ensiling forages should be easily compactable if chopped to the desired lengths and covered to exclude air. Regardless of system of storage, the forage must be compacted as densely as possible such that it is difficult to insert your fingers into the stack. The shorter the material is chopped, the denser it can be packed and less air will be trapped inside the stack. If compaction is by human trampling, be wary of trampling pocket of air inside the stack. The edge of the storage must be well packed. Poles or feet may be used to compress the edges in the drums of materials must be pushed into corner of plastic bags by hands. Be careful not to puncture the plastic bags

with fingers, wooden poles or any other implement. Larger stacks of silage in cement boxes or in pits in the ground will require continual trampling while the forage is being delivered. It should be spread evenly and thinly [no more than 5-7cm thick] over the stack to enable it to pack more densely.

* Complete the entire storage quickly: the entire silage storage should be filled and sealed in one day, and at maximum, two days. Forages should be quickly packed into the storage structure (Kung and Muck, 1997). This is easily achieved with bags, drums and small concrete boxes, in larger stacks, where the forage may require several days to be delivered. The forages from one day should cover that from the previous day to a depth of at least 1m (FAO.2000). The current days's forage then acts as a 'seal' for previous day. If some of the previous days forage is not covered sufficiently, it will suffer from aerobic deterioration causing the stack to heat up, with subsequent losses in both quantity and quality. Each night until it is filled, the stack should be covered with a sheet of plastic or a thick banana or palm leaves. This will minimize the amount of warm air leaving the stack, which sets up convection currents, thus encouraging more air to enter. This is particularly important with wilted tropical forage, as it is more prone to aerobic deterioration than are temperate forage species.
* Ensiling forages must be stored and sealed air tight: silages in well-sealed storages that prevent the entry of air or water will maintain their quality for much longer time than with silage in poorly sealed storages.
* Plastic bags: forages ensiled inside small bags should be stored inside a second bag as the thin plastic is easily punctured .Furthermore, non-punctured stretched plastic can allow entry of air. To ensure a tight seal, the neck should be twisted and then tied or taped, then double over and retied or re-taped. Bags must be stored under cover and protected from any animal (e.g. vermin, rodents, birds and poultry), children or other agents which may cause punctures. They should also be protected from direct sunlight, to prevent the plastic from breaking down and to minimize direct heating of the bags. Plastic and steel drums: The tops of the drums should be covered with a sheet of plastic before the lid is placed on top. The drums should then be stored upside down, preferably under cover or protected from direct sunlight to minimize heating.
* Concrete silo or boxes: To reduce losses through aerobic deterioration once opened, it is useful to divide large concrete silos into smaller compartments. This can be done

with straw, mud, cement bricks or using a rectangular timber frame (Catchpole and Henzell, 1971).

* Maintaining air tight and sealed silo until feeding out: All storage type must be sealed then kept air tight through the entire storage. If the plastic is holed, or Starks start to shrink too much, the cause of air entry into the silage must be determined and repaired as soon as possible. Effluent flowing out of the storage for longer than 2 to 4weeks is indicative that the silage is slowly deteriorating (rotting) due to entry of air. The air entry should be identified and stopped. If it cannot be stopped, ensure that the same mistake is not made in future. Wilted silage should produce little or no effluent unless the stark is poorly sealed. Unwilted silage will produce some effluent, which may leak out of drums and stack into the soil. Silage effluent should be prevented from entering waterways and drinking water as it causes pollution.
* It can kill plants or fishes if in large quantity. Only small amounts of silage effluent will leak from well-sealed drums and plastic bags, and may even leak slowly from upturned drums. It is important not to remove drum lids, untie bags tops or hole their bottoms to let moisture out, or to see how they are going. This will allow far too much air to enter, leading to very poorly fermented silages and compost. Allow to ferment for at least 40-42days depending on the type of materials ensiling.
* Ensiled forages must be fed out between 1-2 days for small storages for large storages the whole face of the stack should be removed any day to a depth at least 20cm (Kayouli and Stephen, 2006). As soon as the storage is opened for feeding, air will enter and the silage will begin to deteriorate. If drums are being fed out longer than three days, plastic and weights should be placed over the open face to minimize air entry into the silage. Unless the forage has been chopped very short (1-3cm) and well compacted, Air enters silage stacks of tropical species very easily.
* Heavy sand bags must be placed over all silages. (Babayemi and Igbekoyi, 2008)
* Silages prepared can be opened as from 15 days to assess the nutritive value. Fasuyi *et al.,* (2010) reported ensiling durations of 7, 14, 21 and 28 days with different molasses levels of 2, 4 and 6% for physical observations.

2.7.1 Cassava Peels as Additive

Cassava belongs to the genus *Manihot* of the order Eurphorbiaceae. Its botanical name is *Manihot esculenta*. Cassava is a major root crop produced in Nigeria; it is the fourth ranking in the world after Brazil, Zaire, and Indonesia. The cultivation of cassava is predominantly confined to the tropics where it thrives successfully from sea level to an elevation of some 3,500ft. Its yield is between 4 and 12 tons or more per acre. General Olusegun Obasanjo in 2004 mandated a raise in the level of cassava production from 42million metric tones to 150million metric tones by the end of the year 2010. This implies that if the level of cassava production increases, utilization or processing also increases and peels also increases. Cassava is one of the most productive root crops in the tropics in terms of yield of dry matter per acre. World production of cassava over the last two decades has steadily increased, mainly because of increases in the areas under cultivation. According to FAO (1985), total world production in 1968 was 85.6million tonnes grown on 9.8 million ha. In 1986, Nigeria produced 14.7million tones of cassava (FAO, 1986) while the demand was put at 25million tones for 1988. Cassava is used as human food, serving as a primary, secondary or supplementary staple for over 200million people in Africa. Cassava is used as raw material in the manufacture of processed food, animal feed and industrial products. Cassava root consist of 15% peels and 85% flesh (the edible portion for man).Cassava root peels of bitter varieties are widely fed to domestic sheep and goats in the cassava producing areas in southern Nigeria. The extent at which this adversely affects these animals and account for losses in them is not known. Cassava peels are richer in protein than the edible root portion. Reports have shown that cassava peels consist of the following composition. Residual DryMatter 86.5-94.5%, Organic matter 89.0-93.9%, crude fibre 10.0-31.8%, crude protein 4.2-6.5% (Oyenuga, 1968; Adegbola, 1980; Carew, 1982 and Onwuka1983).

Cassava peels are used as additives in silage preparation. Additives are used to improve silage preservation by ensuring that lactic acid bacteria dominate the fermentation phase. Additives are in three categories:

1. Fermentation stimulants, such as bacterial inoculants and enzymes.
2. Fermentation inhibitors such as propionic, formic and sulphuric acid.
3. Substrate or nutrient sources such as maize grain, molasses, urea, and anhydrous ammonia (Woolford, 1984; Henderson, 1993 and Bolsen *et al.*, 1995). On small scale

farms, commercial additives which comprise inoculants and enzymes may be too costly or unavailable. Cassava peel falls into the category of nutrient sources such as maize grain, with high carbohydrate percentage will be of most benefit to silage made on small holdings. The most important benefit of additives such as maize or sorghum grain or cassava meal or peel is to improve dry matter in early cut crops when moisture content is high and rapid drying or wilting is not possible or where effluent is lost to the silage through seepage.

Tropical grasses have been successfully ensiled when supplemented with maize meal (Onselsen and Lopez, (1988) cassava meal (Panditharan *et al.*, 1986) and sorghum grain (Alberto *et al.*, 1993).

2.7.2 Silage Quality and Nutritive Value of Ensiled Forages

2.7.3 Silage Quality of Ensiled Forage Materials

Nutritive value of conserved feed must be considered if ensiling is to be economic. Protein and digestible energy levels of tropical pastures are at best modest making them unsuitable for conservative for production feeding. Well fermented silage must be palatable and not be poisonous to animals. Good quality silage possesses the following characteristics:

* A sweet and pleasant smell or slightly acidic smell
* A pleasant taste with acceptable aroma
* The ensiled forage must appear in olive green colour
* The ensiled forage must have little or no deviation from the initial state of the material before ensiling
* The ensiled forage should have the pH between 4.0 - 4.5
* The ensiled forage temperature should be cooled at opening and at the fed out. (Mannetje,1999).

Ensiling is a feed processing technique reported to have helped in the enhancing the feeding quality of agro-industrial by-products and other potential plant feedstuffs by reducing the level of toxicants where present, improving the nutrient value, acceptability of feed and utilization by animals (Fasuyi *et al.*, 2010). While the process of Ensiling forage is well understood there are still some limitations in retaining the nutritive value of the parent

material. This is apparent in ensiling of tropical legumes which have a high buffering capacity and low water soluble carbohydrate content (Kaiser, 1984). This can inhibit lactic acid. Tropical grasses and legumes are not natural ensilage material, largely because at cutting, they have a low content of water soluble carbohydrate (WSC), which are essential to successful ensilage and thus lead them to having a higher buffering capacity and leaves proteins susceptible to proteolysis (Woolford, 1984).

Bolsen (1995), Muck and kung, (1997), reported that in a good silage, once air is removed, fermentation begins, Lactic acid bacteria (LAB) then utilized water soluble carbohydrate (WSC) to produce lactic acid, the primary acid which is responsible for decreasing pH in silage. The acidity of the silage is determined by measuring its pH. He further stressed that depending on the crop or forage material to be ensiled, pH can be decreased to a pH of 3.6-4.5 after acid is produced and that a quick reduction in silage pH will help to limit the breakdown of protein in the silo by inactivating plant proteases. Acid production and the rapid decline in the pH resulting in a poor fermentation dominated by undesirable bacteria, hence microbial inoculants may override this limitation by using rate or fermentation and hence ensilage of the crop (Harrison *et al.*, 1989). A rapid increase in the pH will inhibit the growth of \\undesirable anaerobic micro organisms such as entero bacteria and clostridia. Woolford (1984) opined that mixing of legumes with cereal crops, wilting, addition of silage additive and using small scale silos as a number of practices which contribute to improving the levels of fermentable CHO, reduce buffering and prevent proteolysis and then succeed in producing good quality silage.

MAFF (Ministry of Agriculture Fisheries and Food UK, 1973) reported for fresh *pennisetum purpureum* DM% 15.77%, WSC 9.88%, ensiled *Pennisetum purpureum* with 4% molasses pH 2.98. MAFF reported for fresh *Panicum maximum* DM 19.35% WSC 3.03%, ensiled *Panicum maximum* without additive, pH 4.71, lactic acid 1.84% ensiled *Panicum maximum* with additive 4% molasses, pH 3.27%, lactic acid 2.74%.

Muhammad *et al.*, (2008) reported the use of three forage legumes in the improvement of silage quality of Columbus Grass (Sorghum *almum parodi*). *Centrosema pascourum* L, *Lablab purpureus* and *Arachis hypogea*. Legumes were used in ensiling in *In vitro* silos, at

26°c for 21 days. The pH of compounded silages was moderately acidic with pH varying from 5.33-5.77. Higher acidic value was obtained from silage prepared from 60% Coloumbus grass plus 40% groundnut, dry matter as fed varied significantly ($p<0.05$) from 308.0-508.0kg^{-1}, succulent silage, dry matter significantly higher ($P<0.05$) from diet significantly higher CP was obtained from the inclusion of 60% Columbus grass + 40% lablab.

2.7.4 Nutritive Value of Ensiled Forages

Organic matter content (OM) of the diets vary significantly ($P<0.05$) from 45.7-69.1% ether extract varied ($p<0.05$) from 6-6-19.4% with higher values obtained from 60% Columbus grass plus 40% lablab (Muhammed *et al.*, 2008). Kaiser and Lesch, (1977) showed dolichos bean proved to be at its maximum proportion of 24% when maize plant density was at 54,000 plants/ha and crude protein content of the silage was 110 g/kg DM. Maasdorp and Titteton, (1997) reported planting lablab and velvet been into a maize crop for two weeks after sowing maize, maize yield was not depressed and the legume dry matter yield constitutes about 30% of total dry matter yield bringing silage crude protein content to above 10.5%.

Titterton and Maasdorp (1997) reported sole crops of maize and legumes were mixed at harvesting 50:50 by volume for ensilage, fermentative quality was acceptable (pH range of 3.7-4.5; NH3: N ratio < 12), while crude protein content increases from 77g/kg DM (yellow lupin) to 153g /kg DM (forage soyabean), for maize and dolichos bean CP of 128g/kg DM. Seven legumes(forage soya, grain soya, silver leaf desmodium, lablab, cowpea, lupin and velvet bear) were layered with maize for ensilage in pits, the silage was similar in quality to that of the same legumes proportionately mixed with maize in bags were found, with the exception of silver leaf desmodium to be of no significant differences to that of pure maize silage in palatability (Dry matter intake) and effect on milk yield in Holstein diary cows (Taruona and Titterton, 1996).

2.7.5 The *In vitro* Evaluation of Forages

Recent advances in ration balancing include manipulation of feed in the area of correcting scarcity and fluctuating quantity and quality of the year round feed supply with increase in quantity and quality of protein and energy delivered to the small intestine (Makkar, 1989). Makkar (1989) stated the relevance of evaluating the nutritional value of a ruminant feed is by

determining the concentration of its chemical components as well as the rate and extent of digestion. Cerillo and Jaurez 2004; Nhereru *et al.,* 1999; Topps 1992) also stated the relevance of evaluating the nutritional value of our indigenous shrubs, trees and browse plants as their foliage make important contributions to the protein and energy consumption or ruminant animals. Makkar (1989) reported growth, weight gain, performance, lactation, milk yield of ruminants are largely limited by forage quality which is mainly reflected in low voluntary intake and digestibility. The importance of this parameter in animal nutrition has long been recognised (Getachew *et al.,* 2004). The determination of the intake and digestibility in vivo is time consuming, laborious, expensive, requires large quantities of feed and is requiring large quantity feed and is largely unsuitable for single feedstuff thereby making unsuitable for routine feed evaluation.

The *In-vitro* method for Laboratory estimation of degraded feeds is more important to ruminant nutritionists. This method has the advantage of being more precisely than do in vivo trials (Makkar, 2002). The *in vitro* gas method based on syringes (Menke *et al.,* 1979; Blummel *et al.,* 1997) appears to be the most suitable for use in developing countries. The *in vitro* gas method is more efficient than the *in sacco* method in evaluating the effects of tannins or other anti- nutritional factors. The *in vitro* gas method can better be monitored in nutrient – anti –nutrient and anti-nutrient-anti-nutrient interactions (Makkar *et al.* 1995). The method is convenient and fast, and allows a large number of samples to be handled at a time. It is based on the qualification of substrate degraded or microbial protein produced using internal and external markers and of gas or short chain fatty acids (SCFA) production in an *in vitro* rumen fermentation system based on syringes (Menke *et al.,* 1979). This method does not require sophisticated equipment or the use of a large number of animals. According to Menke *et al.,* (1979), fermentation is conducted in 100ml capacity calibrated glass syringes containing the feedstuff and a buffered rumen fluid. The gas produced on incubation of 200mg feed dry matter after 24hrs of incubation together with the levels of other chemical constituents are used to predict digestibility of organic matter determined *in vivo* and metabolize energy.

Babayemi and Bamikole (2006) studied the effects of *Tephrosia candida* L and its mixtures with *Pa1nicum maximum* on *in vitro* fermentation changes as feed for ruminants in Nigeria. *In vitro* gas production characteristics varied significantly (P< 0.05) among the fermented feedstuffs. It was observed in the study that as the percentage of *Panicum maximum* inclusion was reducing, there was concomitant production of CH_4. The ME and OMD also increased as the level of *Tephrosia candida* was increasing in the mixture.

Krishnamoorthy *et al.,* (1995) evaluated the protein and energy of tropical feedstuffs for whole tract and ruminal digestion by chemical analysis and rumen inoculum studies *in vitro*. These authors reported that the protein supplement had lower gas production compared with energy supplement. This difference reflects the different contents of fermentable carbohydrate and available nitrogen in cereal and protein supplements. They reported that degradable nitrogen compounds decrease gas production to some extent as a result of the binding of CO_2 with ammonia.

2.7.6. The Advantages of *in-vitro* rumen fermentation using the gas method

1. It could be of great value in the determination of few supplements using locally available convention and unconventional feeds to achieve maximum microbial efficiency in the rumen.
2. It has the potential for evaluating large number of feed samples at the same time.
3. It provides a better insight on nutrient-anti-nutrient interactions and on the roles of various nutrients (by changing the composition of the incubation medium) with respect to production of fermentative gases, SCFA and microbial mass.
4. It is less expensive, less time consuming and allows for more precise experimental results than the other methods.
5. It has an important role to play in the study of rumen modulator for increasing efficiency of microbial protein synthesis and decreasing the emission of methane (CH4) an environmental polluting gas.
6. *In vitro* gas production technology developed by Menke *et al.,* (1979) is very useful for the rapid screening of feeds to access their potential as energy sources for ruminant animals. The feed high in methane requires energy supplement to sustain livestock production.

2.7.7. Anti Nutritive Factors in Forage Requirement

The antinutritive factors are defined as those substances generated in natural food or feeds stuffs by the normal metabolism of plant species and by different mechanisms (e.g inactivation of some nutrients,dimmunition of the digestive process, or metabolic utilization of feed) which exert effects contrary to optimum nutrition (Kumar,1992). Despite the positive contribution of forage legumes in animal nutrition, as source of N in the diet which eventually becomes source of crude protein to the animals feeding on such diet, the utilization of forage legumes is still been hampered by the presence of anti-nutritional factors. Forage legumes have been naturally endowed with the potential to synthesize a whole range of chemical substances (toxic) which have detrimental effect when ingested by humans or animals. However, these constituents include a number of anti-inhibitors lecithin, polyphenolic compound, tannins, phytic acid, hydrogen cyanide, saponin, phenol and oxalate. These constituents therefore have different but adverse effect on animal performance including loss of appetite and reduction in dry matter intake, induce pathological changes in intestine and liver tissue thus affecting metabolism, inhibit number of enzymes and nutrients making them unavailable (Onwuka 1983). Preston and Leng (1987) indicated that there is a wide occurrence of tannins in forage legumes which alter the digestion of protein resulting in reduced growth.

The authors indicated that phytin affect the availability of some essential mineral element by chelate of the di- and tri-valent cations, especially iron, calcium, zinc, magnesium and rendering them unavailable to the body. Some are protein inhibitors as they interfere with the proteolytic activity of specific enzymes. Schaffhausen (1963b) reported that the leaves of lablab do not contain tannins making them a good feed for monogastric and ruminant animals. However mixed planting of lablab with forage sorghum prevents the occurrence of bloat in ruminants. The seeds of lablab do contain anti- nutritional factors such as tannins, phytate and trypsin inhibitors. Activities of these compounds could be reduced by processing methods such as removing the seed coat, soaking and cooking (Lambourne and wood, 1985, Deka and Sarkar,1990) and ensiling reduces the level of toxicants, where present in feed stuffs (Fasuyi *et al.*, 2010). A major constraint to the use of legumes as a livestock feed is the presence of toxic and anti nutritional constituents. These constituents such as tannins, phytic acid, anti – inhibitors, and hydrogen cyanide have different but adverse effects on animal performance

including loss of appetite, reduction in dry matter intake and protein digestibility. Tannins inhibit the utilization of nutrient through enzyme inhibition and reduced forage digestibility (Onwuka,1983). Phytate chelate several mineral elements especially Calcium, Magnesium, iron, and molybdenum interfere with their absorption and utilization. Schaaffhausen (1963b) reported that the leaves of lablab do not contain tannins making them a good feed for monogastric animals. He further reported that the seeds do contain anti nutritional factors such as tannins, phytate and trypsin inhibitors while processing methods such as soaking, cooking and removal of seed coat takes care of the nutrient composition and anti-nutritional factors (Osman,2007).

2.8.0 VOLUNTARY INTAKE

Sheep are kept by humans to produce meat and wool and eat as much food as they want from plant materials, which, for the most part, is unsuitable for direct consumption.

The intake of the nutrients depends on the type of food available and the amount eaten. Sheep eats more of the fine food than coarse foods and for this reason straw and stover are chopped before being fed. Sheep and goat in the tropics are raised predominantly on forages which are regarded as conventional diets, but are poor in quality being high in NDF, low nitrogen and slow fermentation rates.

Babayemi *et al.,* (2006) reported the use of *Panicum maximum* and lablab to feed goat. Lablab has been used as protein supplement for Tswana sheep and goats Aganga and Autlwetse, (2000) at 40% level of inclusion to enhance productivity and Matebele goat breed (Ndlovu and Sibanda, 1996). Ruminants in the tropics are predominantly raised on grasses which are inherently poor in digestibility, nutrient value and unavailable in the off season (Babayemi *et al*,2009). At this period the performance of ruminants dependent on the native pasture is seriously impaired due to poor nutrition as a result of inadequacy and poor quality of the available pastures. This low quality is associated with the fibrous and lignified nature of the pasture which limits intake, digestibility and utilization (Olafadehan *et al.,* 2009). Digestibility of forage dry matter by the ruminant is the summation of the digestibility of the component tissues as affected by morphology, anatomy and chemical composition (Aganga and Tshwayane, 2003).

Digestibility is affected by the chemical composition and stage of maturity of the forage and also by processing and chemical treatment. Voluntary feed intake increases with increase in digestibility. The feed intake and digestibility of energy increases as crude protein content of forages increases. Gathenby (1995) reported daily DM intakes for a coarse diet is varied from about 1.5% of body weight for a poor quality diet, is about 3.0% for high quality diet. Anugwa (1990) recorded dry matter intake of 440.5g for lambs fed *Panicum maximum calopogomium spp* and browse (*Fiscus - clasticoides*). Adegbola *et al.,* (1985) in a diet of *Panicum maximum* supplemented with concentrate reported feed intake of 621.6, 670.4, and 697g/day with weight gains of 35.7, 36.5g and 37.1g respectively for WAD sheep.

In a digestibility trial, the feed under investigation is given to the animal in known amount and the output of faeces measured. It should be thoroughly mixed by hand to obtain uniform composition. It is then given to the animal for at least a week before collection of faeces begins in order to accustom the animal to the diet to clear from the tract the residues of previous feeds. This preliminary period is followed by a period when feed intake and faecal output are recorded. It is highly desirable that diet should be given at the same time each day and the amount of feed should not vary from day to day (Mc Donald *et al.,* 1988).

2.8.1 Forage intake, Digestibility and Nitrogen Balance in Sheep

The rate of consumption of forage is related to its readiness with which the forage is selected and eaten. It is related to the rate of passage in the digestive tract which is a function of the fibre mass generated during digestion and quantity of forage available to the animal. (Barro and Ribeiro, 1983). Babayemi *et al.,* (2006) used 16 West African dwarf goats fed *Panicum maximum* and concentrate diets supplemented with *lablab*, *leucaena* and *gliricidia* foliage to compare feed intake, nutrient digestibility and Nitrogen balance.

The dry matter intake (g/KgW$^{0.75}$/day) value varied from 111.54-121.87. The value 121.87 had better dry matter than goats fed with 50% *Panicum maximum* and 50% lablab. Goats fed 75% *Panicum maximum* +25% lablab had the next high value of 115.7dry matter. The crude protein intake (g/kgW0$^{0.75}$/day) values varies from 20.57 (lowest) with animals fed 75% *Panicum maximum* +25% lablab -23.97 (highest value) with goats offered 50% *Panicum maximum* and 50% lablab. The dry matter intake and crude protein intake were not significant

among treatment means. The live weight gain (g/day) was highest in animal fed with 25% *leucaena* (56) and those on 50% *lablab* (50). DMD values varied from 59.74% with goats offered 75 % *Panicum maximum* +25% *luecaena* -71.87% with goats offered 50% *Panicum maximum* +50% *Lablab purpureus* while CPD values varied from 68.47%with goats offered 75% *Panicum maximum* +25% lablab -74.13% with goats offered 50% *Panicum maximum* and 50% *Lablab purpureus*). Significant differences did not occur ($p>0.05$) among the treatments in the DM, CP, NDF and ADF digestibility except for ADL and energy. The Nitrogen balance ($g/kgW^{0.75/day}$) and retention (%) were highest in 50% lablab supplementation which was 1.26 and 50.81% respectively.

Anugwa *et al.* (2000) used 15 West African dwarf kids to compare the feed intake, nutrient digestibility and nitrogen balance of goats fed foliages of *Panicum maximum*, *Daniela oliveri*, *Afzelia Africana*, *Tephrosia bracteolate* and *Tridax procumbens*. The dry matter and crude fiber contents of the legumes averaged 44.1 % and 28.5% were higher than that of the grass (26.5% and 20.5% respectively) and *Tridax procumbens* (27.0% and 19.18% respectively). The Crude Protein content was not significant for all the forages compared (legumes; 13.14%, grass; 13.13% and *Tridax procumbens*; 14.16. The grass had more NFE (56.87%) than the legumes (42.46%) and Tridax (43.89%). Goats offered the legumes and tridax had higher intake of dry matter, crude protein and total digestible nutrients and was significant over that of the *Panicum maximum*. The digestibility of the forages ranged from 59 to 87%. Higher nitrogen balance was obtained in goats on the legumes and *tridax* than for goats on *Panicum maximum*.

Bamikole *et al.* (2001) used 15 West African Dwarf (WAD) goats fed nitrogen fertilized *Panicum maximum* cultivar Ntchisi (NFG) *Panicum maximum Verano stylo* mixture (GSM) and unfertilized grass (UFG), reported total dry matter and organic matter intakes of goats did not vary significantly among forage diets and averages $55.1g/Kg^{-1}W^{0.75}$ and $50.4g/Kg^{-1}$ per day respectively. CP intake ($g\ Kg^{-1W0.75)}$ was highest with NFG (5.6) followed by GSM (4.8) and the UFG (3.5) + animals on GSM had significantly of NFG (25.1g per day) and UFG 21.9g per day which differed significantly. The digestibility (g/Kg^{-1}) of total dry matter (749.4), organic matter (765.2), CP (723.4), NDF (797.9), were higher with GSM than NFG, dry matter (671.6), organic matter (668.5), CP (670.4), NDF (689.6) or UFG, DM (665.7),

OM (676.1) CP (666.1) NDF (714.7). Total nitrogen (g/day) excreted followed the same trends as the CP intake. Total nitrogen excreted with NFG (2.99); Nitrogen excreted with GSM (2.61) and the UFG (2.33) there was no significant difference between nitrogen retention of GSM and NFG (28.50 and 26.7%), but goats on UFG had a negative nitrogen balance (-9.16%).

Van Eys *et al,* (1986) reported the in – situ microbial fermentation of Napier grass and foliages of *Gliricidia maculae*, *Leucaena leucocephala* and *Sesbania grandifolia* and their subsequent treatment with acid pepsin solution. The levels of nitrogen soluble after 2hr incubation and were 46 and 43% for Napier grass and *sesbania* respectively. Rate of protein disappearance was between 2 and 24hrs incubation in the rumen average 2.6% for the legumes and 1.0% for the grass.

Babayemi *et al.,* (2009) stated the poor status of tropical grasses which are inherently or eventually resulting in low intake, low digestibility and low nutritive value of the grass and generally poor performance of ruminant. Fasuyi *et al.,*(2010) stated feed processing technique by ensiling, improves the nutrient value and acceptability of feed utilization by sheep and goat. Akinwande *et al.,* (2011) reported WAD sheep fed ensiled Water Hyacinth (WH). Ensiled water hyacinth with additives prepared diet; WH+BDG (WH+BDGS) WH+PKC (WHPKCS), WH+WO (WHWOS). The dry matter digestibilitiy (%) of WHBDGS was (41.33), WHNOS (40.76) and WHPKCS (37.87). CP digestibility (%) sheep fed WHPKCS was highest (82.09), CPD of sheep fed WHWOS (80.54) and lowest sheep fed WHBDGS (73.74). Nitrogen intake (g/d) for sheep fed WHBDGS (14.15), for sheep fed WHWOS (10.01) and WHPKCS (8.54). Total nitrogen (g/day) excreted with WHBDGS (10.62), nitrogen excreted with WHWOS (8.40) and the WHPKCS (7.00). Nitrogen retention (%) for WHBDGS was (24.85), WHPKCS (17.86) and WHWOS (15.01). Adeyinka *et al.*(2008) reported the best performance of Yankasa rams on the basis of intake and digestibility from treatment with 50:50, lablab-millet ensiled mixtures. The study revealed the comparison of four silage treatments(0:100, 15:85, 30:70 and 50:50 of lablab: millet, respectively) such that silage with 50:50 lablab-millet mixture was the most readily consumed by the rams with a mean intake of 48.4 g kg^{-1} $W^{0.75}$ and the lowest intake of 22.5 g kg^{-1} $W^{0.75}$ for treatment with 0:100 lablab-millet proportion.

Reid *et al.* (1987) reported a study on intake, in digestibility and mineral balance of wether lambs fed two types of grasses (Orchard grass and perennial rye grass) and two types of legumes (alfalfa and red clover). The effects of feeding increasing proportion of legumes in the mixtures on dry matter digestibility (DMD), digestible neutral detergent fibre (DNDF) and digestible dry matter intake differed with species combinations. A quadratic regression for DMD and DNDF indicated a small negative associative effect for mixtures of grasses and legumes compared with pure species. DM showed a quadratic increase with level of legume inclusion, indicating a positive associative effect. Similarly, NDF intake showed a quadratic response to level of legume but lambs tended to eat to a fairly constant intake of 42 to 43g NDF/kg$W^{0.75}$. Mineral utilization (apparent absorption and retention) differed with cutting but not species combination and generally improved with increasing legume content in the mixture. With the exception of Ca retention (negative effect) there was little evidence for significant association between grasses and legumes in mineral utilization.

Olorunnisomo *et al.* (2011) used Sokoto red goat fed ensiled elephant grass (Eg), elephant grass + 10% cassava (CSD) elephant grass + 30% cassava peal and elephant grass = 50% cassava peel(CSP). Feed intake (g/day) for goat fed Eg + CSP50 (357.53), feed Eg + CSP30 (305.83) intake for goat Eg + CSP10 (265.07) while the least value for goat fed Elephant grass alone. There was significant difference among means for the feed intake. Growth rate (g/day) followed the same trend as for the feed intake, but the feed conversion ration (FCR) decreases with increasing levels of cassava peels in the experiment all diet. Crude protein content of the diet, elephant grass + CPS have values varies from Eg + CSP50 (4.90) – 5.61 elephant grass alone crude fibre content of the experimental diet varies from Eg + CSP50931.53 -36.33 elephant alone.

Smith *et al.* (1995) reported a voluntary dry matter intake of West African dwarf sheep and goats fed *Gliricidia sepium* leaves presented in fresh, wilted and dried states at 10, 20 and 30% level of supplementation respectively. The crude protein and DM loss from dried leaves were relatively lower than fresh and wilted leaves by the sheep and goats were relatively higher than the dried leaves. These results suggest that *Gliricidia sepium* leaves should be fed either in the fresh or wilted states to West African dwarf sheep and goats at levels between 20 and 30% of total DM intake.

Ndlovu and Sibanda (1996) conducted two feedings trials of 112 and 84 days duration with indigenous goat kids with average liveweight of 11.5+0.3kg to evaluate the potential of *Dolichos lablab* and *Acacia tortilis* pods in mitigating liveweight losses and improving survival. Trial I consisted of kids offered 200-300g/day of *Lablab* or *Lucerne* hay while kids on trial 2 were offered 300-400g/day of *Acacia tortilis* pods or lablab hay. Trial 2 consisting of kids fed *Acacia tortilis* pods resulted in growth rates of up to 67g/day. It was concluded that A. *tortilis* pod are suitable supplement in a feeding system where kids are penned for most of the day.

2.9.0 HAEMATOLOGICAL PARAMETERS OF WEST AFRICAN DWARF SHEEP

2.9.1 Blood

Blood comprises 5-10% of the body weight depending on the species of the animal and its nutritive state.The blood is a fluid tissue that circulates through vascular channels to carry nutrients to cells and waste products to excretory organs. The blood contains a myriad of metabolites and other constituentwhich provide a valuable medium for clinical investigation and assessment of nutritional status of human beings and animals. It consists of free cells (corpuscles) and a fluid intercellular substance (plasma). The corpuscles components are erythrocytes (red blood cell), leucocytes (white blood cells) and thrombocytes while the plasma component contains water (91-92%), proteins, lipids, carbohydrates, non protein nitrogenous materials and electrolytes. Also the red blood corpuscle make up from 30-45% of blood depending on the species. The solid part of the red corpuscle consist of almost enlive the haemoglobin and others while the plasma contains 10% of solid, half of which are protein and others are fatty substances, sugar, non protein nitrogen and inorganic salts. Blood samples are collected from the animal to reveal certain parameters like Packed Cell Volume (PCV) Neutrophils (N), Monoctye (M) and Eosinophils (E). Blood parameters have been shown to be major indices of physiological, pathological and nutritional status of an organism and changes in the constituent compound of blood when compared to normal values could be used to interprete the metabolic state of an animal as well as quality of feed (Babatunde *et al.*, 1992). Also an ingestion of numerous dietary components has been found to have numerous effects and blood components (Church and pond, 1982).

2.9.2. Packed Cell Volume (PCV)

PCV is a function of erythrocyte (red blood cell) size and number of cells per unit volume of blood. It measures the proportions of red blood cells to plasma in the peripheral bold but not in the entire circulation.The normal range depends on the age and species of animal, previous excitement and the presence of anaemia or hypoproteinaemia. A packed cell volume between 30-40% is considered normal. A fall in PCV below the minimum normal range for the species studied is an indication of the existence of anaemia while haemoconcentration occur when PCV exceeds the maximum normal range (Ganong, 1991).

2.9.3 Red Blood Cells (RBC)

The Red Blood Cells are produced in the bone marrow and carry haemoglogin which gives the red colour. The production of red blood cell is known as erythropolesis which can be inhibited by a rise in the red cells levels to sugar normal values and stimulated by anaemia. Erythropolesis is controlled by a certain glycoprotein secreted primarily by the kidney (Ganong,1991). A range of 14.9-19.7/10/µl was reported by Mitruka and Rawnsley (1977) for normal ruminant animals.

2.9.4 White Blood Cells (WBC)

The White Blood Cells are also produced in the bone marrow. White blood cells or leucocytes use the blood as a means of transport from their site of origin to their destination in varios tissues of the body. They provide the blood with powerful defence against tumours, viral, bacteria and parasitic infection. High amount of WBC is the blood has been associated with the presence of a diseases condition and when it is low in the blood it is an indication of product from the bone marrow. The total leucocytes count, stated in number of cells per cubic millimeter of peripheral blood, is a reflection of the need of leucocytes function in the various tissues of the body (Schalm, 1975). A range of 3.7-11.1/10^3/µl was reported by Mitruka and Rawnsley (1977) for normal ruminant animals.

2.9.5 **Lymphocytes**.

These are components of the white blood cells. It consists of B cells, T cells and natural killer cells. B and T cells are components of the body adaptive immunity. B cells produce antibodies against foreign particles while T cells destroy cells identified by antibodies and

natural killer cells by releasing granules like eosinophils. Mitruka and Rawnsley (1977) gave a range of (60-70x10^3/ml^3) for normal ruminant animals.

2.9.6. **Monocyte (M)**

Monocytes are also components of the white blood cells. They originated from the bone marrow and develop into large macrophages in blood stream. Macrophages are the largest of the white blood cells and are responsible for engulfing cell debris, waste and harmful bacteria. They attack microbes by extending pseudopodia around the cells and they destroy the microbes by releasing enzymes from inside the macrophage. Mitruka and Rawnsley (1977) gave a range of (0-4x10^3/mm^3) for normal ruminant animals.

2.9.7 **Eosinophils (E)**

These defend the body against multicellular parasites and moderate allergic reactions. They develop in the blood marrow before migrating out. They release chemical mediatorsin a process called degranulation. During the process small granules inside the eosinophils are released to destroy the foreign invaders. A range of 1-8x10^3 was reported by Mitruka and Rawnsley (1977) for normal ruminant animals.

2.9.8 Serum Metabolic Parameters

There are concentration of specific blood components which have been used to monitor nutrient status (e.g.total proteins, serum glucose and blood urea nitrogen [BUN], Hammond *et al*., 1994) and have been associated with overall muscle mass (e.g. creatinine, Morgan *et al*., 1993; Meyer *et al*., 1998) in ruminants.

2.9.9 Total Protein

Proteins have been defined as extremely complex nitrogen containing organic compounds which are are found in all animals and plants cells where thay constitute a major part of the protoplasm. The proteins in the serum are referred to as serum protein. Serum protein functions in defence mechanism i.e. the response of immunoglobin to infection. They are also involved in the maintainance of plasma osmotic pressure. The serum protein includes total protein, albumin and globumins. Eggum (1987) reported that total protein is an indirect indices for measuring the nutritional protein adequately. Iyayi and Tewe, (1998) reported that

total protein increases with age while serum total protein and albumin synthesis are related to the amount of calories.

2.9.10 Blood Urea Level

According to Iyayi and Tewe, (1998) reported that the blood urea levels depends on both the quality and quantity of the protein supplied in the diet of an animal. Serum proteins are important in osmotic regulation, immunity and transport of several substances in the animal body (Jain, 1986). Blood urea N is an indication of efficiency of utilization of dietary protein. Eggum (1989) reported that the blood urea N is highly inversely correlated with net protein utilization. Ruminants are not efficient utilizers of dietary protein (Beever, 1982). A positive correlation exists between level of protein (N) intake and BUN concentration (Pfander *et al*., 1975; Karnezos *et al*., 1994).

2.10.0 MINERAL CONTENT AND MINERAL USES OF LIVING THINGS

2.10.1 Mineral requirement in living things

Minerals are required in all living things and as required for normal functioning of basically all biochemical processes in the body (Muller, 1975). Minerals are the major inorganic substances that occur in the cell and tissues of plants and animals, at least 40% of minerals have been found in the living things at measurable quantity. Some of these minerals play significant roles in the life of the living things. Such minerals are said to be essential but most of the minerals that are found in the diet of plant and animals do not seem to play any significant metabolic role. Such minerals are said to be non- essential for example taking silica-sand when eating rice which is not needed in the body.Minerals are needed in varying quantities. Some are needed in large amounts while some others are needed in relatively smaller quantities. The minerals that are needed in large amount are used in the body mostly for the synthesis of structural tissues. On the other hand, those that are needed in very small quantities are used for the activities of enzyme systems. In other words minerals can be classified in another way apart from essential and non-essential but can still be classified as micro and macro elements. Normally 21 minerals are considered to be essential. Seven of these are macro element consisting of four cations which are Ca, Mg, Na, and k, and while 3 anions which are P, Cl and S.

2.10.2 Mineral function and Mineral content in Forage plant and animal body

It has been reported that the most economic way to improve energy intake and performance of animals eating crop residues is to supplement them with good quality forage, including forage legumes (Topps, 1997). Smallholders farmers have also shown increasing interest in the use of forage legumes as a sustainable source of limiting nutrients (Protein, mineral, and vitamins) in roughage based feeding systems (Butterworth and Mosi, 1985). Intercropping cereals with forage legumes has been shown to improve both quality and quantity of fodder. This could improve livestock production considerably (Umunna *et al.*, 1995), in addition to benefit in soil fertility (Haque *et al*,2008). The concentration and balance of minerals, especially calcium and phosphorus is of paramount importance in ruminant nutrition. According to Griffith, (1974) legumes are able to extract phosphorus in low soil available concentrations especially in low production situations. This implies that resource-poor farmers may grow lablab with little or no phosphorus fertilizer and still meet the protein requirement of ruminants.

a. Calcium and Phosphorus form skeletal frame work of the animal body. Cattle contain approximately 12g Calcium per Kg live-weight (ARC, 1965), while for sheep the value is slightly higher (15g/Kg) (Grace, 1983b). Calcium (Ca) value present in the bone is 98.5-99.2% (Grace, 1983b), which acts as a reserve which can be drawn on to maintain a relatively uniform level of calcium in the blood supplying the tissue of the animal. Where diets are low in Phosphorus (P), increasing the Ca level exacerbates the P deficiency. Calcium is required for normal blood clotting, rhythmic heart action and neuromuscular excitability. Low levels of Ca in the blood of lactating animals can lead to milk fever (Underwood, 1981). Deficiencies of dietary Ca in sheep fed high –grain diets weaken bones, deform teeth, and slow growth rates (Franklin, 1950), while *lablab purpureus* cater for 1.9-4.0gkg-1 DM Calcium requirement of livestock. Phosphorus is also important in bone development, growth and reproduction. Deficiencies of P in cattle are unthriftiness, and fragile bones (Underwood, 1981). Sheep are less susceptible to low levels of dietary P but can be adversely affected (McMenimen, 1976; Ozanne *et al.*, 1976; Ternouth and Sevilla, 1984). Cattle contain 6.3gP/kg liveweight (ARC, 1965). P value in the skeleton is 75-80% (ARC, 1965). P has more known functions than any other mineral element in the animal body. In

addition P combine with Ca to form bones and teeth, P is found in every cell of the body and is essential in many metabolic processes including the buffering of body fluids. It is required by the rumen microbes for fermentation of forages (Komisarczuk *et al.*, 1984) and synthesis of microbial protein (Breves *et al.*, 1985). P is often deficient in forage grown on soils derived from parent rock low in P. Phosphorus deficiency reduces intake, estrus, conception rate, milk and wool production, growth rate and survival of ruminants. Legumes contain high levels of protein but there is no evidence that this increases the demand for P and depresses the voluntary intake of diets low in P (McLachlan and Ternouth, 1985).

b. Mineral function as constituents of body fluid for example, the haemoglobin Present in the blood is a compound that contains iron bound to protein. Sodium (Na) and Chlorine (Cl) are important to life; they maintain osmotic pressure in the cells. Sodium plays a major role in the regulation of osmotic pressure and acid –base balance Na tends to be lacking in feeds fed to cattle, sheep and goat or animals that are raised on forages, they need more salt in their rations than poultry and pigs. Underwood, (1981) reported that appetite is depressed by Na deficiency.

2.10.3 Mineral Composition of *Panicum maximum* and *Lablab purpureus*

ARC (1980) reported the concentration of Sodium required in forages by different classes of ruminant can be determined quantitatively, 1.5g Na/kg DM in forages meet the requirement for productions, Na requirement for weaned cattle was too low, a 59% in improvement in growth occurred when an Na supplement was fed to animals grazing forage containing 1.0gNa/kg DM. Adeleye and Fanoiki (1997) reported 1.06% Ca, 0.75 %Mg, and 3.07% K for *Panicum maximum*. Aye (2009) reported that *Panicum maximum* contains 512.98 mgkg-1Ca, 205.88mgkg-1Na, 95.23mgkg Fe, and 1598.50mgkg P.

Yousuf *et al*, (2007) reported 0.38% Ca and 0.17% P for *Panicum maximum* hay. Phosphorus often determines the establishment and persistence of Legume (Haque *et al.*, 2008) and the importance of good re-growth, cutting height and age of pasture to its nutritive value and overall biomass production has been reported by several workers (Adjei and Gentry, 1996;

Aina and Onwukwe, 2002; Odion and Singh, 2005; Ahmadi *et al.*, 2009; Smithson and Giller 2002) from their studies came to the conclusion that farm practices that address Nitrogen through biological fixation should focus on the soil phosphorus deficiencies also because biological nitrogen fixation is limited by low soil phosphorus status among other factors. The concentration and balance of minerals, especially Calcium and phosphorus is of paramount importance in ruminant nutrition.

CHAPTER THREE

3.0 CHEMICAL COMPOSITION OF P*anicum maximum* CULTIVAR NTCHISI INTERCROPPED WITH *Lablab Purpureus* CULTIVARS RONGAI AND HIGHWORTH

3.1 INTRODUCTION

Pasture is established, when an environment which is favourable for seed germination, seedling emergence and growth of planted vegetative material in order to initiate growth of new roots and shoots are provided. Other factors involved in pasture establishment are: soil type and fertility, grass and legume species characterization, seasonality of rainfall, availability of planting material, type and quality of animal (Alokan 1988). Chemical composition of forages depends on the soil type, stage of growth and cultivar (Murphy and Collucci, 1999). The nutritive value of forage is determined by its chemical composition and digestibility. Chemical composition is a factor associated with the plant and its environment. Shortages of forage often pose constraint to livestock production system in Nigeria.The first six months of the year is always noted for abundant green pastures, with high crude protein and energy. This is followed by scarcity of forages as a consequence of dry period, resulting in low quality feed that eventually culminates in retardation of growth of the animals. (Babayemi *et al,* 2003). The available forages at the dry season are low in protein content with a marked decrease in voluntary intake and digestibility and subsequently the animals lose weight.

Panicum maximum is available in almost all ecological zones of Nigeria where the climate favour its growth but with its own peculiar problem of decline in crude protein and soluble carbohydrate, increase in crude fibre and lignin, with increasing maturity which leads to reduction in voluntary intake and digestibility (Agishi, 1985).Cutting regime is very important in pasture establishment if the best chemical composition interms of protein and energy is to be retained. Then, the cutting regime of four weeks of regrowth is adequate to be assured of a reasonable protein content of the grass (Babayemi, 2009). Bamikole *et al.,* (2004) reported a six week old harvesting of *Panicum maximum,* and six weekly cutting frequencies of *Panicum maximum* and *Stylosanthes hamata* with four harvest during the growing season. Odedire

and Babayemi (2007) reported the crude protein of 9.4% of *Panicum maximum* and a corresponding increase in crude fibre from 32.1% - 39.4% as the grass matures.

Legumes have been recommended for grass/legume pasture production in South Western Nigeria, such legumes possess some characteristics such as being able to persist and produce in mixtures with tall growing grass species like *Panicum maximum* (Olanite *et al.,* 2002). *Panicum maximum* has been reported to combine well with *lablab* (Ajayi,2007). Harricharan *et al.,* (1988) also reported an increase in the use of forage legumes in ruminant livestock production system which improves livestock production systems. *Lablab purpureus* has been one of the under-utilized legume, remains green far into the dry season with high nitrogen and relatively low fibre content (Babayemi *et al.* 2006). Cameron (1988) and Karachi (1997) reported that lablab leaf contains 21-38% CP, 41.8% CF, 29.6% NDF, 10.8% ADF and in vitro DMD 64.4%. Lablab is a legume with high biomass yield, which makes it suitable for ruminant feeding systems. Babayemi *et al*, (2006) reported *Lablab purpureus* cv Highworth compatibility with *Panicum maximum* ; and also fed 25% and 50% level of inclusion with *Panicum maximum* to WAD goats.

The *In vitro* gas production and the fermentation parameters indicate the presence of potentially degradable nutrient and are used as tool to assess their potential as energy sources. The gases produced during rumen fermentation are waste product and of no nutritive value to the ruminants. The gas production tests were used routinely in feed research as gas volumes are related to both the extent and rate of substrate degradation (Blummel *et al.,* 1997). The volume of gas reflects the end result of the substrate to short chain fatty acids. Therefore, the first objective was to determine the effect of legume on grass, grass-legume mixture in terms of crude protein and mineral composition of *Panicum maximum* intercropped with a legume, *Lablab purpureus*, using two cultivars and the *In vitro* gas production experiment to evaluate the nutritional quality and effect of dried *Panicum maximum* with *Lablab purpureus* mixtures that did not undergo ensiling process on *in vitro* degradation in the following treatments:

Treatment 1: Sole *Panicum maximum*

Treatment 2: 75% *Panicum maximum*+ 25% *Lablab purpureus* cv Rongai

Treatment 3: 75% *Panicum maximum* + 25% *Lablab purpureus* cv Highworth

Treatment 4: Sole *Lablab purpureus* cv Rongai

Treatment 5: Sole *Lablab purpureus* cv Highworth

3.2 MATERIALS AND METHODS

3.2.1 Experimental site

The experiment was conducted at the Teaching and Research Farm University of Ibadan, Nigeri, Latitude about 7 ¹20° N, 3¹ 50° E, altitude about 200m above sea level between April and July in 2008 and 2009. The area has a tropical humid climate, the mean annual rainfall during the experimental period were 1150 mm and 1250 mm between April 2008 and July 2009 respectively. The mean monthly temperature was 25-29°C.

3.2.2 Forage establishment and collection

A total area of 2006m^2 was cleared, ploughed, harrowed, leveled and divided into twenty five plots each measuring 11m x 6m with 1m pathways between plots. Crown splits of *Panicum maximum* were obtained from fenced and improved paddock within the University Teaching and Research Farm while two varieties of *Lablab purpureus* seeds were obtained from International Institute for Tropical Agriculture IITA, Moniya, Ibadan. The planting operation for the grass was first carried out on June 14, 2008 while legume was planted on September 14, exactly 12 weeks when the grass planted earlier was cut back to a uniform height of 20cm.The depth of sowing using crown split was between 1- 2.5cm, crown split aids germination. Seeds of legumes were scarified to break dormancy and to enhance germination. *Lablab purpureus* seeds were soaked in hot water at 80° C for five minutes to break hard seed coat, they were air-dried before planting. Each legume cultivar seeds were planted 2-3seeds per hole in pure stands by drilling at 1m x 0.5m in grass with legume mixture. Weeding was carried out at every six weeks of harvesting of the pasture.

3.3 EXPERIMENTAL TREATMENTS AND DESIGN

The study was conducted in a completely randomised block design. There were five treatments each with five replicates, consisting of a sole *Panicum maximum* cultivated at 1m x 1m using three crown split per stand, *Panicum maximum* intercropped with *Lablab purpureus cv* Rongai and *Panicum* maximum intercropped with *Lablab purpureus cv* Highworth and each of legume pure stand in the following treatments:

T1. Sole *Panicum maximum*

T2. 75% *Panicum maximum* + 25% *Lablab purpureus cv* Rongai.

T3. 75% *Panicum maximum* + 25% *Lablab purpureus cv* Highworth

T4. Sole *Lablab purpureus cv* Rongai

T5. Sole *Lablab purpureus cv* Highworth

3.4 PASTURE HARVEST

Panicum maximum was harvested manually at six weeks from established plots where sole *Panicum maximum*, *Panicum maximum* plus Highworth and *Panicum maximum* plus Rongai were planted. Sub – sample of each harvest was oven dried at 105°C to determine dry matter (DM).The sub- sample was taken to the laboratory and oven dried at 65°C for Nitrogen determination by Micro-kjeldahl method. Further, the sole *Panicum maximum* and legumes as well as *Panicum maximum* intercropped with legumes were harvested manually at six week interval for four months. Sub-sample of each harvest was oven dried at 105° C. The dried sub-samples were pooled together and milled using 1mm sieve with Thompson hammer mill for proximate analysis and mineral assay.

3.5 CHEMICAL ANALYSIS

Dried Samples were analyzed for crude protein, crude fibre, ether extract, and ash, according to the methods described by (AOAC, 1990). Neutral detergent fibre, acid detergent, fibre, and acid detergent lignin were determined according to the Goering and Van soest, (1991) method. After ashing of samples in a muffle furnace at 550° C, mineral analysis of iron and calcium were read with atomic absorption spectrophotometer. Sodium was read with flame photometer and phosphorus was read with spectrophotometer (AOAC, 1990).

3.6 STATISTICAL ANALYSIS

Data were subjected to analysis of variance using the procedure of SAS (1999). Significant means were separated using the Duncan Multiple Range F-test. Experimental mode of the design is: $Y_{ij} = \mu + \alpha 1 + £ij$

Where Y_{ij} = individual observation μ = general mean of population

$\alpha 1$ = Treatment effect and £ij = Composite error effect

3.7 RESULTS

Table 1 showed that the Proximate composition of the forages differ ($P<0.05$) significantly. The Crude Protein (CP) of the *P. maximum* varied significantly ($P<0.05$). The CP of *P. maximum* was 6.51g/100g DM, CP recorded for *P. maximum* plus Highworth was 8.01g/100g DM Rongai and crude protein value obtained for *P. maximum* plus Rongai was 8.10g/100g DM.Values obtained for CF and EE were not statistically significant ($P>0.05$) across the treatments means.Ash and NFE showed a significant variation ($P<0.05$).Treatments that had *Lablab purpureus* had comparable ash content but significantly ($P<0.05$) higher than sole *P. maximum* treatment.contrary trend was observed for NFE.

Table 1: Proximate composition (g/100g DM) of *P. maximum* in *P. maximum*, *P. maximum* plus Highworth and *P. maximum* plus Rongai.

Nutrient constituents	*P. maximum*	*P.maximum* +Highworth	*P. maximum* +Rongai	SEM
Crude protein	6.51[b]	8.01[a]	8.10[a]	0.23
Crude fibre	36.47	35.62	35.81	1.96
Ash	9.25[b]	10.75[a]	10.67 [a]	0.19
Ether Extract	3.25	4.10	3.92	0.24
Nitrogen Free Extract	44.52[a]	37.52[b]	37.50[b]	2.21

[a,b] means at the same row with different superscript differ significantly (P<0.05)

Table 2 reveals the chemical composition (g/100gDM) of *Panicum maximum* and *Lablab purpureus* that were not ensiled. The chemical composition of the forages differ (P<0.05) significantly. The dry matter of the forages ranged between 28.89-32.40g/100g DM, while the sole *Panicum maximum* had 30.43g/100g DM. The highest dry matter was recorded for sole lablab cv Highworth (32.40g/100g DM) and followed by the value recorded for sole lablab *cv Rongai* (31.08g/100g DM). The Crude Protein (CP) of the forages varied significantly (P<0.05).The CP of the sole *Panicum maximum* value was 6.56g/100g DM, crude protein values recorded for *Panicum maximum* intercropped with *Lablab purpureus cv* Rongai and Highworth were 14.75g/100g DM and 14.05g/100g/DM respectively, CP values for sole lablab cv Rongai was 24.50g/100g/ DM and 24.94g/100g DM for sole lablab cv Highworth. The Crude Fibre (CF) varied significantly among treatments (P<0.05).The CF mean values ranged from (the lowest,10.16g/100g) for sole lablab cv Rongai to 16.25g/100g, the highest value for sole *Panicum maximum.* The Ether Extract (EE) mean values varied significantly (P <0.05). EE values ranged from (the lowest, 10.12g/100g) for *Panicum maximum* intercropped with lablab cv Rongai to 12.25g/100g, the highest value for sole lablab cv Highworth. The ash mean values were not statistically significant (P>0.05). Ash mean value for sole *Panicum maximum* was 8.01. The ash mean values of 9.04g/100g and 9.03g/100g obtained for *Panicum maximum* intercropped with *Lablab purpureus cv* Rongai and Highworth, respectively were not statistically different from value obtained for *P. maximum*. Lower ash values 7.07g/100g and 7.10 were recorded for sole *Lablab purpureus* cv Rongai and Highworth, respectively.

The Nitrogen Free Extract (NFE) mean values varied significantly (P <0.05). NFE values ranged from (the lowest, 41.06g/100g) for sole lablab cv Highworth to 58.44g/100g, the highest value for sole *Panicum maximum*. The Nitrogen Detergent Fibre (NDF), Acid Detergent Fibre (ADF), and Acid Detergent Lignin (ADL) mean values varied significantly (P <0.05). The highest NDF (60.10), ADF (37.65) and ADL (9.06) mean values were recorded for the sole *Panicum maximum*, but lower (NDF 43.20 and 44.23), (ADF 31.07 and 30.01), (ADL 7.21 and 7.10) mean values were recorded for sole lablab cvs Rongai and Highworth respectively. Also lower (NDF 54.31 and 55.01, ADF 37.06 and 35.25 and ADL 8.04 and 8.02) mean values were obtained for P. *maximum* with *Lablab purpureus cv* Rongai and Highworth respectively, but the values were higher than those obtained for sole lablab.

Table 2: Chemical composition (g/100gDM) of the *Panicum maximum*/lablab mixture

Nutrient constituents	T1	T2	T3	T4	T5	SEM
Dry matter	30.43^{ab}	28.89^{a}	29.02^{a}	31.08^{bc}	32.40^{c}	0.44
Crude Protein	6.56^{e}	14.75^{c}	14.05^{cd}	24.50^{ab}	24.94^{a}	1.09
Crude Fibre	16.25^{a}	15.32^{ab}	15.25^{ab}	10.16^{cd}	10.23^{c}	2.89
Ether extract	12.10	10.12	10.20	12.21	12.25	2.83
Ash	8.01	9.04	9.03	7.07	7.10	0.86
Nitrogen free extract	58.44^{a}	45.25^{cd}	50.10^{b}	46.50^{c}	41.06^{e}	2.82
Neutral Detergent fibre	60.10^{a}	54.31^{bc}	55.01^{b}	43.20^{cd}	44.23^{c}	3.56
Acid Detergent fibre	37.03^{a}	35.06^{a}	35.04^{ab}	31.02^{cd}	30.01^{c}	2.41
Acid Detergent Lignin	9.06^{a}	8.04^{b}	8.02^{b}	7.24^{c}	7.10^{cd}	1.29

^{a,b,c,d,e} means at the same row with different superscript differ significantly (P<0.05)

T1 = 100% *Panicum maximum*

T2 =75% *Panicum maximum* + 25% lablab cv Rongai

T3 = 75% *Panicum maximum* +25% lablab cv Highworth

T4 = 100% lablab cv Rongai

T5 = 100% lablab cv Highworth

Table 3. Shows the mineral composition of dried *Panicum maximum* and the two cultivars of *Lablab purpureus* that did not undergo the ensiling process. The means for calcium (Ca), phosphorus (P), Magnesium (Mg) and Potassium (K) differed significantly (P<0.001) among treatments. The mean values for sodium (Na), Manganese (Mn), iron (Fe), Cupper (Cu), and Zinc (Zn) differed significantly (p< 0.001) among treatments. The calcium content ranged from 0.42g/100g DM in sole *Panicum maximum* to 0.91g/100g DM in *Panicum maximum cv* Highworth. The Ca content value of 0.03g/100g DM was the same for both lablab *cvs* Rongai and Highworth. The Ca content value of 0.91g/100g DM for *Panicum maximum* intercropped with lablab *cv* Highworth was significantly similar with the value 0.90g/100g DM obtained for *Panicum maximum cv* Rongai. The P content was highest (0.41g/100g DM) in sole *Lablab purpureus* cv Rongai which was not significantly different from0.40g/100g DM obtained in sole *Lablab purpureus* cv Highworth. The lowest (0.15g/100g DM) P content was obtained in sole *Panicum maximum.* The P content in *Panicum maximum* intercropped with lablab Rongai cv 0.24g/100g DM which was not significantly different from 0.25g/100g DM obtained in *Panicum maximum* intercropped with lablab cv Highworth.The Mg content value ranged from 0.01g/100g for sole lablab cvs Rongai and Highworth to 0.33g/100g *Panicum maximum* intercropped with lablab cvs Rongai and Highworth.The lowest value for K,0.01g/100g was obtained from sole lablab cv Hghworth while the highest value for K ,0.19g/100g was obtained from *Panicum maximum* intercropped with lablab cvs Rongai and Highworth. The Na content ranged from 90.18ppm, the lowest value obtained for sole lablab cv Rongai to the highest (2685.55ppm) value in *Panicum maximum* with lablab *cv* Highworth. The Na content value for sole Panicum *maximum* was 691.33ppm while 2208.08ppm was the value obtained for *Panicum maximum* with lablab *cv* Rongai.The Mn content value ranged from the lowest, (1026.78 ppm) for sole *Panicum maximum* to the highest (2506.00ppm) value obtained from sole lablab cv Rongai. The Fe content ranged from lowest (329.94ppm) value for sole *Panicum maximum* to the highest (783.50ppm) value obtained for sole lablab cv Rongai. The Fe content value was (377.03ppm) for *Panicum maximum* intercropped with lablab *cv* Rongai and which was not significantly different from (379.62ppm) obtained for *Panicum maximum* intercropped with lablab cv Highworth.The Cu content ranged from the lowest (89.93ppm) *Panicum maximum* intercropped with lablab *cv* Rongai to the highest (584.94ppm) value obtained for sole *Panicum maximum* in this study.

Table 3: Mineral composition (g/100g DM) of unensiled *Panicum maximum* intercropped with *Lablab purpureus*

Treatments	T1	T2	T3	T4	T5	SEM
Calcium %	0.42[b]	0.90[a]	0.91[a]	0.03[c]	0.03[c]	0.004
Phosphorus %	0.15[d]	0.24[c]	0.25[c]	0.41[a]	0.40[a]	0.003
Magnesium %	0.08[b]	0.33[a]	0.33[a]	0.01[c]	0.01[c]	0.001
Pottasium %	0.06[b]	0.19[a]	0.19[a]	0.02[c]	0.01[c]	0.001
Sodium ppm	691.32[c]	2208.08[b]	2685.55[a]	90.18[d]	100.69[d]	5.681
Manganese ppm	1026.78	1242.72	1249.32	2506.00	2347.00	14.512
Iron ppm	329.94[d]	377.03[c]	379.62[c]	783.50[c]	692.45[b]	1.144
Copper ppm	584.94[a]	89.93[d]	91.16[d]	435.30[b]	362.20[c]	8.823
Zinc ppm	759.36[c]	149.87[d]	154.10[d]	2870.00[a]	2820.00[b]	10.23

[a, b, c] Means along the same row with different superscript are significantly different (P<0.05)

T1: 100% *Panicum maximum*

T2: 75% *Panicum maximum* + 25% *Lablab purpureus* cv Rongai

T3: 75% *Panicum maximum* +25% *Lablab purpureus* cv Highworth

T4: 100% *Lablab purpureus* cv Rongai

T5: 100% *Lablab purpureus* cv Highworth

Table 4 show the *in vitro* gas production characteristics of *Panicum maximum* and legume mixtures incubated at 48 hours. The mean values differed significantly $p<0.05$ among the treatment means. The least gas volume, y (7.67 ml) was reported for sole *Panicum maximum* at 48hrs, y (14.00ml) was the highest gas value for *Panicum maximum* intercropped with lablab cv Highworth at 48hrs. The highest mean value of b fraction (extent of gas production) was observed in *Panicum maximum* intercropped with lablab cv Rongai mixture 22.33ml at 48 hrs for *Panicum maximum* with lablab cv Rongai. The value of 'b' did not increase as the incubation period increase. Similar observation was recorded for the potential extent of gas production, a+b as for the b fraction. Potential extent of gas production was highest (25.67ml) in *Panicum maximum* with lablab cv Rongai at 48 hours of incubation period while the lowest (24ml) was in sole *Panicum maximum* and sole highworth. Khazaal *et al*, (1995) reported that gas production from protein fermentation is negligible. The rate of fermentation C, of substrates ranged from 0.020h-1 in sole *Panicum maximum* to 0.055h-1 in sole lablab cv Rongai at 48 hours.

Table 4: *In vitro* fermentation characteristics of *Panicum maximum* with lablab mixtures incubated for 48hours

Treatment	Fermentation characteristics					
	A	a+b	b	c	t	Y
T1	3.33	24.00	20.67	0.020^{b}	12.00	7.67^{c}
T2	3.33	25.67	22.33	0.025^{ab}	13.00	10.00^{b}
T3	4.33	24.67	20.33	0.033^{ab}	15.00	12.33^{ab}
T4	5.00	25.67	20.67	0.055^{a}	13.00	14.00^{a}
T5	5.00	24.00	19.00	0.038^{ab}	12.00	12.00^{ab}
SEM	0.39	1.31	1.05	0.005	0.73	0.38

^{a,b,c} means along the same column with different superscript differ significantly($p<0.05$)

a=zero time interest which ideally reflectsthe fermentation of soluble fraction

b=extent of gas production

a+b=potential extent of gas production

c=rate of gas production (t)

t=incubation time

T1:100% *Panicum maximum*

T2: 75% *Panicum maximum* + 25% *Lablab purpureus* cvRongai

T3:75% *Panicum maximum* + 25% *Lablab purpureus* cv Highworth

T4:100% *Lablab purpureus* cv Rongai

T5: 100% *Lablab purpureus* Highworth

Table 5 presents Metabolizable energy (MJ/kg DM), organic matter digestibility (%) and short chain fatty acids of *Panicum maximum* with lablab mixture at 48hours. The Metabolizable energy (ME) ranged between5.88 to 7.10(MJ/Kg DM). There were no significant difference (P>0.05) among the forages in OMD and SCFA but ME differ significantly (P>0.05). OMD was highest (52.70) in sole lablab *cv* Rongai and the least for *Panicum maximum* only (44.16). The short chain fatty-acids ranged between 0.51-0.55 while metabolizable energy for the forage samples were 5.88, 6.66, 6.37, 7.10 and 6.93 for sole *Panicum maximum*, *Panicum maximum* intercropped with lablab cv Rongai, *Panicum maximum* intercropped with lablab *cv* Higihworth, sole lablab *cv* Rongai and sole lablab *cv* Highworth respectively. However, sole lablab cv Rongai and *Panicum maximum* intercropped with lablab cv Rongai had the highest (0.55) SCFA while the lowest (0.51) SCFA value was observed in sole *Panicum maximum*.

Table 5: Methabolizable Energy (ME MJ/Kg DM), Organic Matter Digestibiity (OMD %) and Short Chain Fatty Acids (SCFAμmol) of *P . maximum/L.purpureus* at 48 hours.

	Estimated parameters		
	ME	OMD	SCFA
T1	5.88[b]	44.16[c]	0.51 [c]
T2	6.66[ab]	50.86[ab]	0.55[a]
T3	6.37[ab]	48.57[b]	0.53[b]
T4	7.10[a]	52.70[a]	0.55[a]
T5	6.93[a]	51.86 [a]	0.51[c]
SEM	0.18	1.47	0.03

[a,b,c] means along the same column with different superscript differ significantly($p<0.05$)

T1: 100% *Panicum maximum*

T2: 75% *Panicum maximum*+25% *Lablab purpureus cv Rongai*

T3: 75% *Panicum maximum*+25% *Lablab purpureus cv* Highworth

T4: 100% *Lablab purpureus* cvRongai

T5: 100% *Lablab purpureus* cv Highworth

3.8 DISCUSSION

The crude protein content of *Panicum* maximum was influenced positively by the legume, lablab either cultiver Rongai or Highworth that were used to intercrop with *P. maximum.* The lablab enhanced the CP of the *P. maximum* from 6.51g to 8.01g and 8.10g in the first study. The dry matter DM content of the forages obtained in the second study was higher than the value of 27.60g/100g DM reported in another study (Arigbede *et al.,* 2005). The value obtained in this study for sole *Panicum maximum* was higher than 26g/100g DM reported by Odedire and Babayemi (2008) and 27.30g/100g DM (Bamikole *et al.,* 2003) probably due to harvesting which was carried out during late raining season, though the value fell within the range reported by Otukoya (2007) that *Panicum maximum* had DM of 30.17g/100g DM, Babayemi and Bamikole (2006) reported 30.71g/100g DM while Babayemi (2007) reported higher value 35.13 g/100g DM and Ajayi (2007) reported 38.49g/g DM which was higher compared to the value observed in this study. The highest dry matter recorded in this study was for sole lablab cv Highworth and it was not as high as the value reported by (Babayemi, 2007). The higher dry matter values recorded for the two sole cultivars of lablab implies that they might be able to accommodate nutrients better than *Panicum maximum* and other forage samples and as such able to utilize more of the atmospheric carbon dioxide by converting it into useful products during the process of photosynthesis. The dry matter of the grass and forage legumes recorded in this study reflected the state of dryness of the samples.

The Crude Protein CP value obtained for the sole *Panicum maximum* in this study was relatively similar to the value 6.8g/100g DM and 6.6g/100g DM recorded by Johnson *et al.,* (1968) and McDowell *et al.,* (1974) also Babayemi and Bamikole (2006) reported 7.35g/100g DM for *Panicum maximum* but lower than 12.3%, 9.36% reported for sole *Panicum maximum* by Ademosun (1973) and Babayemi (2007), but fell within the values of 5.7-13.55% reported by Mohammed Salem (1972). It was however, observed in this study that crude protein value of the sole *Panicum maximum* fell below 7 % recommended by Devandra, (1987) for rumen microbial functioning. The CP value obtained in this study for the grass intercropped with lablab cvs fell within the range (11-14%) recommended by Devandra, (1987) for maintenance and production, higher than11% recommended by (NRC, 1981). The CP values for sole lablab cv *Rongai* and for sole lablab cv Highworth obtained in this study was higher than 14.06g/100g DM cited by (Babayemi *et al.,* 2006), but comparable to the value of

21.08g/100g DM reported by Nworgu and Ajayi (2005) also close to 23.29g/100g DM for sole lablab reported by Ajayi (2007). Murphy and Colluci, (1999) reported 17% CP for *Lablab purpureus.* It was however, observed in this study that crude protein value of the *Panicum maximum* intercropped with legume were significantly differ and higher than the sole *Panicum maximum.* Although, highest crude protein value 24.94 and 24.50g/100g DM was observed in the two sole cultivars. In the same vein, Murphy and Colluci, (1999) stressed the fact that legumes are important sources of protein and minerals consumed worldwide.

Comparatively, the crude protein value obtained for lablab in this study was higher than crude protein 16g/100g DM and 22g/100g DM reported for *Centrosema pubescens* and *Pueraria phaseoloides* (Babayemi, 2007). Crude protein value of lablab in this study was higher than crude protein value for *Leucaena leucocephala*, 22.07 and 22.4g/100g DM reported by (Arigbede *et al.,* 2002). The highest NDF, ADF and ADL mean values were recorded for *Panicum maximum* but lower values were recorded for sole lablab and *Panicum maximum* with *Lablab purpureus.* The NDF values for sole *Panicum maximum*, sole lablab cv Rongai, sole lablab *cv* Highworth and *Panicum maximum* with lablab mixtures were within the range of 24-61 reported for tropical forages (Topps, 1992). NDF values for sole *Panicum maximum*, sole lablab *cv* Rongai, sole lablab *cv* Highworth and *Panicum maximum* with lablab mixtures. NDF values obtained were comparable to the 46% reported by (Murphy and Colluci, 1999)

Ademosun (1973) reported ADF values of 50g/100g DM, higher than the value obtained in this study for *Panicum maximum*. Murphy and Colucci, (1999) reported 41 ADF for lablab higher than the value obtained for ADF for sole *Lablab purpureus cv* Rongai and Highworth.
Table 5 presented the ME, OMD and SCFA of *Panicum maximum* with lablab mixture at 48hours. There were no significant difference (P>0.05) among the forages in OMD and SCFA but ME differ significantly (P>0.05). The Metabolizable energy (ME) ranged between 5.88 to 7.10 (MJ/Kg DM). Organic matter digestibility was highest in lablab cultivar highworth and the least for *Panicum maximum* only. Although gas production is a nutritionally waste product (Maurio *et al.,* 1999) but provides a useful basis from which metabolizable energy (ME), organic matter digestibility (OMD) and short chain fatty-acids (SCFA) could be estimated.

OMD was highest (52.70) in sole lablab *cv* Rongai and the least for *Panicum maximum* only (44.16). The short chain fatty-acids ranged between 0.51-0.55 while metabolizable energy for

the forage samples were 5.88, 6.66, 6.37, 7.10 and 6.93 for sole *Panicum maximum*, Panicum maximum intercropped with lablab cv Rongai, *Panicum maximum* intercropped with lablab *cv* Higihworth, sole lablab *cv* Rongai and sole lablab *cv* Highworth respectively. However, sole lablab cv Rongai and *Panicum maximum* intercropped with lablab *cv* Rongai had the highest SCFA while the lowest SCFA value was observed in sole *Panicum maximum*. Importantly, gas production helps to measure digestion rate of soluble and insoluble fractions of feed stuff. (Menke and Steingass, 1988; Pell and Schofield 1993). The gas produced is directly proportional to the rate at which substrate are degraded (Dhanoa *et al.*, 2000). Somart *et al.*, (2000) reported that gas volume is a good parameter to predict digestibility, fermentation and its product and microbes in the *in vitro* system. Gas volumes also have shown a close relationship with feed in take (Blummel and Becker, 1997) and growth rate in Cattle (Blummel and Orskov, 1993).

Energy supplement produced higher gas compared with protein supplement because protein fermentation does not lead to much gas production (Menke and Steingass, 1988, Getachew *et al.*, 1998, Khazaal *et al*: 1995 and France and Siddon, 1993). Beuvink and Spoelstra (1992) reported that gas is produced mainly when feedstuff carbohydrate are fermented to acetate and butyrate with fermentation to propionate yielding gas only from buffering of acid, therefore forage which produce high amount of propionate should produce low gas volumes. Acetate and butyrate are lipogenic, which leads to synthesis of butter fat in milk while propionate is glucogenic which leads to production of lean meat. Gas production was directly proportional to SCFA (Beuvink and Spoelstra, 1992), the higher the gas produced the higher the short chain fatty-acids.

Short chain fatty acids level indicates the energy available to the animal. It contributes up to 80% of animal daily energy requirement (Fellner, 2004). SCFA was directly proportional to metabolizable (ME) (Menke *et al.*, 1979). Moreover, short chain fatty-acids (SCFA) is very important for relating feed composition to production parameters and to net energy value of the forages, therefore production of SCFA from *in vitro* gas measurement will be increasingly important in a developing Country. Blummel and Orskov (1993); Pell and Schofield (1993) and Nitipot and Somart (2003), all reported direct relationship between OMD and gas production. The quality of gas produced during fermentation reflects the amount of substrate digested and the microbial metabolic pathway (Doana *et al.*, 1997).

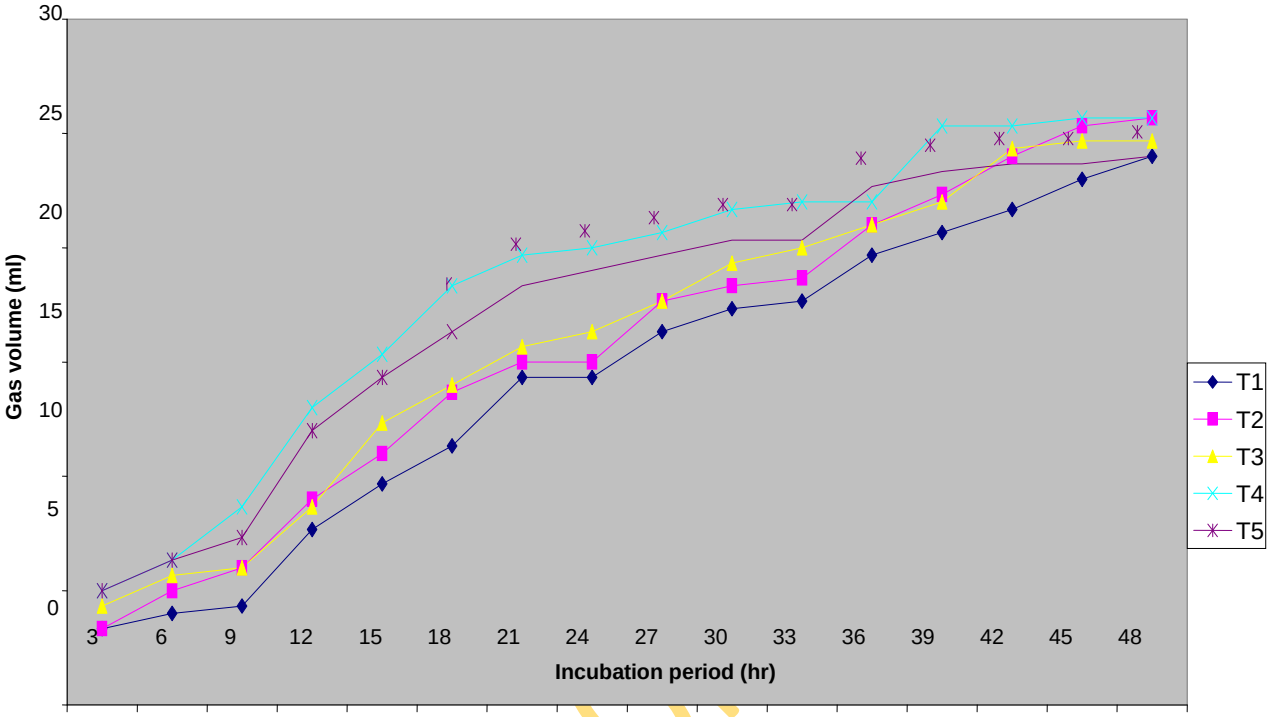

Fig 1: *In vitro* gas production of *Panicum maximum* and lablab mixture incubated for 48hrs

Treatment 1= Sole *Panicum maximum*

Treatment 2= *Panicum maximum* + lablab cv Rongai

Treatment 3= *Panicum maximum* + lablab cv Highworth

Treatment 4= Sole lablab cv Rongai

Treatment 5= Sole lablab cv Highworth

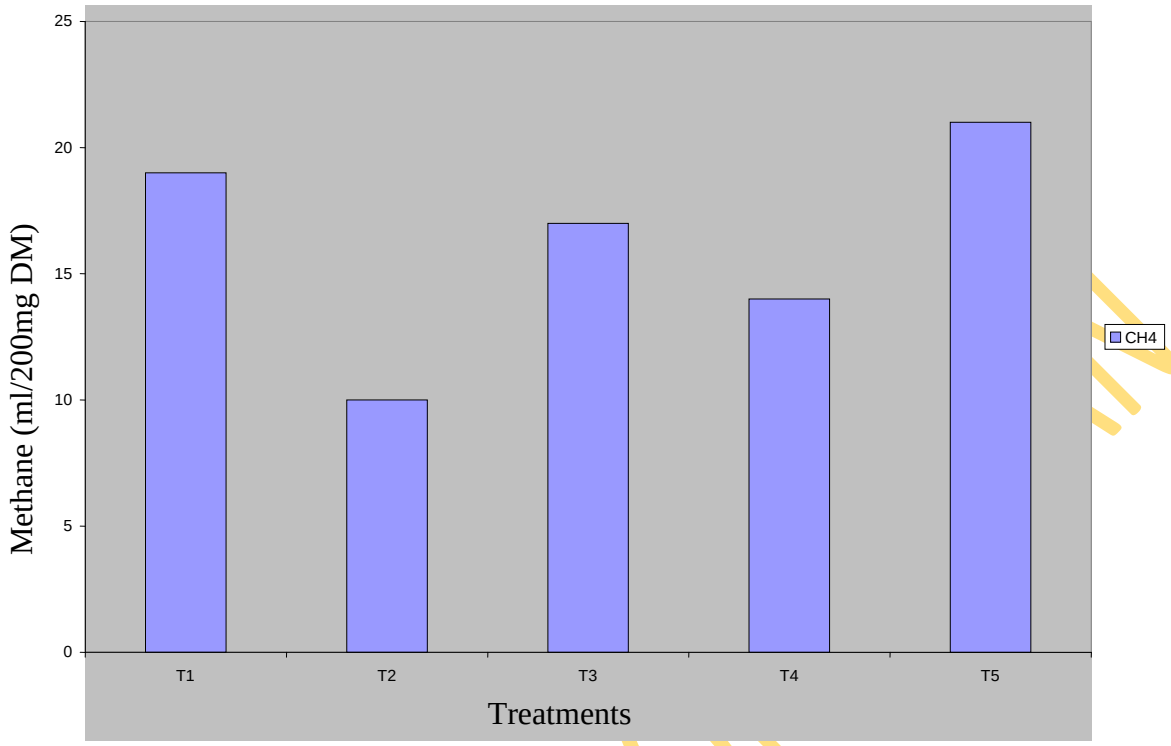

Fig 2: Methane production (48H)

T1= Sole *Panicum maximum*

T2= 75% *Panicum maximum* +25% lablab cv Rongai

T3= 75% *Panicum maximum* + 25%lablab cv Highworth

T4= Sole lablab cv Rongai

T5= Sole lablab cv Highworth

CHAPTER FOUR

4.0 CHEMICAL AND MINERAL COMPOSITION OF SOWN *Panicum maximum* WITH *Lablab purpureus* SILAGES AND SILAGE QUALITY

4.1 INTRODUCTION

Sheep and Goat benefit little from matured or over matured grass due to lignification. Improved pastures are intentionally cultivated, so that there will be need to adequately cater for them at all stages of pasture growth in order to meet the normal feed requirement (Babayemi, 2009). Babayemi and Bamikole (2006a) reported that feeding grass after anthesis may be a sign that lignifications have occurred and might not be beneficial to livestock consuming it. Several workers have reported forage scarcity in the dry season, and in order not to deprive ruminants from taking nutritious pastures, alternative feed can be made in form of ensiling. Ensiling is the process of preserving fresh cut forages in silo under completely anaerobic conditions (McDonald *et al.,* 1991). Babayemi and Igbekoyi (2008) described that silage production in the tropics is a sustainable means of supplementing feed for ruminants in the dry season. Bamikole *et al.,* (2004) reported that young pastures are high in crude protein, low in fibre but very low in dry matter. On the other hand, older grasses are low in crude protein but high in fibre and dry matter (Babayemi and Bamikole, 2006b).

Some of the forages are purposely grown for silage making, while others are ensiled when surplus, after fulfilling the immediate feeding requirement of the livestock. Ensiling can be considered the most effective way of preserving excess green forages over hay making if all essential steps of silage making are carefully followed (Rahman and Annela, 2004). Young pastures may be low in fermentable carbohydrates or water soluble carbohydrates and have a high buffering capacity, making them practically difficult to ensile without injecting additives (Salawu *et al.,* 2001; Ohba *et al.,* 2004). Silage additives can be added to ensure successful fermentation because of the low concentration of water soluble carbohydrate (Patterson, 1988). However, additive such as cassava peel can be used (Olorunnisomo and Dada, 2011). Well prepared silage will have little or no deviation from the initial state of the material ensiled. The primary goal of making silage is to maximize the preservation of original nutrients in the forage for feeding at a later date. Quality is described as a fitness for purpose

at minimum cost. In making good quality silages, fermentation process in the silo must be anaerobic and controlled leading to nothing less than optimal preservation of nutrients. Babayemi, (2009) reported the quality of ensiled *Panicum maximum* pertaining to 4 weeks and 12 weeks cutting regime and different mixtures were reflected in terms of colour, taste, texture, odour and temperature. Babayemi and Igbekoyi (2008) reported quality parameters such as colour, smell, taste, pH and temperature. Good silage usually preserves well the original colour of the pasture or forage (Mannetje, 1999). Hendricksen (1981); Ehrlich *et al.*, (1996) reported annual summer growing legumes provides higher levels of protein when grazed but when conserved they provide higher quality when needed (Mullen and Watson, 1989; Ehrlich and Casey, 1998). The present study was conducted to evaluate the chemical and mineral composition of ensiled *Panicum maximum* with *Lablab purpureus* mixtures and to assess the quality of the prepared silage.

4.2 MATERIALS AND METHODS

The Experiment was carried out at the Teaching and Research Farm of the University of Ibadan in August, 2009.The location was 7 °27 ¹N and3 °45¹ E at an altitude of 200-300m above sea level. The average annual rainfall was about 1250mm with a mean temperature of 25° C-29° C.

4.3 SILAGE PREPARATION

Panicum maximum was obtained manually with knives from existing pasture established in 2008. *Lablab purpureus* of two cultivars were re-sown in June 2009 and were harvested manually from each of the legume pure stands from the plots allotted for *Lablab purpureus* every six weeks. This continues till five harvesting were achieved. Harvested forages were weighed in order to determine the expected amount for the making of silage. After harvesting the forages, they were chopped into 3cm lengths. Representative samples of known weight were taken for dry matter analysis. The harvested samples were wilted for two hours. The grass with legumes weighed 25kg in ten replicates for the nine different treatments were filled in a 25kg capacity plastic used as storage silos. The storage silos were lined with white polythene. Cassava peels were included at 10% into each silo. For each treatment, *Panicum maximum*, lablab and additive were thoroughly mixed together with hand before rapidly filling the silos, compacted and compressed and trampled with legs. Silos were compacted and consolidated to exclude any air present in the silo. This is to secure an anaerobic

condition. They were sealed airtight. Sand bags were placed on each silo. Silages were made into nine treatments comprising the mixtures of *Panicum maximum* and *Lablab purpureus* (highworth and Rongai).

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75%*Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75%*Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Rongai)

H-100= 100% *Lablab purpureus* (Highworth)

R-100= 100% *Lablab purpureus* (Rongai)

4.4 DETERMINATION OF SILAGE QUALITY

After 21 days, fermentation was terminated and silos were opened for silage quality. A laboratory thermometer was inserted to determine the temperature.

pH determination: The pH of sub sampled silages were taken by heating 100g of each sub sample in a beaker containing 100mls of distilled water for 5 minutes at 60°C. The supernatant liquid was decanted, cooled at room temperature and digital pH meter was used to determine the level of the pH.

Colour: Colour assessment was ascertained by using visual observation with the aids of colour charts.

Odour: The odour or smell of the silage was relatively assessed as to whether nice or pleasant or fruity/vanilla.

A taste panel of seven people was set up for taste assessment by training them on how to use tongue to detect the taste by comparing it with what they are accustomed to. A variety of **Taste:** Like substances such as wine, vinegar, fruits, are provided for their options.

Texture: Texture of silage was determined by touching whether it is firm or not.

Dry matter analysis was determined by taking sub samples from different points and depths mixed together and oven dried at 65˚C until constant weight was achieved. The samples were later milled and stored in an air–tight container until ready for chemical analysis.

4.5 CHEMICAL ANALYSIS

Sub-sample of each ensiled harvest was oven dried at 105°C. The dried sub samples were pooled together and milled using 1mm sieve with Thompson hammer mill for proximate analysis and mineral assay.Dried samples were analyzed for crude protein, crude fibre, ether extract, and ash according to the methods of (A.O.A.C, 1990). Neutral detergent fibre, acid detergent fibre and acid detergent lignin determined according to the (Van soest *et al.*, 1991).Hemicellulose values were calculated by the difference between Neutral detergent fibre and Acid detergent fibre, while the cellulose values were calculated by the difference between acid detergent fibre and Acid detergent lignin. After ashing, the samples in a muffle furnace at 550° C, mineral composition was determined.

4.6. *In vitro* GAS PRODUCTION OF *Panicum maximum and Lablab purpureus cv* Highworth and Rongai silages

4.6.1. The *in vitro* gas production technique

Rumen fluid was obtained from three West African dwarf goats using suction tube before the morning feed. The animals were previously fed with concentrate feed (40% corn, 10% wheat offal, 10% palm kernel cake, 20% groundnut cake, 5% soybean meal,10% dried , brewers grain, 1% common salt, 3.75% oyster shell and 0.25% fish meal) and 60% *P. maximum* at 5% body weight. The rumen liquor was collected into the thermo flask that had been pre-warmed to a temperature of 39ºC from the goats before they were offered the morning feed. Incubation was as reported (Menke and Steingass, 1988) using 120 ml calibrated syringes in three batch incubation at 39 ºC. Into 200 mg sample in the syringe was introduced 30 ml inoculums containing four layers cheese cloth strained rumen liquor and buffer ($NaHCO_3$ + Na_2HPO_4 + KCl + NaCl + $MgSO_4.7H_2O$ + $CaCl_2.2H_2O$) (1:4, v/v) under continuous flushing with CO_2. The gas production was measured at 3, 6, 9, 12, 15, 18, 21, 24 36 and 48h. At post incubation period, 4 ml of NaOH (10 M) was introduced to estimate methane production as reported by Fievez *et al*. (2005). The average of the volume of gas produced from the blanks was deducted from the volume of gas produced per sample.The volume of the gas produced at intervals was plotted against the incubation time, and from the graph, the gas production characteristics were estimated using the equation $Y = a + b (1 – e^{-ct})$ described by Ørskov and McDonald (1979), where Y = volume of gas produced at time 't', a = intercept (gas produced from the soluble fraction), b = gas production from the insoluble fraction, c = gas production

rate constant for the insoluble fraction (b), t = incubation time. Metabolizable energy (ME, MJ/Kg DM) and organic matter digestibility (OMD, %) were estimated as established (Menke and Steingass, 1988) and the value of short chain volatile fatty acids (SCFA) was calculated as reported (Getachew *et al.*, 1998) : ME = 2.20 + 0.136*Gv + 0.057*CP + 0.0029*CF; OMD = 14.88 + 0.889Gv + 0.45CP + 0.651 XA; SCFA = 0.0239*Gv – 0.0601; where Gv, CP, CF and XA are net gas production (ml/200 mg DM), crude protein, crude fibre and ash of the incubated samples respectively.

This study evaluated the nutritional quality and effect of *Panicum maximum* with *Lablab purpureus* silages on *in vitro* degradation using *in vitro* fermentation technique in the following treatments:

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75%*Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75%*Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Rongai)

H-100= 100% *Lablab purpureus* (Highworth)

R-100= 100% *Lablab purpureus* (Rongai)

4.7 STATISTICAL ANALYSIS

Data were subjected to analysis of variance using the procedure of SAS (1999). Significant means were separated using the Dunan multiple range F-test.

4.8 EXPERIMENTAL DESIGN

The Study was in a completely randomized design.

4.9 RESULT

Chemical composition (g/100g/DM) of ensiled *Panicum maximum*, *Panicum maximum* with *Lablab purpureus cvs* Highworth and Rongai mixtures are shown in table 6. Dry matter content ranged between 33.11g/100g/DM in *Panicum maximum* with 25% Highworth to 46.39% in sole *Panicum maximum* and (46.01%) in sole Rongai which was not significantly different from (46.39%) obtained in sole *Panicum maximum*. Crude protein content ranged between lowest (9.01) in sole *Panicum maximum* to highest (26.2%) in sole Rongai which was not significantly different from 25.25% obtained in sole Highworth. NDF value ranged from lowest (44.7%) in *Panicum maximum* with 25% Highworth to highest (56.2 %) in sole *Panicum maximum*. There were variations also in ADF, the highest value (39.4%) was obtained for sole *Panicum maximum*, lowest value (30.2%) for sole Highworth which was not significantly different from (33.2%) obtained for sole Rongai. *Panicum maximum* with 75% Rongai had the lowest (7.8%) ADL value and the highest value (10.3%) were recorded for sole Highworth which was not significantly different from (10.20%) obtained in sole Rongai. Ether extract also varied, it ranged from (8.2%) in sole *Panicum maximum* to (10.4%) in *Panicum maximum* with 50% Highworth. The value of ash content was lowest (9.9%) in sole Rongai and highest (12.97%) in *Panicum maximum* with 50% Rongai. Generally, *Panicum maximum* being grass was highest in NDF, ADF, and ADL bsut least for CP, EE, and ash contents when compared to *Panicum maximum* with *Lablab purpureus* mixtures.

Table 6: Chemical composition (g/100g DM) of ensiled *Panicum maximum* with *Lablab purpureus* mixtures

Treatments	DM	CP	CF	EE	ASH	NDF	ADF	ADL	HEMI	CELL
Pm-100	46.39^{a}	9.01^{d}	33.08^{b}	8.15^{d}	10.01^{b}	56.16^{abc}	39.42^{a}	9.42^{ab}	12.59^{ab}	27.99^{ab}
Pm-75/H-25	33.10^{e}	15.01^{c}	36.15^{b}	9.03^{cd}	11.33^{ab}	44.73^{cd}	37.41^{abc}	8.61^{bc}	5.31^{b}	30.81^{a}
Pm-50/H-50	36.26^{de}	15.13^{c}	37.07^{b}	10.35^{a}	12.00^{ab}	48.58^{bc}	38.75^{ab}	8.73^{bc}	9.83^{ab}	30.02^{a}
Pm-25/H-75	41.47^{bc}	16.78^{b}	36.33^{b}	9.16^{bcd}	12.01^{ab}	54.36^{ab}	36.71^{abc}	9.15^{ab}	17.65^{a}	27.56^{ab}
Pm-75/R-25	35.62^{de}	15.15^{c}	35.51^{b}	10.11^{ab}	11.01^{ab}	52.98^{ab}	37.61^{abc}	8.25^{bc}	15.37^{a}	29.36^{a}
Pm-50/R-50	39.80^{cd}	15.16^{c}	46.05^{a}	10.06^{ab}	12.97^{a}	50.01^{a}	37.53^{bc}	8.61^{bc}	18.63^{a}	28.92^{a}
Pm-25/R-75	43.49^{abc}	16.51^{c}	36.17^{b}	8.80^{cd}	12.00^{ab}	53.60^{ab}	34.53^{bc}	7.80^{c}	19.10^{a}	26.75^{a}
H-100	45.60^{ab}	25.25^{a}	36.47^{b}	9.56^{abc}	10.25^{ab}	41.62^{d}	30.10^{d}	10.25^{a}	11.45^{ab}	19.92^{bc}
R-100	46.01^{a}	26.18^{a}	33.08^{b}	8.84^{cd}	9.95^{b}	38.88^{d}	33.20^{cd}	10.20^{a}	5.68^{b}	23.01^{bc}
SEM	1.36	0.45	6.32	0.33	0.81	2.20	1.35	0.37	2.83	1.61

$^{a, b, c, d,e}$ Means on the same row with different superscript are significantly different ($p<0.05$)

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75%*Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75%*Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Rongai)

H-100= 100% *Lablab purpureus* (Highworth)

R-100= 100% *Lablab purpureus* (Rongai)

Table 7 presents the Colour, Texture, odour, pH, temperature and taste, characteristics of ensiled *Panicum maximum* and Lablab mixture. Silage making is very relevant in ruminant nutrition since good quality grasses are not always available all the year round. Good silage provides feed to animals during period of scarcity. The quality of ensiled *P. maximum* with *lablab purpureus* harvested at every six weeks of re-growth was reflected in terms of colour, texture, odour, temperature, taste and pH were shown in table 7. Good silage maintains the original colour of the forage (Mannetje, 1999). The olive green and the other greenish yellow colour obtained in the present study were in order. The olive green colour was closer to the original colour of the grass which was an indication of quality silage that was well preserved (Babayemi, 2009). Also the different yellow colour was in accordance with the report of Kung and Shaver (2002) that when a green plant material that is ensiled produces yellow colour, it can be classified as well - made silage. The temperature of all the present silages was below 26°C and indicated well preserved silage. Temperature is one of the essential factors affecting silage colour. The lower the temperature during ensilage, probably the less will be the colour change. If the temperature obtained for the present study was above 30° C, the grass silage would have become dark yellow or close to brown due to caramelization of sugars (McDonald *et al.*, 1995). The texture for the present silage was firm, which was expected to be the best texture of good silage (Kung and Shaver, 2002). The pH of this study was within the range of 4.1-4.5 classified to be pH for good silage (Meneses *et al.*, 2007).

Table 7: Colour, Texture, odour, pH, temperature and taste, characteristics of ensiled *Panicum maximum* and *Lablab purpureus* mixture.

Treatments	Colour	Texture	Odour	Temperature °c	Taste	pH
Pm-100	Olive green	Firm	Fruity	23	Alcoholic	4.14
Pm-75/H-25	Greenish yellow	Firm	Pleasant	24	Alcoholic	4.24
Pm-50/H-50	Olive yellow	Firm	Pleasant	23	Alcoholic	4.32
Pm-25/H-75	Olive green	Firm	Pleasant	25	Alcoholic	4.35
Pm-75/R-25	Olive green	Firm	Pleasant	23	Alcoholic	4.20
Pm-50/R-50	Olive yellow	Firm	Pleasant	24	Alcoholic	4.31
Pm-25/R-75	Olive green	Firm	Pleasant	23	Alcoholic	4.50
H-100	Olive green	Firm	Pleasant	23	Alcoholic	4.25
R-100	Olive green	Firm	Pleasant	24	Alcoholic	4.50

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75%*Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75%*Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Rongai)

H-100= 100% *Lablab purpureus* (Highworth)

R-100= 100% *Lablab purpureus* (Rongai)

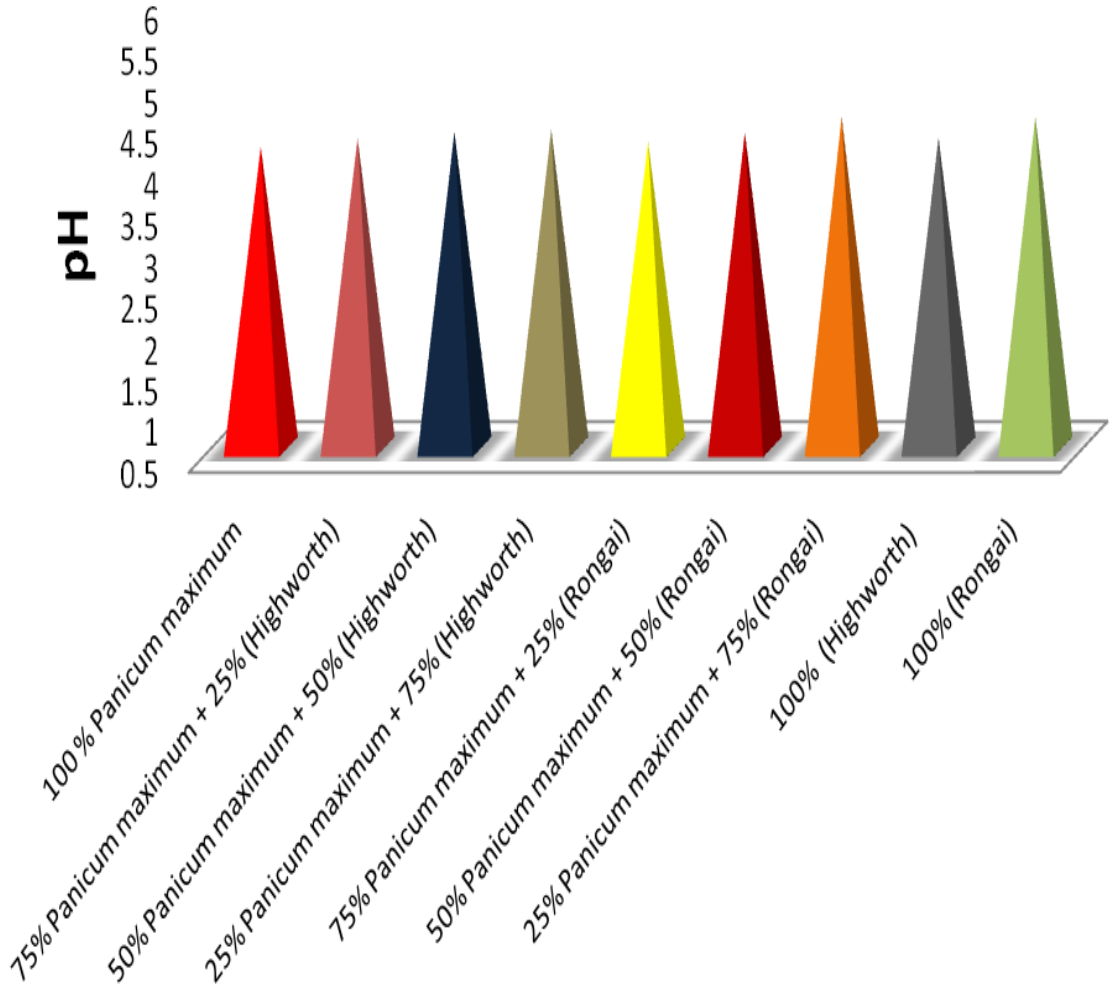

Fig 3: pH of ensiled *Panicum maximum* and *Lablab purpureus* mixture

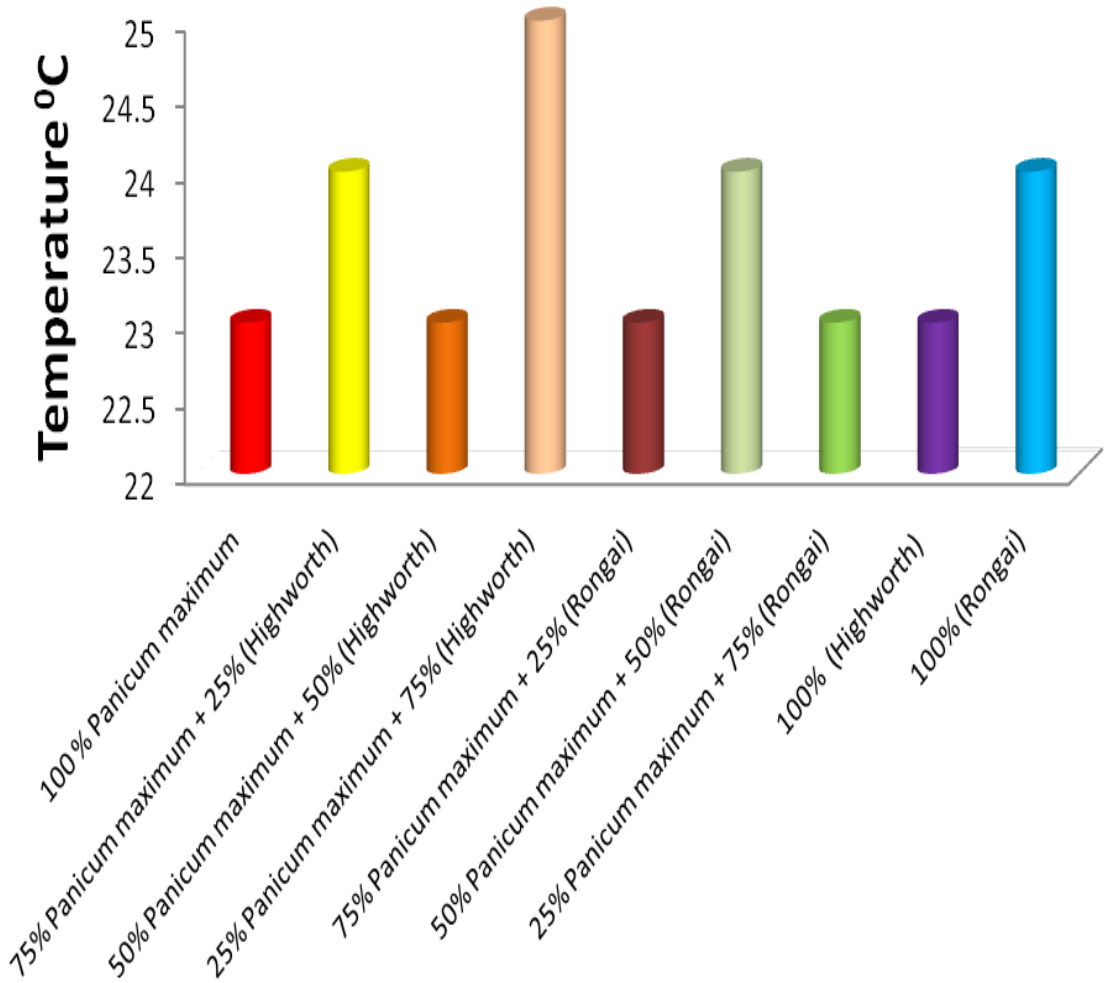

Fig 4:Temperature of ensiled *Panicum maximum* and *Lablab purpureus* mixture

Table 8 shows the *In vitro* gas production characteristics of ensiled *Panicum maximum* with *Lablab purpureus* mixtures at 48 hours. The mean values differed significantly ($p< 0.05$) among the treatment means for gas volume y, gas produced from fermentable soluble fraction a, extent of gas produced b, rate of gas production c, and cumulative gas volume a + b. The gas volume, y, for sole *Panicum maximum* was 15.67ml, *Panicum maximum* with lablab mixtures varied from 11.00ml in 50% *Panicum maximum* with 50% Rongai to 17.33ml (highest) in 75% *Panicum maximum* with 25% Rongai. The y values for 100% Highworth and 100% Rongai were 9.00ml and 9.00ml respectively. The a, values obtained for sole *Panicum maximum* was 1.33, the values obtained for *Panicum maximum* with *Lablab purpureus* mixtures ranged from 1.00-1.67ml, a values for 100% Highworth and 100% Rongai were 2.67ml and 1.33ml respectively.The b values for sole *Panicum maximum* was 28.00ml, values for *Panicum maximum* with lablab ranged from 24.00 - 32.33ml, 100% Highworth and 100% Rongai had 25.33ml and 24.33ml respectively.The c value obtained for sole *Panicum maximum* was 0.042h-1, c value obtained for *Panicum maximum* with lablab varied from 0.032-0.049h-1. The cumulative gas volume (a+ b) at 48 hours were significantly different with values of 29.32 for sole *Panicum maximum*, values varied from 24.67-34.00for *Panicum maximum* with *Lablab purpureus* mixtures and values for 100% Highworth and 100% Rongai had 28.00 and 25.67 respectively. This is an indication that the ensiled sole *Panicum*, *Panicum maximum* with lablab mixtures and sole lablab had exhibited high ferment ability in the rumen. Furthermore, it indicated that efficient rumen fermentation was achieved when herbaceous legumes were fed in combination with *Panicum maximum*. Intercropping *Panicum maximum* with *Lablab purpureus* also improves the proximate composition and organic matter digestibility (Blummel *et al.*, 1997).

Table 8: *In vitro* fermentation characteristics of ensiled *Panicum maximum* with lablab mixtures incubated for 48 hours.

Treatment	Fermentation characteristics					
	a	**a + b**	**B**	**c**	**t**	**y**
Pm-100	1.33^{bc}	29.33^{ab}	28.00^{ab}	0.042	18.00^{ab}	15.67
Pm-75/H-25	1.67^{abc}	34.00^{a}	32.33^{a}	0.049	13.00^{bcd}	16.33
Pm-50/H-50	1.00^{c}	27.33^{ab}	26.33^{ab}	0.033	18.00^{ab}	13.00
Pm-25/H-75	3.00^{a}	32.00^{ab}	29.00^{ab}	0.042	9.00^{cd}	12.33
Pm-75/R-25	1.00^{c}	29.33^{ab}	28.33^{ab}	0.043	20.00^{a}	17.33
Pm-50/R-50	1.00^{c}	27.00^{ab}	26.00^{ab}	0.033	15.00^{abc}	11.00
Pm-25/R-75	1.00^{c}	24.67^{b}	24.00^{b}	0.032	20.00^{a}	12.00
H-100	2.67^{ab}	28.00^{ab}	25.33^{b}	0.036	8.00^{d}	9.00
R-100	1.33^{c}	25.67^{b}	24.33^{b}	0.031	13.00^{cd}	9.00
SEM	0.46	2.26	1.97	0.006	1.97	2.51

^{a,b,c,d} Means in the same column with different superscript differ significantly($P<0.05$)

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75%*Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75%*Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Rongai)

H-100= 100% *Lablab purpureus* (Highworth)

R-100= 100% *Lablab purpureus* (Rongai)

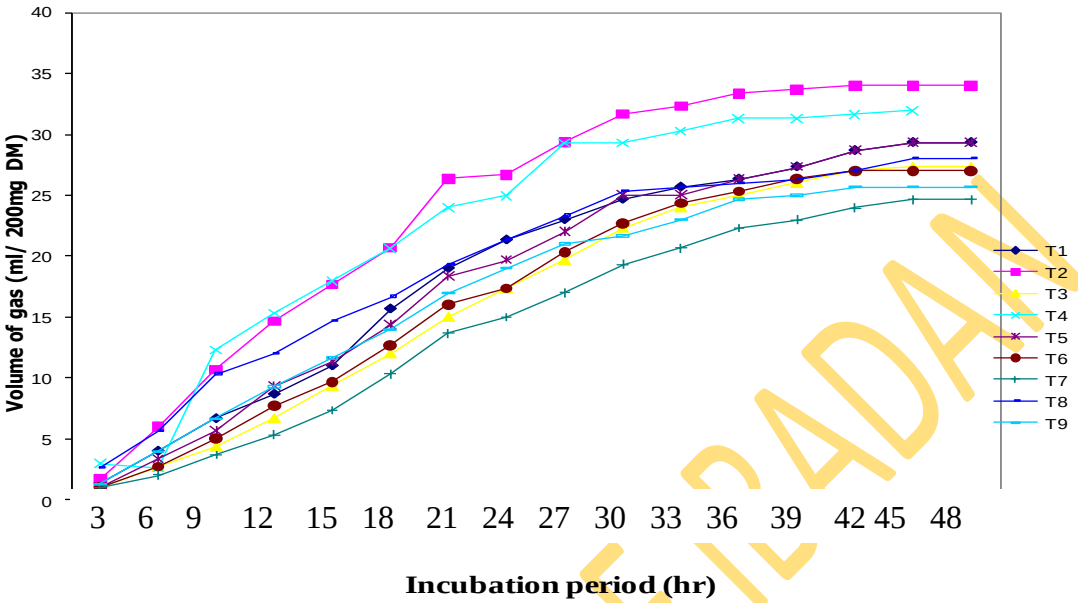

Figure 5: *In vitro* gas production of ensiled Guinea grass and Lablab mixture

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75%*Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75%*Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Rongai)

H-100= 100% *Lablab purpureus* (Highworth)

R-100= 100% *Lablab purpureus* (Rongai)

Table 9 shows the Methane, Metabolizable Energy (ME) MJ/Kg DM, Organic Matter Digestibility (OMD) %, Short Chain Fatty Acids (SCFA) µmol of *Panicum maximum* with *Lablab purpureus* mixtures silages incubated for 48 hours. There were no significant differences ($p>0.05$) among the ensiled forages for ME, OMD and SCFA. The highest ME value was (7.45), highest OMD value (57.05), highest SCFA (0.75) in forage 75% *Panicum maximum* with 25% Highworth. The SCFA ranged between (0.53 - 0.75), the OMD values ranged between 47.97 and 57.05, while the ME value ranged between (6.10 and 7.45).100% Rongai had the least SCFA (0.55) value while the highest value (0.75) was observed in 75% *Panicum maximum* with 25% Highworth. The ensiled forages of *Panicum maximum* with *Lablab purpureus* mixtures had higher ME, OMD and SCFA than the mixtures that were not ensiled.

Table 9: Methane, Metabolizable energy (ME), Organic matter digestibility and SCFA of *Panicum* maximum and *L*ablab *purpureus* mixtures silages incubated for 48 hours

Treatments	Methane	ME	OMD	SCFA
Pm-100	15.00^{a}	6.72^{ab}	50.82^{ab}	0.64^{ab}
Pm-75/H-25	11.00^{c}	7.45^{a}	57.05^{a}	0.75^{a}
Pm-50/H-50	10.00^{d}	6.54^{ab}	52.23^{ab}	0.59^{ab}
Pm-25/H-75	10.00^{d}	7.48^{a}	55.69^{a}	0.70^{ab}
Pm-75/R-25	11.00^{c}	6.76^{ab}	52.98^{ab}	0.64^{ab}
Pm-50/R-50	10.00^{d}	6.61^{ab}	53.37^{ab}	0.59^{ab}
Pm-25/R-75	10.00^{d}	6.10^{c}	47.97^{b}	0.53^{b}
H-100	12.00^{b}	7.16^{a}	53.90^{b}	0.61^{ab}
R-100	12.00^{b}	6.70^{ab}	51.95^{ab}	0.55^{b}
SEM	0.42	0.31	2.01	0.05

^{a,b,c,} Means in the same column with different superscript differ significantly($P<0.05$)

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75%*Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75%*Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Rongai)

H-100= 100% *Lablab purpureus* (Highworth)

R-100= 100% *Lablab purpureus* (Rongai)

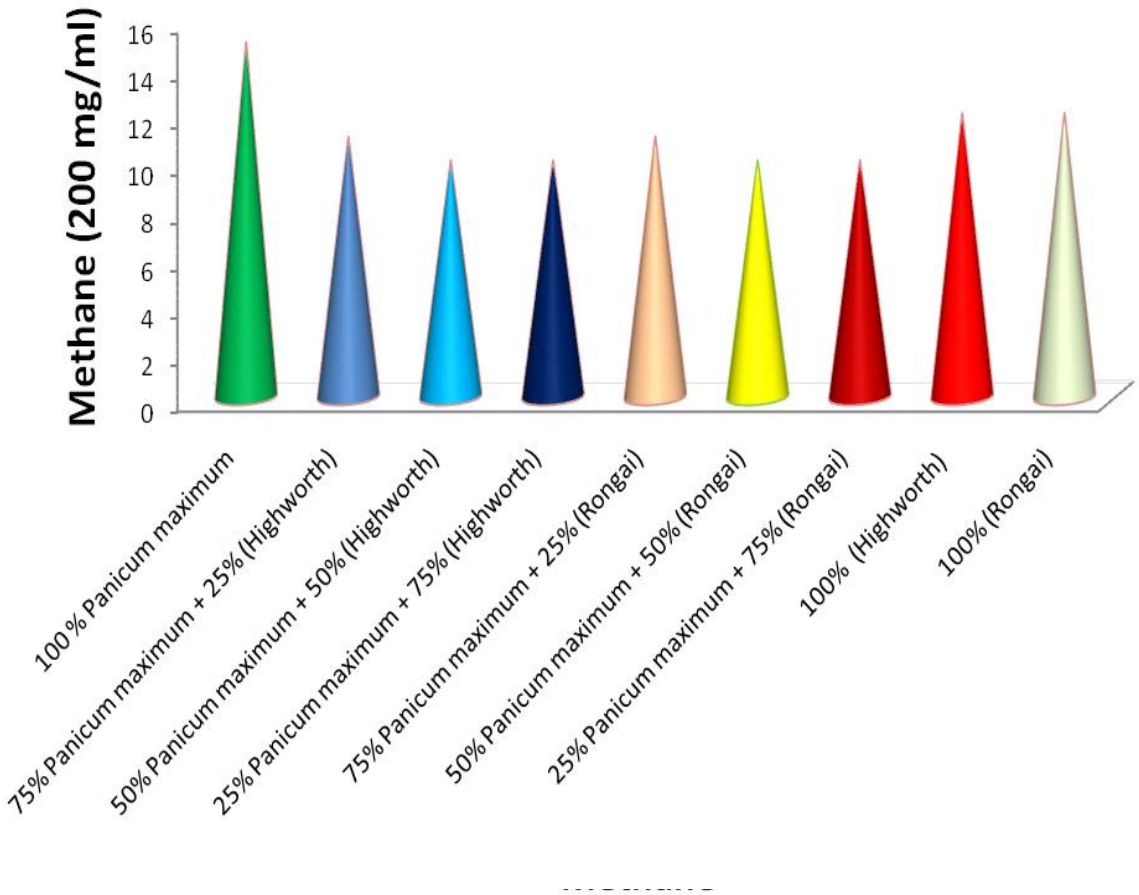

Fig 6: Methane production of ensiled *Panicum maximum* and *Lablab purpureus* mixture

Table 10 shows the mineral composition (g/100g) of ensiled *Panicum maximum* with two cultivars of *Lablab* purpureus. The means for Magnesium Mg, Potassium K, Manganese Mn , Cupper Cu, and Zinc Zn differed significantly (P<0.001) among treatment. The means for phosphorus P, calcium Ca, sodium Na, and iron Fe, differed significantly (p< 0.001) among treatment. The P content was highest (0.46g/100g DM) in 25% *Panicum maximum* with 75% Rongai while the lowest (0.242g/100g DM) value was obtained in sole *Panicum maximum.* The P content (0.271g/100g DM) obtained in 50% *Panicum maximum* with 50% Highworth was not significantly different from 0.277g/100g DM obtained in 25% *Panicum maximum* with 75% Highworth. The calcium content ranged from the least value 0.90g/100g DM in sole *Panicum maximum* to the highest value 0.96g/100g DM in sole *lablab cv* Rongai. The Ca content 0.93g/100g DM obtained in *Panicum maximum* with 25% (Highworth was significantly similar to 0.93g/100g DM obtained for 25% *Panicum maximum* with 75% Rongai. The Ca value (0.94g/100g DM) obtained in *Panicum maximum* with 50% Highworth was significantly similar with the value 0.95g/100g DM obtained for 25% *Panicum maximum* with 75% Highworth. The Na content ranged from 2351.61ppm, the lowest value obtained for sole *Panicum maximum* to the highest (3968.66ppm) value in sole Highworth. The Fe content ranged from lowest (338.78ppm) value for sole *Panicum maximum* to the highest (432.90ppm) value obtained for *Panicum maximum* with 75% Highworth which *was* significantly similar *to* the Fe value(430.95ppm) for sole Highworth.

Table 10: Mineral composition of *Panicum maximum* with *Lablab purpureus* silages

Treatments	Ca%	Mg%	K%	P%	Na(Ppm)	Mn(Ppm)	Fe(Ppm)	Cu(Ppm)	Zn(Ppm)
Pm-100	0.90^{a}	0.33^{g}	0.20^{e}	0.242^{g}	2351.61^{i}	1248.97^{abc}	438.78^{a}	98.31^{a}	149.15^{b}
Pm-75/H-75	0.93^{c}	0.35^{f}	0.20^{e}	0.271^{f}	2808.65^{h}	1244.57^{bc}	377.19^{f}	92.01^{c}	152.55^{a}
Pm-50/H-50	0.94^{b}	0.36^{e}	0.22^{d}	0.277^{e}	2822.53^{g}	1234.66^{c}	378.51^{ef}	92.87^{c}	153.01^{a}
Pm-25/H-75	0.95^{b}	0.42^{a}	0.33^{b}	0.305^{e}	3814.40^{b}	1276.37^{ab}	432.90^{ba}	79.88^{e}	149.60^{b}
Pm-75/R-25	0.95^{b}	0.39^{bc}	0.23^{cd}	0.32^{ed}	3454.62^{f}	1221.23^{c}	419.84^{cb}	88.65^{d}	143.25^{c}
Pm-50/R-50	0.92^{d}	0.39^{bc}	0.23^{cd}	0.39^{c}	3551.62^{e}	1187.49^{d}	400.91^{c}	78.99^{f}	137.35^{d}
Pm-25/R-75	0.93^{c}	0.38^{bc}	0.23^{c}	0.46^{b}	3660.63^{d}	1153.75^{e}	381.98^{de}	69.33^{h}	131.45^{e}
H-100	0.95^{b}	0.40^{ab}	0.36^{a}	034^{d}	3968.66^{a}	1283.50^{a}	430.950^{a}	73.74^{a}	149.60^{b}
R-100	0.96^{a}	0.37^{d}	0.24^{c}	0.34^{a}	3763.63^{c}	1120.01^{f}	363.05^{ef}	59.67^{i}	125.55^{f}
SEM	0.38	0.04	0.04	0.006	2.52	10.20	1.45	0.22	0.3

^{a,b,c,d,e,f,g} Means in the same column with different superscript differ significantly($P<0.05$)

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75% *Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50% *Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25% *Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75% *Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50% *Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25% *Panicum maximum* + 75% *Lablab purpureus* (Rongai)

H-100= 100% *Lablab purpureus* (Highworth)

R-100= 100% *Lablab purpureus* (Rongai)

4.9.1 DISCUSSION

The high net gas production in (fig.5) for all treatments may be due to the high fibre content of the mixtures. A downward trend is observed in the amount of gas produced with decreasing amount *P. maximum* except for in Pm-75/H-25 and Pm-75/R-25. *Panicum maximum* is high in crude fibre and this may reduce its digestibility. Digestibility has been described to be synonymous to *in vitro* gas production (Fievez *et al.*, 2005), the higher the gas production, the higher the digestibility. From the present study the higher the gas production, the higher the digestibility.The inclusion of *P.maximum* was important, being one of the commonest grasses in the tropics. Apart from being abundant, its downward trend of inclusion as *P.*maximum/lablab purpureus mixtures consistently reduced the production of methane (Table 9). The low methane production in this study for grass and legume mixtures is in order with ealier work (Babayemi and Bamikole, 2006). Methane production represents a significant energy loss to ruminants and also contributes to global warming (Babayemi and Bamikole, 2006). From the present study, the least methane production was observed from the following treatments, Pm-50/H-50, Pm-25/H-75, Pm-50/R-50 and Pm-25/R-75. These were 50% *P.* maximum/ 50% lablab (Highworth and Rongai) and 25% *P. maximum* with 75% lablab (Highworth and Rongai). It was observed that 75% *P. maximum* with 25% lablab (Rongai and Highworth) among the mixtures had the highest methane production (which symbolizes energy loss). It must be supplemented with an energy supplements for adequate utilization by ruminants.

The ME and OMD of Pm-75/H-25 and Pm-25/H-75, which are mixtures of *P. maximum* and lablab were better than for sole *P. maximum.* The lower values of ME and OMD observed in sole *P.maximum* was as a result of high NDF obtained in sole grass. Short Chain Fatty Acid (SCFA) or Volatile Fatty Acid (VFA) is a reflection of energy availability in a feed stuff. This is one of the end products of rumen fermentation. High volume of gas was produced when substrate was fermented to acetate and butrate. A relatively lower gas production is associated with propionic production. *In vitro* gas production had low correlationwith volatile fatty acid production particularly that of propionate (Nsamsaeng *et al.*,2006). *Panicum maximum* with *Lablab purpureus* mixtures had higher SCFA and moderate gas production which was significantly similar to SCFAand OMD of sole *Panicum maximum*, sole lablab (Highworth) and sole lablab (Rongai). This implies that more energy would be more available to animals

when grass is supplemented with legumes in the diet of ruminants. The mineral composition of ensiled *Panicum maximum* with two cultivars of *Lablab* purpureus was presented in Table 10. The highest calcium Ca value (0.95g/100g) was obtained in 25% *Panicum maximum* with 75% Highworth while the lowest Ca value was obtained for sole *Panicum maximum.* The P content was highest (0.46g/100g DM) in 25% *Panicum maximum* with 75% Rongai while the lowest value (0.242g/100g) was obtained for sole *Panicum maximum*. Ca and P are very important for the growing animals.Mature ruminants needs Ca and P for maintenance as well as for repairs of damaged tissues.The absorbtion of Ca and P from the intestine is aided by the presence of vitamin D.The performance of ruminants tends to be related to the availability of these two minerals when meat, milk and even eggs are produced in poultry at a high rate. Therefore, the Ca and P supply to the ruminant animals and even, to the birds should be high.On weight basis, more calcium is required than P. In the case of ruminants, more Ca tends to be present in the feeds because forages contain more Ca than P. More Ca than P is needed by animals in definite proportions or ratios. When there is an excess of one these two minerals over the other, the animals is adversely affected. It is true that vitamin D is needed for the absorbtion, transport and utilization of Ca than P by the animals but less of vitamin D is required when more Ca than P are supplied to the animal in the ratio 2:1of Ca:P.When animals do not have enough of Ca and P,a deficiency is said to occur. Ricket is a deficiency disease that occurs when animals do not have adequate dietary level or suitable ratios of Ca and P. In the young cattle rickets lead to stiffness and swollen joints. The highest Magnesium Mg (0.42g/100g) value was obtained from 25% *Panicum maximum* with 75% Highworth while the lowest Mg (0.33g/100g) value was obtained for sole *Panicum maximum.*

The highest Potassium K (0.33g/100g) value was obtained from 25% *Panicum maximum* with 75% Highworth while the lowest K (0.20g/100g) value was obtained for sole *Panicum maximum*. K regulates the intracellular osmotic pressure, acid –base balance in the body of animals. The lowest Fe (338.78ppm) value was obtained for sole *Panicum maximum* while the highest (432.90ppm) value was obtained for 25% *Panicum maximum* with 75% Highworth. Ruminants are supplied ample amount of Iron and cupper from forages while concentrates or a good salt-lick should be given to avoid Cu deficiency.

CHAPTER FIVE

5.0 NUTRITIVE VALUE OF *Panicum maximum* ENSILED WITH *Lablab purpureus* FOR West African Dwarf RAM.

5.1 INTRODUCTION

Sheep and goats play an integral part in livestock production systems while poor nutrition affects their productivity greatly in Nigeria (Hossain *et al*.2004). This is due to the fact that during the dry months of the year forages are scarce and are of low nutritional quality. Sheep and goats provide a significant proportion of meat consumed in Nigeria (RIM,1992). Their productivity is however limited by scarcity and fluctuating quality of year round forages supply (Ajayi *et al.,* 2005). Furthermore, most available ruminant feeds during dry season have been described as fibrous, resulting in low digestibility and poor livestock production (Richard *et al.,* 1994). Poor nutrition is a major constraint in Tropical Africa which lowers the resistance of animals to infections and parasitic diseases thus leading to high mortality rates especially among young animals (30-40% in calves and 50% in lambs and Kids) and low fecundity in adult females (60-66%) (Riviere,1991).The growth rate and milk production of ruminants grazing tropical pastures are generally low and represent about 10% of the ruminants genetic potential (FAO,1997). Protein supplementation of grass diets with forage legumes is essential to achieve high productivity in the animals. This protein supplementation affects voluntary feed intake and digestibility positively. The use of forage legumes such as lablab as feed supplements has been shown to enhance intake of poor quality forages, improve growth rates and increase production efficiency in ruminants (Orden *et al.,* 2000). Feed intake increases as digestibility of energy increases and as crude protein content of the feed increases.

Herbaceous forage legumes have been identified as potential supplements for ruminants. They contain crude protein (150-300g/100g DM), minerals and vitamins (Norton and Poppi, 1995). Protein supplementation of grass diets containing 70g cp/kg DM or less has been reported to increase dry matter intake, dry matter digestibility and animal performance (Osuji *et al*, 1993; Umuna *et al.,* 1995). Forage legumes are kwown to have an important role in the nutrition of ruminants in terms of providing energy, protein, minerals element (Ahmad *et al.,* 2000;

Ranibar, 2007; Osman, 2007). Forage legumes enhance efficient rumen fermentation which optimizes microbial growth for increased digestibility of feedstuffs. Adeyinka *et al.*(2008) sowed pearl millet (*Pennisetum americana*) and lablab to study the effect of the addition of lablab legume in varying composition of daily intake and utilization of millet-silage by Yankasa rams. Alasa and Babayemi (2010) sowed *Lablab purpureus cvs* Highworth and Rongai. Lablab is a valuable feed resource that can be grazed by both small and large ruminant (Muhammad *et al.*2004). Lablab can be fed as either hay or silage. Muhammad *et al.*, (2008) reported the use of *Lablab purpureum* (L) in silage making and that its inclusion improves the silage quality. Sole Lablab leaves and lablab leaves with stems have been used in pig and cattle feeding (Rogers, 2002). Lablab has been used in combination with *Acacia tortilis* pod in goat feeding in Southern Africa (Ndlovu and Sibanda 1996). Amole *et al.*, (2013) reported the effect of maize-lablab silage on the ruminal volatile fatty acids grazing calves. The present study was conducted to evaluate the utilization of ensiled *Panicum maximum* supplemented with *Lablab purpureus cvs* Highworth and Rongai by West African dwarf rams.

5.2 MATERIALS AND METHODS

5.2.1 Experimental Sites

The experiment was conducted at the Teaching and Research Farm University of Ibadan, Nigeria. Latitude about 7 ¹20° N, 3¹ 50° E, altitude about 200m above sea level between December and April in 2011 and 2012. The area has a tropical humid climate, the mean annual rainfall during the experimental period were 1150 mm and 1250 mm between April 2011 and July 2012 respectively. The mean monthly temperature was 25-27°C.

5.2.2 Experimental Animals and Management

Twenty one West African dwarf rams, average age of eight months old and 14.17kg - 15.50kg liveweight were used for the feeding trial. The animals were confined for one month adaptation period. During this period they were treated against external and internal parasite infections.They were also vaccinated against Peste de Petis ruminante (PPR). During this time, they were fed *Panicum maximum* and cassava peels *ad libitum* as well as vitamin and mineral supplement in form of salt-licks.The rams were weighed and randomly divided into seven treatment groups of three animals per treatment in a completely randomised design. The

animals were balanced for weight such that the initial weights were not statistically different. The rams were housed in individual pens measuring 2m x 1m in concrete –floored pens partitioned with slatted planks to allow visual contacts. The pens were cleaned and washed thoroughly with warm disinfectant to remove dirts and obnoxious odour prevailing in the house. The pens were further disinfected with Morigad while the surroundings were furnished with formalin. The overgrown weeds and grasses were sprayed with grammozone to check the growth. The feeding and drinking troughs were washed and disinfected while the whole house was left to rest for two weeks before usage. The floor was spread with wood shavings at 5cm depth to enhance the removal of urine and faeces.

5.2.3 Animal feeding

The rams were weighed on arrival, rested, watered and tagged for easy identification. Rams were fed with the feedstuff (including, cassava peels and wheat offal), which they consumed from where they were purchased during the acclimatization periods. The animals were placed on prophylactic treatment through the administration of antibiotics (long acting). Animals were also treated against endoparasites and ectoparasites using 10% of Levamisol and diazintol respectively. They were allowed to adapt for 1 month and were also fed with concentrate supplementation.

After adaptation, the animals were randomly grouped into seven treatments in a completely randomized design comprising three animals per diet. They were individually kept in separate pens that were previously embedded with wood shavings. Feeders and drinking troughs were placed in the pens for free access to feed and fresh water daily. Feed were offered at approximately 5% of their body weight. Voluntary feed intakes were estimated as the difference between feed offered and feed refusal. The animals were weighed prior to feeding to minimize error due to “fill” in the morning on a weekly basis to calculate average weight gain. A ninety eight (98) day feeding trial was initiated and carried out during December, 2011 to April 2012. Change of bedding was done fortnightly while the rams were dipped in diasuntol and given antibiotics when the need arose.

5.2.4 Experimental diets

In a completely randomized design with three replicate rams were randomly distributed to treatment diet which is ensiled as follows. The rams were allotted to seven treatments namely:

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75%*Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75%*Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Rongai)

5.3 Digestibility and nitrogen balance

Two rams were used per treatment for digestibility and nitrogen balance study. There was an adjustment period of a week to the cage environment after which collection of urine and faeces was done for 7 days. The quantity of feed offered and refusals as well as faecal output from each ram were determined. Nitrogen loss from the urine by volatilization was prevented by adding 10 ml of 10% tetraoxosulphate IV oxide (H_2SO_4) into the container for collecting the urine sample (Chen and Gomez, 1992). Daily collections of faeces and urine were separately bulked and 10 % sub- sample of each was taken. Faecal samples were oven dried at 105^0 C for 24 hours. The urine samples were stored in a deep freezer (-20^0c) until required for analysis.

5.4 Chemical Analysis

Ground samples of grass, legumes and faeces were analyzed for nitrogen by the Micro-Kjeldahl method. Dry matter, crude fibre, ether extract and ash were determined according to AOAC (1990) method. All samples were analyzed in duplicate. Acid detergent fiber, acid detergent lignin and neutral detergent fiber were determined according to Van Soest and Robertson (1985). .Hemicellulose values were calculated by the difference between Neutral detergent fibre and Acid detergent fibre, while the cellulose values were calculated by the difference between acid detergent fibre and Acid detergent lignin. After ashing, the samples in a muffle furnace at 550° C, mineral composition was determined.

5.5 Blood Collection

Blood samples were collected and at the end of the growth trial to analyze for haematology and biochemical components. Blood samples were taken before morning feeding via jugular vein puncture into two blood tubes. One containing an anticoagulant (Disodium salt of ethylene diamenetetracetic acid (EDTA)) and the other with no anticoagulant from which serum was harvested for biochemical analysis. Packed Cell Volume (PCV), Haemoglobin (Hb), red blood cell (RBC) and total white Blood Cells (WBC) were determined. Glucose, cholesterol, total protein, albumin, urea and creatine were determined.

5.6 Statistical analysis

The experimental design was completely randomized design (CRD). Data generated were subjected to the analysis of variance procedure of SAS (1999). Significant means were separated using the Duncan Multiple range test of the same package. Experimental model of the design was: $Y_{ij} = \mu + \alpha_i + \Sigma_{ij}$

Where: Y_{ij} = Individual observation μ = general mean of the population

α_i = treatment effect Σ_{ij} = composite error effect.

5.7 RESULTS

Chemical composition of ensiled *Panicum maximum*, *Panicum maximum* with *Lablab purpureus* cvs Highworth and Rongai mixtures are shown in table 11. Dry matter content ranged between 33.1% in Pm-75/H-25 to 46.4% in Pm-100. Crude protein content ranged between lowest (9.0%) in Pm-100 to highest (16.8%) in Pm-25/H-75 and followed by (16.5%) in Pm-25/R-75. NDF value ranged from lowest (44.7%) in Pm-75/H-25 to highest (56.2%) in Pm-100. There were variations also in ADF, the highest value (39.4%) was obtained for Pm-100, while the lowest value (34.5%) was in Pm-25/R-75. There were variations also in ADL, Pm-25/R-75 had the lowest (7.8%) ADL value and the highest value (9.4%) recorded for Pm-100. Ether extract also varied, it ranged from (8.2%) in Pm-100 to (10.4%) in Pm-50/H-50. The value of ash content was lowest in sole *Panicum maximum* and highest (13.0%) in Pm-50/R-50. Generally, sole *Panicum maximum* being grass was highest in NDF, ADF, and ADL but least for CP, EE, and ash contents when compared to *Panicum maximum* with *Lablab purpureus* mixtures.

Table 11: Chemical composition (g/100g DM) of ensiled *Panicum maximum* with Highworth and Rongai

Treatment	DM	CP	CF	EE	ASH	NDF	ADF	ADL	HEMI	CELL
Pm-100	46.39^{a}	9.01^{d}	33.08^{b}	8.15^{d}	10.01^{b}	56.16^{abc}	39.42^{a}	9.42^{ab}	12.59^{ab}	7.99^{ab}
Pm-75/H-25	33.10^{e}	15.01^{c}	36.15^{b}	9.05^{cd}	11.33^{ab}	44.73^{cd}	37.41^{abc}	8.61^{bc}	5.31^{b}	30.81^{a}
Pm-50/H-50	36.26^{de}	15.13^{b}	37.07^{b}	10.35^{a}	12.00^{ab}	48.58^{bc}	38.75^{ab}	8.73^{bc}	9.83^{ab}	30.02^{a}
Pm-25/H-75	41.47^{bc}	16.78^{c}	36.33^{b}	9.16^{bcd}	12.01^{ab}	54.36^{ab}	36.71^{abc}	9.15^{ab}	17.65^{a}	27.56^{ab}
Pm-75/R-25	35.62^{de}	15.15^{c}	35.51^{b}	10.11^{ab}	11.01^{ab}	52.98^{ab}	37.61^{abc}	8.25^{bc}	15.37^{a}	29.36^{a}
Pm-50/R-50	39.80^{cd}	15.16^{c}	46.05^{a}	8.80^{cd}	12.97^{a}	50.01^{ab}	37.53^{abc}	8.61^{bc}	18.63^{a}	28.92^{a}
Pm-25/R-75	43.49^{abc}	16.51^{c}	36.17^{b}	9.56^{abc}	12.00^{ab}	53.60^{ab}	34.53^{bc}	7.80^{c}	19.10^{ab}	26.75^{a}
SEM	1.36	0.45	6.32	0.33	0.81	2.20	1.35	0.37	2.83	1.61

^{a,b,c,,} Means in the same column with different superscript differ significantly(P<0.05

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75%*Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25 = 75%*Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Rongai)

The performance characteristics of West African Dwarf (WAD) rams fed a basal diet of *P. maximum* supplemented with a forage legume using two cultivars is presented in Table 12. The performance characteristics of the rams placed on the treatments differed significantly ($P< 0.05$). The DM intakes of the rams ranged from lowest (573.87g/day) in Pm-100 to highest (715.47g/day) for rams fed Pm-25/R-75. The DM intakes varied significantly between rams fed Pm-100 and other six treatments. The intakes of rams fed Pm-75/H-25 (658.15g/day) and Pm-75/R-25 (626.25g/d) were not significantly different, intakes of rams fed Pm-50/H-50 (673.11g/d) and Pm-50/R-50 (683.62g/d) were significantly similar. Also, intakes of rams fed Pm-25/H-75 (700.11g/d) and Pm-25/R-75 (715.47g/d) were significantly similar. The Daily Weight Gain (DWGg/day) differed ($P<0.05$) significantly and Body Weight Gain (kg) differed ($P<0.05$) significantly and follow similar trend as DM intakes. The Feed Conversion Ratio (FCR) of the rams fed Pm-25/H-75 (15.82) and Pm-25/R-75 (16.05) were the lowest, FCR for rams fed Pm-50/H-50 (17.77) and Pm-50/R-50 (18.11), FCR for rams fed Pm-75/H-25 (24.42) and Pm-75/R-25 (24.66) and FCR for rams fed Pm-100(24.10).

Table 12: Performance characteristics of West African dwarf rams Fed ensiled *Panicum maximum* and *Lablab purpureus* mixture.

Parameters	Pm-100	Pm-75/H-25	Pm-50/H-50	Pm-25/H-75	Pm-75/R-25	Pm-50/R-50	Pm-25/R-75	**SEM**
Initial body weight (Kg)	14.17	15.00	15.33	14.50	15.50	15.33	15.00	0.681
Final Body weight (Kg)	16.17^{b}	17.33^{ab}	18.83^{a}	18.50^{a}	17.83^{ab}	18.83^{a}	18.92^{a}	0.641
Body weight gain (Kg)	2.00^{b}	2.33^{ab}	3.50^{ab}	4.00^{a}	2.33^{ab}	3.50^{ab}	3.92^{a}	0.603
Daily weight gain (g/day)	23.81^{b}	27.78^{ab}	41.67^{ab}	47.62^{a}	27.78^{ab}	41.67^{ab}	46.63^{a}	6.634
Dry matter intake (g/day)	573.87^{c}	658.15^{ab}	673.11^{ab}	700.11^{a}	626.25^{bc}	683.62^{ab}	715.47^{a}	23.26
Feed conversion ratio	24.10^{c}	24.42^{c}	17.77^{b}	15.82^{a}	24.66^{c}	18.11^{b}	16.05^{a}	3.562

^{abc} means with similar superscripts along the same row are not significantly different ($p< 0.05$)

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75%*Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75%*Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Rongai)

The Haematological Parameters of WAD rams fed *P. maximum* with *Lablab purpureus* mixture is presented in Table 13. The haematological parameters of the rams fed *Panicum maximum* with *Lablab purpureus* cvs Highworth and Rongai differed significantly ($P < 0.05$). The Packed Cell Volume (PCV) varied significantly among the treatment means ($P<0.05$) PCV values ranged between lowest (25.0%) for rams fed Pm-100 and highest (37.0%) for rams fed diet Pm-25/H-75. PCV for rams fed Pm-25/R-75 (36.0%) was significantly similar to PCV for rams fed Pm-25/H-75(37.0%). PCV for rams fed Pm-50/H-50 (34.0%) and Pm-50/R-50 (36.5%) was significantly different, while PCV for diets fed Pm-75/H-25 (32.0%) and Pm-75/R-25 (33.0%) and were significantly different. Haemoglobin (Hb) varied significantly among the treatment means ($P< 0.05$). Hb values varied between lowest (8.3%) for rams placed on Pm-100 and highest (9.8%) on rams fed Pm-25/R-75. Red Blood Cell (RBC) varied significantly $p<0.05$ and followed the same trend as Hb. White Blood Cell (WBC) varied significantly among the treatments. WBC values ranged between 3.5-11.3 x 10^3µL. Neutrophils (N) varied significantly. N Values ranged between lowest (39.0) for rams fed Pm-75/H-25 and highest (77.0) for rams fed Pm-25/R-75. Monophils values ranged between lowest (1.00) for animals fed Pm-100 and highest (1.28) for animals fed Pm-50/R-50.

Table 13: Haematological Parameters of WAD rams fed *Panicum maximum* with *Lablab purpureus* mixture

Parameters	Pm-100	Pm-75/H-25	Pm-50/H-50	Pm-25/H-75	Pm-75/R-25	Pm-50/R-50	Pm-25/R-75	**SEM**
Packed Cell Volume (PCV,%)	25.0^{d}	32.0^{c}	34.0^{b}	37.0^{a}	33.0^{bc}	35.0^{b}	36.0^{a}	0.40
Haemoglobin (Hb %)	8.25^{f}	9.15^{e}	9.51^{c}	9.43^{c}	9.25^{d}	9.67^{b}	9.80^{a}	0.03
Red Blood Cell (RBC/10 /µl)	8.10^{g}	8.60^{f}	9.60^{c}	11.20^{b}	8.80^{e}	9.50^{d}	11.60^{a}	0.03
White Blood Cell (WBC x 10^{3}µl)	35.00^{e}	100.25^{b}	113.50^{a}	73.25^{d}	103.00^{b}	110.25^{a}	90.75^{c}	114.60
Neutrophils x 10^{3})	50.0^{d}	39.0^{f}	66.0^{c}	74.0^{b}	49.0^{e}	66.0^{c}	77.0^{a}	0.010
Lymphocytes (LYMPx10^{3}/ml3)	50.00^{c}	55.00^{a}	33.46^{g}	37.93^{e}	54.76^{b}	34.04^{f}	38.01^{d}	0.001
Monocytes (MONOx10^{3}/mm3)	1.00^{g}	1.24^{f}	1.26^{d}	1.25^{e}	1.27^{b}	1.28^{a}	1.26^{c}	0.0001
Eosinophils (EOSIx10^{3})	1.01^{f}	1.00^{g}	2.20^{c}	2.35^{a}	1.25^{e}	2.15^{d}	2.30^{b}	0.001

^{a,b,c} means with the similar superscript along the same row are not significantly different ($p<0.05$).

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75% *Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75%*Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Rongai)

The serum parameters of WAD rams fed *Panicum maximum* with *Lablab purpureus* mixture is presented in table 14. The serum parameters of the rams fed *Panicum maximum* with *Lablab purpureus* cvs Highworth and Rongai differed significantly ($P < 0.05$). The Glucose varied significantly among treatment means ($P<0.05$). The glucose values ranged between lowest (53.0) % for rams fed Pm-75/H-25, Pm-50/H-50 and Pm-50/R-50 and highest (60.0%) for rams fed Pm-100. Total Blood Protein (TBP) varied significantly among treatment means ($P<0.05$). TBP values ranged between lowest (6.00 g/dL) for rams fed Pm-100 and highest 6.43 g/dL for rams fed Pm-25/R-75. The Blood Urea (BU) varied significantly among treatment means ($P<0.05$). BU values ranged between lowest (20.00mg/dL) for rams fed Pm-75/R-25 and highest (29.00 mg/dL) for rams fed Pm-100.

Table 14: Serum parameters of West African Dwarf rams fed *Panicum maximum* with *Lablab purpureus* mixture

Treatment	Pm-100	Pm-75/H-25	Pm-50/H-50	Pm-25/H-75	Pm-75/R-25	Pm-50/R-50	Pm-25/R-75	**SEM**
GLUCOSE mg/dl	60.0^{a}	53.00^{d}	53.50^{c}	57.0^{b}	50.50^{e}	53.00^{d}	57.0^{b}	0.151
CHOLESTEROL mg/dL	80.0 ^{c}	100.0^{b}	100.0^{b}	120.0^{a}	100.0^{b}	100.0^{b}	120.0^{a}	0.000
TOTAL PROTEIN g/dL	6.00^{b}	6.10^{b}	6.20^{ab}	6.46^{a}	6.26^{ab}	6.20^{ab}	6.43^{a}	0.090
ALBUMIN g/dL	2.80^{f}	3.90^{e}	4.16^{b}	4.23^{b}	4.10^{d}	4.20^{b}	4.34^{a}	0.011
UREA mg/dL	29.00^{a}	24.00^{c}	24.00^{c}	28.00^{b}	20.00^{e}	23.00^{d}	28.00^{b}	0.001
CREATINE	0.90^{a}	0.90^{a}	0.90^{a}	0.81^{b}	0.90^{a}	0.90^{a}	0.90^{a}	0.001

^{a,b,c} means with the similar superscript along the same row are not significantly different ($p<0.05$).

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75% *Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50% *Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25% *Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75% *Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50% *Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25% *Panicum maximum* + 75% *Lablab purpureus* (Rongai)

The apparent digestibility of WAD rams fed *Panicum maximum* with *Lablab purpureus* mixture was presented in Table 15. The DM values differed (P< 0.05) significantly among the treatments. Rams placed on Pm-100 had (41.4%) value for DM digestibility. Among the rams fed the supplemented diets (Pm-75/R-25 to Pm-25/R-75), the DM digestibility ranged from (40.4%) for rams placed on Pm-75/R-25 and (41.1%) for rams placed on fed Pm-75/H-25 to (56.7%) for rams fed Pm-25/H-75 and (56.9%) fed rams fed Pm-25/R-75. The CP digestibility also differed (P<.0.05) significantly among treatments. Rams placed on Pm-100 had the least (70.0%) CP digestibility value while rams placed on Pm-25/H-75 had (78.3%) and those on Pm-25/R-75 had (78.3%), they both had the highest CP digestibility values. The NDF digestibility values differed significantly (P<0.05) among the treatments, the values ranged from lowest (73.1%) for rams placed on Pm-75/R-25 to highest (80.5%) for rams placed on Pm-100. The ADL digestibility values and the ADF digestibility values also differed fed Pm-75/H-25 significantly (P<0.05). The ADL digestibility values ranged from the least (16.4 %) for rams to highest (28.8%) for rams fed Pm-25/R-75 and (28.6%) for rams fed Pm-25/H-75. The ADF digestibility values follow the same trend as ADL digestibility. The Hemi- cellulose digestibility values differed significantly (P<0.05), the values ranged from the least (83.0%) for rams fed Pm-50/H-50 to the highest (93.1%) for rams fed Pm-25/R-75.

Table 15: Apparent digestibility (%) of West African Dwarf rams fed *P.maximum*/*L. purpureus* mixtures.

APPARENT DIGESTIBILITY	Pm-100	Pm-75/H-25	Pm-50/H-50	Pm-25/H-75	Pm-75/R-25	Pm-50/R-50	Pm-25/R-75	SEM
DDM	41.4^{b}	41.9^{c}	42.6^{c}	56.7^{a}	40.4^{c}	42.6^{c}	56.9^{a}	0.74
DCP	70.0^{c}	70.9^{c}	71.3^{c}	78.3^{a}	70.7^{c}	71.3^{c}	78.3^{a}	0.37
NDF	80.5^{a}	73.4^{b}	76.2^{c}	79.6^{a}	73.1^{b}	76.7^{ab}	79.7^{a}	1.23
ADL	24.9^{c}	16.5^{c}	16.6^{c}	28.6^{bc}	18.3^{c}	17.8^{ab}	28.8^{bc}	3.85
DEE	27.6^{c}	56.8^{b}	66.1^{a}	61.3^{ab}	57.9b	60.7^{ab}	64.0^{ab}	2.26
DASH	33.0^{bc}	43.7	44.3^{ab}	51.3^{a}	44.7^{ab}	44.1^{ab}	51.7^{a}	3.67
DCF	90.4^{ab}	84.9^{b}	82.7^{ab}	87.6^{ab}	85.4^{ab}	84.5^{b}	82.8^{b}	1.71
ADF	72.4^{a}	62.9^{b}	77.7^{a}	72.2^{a}	63.0^{b}	70.7^{a}	72.2^{a}	1.86
DHEM	91.6^{a}	85.6^{b}	83.0^{c}	91.4^{a}	85.4^{b}	88.2^{a}	93.1^{a}	2.78
DCELL	89.9^{ab}	88.4^{bc}	94.5^{a}	81.9^{d}	76.5^{e}	89.9^{ab}	84.5^{cd}	1.65

^{a,b,c} means with the similar superscript along the same row are not significantly different ($p<0.05$).

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75%*Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75%*Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Rongai)

Table 16 reveals the nitrogen utilization of WAD rams fed *P. maximum* and *L. Purpureus* mixtures. The mean values obtained differed ($p < 0.05$) significantly among the treatments. The least value of nitrogen intake and nitrogen balance was observed in rams fed Pm-100, while the least percent retention(30.7%) was observed in rams fed Pm-75/H-25, which was not statistically different from percent retention (34.9%) obtained for animals fed Pm-100.The highest nitrogen intake (14.10g/day), nitrogen balance (8.03g/day) and percent retention (56.8%) was observed in rams fed Pm-25/R-75), which was not significantly different from the values obtained for nitrogen intake (13.75g/day), nitrogen balance (7.36g/day) and percent retention (53.3%) was for rams fed Pm-25/H-75). Among the sheepfed Panicuim *maximum* supplemented with lablab, nitrogen intake ranged from 11.42g/day (Pm-75/R-25) to 14.10 g/day (Pm-25/R-75). The percent nitrogen ranged from 30.7% (Pm-75/H-25) to 56.8% (Pm-25/R-75).

Table 16: Nitrogen utilization of WAD rams fed *Panicum maximum* with two cultivars of *Lablab purpureus*

PARAMETERS	Pm-100	Pm-75/H-25	Pm-50/H-50	Pm-25/H-75	Pm-75/R-25	Pm-50/R-50	Pm-25/R-75	SEM
Nitrogen intake	6.95^{c}	12.51^{b}	11.47^{b}	13.75^{a}	11.42^{b}	11.51^{b}	14.10^{a}	0.38
Nitrogen excretion g/day								
Faecal nitrogen	2.52^{e}	6.80^{a}	5.80^{b}	4.34^{c}	4.34^{c}	4.24^{c}	3.33^{d}	0.25
Urinary nitrogen	2.00^{ab}	1.90^{ab}	1.82^{b}	2.10^{ab}	3.43^{a}	2.30^{ab}	2.74^{ab}	0.46
Total	4.52	8.70	7.62	6.44	7.77	6.54	6.07	
Nitrogen balance	2.43^{c}	3.81^{bc}	3.85^{c}	7.36^{a}	3.64^{bc}	4.97^{b}	8.03^{a}	0.52
Nitrogen retention%	34.9^{cd}	30.7^{d}	33.7^{cd}	53.3^{ab}	31.8^{d}	43.6^{bc}	56.8^{a}	3.36

^{a,b,c,d} means with the similar superscript along the same row are not significantly different ($p<0.05$).

Pm-100 = 100% *Panicum maximum*

Pm-75/H-25 = 75%*Panicum maximum* + 25% *Lablab purpureus* (Highworth)

Pm-50/H-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Highworth)

Pm-25/H-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Highworth)

Pm-75/R-25= 75%*Panicum maximum* + 25% *Lablab purpureus* (Rongai)

Pm-50/R-50 = 50%*Panicum maximum* + 50% *Lablab purpureus* (Rongai)

Pm-25/R-75 = 25%*Panicum maximum* + 75% *Lablab purpureus* (Rongai)

5.8 DISCUSSION

Some of the determinants of suitable forage species for use as a silage material include high yield per unit area, nutritional quality at ensiling and quality of the resultant silage (Kallah *et al*,1997). The treatments evaluated did manifest a defined trend for Dry Matter (DM) as fed. Apart from the Pm-100 diet, the other treatments with increasing levels of inclusion of lablab irrespective of the cultivar had increasing percent of DM.

The Crude Protein (CP) content of the prepared silage was outstanding. The CP of the *Panicum maximum* obtained in this study compared well with values reported in literature (Babayemi, 2009).The CP of the *Panicum maximum* obtained in the present study is higher than the critical value of 7.7% or 70g/kg recommended for small ruminants (NRC,1981) and very close to the minimum requirement of 10-12% recommended by ARC (1985) for ruminants. Increase in the level of lablab (25%, 50% and 75%) incorporated in the silages resulted to increase in the percent CP,CF, EE and ash in all the treatments examined. This perhaps suggests the need for inclusion of higher levels of legume to capture the optimum legume requirement for inclusion in *Panicum maximum* silages at soft dough stage of maturity. The higher CP, the lower the fibre and the lower the DM recorded in this study also reflected that they were still young at cutting for ensiling (Bamikole *et al.*,2004). On the other hand, older grasses are low in CP, but high in fibre and DM (Babayemi and Bamikole, 2006b), while the increasing trend observed in CP is in agreement with several reports (Azim *et al.*, 2000; Mustafa *et al.*,2001; Mthiogane *et al* .,2001) . However, Titterton and Maasdorp (1997) recommended 40% inclusion of legumes in grass – legume silage. In the same vein, earlier reports such as that of Miller (1970) had indicated that mixtures of cereals and legumes are particularly suitable for ensilage: The deficiency of protein in cereal crop and the absence of carbohydrate in legumes are thus overcome. In mixed *Panicum maximum* – legume silage, *Panicum maximum* provides the fermentable carbohydrate while the legumes improve the protein of the silages. The level of CP in the sole *Panicum maximum* is above the minimum requirement for ruminants (Minson, 1976).

The NDF values obtained for the grass and forage legumes are within the range of 24 – 61 reported for tropical forages (Topps, 1992). While, silages prepared with lablab and *Panicum maximum* in addition, lablab contributed more to the content of EE in the silage prepared.

This could perhaps mean that lablab is higher in some components of nutritive value relative to others. While crude protein values realized for sole silages compare with data reported by Kallah *et al.*(1997), higher values were obtained from the legume fortified silages. The high dry matter intake (DMI) of rams on the silages which could be as a result of the succulent nature of the silage coupled with the high CP content. Dry matter intake was high. This could be as a result of the succulent nature of the silage coupled with its higher CP content. The higher total dry matter intake DMI for the legume supplemented diets (Pm-75/H-25 to Pm-25/R-75) compared with the sole *Panicum maximum* diet (Pm-100) in this study could be due to the higher crude protein content and low NDF and ADF contents of the *Lablab purpureus*. However, it has been observed that DMI could be favorably influenced by dietary CP level (Karim *et al*., 2001; Karim and Santra, 2003). The DMI for the 25% lablab *cvs* Highworth and Rongai supplemented diets (Pm-75/H-25 and Pm-75/R-25) were significantly similar, were higher than DMI for Pm-100.The DMI for the 50% lablab *cvs* Highworth and Rongai supplemented diets (Pm-50/H-50 and Pm-50/R-50) were significantly similar and were higher than DMI for supplemented diets (Pm-75/H-25 and Pm-75/R-25). The DMI for the 75% lablab *cvs* Highworth and Rongai supplemented diets (Pm-25/H-75 and Pm-25/R-75) were significantly similar and were higher than DMI for supplemented diets (Pm-50/H-50 and Pm-50/R-50). The same trend follows for DWG. It is a kwown fact that the high CP content of a feed stimulates more feed intake (Oldham and Alderham, 1980). The similarity of the DMI of the legumes supplemented diets Pm-75/H-25 and Pm-75/R-25, Pm-50/H-50 and Pm-50/R-50, Pm-25/H-75 and Pm-25/R-75, could be ascribed to the comparable values of the CP contents of the legumes. Overall, DMI of sheep were within the 310 to 870 g/day values reported by ARC (1980) and McDonald *et al*. (1987) as adequate for sheep with body weight of 20 to 35 kg. However NRC (1985) reported that DMI could go up to 1000 to 1300 g/day for growing sheep. Low DMI reported for *Panicum maximum* in this study could be linked to the high NDF content of the grass. A feed high in NDF usually has low voluntary intake as it occupies a large volume in the rumen. NDF concentration is used as an index of gut fill to predict voluntary feed intake (Mupangwa *et al.* 2000). Supplementation of a basal diet of grass or crop residue with legume usually increases DMI of the animals. This conforms to earlier findings (Mtenga and Shoo, 1990; Ifut,1992).

Haematology and blood biochemistry measurements may vary depending on factors such as sex, age, weather, stress, season, pregnancy status and physical exercise (Kaneko *et.al*., 1997). Significant changes in these parameters are used to draw inference in clinical investigation. It may give some insight as to the animals' production performance potential. PCV and Hb levels indicate the nutritional status of the animal. The PCV value in Pm-100 was the lowest when compared to the mean values obtained for rams fed Pm-75/H-25, Pm-50/H-50, Pm-25/H-75, Pm-75/R-25, Pm-50/R-50 and Pm-25/R-75, the values are still within the normal physiological range for PCV for sheep (Oscar, 1971). Also, the Mean PCV values obtained in this study were within the range of 21 – 37 % reported by Daramola *et al*. (2005). The drop in PCV values obtained for rams fed Pm-100 than those placed on Pm-75/H-25 and others could perhaps be as a result of feed effect (grass only), the feed struggling to meet the normal body requirement of the animals, it seems these animals on Pm-100 were tending towards being anaemic at the 13th week when the blood examination was carried out. This finding suggested that WAD sheep have the tendency for compensatory accelerated production (CAP) of PCV in case of infection and stress. Compensatory accelerated production has been shown to return PCV to normal level following infection (Dargie and Allonby, 1975). Comparative studies showed that PCV varies proportionatately with total protein; this suggested that PCV is beneficial in assessing the protein status and possibly forecasting the degree of protein supplementation in sheep at different physiological states. Haemoglobin (Hb) concentration in this study fell within the range of high values obtained for Red Sokoto goats (Tambuwal *et al,* 2002). West African Dwarf sheep seem to possess relatively high Hb values, and this is an advantage in terms of the oxygen carrying capacity of the blood. The total WBC count was higher in this study than values obtained for Red Sokoto goats (Tambuwal *et al*., 2002). The value of WBC obtained for all rams depict absence of infection since elevation of WBC suggest infection by microorganism especially bacteria (Meyer and Harvey, 1998). However, the values obtained in this study fell within the broad range recorded for Red Sokoto goats (Tambuwal *et al.*, 2002) and suggestive of well developed immune system of the WAD sheep to proffer good health. This higher RBC values that were observed in the intensively managed sheep in the present study may be due to higher plane of diet and veterinary care given to them. Rekwot *et al.* (1987) observed that White Fulani that were fed with high protein diet (14.45% crude protein) had higher erythrocyte values than those on low protein diet (8.51%). The values of the Hb, RBC and WBC obtained for rams for all treatments fell within the

normal physiological range (PCV: 19 -38.0%, Hb: 8.0 -14g/dL, RBC: 8.0 x10^6 µL) quoted by Oscar, (1971). Wide variation in leucocytes number is a reflection of the leucocytes' response to infection. Lazzaro (2001) noted that depressed level of lymphocytes might indicate either an exhausted immune system or elevated neutrophil level in an active infection in sheep, like other ruminants there are more lymphocytes than neutrophils in circulation (Olusanya *et al*., 1976). Osueni (2001) and Lazzaro (2001) observed an increase in neutrophils and this is associated with a decrease in lymphocyte and vice versa. Neutrophils and lymphocyte have been noted to fight pathogens once they have passed the barrier of the shin into the cell (Politis *et al.,* 2002). Therefore, increase number will increase immunity, thus suggestive of a well developed immune system in the WAD sheep with such number of immune cells to offer good health.

According to Otesile *et al*. (1991), Serum biochemistry is a generalized medium of assessing the health status of animals. Differences in serum biochemical parameters may be caused by nutrition, environment and hormonal changes (Chineke *et.al*., 2002). Concentration of blood components of sheep were used to monitor nutrient status (e.g. serum glucose) and blood urea nitrogen (BUN) and associated muscle mass (e.g. creatinine). Glucose is one of the metabolites measured as an indicator of the energy status of the animal. Normal glucose levels in the ram indicate adequate synthesis in the liver from propionate metabolism as the major glucose precursor (Houtert, 1993). Fisher *et al*. (1974) reported that the concentrations of blood glucose and protein albumin are respectively the preferred indicators of adequacy of diets in terms of energy and protein. Based on the different dietary regimes it could be concluded that the efficiency of utilization of available dietary protein and energy were responsible for the variations in the concentration of blood glucose of the ram.

The Glucose content obtained for rams fed Pm-100 was the highest when compared to the mean values obtained for rams on Pm-75/H-25, Pm-50/H-50, Pm-25/H-75, Pm-75/R-25, Pm-50/R-50, and Pm-25/R-75, the values were within the normal range for Glucose. Total Protein reflected the quality of protein in the feed; the values obtained for rams fell within the normal range. The Blood Urea was within the normal range, values obtained for Blood Urea indicated better Nitrogen utilization. The values obtained for Glucose, Total Protein and Blood Urea were within the normal range (Glucose: 43 -100 mg/dL, Total Protein: 5.9 - 7.8 g/dL, Blood

Urea: 13 - 44 mg/dL, Albumin: 2.70-4.55g/dL) quoted by Mitruka and Raswnley (1977) for rams fed ensiled *Panicum maximum* and *Lablab purpureus* mixtures.

Apparent nutrient digestibility (DCP, DADL, DEE, DASH) of rams fed the *Lablab purpureus* supplemented diets were significantly ($P<0.05$) higher than those on sole *Panicum maximum* diet, probably because they consumed higher levels of crude protein occasioned by the higher concentration of crude protein in the legumes. The nitrogen retained or balance and retention values were the best in rams placed on Pm-25/H-75 and Pm-25/R-75. However, the highest values obtained from these two treatments are in agreement with the assertion that nitrogen retention increased with protein supplementation. (Mupangwa *et al.*,2000).

CHAPTER SIX

6.0 SUMMARY, CONCLUSION AND RECOMMENDATION

6.1 SUMMARY

The nutritional assessment of *Panicum maximum* intercropped with *Lablab purpureus cvs Highworth and Rongai* was carried out *In vitro* techniques.

The first experiment focussed on the planting of *P. maximum* intercropped with Lablab purpureus using two cultivars, such that there were five treatments with five replicates (11m x 6m). Six weeks regrowth was harvested. The five treatments comprised of *P. maximum* with *L. purpureus cvs Rongai and Highworth* mixtures and the P. *maximum* only. The experimental design was completely randomized block design. After harvesting, forages were taken to the laboratory for chemical analysis which revealed in study that the CP of *P. maximum* in *P.maximum* + Highworth and *P.maximum* + Rongai was influenced positively. In study 2, the chemical and mineral composition of the sole L. *purpureus* had the highest DM, CP, than the sole P. *maximum* and grass with legume mixture. The sole *P.maximum* had the highest CF, EE, NDF, ADL and ADF. The CP of grass with legume mixtures was higher than the sole grass. The concentration of CP and CF were in order of L. *purpureus* > P. *maximum* with L. *purpureus* >*P. maximum.*There were observed variations in the P, Ca, Na, and Fe contents of the sole *P. maximum*, *P. maximum* in *L. purpureus* intercrop. Sole L. purpureus had the highest P and Fe. The *P. maximum* in *L. purpureus* intercrop had the highest Ca and Na. Sole *P.* maximum had the least P, Ca, Na and Fe.

The second experiment focussed on silage preparation and effect of legumes on quality of ensiled *P. maximum.* Silages made from sole *P. maximum* had the least CP content while sole lablab of the two varieties had the highest CP content and CP of *P. maximum* with lab-lab mixtures fell in between the least and the highest. The mineral composition of the ensiled grass with legume revealed that highest P was in *Panicum maximum* with 75% Highworth while the least P was in sole *Panicum maximum.* The sole lablab cv Rongai had the highest Ca. The sole *lablab* cv Highworth had the highest Na while the least Na was in sole *Panicum maximum. Panicum maximum* with 75% Highworth had the highest Fe while the least Fe was in sole *Panicum maximum.* They all possess good silage properties in terms of colour, odour,

texture, temperature and $P^{H.}$ The third experiment focused on the *In vitro* gas production of ensiled *Panicum maximum* with *Lablab purpureus* mixtures. The *In vitro* studies for the ensiled mixtures at 48 hrs revealed that the high net gas production in (fig.4) for all treatment may be due to the high fibre content of the mixtures. A downward trend is observed in the amount of gas produced with decreasing amount *P. maximum* except for this treatment (Pm-75/H-25).

The ME and OMD of these two treatments, Pm-75/H-25 and Pm-25/H-75 which are mixtures of *P. maximum* and lablab were better than for sole *P. maximum.* The lower ME and OMD observed in sole *Panicum maximum* was as a result of high NDF obtained in sole grass. Short Chain Fatty Acid SCFA or Volatile Fatty Acid (VFA) is one of the end products of rumen fermentation. High volume of gas was produced when substrate is fermented to acetate and butrate. Relatively lower gas production is associated with propionic production. *In vitro* gas production had low correlation with volatile fatty acid production particularly that of propionate (Nsamsaeng *et al.,* 2006). *Panicum maximum* with *Lablab purpureus* mixtures had higher SCFA and moderate gas production which was significantly similar to SCFA and OMD of sole *Panicum maximum,* sole lablab (Highworth) and sole lablab (Rongai). This implies that more energy would be more available to animals when grass is supplemented with legumes in the diet of ruminants.

The fourth experiment assessment of the performance characteristics of West African Dwarf sheep fed *P. maximum* with *Lablab purpureus* mixtures was carried out in experiment four. The feed intake was highest in sheep fed Pm-25/H-75 and Pm-25/R-75, while the least intake was in sheep fed Pm-100. The weight gain in sheep fed Pm-25/H-75 and Pm-25/R-75 was higher than sheep fed sole *P. maximum* (Pm-100). The weight gain in sheep fed Pm-25/R-75 and Pm-25/H-75 was higher than sheep fed *Panicum maximum* only.

Sheep on Pm-25/H-75 and Pm-25/R-75 had the highest apparent digestibility of DM and CP while sheep placed on Pm-100 had the least DDM and DCP. The nitrogen retention values were highest in sheep fed Pm-25/H-75 and Pm-25/R-75, these were diets supplemented with 75% lablab of either Highworth or Rongai.

The nitrogen balance and retention values were highest in sheep fed Pm-25/R-75 and Pm-25/H-75. The least nitrogen balance and retention were observed in sheep fed *Panicum maximum* only and *Panicum maximum* with 25% Highworth. The PCV, Hb, RBC and WBC values were highest in sheep fed Pm-25/H-75 and Pm-25/R-75 while sheep fed Pm-100 had the least PCV, Hb, RBC and WBC value. The glucose, cholesterol and total protein values were highest in sheep fed Pm-25/H-75 and Pm-25/R-75 while sheep fed Pm-100 had the least glucose, cholesterol and total protein values.

6.2 CONCLUSION

From the summary, it is concluded that intercropping of *P. maximum* with *Lablab purpureus* will improve the quality or crude protein of the grass. Intercropping grasses with forage legumes improves the quality of the fodder. The quality of the intercropped fodder is enhanced especially by the legume component which has the potential to alleviate nutrient deficiencies in poor quality grass, for example, (lablab has more protein than grasses) with a consequent increase in livestock dry matter intake, weight gain, and productivity.

Silages are made to preserve excess forages at the time of abundance later to be used at the dry season. Ensiling *P. maximum* with *Lablab purpureus* mixtures enhances the crude protein of grass/ legume mixtures. Ensiled *Panicum maximum* with *Lablab purpureus* mixtures had good silage properties and improved nutritive value. The quality of the ensiled grass/legume mixture (especially the crude protein content) has the potential to alleviate nutrient deficiencies in poor quality grass, which when fed proffers solution to forage scarcity during the dry period and considerably enhanced Livestock production.

The higher the gas production, the higher the ME and OMD produced. The inclusion of *P.maximum* is important and apart from being abundant, its downward trend of inclusion as *P.maximum*/*Lablab purpureus* mixtures consistently reduced the production of methane. The least methane production was observed from dietary treatments Pm-50/H-50, Pm-25/H-75, Pm-75/R-25, Pm-50/R-50, and Pm-25/R-75. These were 50% *P. maximum*/ 50% lablab (Highworth and Rongai) and 25% *P. maximum*/ 75% lablab (Highworth and Rongai). The low methane production for grass with legume mixtures is in order and essential in promoting ruminant production. Methane production represents a significant energy loss to ruminants.

The observed low DM intake in sheep fed *P. maximum* diet alone could be linked to the high fibre fractions recorded. A feed high in NDFand low in CP usually has low voluntary intake as it occupies a large volume in the rumen. Supplementation of grass diet with any of the two varieties of legume (lablab) usually increases DM intake. Sheep fed the grass /legume diets had higher nutrients digestibility which was as a result of their higher CP content. Increase growth rate could be achieved as a result of higher DMI, WG and DMD from sheep fed ensiled *Panicum maximum* with 75% *Lablab purpureus* mixtures. Better dry matter intake,

nutrient digestibility, nitrogen utilization and growth rates of rams could be achieved when *Panicum maximum* basal diets are supplemented with either of the two cultivars Highworth or Rongai silages at 25:75 of *Lablab purpureus* used. Blood parameters showed the metabolic state of animal and quality of feed. The sheep fed Pm-25/H-75 and Pm-25/R-75 had the highest PCV, Hb, RBC and WBC values while sheep fed Pm-100 had the least PCV, Hb, RBC and WBC value, this interpretes the quality of Pm-25/H-75 and Pm-25/R-75 as the best options. The glucose, cholesterol and total protein values were highest in sheep fed Pm-25/H-75 and Pm-25/R-75 while sheep fed Pm-100 had the least glucose, cholesterol and total protein values. The study established the potential of ensiled *Panicum maximum* with *Lablab purpureus* as feed for sheep.

6.3 RECOMMENDATION

The following recommendations are hereby stipulated:

1. *Panicum maximum* (*Panicum maximum* cvNtchisi) which is widely cheriched by ruminants can best be improved by interplanting it with common herbaceous legumes.
2. Interplantig *Lablab purpureus* with *Panicum maximum* (improved pastures) enhances nitrogen content and other chemical constituent in the grass which is essential to promote ruminant production.
3. Short cutting interval of six weeks is important in sustaining the nutrients in grass which makes it relevant to sheep due to low lignification.
4. Ensiling *Panicum maximum* with *Lablab purpureus* produces silages with good properties and of better nutritive value.
5. The phosphorus, calcium, sodium and iron contents were increased when *Panicum maximum* was ensiled with *Lablab purpureus.*
6. *In vitro* evaluation of *Panicum maximum* ensiled with *Lablab purpureus* mixtures shows the importance of feeding legume in combination with grass to ruminant. Also, the downward trend of inclusion as *P.*maximum/lablab purpureus mixtures consistently reduced the production of methane and thereby encouraged as feed. Feeding of sole legume and sole grass to ruminant should be discouraged due to higher methane production which is energy loss.
7. The DMI, WG and DMD of sheep fed ensiled *Panicum maximum* with *Lablab purpureus* mixtures is influenced positively. Legume enhances rumen fermentation which optimizes microbial growth for increased digestibility of feed for livestock. *Panicum maximum* with 75% Highworth or Rongai enhanced feed intake, weight gain and digestibility.
8. Ensiling *Panicum maximum* with *Lablab purpureus* could be included in sheep production and it proffers solution to pasture scarcity during dry season.

REFERENCES

Abule, E., N.N Umunna, Nsahlai I.V,Osuji P.O and Alemu, Y (1995).The effect of supplementing teff (*Eragrostis tef*) straw with graded levels of cowpea (*Vigna unguiculata*) and lablab (*Lablab purpureus*) hays on degradation, rumen particulate passage and intake by cross bred (FriensianxBoran(Zebu)). *Livestock Production Sciences*,44,221-228

Adegbola, T. A. (1985). Browse Plants: Propagation, management and utilization in small ruminant production in Nigeria. In: Adu I.F, Taiwo B.B, Osinowo O.A and Alhassan W.S (eds). Proceedings of the National Conference on Small Ruminant Production, Zaria, Nigeria, October 6-10. pp. 85-99

Adeleye, I. O. A and Fanoiki, O.A (1997). Macro mineral utilization by sheep fed *Panicum maximum* and *Spirodela polyrhiza*. M.SC.Thesis. Department of Animal Science, University of Ibadan.pp46-48.

Adeloye, A.A. (2001). Nigeria small ruminants species. Corporate Office Max.Ilorin, Nigeria. Pp 3-15

Ademosun, A. A. (1973). Nutritive evaluation of Nigerian forages 4: The effect of stage of maturity on the nutritive value of *Panicum maximum. Nigerian Agricultural Journal*, 10(2): 170-177.

Ademosun, A. A. (1985). Goat spp. The emblem of anarchy. The king pin of man's pastoral life. Ife Lecture Series No. 3

Ademosun, A. A. (1977). The effect of stage of maturity of the nutritive value of *Panicum maximum* (*Panicum maximum*) *Nigerian Agricultural Journal*, 10(2): 170-177.

Adeneye, J. A. and Sunmonu E.M (1994). Growth of male WAD sheep fed cassava waste or dried Sorghum Brewer's grain as supplements to tropical grass/legume forage. Small. Rum. Res. 13: 242 – 249

Adeoye S. A., Ojo V.O.A., Olanite J.A., Amole P.A, Bolaji., O.J, Ike K. A., Ogundele, S. O and Ogunlolu, B. T. (2011). Effects of grass spacing and time sowing legume on dry matter yield and legume seed production of Brachiaria decumbens, Tephrosia bracteolate pasture. Fast- tracking animal agriculture in a challenged economy. In: Babayemi O.J, Abu O.A and Ewuola E.O (eds). Proceedings of *36th Conference of Nigeria Society for Animal Production. 13th -16th March, 2011, University of Abuja, Nigeria.* Pg. 492- 495.

Adeyinka, I.A., Amodu J.T., Kallah M.S., Lakpini C.A.M and Alawa J.P (2008).The Nutritive Value of Silages made from mixtures of Pearl millet (*Pennisetum americanum*) and lablab (*Lablab purpureus*) as feed for Yankasa rams. *Asian Journal of Animal and Veterinary Advances*, 3:78-84.

Adjei, M. B. and Gentry,T.G (1996). Forage characteristics of lablab beans in semi-arid tropics. Agron Abstr, Annual Meeting 1996, pp: 42.

Aganga, A. A. and Autlwetse,M.N (2000). Utilization of sorghum forage, millet forage, veldt grass and buffel grass by Tswana sheep and goats when fed *Lablab purpureus* L. as protein supplement. *Asian-Australian Journal of Animal Science*, 13: 1127-1132.

Aganga, A. A. and Tshwenyane, S.O (2003): *Lucerne, lablab* and *Leucaena leucocephala.* Forages: production and Utilization for livestock produce in *Pakistan Journal of Nutrition* 2(2): 46-53, 2003.

Aghisi, E. C. (1985). Forage resources of Nigeria rangeland. In Adu, I.F., Taiwo, B. B., Osinowo, O. A. and Alhassan, W. S. (eds.) Small Ruminant Production in Nigeria. Proceedings National Conference on Ruminant Production, Zaria, Nigeria, October 6-10. Pp 115-140.

Agishi, E. C. (1985). Forage legumes and pasture development in Nigeria. In saka Murn and Ryan J. G, (Eds) ACIAR proceeding series of No. 4 ACIAR Canberra pp 79-87.

Agishi, E.C. (1991). A Bibliography on *Lablab purpureus.* Plant science division working documention A6. International livestock centre for Africa (ILCA). Addis Ababa, Ethiopia.

Ahmad, Z. A, Ghafoor, A and Ali, A (2000). Evaluation of three exotic legume species for fodder potential. *Pakistan Journal Biological Science*, 3:2079-2081.

Ahmadi, A. H. A.,Chaichi M.R and Mirabzade M, (2009). Effects of nitrogen fertilizing system and harvest frequencies on forage dry matter yield and quality of snail medic (*Medicago scutellata* var. Robinson). *Asian Journal of Plant Science*, 8: 160-165.

Aina, A.B.J and Onwukwe, S.C (2002). Estimation of nutrient contents of some selected grasses as affected by age of cuttings. Proceedings of the 7th Annual Conference of Animal Science Association of Nigeria (ASAN), September 16-19, 2002, University of Agriculture, Abeokuta, Nigeria, pp: 212-214.

Ajayi D.A., Adeneye, J.A and Ajayi,F.T (2005). Intake, Nutrient Utilization of West African Dwarf goats fed mango (Magnifera indica), ficus (Ficus thionningii), gliricidia (Gliricidia sepium) foliages and concentrates to basal diet of *Panicum maximum*. *World Journal of Agricultural Sciences*, 1; 184-189.

Ajayi F.T. (2007). Nutritional Evaluation of *Panicum maximum* cv Ntchisi Intercropped With some legumes for West Africa Dwarf Goats. Ph.D. Thesis, University of Ibadan Nigeria.Pp 30

Akinola, J. O. (1974). Grassland research in Nigeria: A survey with recommendations. *Nigerian Journal of Animal Production*, 1:162 – 167.

Akinwande.V.O., Mako A. A. and Babayemi O.J. (2011). Silage quality, Voluntary Feed Intake(VFI),Nutrient Digestibility and Nitrogen Balance in WAD Sheep fed ensiled Water Hyacinth (WH) In Fast- tracking animal agriculture in a challenged economy. In: Babayemi O.J, Abu O.A and Ewuola E.O (eds) Proceeding of 36th conference of Nigeria society for Animal. Production, held between 13-16th March 2011.University of Abuja.

Alabi D. A. and Alausa A. A. (2006). Evaluation of mineral Nutrients and organic food contents of the seeds of lablab purpureus and Leucena leucocephala and mucuna utilis for domestic consumption and industrial utility.*World Journal of Agricultural Sciences* 2 (1):115-118, 2006 @ IDOSI Publication ISSN1817-3047.

Alasa, M. C and Babayemi O.J (2010). Chemical compostion and *in vitro* gas production of *Panicum maximum* intercropped with two cultivars of *Lablab purpureus*. Fast-tracking animal agriculture in a challenged economy. In: Babayemi O.J, Abu O.A and Ewuola E.O (eds). Proceedings of Nigerian society for Animal Production. 35th Anuual conference held at University of I badan. 14th-17th March,2010 pp 587-560.

Alberto, G., Portella J.S and Oliveira de O.L.P. (1993). Effects of addition of ground sorghum grain and of wilting on elephant grass. Grassland Forage Absts. 65(2)

Alokan, J.A (1988). Pasture Establishment in An Introduction to Pasture, fodder crop production and conservation pp23-44.Topfun publications,Akure

Aminah A., Abubakar C and Izham A. Silages from tropical forages: nutritional quality and milk production…. IN FAO CORPORATE DOCUMENT REPOSITORY… www.fao.org.

Amodu, J. T and Abubakar S.A (2004). Forage conservation practices. Proceedings of Training Veterinary managementin Nigeria held at the National Animal Production Research Institute, October 10-14. Abuja.

Amole, T.A., Ojo, V.O.A., Dele, P.A., Adeoye, S.A., Onifade O.S., Jolasho, A.O., Olanite, J.A and Oyewole, S. T. (2011). Nutrient Digestibility of Calves Fed Maize - Lablab Silage Supplement 2011, Proceeding 36th Conference, Nigeria Society for Animal Production. 13-16 March. Pp 485-487.

Amole,T.A., Oduguwa, B.O., Jolaosho A.O., Onifade O.S., Arigbede O.M., Olanite J. A., Ojo V.O.A., Dele P.A., Aderinboye R.Y., Idowu O.J and Akinyemi B (2013). Effect of sole maize and maize- lablab silage on the ruminal volatile fatty acids (VFAS) grazing calves in the dry season in Nigerian Journal of Animal Production, pp 133-143

Andrade, I.F., Atkinson, L.G., Sollenberger, L.E., Ruegsegger, G.J. Misley, P and Kalmbacher, R.S. (1998).Stockpiling herbaceous tropical legumes for dry season feed in Jamaica.Tropical Grasslands 32,166-172.

Anugwa, F.O.I., Okwori, A.I. and Ekwuno, P.O.(2000). Feed intake, nutrient digestibility and nutrient value for goats fed *Panicum maximum* and selected browse in the southern guinea savannah zone of Nigeria. In: Ikachukwu (ed). Animal production in the new millennium : challenges and options. Proceedings 25th Annual conference of Nigerian society for Animal production at Michael Okpara University of Agriculture,Umudike, Abia, Nigeria.pp 63-66.

Anugwa, F.O. (I990). Feed intake, nutrient digestibility and nitrogen balance by sheep fed leaves of *Panicum maximium, Calopogonium mucunoids* and *Ficus elasticoides Bull.Anim.Health prod.Afri* 38:113-118.

AOAC, (1990). Official Methods of Analysis, 15th edn. Washington, DC, USA: Association of Official Analytical Chemists, pp. 69-88

ARC, (1965). "The Nutrient Requirements of farm Livestock. 2. Ruminants". Agric. Res. Council Her Majesty's Stationery office, London

ARC, (1984). The Nutrient Requirement of Ruminant Livestock Suppl. No. 1 Commonwealth Agriculture Bureaux. Farnham Royal, UK.

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

ARC, (1980). The Nutrient Requirements of Ruminant Livestock. CAB International, Wallingford, Oxon.

ARC. (1985). Agricultural Research Council. The nutrient requirements of farm animals. No. 2, Ruminants: Tech. Rev. and Summanes. ARC, London.

Aribido, S.O.(1990).Intake and digestibility of raintree pods (*Samanea saman Jacqmerrill)* by white Fulani calves M.SC. Project (unpublished) thesis, departmnt of Animal Science, University of Ibadan, Ibadan.

Arigbede O. M., Bamikole M. A., Olanite, J. A., Jolaoso, A. O and Olanite, O. S. (2002). Seasonal degradability of dry matter, organic matter and crude protein in some multipurpose tree species by West African dwarf goats. Proceedings 27th Annual

Conference of Nigerian Society for Animal production at FUTA, Akure, Nigeria, March17-21, 2002. pp 191-194.

Arigbede, O. M., Olanite, J. A. and Bamikole, M. A. (2005). Intake, performance and digestibility of West African Dwarf goats supplemented with graded levels of *Grewia pubescens* and *Panicum maximum*. *Nigerian Journal of Animal Production*, 32: 293 – 300.

ASARECA - Information from the project on "Crop-livestock integration for sustainable management of natural resources and building livelihoods resilience in Eastern and Central Africa".

Atteh, J.O. (2002). Principals and practice of livestock feed manufacturing, pp33-201 Adlek printers Ilorin, Nigeria.

Aye, P. A. (2009). Performance of West African Dwarf (WAD) sheep Fed leucaena- Based multi nutrient Blocks.In: Akinlade J.A, Olayemi T.B, Rafiu. T.A, A.O Akinwunmi A.O, Aderinola O.A, Ojebiyi O.O and Odunsi, A.A (eds) in *Proceedings of 14th Annual Conference of Animal Science Association of Nigeria (ASAN) September 14th – 17th 2009. LAUTECH Ogbomoso, Nigeria.622-627*

Ayisi, K. K., Bopane, M. P and Pengelly, B. C. (2004). Assessment of the variation in growth and yield of diverse (*Lablab purpureus*) germplasm in Limpopo Province, South Africa. In: Whitbread, A. M. pengelly, B. C. (eds). *Tropical legumes for Sustainable Farming systems in Southern Africa and Australia.* ACIAR proceedings No 115.pp.44-50

Ayisi, K. K., Putnam D. H., Vance, C. P., Russell M. P and Allan, D. L (1997). Strip Intercropping and Nitrogen effects on seed, oil and protein yields of canola and soyabean. *gronomy Journal* 89, 23-29.

Azim, A., Khan A.G., Nadeem M.A and Muhammad D (2000). Influence of maize and cowpea intercropping on fodder production and characteristics of silage.*Asian-Australian Journal of Animal Science* 4 (3):781-784.

Babatunde, G. M., Fajimi A. O. and Oyejide A. O. (1992). Rubber seed oil versus palm oil in broiler chiken diets. Effects on performance, nutrient digestibility, haematology and carcass characteristics. Anim. Feed Sci. Technol., pp35:133-146.

Babayemi, O. J and Bamikole, M. A. (2006). Effects of Tephrosia candida DC Leaf and its mixtures *Panicum maximum* on the *in vitro* fermentation changes as feed for ruminants in Nigeria. *Pakistan journal of Nutrition* 5 (1) 14-18.

Babayemi, O.J., Ajayi, F.T., Taiwo, A.A., Bamikole, M.A. and Fajimi, A. K. (2006). Performance of West African dwarf goats fed *Panicum maximum* and concentrates diets supplemented with *Lablab purpureus, Leucaena leucocephala* and *Gliricidia sepium* foliage.*Nigerian Journal of Animal production*, 33; 102-111.

Babayemi, O.J (2007). *In vitro* fermentation characteristics and acceptability by West African dwarf goat of some dry season forages. *African Journal of Biotechnology*.Vol.6 (10) pp 1260-1265.

Babayemi, O.J. (2009). Silage quality, dry matter intake and digestibility by West African dwarf sheep of *Panicum maximum* (*Panicum maximum* cv Ntchisi) harvested at 4 and 12 week regrowths. *African Journal of Biotechnology*. Vol.8 (16) pp3983- 3988.

Babayemi O. J., Daniel I. O., Bamikole M.A., Ogungbesan A. and Oduguwa B. O. (2003a). Prelimainary studies on Tephrosia species: Effect of seed treatments on germination. *Nigeria Journal Animalof Production*. 30: 209-216.

Babayemi O. J and Bamikole M. A.(2006a). Nutritive value of *TephrosiaCandida*seed in West Africa dwarf Goat. J. Central Eur. Agric 7(4): 731-738

Babayemi O. J and Bamikole M.A. (2006b). Supplementary value of *Tephrosia bracteolate, Tephrosia candida, Leucocephala* and *Gliricidia sepium* hay for West African dwarf goat kept on a range. J. Central Eur. Agric 7(2) 323-328.

Babayemi O. J. and Igbekoyi, A. J (2008). Intake, growth and digestibility of ensiled *Albzia saman*pods with *Panicum maximum* (*Panicum Maximum* cvNtsichi) by West African dwarf rams. M.sc dissertation, University of Ibadan, Nigeria.

Babayemi, O.J., Ekokotu O.A and Iyang U.A (2009). Evaluation of ensiled cassava peels together with *Albizia saman* pods.In: Animal Agriculture and the global food challenges.Proceedings of the 34th Annual Conference of the Nigerian Society for Animal Production held at University of Uyo, Akwa Ibom State, Nigeria:544-546

Bamikole, M.A. and Ezenwa, I.(1999).Performance of rabbits on *Panicum maximum* and verano-stylo hays in the dry season and the effect on concentrate supplementation. Animal feed Science and Technology, 69; 67-74.

Bamikole, M. A. (1999).Performance of goats fed *Panicum maximum* and Stylosanthes hamata mixture and Panicum sward with or without N-fertilizer.Ph.D Thesis, University of Ibadan, Nigeria.

Bamikole. M.A., and Babayemi O. J. (2004) Feeding goats with *Panicum maximum-Veranostylo* and Nitrogen Fertilized grass with energy concentrate. (2004).Archivos de zootecnia vol. 53(201):13-23

Bamikole, M.A., Akinsoyinu,A.O., Ezenwa, I., Babayemi, O.J., Akinlade, J. and Adewumi, M.K.(2004). Effect of six – weekly harvests on the yield, chemical composition and dry matter degradability *Panicum maximum* and *Stylosanthes hamate* in Nigeria. Grass and Forage Science, 59: 357- 363.

Bamikole, M.A., Babayemi, O.J., Arigbede, O.M., Ikhatua, U.J. (2003a). Nutritive value of Ficus religiosa in West African dwarf goats. *Journal of Animal feed Science and Technology*, 105:71-79

Bamikole, M.A., Ezenwa, I.A., Akinsoyinu, A.O., Arigbede, M.O. and Babayemi, O.J.(2001). Performance of West African dwarf goats fed Guniea grass-veranostylo mixture, NS fertilized and unfertilized *Panicum maximum*. *Small Ruminant Research*, 39: 145-152.

Bamikole, M.A., Ikhatua, U. J., Anota, B. and Omaduvie, F (2003b). Feed intake, feed utilization and weight gain of West Africandwarf goats fed varying proportions of ficusreligosia and *Panicum maximum*. Proceedings 28th Annual conference of Nigeria Society forAnimal production, held at I.A.R.T, Obafemi Awolowo University, Moor Plantation, Ibadan, 16th - 20th March 2003.Pp 274 -278.

Bamikole, M.A., Ikhatua, U. J., Anota, B. and Omaduvie, F. (2003b). Feed intake, feed utilization and weight gain of West Africandwarf goats fed varying proportions of *Ficus religosia* and *Panicum maximum*. Proceedings 28th Annual conference of Nigeria Society for Animal production, at I.A.R.T, Obafemi Awolowo University, Moor Plantation, Ibadan, March 16 – 20 2003. Pp 274 -278.

Bamikole, M.A., Ikhatua, U. J., Arigbede, O. M., Babayemi, O. J and Etela, I (2004). An evaluation of the acceptability as forage of some nutritive and antinutritive components andof the dry matter degradation profiles of five species of *Ficus*. *Tropical Animal Health and Production*, 36:157-167.

Bareeba, F.B. (1992).Forage conservation and utilization.Nomadic Peoples 31:91-96.

Barro, C and Riberio, A (1983).The Study of *Clitoria ternatea* L.Hay as a Forage Alternative in Tropical Countries. Evolution of the chemical composition at four different growth stages. *Journal of the Science of food Agriculture*.34:780-782

Beever, D.E., (1982). Protein utilization from pasture. In: Griffiths, T.W., Maguire, M.F. (Eds.), Forage Protein Conservation and Utilisation. Commission of the European Communities, Dublin, Ireland, p. 99. Silanikove, N., 2000. The physiological basis of adaptation in goats to harsh environments. *Small Ruminant Research* 35, 181–194.

Beuvink, T and Spoelstral S.O (1992) Interactions between substrate, fermentation and products buffering systems and gas production upon fermentation of different carbohydrates by mixed rumen micro organisms in vitro. Appl. Microbial Biotechnology.

Bhaghat, R.K, Prassad N.K and Singh A.P (1992) Nitrogen levels and spacing of hybrid Napier intercropped with legumes. J. Res. Birsa Agric. Uni. 4 : 67-69.

Blummel, M and Orskov. E. R. (1993). Comparison of gas production and nylon bag degradability of roughages in predicting feed intake in cattle. *Animal Feed Science and Technology*. 40, 109-119.

Blummel, M and Becker K (1997). The degradability characteristics of fifty four roughages and roughage neutral detergent fibre as described by *in vitro* gas production and their relationship to voluntary feed in take. *British Journal of Nutrition* 77-757-76

Blummel, M., Makkar, H. P. S., and Becker, K (1997).*In vitro gas production*: a technique revisited. J. Anim. Physiol. Anim. Nutr. 77, 24-34.

Bogdan, A. V. (1977).*Tropical Pasture and Fodder Plants (Grasses and Legumes). Pp. 181-191*. (Longman: London and New York).

Bolsen K. K, (1995) Silage additives. In: Biotechnology in Animal Feeds and Animal Feeding. Wallace. R. J. and Chesson A., Eds. VCH, New York. Pages 33-54

Bolsen, K.K, Ashbell G and Wilkinson J. M. (1995). Silage additives. In A. Chesson and Wallance R. J (eds). Biotechnology in Animal Feeds and Animal. VCH press, Weinhein, Germany Pp 33-54

Breves, G., Hoeller, H and Lessmann, H. W (1985).*Proc.Nutr.Soc*.44, 145A

Butterworth M. H. and Mosi A. K. (1985).The voluntary intake and digestibility of combinations of cereal crop residues and legume hay for sheep. *Animal Feed Science and Technology* 12, 241-251

Cameron, D.G (1988). Tropical and Subtropical Pasture legumes. Lablab beans (*Lablab purpureus*) the major leguminous forage crop. *Queensland and Agricultural Journal* 114, 110-113.

Carew, B. A. R. (1982). Free choice response of extensively managed goats in a tropical environment Humid zone programme Document number 8, ILCA, Ibadan, Nigeria.

Catchpoole. V. R. and Henzell, E. F. (1971). Silage making from tropical herbage species. Herb. Abstr., 41(3): 213-221

Cerillo M. A. and Juarez R. A. S. (2004): *In vitro* gas production parameters in cacti and tree species commonly consumed by grazing goats in a semiarid region of North Mexico. *Livestock Research for Rural Development.* Vol.16, Art, #4 Retrieved March 19, 2004, *http:/www.cipav.org.co/lrrd/lrrd16/4/cerr16021.htm*

Chauhan, T.R. (1985): Comparative nutritive value of winter-maize stover. (WM9) as hay and silage made with or without enrichment. *India Journal of Animal Nutrition* 2:75-78.

Chen, C. P., Gomez, M.J and Hutton, E. M. (1992). *Panicum maximum (*Jacq) In: 'tMannetje, L. and Jones, R. M. (eds) *Plants Resources of South-East Asia No. 4.Forages. Pp. 172-174.* (Pudoc Scientific Publishers, Wageinngen, the Netherlands).

Chen, X.B and Gomez, M.J. (1992). Estimation of microbial protein supply to sheep and cattle based on urinary excretion of purine derivative; an overview of the technical details. International Feed Research Unit. *Rowett Research Institute Occasional Publication, Aberdeen.* Pp2 - 20

Chineke C. A., Adeniran F.A., Olugun A. G., Ikeobi, C.O N and Oseni O. A. (2002). Analysis of some serum biochemical parameters in New Zealand white Rabbit and their crosses. In: VA Aletor, GE Onibi (Eds) *Proc. 27 Anim. Conf. Nig. Soc. Anim. Prod. March 17-21, 2002. FUT. Akure, Nig. PP5-7.*

Church, D. C. and Pond. W. G. (1982). Basic Animal Nutrition and Feeding.3rd edition. Wiley. New York Inc. pp351-354.

Crowder L.V and Chheda, H.R (1982). Tropical grassland husbandry.Longman, London and New York pp 3467-3481.

Cowan. T. (2000).Use of ensiling forages in large scale animal production systems in the tropics. Paper presented in the FAO e- conference on tropical Silage, September 7th - 15th December 1999. P.29-37, in FAO, 2000, q.v

Daramola, J.O., Adeloye, A.A., Fatoba , T.A. and Soladoye , A.O. (2005). Haematological and biochemical parameters of West African Dwarf goats. Livestock Research for Rural Development, Vol.17 #8. Retrieved from: http://www.cipav.org. co/ lrrd/ lrrd17/8/dara17095.htm

Dargie, J.D. and Allonby E.W (1975). Path physiology of single and challenge infections of *Haemochus contortus* in Merino sheep: studies of red cell kinetics and self-cure phenomenon. *International Journal of Parasitology*, 5: 147-157.

Dekar, R.K and Sarker C.R (1990). Nutrient composition and anti-nutritionalfactors of Dolichos lablab seeds food chemistry 38:239-246.

De Leeuw, P.N (1979).A review of ecology and fodder resources of the sub humid zone paper presented at ILCA/NAPRI Conference, Kaduna, Nigeria.

Devandra, C and Mclenroy, G. B (1987). Goats and sheep production in the tropics. Intermediate Tropical Agricultural series. Longman Singapore Publishers, Singapore. pp55-61.

Dube, D.M.J. (1995). The role of high quality dry season forage from mixed crop silage in the small holder dairy sector of Zimbabwe: a Diary Development Programme perspective. *In*: Proc. Workshop on Forage conservation for dry season feeding of livestock in sub-Saharan Africa. Rockefeller Foundation. University of Zimbabwe, Harare. Zimbabwe, August 1995.

Dhoanoa, M.S (2000).Forage ingestion: Effects of sward characteristics and body size. *Journal of Animal Science* 66, 2380-2392.

Doana, P.H., Schofield, P and Pell, A.N. (1997).Neutral detergent fiber disappearance and gas and volatile fatty acids productionduring *in vitro* fermentation of six forages, Department of Animal Science.Cornell University, Theca, N4148353.

Duncan, D. B. (1955) Multiple range and multiple F-test. Biometrics.11:1-2

Edwards, D.C. and Bodgan A. V. (1951). Important grass land. Plants of Kenya.Isaac Pitman and Sons. Pg 48-50.

Eggum, B. O. (1987). Protein quality of Cassava leaf. *British Journal of Nutrition.* Pp 24:761-768

Eggum, B.O. (1989). Biochemical and Methodological Principles. In: Protein Metabolism in Farm Animals: Evaluation, Digestion Absorption and Metabolism.In: Bock, H.D., Eggum, B.O., Low, A. G., Simon, O. and Zebrowska, T., (eds). Oxford University Press, Berlin. pp 1-52.

Ehrlich, W. K., and Casey, N. D. (1998). Effects of planting rate, cutting date and chopping on intake of soyabean silage fed to dairy cows. Anim. Prod. In Aust, 22:378

Ehrlich, W. K., Cowan, R. T. and Casey, N. D. (1996). Regrowth of late maturing soybean following grazing at various stages of growth. Proc. Aust. Soc. Anim. Prod. 21:361.

Elliot, R and McMeniman N.P (1987) Supplementation of ruminant diets with forage. In 'The nutrition of herbivores'. (Eds JB Hacker, JH Ternouth) (Academic Press: Sydney)

Evans, D. O (2002).Sustainable Agriculture in Hawaii. Green manure, Legumes. (*Lablab*) *http://www.2.ctahr.hawaii.edu/sustainableAg/Greenmannure/lablab.asp*

Ewansiha, S. U., Chiezeu, U. F., Tarawali, S. A. and Iwuafor, E.N.O, (2007). Potential of *Lablab pupereus* accessions for crops. LIS production in the West African Savanna Junior Science 145:229-238.

Ezenwa, V.I (1995). Forage production potential of herbaceous and tree legumes in mixtures in grasses in Oyo state, Nigeria, Ph.D Thesis, University of Ibadan, Nigeria.

Ezenwa. I. and Aken'ova M. E. (1998). Performance of mixtures of selected grasses and adapted herbaceous legumes in southwest Nigeria. *Tropical Grasslands*, 32, 131-138.

Fajemilehin, S. O. K., Babayemi and Fagbuaro S. S. (2008). Effect of anhydrous magnesium sulphate fertilizer and cutting frequency on yield and chemical composition of *Panicum maximum. African Journal of Biotechnology*. 7(7): 907-911

Familade F. O. and Babayemi, O. J. (2009). In vitro Gas Production and Dry matter Degradability of Ensiled *Panicum maximum* (Panicum maximum) Harvested at 1 and 3 months Regrowths *Proceedings of 14th Annual Conference of Animal Science Association of Nigeria(ASAN) September 14th – 17th 2009. LAUTECH Ogbomoso, Nigeria.*

FAO (Food and Agriculture Organization) (1985). Production year book 1985. Vol. 39. FAO, Rome

FAO. (1986). Food and Agriculture Organization and the environment. Chakravorty, U. N. (comp), Pg. 68

FAO. (1997). Tree foliage in ruminant nutrition, Animal production and health paper, FAO, Rome.

FAO. (2000). Silage making in the tropics, with particular emphasis on smallholders. L.'t' Mannetje (Ed).Plant production and Protection.

Fasuyi, A. O., Adegun, M. K. and Ibitayo F. J. (2010): Physicochemical properties of ensiled wild sun flower (*Tithonia diversifolia*) Leaves with sugar cane molasses as silage additive *Proc.35th Conf., Nig. Soc. for Anim. Prod. 14-17 Mach, 2010, Univ. of Nigeria.*

Fellner, V. (2004). *In Vitro* versus in vivo estimates of ruminal fermentation. Department of Animal Science, North Carolina State University.

Fievez. V., Babayemi O. J. and Demeyer D. (2005). Estimation of direct and indirect gas production in syringes: a tool to estimate short shain fatty acid production requiring minimal laboratory facilities. *Animal Feed Science and Technology*.123-124(2005)197-210

Fisher, L .J., Donnelly, P. E., Hutton, J. B. and Duganzich, D. M. (1974). Relationship between levels of feeding and certain blood metabolites in dairy cows in mid lactation. *Journal of Agricultural Science* 84, 29-37 (Cambridge)

FMAW R, (1988). Agricultural policy for Nigeria: Strategies for implementation. Lagos Federal Ministry of Agriculture, Water Resources and Rural Development.

France, J. and Siddon, R.C (1993). Volatile fatty acid production. In: Forbes, J.M, France, J (Eds), Qualitative aspects of ruminant digestion and metabolism CAB international, wallingord, U. K.

Franklin, M.C. (1950).”Diet and Dental Development in sheep”Bull.252, Commonwealth of Scientific Organisation, Melbourne, Australia.

Fream, W (1989). The grasses: Systematic and biology of Akashdeep Publ. Delhi

Ganong, W.F (1991). Review of medical Physiology. 15th Edition. Appeton and large Connecticut Pg. 444-467.

Gathenby, R. M (1995). Sheep revised edition.Tropical Agricultural series Macmillan Publishers Ltd.Malasia pp 8.

Getachew G, Blummel M, Makkar H. P. S. and Becker K. (1998). *In Vitro* gas measuring techniques for assessing of nutritional quality of feeds: A review. Animal Feed Science and Technology 72, 3342 – 3352.

Getachew G., Blummel M., Makkar H. P. S. and Becker K. (1999). Stoichoiometric relationship between short chain fatty acid and in vitro gas production in presence and absence of polyethylene glycol for tannin containing browses, EAPP Satellite Symposium, Gas production fermentation kinetics for feed evaluation and to assess microbial activity,18th -19th August ,Wageningen, The Netherlands.

Getachew G., De Peters E. J. and Robinson P. H. (2004). *In vitro* gas production provides effective method for assessing ruminant feeds. Califonia Agriculture 58, 1-12.

Getachew, G., Crovetto, G. M, and Fonderila, M. (2002): Laboratory variation of 24 hour *In vitro* gas production and estimated metabolizable energy value of ruminant feeds Science and Technology. 102:169-189.

Gibbs Russell, G.E., Watson, L., Koekemoer, M., Smook, L., Barker, N. P., Anderson, H.M. & Dallwitz, M. J. (1990).Grasses of southern Africa *Memoirs of the Botanical Survey of South Africa* No. 58: 10, 11.

Gill, A. S. and Tripathi. S. N. (1991). Intercropping Leucaena with particular reference to hybrid Napier varieties. *In* Range Management and Agroforestry. 12(2): 201-205

Grace N. D (1983b) New Zealand Journal of Agricultural Research 26,59-70

Griffith, W.K (1974). Satisfying the nutritive requirements of established legumes in forage fertilizer, Mays, D. A (Ed). American society of Agronomy,Madison,W I.,U.S.A.

Grof, B. and Harding, W.A.T. (1970). Yield attributes of some species and ecotypes of *Centrosema*in North Queensland. *Queensland Journal of Agricultural and Animal Sciences*, 27, 237-243.

Gutteridge, R.C and Shelton,H.M (1994).The rate of forage tree legumes in cropping and grazing systems. In: Gutteridge, R.C.and Shelton, H.M. (eds.) Forage Tree Legumes in Tropical Agriculture, C.A.B. International Wallingford, U.K.pp 4-5

Hague I., Nandi L. A. and Mohammed-saleem M. A. (2008). Phosphorus management with special reference to forage legumes in sub-sahran Africa, food and agricultural organization.

Halim, R.A. (1992). *Pueraria phaseolodies (*Roxb.) Benth. In: 'tMannetje, L and Jones, R. M. (eds) *Plant Resources of South-East Asia NO.* 4. *Forage.* Pp. 192-194. (PSudoc Scientific Publishers, Wageningen, the Netherlands).

Hammond, A.C., Kunkle, W.E., Genho, P.C., Moore, S.A., Crosby, C.E., Ramsay, K.H., (1994). Use of blood urea nitrogen concentration to determine time and level of protein supplementation in wintering cows. Prof. Anim. Scientist 10, 24–31.

Harricharan H J., Morris J and Devers C (1988). Mineral content of some tropical forage legumes. Tropical Agriculture (Trinidad). 65(2):132-136

Harrison, J. H., Soderlund, S. D. and Loney, K. A. (1989). Effect of inoculation rate of selected strains of lactic acid bacteria on fermentation and *In vitro* digestibility of grass-legume forage. J. Dairy. Sci. 72:2421-2426.

Henderson, N. (1993). Silage additives. *Animal Feed Science and Technology Journal* 45: 35-56

Hendricksen, R. E and Myles, D. J (1980). Methods of using Rongai Lablab for beef cattle production. Proceedings of the Australian Agronomy Conference, Queensland Agricultural College Lawes. pp 257.

Hendricksen R. E and Minson D. J. (1985). *Lablab purpureus*- A Review, Herbage abstracts 55, 215-227.

Hendricksen R. E. and Minson D. J. (1985b). *Lablab purpureus* - A Review. Herbage Abstracts. 55:215-227.

Hendricksen, R. E. (1981). The agronomy, yield, composition and nutritional value of *lablab purpureus* and *Vigna unguiculata* In: Forage crop forage systems in Queensland. Toowoomba, May 1980. DPI, Brisbane, Qld. Pp. 2-1 to 2-21

Hendrickson, R. E and Myles, D. J. (1980): Methods of using *Lablab* for beef cattle Production: Proceeds Austrailian Agronomy- conference. QainLawes. Pp: 257

Hossain, S. M. J., Adam, M.R., Sultana, N., Anim, M. R. and Rashid, M. M. (2004) Milk production from indigenous Black Bengal Goat. *Bangladesh Journal of Biological Science* 4(3) 262-265.

Houtert, M. F. (1993). The production and metabolism of volatile fatty acids by ruminants fed roughages; A review. *Animal Feed Science and Technology. 43:189-225.*

Humphreys L. R. (1987). Tropical Pastures and Fodder crops Longman Group U.K. Ltd.

Humphreys, L. R. (1995). Diversity of Productivity of Tropical Legumes In: Tropical Legumes in Animal Nutrition; D'Mello, J.P.F. and C. Devendra (eds). CAB International, Wallingford, UK. pp 1-21.

Ifut, O. J. (1992). Body weight response of WAD goats fed G. *sepium*, *P. maximum* and cassava peels. In: The complementary of feed resources for animal production in Africa. Proceedings of the Joint Feed Resources Network Workshop at Gaborone, Botswana, 4th-8th March.

Iyayi, E.A and Tewe, O.O (1998). Serum total protein, urea and Creatinine levels as indices of quality of cassava diet for pig. *Tropical Veterinary*, pp36:59-67.

Ismartoyo., Dixon R. M., Slocombe R. F and Holmes J .H. G (1993). *Lablab purpureus* Seed as a supplement for Goats fed low Quality Roughage *Asian Australasian Journal of Animal Sciences. Vol.6 No.4: 515-519.*

Iwuafor, E.N.O. and A.C. Odunze, (1999). Performance of Selected Legume Cover Crops in an Arid Zone of Nigeria. In: Cover Crops for Natural Resource Management in West Africa, Carsky, R.J., A.C. Eteka, J.D.H. Keatinge and V.M. Manyong (Eds.). International Institute of Tropical Agriculture, Cotonou, Benin, pp: 209-213.

Jain, N.C. (1986). Veternary Haematology 4th Edition Lea an Febiger, Philadelplua: 179-180.

Johnson, W.L., Hardinson, W. A and Castello L. S (1967). The Nutritive value of *Panicum maximum* Yield and Chemical Composition related to season and herbage growth stage. *Journal Agriculture of Science* 69: 155-160.

Kaiser, A. G. (1984). The influence of silage fermentation on animal production, In" Silage in the 80's" (Ed, Kempton, T. J., Kaiser A. G, and Trigg T. E). Armidale NSW. August, 1984, pp 106-135.

Kaiser, A.G and Lesch S. F. (1977). A comparison of maize and maize-legume mixtures for silage production in the Natal Midlands. Agroplantae, 9:1-6.

Kallah, M. S., Mohammed, B., Alawa, J. P., Muhammad, I. R. and Tanko R. J. (1997). Ensiling quality of Columbus grass (S. *almum Parodi grow*n in Northern Nigeria. *Animal Feed Science and Technology*, 68:153-163.

Kaneko, J. Harvey J, Bruss M. 1997. Clinical Biochemistry of Domestic Animals: 5Edn. Academic press, New yorks, pp 932

Karachi, M. (1987). Yield and quality of *Lablab purpureus* ecotypes in high altitude semi-arid lands in Nigeria at the International Conference Centre, 27th-30th April,Arusha, Tanzania,pp:121-126.

Karim, S.A and Santra, A., (2003). Nutrient requirements for growth of lambs under hot semi-arid environment. *Asian-Australian Journal of Animal Science 16 (5), 665– 671.*

Karim, S.A., Santra, A, Sharama, V (2001). Growth performance of weaner lambs maintained on varying levels of dietary protein and energy in the pre-weaning phase. *Asian-Australia Journal of Animal Science*. 14(10), 1394– 1399.

Kariuki, J.N., Gitau, J.K., Gachuiri, C.K., Tamminga, S and Muia, J.M.K (1999). Effect of supplementing napier grass with desmodium and lucern on DM, CP and NDF intake and weight gains in dairy heifers. Livestock Production Science, 60, 81-88

Karnezos, T.P., Matches, A.G., Preston, R.L., Brown, C.P., (1994). Corn supplementation of lambs grazing alfalfa. *Journal of Animal Science* 72, 783–789.

Kavana, P.Y., Kizima, J. B., Msanga, Y.N., Kilongosi, N.B., Msangi, B.S.J., Kadenguku, L.A., Mngulu, S. and Shimba. P.K. (2005). Potential of pasture and forage for ruminant production in Eastern zone of Tanzania. http//www.cipav.org.co./lrrd/lrrd 17/12/ka 17144.htm.

Kay, D. E. (1979). Hyacinth Bean–food legumes crop and product Digest No 3. Tropical products Institute 16, 184-196

Kayouli, C. and Stephen, Lee. (2006). Supplementary feeding for dairy smallholders in pacific island countries: Fiji, Samao, Vanuata, Cook Island, Solomon Islands and Tonga. P. 67-101, In: S. Lee, R. Kennard and Kayouli (eds) Manual of smalholder Milk production in the South Pacific. FAO sub-Regional Office for the pacific, Apia, Samao.

Khazaal, K., Dentino, M.T., Riberio, J.M and Orskov, E. R. (1995). Prediction of apparent digestibility and voluntary intake of hays fed to sheep, comparison between using fibre components, *In vitro* digestibility or characteristics of gas production or nylon bag degradation. *Animal Sciences Journal* 61, 527-538.

Koon, L. L. (1993). Production of silage from fodder grass species for dry season feeding. In: Strategies for suitable forage-based livestock production in S. E. Asia. Proc. 3rd Meet. Region.Working Grp. On Grazing and Feed Resources for S. E. Asia. 31st Jan – 6th Feburary. 1993 KhonKaen, Thailand pp. 99-101.

Komisarczuk, S., Merry, R. J, McAllan, A. B, Smith, R.H. and Durand, M (1984). Can. *Journal of Animal Science Supplementary* 64, 35-36

Krishnamoorthy, U, Soller, H, Steingass, H and Menke K.H.(1995). Energy and protein evaluation of tropical feedstuffs for whole tract and ruminal digestionby chemical analysis and rumen inoculums studies in *In vitro*. *Animal Feed Science and Technology*.52:177-188

Kumar, R (1992) Anti-nutritional factors, the potential risks of toxicity and methods to alleviate them. In: Andrew speedy and pierre-luc pugliese.Proceedings of the FAO expert consulation held at the Malaysian Agricultural Research and Development Institute (MARDI), Kuala Lumpur Malaysia, 14th-18th October, 1991

Kung, L. J. R. and Muck R. E. (1997). Animal Response to silage additives. Proc. From the silage: Field to feed bunk North American Conference. NRAES-99. Pp 200-210.

Kung, L. and Shsaver R. (2002). Interpretation and use of silage fermentation analyses reports. Department of Animal and Food Science, University of Delaware Newark, DE 19717.

Lambourne, L.J and Wood I.M (1985). Nutritional quality of Australian Cultivators of Lablab bean. *Autralian Journal of Experimental Agriculture and Animal Husbandry* 25:169.

Lazzaro , J. (2001). Normal blood chemistry values for Adult goats. www.Saanendoah. com./bloodvalues.html.

Luck, P. E. (1965b). Dolichos lablab: a valuable grazing crop. *Queensland Agricultural Journal.*

Maasdorp, B. V. and Titterton. M. (1997). Nutrition improvement of maize silage for dairying: mixed-crop silages from sole and intercropped legumes and a long-season variety of maize. 1. Biomass yield and nutritive value. *Journal of Animal Feed, Science and Technology*. 69:241-261.

Macharia, P. N (2003). Introduction of forage legumes into natural pastures of semi–arid rangelands of Kajiado district of Kenya, Kenya Agricultural Research Institute (KARI).Legume Reseach Network project Newsletter Issue No.10.

Makembe, N.E.T and Ndlovu, L.R (1996) *Dolichos lablab (Lablab purpureus* cv Rongai) as supplementary feed to maize stover for indigenous female goats in Zimbabwe. *Small Ruminant Research*, 21:31-36

Makkar, H. P. S. (1989), Protein precipitation methods for quantification of tannins: A review. *Journal of Agriculture and Food Chemistry* 37, 1197-1202.

Makkar, H. P.S. (1995). *In vitro* effects and interactions between tannins and sapponins and fate of tannins in the rumen. *Journal of food Science and Agriculture* 69:481-493.

Makkar, H.P.S (2002). Application in the in vitro gas method gas method in the evaluation of feed resourcesand enhancementof nutritional value of tannin-rich tree/browse leaves and agro –industrial by product. Proceedings of the final review meeting of an IAEA Technical Co-operation, regional AFRA Project organized by the joint FAO/IAEA Division of nuclear Techniques in Food and Agriculture held on 25th -29th November 2000, Cairo, Egypt.pp23-40.

Makkar, H. P. S. and Becker, K. (1999). Purine quantification in digesta from ruminants by spectrophotometric and HPLC methods. *British Journal of Nutrition*, 81, 107-112.

Makkar, H. P. S., Blummel M., and Becker K. (1998a). Application of an *in vitro gas* method to understand the effects of natural plant products on availability and partitioning of nutrients. In : Deaville, E.R., Owen, E., Adesogan, A.T., Rymer, C., Huntington, J. A., Lawrence, T. L. J., (Eds.) *In vitro* Techniques for Measuring Nutrient Supply to Ruminants pp 147-150, Edinburgh: BSAS No 22.

Mannetje. L't., (1999). Introduction to the conference on silage making in the tropics in L'tMannetje (Ed). Silage making in the tropics with particular Emphasis on Smallholders. FAO. Plant Production and Protection. Paper 161.

Mayer L, Chandler D.R and Taylor, M. S (1986). *Lablab purpureus* – A folder crop for Botswana.Bulletin of Agricultural research in Botswana 5, 37- 48.

McDonald, H.A.R (1981): The Biochemistry of Silage, John Wily & Sons Publication, Bath, England, 340.

McDonald P, Edwards R.A, Greenhaulgh J.F.D (1987). Animal Nutrition. 4th Edition, Longman scientific and Technical. England

McDonald P., Edwards, R. A and Greehalgh, J.F.D (1988). Animal Nutrition 4th (edn). Longman publisher.pp200-205.

McDonald P., Edwards, R.A and Greenhalph,J.F.D and Morgan,C.A (1995).Animal Nutrition (5th edition). Longman Group Limited.London, PP 607

McDonald, P., Henderson A. R and Heron S.J.E. (1991). *In* The Biochemistry of Silage.2nd Ed. Chalcombe Publications. Marlow, Aberystwwwyth,UK,32-37.

McLachlan, B.P and Ternouth J.H (1985) *Proc. Nutr. Soc. Aust*.10, 148

McMeniman, N.P. (1976). *Australian Journal of Agriculture and Animal Husbandry* 16, 818-822.

McSweeney, C. S., Palmer B., McNeil D.M and Krause D.O (2001). Microbial interactions with Tannins: nutritional consequences for ruminants. *Animal Feed Science and Technology* 91, 83-93. doi: 10.1016/s0377-8401(01)00232-2

Melaku, S. (2004). Nitrogen utilization and rumen function in Menz rams supplemented with foliages of *Lablab purpureus* or graded levels of *Leucaena pallida* 14203 and Sesbania 1198. *Australian Journal of Agricultural Research*, 2004, 55, 1117-1124.

Meneses M.D., Meglas J., Madrid A., Martinez-Teruel F., Hermandez J and Oliva J. (2007). *Evaluation of the phytosanitry, fermentative and nutritive characteristics of the silage made from crude artichoke (Cyara scolymus L) by-product feeding for ruminants. Small Ruminants Research.* 70:292-296.

Menke, K. H. and Steingass H. (1988). Estimation of the energetic feed value Obtained from chemical analysis and gas production using rumen fluid. Animal feed resource and Development. 28, 7-55.

Menke, K. H., Raab, L., Salewski, A., Steingass, H., Fritz, D., and Schneider, W. (1979). The estimation of the digestibility and metabolizable energy content of ruminant feedstuffs from the gas production when they are incubated with rumen liquor *In vitro. Journal of Agricultural Science* (*camb.*)92, 217-222.

Meyer, D. J. and Harvey, J. W. (1998). Veterinary laboratory medicine. Interpretation and diagnosis. 2nd edition. W.B. Saunders Company. An imprint of Elsevier Science. Philadelphia, Pennsylvania.

Mhere, O., Maasdorp B. V and Titterton, M. (1999). *In* (Ed.Smith .T.) Proc. Workshop on livestock production Research in the Semi-Arid Tropics, held by Dept. for Int. Devel. (DFID). Matopos, Zimbabwe. Feb 1999.

Miller, T.B. (1970).Forage conservation in the tropics.British Grassland Society 2:158-162.

Minson, D. J., Stobbs, T. H., Hegarty, M. P and Playne, M. J. (1976). Measuring the nutritive value of pasture plants. In: Shaw, NH and Bryan, W. W. (eds.) Bulletin Commonwealth Bureau for pasture and field crops No 51. Pp. 308.

Minson, D.J (1990). Forage in Ruminant Nutrition. Academic Press, New York, USA.

Mitruka B. M. and Rownsley H. M. (1977). Clinical biochemical and haematological reference values in normal experimental Animals., *Masson Pub*. U.S.A. *Inc*. N.pp:11-174.

Mohammed Saleem, M.A (1972). The effect of sowing time on the grain yield and fodder potential of sorghum under sown with stylo in the sub–humid zone of Nigeria. Tropical Agric. (Trinidad) 62,151-153.

Morgan, J.B., Wheeler, T.L., Koohmaraie, M., Crouse, J.D and Savell, J.W., (1993). Effect of castration on myofibrillar protein turnover, endogenous proteinase activities, and muscle growth in bovine skeletal muscle. *Journal of Animal Science.* 71, 408–414.

Mtenga, L.A and Shoo, R.A (1990). Growth rate, feed intake and feed utilization of small East African goats supplemented with *Leucaena leucocephala. Small Ruminant Research*, 3: 9-18.

Mthiogane, D.M.W., Nsahlai I.V and Bons, M.L.K (2001). The nutritional composition, fermentation characteristics, *in sacco* degradation and fungal pathogen dynamics of sugarcane tops ensiled with or without water. *Animal Feed Science andTechnology* 3 (4): 171-185.

Muck, R. E., and Kung, L. Jr. (1997). Effects of silage additives on ensiling Proc. From the silage: Field to Feedbunk North American Conference. NRAES–99.Pages 187-199. Oude Elferink, S. J., Diehuis F., Krooneman J., Gottschal J., and Spoelstra S. F. 1999.

Muhammad, I. R., Baba, M., Mustapha, A., Ahmad M.Y. and Abdurrahman, L. S., (2008). Use of Legume in the Improvement of Silage Quality of Columbus Grass (*Sorghum almum Parodi). Research Journal of Animal Sciences* 2(4): 109-112, 2008.

Muhammad, I.R., Ashiru Rabi and Abdullahi A.Y., (2007). Implications of the slaughter of pregnant ewe and does to future stock in the semi arid urban abattoir. *Journal of Animal Veterinary Advances*, 6(6): 819-822.

Muhammad, I.R., Olorunju S.A, Hena S.W and Agishi E.C, (2004). Forage yield, crude protein, *in vitro* dry matter digestibility and mineral content of three cultivars of lablab (*Lablab purpureus*). *Journal of Animal Production Research*, 19: 51-59.

Muhammed - Saleem, M.A.(1972). Effect of cutting frequency on *Panicum maximum* yield, chemical composition and its utilization by yankassa sheep of Nigeria Ph.D Thesis, University of Ibadan.

Muhr, L., Peters, M., Tarawali, S.A and Schultze-Kraft, R. (1999). Forage legumes for improved fallows in agropastoral systems of sub humid West Africa: I. Establishment, herbage yield and nutritive value of legumes as dry season forage. *Tropical Grasslands*, 32, 222-233.

Mullen, C.L. and Watson R.W. (1989). Summer legume forage crops: cowpeas, lablab, soybeans.NSW Agriculture and Fisheries AgFact pp 2.16.

Muller, W. J. (1975). New Concepts and developments in metabolism and homeostatis of inorganic elements in diary cattle. A review. *Journal of diary Science* 58: 1549-1560

Mupangwa, J.F., Ngongoni, N.T and Hamudikuwanda H, (2000). Effects of supplementing a basal diet of *Chloris gayana* hay with one of three protein-rich legume hays of *Cassia rotundata*, *Lablab purpureus* and *Macroptilium atropurpureus* forage on some nutritional parameters in goats. Tropical animal health and production, 32(4), 245-256

Mupangwa, J. F., Ngongoni, N. T and Hamudikuwanda, H (2006). The effect of stage of growth and method of drying fresh herbage on chemical composition of three tropical herbaceous forage legumes. Trop. Subtrop. Agroecosyst., 6: 23-30.

Murphy A. M. and Colucci P. E. (1999). A tropical forage solution to poor quality diets: A review of *Lablab purpureus*. *Livestock Research for Rural Development* 11: (2): http://www.cipav.org.co/lrrd11/2/colu112htm.

Murphy A. N., Pablo E Colucci and Mario R. Padilla. (1999). Effect of different traditional processing methods, Soaking, Cooking, roasting, autoclaving and germination on the nutrient composition, anti-nutritional factors and *in vitro* digestibility in Dolichos lablab seeds. *Pakistan Journal of Nutrition* 6 (4). 299-303.

Murungweni, C., Mabuku, O. and Manyawu, G. J. (2004) *Mucuna, Lablab* and *Paprika calyx* as substitutes for commercial protein sources used in dairy and pen-fattening diets by

smallholder farmers in Zimbabwe. In: Whitbread, A. M. and B. C. Pengelly, B. C. (eds). ACIAR *Proceedings No 115. pp. 126-135.*

Murungweni, C, Mabuku, O and Mangawu, G.J (2004). Mucuna, Lablab and Paprika Calyx as Substitutes for Commercial Protein Sources Used in Dairy and Pen-Fattening Diets by Smallholder Farmers of Zimbabwe. In: Tropical Legumes for Suitable Farming System in Southern Africa and Australia, Whitbread, A.M. and B.C. Pengelly, (Eds.), ACIAR Proceedings, No. 115. Australian Centre for International Agricultural Research, Canberra, pp: 126-135

Mustafa ,A. F., MCkinnon J.J and D.A.Christenson D.A (2001). Effect of feeding spearmint (*Mentha spicata*) by product on nutrient utilization and ruminal fermentation of steers *Animal Feed Science and Technology* 92, (1, 2) : 33-43

Myer, H.H., Abdulkhaliq, A., Davis, S.L., Thompson, J., Nabioullin, R., Wu, and Forsberg, N.E., (1996). Effects of the callipyge phenotype on serum creatinine, total cholesterol, low densitylipoproteins, very-low-density lipoproteins, high-density lipoproteins, and triacylglycerol in growing lambs. *Journal of Animal Science* 74, 1548–1552.

National Research Council (1981). Nutrient requirement of goats: Angora, dairy and meat goats in temperate tropical countries. Nutrient Requirement of Domestic Animals No 15, National Research Council, Washington. Dc USA.

National Research Council (1994), Nutrient requirements of poultry. 8th National Academy Press. Washington Dc.

Ndlovu, L. R. and Sibandra, L. M. (1996). Potential of dolichos lablab (*Lablab purpureus)* and Acacia tortilis pods in smallholder goat kid feeding systems in semi –arid areas of Southern Africa. *Small Ruminant Research*, 21 (3):273-276.

Ngamsaeng, A, Wanapat, M. and Khampa. S. (2006). Evaluation of local Tropical plants by *In vitro* rumen fermentation and their effects on fermentation end–products. *Pakistan Journal of Nutrition*, 5 (5):414-418.

Nherera F.V, Ndlovu N.R and Dzowela, B.H.(1999). Relationships between *In vitro* gas production characteristics, chemical composition and *in vivo* quality measurements in goats fed tree fodder supplements, *Small Ruminants Research*, 31:117-126.

Nittipot, P and Somart, K, (2003).Evaluation of ruminant nutritive value of cassava starch industry by products, energy feed resources and roughages using *in vitro* gas production technique. In proceeding of annual agricultural seminar for year 2003, 27th-28th January, ICKU 179-190.

Njoya, A., Awa, D.N. and Chupamom J. (2005). The effects of a strategic supplementation and prophilaxis on the reproductive performance of primiparousfulbe ewes in the semi-arid zone of Cameroon. *Small ruminant Research* 56(1-3): 21-29.

Norton, B.W. and Poppi, D.P. (1995). Composition and nutritional attributes of pasture legumes. In: D'Mello J. P. F and Devendra C. (eds). Tropical legumes in Animal nutrition (CAB international) Walling ford, United Kingdom. Pp.23-46.

Norton, B.W., (1994). The Nutritive Value of Tree Legumes. In: Forage Tree Legumes in Tropical Agriculture, Gutteridge, R.C. and H.M. Shelton (Eds.). CAB International, United Kingdom, pp: 177-191.

NRC National Research Council (1981). Academy of Science, National Research Commission ,Washiongton D. C.

NRC, (1985). National Research Council. Nutrition Requirements for Sheep Sixth Revised Edition. National Academy Press, Washington, DC.

Nworgu, F.C. and Ajayi, F.T (2005). Biomass, dry matter yield, proximate and mineral composition of forage legumes grown as early dry season feeds. *Livestock Research for Rural Development.*www.cipav.org.co/lrrd17/11/Nwor17121.htm

Obioha F. C. and Ndukwe N. (1976): Changes in yield and chemical composition standing of conserve forage during the dry season in East-Central Nigeria. *Journal of Animal Production* 3:105-115

Odedire J.A and Babayemi O.J (2007). Comparative studies on the yield and chemical composition of *Panicum maximum* and *Andropogon gayanus* as influenced by *Tephrosia candida* and *Leucaena leucocephala*. *Livestock research for rural development*. Volume 20, Article#27, retrieved July 22, 2009, from http://www.lrrd20/2/oded20027.htm.

Odhiambo, J. O. (2004), New directions for a diverse planet proceedings of the 4th International Crop Science Congress Brisbane, Australia, 26th Sept – 1st Oct. 2004/ISBN/920842 20 9/ www.cropscience.org.au'

Odion, E. C. and Singh, B.B (2005). Production of dual purpose cowpea varieties at two clipping heights in the Sudan savanna of Nigeria, 2. Pod and grain production in pure stand. *Journal of Arid Agriculture*, 15: 15-19.

Ogedegbe S. A., Ogunlela V.B., Olufayo O.O and Odion, E.C (2012). Mineral content of *Lablab purpureus* L. Sweet) Herbage as influenced by phosphorus Application, cutting height and age of cutting at Samaru Nigeria. *Asian Journal of crop Science*, 4:1-11.

Ogundipe, S.O, Abeke, F.O, Sekoni A.A, Dafwang I.T and Adeyinka I.A. (2003).Effect of cooking duration in the utilization of *Lablab purpureus* beans by pullet chicks.Proc. 28th Annual Conference of the Nigerian Society for Animal Production pp233-235.

Ohba N., Ohnishi T., Tobisa M., Yano Y., Simojo M and Masuda Y (2004). Effect of adding glucose and fermented juice of lactic acid bacteria on the quality of (*Sesbania sesbania cannabina*(Retz.) Poir.) Silages, Kyushu Branch J. Jpn. Grassl. Sci.34:23-28.

Ojo V. O., Dele, A.P., Amole T.A., Adeoye S.A., Anele U.Y., Olanite J.A and Hassan O.A (2009). Effect of intercropping *Panicum maximum* Var. Ntchisi and Lablab purpureus on the Growth, Herbage Yield and Nutritive Qualities of *Panicum maximum* cultivar Ntchisi at different Harvesting times. Proceedings of 14th Annual conference of Animal Science Association of Nigeria (ASAN). Lautech Ogbomoso.

Olanite, J.A. (2003).Evaluation of selected grass –legume mixtures as feed for weaner calves under traditional cattle management in Ibadan, Nigeria. Ph.D Thesis, Department of Agronomy, University of Ibadan, Nigeria, pp233.

Olanite, J.A., Arigbede, O.M., Jolaosho, A.O., Onifade O.S and Alabi B.O (2006). Effect of cutting intervals on the dry matter yield and nutritive quality of two varieties of *Panicum maximum* in the humid zone of Nigeria. Asset Series 6(1): 171-180.

Oldham, J.D and Alderman, G (1980). Recent advances in understanding protein-energy interrelationship in intermediary metabolism in ruminants in protein and energy supply of high production of milk and meat pergamon, press, Oxford, pp33.

Ologhobo A. D. (1980). Biochemical and Nutritional studies of cowpea and lim bean with particular reference to some inherent anti nutritional components Ph. D. Thesis, University of Ibadan.

Olorunnisomo O. A and Dada O.A (2011). Digestibility and intake of Elephant Grass ensiled with cassava peels by Red Sokoto Goats in Ibadan.In: Adeniji,A.A Olatunji E.A and Gana,S.E (eds)Value Re-Orietation in Animal ptoduction:A key to National food security and stable economy.Proceedings *36th Conference of Nigerian Society for Animal Production 13-16 March, 2011, University, of Abuja, Nigeria.*

Olorunnisomo, O. A., Adebayo O. B., and Fayomi, O. H (2011). Growth rate and Feed conversion ratio of red Sokoto Goats fed Elephant grass and cassava peel silage. In: Adeniji, A.A Olatunji E.A and Gana, S.E (eds).Value Re-Orietation in Animal ptoduction: A key to National food security and stable economy.Proceeding of *36th Conference of Nigerian Society for Animal Production. 13th-16th March, 2011, University, of Abuja, Nigeria.*

Olusanya, S. K., Edewor, E. E. and Health, E. (1976). Studies on the blood chemistry and other haematological parameters of Buffaloes in a Ranch in Nigeria. *Nigerian Veterinary Journal* 5 (1), 27-31.

Onayinka, E. A. O and Akinyemi A.A (1976). The effects of nitrogen and interval of cutting on the dry matter yield and crude protein content of some *Panicum maximum* varieties Dry matter yield.*Nigerian Agricultural Journal*, 13: 36-43

Onselen, V. J. V and Lopez, J. (1998). Effects of addition of carbohydrate sources and of a commercial enzymatic product on the chemical and nutritional composition of elephant grass (*Pennisetum purpureum*) silage. Revista da Sociadade Brasiliera de Zootecnia. 17(5): 421-427.

Onwueme, I. C. (1979). Tuber and Vegetable crops in Crop science cassell's Tropical Agriculture series, Book 2, Pg. 68-72.

Onwuka, C.F. (1983). Nutritional Evaluation of some Nigerian browse plant in the humid tropics Ph.D thesis, Department of Animal Science University of Ibadan, Nigeria.

Onyeonagu, C.C. and Asiegbu,J.E (2006). Frequency of collection, distance from source of collection, Seasonality and preference rating of identified forage species in Nsukka Rural communities of Enugu state, Nigeria. *Agro-science Journal of Tropical Agriculture, food Environment and Extention* 5(2) 33-39.

Orden, E. A., Abdulrazak S.A., Cruz E.M., Orden M.E., Ichinohe T and Fujiharaz T(2000). *Leucaena leucocephala* and *Gliricidia sepium* Supplementation in sheep fed with ammonia treated rice straw: effect on intake, digestibility, microbial protein yield and live weight changes. *Asian Australian Journal of Animal Science*, 13: 1659-1666.

Orskov, E. R. and McDonald, L (1979). The estimate of protein degradation ability in the rumen from incubation measurement weighed according to the rate of passage. *Journal of Agricultural science*, Cambridge.92:499-503.

Oscar, W.S (1971). Veterinary Haemotology 2nd Edition, Lea and Febiger, Philadelobia. Pp24

Osman-Magdi, (2007). Effects of different processing methods on Nutrient composition, Anti nutritional factors and *in vitro* protein Digestibility of *Dolichos Lablab* bean (*Lablab purpureus* L. Sweet). *Pakistan Journal of Nutrition* 6 (4):299-303.

Osueni, J.E. (2001).Variation in zoometric and haematological indices of West African Dwarf goats from different locations in Edo state. M.Sc. Thesis, Ambrose Alli University, Ekpoma, Nig. pp57.

Otesile, E. B., Fagbami B.O. and Adeyemi O. (1991). The effect of *Trypanosoma brucei* infection on serum biochemical parameters in boars on different planes of dietary energy. *Veterinary Parasitology*, *40:* 207–216.

Otukoya, F.K. (2007). Intake, growth and digestibility of *Albizia Saman* pod by the West African dwarf goats.Ph.D Thesis, Animal science Department, University of Ibadan.pp 34-53

Oyenuga V. A (1960). Effect of stage of growth and frequencyof cutting on the yield and chemical composition of some Nigeria fodder grasses-*Panicum maximum Journal of Agricultural Science*, 25: 339-350.

Oyenuga, V. A. (1955). Nigeria's feeding-stuffs their composition and nutritive value printed at the University Press. Production from Indigenous Black Bengal Goat in Bangladesh. *Journal of biological Science. 4(3) 262-265.*

Oyenuga, V. A. (1968). Nigeria's foods and feeding stuffs 3rd edition, Ibadan University Press. Pp 99.

Ozanne, P.G, Purser D.B, Howes K.M and Wandsouthey, I (1976) *Australian* Journal of *Experimental Agriculture. Anim*al *Husbandry* 16,353-360.

Panditharane, S., Allen, V.G, Fontenot J. P. and Jayasuriya. M.C.N (1986). Ensiling characteristics of tropical grasses as influenced by stage of growth, additives and chopping length. *Journal of Animal Science* 63(1): 197-207.

Patterson , K (1988). Ensiling of forages. Factors affecting silage fermentation and quality Dissertation. Swedish University of Agricultural Science.Reports 179,Uppsala

Pell, A.N and Schofield, P. (1993) .Computerized monitoring of gas production of measuring forage digestion *In vitro*. *Journal of Diary Science* 76:1063-1073.

Pfander, W.H., Grebing, S.E., Price, C.M., Lewis, O., Asplund, J.M., Ross, C.V. (1975). Use of plasma urea nitrogen to vary protein allowances of lambs. *Journal of Animal Science* 41, 647–653.

Politis, I., Zavizoion, B., F., Cheli A, Baldi, A. (2002). Expression of Urokinase plasminogen activator receptor in resting and activated bovine neutrophils. *Journal of Dairy Research*. 69:195-204.

Preston, T.R. and Leng , R.A (1987). Matching ruminant production systems with available resources in the tropics and sub-tropics.Penarbul Books, Artnidale,Austria.

Pulsegra, J. W. (1968). Tropical Crops, Dicotyledon, John. I. W and Sons. *New York,* pp 273-276.

Quigley S., Moss R. J. and Brock I (1998). Evaluation of Inoculated Lablab Silage for Growing Dairy Heifers *Australian Tropical Dairy Institute, Research Station,* M. S. 825.

Rahman A and Aneela K. (2004). Effects of Ensilage on chemical composition of whole crop Maize Maizestover and mott grass *Pakistan Veterinary Journal* 24(3): 2004.

Ramaru, J., Maniabolo Z. and Dekaoro, J. (2000). Improving soil fertility management in south Africa: Learning through participatory extension approaches. *Managing African soil* No.19. *Russell Press Nuttingham.*

Ranibar, G.A (2007). Forage hay yield performance of different berseem clover (*Trifolium alexandinum*) genotypes in mazandaran conditions. *Asian Journal of Plant Science,* 6:1006-1011

Rasha, M. S., Khadiga A and Abdel Ali. (2007). Effect of dietary Hyacinth Bean (*Lablab purpureus)* pp70.

Reed J. D, and Soller H (1987). Phenolics and nitrogen utilization in sheep fed browse. In: Herbivore nutrition research: 2nd International Symposium on Nutrition of Herbivores, 6-10 July'. (Ed. M. Rose) pp, 47-48. (University of Queensland press: Brisbane).

Reed J. D., Soller H and Woodward A (1990). Fodder tree and stover diets for sheep: intake, growth, digestibility and effects of phenolics on nitrogen utilization. *Animal Feed Science and Technology* 30, 39-50. Doi: 10.1016/0377-8401 (90) 90050-1.

Rekwot, P.I., Kumi-Diaka, J., Akerejola, O. and Oyedipe, O. (1987). Haematological values of Bunaji and Fresian x Bunaji bulls fed two levels of protein diets. *Nigerian Veterinary Journal* 18: 63-72.

Reynolds, I and Cobbuna, J. (1992). The integration of livestock production in Alley farming. In: Tripathi R.B.and Psychas, J.P (eds).The AFNETA Alley farming training Manual vol 1.Core course in Alley farming, ILCA Addis Ababa. Pp 20-21.

Richard. D. E, Brown W. G, Ruegsegger G and Bates D.B, (1994). Replacement value of tree legume for concentrate in forage based diets 1: Replacement value of *Gliricidia sepium* growing goats. *Journal of Animal feed Science and Technology*, 46:37-51.

RIM, (Resource Inventory and Management Studies), (1992). RIMS Report, Federal Department of Livestock and pest control services. Federal Ministry of Agriculture and natural resources.Garki Abuja, Nigeria, pp 440.

Riviere, R. (1991). Alimentation des ruminant domestiques en miliu tropical, La Documentation Francais.

Rogers. B.(2002). Legumes offer a ray of hope in s/Africa In: Partners in Research for development. No 15:12-16

Said A. N. and Tolera A. (1993). The supplementary value of forage legume hays in sheep feeding: feed intake, nitrogen retention and body weight changes. *Livestock Production Science*. 33:229-237.

Salawu, M.B., Adesogan A.T.,Weston C.N and Williams,S.P. (2001).DM yield yield and nutritive value of pea /wheat bi-crops differing in maturity at harvest, pea variety,*Animal Feed Science and Technology* 94:77-87.

SAS (1999): SAS/STAT User's guide version 8, SAS institute Inc. Cary, North Caroline, 1999, Edition.

Schaaffhausen R. V. (1963a). *Dolichos lablab* or Hyacinth Bean; Its uses for feed, food and soil improvement. Economic Botany. 17:146-153.

Schaaffhausen R. V. (1963b). Economic methods for using *Dolichos lablab* for soil improvement, food and feed Turrialbla.13:172-178.

Schalm, Y.W., Jane, N.C and Carol, E. J. (1975). Veterinary haematology 3rd Edn. Lea and Ferigar Philadelphia. U.S.A, pp: 15-81.

Siebert, B. D and Kennedy P. M. (1972). The utilization of spear grass (*Heteropogon concortus* I. factors limitation, intake and utilizable by cattle and sheep. *Australian Journal of Agriculture. Research 23: 35-44.*

Smith, J.W, Larbi, A. Jabbar, M.A. and Akinlade, J (1995b).Voluntary intake by sheep and goats of *Gliricidia sepium* fed in three states and at three levels of supplementation to a basal diet of *Panicum maximum*. Agroforestry System, 32:287-295.

Smithson, P.C. and K.E. Giller, (2002). Appropriate farm management practices for alleviating N and P deficiencies in low-nutrient soils of the tropics. Plant Soil, 245: 169-180.

Snedecor, G.W. and Cochran, W.G (1967). Statistical Methods. 6th Edn., Iowa State University, Ames, IA., USA., Pages: 456.

Steel, R.G.D., Torrie J.H and Dickey D.A, (1997). Principles and Procedures of Statistics: A Biometrical Approach. 3rd Edn. McGraw-Hill Co., New York, USA., ISBN: 9780070610286, Pages: 666.

Tambuwal, F. M., Agaie, B. M. and Bangana, A. (2002). Hematological and Biochemical values of Apparently Healthy Red Sokoto Goats. *Proceeding of 27th Annual Conference, Nigerian Society of Animal Production (NSAP), March, 17th-21th, FUTA, Akure, Nigeria. Pg. 50-53*.

Taruona, M and Titterton, M. (1996). Effects of mixed-crop maize and legume silages on dry matter intake and yield and quality of milk of Holstein dairy Cows. *In* Proc. Workshop

on Maize for Crop/Livestock interaction in sub-Saharan Africa held by Rockefeller Foundation. Africa University, Mutare. Zimbabwe. October, 1996.

Tarawali, S. A (1991).Preliminary agronomic evaluation of forage legumes for sub-humid West Africa.*Tropical Agriculture (Trinidad)* 68:88-94.

Ternouth, J. H. and Sevilla, C. C. (1984). Can Journal Anim.Sci.,Suppl.64,221-222.

Tessemia, S (1988). Improving ruminant livestock production on small farm system under semi-arid farming conditions of Eastern Kenya. UNDP/FAO- Dry land farming Research and Development Project KEN/74/6/7, KEN/81/011and KEN/86/028,M.c chakos, Kenya.

Thomas, D. and Sumberg, J.E (1995). A review of the evaluation and use of tropical forage legumes in Sub-Saharan Africa. Agric. Ecosyst. Environ., 54: 151-163.

Thomas C and Thomas P.C. (1985). Factors affecting the nutritive value of grass silages. In: D. J. Cole and W. Haresign (eds). Recent Advances In Animal nutrition. London; Butterworths. Pp 223-256

Titherton, M (1997). The feasibility of using forage sorghum in drought years for silage in Zimbabwe. *In (*Ed R. Kirk) Proc.Annual General Meeting on Forage production for dairying in Zimbabawe, Grasslands Society of Zimbabwe.August, 1997.

Titterton, M and Maasdorp, B.V. (1997). Nutritional improvement of maize silage for dairying: Mixed crop silages from sole and intercropped legumes and a long season variety of maize. 2. Ensilage. Animal Feed Sciece and Technolology, 69(1,3): 263-270.

Titterton, M. and Bareeba F. B. (1999). Grass and Legume silages in the Tropics Paper presented in the FAO e-conference on Tropical Silage. December, 1999.

Topps, J. H and Oliver J. (1993). Animal Foods of Central Africa.Zimb. *Agricultural Journal of Techology and Handbook.* 2,135.

Topps, J.H. (1992). Potential composition and use of legume shrubs and trees as fodder for livestock in the tropics. *Journal of Agricultural Science,*118:1-8.

Topps, J.H (1997). Forage legumes as proteins supplements to poor quality diet in the semi – arid tropics. In Wallasce, R.J and Lahlose-Kassi A (Eds). Rumen Ecology Research planning.Proceedings of a workshop held at ILRI.13th-18th March 1995. Addis. Ababa Ethiopia.

Underwood, E.J. (1981) .The mineral nutrition of Livestock 2nd ed. Commonw. Agric. Bur., Farnham Royal, England.

Ummuna N.N., Osuji ,P.O, Nsahlai,I. V., Khalil, H and Mohammed Saleem, M. A. (1995). Effects of supplementing oat hay with lablab,sesbania,tagasaste and wheat middlings on voluntary intake, N-utilization and weight gain of Ethiopia Menz.sheep.*Small Ruminant Research,*18:113-120.

Valenzuela, H. and J. Smith, (2002). Cooperative Extension Service publication. University of Hawaii at Manoa, Honolulu, United States.

Van Eys, J. E., Mathius, L. W., Pongsapan P and Johnson, W. L. (1986). Foliage of tree legumes gliricidia, leucaena and Sesbania as supplements to Napier grass diet for growing goats. *Journal of Agricultural Science* Cambridge, 92, 227-233.

Van soest P. J. and Robertson J. B. (1985). Analysis of forages and fibrous foods As 613 manuals. Department of Animal science Cornell University, Ithaca. Pg. 105-156.

Van soest P. J., Robertson J. B. and Lewis B. A. (1991). Methods for dietary fibre, neutral detergent fibre and non- starch polysaccharides in relation to animal nutrition. *Journal of Dairy science*, 74, 3583-3597.

Wattiaux, M. (2000). Introduction to silage making. The Babcock Institute University of Winconsin. www.babcock.cals.edu/downloads/du/du_502.en.pdf.

Whiteman, P.C (1980).Tropical Pasture Science. Oxford University Press, Oxford.

Willey, R. W. (1979). Intercropping: its importance and research needs. II. Agronomy and Research Approaches. Field Crop Absts.32 (2. Feb. 1979).

Wong, C. C. (1999). The place of silage in ruminant production in the humid tropic. In: L't Mannetje (Ed.) Proc. FAO e- Conf. on Trop. Silage. FAO plant Prod. And Protect. Paper 161. 1st September – 15th December, 1999. Poster 1.1:5-6.

Wong, C. C. (2000). The place of silage in ruminant production, in the humid tropics: poster presented in the FAO e-conference on tropical silage, 1st September- 15th December 1999. P. 34-36, in FAO, 2000, q.v.

Woolford, M. K. (1984). *In* The Silage Fermentation. Marcel Dekker, New York www.cipav.org.co/lrrd17/11/Nwor17121.htm.

Yousouf M. B, Balewu M. A, Daramola J. O. and Ogundun N. I. (2007) Protein supplementing values of cassava- leucaena- and gliricidia leaf meals in goats fed low quality *Panicum maximum* hay. *Livestock research for rural development* (1992)

APPENDIX 1

Plate 1: Sole *Panicum maximum* at six weeks

Plate 2: *Panicum maximum* intercropped with lablab cv Rongai at six weeks

Plate 3: *Panicum maximum* intercropped with lablab cv Highworth at six weeks

Plate 4: Sole lablab cv Rongai at six weeks

Plate 5: Sole lablab cv Highworth at six weeks.

Plate 6 :Full view of Sole lablab cv Rongai at six weeks

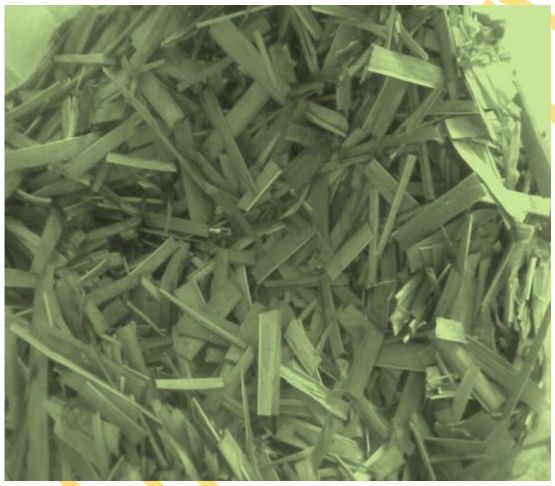

Plate 7: Silage: 100% *Panicum maximum*

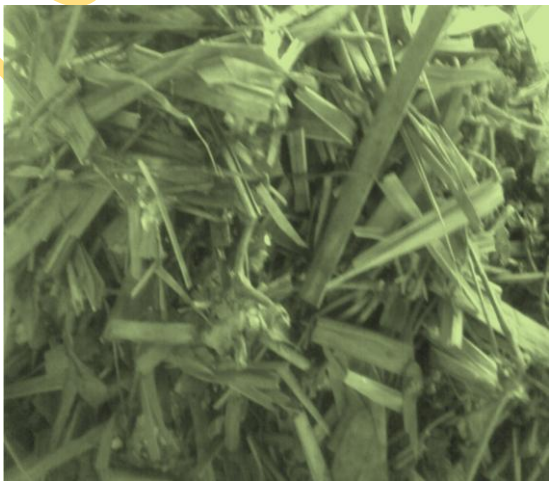

Plate 8: Silage: *Panicum maximum* with *Lablab purpureus* mixture

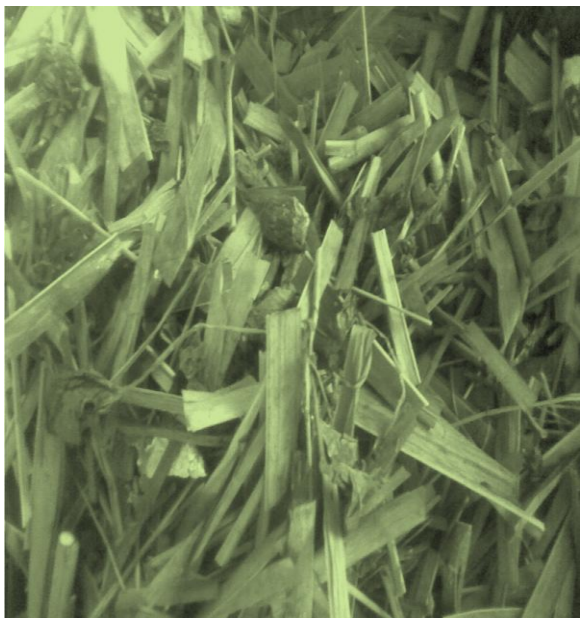

Plate 9: Silage: *Panicum maximum* with *Lablab purpureus* mixture

Plate 10: WAD ram feeding on experimental diet

Plate 11: WAD ram feeding on experimental diet

Plate 12:WAD ram, silage, concentrates and fresh water