COMPARATIVE ASSESSMENT OF YIELD, NUTRITIVE VALUE AND RUMEN DEGRADATION OF GROUNDNUT (*Arachis hypogea* L.) VARIETIES

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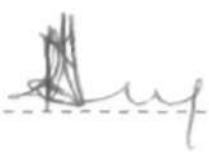
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DECLARATION

I hereby declare that this thesis is wholly the result of the author's research work. The work of other investigators referred to is duely acknowledged. No part of this thesis has been previously submitted for any other qualification.

Signed 

Date 17/7/98

CERTIFICATION

This thesis 'COMPARATIVE ASSESSMENT OF YIELD, NUTRITIVE VALUE AND RUMEN DEGRADATION OF GROUNDNUT VARIETIES' by Mr Dachung D. Dung meets the guidelines for the award of Master of Science (MSc) of Ahmadu Bello University, Zaria and is certified for its contribution to knowledge and literary presentation.

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DEDICATION

This project is dedicated to my parents Mr and Mrs D.P. Dung who have been a major inspiration in my academic pursuit. They toiled hard, by the grace of God to ensure that I went to school.

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I acknowledge the grace of His majesty, the God of Israel in all my academic endeavours. He has been my source of strength.

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The Directors of NAPRI and IAR, ABU Zaria approved the collaboration between ILRI, NAPRI and IAR.

May the Almighty God bless the efforts of all who contributed in making this work a success. Amen.

ABSTRACT

Thirty-eight varieties of groundnut*(Arachis hypogea L.)* harvested approximately four months after planting date were assessed for forage yield (FOYLD) leaf to stem ratio, (LFST), dry pod yield (DPYLD), shelling (SHLG) and seed yield (SEYLD). The chemical composition-crude protein (N x 6.25) and neutral detergent fibre (NDF) of forage, and rumen degradation characteristics of leaf and stem portions were also determined. There were significant differences ($P<0.05$) among varieties in dry pod yield, seed yield, potential degradability, rate of degradation and effective degradability. Dry pod yield varied among varieties from 1457 kg/ha to 3980 kg/ha, while SEYLD was from 729 kg/ha to 2218 kg/ha. Forage yield varied from 2177 kg/ha to 7831 kg/ha. Leaf potential degradability (PD) varied from 678 g/kg to 914 g/kg dry matter (DM) while stem PD was from 538 g/kg to 702 g/kg DM. Both the leaf and stem fractions had protein content above 7%, which would suffice for the protein needs of cattle for maintenance. Varieties assessed were recommended for the dual purpose needs of the farmer with regards to seed and forage yields. Farmers who have a bias for seed production are recommended to use M572 - 801, ICGV 86222, RMP 12 and M554 - 76. These had seed yields from 2003 kg/ha to 2218 kg/ha. Varieties recommended for forage production were M170 - 801, 2546 - 79, 42 - 85, and UGA 2. The forage dry matter yields of these varieties varied from 6459 kg/ha to 7831 kg/ha of dry matter.

TABLE OF CONTENTS

TITLE	PAGE
Title page	i
Declaration	ii
Certification	iii
Dedication	iv
Acknowledgement	v
Abstract	vii
Table of Contents	viii
List of Tables	xi
Abbreviations	xii
CHAPTER ONE	
1.0 INTRODUCTION	1
CHAPTER TWO	
2.0 LITERATURE REVIEW	**3**
2.1 Seed yield of groundnut	3
2.2 Pod yield of groundnut	5
2.3 Groundnut cultivars developed	8
2.4 Fodder yield of groundnut	10
2.5 Groundnut fodder intake and animal performance	13
2.6 Nylon bag degradation	22
2.6.1 Degradation of DM and its fractions *in sacco*	22
CHAPTER THREE	
3.0 EXPERIMENTAL PROCEDURE	**27**
3.1 Forage DM and pod yield determination	27

3.2 Sample preparation & chemical analysis -- 28

3.3 *In sacco* dry matter degradation --------- 29

3.3.1 Degradation data ---------- 30

3.4 Statistical analysis ---------- 31

CHAPTER FOUR

4.0 RESULTS ---------- 32

4.1 Dry pod yield ---------- 32

4.2 Shelling percentage and seed yield ------ 34

4.3 Forage yield and leaf to stem ratio ----- 34

4.4 Chemical composition ---------- 34

4.5 Degradation characteristics of leaf and stem. ---------- 37

4.6 Nitrogen loss in the rumen ---------- 40

CHAPTER FIVE

5.0 DISCUSSION ---------- 44

5.1 Dry pod yield ---------- 44

5.2 Shelling percent and seed yield ---------- 45

5.3 Forage yield and leaf to stem ratio ------ 46

5.4 chemical composition ---------- 48

5.5 Degradation characteristics of leaf and stem ---------- 48

5.6 Nitrogen loss in the rumen ---------- 50

CHAPTER SIX

6.0 **SUMMARY AND CONCLUSION** ---------- 51

6.1 Pod and related parameters ---------- 51

6.2 Forage and ralated parameters ---------- 52

LITERATURE CITED: ---------- 55

APPENDICES: ---------- 64

LIST OF TABLES

TABLE NO **PAGE**

Table 1. Dry pod yield (DPYLD), shelling (SHLG), seed yield (SEYLD), forage yield (FOYLD), and leaf to stem ratio (LF:ST) of 38 groundnut varieties in Zaria, Nigeria.-- 33

Table 2. Crude protein and neutral detergent fibre of leaf and stem portions of 38 groundnut varieties in Zaria, Nigeria. ---------- 36

Table 3. Degradation characteristics of dry matter in stem portion of 38 groundnut varieties in Zaria, Nigeria. ---------- 38

Table 4. Degradation characteristics of dry matter of stem portion of 38 groundnut varieties in Zaria, Nigeria. ---------- 39

Table 5. Nitrogen loss (N_L, gkg^{-1}) in leaf and stem portions of 38 groundnut varieties after 48h incubation in the rumen of N'dama steers. ---------- 41

Table 6. Forage yield (FOYLD, $kgha^{-1}$), leaf to stem ratio (LF:ST,%), CP,NDF and PD (g/kg), nitrogen loss (N_L,g/kg) and seed yield(SEYLD) of 21 groundnut varieties in Zaria, Nigeria. --43

ABBREVIATIONS/ACRONYMS

ADF	Acid detergent fibre
ADL	Acid detergent lignin
ANOVA	Analysis of variance
Ca	Calcium
cm	Centimetres
CP	Crude protein
Cv	Cultivar
d	days
DAS	Days after sowing
DM	Dry matter
DPYLD	Dry pod yield
ED	Effective degradabbility
EE	Ether extract
FOYLD	Forage yield
g	Grammes
h	Hour
ha	Hectare
hd	head
K	Potassium
kg	Kilogrammes
LFST	Leaf to stem ratio
m	Metres
mm	Millimetres
mo	months
N	Nitrogen
Na	Sodium

P	Phosphorus
PD	Potential degradability
RCBD	Randomised complete block design
SEYLD	Seed yield
SHLG	Shelling
t	Tonnes
TDN	Total digestible nutrients
W	Weight

CHAPTER ONE

1.0 INTRODUCTION

Forages constitute the basal and cheapest feed resource for ruminant livestock. In Nigeria, the native rangelands are the main sources of grazing for animals, complemented by crop residues from farmlands. However, increasing pressure on the rangelands has resulted in a decrease in available land area for grazing. In addition to the reduction in land area, the widespread burning of natural rangelands further drastically reduces the amount of forage on offer in the dry season. These combined effects on both the land area and productivity of the rangelands have made the contribution of crop residues more significant. Most cereal crop residues fed to livestock are of poor quality.

Tops and haulms of grain legumes have been recognised to be of very high nutritive value. This is evident from the efforts made by crop-livestock farmers in the drier zones of Nigeria and other parts of the tropics to produce and conserve legume tops/haulms. The general practice now indicates a strong crop/livestock linkage. Reports by Brumby (1987) indicated that in tropical Africa, 40 to 80% of the livestock are associated with mixed crop-livestock farming systems. Because of this close relationship between crop and livestock production, animal scientists are highly concerned by plant breeders' efforts to change the distribution of plant nutrients to the point that the nutritive value of the crop residues becomes too low for animals to obtain

even their maintenance requirements. Hart and McDowell (1985) reported a poor adoption by smallholder peasant farmers of either agronomic or animal-based interventions which were developed in isolation. It is clear that agronomists and animal scientists must work together to increase production from mixed farms and the extent of interaction between crops and livestock must be determined before interventions can be developed.

Groundnut haulms have been widely used in the farming system in Nigeria. Adu and Lakpini (1983) reported a daily gain of 130.7 g by lambs fed chopped groundnut haulms. Most of the groundnuts grown by farmers in the country are local varieties most of which are early maturing. They are harvested during the rainy season when the haulms cannot be properly cured so they rot away.

The Institute for Agricultural Research (IAR), Ahmadu Bello University (ABU), Zaria has been involved in breeding late maturing varieties with the aim of increasing pod/seed yield. Quite a number of varieties have been developed and are under trial to determine productivity. This trial was aimed at:

1. Assessing 38 varieties of late maturing groundnuts for pod/fodder dry matter yield, nutritive quality and rumen degradation characteristics of the fodder.
2. Selection of varieties with potential for seed and forage production.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Seed yield of groundnut.

Seed yield is the primary product in groundnut production. The seed is rich in energy and protein. A lot of work has been done on seed yield as it affects pod yield and dry matter production.

Varman *et al.* (1990) worked on the effect of seed size on dry matter (DM) production and pod yield of groundnut using eight cultivars. The 100-seed weights varied from 20 g to 47 g. Dry matter production at 15 d after sowing (DAS) and yield at 105 DAS were positively correlated with 100-seed weight. Pod yield was highest in cultivar (cv.) VG17 (8.81 g/plant) which had the largest seeds. Ponnuswamy (1986), in comparing graded and ungraded seeds of groundnut cvs. POL 1 and TMV 2 found that larger seed size gave increased number of mature pods/plant and greater haulm weight/plant. Mature haulm dry weight varied from 1.86t to 2.12t/ha for POL 1 and from 1.67t to 1.88t/ha for TMV 2. The effect of seed size and sowing depth was reported by Knauft *et al.* (1990) using Spanish cv. F435. The total number of plants harvested was reduced for the smallest seed size at the two sowing depths used. The number of plants harvested was also reduced at the deepest sowing depth. Pod yields were unaffected by sowing depths but seed size had a significant

effect on pod yield. The larger seed sizes produced the highest pod yields (2.66t/ha), largest pods and seeds and had a higher shelling percentage than the smaller seeds.

Shorter and Simpson (1987) worked on yield and quality variations across dates for groundnut grown under rainfed conditions. Yield reported for cv. Virginia bunch in the first year ranged from 1862 kg/ha at 133 (DAS) to 2432 kg/ha at 168 DAS while in the second year it was from 687 kg/ha at 201 DAS to 1618 kg/ha at 152 DAS. In both years seed yield and crop value exhibited bimodal responses to delayed harvesting with maximum values obtained at about 150 - 170 DAS. These responses were associated with the rainfall distribution and available soil moisture during flowering. No maturity index was sensitive enough to detect the two peaks for yield or crop value and therefore were not suitable for determining optimum harvest periods. Cultivar Red Spanish and White Spanish, when evaluated produced average seed yields of 1777 kg/ha and 1535 kg/ha respectively. For these, cultivar differences in yield and crop value over harvest dates were not significant. Chung *et al*. (1989) reported a significant increase in seed yield by early sowing. Reported values were 3.04t/ha and 2.77t/ha in cv. 01 dangkong and youngho dangkong respectively, when sown early compared with 1.89t and 1.78t/ha respectively when sown late. Sombatsiri and Nuan-on (1989) reported a production of more immature than mature pods when cv. Tainan 9 was harvested 80 - 90 d after emergence. Seed dry weight

and percent germination were highest 94 and 100 d after emergence, respectively. Later sowing did not improve seed yield or quality and risked exposure to unfavourable conditions. Leocov and Pavel (1989) reported seed yields of groundnut ranging from 0.9t/ha to 1.22 t/ha when sown on 6 dates of 5 d interval from 25 April to 20 May. Yields were 0.50, 0.56, and 0.65 t/ha when sown at 60,000, 80,000 and 100,000 plants/ha. The largest number of seedlings emerged from seeds sown at a depth of 5 - 7.5 cm (68 - 84%) compared to 64 - 70% from a depth of 2.5 cm and 60 - 66% from a depth of 10 cm.

Mamza (1996) in on-farm trials in Swaziland, reported a seed yield of 606.6 kg/ha for improved cv. ICG 221. This was higher than that of the local cv. (547.8 kg/ha) and Natal Common (549.6 kg/ha). Zengeni (1996) also reported seed yields of 10 cvs. of groundnut in field trials at Sigoro, Zimbabwe. The cv. ICGV SM 89001 gave the highest seed yield of 3.96 t/ha followed by ICGV 87480 and Makulu Red (both 3.13 t/ha).

2.2 Pod yield of groundnut

Pods serve to protect the seeds from damage, pest attack and diseases. The protective covering (husks) may also be useful after shelling out. Pod yields reported in the literature vary mainly due to varietal differences and cultural practices.

Prasad and Reddy (1992) reported pod yields of 2.47, 2.70, and 1.41t/ha for cv. TMV 2, ICGS(E)-21 and JL 24, respectively. Mozingo *et al*. (1992) in field trials with groundnut cv. NC7, NC9 and VA81B reported significant differences in pod yield among cultivars. Cultivar NC7 produced the highest yield value, percent extra-large seeds, and total seed number. Later harvesting dates produced higher yield value and total number of seeds and extra-large seeds in the first planting season. The same was obtained in the second planting season.

Han (1991) reported mean pod yields of 3.75t/ha with groundnut variety Tian-Fu 7. Jadhav *et al*. (1991), in their work with three groundnut cvs., reported highest pod yield of 1.62t/ha followed by 1.41t/ha. Rao and Rao (1991) reported that the delay in sowing cv. TMV 2 progressively reduced yield from 2.13t to 0.73t/ha. Desai *et al*. (1991) reported pod yield of 2.95t, 2.17t, and 0.91t/ha respectively, for cv. GAUG 1 sown on three different planting dates. Average pod yield of three cultivars sown at three different planting dates of 10 d interval were 1.37t, 1.32t and 1.12t/ha with early sowing giving the highest yield as reported by Dhillon and Dhalliwal (1989). The yield was 1.51t/ha in crops harvested 130 DAS compared with 0.95t to 1.49t in those harvested 100 to 120 or 140 DAS. Cultivars M13, M37 and PG No 1 gave yields of 1.49t, 1.20t and 1.11t/ha respectively. Saxena *et al*. (1991) reported a pod yield of 3.25t/ha for cv. RG 141 under irrigation. The

cultivar had medium-sized pods (85-90g/100pods), and 100seed weight of 40 - 45 g. Under rainfed conditions, cv. RG 141 yielded 0.21t and 0.54t/ha more than cv. JL 24 and AK 12-24 respectively. Variety TG19A was tried by Chandra *et al.* (1991b) at several sites in India. The average pod yield obtained was 2.7t/ha maturing at 125 DAS and with a shelling turn out of 72%. The seeds had a large size, having a 100-seed weight of 90g. Mittra and Rao (1989) tested eight cultivars of groundnut on the rainfed uplands of Bengal. Cultivar Kadiri 3 and ICGS-FDRS 4 gave highest pod yields of 2.4t and 2.39t/ha and had oil contents of 45.5% and 43.4% respectively compared with 1.62t and 44.3% for the standard cv. TMV 2. Ishag and Said (1989) worked on irrigated groundnut in Sudan and reported an average yield of 6.7t/ha. The main factors reported to have contributed to this yield were climate, soils, fertilizers and crop management. Thorat and Patil (1981) had trials under irrigation with five cultivars grown at three spacings. Cultivar SB-x1 gave the highest average pod yield of 1.91t/ha and had the highest seed oil content of 51.46% compared with 1.54 - 1.78t/ha and 42.23 - 48.75%, respectively, for other cultivars. Yields at spacings of 30cm x 15cm, 45cm x 15cm, 30cm x 30cm were 1.40t, 1.36t and 1.14 t/ha, respectively. Irrigated groundnut cultivation was studied in field trials in Niger and Bourkina Fasso. Pod yields were 1 - 3t/ha using occasional irrigation during the rainy season, 3 - 5 t/ha under controlled cultivation conditions during the dry season, 2 - 4t/ha in a small scale farm environment during

the dry season. High forage yields (2.8tDM/ha) were obtained. It was concluded that irrigation helps secure income from seed production in areas with uncertain rainfall. Groundnut forage was able to cover 50 - 100% cultivation costs due to its high quality and productivity and availability several times a year. In field trials throughout South Africa cv. Norden yielded an average of 5130 kg/ha against 4730 kg/ha for Spanish-type cv. Sellic. Norden requires a long growing season, performs best in regions with hot subtropical climate (Merwe and Swanevelder, 1989). An average yield of groundnut over a nine year period of trial had cv. Nakateyutaka giving 2.89t/ha while Tachimasari gave 2.58t. The components most closely related to yield were ripe pod yield and pod number. Flower number increased over a period of 30 days and the proportion of flowers producing pods was higher in Nakateyutaka than in Tachimasari and varied between years. Pod number decreased with increasing flower number. Leaf area index (LAI) was higher in Nakateyutaka than in Tachimasari (Khudo and Syodai, 1989).

2.3 Groundnut cultivars developed

Groundnut cultivars are usually developed for various ecological zones to help improve productivity. Lee *et al.* (1991) developed a large-seed, high-yielding Virginia type peanut variety which has few branches and a high shelling percentage of about 69%. It has a high oil content (53.3%), protein content of 23.8% and is resistant to lodging. This

cv. (Namdaettangkong) was recommended for the southern parts of Korea. Reddy (1991) introduced a Spanish groundnut variety with multiple resistance to diseases and insect pests. This variety (Ginar-1) has compact growth, clustered evenly-maturing pods containing 2 - 3 seeds. Manoharan *et al*. (1991) developed a drought resistant variety which produces average pod yields of 1.79t and 2.06t/ha under rainfed and irrigation conditions respectively. This variety matures in 100-105 days and its leaves remain green until maturity and pods have 1-3 seeds which ripen at the same time. Chandra *et al*. (1991a) introduced the cultivar "Somnath" which is high yielding, has a shelling percentage of 72.3%, a 100seed weight of 62g and an oil content of 50%. Its pest and disease resistance is, however, not superior to those of standard varieties. Another cultivar released in 1989 was ICGV 87141 (ICGS 76) by ICRISAT, for cultivation in India's zone five. It is adapted to low input rainfed cultivation. In a three year trial, it gave pod yield of 1.2 - 2.6t/ha and seed yield of 0.85 - 2.05t/ha, exceeding the standards by an average of 30 and 36% respectively. The shelling percentage was 73% and the 100 seed weight 44g. The seeds contain 43% oil and 20% protein. Hadjichristodoulou (1991) evolved a new cultivar HYQ 25 which out yielded the local by 2.3% in pod yield and 6.2% in seed yield. Oil and crude protein (CP) contents were similar.

Mohapatra *et al*.(1996) conducted a three year trial to find the most suitable Kharif groundnut varieties for sandy loams

of the north west zone of Orissa, India under rainfed conditions. OG-line genotypes were the most promising among the 13 varieties tested. Of these, OG86-15-1 gave the highest yield, (2247 kg pods/ha) followed by OG86-12-4 (2203 kg/ha) and OG86-5-9 (2105 kg/ha) under normal agronomic practices.

2.4. Fodder yield of groundnut

Groundnut fodder has been widely used as livestock feed supplement in farming systems where the bulk of feed available is from cereal-based crop residues. In farming systems in the northern part of Nigeria, groundnut has been widely cultivated for the dual purpose needs of seed and fodder. A closely related species cultivated in most parts of the world today is the perennial groundnut.

Field work on dual purpose legumes by Tanko *et al.* (1990) showed a fodder yield of groundnut ranging from 2.4 - 5.0 tDM/ha over a period of three years. Most of the leaves were retained at maturity. Relatively higher yields were recorded by Chiteka (1993) with trials involving three cvs. (Flamengo, Makulu Red, and Egret). Mean hay yields for the three culltivars at 141 DAS were 6.5 tDM/ha while CP content gradually decreased from 19.7% at 120 DAS to 11.8% at 160 DAS. Calub *et al.* (1986), in crop/livestock systems report, observed a residue yield of 11.2 - 19.7 tDM/ha in a groundnuts/maize (corn-on-the cob) mixture. In this system, the groundnut hay should help to improve the nutritive

quality of the fodder.

Rangkuti and Djajanegara (1983), in their work on the utilisation of agro-industrial by-products and wastes in Indonesia reported an average DM yield of 2.70 t/ha and total digestible nutrients (TDN) yield of 1.07 t/ha for groundnut straw. Muldoon (1986) reported over 3% nitrogen levels in the leaves of groundnut amongst other legume species, with mature stems having only half that concentration. All the species contained satisfactory levels of sulphur in both leaves and stem. Suriyajantratong and Sekanas (1985) reported average DM yields of whole groundnut vines ranging from 2282 to 2988 kg/ha. This excluded the roots. The average DM yield for groundnut vine tops (approximately 30 cm length from the top of the plant) was 638 kg/ha. Groundnut vine tops contained more CP (15.1% against 12.1%) but less neutral detergent fibre (NDF) than the whole groundnut vines.

Work on the establishment and yield of forage groundnut has been done extensively. The two species commonly cultivated are *Arachis pintoi* and *Arachis glabrata*. Several cultivars of these two species are in use for livestock feeding. Forage groundnut is rhizomatous, therefore survives underground in unfavourable conditions. This makes it difficult to eradicate, enabling it exhibit its perennial characteristics. Under good management it gives high fodder yields and it is persistent in terms of resistance to

grazing pressure.

Cook *et al.* (1991), worked on Pinto peanut cv. Amarillo with reports of its persistence and productivity in both tropical and subtropical environments. Annual dry matter yields of 5.2 -9.6 t/ha were obtained from Amarillo grown with *Brachiaria spp* producing 10.8 - 20.1 t/ha in the tropics. Irrigated and non-irrigated pure stands in the tropics produced 7.3 and 6.5 t/ha respectively. Amarillo is tolerant to low rates of phenoxy and glyphosate herbicides, resistant to *Puccinia arachidis* and *Mycosphaerella spp* (fungal infections). It also possesses moderately high field resistance to *Meloidogyne spp*. Cameron *et al.* (1989) further proved the persistence of perennial peanut in grazing trials in sub-tropical Australia. Over 30 tropical and sub-tropical legumes were screened for their ability to persist under heavy grazing and Amarillo was found to be amongst the five most persistent commercial species.

Ocumpaugh (1990) reported a total seasonal dry matter accumulation of 8 - 10 t/ha in experiments with *Arachis glabrata* cv. Florigraze:rainfall influenced DM production patterns and % leaf/stem. It lost its leaves in response to drought stress. Grof *(1985)* worked on the forage attributes of *Arachis pintoi* in oxisol soil type savanna conditions in association with *Brachiaria spp*. Total grass and legume DM yields were 20.5 - 25.4 t/ha yearly. *A.pintoi* in a mixture yielded 5.2 - 9.6 t/ha yearly when harvested at 4-wk

intervals.

Forage yields have been enhanced with fertilizer treatment. This also has a rippling effect on animal performance because of the increase in nutrient uptake by the plants. Valentim *et al.* (1987) worked on the yield and quality responses of tropical grasses, a legume and grass/legume associations as affected by fertilizer nitrogen in field trials. There were remarkable yield increases with fertilizer input. The grass species that gave the highest yields when grown alone also gave the highest yields when grown in association with *Arachis glabrata cv.* Florigraze. The legume without nitrogen, constituted more than 70% of forage harvested from intercrops giving yields 100 - 300% higher than those of grasses in monoculture. Total forage yields increased with increasing nitrogen rate except for the legume. Crude protein followed a similar pattern but less marked than that of DM yield. Irrespective of nitrogen rate, the legume competed successfully with grasses and weeds and benefitted from an application of nitrogen in early spring.

2.5. Groundnut fodder in animal rations

Groundnut haulms have been widely used in animal feeding with good responses. Their high nutritive value has been reported by Ayoade *et al.* (1983) and Ikhatua and Adu (1984). The fodder could be fed fresh, as silage or as hay. The hay form is the most commonly used in areas of feed shortage in

the tropics. Its high crude protein content which varies from 11.4 - 16.7% in some cultivars (Alhassan, 1985) helps immensely in augmenting protein deficiencies in cereal residue based diets.

Daily gains of 130.7 g by lambs was reported by Adu and Lakpini (1983) when the lambs were fed chopped groundnut haulms. This is useful information for crop-livestock farmers especially in northern Nigeria where groundnut haulms are widely used. Apart from fattening, it is used to augment the shortage and low quality of feed prevalent in this area for most part of the dry season.

Work done by Oyawoye *et al.* (1990) on some tropical legumes as replacements for alfalfa in rabbit diets proved further the quality of groundnut haulms. Forage meals of groundnut, cowpea, (*Vigna unguiculata*), lablab (*Lablab purpureus*) and Stylo (*Stylosanthes hamata*) were analysed for proximate and mineral composition at two stages of growth. They were generally higher in CP, ether extract (EE) and minerals at flowering stage than at maturity. All legumes were fairly high in Ca, Na and K but low in P. Their nutrient levels indicate that they compare well with Lucerne in chemical composition and therefore have a potential in replacing lucerne in rabbit diets in tropical areas.

Work on the physical form of haulms with regards to utilisation was conducted by Ayoade and Njewa (1986) in

their report on bean *(Phaseolus vulgaris)* and groundnut haulms. Chopping or grinding did not affect the voluntary dry matter consumption and digestibility coefficient of the nutrients of both feeds by goats. There were, however, significant physical form effects on the daily mean free water intake of the goats used in the experiment. In an earlier study by Ayoade *et al* (1983), residues of groundnut and bean (*Phaseolus vulgaris*) were evaluated as feed for indigenous Malawian goats. Nutrients in bean haulms were better digested and utilised by goats than those in groundnut haulms. The goats however, met their requirements of dry matter intake and digestible crude protein when adequate amounts of both roughages were made available.

In forage utilisation, species differences as regards performance do occur. Devendra (1982) reported on the utilisation of cassava, pigeon pea, leucaena and groundnut hay by sheep and goats. He observed a daily goat DM intake of 33.0 to 64.0 g/kg$W^{0.75}$ and 27.8 to 53.7 g/kg$W^{0.75}$ for sheep. Goats had a higher digestibility of DM, organic matter (OM), and crude fibre (CF); higher nitrogen retention than sheep. McBrayer *et al*. (1982), in their comparison of high quality groundnut hay and Tifton 44 Bermuda grass hay used 26 crossbred yearling heifers for 84 d. Overall average daily weight gain was 0.51 and 0.68 kg with groundnut hay and Bermuda grass hay respectively. This was due to an initial setback in adapting to groundnut hay feeding. Apparent digestibilities of DM and nitrogen-free extract (NFE) were

significantly greater for groundnut hay but the apparent digestibilities of CF and neutral detergent fibre were significantly greater for Bermuda grass. Ahmed and Pollot (1981) worked on the performance of Sudan zebu calves on three levels of concentrate and given groundnut hay *ad libitum*. The animals were fed concentrates containing 100, 150, or 200 g CP/kg DM up to 3 kg/animal for a period of up to 112 d. Daily average liveweight gain was 0.55, 0.75, and 0.85 kg and daily average hay dry matter and CP intake was 2.0, 2.5, and 2.7 kg and 443, 605, and 700 g for the three CP levels respectively. In comparing *Digitaria smutsii* hay and groundnut hay, Ikhatua and Adu (1984) reported daily gains by Red Sokoto goats of 59 g and 88 g, feed intake 494 and 603 g, feed efficiency 8.4 and 6.8, daily nitrogen (N) retention 38 and 43 g/kg$W^{0.75}$ and apparent nitrogen digested 61.8 and 67.9%, all significantly better for groundnut hay. It was concluded that groundnut hay was better and had adequate protein to maintain ruminants.

Secondary products of harvest could also be of use in achieving some weight gains at cheaper costs. Herrera and Combellas (1986) worked on the substitution of *Cenchrus ciliaris* hay for groundnut husks in complete rations for lambs. The lambs were fed (a) 30% *C. ciliaris* hay (b) 15% *C. ciliaris* and 15% groundnut husks or (c) 30% groundnut husks. After 63 d, daily liveweight gains were 156, 133.8 and 184.5 g for (a), (b), and (c) respectively. Corresponding daily intake values were 673, 695, and 755 g DM.

Closely related groundnut species (perennial groundnut mentioned earlier), mainly cultivated as sole crop or in mixed pastures with grasses give very satisfactory results in animal production. This is despite the fact that they have some anti-nutritive factors (tannins) known to tie up protein, thereby reducing digestibility. They have high levels of energy and nitrogen. Two species released are often used and are widely accepted: these are - *Arachis pintoi* and *Arachis glabrata cv. Florigraze*. These species compete favourably well with legumes commonly used in animal production. They have been reported to grow with aggressive grasses and persist under a wide range of grazing management conditions including continuous grazing. Heavy grazing appears to favour increased legume content, particularly in areas with little dry season stress.

Gelaye *et al.* (1990) worked on performance of animals fed alfalfa and Florigraze rhizoma peanut hay. Goats were fed twice daily with similar amounts of *Arachis glabrata* hay (P) or lucerne hay (A) or equal parts of the two hays in separate feeders (AP). Goats fed on "P" reportedly had similar intakes of DM but gained more body weight ($P<0.10$) and were more efficient ($P<0.10$) in converting DM into gain than those fed on "A" and "AP".

Forage *Arachis* gave a considerable increase in liveweight gains when animals were allowed to graze its pastures. Annual liveweight gains of steers grazing well-managed pastures with *Arachis pintoi* ranged from 160 - 200 kg/hd and

from 250 - 600 kg/ha. In Carimagua, Llanos of Colombia, with a well defined dry season (3 to 4 mo), maximum gains have been in the order of 180 kg/hd and 400 kg in an association of *Arachis pintoi* with *Brachiaria dictyoneura* cv. Llanero under rotational grazing. In the humid forest of Costa Rica (Guapiles), with no dry season stress, animal production on *B. brizantha* cv. Diamantes in association with A. *pintoi* has also been high both in terms of individual animal gains and production per hectare - 183 to 188 kg/hd and 282 to 458 kg/ha respectively (Lascano, 1993). Individual animal liveweight gains in pastures based on A. *glabrata* cv. Florigraze pasture have also been high. Sollenberger *et al* (1987) reported that in two grazing seasons, steers in Florigraze pasture gained, on average, 980 g/hd/d. In Brooksville, Florida, animal gains during the growing season ranged from 680 - 900 g/hd/d on a mixture of *Cynodon* and *Paspalum* sp with *A. glabrata* cv. Florigraze (Williams *et al.*, 1989). The productivity of A. *pintoi* based pastures in terms of animal performance has proved to be higher than that of other grass-legume mixtures even in areas with 3 - 4 mo dry season. For example in Carimagua, Colombia, the liveweight gain in pastures of *Andropogon gayanus-Stylosanthes capitata* or *Brachiaria decumbens/Pueraria phaseoloides* has been in the order of 200 - 300 kg/ha (Lascano and Estrada, 1989; Lascano and Thomas 1988), which is 30 - 40% less than the highest gain per hectare obtained in pastures based on A. *pintoi*.

Work on forage *Arachis* has shown that animal production on

its grazed pastures yields far more than on sole grass pastures. In the Llanos of Colombia, liveweight gains have been 20 to 200% greater in pastures with A. *pintoi* than on sole grass (Rincon *et al.*, 1992). Part of this variation appears to be related to quality of the companion grass and to the legume content in the forage-on-offer. In another work involving several *Brachiaria species* in association with *A. pintoi* and with legume content of 30 to 60% in all pastures, the greatest increment in liveweight gain (213%) over the sole grass was in the association of *A. pintoi* with *B. humidicola* - a grass known to be deficient in protein (Hoyos and Lascano, 1985). In a second grazing experiment in Carimagua also involving *B. humidicola*, but with a relatively low proportion of *A. pintoi* (10%), liveweight gains were only 36% higher in the grass-legume pastures compared with pastures with no legume (Lascano, cited by CIAT 1993). In Guapiles, Costa Rica, liveweight gain on *A. pintoi* pastures was 15% higher than on sole grass when legume content was low (6%) in the forage-on-offer and 45% higher when the pasture had a high legume content. Animal performance on pastures based on *A. glabrata* cv. Florigraze also appears to be related to legume content in the pasture. In Brooksville Florida, animal liveweight gains on an association of Florigraze with *Paspalum notatum - Cynodon dactylon* were 30% greater in a rainy spring than in a dry spring which was mainly related to more legume content in the pastures in rainy spring (Williams *et al.*, 1989).

The effect of forage *Arachis* on milk production has also

been reported. In an association of *A. pintoi* with aggressive giant star grass (*Cynodon nlemfluensis*), milk production increased 17% over that of the grass alone fertilized with nitrogen (Van Heurck, 1990). A similar increment in milk production was recorded on a pasture of *B. decumbens* - *A. pintoi* in Quilichao, Colombia (Lascano, cited by CIAT 1993). In this pasture, however, milk production increased significantly over the grass alone only when the proportion of *A. pintoi in the forage*-on-offer was at least 10%.

The ability of a forage to produce rapid regrowth after grazing gives it an edge over others in terms of animal production. One of the qualities of forage *Arachis* is its grazing persistence. Cameron *et al.*(1989) screened about 42 tropical and sub-tropical legumes for their ability to persist under heavy grazing on the east coast of Australia. The legumes were sown into cultivated strips in existing grassland which grew back into the strips. The most persistent species were *Aeschynomene falcata cv.* Bargoo, *Trifolium semipilosum cv.* Safai, *Arachis pintoi cv.* Amarillo and *Lotonis bainesii cv.* Miles. Perennial *Arachis* spp. 12121 persisted well although it was slow to establish. Amarillo was selected on the basis of fodder yield, quality and shed tolerance.

Forage *Arachis* species selected for use in pastures in association with grasses have proved their persistence. Dunavin (1992) examined the associative capacity of *A.*

glabrata cv. Florigraze with three grasses under cutting. *A. glabrata* was persistent after eight years when grown in association with "Tifton 44" Bermuda grass (*Cynodon dactylon)* and "Floralta" limpograss (*Hemarthia altissima)* but was not persistent with "Pensacola" bahia grass *(Paspalum notatum)*. In another study, the association of Florigraze with "Pensacola" bahia grass "Tifton Hybrid - 81" Bermuda grass and "Survenola" digit grass(*Digitaria* x *Umfolozi* cv. Survenola) resulted in a 100 - 300% increase in total dry matter yield compared with that of pure grass (Valentim *et al.*, 1987). In this study Florigraze was also able to compete with the sown grasses and weeds even when high levels of N were applied.

Legume persistence under grazing can only be assessed in long-term experiments under different management systems. In the Llanos of Colombia, the availability of *A. pintoi* in association with *B. humidicola* increased after four years of grazing regardless of stocking rate (CIAT, 1993). The content of *A. pintoi* in pastures with *B. dictyoneura* was relatively stable after three years of grazing with an alternate system and contrasting stocking rates. In this association, there was a trend for rotational grazing at a higher stocking rate to favour the grass over the legume. In contrast, in the humid forest of Costa Rica, a high stocking rate under rotational grazing favoured *A. pintoi*, whereas a low stocking rate favoured the grass. In sub-tropical areas such as Gainesville, Florida, *A. glabrata* cv. Florigraze has been productive and persistent over a wide range of grazing

frequencies and intensities (Ortega-S *et al.*, 1992). In these pastures, however, availability of Florigraze was reduced by high grazing intensities, regardless of rest period.

The evidence available shows that *A. pintoi* and *A. glabrata* can be associated with aggressive grasses and that both species are productive and persistent under a wide range of grazing management. But it would seem that in areas with little dry season stress, light grazing can result in low legume content in the pasture, with the consequence of decreasing long-term pasture productivity.

2.6. Nylon bag degradation

2.6.1. Degradation of dry matter and its fractions, *in sacco*

The degradation of dry matter in nylon bags gives an idea about the rate and extent to which a feed will be digested. It is a desirable thing for certain feeds to be degraded in the abomasum, i.e. by-passing the rumen of the animal. Such feeds as high protein concentrates are more useful to the animal when digested by enzymes in the abomasum. Roughages, however, need to digested in the rumen where microbes operate in order to be of more use to the animal. The degradation of many of the fractions of dry matter such as nitrogen, neutral detergent fibre (NDF) acid detergent fibre (ADF), acid detergent lignin (ADL), minerals etc., have been reported by several workers. These reports have been of help in selecting both basal and concentrate feeds in animal

nutrition for enhanced performance.

Jones *et al.* (1992) worked on the dry matter, nitrogen and mineral losses from nylon bags containing *Leucaena leucocephala*, *Calliandria calothyrsus* and *Calliandria surinamensis*. Samples were incubated for 12, 24, 36 and 48h in the rumen. *Leucaena* had much faster rates of loss of DM, N, P and Ca. It also had a faster rate of loss of S than *C. calothyrsus* whereas *C. surinamensis* showed very high levels of soluble S. Loss of NDF after 48h was also far greater with *Leucaena* than with *C. surinamensis* (46.4% against 10.3%), whereas with *C. calothyrsus* there appeared to be an increase in ADF and NDF. For all species, ADL appeared to be higher than initial plant values throughout the period of incubation, markedly so for *C. calothyrsus*. The *Calliandria* spp had higher levels of silica and aluminium in their DM. These findings and other reports indicate that *Calliandria* spp. investigated may not be suitable alternatives to *Leucaena* as ruminant feed. Jalc *et al.* (1983) worked on lignocellulose degradation using pure sulphate cellulose, barley straw and untreated beach sawdust. The amount of lignocellulose digested increased with the length of time that the sample was in the rumen except for untreated sawdust; 90% of the DM of the substrates had been digested in 48h. Untreated beach sawdust showed low digestibility. Ørskov *et al.* (1983) studied the disappearance rates of protein from fishmeal, meat and bone meal, soybean oil meal, cotton seed meal, linseed meal and groundnut oil meal in the rumens of sheep and cattle and reported no consistent

differences between degradabilities estimated with sheep and cattle. Siddons and Paradine (1984), however, reported that the rumen degradation of cotton seed, groundnut, soybean, meat and bone was significantly higher in sheep than cattle except for fishmeal. Ruminal casein degrading activity was higher with good than with poor quality roughage.

Hennessy *et al*. (1984) reported N losses from some protein meals after incubation for 15h in the rumen of steers. Fishmeal was the most resistant of those tested to fermentative breakdown in the rumen. It had 62 to 81% of total N undegraded. Vegetable meals were least resistant to degradation in rumen having 48 to 55% of total N undegraded. Meat meals were the most variable group with 38 to 61% of total N undegraded. Stern and Satter (1984) also worked on N disappearance in the rumen after 1 to 24 h. Correlations between N disappearance and *in vivo* measurements increased from -0.08 after 1h to 0.68 after 24h. Degradation values for protein sources using Holstein steers and cows by Ha and Kenelly (1984) were: 53.6, 65.8, 41.4, 28.9, 65.5, 22.2, 71.2, and 70.8% for soybean meal, canola meal, dehydrated lucerne meal, fishmeal, blood-treated canola meal, formalin-treated canola meal, 30% blood-treated canola meal and 50% blood-treated canola meal, respectively. Protein degradation and alteration of amino acid composition of feeds during incubation in the rumen was studied by Aitova *et al*.(1985) with reports that protein degradation occurred most vigorously, accompanied by a fall in amino acid concentration during the first two hours of incubation of

feeds in the rumen of cows fed a diet of silage, hay and concentrates. The ratio of non-essential to essential amino acids increased slightly during incubation. The rate of degradation of feed protein in the rumen depended on the type of feed, and it decreased in the order: wheat, barley, lucerne hay and soybean oil meal. Deville *et al.*(1980) studied the rumen degradability of some feeds using the nylon bag technique and found the rate of degradation of fishmeal to be slow confirming its high value as a slowly degraded protein supplement. Copra cake and lucerne forage were next in rank in providing by-pass protein and rice bran and cassava tuber were of similar quality in providing by-pass starch. Lindberg (1982) observed a slow rate of DM and N degradation for dried brewers' grain, coconut meal and cotton seed meal, but very rapid for dried sugar beet pulp and starea; that of soybean meal and barley were moderate. The composition of diet affected rate of degradation of DM and N, but that of DM was more highly affected. Kristensen *et al.* (1982) reported an effective protein degradation of 73%, 73% and 50% for soybean meal, cottonseed meal and fish meal, respectively, when incubated in the rumen.

Kumaresan *et al.* (1984) reported higher DM disappearance values for millet and maize than that of sorghum after 48 h of incubation. The differences were, however, not significant. There was an increase in trace mineral content after 48 h. Armentano *et al.* (1986) reported protein digestion predicted from *in situ* data as 42%, 73% and 83% for brewers' dried grain, wet brewers' grain and soybean

meal, respectively. Sampath and Sivaraman (1987) reported disappearance values for five cakes incubated in the rumen. Disappearance of DM and protein in 3 - 24h was, from groundnut cake 25-80% and 28-44%; from gingelly cake 48-92% and 68-95%; from rubber seed cake 31-74% and 27-96%; and from coconut cake 10-64% and 3-38%, respectively. The effective protein degradability estimated at an outflow rate of 0.05/h was 66.8%, 85.1%, 68.6% and 19.1% for the respective cakes. Coconut cake was resistant to microbial degradation in the rumen thereby proving to be a good source of by-pass protein.

CHAPTER THREE

3.0. EXPERIMENTAL PROCEDURE

Thirty-eight varieties of groundnut (*Arachis hypogea L.*) were planted at the Institute for Agricultural Research (IAR) farm in the 1995 planting season. They were planted on June 20 and harvested on October 24 of same year. Total annual rainfall for the year, which occurred largely between April and October was 867mm. The soil type at the experimental site as reported by Moberg and Esu (1989), are Alfisols - loamy in texture.

Each groundnut variety was planted in a plot measuring 3m x 5m. The plant spacing was 20cm between stands and 75cm between ridges. Each of the 38 varieties was planted in three replicates in a Randomised Complete Block Design (RCBD). Blocking was done against gradient of the field. Weeding was done three times during the experimental period. Phosphate fertilizer was applied at the rate of 300kg P_2O_5/ha. After harvest, forage dry matter yield (FOYLD), dry pod yield (DPYLD), seed yield (SEYLD), shelling out values (SHLG), nylon bag degradation of the leaf and stem portions, nitrogen (N) content and neutral detergent fibre (NDF) contents were determined.

3.1 Forage dry matter and pod yield determination

Ten plants were harvested per replicate and separated into pods and fodder. The two fractions of fresh fodder and fresh pods were separately weighed. Sub-samples of the fodder were taken and weights determined after which they were separated

into leaf and stem, weighed fresh before they were oven dried at 60°C for 48h. A low drying temperature was used to reduce the probability of the formation of Maillard products (Van Soest and Mason, 1991) which could interfere with protein solubility and fibre analysis. The dry leaf and stem fractions were weighed to determine leaf:stem (LFST) ratios on a dry matter basis. Forage dry matter yield was also determined.

Pod subsamples were also taken, weighed fresh sun-dried, before dry weights were recorded. The pods were then shelled before shelling values and seed weight per hectare were determined.

3.2 Sample preparation and chemical analysis

Samples were prepared for rumen degradation study,nitrogen (N) and neutral detergent fibre (NDF) analyses. One half of the leaf and stem fractions was ground to pass through 2.5 mm screen while the other half was ground to pass through 1.0 mm screen. The 2.5 mm size samples were used for rumen degradation study while the 1.0 mm samples were used for N and NDF analyses.

Nitrogen was determined by the Kjeldhal method (AOAC, 1990). Crude protein was estimated as N X 6.25. Neutral detergent fibre was determined according to procedures described by Goering and Van Soest (1970).

3.3 *In sacco* dry matter degradation

The samples of leaf and stem fractions ground to pass through 2.5 mm screen were used to determine rumen degradation characteristics (Ørskov *et al.*, 1980) at the International Livestock Reseach Institute (ILRI), Ibadan between April and June 1996. Three rumen-fistulated N'dama (*Bos indicus*) steers with average weight of 250 kg and three years old were used. They were grazed daily on a grass-legume pasture of *Panicum maximum* and *Centrosema pubescens* mixture and supplemented with wheat bran given at 2 kg per head daily. Animals had free access to water and mineral salts. Samples were incubated for 6, 12, 24, 48, 72, and 96 h in the rumen. The zero hour was determined by using two replicates. The nylon bags were initially dried in the oven and their weights taken. Nylon bags of 13 cm x 6 cm with mesh size of about 50um were used. Three grammes of each sample was measured and placed into the nylon bag of known weight. Samples of each variety were replicated three times for each incubation time period. The bags were then attached to a rubber hose by use of rubber bands and then incubated in the rumen. For the zero hour, the samples were placed in warm water at 39°C for an hour before washing in cold water to determine "washing loss".

The bags incubated in the rumen were withdrawn at the specified time periods and placed in water to prevent further fermentation and also for temporary washing. Thorough washing was then done under tap water for about 15 min before the bags containing the residue were detached

from the plastic hose and dried to a constant weight at 60°C for 48h in the oven. The residues in each case were weighed and the dry matter disappearance determined. Nitrogen loss (N_L) for both leaf and stem fractions after 48h of incubation was determined as the difference between initial nitrogen (N_o) and nitrogen obtained (N_D) after 48h of incubation, divided by the initial nitrogen and expressed as a percentage, thus:

$$N_L = \frac{N_o - N_D}{N_o} \times 100$$

3.3.1 Degradation characteristics

Degradation data were fitted to the non-linear equation suggested by Ørskov and McDonald (1979) to determine dry matter degradation as: $P = a + b\,(1 - e^{-ct})$,

where P = degradation after time 't'

a = the intercept of the degradation curve at time zero which also represents the soluble fraction.

b = the insoluble but degradable fraction.

c = rate constant of degradation of 'b'

t = the time of degradation

(a + b) = the potential extent (asymptote) of degradation.

The effective degradability (ED) was calculated as:

ED = a+([bc]/[c+k]), with 'k' being the particulate outflow rate from the rumen. Degradation constants were determined using PROC NLIN procedures (SAS, 1989). Bhargava

and Ørskov (1987) considered an outflow rate of 5% per hour for the estimation of effective degradability of feeds for beef cattle among others.

3.4 Statistical analysis

Data were analysed using the Statistical Analysis Systems (SAS) package (SAS, 1989).Forage yield, leaf to stem ratio, seed yield, shelling percent and pod yield for all the varieties were analysed as a randomised block design with three field replications. The rumen degradation data were analysed as a split-plot design, using plant parts (leaf and stem) as main plots and groundnut varieties as sub-plots with three replicates (fistulated animals). The replicate by plant part mean square was used as error term to test significance for plant part. The means were compared using the Least Significant Differences (LSD).

CHAPTER FOUR.

4.0 RESULTS

4.1 Dry pod yield

Table 1 shows the pod yield, shelling, seed yield, forage yield and leaf to stem ratio of the 38 varieties of groundnut obtained from Institute for Agricultural Research (IAR), Zaria Nigeria. There were significant ($P < 0.05$) differences among varieties as regards pod and seed yield.

The pod yield varied among varieties from 1457 kg to 3980 kg/ha. These yields were grouped into high, medium and low as follows: 2579 kg to 3980 kg/ha, 1969kg to 2578 kg/ha and below 1969 kg/ha respectively. Variety ICGV 86229 had already sprouted at harvest time showing its dormancy period had already elapsed. It had most of its leaves shed at harvest also.

In the present study, variety ICGV 86868 had the highest pod yield of 3980 kg/ha while RG 1 ranked lowest with 1457 kg/ha (Table 1). Varieties in the high class were ICGV 86868, M572-80I, M554-76, ICGV 86222, UGA 1, 59-85A, M170-80I, 42-85, M558-79, 1691-79, M354-81 and RMP 12. Varieties in the medium class were M554-79I, 219-85, 249-85, UGA 2, ICGV 86230, 530-80I, UGA 5, ICGV 86347, 2546-79, ICGV 86229, ICGV 86869, ICGV 86191, M516-79I, 176-85A and ICGV 86231. Varieties in low class were M521-79, 49-85, UGA 7, M569-80I, UGA 11, M364-80I, 16-85, ICGV 86220, 82-85, UGA 12 and RG 1. There were 12 varieties in the high, 15 in the medium and 11 in the low groups as regards pod yield.

TABLE 1: Dry pod yield (DPYLD), shelling (SHLG), seed yield (SEYLD), forage yield (FOYLD) and leaf to stem ratio (LF:ST) of 38 groundnut varieties in Zaria, Nigeria.

VARIETY	DPYLD, kgha^{-1}	SHLG, %	SEYLD, kgha^{-1}	FOYLD, kgha^{-1}	LF:ST, %
ICGV 86868	3980^{a}	51^{e}	1999^{ab}	2779de	27^{e}
M572-80I	3107^{b}	71^{ab}	2218^{a}	5745^{bc}	39^{cd}
M554-76	3052^{b}	70^{b}	2168^{ab}	6035^{bc}	42^{cd}
ICGV 86222	3042^{bc}	73^{ab}	2216^{a}	4847^{cd}	27^{e}
UGA 1	3041^{bc}	63^{cd}	1969^{ab}	6036^{bc}	35de
59-85A	2980^{bc}	73^{ab}	2170^{ab}	5747^{bc}	32de
M170-80I	2874^{bc}	70^{b}	1963^{ab}	7463^{a}	65^{a}
42-85	2849^{bc}	70^{b}	2003^{ab}	6906^{a}	37^{d}
M558-79	2715^{bc}	62^{cd}	1649^{bc}	4554^{cd}	25^{e}
1691-79	2673^{bc}	66^{bc}	1747^{bc}	4543^{cd}	27^{e}
M354-81	2658^{bc}	73^{ab}	1954^{ab}	6248^{bc}	39^{cd}
RMP 12	2579^{bc}	75^{a}	2193^{a}	5227^{c}	70^{a}
M554-79I	2496^{c}	73^{ab}	1812^{bc}	4030^{d}	37^{d}
219-85	2494^{c}	73^{ab}	1828^{b}	5715^{bc}	49^{bc}
249-85	2463^{cd}	74^{ab}	1835^{b}	5860^{bc}	36de
UGA 2	2434^{cd}	73^{ab}	1789^{bc}	6459^{b}	39^{cd}
ICGV 86230	2420^{cd}	68^{bc}	1639^{bc}	3097de	12^{f}
530-80I	2419^{cd}	73^{ab}	1777^{bc}	5255^{c}	35de
UGA 5	2357^{cd}	72^{ab}	1693^{bc}	6175^{bc}	35de
ICGV 86347	2337^{cd}	68^{bc}	1588^{bc}	2703de	35de
2546-79	2301^{cd}	71^{ab}	1630^{bc}	7831^{a}	34de
ICGV 86229	2274^{cd}	69^{bc}	1210^{c}	3192de	13^{f}
ICGV 86869	2272^{cd}	64^{cd}	1455^{c}	2999de	62^{ab}
ICGV 86191	2269^{cd}	61^{cd}	1378^{c}	2882de	22^{e}
M516-79I	2210^{cd}	70^{b}	1550^{bc}	5458^{bc}	51^{bc}
176-85A	2209^{cd}	67^{bc}	1480^{c}	2177de	34de
ICGV 86231	2197^{cd}	65^{c}	1425^{c}	3298de	22^{e}
M521-79	2196^{cd}	67^{bc}	1451^{c}	5390^{bc}	35de
49-85	2166^{cd}	73^{ab}	1582^{bc}	5561^{bc}	57^{b}
UGA 7	2122^{cd}	69^{bc}	1468^{c}	5483^{bc}	41^{cd}
M569-80I	2044^{cd}	72^{ab}	1474^{c}	5402^{bc}	55^{bc}
UGA 11	1969^{cd}	60^{d}	1186^{c}	4693^{cd}	28^{e}
M364-80I	1917^{d}	71^{ab}	1361^{c}	5491^{bc}	48^{c}
16-85	1861^{d}	66^{bc}	1248^{c}	6138^{bc}	48^{c}
ICGV86220	1824^{d}	62^{cd}	1135^{c}	3893de	22^{e}
82-85	1805^{d}	72^{ab}	1301^{c}	3789de	26^{e}
UGA 12	1749^{d}	71^{ab}	1248^{c}	3660de	49^{bc}
RG 1	1457^{d}	53^{e}	729^{d}	4178^{cd}	25^{e}
SED, (df=74)	422.3	3.1	267.2	862.6	6.5

^{abcde}. Means within the same column bearing different letter superscripts differ significantly ($P<0.05$).

4.2 Shelling percent and seed yield

The shelling percent of the 38 groundnut varieties studied is presented in Table 1. It varied among varieties from 51% for ICGV 86868 to 75% for RMP 12.

Seed yield is also presented in Table 1. It varied among the 38 varieties from 729 kg/ha for variety RG 1 to 2218 kg/ha for M572-80I. The high yielding varieties had seed yields varying from 1954 kg to 2218 kg/ha, the medium yielding varieties from 1550 kg to 1955 kg/ha while the low cadre had below 1550 kg/ha.

4.3 Forage yield and leaf to stem ratio

The forage yield and leaf to stem ratio are presented in Table 1. The forage yield varied among varieties from 2177 kg/ha to 7831 kg/ha . Variety 176-85A had the lowest while variety 2546-79 had the highest forage yield. All varieties except ICGV 86229 retained their leaves at harvest. Twenty-one varieties gave a forage yield of more than 5000 kg/ha.

The leaf to stem ratio varied among varieties from 12% to 70%. Variety ICGV 86230 had the lowest leaf to stem ratio while variety RMP 12 had the highest.

4.4 Chemical composition

Table 2 shows the crude protein and neutral detergent fibre contents of leaf and stem portions of the 38 groundnut varieties. Leaf CP concentration of all varieties was above 120 g/kg DM. Only seven varieties however, had stem CP

concentrations greater than 120 g/kg DM. Variety ICGV 86220 had the lowest leaf CP concentration and variety 49-85 had the highest. Stem CP concentration was lowest in variety M364-80I and highest in variety UGA 5. With the exception of variety M569-80I, the leaf NDF concentration of all varieties was below 400 g/kg DM.

In contrast, 36 out of 38 varieties recorded stem NDF concentration of more than 400 g/kg DM. Leaf NDF concentration was lowest in variety ICGV 86220 and highest in M569-80I. Stem NDF concentration was lowest in variety M170-80I and highest in variety UGA 7. Generally, the leaf portion had relatively higher CP but lower NDF concentration than the stem.

TABLE 2: Crude protein and neutral detergent fibre of leaf and stem portions of 38 groundnut varieties in Zaria, Nigeria.

VARIETY	CP, gkg^{-1}		NDF, gkg^{-1}	
	Leaf	Stem	Leaf	Stem
ICGV86868	127	118	276	402
M572-80I	168	126	257	423
M554-76	159	114	268	410
ICGV86222	160	120	292	378
UGA 1	154	109	277	425
59-85A	163	116	291	448
M170-80I	148	98	293	355
42-85	171	105	299	402
M558-79	162	112	300	502
1691-79	161	105	300	504
M354-81	151	118	274	412
RMP 12	155	117	377	398
M554-79I	171	121	311	432
219-85	140	108	304	453
249-85	158	121	292	479
UGA 2	160	114	291	400
ICGV86230	156	98	342	460
530-80I	157	113	313	451
UGA 5	137	136	280	447
ICGV86347	155	118	288	411
2456-79	157	119	353	470
ICGV86229	146	93	264	469
ICGV86869	161	113	268	407
ICGV86191	149	94	285	416
M516-79I	169	108	331	424
176-85A	156	107	300	483
ICGV86231	156	104	289	424
M521-79	168	107	302	441
49-85	182	122	274	450
UGA 7	163	111	332	512
M569-80I	162	103	472	498
UGA 11	172	97	334	480
M364-80I	160	90	300	436
16-85	171	104	304	414
ICGV86220	125	108	225	497
82-85	160	103	306	400
UGA 12	176	122	326	431
RG 1	159	129	330	430
SE	11.9	10.3	39.5	37.1

4.5 Degradation characteristics of groundnut leaf and stem.

The soluble or more readily degradable fraction (a), degradable fraction (b), rate constant of degradation (c), potential degradability (PD) and the effective degradability (ED) of dry matter of the leaf and stem portions are presented in Tables 3 and 4.

Leaf soluble DM fraction was lowset in variety 176-85A (54 g/kg DM) and highest in variety 59-85A (436 g/kg DM) as shown in Table 3. Leaf degradable DM fraction was lowest in variety 219-85 (380 g/kg DM) and highest in variety ICGV 86229 (624 g/kg DM). The slowest rate of DM degradation was recorded in variety 59-85A (0.013%/h) and the fastest in variety ICGV 86347 (0.117%/h). Potential degradability was lowest in variety 176-85A (678 g/kg DM) and highest in variety RG 1 (914 g/kg DM). Variety UGA 7 had the lowest effective degradability of 536 g/kg DM while variety 42-85 had the highest effective degradability of 626 g/kg DM.

The stem soluble DM fraction had its lowest value as 158 g/kg DM recorded in variety ICGV 86347, while the highest value 277 g/kg DM was recorded in variety M554-79I (Table 4). The degradable DM fraction was lowest in variety RG 1 (325 g/kg DM) and highest in 176-85A (471 g/kg DM). The rate of degradation was slowest in variety 176-85A (0.012%/h) and fastest in variety M569-80I (0.069%/h). Potential degradability was lowest in variety IGCV 86220 (538 g/kg DM) and highest in variety 176-85A (702 g/kg DM). The effective degradability was lowest in variety 176-85A (379 g/kg DM) while variety RG 1 had the highest (475 g/kg DM).

TABLE 3: Degradation characteristics of dry matter in leaf portion of 38 groundnut varieties, Zaria, Nigeria.

VARIETY	a[1], gkg^{-1}	b[2], gkg^{-1}	c[3], %hr^{-1}	PD[4], gkg^{-1}	ED[5], gkg^{-1}
ICGV 86868	282^{e}	488^{ef}	0.035^{ef}	770^{fg}	544^{j}
M572-80I	307de	497de	0.043^{d}	804de	560^{hi}
M554-76	369^{bc}	493^{def}	0.024^{gh}	862^{bc}	588^{e}
ICGV 86222	359^{bc}	437^{gh}	0.031^{f}	796^{ef}	579^{f}
UGA 1	412^{a}	400^{ij}	0.030^{f}	812de	610^{bc}
59-85A	436^{a}	483^{def}	0.013^{i}	908^{ab}	585^{ef}
M170-80I	319^{d}	473^{ef}	0.035^{ef}	792^{ef}	575^{fg}
42-85	406^{ab}	427^{gh}	0.032^{f}	833^{cd}	626^{a}
M558-79	348^{c}	470^{f}	0.031^{f}	818de	578^{fg}
1691-79	288^{e}	488^{ef}	0.036^{ef}	776^{ef}	554^{i}
M354-81	358^{bc}	460^{f}	0.033^{f}	818de	599^{cd}
RMP 12	378^{b}	434^{gh}	0.026^{g}	812de	576^{fg}
M554-79I	270^{ef}	507^{ef}	0.054^{c}	777^{ef}	595de
219-85	418^{a}	380^{j}	0.020^{h}	798^{e}	570^{g}
249-85	368^{bc}	404^{ij}	0.033^{f}	773^{f}	579^{f}
UGA 2	300de	557^{bc}	0.029^{f}	857^{bc}	572^{g}
ICGV 86230	410^{ab}	403^{ij}	0.027^{g}	814de	592de
530-80I	371^{bc}	462^{f}	0.025^{gh}	834^{cd}	578^{f}
UGA 5	298de	521^{cd}	0.038^{ef}	819de	588^{e}
ICGV 86347	269^{ef}	473^{ef}	0.073^{b}	741^{g}	604^{c}
2546-79	335^{cd}	452^{f}	0.046^{d}	787^{ef}	609^{bc}
ICGV 86229	249^{f}	603^{a}	0.031^{f}	852^{c}	548^{i}
ICGV 86869	340^{cd}	427^{gh}	0.048^{d}	767^{fg}	600^{cd}
ICGV 86191	380^{b}	443^{g}	0.030^{f}	823^{d}	596de
M516-79I	319^{d}	545^{c}	0.023^{gh}	864^{bc}	551^{i}
176-85A	54^{g}	624^{a}	0.117^{a}	678^{h}	551^{i}
ICGV 86231	369^{bc}	415^{h}	0.028^{f}	783^{ef}	569^{g}
M521-79	382^{b}	458^{f}	0.033^{f}	839^{cd}	614^{b}
49-85	398^{ab}	473^{ef}	0.026^{g}	871^{bc}	613^{b}
UGA 7	316de	562^{bc}	0.019^{hi}	879^{b}	536^{k}
M569-80I	348^{c}	411^{i}	0.040^{e}	759^{fg}	581^{f}
UGA 11	305de	443^{g}	0.037^{ef}	748^{g}	548^{i}
M364-80I	355^{bc}	491^{def}	0.022^{gh}	845^{cd}	563^{h}
16-85	313de	480^{ef}	0.049^{cd}	793^{ef}	609^{bc}
ICGV 86220	276^{ef}	485^{ef}	0.040^{e}	761^{fg}	552^{i}
82-85	348^{c}	456^{f}	0.035^{ef}	805de	590^{e}
UGA 12	336^{cd}	496de	0.033^{f}	832^{cd}	597^{d}
RG 1	341^{cd}	573^{b}	0.017^{hi}	914^{a}	548^{i}
SED, (df=74)	24.5	22.0	0.0045	17.7	5.1

^{abcde} Means within the same column, bearing different letter superscripts differ significantly ($P<0.05$).

[1]: Soluble fraction

[2]: Insoluble, but degradable fraction

[3]: Rate of degradation of 'b'

[4]: Potential degradability (a + b)

[5]: Effective degradability

TABLE 4: Degradation characteristics of dry matter in stem portion of 38 groundnut varieties, Zaria, Nigeria.

VARIETY	a[1], gkg^{-1}	b[2], gkg^{-1}	c[3], %hr^{-1}	PD[4], gkg^{-1}	ED[5], gkg^{-1}
ICGV 86868	204^{d}	419^{bc}	0.039^{de}	623de	442de
M572-80I	230^{c}	409^{bc}	0.040^{de}	639^{cd}	461^{cd}
M554-76	215^{cd}	399^{cd}	0.033^{e}	614de	424^{g}
ICGV 86222	271^{ab}	356de	0.038^{e}	628^{cd}	467^{b}
UGA 1	189de	437^{b}	0.048^{c}	626^{d}	456^{c}
59-85A	253^{b}	372^{d}	0.040^{de}	625^{d}	444^{d}
M170-80I	258^{ab}	405^{c}	0.023^{g}	663^{bc}	428^{fg}
42-85	218^{cd}	373^{d}	0.031^{f}	591^{ef}	403^{i}
M558-79	258^{ab}	364de	0.033^{e}	622^{cd}	443de
1691-79	227^{c}	355de	0.037^{e}	582^{f}	423^{g}
M354-81	250^{bc}	365^{d}	0.047^{c}	615de	473^{ab}
RMP 12	227^{c}	348de	0.050^{c}	575^{f}	442de
M554-79I	277^{a}	359de	0.035^{e}	637^{cd}	469^{b}
219-85	194de	397^{cd}	0.060^{b}	591^{ef}	456^{c}
249-85	253^{b}	333^{e}	0.038^{e}	586^{ef}	438^{e}
UGA 2	237^{bc}	411^{bc}	0.031^{f}	648^{c}	445^{d}
ICGV 86230	223^{cd}	367^{d}	0.026^{fg}	590^{ef}	391^{j}
530-80I	197de	381^{cd}	0.045^{d}	581^{f}	425^{g}
UGA 5	265^{ab}	372^{d}	0.037^{e}	637^{cd}	468^{b}
ICGV 86347	158^{e}	445^{ab}	0.067^{a}	603^{e}	461^{cd}
2546-79	174^{e}	432^{bc}	0.030^{f}	606de	388^{k}
ICGV 86229	249^{bc}	426^{bc}	0.020^{g}	675^{b}	414^{h}
ICGV 86869	231^{bc}	378^{cd}	0.037^{e}	609de	431^{f}
ICGV 86191	189de	411^{bc}	0.043^{de}	599^{ef}	430^{f}
M516-79I	178^{e}	425^{bc}	0.053^{c}	603^{e}	447^{d}
176-85A	230^{c}	471^{a}	0.012^{h}	702^{a}	379^{l}
ICGV 86231	195de	414^{bc}	0.043^{de}	609^{cd}	438^{e}
M521-79	192de	430^{bc}	0.035^{e}	623de	423^{g}
49-85	177^{e}	399^{c}	0.059^{b}	576^{f}	438^{e}
UGA 7	264^{ab}	368^{d}	0.030^{f}	631^{cd}	425^{g}
M569-80I	200de	393^{cd}	0.069^{a}	593^{ef}	471^{ab}
UGA 11	192de	442^{ab}	0.042^{de}	634^{cd}	447^{d}
M364-80I	265^{ab}	328^{c}	0.033^{e}	594^{ef}	436^{e}
16-85	162^{e}	435^{bc}	0.056^{b}	597^{ef}	446^{d}
ICGV 86220	158^{e}	380^{cd}	0.053^{c}	538^{g}	401^{i}
82-85	175^{e}	437^{b}	0.036^{e}	612de	414^{h}
UGA 12	190de	381^{cd}	0.060^{b}	571^{f}	443de
RG 1	270^{ab}	325^{c}	0.054^{bc}	595^{ef}	475^{a}
-----SED, (df=74)	19.1	26.3	0.0058	21.2	3.9

^{abcde} Means within the same column, bearing different letter superscripts differ significantly (P<0.05).

[1]: Soluble fraction

[2]: Insoluble, but degradable fraction

[3]: Rate of degradation of 'b'

[4]: Potential degradability (a + b)

[5]: Effective degradability

The soluble and degradable fractions, potential and effective degradabilities of the leaf were higher than those of the stem portion.

4.6 Nitrogen loss in the rumen

Nitrogen loss of leaf and stem portions after 48h degradation are presented in Table 5. Nitrogen loss varied among the varieties studied. Leaf N loss was lowest in variety ICGV 86868 (177 g/kg DM) while variety RG 1 had the highest N loss of 579 g/kg DM in the stem portion. Nitrogen loss values were generally higher in the stem portion for all varieties except UGA 11 and M364-80I.

TABLE 5: Nitrogen loss (N_L, gkg^{-1}) in the leaf and stem portions of 38 groundnut varieties after 48h incubation in the rumen of N'dama steers.

Variety	*NITROGEN LOSS Leaf	Stem
UGA 11	495	394
176-85A	438	497
ICGV 86231	426	461
1691-79	423	441
M572-80I	405	490
M554-76	365	550
RMP 12	351	513
530-80I	347	475
UGA 12	345	549
16-85	343	470
M516-79I	332	457
UGA 7	330	545
42-85	326	452
M364-80I	324	250
249-85	321	562
M569-80I	317	496
UGA 2	316	418
49-85	313	508
M170-80I	312	417
59-85A	308	535
M554-79I	296	503
M558-79	278	514
M521-79	276	456
2546-79	275	492
ICGV 86230	273	399
ICGV 86347	258	516
ICGV 86220	255	462
RG 1	255	597
ICGV 86229	248	415
ICGV 86869	240	464
219-85	237	436
ICGV 86222	231	469
ICGV 86191	227	391
UGA 1	215	417
82-85	207	445
UGA 5	206	514
M354-81	194	497
ICGV 86868	177	508

* = Nitrogen loss in the rumen after 48h incubation.

$$N_L = \frac{N_o - N_D}{N_o} \times 100$$

N_L = Nitrogen loss.
N_o = Nitrogen content of initial sample.
N_D = Nitrogen content after degradation of sample in the rumen.

Among the high forage yielding varieties, 21 had forage yields varying from 5227 kg (RMP 12) to 7831 kg/ha (2546-79). These varieties are presented in Table 6. The parameters in Table 6 are pooled from the other Tables to give a clearer picture for comparison. Table 6 indicates that the best four varieties in terms of forage yield are: 2546-79, M170-80I, 42-85 and UGA 2. Variety M170-80I which ranked second best in forage had better values of leaf to stem ratio, NDF (low fibre content), potential degradability, leaf/stem portion N loss than the first variety (2546-79).

The best four varieties in terms of seed yield are also found in the high forage yielding group (Table 6). They are: M572-80I, RMP 12, 59-85A and M554-76.

TABLE 6: Forage yield (FOYLD, kg/ha), leaf to stem ratio (LF:ST,%), CP,NDF and PD(g/kg), N loss (N_L,g/kg) and seed yield(SEYLD, kg/ha) of 21 groundnut varieties , Zaria Nigeria.

VARIETY	FOYLD	LFST	CRUDE PROTEIN LEAF	CRUDE PROTEIN STEM	N D F LEAF	N D F STEM	P D LEAF	P D STEM	NL LEAF	NL STEM	SEYLD
2546-79	7831^{a}	34^{de}	157	119	313	470	787^{ef}	606^{de}	275	492	1630^{bc}
M170-80I	7463^{a}	65^{a}	148	98	293	355	792^{ef}	663^{bc}	312	417	1963^{ab}
42-85	6906^{a}	37^{d}	171	105	299	402	833^{cd}	591^{ef}	326	452	2003^{ab}
UGA 2	6459^{b}	39^{cd}	160	114	291	400	857^{bc}	648^{c}	316	418	1789^{bc}
M354-81	6248^{bc}	39^{cd}	151	118	274	412	818^{de}	615^{de}	194	497	1954^{ab}
UGA 5	6175^{bc}	35^{de}	137	136	280	447	819^{de}	637^{cd}	206	514	1693^{bc}
16-85	6138^{bc}	48^{cd}	171	104	304	414	793^{ef}	597^{ef}	343	450	1248^{c}
UGA 1	6036^{bc}	35^{de}	154	109	277	425	812^{de}	626^{d}	215	417	1969^{ab}
M554-76	6035^{bc}	42^{cd}	159	114	268	410	862^{bc}	614^{de}	365	550	2168^{a}
249-85	5860^{bc}	36^{de}	158	121	292	479	773^{f}	586^{ef}	321	562	1835^{b}
59-85A	5747^{bc}	32^{de}	163	116	291	448	908^{ab}	625^{d}	308	535	2170^{ab}
M572-80I	5745^{bc}	39^{cd}	168	126	256	423	804^{de}	639^{cd}	405	490	2218^{a}
219-85	5715^{bc}	49^{bc}	140	108	304	453	798^{e}	591^{ef}	237	436	1828^{b}
49-85	5561^{bc}	57^{b}	182	122	274	450	871^{bc}	576^{f}	313	507	1582^{bc}
M364-80I	5491^{bc}	48^{c}	160	90	299	436	845^{cd}	594^{ef}	324	250	1361^{c}
UGA 7	5483^{bc}	41^{cd}	163	111	332	512	879^{b}	631^{cd}	330	545	1468^{c}
M516-79I	5458^{bc}	51^{bc}	169	108	331	424	864^{bc}	603^{e}	332	457	1550^{bc}
M569-80I	5402^{bc}	55^{bc}	162	103	472	498	759^{fg}	593^{ef}	317	467	1474^{c}
M521-79	5390^{bc}	35^{de}	168	107	302	441	839^{cd}	623^{de}	276	456	1451^{c}
530-80I	5255^{c}	35^{de}	157	113	313	451	834^{cd}	581^{f}	347	475	1777^{bc}
RMP 12	5227^{c}	70^{a}	155	117	377	398	812^{de}	575^{f}	351	513	2193^{a}

Means within the same column, bearing different letter superscripts, differ significantly ($P<0.05$) statistically.

CHAPTER FIVE

5.0 DISCUSSION

5.1 Dry pod yield

The pod yield varied among varieties from 1457 kg to 3980 kg/ha and the yields were classified into high, medium and low groups.

Dry pod yields of 6700 kg/ha were reported by Ishag and Said (1989) under irrigation in Sudan. In South Africa Cv. Norden yielded an average of 5130kg/ha while Spanish Cv. Salic yielded 4730kg/ha as reported by Merwe and Swanevelder 1989. Saxena *et al*. (1991) reported a pod yield of 3250kg/ha for Cv. RG 141 under irrigation. These yields belong to the high yielding class. For the medium class, Mittra and Rao (1989) reported pod yields of 2400 kg and 2390 kg/ha for Cvs. Kadiri 3 and ICGS-FDRS 4, respectively. In the low category, Dhillon and Dhalliwal (1989) reported yields of 1370kg, 1320kg and 1120kg/ha for three groundnut cultivars. The reports from literature tend to indicate remarkably high yields under irrigation. The cost of inputs, however, may eventually determine the profit margin and invariably the adoption of such an intensive venture.

In the present study variety ICGV 86868 had the highest pod yield of 3980 kg/ha while RG 1 ranked lowest with 1457 kg/ha. The high yielding varieties in this study, when compared to yields reported in literature, performed averagely. In the

study, variety ICGV 86229 had already sprouted at harvest, showing that its dormancy period had elapsed. It would therefore not pass for a late maturing variety.

The large variation in yield for varieties in the present trial compared to other trials cited above may be attributed to differences in genetic material, ecological zones and probably cultural practices adopted. For instance, seed size is known to affect pod yield in groundnut (Knauft *et al.*, 1990). Different ecological zones also give rise to different climatic and soil types and invariably differences in the incidence of pests and diseases. These environmental factors in turn affect the yield of crop at varying intensities, giving rise to differences in yield. Resistance to adverse effects of the environment is a genetic trait which varies with variety of crop.

5.2 Shelling percent and seed yield

The range of shelling percent reported in the present study, from 51% for ICGV 86868 to 75% for RMP 12 is in agreement with those reported in previous studies. Chandra *et al.* (1990) reported a shelling percent of 72% while Lee *et al.* (1991) reported a value of 69% for other groundnut varieties. High shelling gives good returns in terms of seed yield, while low shelling gives mainly husks which may not be of importance to farmers. It is common knowledge that most of the husks are burned off.

Seed yield data show that variety ICGV 86868 which produced

the highest pod yield, did not maintain its ranking in terms of seed yield per hectare because of the low shelling out turn recorded. This confirms the importance of shelling out turn mentioned earlier. Breeding and selection for both high pod yield and shelling out turn would therefore improve the seed yield tremendously. In the current study, seed yield varied from 729 kg/ha for RG1 to 2218kg/ha for M572-80I. These yields are lower than those obtained by Chung *et al.* (1989) for Cvs. Dangkong and Youngho dangkong (respectively 3000 kg and 2770 kg/ha). They are also lower than seed yields of 3960 kg/ha for Cv. ICGV SM 89001 and 3130 kg/ha for both Makulu Red and ICGV 87480 (Zengeni, 1996) but higher than yield of 606.6 kg/ha for Cv. ICG 221 (Mamza, 1996). Seed yield of the high yielding varieties in the present study therefore fared averagely well. Yields of varieties commonly cultivated in the study area will serve as a basis for selection of the promising varieties.

5.3 Forage yield and leaf to stem ratio

The forage yields obtained in the current study were fairly high and varied among varieties from 2177 kg for the lowest (176-85A) to 7831 kg/ha for the highest (2546-79). Tanko *et al.* (1990) reported a forage yield varying from 2,400 kg to 5,000 kg/ha for groundnut hay while Chiteka *et al.* (1993) reported a higher value of 6500 kg/ha.

High fodder yield is important in the tropics where a pronounced dry season occurs. Variety ICGV 86869 had lost its leaves at harvest time, reducing its usefulness as a

dual purpose variety. Groundnut hay is normally used to supplement poor quality forages obtained from the rangeland which sometimes have a low CP of below 70 g/kg DM, a level that cannot provide for the daily maintenance requirements for protein in cattle. Groundnut hay is therefore an invaluable asset in ruminant feeds where the bulk of the feed is obtained from cereal stover and poorly maintained rangelands.

The high fodder yield also serves as a source of income because of the high demand for the commodity during periods of feed scarcity. It is common knowledge that some farmers in the northern part of Nigeria grow groundnut solely for fodder. Farmers engaged in mixed farming can avail themselves of this opportunity of using high fodder yielding varieties to cut down on cost of using supplements for feeding livestock during lean times.

Leaf to stem ratio varied among varieties from 12% (ICGV 86230) to 70% (RMP 12). A high leaf to stem ratio adds value to the fodder. This is due to the fact that of all the botanical fractions, the leaf portion is generally more digestible. Cherney and Marten,(cited by Wheeler and Mochrie, 1980) reported high digestibility for forages with higher leaf to stem ratios. This was attributed to the higher concentration of lignified portions in the stems than in the leaves. Ramanzin *et al.* (1987) reported higher degradability in leaf portions of barley cultivars as compared to Chaff, nodes and internodes.

5.4 Chemical composition

The crude protein values of 90 g to 129 g/kg for stem DM and 125 g to 176 g/kg for leaf DM obtained in the present study (Table 2) are slightly lower than those reported by Muldoon (1986) for leaf (188 g CP/kg DM). Suriyajantratong and Sekanas (1985) reported a higher leaf CP of 232 g/kg DM and a moderate stem CP of 110 g/kg DM which is comparable to stem CP values obtained in this study. A CP content of 110g to 167 g/kg DM for the whole plant was reported by Alhassan (1985).

The observation that the leaf fraction had relatively higher CP, but lower NDF concentration than the stem confirms reports by Powell (1985). All the varieties studied in the present trial had leaf and stem concentrations of crude protein in excess of 80 g/kg DM, the level below which voluntary intake of tropical forages is reduced (Minson, 1980). The high concentration of CP in the leaf and stem portions of varieties in this study, therefore indicate they could provide supplemental N to ruminants fed low N cereal residues in the dry season.

5.5 Degradation characteristics of leaf and stem

The soluble fraction portrays the amount of forage nutrient readily available to the animal on ingestion while the degradable fraction is the portion made available with time after degradation. The rate of degradation shows how fast and efficient the forage is degraded while the potential degradability indicates the component that could be

cumulatively made available to the animal from the forage. The effective degradability shows the particles of forage actually made available.

The different varieties significantly varied in degradation characteristics, providing an opportunity for selection of top performers. Leaf portion potential degradability varied from 678 g to 914 g/kg DM while that of the stem varied from 538 g to 702 g/kg DM. Kibon and Ørskov (1993) reported potential degradability values for browse plants as follows: 939 g/kg DM for *Acacia albida*, 710 g/kg DM for *Tamarindus indica*, 867 g/kg DM for *Etanda africana*, 758 g/kg DM for *Anogeissus leiocarpus* and 765 g/kg DM for *Sterculia setigeŕa*. Shem *et al.* (1995) reported a potential degradability of 749 g/kg DM for Belabela bean (*Phaseolus vulgaris)* straw which is slightly higher than the figure reported for the stem portion in this study.

Higher soluble and degradable DM fractions, potential and effective dagradabilities for leaf than for stem in this study, may be partly due to higher groundnut stem cell wall contents relative to the leaf (Pavell, 1985).

Cattle in the tropics require a minimum digestibility of 450 g/kg DM of whole plant for maintenance (McDowell, 1972). Most of the varieties would meet this minimum requirement as shown by the leaf and stem potential degradabilities.

CHAPTER SIX

6.0 SUMMARY AND CONCLUSION

This study evaluated numerous parameters for both pod and fodder yield that provide a basis on which to select varieties for use by the farmer. The whole study can be grouped into pod and fodder aspects. The pod aspect includes dry pod yield, shelling out turn, and seed yield while the fodder aspect includes fodder yield, leaf to stem ratio, CP and NDF. It also includes nitrogen loss after 48h degradation and degradation characteristics of leaf and stem portions.

6.1 Pod and related parameters

From the study, some varieties were ranked in the high performing cadre as regards pod and seed yields. Varieties recommended for testing on-farm and subsequent usage by the farmer to improve both pod and seed yield are shown below. They are ranked according to pod yield as follows:

ICGV 86868

M572-80I

M554-76

ICGV 86222

UGA 1

59-85A

M170-80I

42-85

M558-79

1691-79

M354-81

These varieties had pod yields varying from 2579 kg/ha to 3980 kg/ha. Variety RMP 12 which occupied the lower rung of the high class in terms of dry pod yield came third in seed yield with 2193 kg/ha due to the fact that it had the highest shelling percentage among all the varieties tested. The high shelling out turn, influenced the seed yield to a great extent. This variety incidentally served as the control. It was released earlier to farmers for use in the study area to improve seed yield. The present results confirm the basis for its release to farmers earlier on.

Variety M572-80I had the highest seed yield of 2218 kg/ha followed by ICGV 86222 with 2216 kg/ha. Other varieties which had more than 2000 kg/ha are RMP 12 mentioned earlier, with 2193 kg/ha, 59-85A with 2170 kg/ha, M554-76 with 2168 kg/ha, and 42-85 with 2003 kg/ha of seed. These varieties are highly recommended for release to farmers after adequate on-farm tests.

6.2 Forage and related parameters.

Twenty-one varieties out of the 38 performed fairly well in forage yield per hectare. They had forage DM yields varying from 5227 to 7831 kg/ha for RMP 12 and 2546-79 respectively. They are ranked according to performance below.

2546-79

M170-80I

42-85

UGA 2

M354-81

UGA 5

16-85

UGA 1

M554-76

249-85

59-85A

M572-80I

219-85

49-85

364-80I

219-85

49-85

364-80I

UGA 7

M516-79I

M569-80I

M521-79

530-80I

RMP 12

Further screening of these varieties will help give a clearer picture as to those to be recommended for on-farm tests and adoption by farmers.

In conclusion therefore, varieties M572 - 80I, ICGV 86222, RMP 12 and 59 - 85A are recommended for seed production in that order while M170 - 80I, 2546 - 79, 42 - 85 and UGA 2

are recommended for fodder production in that order of priority based on yield and nutritive characteristics.

Farmers having a dual purpose need with a bias for seed production are advised to use variety M572 - 80I, while variety M170 - 80I is recommended for farmers with a greater desire for forage production.

These varieties would provide the needed supplemental N for feeding of ruminant livestock. It would also provide a fairly high amount of forage DM per unit area relatively while satisfying the farmers' primary objective of getting a reasonable seed yield.

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APPENDICES.

'APPENDIX 1:RAINFALL DATA IN THE STUDY AREA.

Monthly and cummulative rainfall for the 1995 wet season in Samaru - Zaria, Nigeria.

Month	Rainfall (mm)	Cummulative rainfall (mm)
April	90.5	90.5
May	45.3	135.8
June	125.4	261.2
July	155.6	416.8
August	258.6	675.4
September	159.1	834.0
October	32.5	867.0
Annual Total		867.0

Source : Meteorological unit, Institute of Agricultural Research Ahmadu Bello University, Samaru - Zaria, Nigeria.

APPENDIX 2: Nitrogen content in initial Sample (N_o,gkg^{-1}) and after 48 h degradation (N_D,gkg^{-1}) in leaf and stem portions of 38 groundnut varieties Zaria Nigeria

Variety	Leaf		Stem	
	N_o	N_D	N_o	N_D
49-85	29	20	20	10
UGA 12	28	18	20	9
UGA 11	28	14	16	9
M554-79I	27	19	19	10
16-85	27	18	17	9
42-85	27	18	17	9
M516-79I	27	18	17	9
M572-80I	27	16	20	10
M521-79	27	19	17	9
UGA 7	26	18	18	8
59-85A	26	18	19	9
M558-79	26	19	18	9
M569-80I	26	18	17	9
ICGV86869	26	20	18	10
1691-79	26	15	17	9
M364-80I	26	17	14	11
82-85	26	20	16	9
ICGV86222	26	20	19	10
UGA 2	26	18	18	11
M554-76	26	16	19	10
RG 1	26	19	21	8
249-85	25	17	19	9
530-80I	25	16	18	10
2546-79	25	18	19	10
176-85A	25	14	17	9
ICGV86230	25	18	16	10
ICGV86231	25	14	17	9
RMP 12	25	16	19	9
ICGV86347	25	18	19	9
UGA 1	25	19	18	10
M354-81	24	20	19	10
ICGV86191	24	18	17	9
M170-80I	24	16	16	9
ICGV86229	23	18	15	9
219-85	22	17	17	10
UGA 5	22	17	22	11
ICGV86868	20	17	19	9
ICGV86220	20	15	17	9

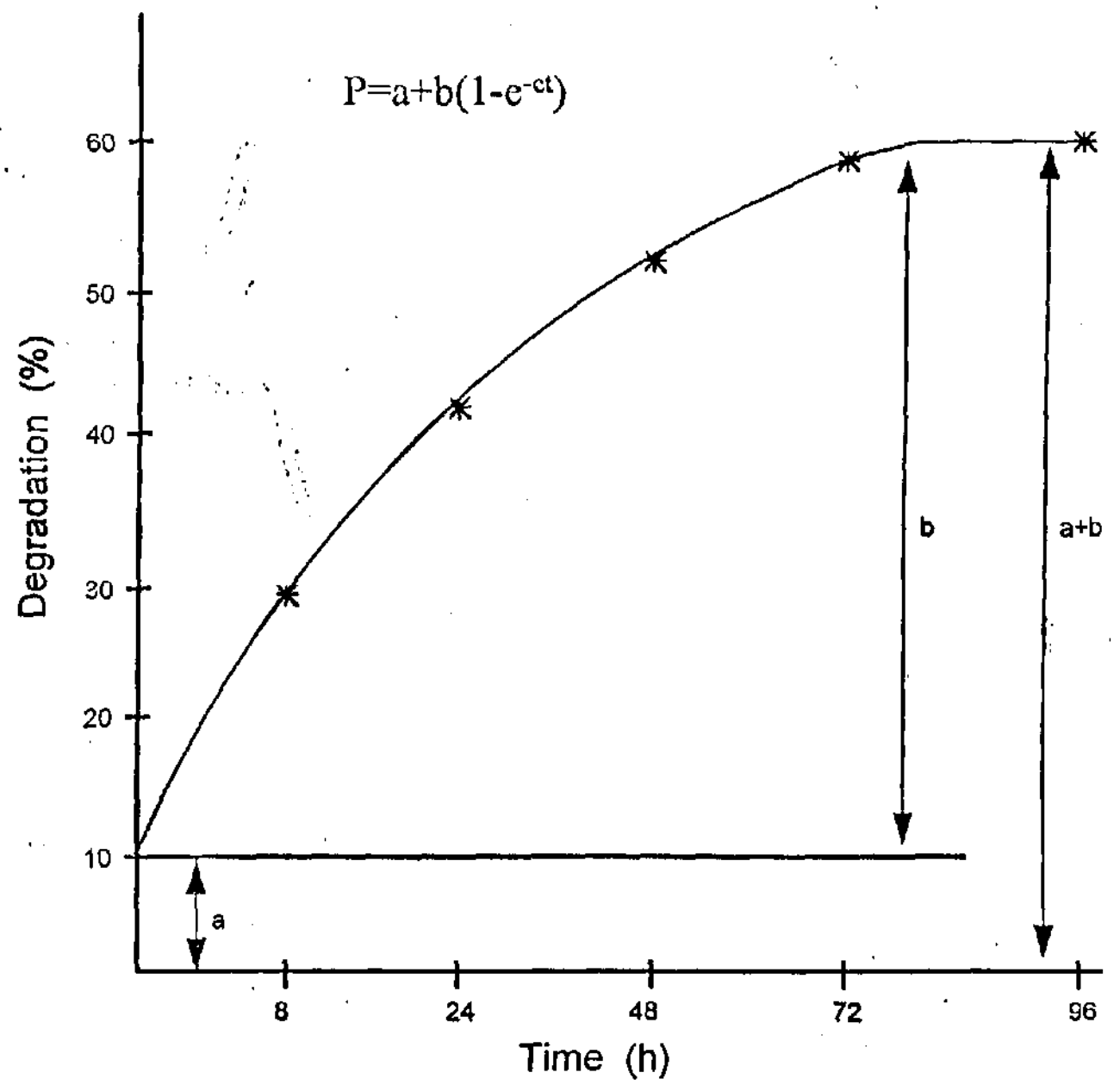
Appendix 3: ***In sacco*** **dry matter loss (gkg^{-1}) from the leaf portion of 38 groundnut varieties Zaria Nigeria.**

	Incubation Hours					
Variety	6h	12h	24h	48h	72h	96h
RG 1	404	474	463	696	767	778
59-85A	463	564	461	708	782	767
UGA 7	393	443	456	706	744	778
49-85	443	572	577	733	803	816
M516-79I	410	421	542	670	789	790
M554-76	454	474	568	724	789	798
UGA 2	405	447	561	741	790	809
ICGV86229	NA	435	558	702	763	807
M364-80I	452	462	464	737	786	738
M521-79	458	523	558	693	785	815
530-80I	457	481	531	737	760	771
42-85	464	583	597	754	798	802
UGA 12	462	480	628	743	794	797
ICGV86191	452	517	586	716	773	782
UGA 5	431	445	622	749	779	795
M354-81	453	510	568	765	769	771
M558-79	409	502	612	656	762	786
ICGV86230	377	541	567	705	732	749
UGA 1	466	529	589	765	768	771
RMP 12	462	469	559	717	727	765
82-85	384	576	588	775	783	793
M577-80I	437	468	661	727	776	800
219-85	466	477	603	608	766	769
ICGV86222	453	470	573	712	751	763
16-85	449	497	661	743	772	792
M170-80I	432	442	588	744	760	766
2456-79	432	552	623	744	753	793
ICGV86231	416	528	540	687	725	753
M554-79I	408	514	640	726	772	776
1691-79	390	464	533	731	734	748
249-85	444	520	535	740	724	742
ICGV86868	444	520	535	705	734	735
ICGV86869	459	512	610	760	744	746
ICGV86220	390	410	590	695	725	755
M569-80I	423	534	567	719	721	748
UGA 11	405	462	517	692	684	731
ICGV86347	432	560	650	668	679	728
176-85A	358	557	595	658	661	670

Appendix 4: *In sacco* dry matter loss (gkg^{-1}) from the stem portion of 38 groundnut varieties, Zaria Nigeria.

	Incubation Hours					
Variety	6h	12h	24h	48h	72h	96h
176-85A	285	392	401	439	530	583
ICGV86229	293	347	396	505	568	597
M170-80I	312	364	367	557	585	593
UGA 2	301	341	461	577	600	615
M572-80I	306	319	530	560	609	634
M554-79I	346	395	483	559	616	619
UGA 5	352	364	511	561	599	631
UGA11	285	359	494	541	599	632
UGA 7	314	359	448	479	558	575
ICGV86222	326	424	482	549	597	626
UGA 1	322	326	537	551	608	620
59-85A	331	361	487	523	544	605
ICGV86868	302	335	490	544	583	620
M521-79	276	340	421	561	577	606
M558-79	282	434	440	511	588	608
M354-81	339	405	516	544	604	611
M554-76	328	332	448	546	574	594
82-85	287	316	437	557	569	594
ICGV86869	306	357	458	510	566	589
ICGV86231	302	328	505	526	580	590
2546-79	270	284	428	491	554	577
M516-79	289	383	488	540	590	598
ICGV86347	305	400	528	533	589	600
ICGV86191	284	350	466	529	577	594
16-85	319	325	521	568	585	587
RG 1	355	427	516	530	583	591
M364-80I	309	324	476	524	553	569
M569-80I	382	419	526	539	582	587
42-85	307	315	446	491	543	565
219-85	320	390	496	559	574	586
ICGV86230	274	341	359	486	539	582
249-85	320	333	513	518	553	578
1691-79	298	349	457	491	557	566
53-80I	278	362	466	501	567	576
249-85	302	368	494	520	560	570
RMP 12	318	377	491	512	559	564
UGA 12	306	365	498	507	524	560
ICGV86220	267	328	443	490	521	517

Appendix 5: Graph showing a degradation curve.



APPENDIX 6. ANALYSIS OF VARIANCE TABLES

General Linear Models Procedure

Dependent variable: **Dry pod yield**

Source	DF	SS	MS	F
Model	39	36862365.744	945188.865	0.76
Error	74	91695127.146	1239123.340	
Corrected Total	113	128557492.890		

Source	DF	SS	MS	F
VAR	37	28694809.710	775535.398	0.63*
REP	2	8167556.034	4083778.017	3.30NS

General Linear Models Procedure

Dependent Variable: **Forage yield**

Source	DF	SS	MS	F
Model	39	289443547.05	7421629.41	1.24
Error	74	441371313.65	5964477.21	
Corrected Total	113	730814860.70		

Source	DF	SS	MS	F
VAR	37	282977346.89	7648036.40	1.28*
REP	2	6466200.16	3233100.08	0.54NS