Changes in Yield and Chemical Composition of Standing and Conserved Forage During the Dry Season in East Central Nigeria

by

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SUMMARY

THE results of proximate analysis of five tropical forage species and two forms of conserved forage over sampling period of 147 days of the dry season are presented. Three plots of *Panicum maximum* (Guinea grass) one plot of *Cynodon nlenfuensis* (giant star grass) and one plot of *Centrosema pubescens* (centro) were used as sample plots.

Trends indicated in the results suggest a general decline in crude protein, ether extract, dry matter yields and ash, and a progressive increase in crude fiber, dry matter content and nitrogen free extract from the onset of the dry season in early November to the first rains in March in the next year, when trends were reversed. In the standing forage samples the mean values of the species were significantly different in all proximate constituents. These differences were generally higher between grass and centrosema than among grasses. There were also significant periodic effects between sampling dates for all chemical constituents except ash which showed no significant periodic effect at 5% level. These differences were concentrated mainly within the first few weeks of dry season. The mean crude protein values of grasses and grass silage during most of the dry season period fell substantially below the 6% level which is considered the minimum value for maintenance of Nigerian indigenous Fulani cattle. Dry season grass pasture and grass silage should therefore be supplemented for protein as from late November. Where legume pasture or hay is available and constitutes up to 20% of the roughage ration, supplementation does not appear to be necessary for maintenance of cattle until late December, under Nsukka conditions.

INTRODUCTION

The nutritive value and productivity of forages are controlled by climatic, edaphic, genetic and management factors. For a given genetic material climate appears to be the most overriding factor particularly in the tropics where rainfall

has distinct seasonality. In Nigeria rainfall seasonality and poor distribution pose serious forage management and animal feeding problems during the dry season (Haggar 1972).

Some attempts have been made to measure the exact duration of the rainy or dry season in Nigeria from long-term rainfall data (Walter, 1968) and from regression equations involving latitude (Kowal and Davies, 1974). From these two sources it can be estimated that the duration of the dry season in Nigeria varies between 51 days in the coastal regions around latitude 7° N to about 275 days in the Sahel regions above latitude 11° 30' N. This wide variability reflects the complexity of dry season feeding of grazing ruminants, and invalidates a common pasture management approach for the whole country (Akinola 1974).

The dry season in Nigeria is preceded by a season of frequent and often torrential rains which support rapid and excessive growth of forage, rapid development of forage structural components and rapid decline in the soluble and proteinacious fractions. These forage characteristics are shared by most tropical and some subtropical forages (Johnson, Guerrero and Pezo, 1973). Tropical forage grasses are generally believed to have lower nutritive value than temperate species of the same age (McDowell, 1972), probably due to the rapid lignification of the cell wall arising from such climatic factors as temperature, evaporation and high intensity (Minson and McLeod, 1970; Denium, VanEs and Van-Soest, 1968).

The scarcity of grazeable material during the dry season in most locations in Nigeria is widely recognized but not

enough data is available on the composition and variability of standing or conserved dry season forage that would cover all locations of improved or natural pastures. Some efforts have been made to increase the feeding value of silage by adopting a wide variety of silo environments, additives and pre-wilting of the insiled material (Miller, Rains and Thorpe, 1964). Other workers (Akinyemi, 1974) have attempted to extend the effective grazing period into the dry season by a system of fertilizer application and cutting frequencies. The problem of dry season feeding is more serious with private producers and nomadic herdsmen in Nigeria to whom hay and silage making or pasture irrigation is neither attractive nor feasible. Information on the variability of forage chemical constituents is necessary as a prelude to establishing the levels of supplementation that may be required by various stock at various stages of the dry season. This study investigates the composition, yield and variability of five pastures sampled at two-weekly intervals as well as three forms of conserved forage

sampled at one monthly intervals throughout the dry season.

EXPERIMENTAL

Location

The University of Nigeria, Nsukka farm on which this experiment was conducted is located at an altitude of 447 meters above sea level between latitude 6° 5' and 6° 53' N and longitudes 7° 22' and 7° 26' E. The natural vegetation is within the Southern fringes of the Derived Savanna as classified by Keay (1959). The climatic conditions prevailing during the experimental period are presented in Table 1. These data were compiled from a meteorological station located less than 0.6 kilometers from the farthest experimental plot. The exact duration of the dry season for this period was from November 4, 1974 to February 26, 1975, a period of 114 days. The months of December and January were absolutely rainless while February was the hottest month within the dry season period.

TABLE 1
Meteorological Conditions at Experimental Farm
October 1974 to March 1975

Month	Total Rainfall (cm)	Mean Rainfall (cm)	Dates Rainy days	No. of Rainy days	Mean Max Temp. (°C)	Mean Max Temp. (°C)	Av. Sunshine Hours/ day	No. Sun- less days
October	29.65	0.96	—	17	70	86	4.5	—
November	0.18	0.006	4th	1	69	87	6.9	—
December	0.00	0.00	—	—	65	87	4.8	—
January	0.00	0.00	—	—	65	88	5.3	—
February	0.38	0.013	26th	1	72	91	6.8	—
March	1.40	0.08	9th & 19th	2	74	91	4.1	2

Sample plots

Five established pastures were chosen as sample plots. They had been grazed during the rainy season and some even cut prior to the sampling. Their history is presented as follows:

Plot 1: A local Guinea grass *Panicum maximum* (variety 1), pasture on

a sandy clay loam soil. This pasture was mowed in September 1974.

Plot 2: A pasture of introduced Guinea grass (variety 2) on a sandy clay loam. This variety is olive green with pubescent leaves and can easily be distinguished from variety 1 which is dark green and

- glabrous. This pasture was mowed in August 1974.
- Plot 3:* A giant star grass, *Cynodon nlemfuensis*, pasture on a sandy clay loam soil.
- Plot 4:* A local Guinea grass (variety 1) pasture located on a sandy loam soil. This pasture had been grazed prior to sampling.
- Plot 5:* A legume, *Centrosema pubescens* (Centro), pasture located on a sandy loam soil. Plots 3 and 5 were relatively undisturbed except for a seed harvest on plot 5 in January and February during the experimental period. There was no further disturbance of experimental plots during the course of the experiment.

Sampling

Sampling was started on November 1, 1974 and proceeded at two-weekly intervals until March 21, 1975. Samples were taken in each of the plots by demarcating an area of 50 cm radius and clipping at a height of 3.8 cm. Yield was estimated from an average of five clippings per plot by the method outlined by Burzlafl (1964). The clipped material was sub-sampled; one half was dried at 100°C overnight for dry matter determination and the other at 65°C for 96 hours for protein and proximate analysis, using Kjeldahl and AOAC (1970) procedures respectively. Analytical samples were ground through a 1 mm sieve in a Wiley mill.

Conserved Forage

Three forms of conserved forage were also sampled and analysed as described for the standing forage. These were:

1. A composite grass silage of *Panicum maximum*, *Cynodon nlemfuensis* and *Pennisetum purpureum*
2. A *Cynodon nlemfuensis* silage, and
3. A soya bean (*Glycine max*) hay.

The silages were prepared in a one-meter cube container from which air was drawn continuously during the ensiling process by a 1.5 horse power vacuum pump. The hay was prepared by cutting at early seed stage and field curing for 24 hours and then baling and stacking in a dwarf wall building.

RESULTS AND DISCUSSION

Results of the proximate composition of the five forage plots are shown in Tables 2 to 7 over the eleven sampling dates between November 1, 1974 and March 21, 1975. The general trend in the variability of the chemical constituents show a decline in crude protein, ether extract and ash, and a progressive increase in crude fiber, dry matter and nitrogen free extract contents over the period. This trend persisted in each case from the onset of the dry season until the first rain of the next rainy season, when the trend was reversed. The turning point varied among species but generally occurred after February 21, 1975. After the first rain on February 26, 1975 the trend was reversed in all cases. The chemical composition of the conserved forage samples is shown in Table 8. The variation of the chemical components of silage with time, appears to be a function of the storage conditions prevailing in the micro-environment rather than factors of maturity or climatic conditions of the external environment. There was a general decline in crude protein, ether extract, ash and dry matter contents, and a general increase in crude fiber and nitrogen free extract contents, of the two silage samples. The hay showed similar trends as the silage, with the exception that hay dry matter content increased rapidly rather than declined with storage. The results of individual chemical components for all forage samples are summarised in Tables 2 to 7 for dry matter content, crude protein, crude fiber, nitrogen free extract, other extract and ash, respectively. The proximate composition of the conserved forage samples is presented in Table 8.

TABLE 2
Dry Matter Content of Dry Season Pastures
(Percent of Dry Matter)

Sampling	PLOTS						+ Mean			
	1	1	2	1	3	1		4	1	5
	<i>Panicum maximum</i> var 1		<i>Panicum maximum</i> var 2		<i>Cynodon nlemfuensis</i>		<i>Panicum maximum</i> var 1		<i>Centrosema pubescens</i>	
Nov. 1, '74	43.33		38.67		38.78		46.27		30.97	
Nov. 15, '74	45.51		48.90		42.04		47.29		34.64	
Nov. 29, '74	56.32		56.90		52.23		54.54		35.00	
Dec. 13, '74	54.97		53.33		53.20		49.10		36.08	
Dec. 27, '74	53.15		5.75		54.00		47.51		36.50	
Jan. 10, '75	53.28		51.00		52.46		46.21		38.15	
Jan. 24, '75	49.71		49.65		49.96		48.18		38.94	
Feb. 7, '75	48.84		47.65		46.72		48.96		39.43	
Feb. 21, '75	45.22		46.24		42.72		47.42		40.32	
Mar. 7, '75	43.95		44.92		39.20		45.20		47.41	
Mar. 21, '75	40.22		35.21		36.50		40.00		30.02	
Mean	48.41a		47.65a		46.16a		47.33a		36.13b	Fd=11.44—
Sa	5.195		6.295		6.573		3.452			Fp=33.42—

+a,b,c Means followed by the same letters are not significantly different at the indicated level.

1. Fd=F value for sampling date

2. Fp=F value for plot

3. Sd=Standard deviation

— Highly significant ($P < 0.01$).

TABLE 3
Crude Protein Content of Dry Season Pastures
(percent of Dry Matter)

Sampling Dates	PLOTS					+ Mean
	1	2	3	4	5	
	<i>P. maximum</i> (var 1)	<i>P. maximum</i> (var 2)	<i>C. nlemfuensis</i>	<i>P. maximum</i> (var 1)	<i>Entrosema pubescens</i>	
Nov. 1, 1974	6.08	6.17	8.92	5.86	21.84	7.77a
Nov. 15, "	5.79	5.30	8.20	5.33	20.28	8.98ac
Nov. 29, "	5.13	4.47	6.56	4.05	19.57	7.96ab
Dec. 13, "	2.48	3.25	5.78	3.48	17.03	6.40ab
Dec. 29, "	2.16	2.71	3.14	2.87	14.32	5.04b
Jan. 10, 1975	2.29	3.23	4.21	2.54	12.22	4.90b
Jan. 24, "	2.46	3.10	2.76	2.89	11.77	4.60bc
Feb. 7, "	2.45	3.37	3.16	3.44	10.42	4.59b
Feb. 21, "	2.68	3.75	3.51	2.72	9.42	4.42b
Mar. 7, "	3.94	3.96	3.71	4.23	9.77	5.12bc
Mar. 21, "	4.26	4.46	4.07	4.41	10.52	5.54ab
Mean	3.61c	3.98c	4.91b	3.80c	14.29a	1 Fd= 6.99**
3 Sd	1.492	1.046	2.142	1.090	4.606	2 Fp=77.14**

+ Means followed by the same letter are not significantly different at the indicated level.

** Highly significant $P < 0.01$

1 Fd = F Value for sampling date

2 Fp = F Value for plot.

3 Sd = Standard deviation.

TABLE 4
Crude Fiber Content of Dry Season Pastures
(per cent of dry matter)

Sampling Date	PLOTS					Mean +
	1 <i>P. maximum</i> var 1	2 <i>P. maximum</i> var 2	3 <i>C. nlemfuensis</i>	4 <i>P. maximum</i> var 1	5 <i>Centrosema</i> <i>pubescens</i>	
Nov. 1, '74	37.62	39.17	37.07	40.31	25.24	35.88a
Nov. 15, '74	41.89	37.97	37.11	40.54	25.42	36.59ab
Nov. 29, '74	42.05	37.75	38.05	38.98	27.55	36.88ab
Dec. 13, '74	41.95	38.91	38.22	38.72	26.98	36.96ab
Dec. 27, '74	39.19	37.55	36.38	39.35	27.10	35.91a
Jan. 10, '75	42.34	40.39	35.78	39.18	27.90	37.12ab
Jan. 24, '75	42.56	37.76	36.59	42.75	28.57	37.65ab
Feb. 7, '75	42.12	38.58	38.83	45.76	31.26	39.31b
Feb. 21, '75	41.57	37.56	38.97	43.58	31.54	38.64ab
Mar. 7, '75	41.60	39.48	37.25	42.96	30.34	38.33ab
Mar. 21, '75	41.27	37.95	37.05	41.90	29.00	37.43ab
Mean ±	41.29a	38.46b	37.44b	41.27a	28.26c	1Fd = 2.92*
3 Sd	1.510	0.924	0.805	2.284	2.132	2Fp = 156.16**

+ Means followed by the same letter are not significantly different at the indicated level.

* Significant $P < 0.05$

** Highly significant $P < 0.01$

1 Fd = F value for sampling date

2 Fp = F value for plot.

3 Sd = standard deviation

TABLE 5
NITROGEN-FREE EXTRACTS OF DRY SEASON PASTURES
(per cent of dry matter)

Sampling Dates	1 <i>Panicum</i> Maximum Var 1	2 <i>Panicum</i> Maximum Var 2	3 <i>Cynodon</i> <i>nlemfuensis</i>	4 <i>Panicum</i> maximum Var 1	5 <i>Centrosema</i> <i>pubesceus</i>	+ Mean
Nov. 1, 1974	41.93	39.67	43.08	43.45	40.49	41.72b
Nov. 15, "	43.61	44.15	48.20	46.03	45.15	45.43ab
Nov. 29, "	46.28	47.71	50.20	48.80	43.83	47.36ab
Dec. 13, "	50.19	48.51	51.53	51.88	47.46	49.91a
Jan. 10, 1975	45.13	43.53	56.52	51.38	52.15	49.74a
Jan. 24, "	45.97	47.28	57.76	49.18	52.32	50.50a
Feb. 7, 1975	54.61	46.02	54.07	45.97	51.69	48.67a
Feb. 21, "	46.17	46.46	54.60	49.32	53.13	49.94a
Mar. 7, "	43.78	44.77	55.60	47.46	53.43	49.01a
Mar. 21, "	43.80	43.47	55.27	47.45	53.63	48.72a
Mean	45.52c	45.19c	52.63a	48.30bc	49.32ab	Fd = 5.68*
Sd	2.306	2.485	4.259	2.520	4.490	Fp = 17.57*

* Significant $P 0.05$

** Highly significant $P 0.01$

1 Fd = F value for sampling date

2 Fp = F value for plot.

3 Sd = Standard deviation.

+ Means followed by the same letter are not significantly different at the indicated level.

TABLE 6
ETHER EXTRACT OF DRY SEASON PASTURES (Percent of dry matter)

Sampling Dates	PLOTS					+ Mean
	1 <i>Panicum</i> maximum Var 1	2 <i>Panicum</i> maximum Var 2	3 <i>Cynodon</i> <i>nlemfuensis</i>	4 <i>Panicum</i> maximum Var 1	5 <i>Centrosema</i> <i>pubescens</i>	
November 1, 1974	2.92	3.09	2.75	2.40	4.87	3.20a
November 15, "	2.11	2.47	2.45	2.02	3.67	2.54ab
November 29, "	0.11	1.32	2.32	1.85	3.62	1.84ab
December 13, "	0.07	1.24	2.24	0.08	3.31	1.39ab
December 27, 1974	1.93	2.61	2.17	0.81	4.50	2.40ab
January 10, 1975	1.65	2.49	1.19	2.18	3.09	2.12ab
January 24, 1975	1.07	0.22	1.16	0.93	2.72	1.22ab
February 7, "	1.19	0.20	1.10	0.90	2.54	1.18b
February 21, "	1.12	0.17	1.02	0.89	2.36	1.22b
March 7, "	1.34	0.96	1.14	1.24	2.53	1.44ab
March 21, "	1.47	1.36	1.23	1.43	2.62	1.62ab
Mean—	1.36c	1.47c	1.71b	1.34cd	3.26a	1.Fd = 2.655*
3.Sd	0.822	1.056	0.657	0.804	0.838	2.Fp = 8.567**

+ Means followed by the same letter are not significantly different at the indicated level.

*Significant $P < 0.05$

**Highly significant $P < 0.01$

1. Fd = F value for sampling date

2. Fp = F value for plot

3. Sd = Standard deviation

TABLE 7
ASH CONTENT OF DRY SEASON PASTURES
 (per cent of dry matter)

Sampling Dates	PLOTS					—Mean
	1 <i>Panicum</i> maximum	2 <i>Panicum</i> maximum	3 <i>Cynodon</i> <i>nlemfuensis</i>	4 <i>Panicum</i> maximum	5 <i>Centrosema</i> <i>pubescens</i>	
Nov. 1, 1974	11.07	12.2	7.81	7.72	7.56	9.27
Nov. 15, "	7.00	10.48	3.84	7.28	5.47	6.81
Nov. 29, "	6.56	8.44	3.26	6.23	5.42	5.98
Dec. 13, "	5.61	8.35	2.65	5.70	5.21	5.50
Dec. 27, "	8.85	11.64	5.77	4.95	4.77	7.19
Jan. 19, 1975	8.93	9.94	2.15	4.58	4.64	6.05
Jan. 24, "	7.84	11.33	2.00	4.68	4.59	6.09
Feb. 7, "	8.69	11.58	2.42	3.97	4.09	6.15
Feb. 21, "	8.72	11.77	1.65	3.75	3.58	5.90
Mar. 7, "	8.89	12.33	2.00	4.13	3.93	6.25
Mar. 21, "	8.96	12.30	2.30	4.71	4.47	6.55
—Mean	8.28ab	10.12a	3.26c	1.906	1.079	Fd—0.57n.S
Sd	1.537	1.464	1.906	1.329	1.079	Fp—1.82*

—Means followed by the same letter are not significant at the indicated level

ns. — Not statistically significant ($P=0.05$)

* — Significant $P=0.05$

** — Highly significant $P=0.01$

1.Fd — F value for sampling date

2.Fp — F value for plot

3.Sd — Standard deviation

Dry Matter Content (DM)

Plot differences in mean dry matter content were significant between grasses and centrosema ($P < 0.05$), but not between Guinea grass and Giant Star grass, nor among the three Guinea grass varieties. Seasonal effect was also significantly different during the sampling period. Tukey's procedure as described by Steel and Torrie (1960) was used to separate the means. Results show that with the exception of periods November 29 to January 24, and between early and late February the dry matter content varied significantly every two weeks. The stable period appeared to come after the mean dry matter had attained a peak value on November 29, suggesting a gradual decline following the cessation of vegetative growth. This decline can be attributed to defoliation losses and seed formation. In the case of centrosema the continual increase in D.M. content from November to late February was probably due to decrease in leaf-stem ratio as well as some continued growth activity. The ultimate rapid decrease in dry matter content of both grasses and Centrosema from late February to late March was obviously due to a flush of new leaves and renewed growth activity following the early rains in late February.

The variation of dry matter content of forage with maturity and season is well documented in literature. Coward-Lord, Arroyo-Aguilu and Garcia-Molinari (1974) reported that mean total dry matter content of 10 forages in Puerto Rico varied from 20.52% to 54.0% between 30 and 180 days of growth. The largest increase occurred between 150 and 180 days and this was related to increases in fiber and decline in crude protein contents. Hagggar and Ahmed (1971), reported large increases in the dry matter content of *Andropogon gayanus* during the dry season in Zaria, from 43% in October to 70% in February even though the dry matter yield did not vary substantially during the same period. These data are higher than the mean values of 30.97% to 47.41% for centrosema or 41.76% to 55.0% for grasses obtained in this study. The differences may be due mainly to

climatic factors particularly the cool dry harmattan wind which is more intense in the Northern latitudes than the South during the month of December, as well as species or genetic differences.

Crude Protein

Crude protein values (Table 3) were significantly variable between forage species and between sampling dates. Mean values decreased from 9.77% on November 1, to a low value of 4.42% on February 21, rising thereafter to 5.54% on March 21. For the grasses alone the corresponding values were 6.76% on November 1, 2.72% on December 27 and 4.30% on March 31. There was no significant difference between the three plots of *Panicum maximum* in crude protein content. The crude protein content of the giant star grass was significantly higher than the mean value for the Panicum but was significantly lower than that of centrosema. All sampling dates varied significantly from one another except late November to mid December and early January to late February. Crude protein values reported by Olubajo and Oyenuga (1974) indicate consistently higher values for *Cynodon* than for Panicum at the same age, although their values were higher than those reported here presumably because they were harvested in May in the rainy season. Hagggar (1971) obtained 1.3% crude protein for *Andropogon gayanus* in Zaria (latitude 11°N) during the dry season, while Akinycmi (1974) obtained a range of 7.4% to 10.7% for *Panicum maximum*, *Pennisetum purpureum* and *Tripsacum laxum* at Ibadan (latitude 7° 28' N). It would appear from these and other published data that the crude protein content of forages follows a distinct seasonal pattern and rainfall appears to have an overriding effect, although soil fertility status and previous manurial or cutting treatment have definite contribution. Dradu and Harrington (1972) reporting on seasonal crude protein content of ingesta from esophageal fistulated Ankole cattle in Uganda observed that the crude protein content followed a bimodal pattern through the year and that this pattern was roughly in phase with rainfall patterns. In the peak

of the rainy season in May their value was 16.6%, while in the dry season it was 5.5% crude protein. Low crude protein content during the dry season is a definite problem in Nigeria particularly where the dry season is protracted. Akinyemi (1974) obtained higher values of crude protein in January from previous cuts made in September than in October, and concluded that the time of last cut was more effective than fertilizer application in extending the effective grazing period into the dry season.

The crude protein content of centrosema fell from a value of 21.84% in November to 9.42% in February and rose again to 10.52% in March. Soya bean hay also fell from 17.72% in October to 9.43% in January. The composite and straight silage samples had the highest crude protein values of 7.2% and 5.5% respectively in August, and the lowest in February, 3.5% and 3.0% respectively (Table 8).

These values agree generally with figures reported by Miller, Rains and Thorpe (1963) who obtained a range of 3-9% from 18 grass silages and 5-10.5% from 15 forage crop silages which had various additives. From digestion and nitrogen balance studies they concluded that a crude protein content of 6% or 3% digestible crude protein and 50% digestible organic matter were the minimum requirements for zebu cattle maintenance at Samaru. Based on these figures, the data on crude protein suggests that grass pastures at the University of Nigeria farm do not contain enough crude protein to meet maintenance requirements for grazing cattle during most of the dry season months beyond mid November. Cattle show serious loss of condition in the dry season when grazed or fed conserved grass forage not adequately supplemented with concentrates. Baa (1974) obtained an average daily gain of 0.29 kg from feeding 0.45 kg per head per day of 16% protein concentrate and soya bean hay to N'dama cattle in January at Nsukka, but recorded as average daily loss of 0.25 kg when giant star grass hay replaced soya-bean hay at the same level of concentrate feeding. These data are in agreement

with those of Rains (1963) and Haggard (1972), and further confirm the need for dry season protein supplementation for grazing animals.

Crude Fibre

The crude fibre data are presented in Table 4 for all the forage samples. Analysis of variance showed significant differences between forage species and between sampling dates. The crude fibre content of centrosema was significantly lower than that of the grasses which maintained a value higher than 39% through most of the dry season. The local Guinea grass (variety 1) had significantly higher crude fibre than either the introduced variety or the giant star grass. The crude fibre contents of conserved forages were generally lower than those of the standing grass forage. Mean values were 29.84, 32.62% and 29.09% respectively for the composite, straight silage and the soya bean hay (Table 8). Haggard (1970) reported an increase in crude fibre content of *Andropogon gayanus* hay from 31.6% in August to 37.7% in November and recommended that cutting for hay should be in September before forage quality falls substantially in late October. He also established significant differences in crude fibre contents of stem between every successive sampling date from September 20 to October 18. Olubajo and Oyenuga (1974) obtained values which ranged from 30.3% to 33.3% for *Pennisetum purpureum* harvested at 4 and 8 weeks of growth respectively and 34.7 to 36.3% for *Panicum maximum* between 4 and 8 weeks of growth and reported a higher degree of utilization of the former by sheep, based on its lower crude fibre content.

Nitrogen Free Extract

The nitrogen free extract values are presented in Table 6 for all forages. These results indicate statistically significant differences between forage species. Periodic differences in nitrogen free extract content varied significantly between November 1 and 29, but remained stable thereafter. The nitrogen-free extract fraction as an indicator of the soluble car-

TABLE 8
CHEMICAL COMPOSITION OF CONSERVED FORAGE

A. Composite Silage of *P. maximum*, *P. Purpureum* and *C. nlemfuensis* (% D.M.)

Date	CP	CF	EE	Ash	NFE	DM
Oct. 31st	7.2	26.48	3.4	3.5	59.42	39.3
Dec. 2nd	4.7	29.05	2.7	2.2	61.35	36.0
Jan. 6th	4.6	31.19	2.2	1.6	59.70	32.5
Feb. 7th	3.5	32.64	1.9	1.1	60.86	30.9
Mean	5.0	29.84	2.55	2.1	60.33	34.675
S _d	1.564	2.682	0.66	1.036	0.876	3.747

B. *Cynodom Plectastachyus* Silage

Nov. 26	5.5	28.61	2.8	2.3	60.79	37.5
Dec. 26	4.6	32.86	2.1	1.5	58.94	32.7
Jan. 26	3.1	33.82	1.3	1.1	59.68	32.2
Feb. 26	3.0	35.19	1.1	1.1	59.61	31.9
Mean	4.05	32.62	1.825	1.50	60.005	33.575
S _d	1.214	2.839	0.78	0.57	0.887	2.637

C. Soya Bean Hay

Oct. 2nd	17.72	22.51	5.75	3.77	50.25	36.00
Nov. 3rd	15.32	23.92	3.76	2.84	54.16	94.50
Dec. 4th	11.32	26.18	2.81	2.80	56.89	97.32
Jan. 5th	9.43	27.75	2.20	2.43	58.19	97.00
Mean	13.448	25.09	3.63	2.96	54.873	81.205
S _d	3.758	2.33	1.553	0.57	3.499	30.16

S_d = Standard Deviation

bohydrate content has a limited nutritional validity arising from imperfections of the crude fiber determination in particular and the Weende procedure in general (Fonnesbeck, 1968). Sullivan (1955) showed that the NFE fraction included some cellulose, hemicellulose and lignin which have lower digestibilities than soluble carbohydrates. Arroyo-Aguilu and Coward-Lord (1974), obtained significant positive correlation between NFE and age but a lower correlation between age and crude fiber. Although dry season forage quality relates mainly to protein rather than energy deficiency (Haggar 1972) it is planned in future studies to estimate energy content, intake and digestibility of dry season forage.

Ether Extract

Ether extract values are presented in Table 6. Analysis of variance showed significant periodic differences ($P < 0.05$) and highly significant plot differences ($P < 0.01$). The ether extract of standing

or conserved forage legumes was significantly higher than those of the standing or conserved forage grasses. In all cases ether extract values fell to a minimum in February and rose thereafter.

Ash

The ash content is present in Table 7. The high content of ash in all standing forage is attributed to silica content since the cutting height was only 3.8 cm and the ash was not corrected for silica. Analysis of variance showed no significant differences for sampling dates but highly significant differences between forage species.

Dry Matter Yield

Figure 1 shows the variation of dry matter yield between the five forage samples during the dry season. All the sample plots showed a progressive decline in the yield of dry matter from November 29, long before the plots were grazed on January 10. The slight increase

in dry matter yield around February 7 was probably due to post-grazing regrowth, while the levelling off period beyond February 21 was due to a sharp decrease in dry matter content following the rains in late February.

Analysis of variance indicates highly significant differences between plots and between dates. The Guinea grass that was pre-grazed (plot 4) and significantly higher average dry matter yield of 1.55 tons per hectare than the introduced guinea grass (plot 2). The other values of 1.08 tons per hectare, 1.14 tons per hectare and 1.08 tons per hectare respectively for the pre-cut guinea grass (plot 1), giant star grass (plot 3) and centrosema (plot 5) did not vary significantly. There was no significant variation in average dry matter yield of the forages within November. These values were significantly higher than those from February and March. December to January values were half-way between November and March values but were not significantly different from either.

It appears from these data that the inverse relationship reported by Haggar (1970) between yield and forage quality does not apply during the dry season. Dry matter yield appears to reach a maximum value at the beginning of the dry season and then decline, while forage crude protein content appears to decline from the middle of the rainy season to a minimum value sometime in January.

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