Haymaking Technology to Improve Dry Season Feed Availability in the Adamawa Plateau of Cameroon

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Abstract

An experiment to test the effect of length of deferment of native and *Brachiaria ruziziensis* pastures on the characteristics of their hays was carried out at the Wakwa Research Centre, located in the Adamawa plateau of Cameroon between April 1995 and April 1997. Three pasture deferment lengths (12, 10 and 8 weeks) and three hay storage lengths (0, 12 and 20 weeks) were studied.
Increase in deferment and storage length led to increased dry matter yield and crude fibre content, but caused a drop in the crude protein, organic matter cellulase solubility percentage and nylon bag degradability rate. The 10 week *Brachiaria* deferment was recommended for hay making because of its high digestible nutrient yield.

Keywords: Brachiaria ruziziensis, native pastures, quality, storage, hay

1. Introduction

The Adamawa plateau is a vast region with a Sudano-guinean savannah vegetation covering up to 100,000 km². The main occupation of the inhabitants is cattle rearing and it contains 28.5% of the cattle population of the country making this region to be the first national producer of cattle **(MINEPIA, 1996/97)**. It has a cool tropical climate (mean annual temperature of 22°C), 7-9 months of rain falling mainly between March and November and a relative humidity of 40-60%.

The herbaceous vegetation cover of the Adamawa Province, is like that of most tropical regions. Pastures are luxuriant early in the rainy season but become lignified with a resulting sharp drop in their energy and protein content. In the Adamawa plateau all these conditions are optimal leading to rapid growth during the onset of rains (mid March to early April) but with the continuously high temperatures, lignification is promoted at the expense of food reserves. This makes the forages to be overall of low nutritive value and the need for yearly fertilization arises if they are to support a higher quality of feed **(Ripppstein, 1985**

2. Statement of the problem

The lack of sufficient forage during the dry season and the low nutritive value of these forages with increasing maturity adversely affect year round livestock productivity. Possible solutions to this problem are:

1) Rotational grazing involving appropriate stocking rates and rest periods, 2) Transhumance, 3) Dry season supplementation with protein-rich oil cakes, 4) Conservation through hay production and ensilage, and 5) Integration of Crop-livestock activities, amongst others.

Among all these, the one livestock farmers said they wanted to master was hay making know how **(IRZ/GTZ, 1989).** The quality of any conserved feed for ruminants during the dry season (winter) is dependent on the method of its preparation. Native grassland hay is used by livestock farmers of the Adamawa plateau. Its quality is bad and is affected by the type of pasture, pasture management and hay making know how. Researchers at the Institute of Agricultural Research for Development (IRAD) at Wakwa centre, have been carrying out studies for several decades on the use of protein and energy feeds, introduced grasses and legumes e.g. **Enoh (1990)** and conserved feeds for the maintenance of body weight and milk production of local zebu and cross-bred dairy and beef cattle **(CRZ Wakwa, Annual Reports, 1985 – 1997)**. Most of the work was done on station and some on-farm. However, trials on the deferment of pasture for hay production have neglected estimating the nutritive value of the deferred pastures grazed by the animals.

3. Objective

The aim of the experiment was to test the effect of different lengths of deferment on the yield and quality of native and introduced pastures. Also, to test the effect of storage length on the quality of the hays produced from these pastures.

4. Research Hypothesis

There were 2 Hypotheses in the study:
1. Length of grazing deferment does influence the yield and quality of *Brachiaria* and native pastures i.e. while the length of growth should have an negative effect on hay quality, but a positive effect on the yield. The optimum production of digestible DM could be the intermediate medium growth length.
2. Storage length under good indoor storage conditions does not effect hay quality.

5. Methodology

The experiment was carried out between 1995 and 1997 at the Wakwa centre on two sets of pasture. One was mostly *Hyparrhenia spp.*-predominant native grasses and the other was a cultivated grass species, *Brachiaria ruziziensis* cv. Germain and Evrard. Both pastures were grazed in order to remove the rainy season growth, the animals removed and then the vegetation was left to bulk up before hay making at the end of the rainy season on November 6 of 1995 and 1996 respectively. There was a 4 day field curing length then the hay was baled into large round bales and taken on November 10 to a storage room with straight through ventilation. There were three deferment lengths with mowing carried out on 14th August, 28th August and 11th September of 1995 and 1996 respectively, in order to have **12, 10 or 8 week re-growths** of vegetation at hay harvest time on November 6. The hay was sampled after an initial 10 day equilibration on November 20, (**week 0** of **storage**), on February 12, (**week 12**) and on April 20, (**week 20** of storage). Each pasture type contained 6 subplots each 40 x 40m in size. The yield of the pastures was done via the quadrat method. Vegetation was sampled at a height of 10 cm from the ground, field weighed and dried. Dry matter was determined at 105° C after 24 hours and expressed as kg/ha while samples for chemical analysis and digestibility studies were dried at 65° C for 48 hours. The laboratory analysis and digestibility measurements were carried out from 1995 to 1998. Quality measures used were proximate and detergent analyses according to **AOAC, (1975)**, nylon bag method, **Osuji et al, (1993)** and pepsin cellulase method, according to **Naumann and Bassler, (1976)**

Yield of digestible nutrients were based on the DM yield and the 48 hour nylon bag values. The 48 h degradation value has been shown, to have very close correlation with voluntary intake, energy and live weight gain in ruminants, (**Blümmel et al., 1997).** For the deferment trial, there were two years, two pasture types, and 3 deferment lengths in two replications per deferment length giving a total of 18 plots for each pasture type. For the storage length trial, the samples from similar treatment combinations were pooled and sampled at 0, 12 and 20 weeks respectively giving 54 samples per year or 108 over 2 years.

Statistical methods

A replicated transect design was used. Data were entered using Dbase IV and analysed using the general linear models (GLM) procedure of SAS **(SAS 6.03 , 1991)**. Type III type of sums of squares were used since this takes care of unbalanced designs and missing values in testing the null hypothesis

6. Results and discussion

Dry matter (DM) yield was 2017.3 kg/ha on average for both years and pastures (Table 1). It is lower than normal yield of biomass of these pastures on the plateau **(Rippstein, 1985).** It is understandable since biomass values are obtained from cuts done on un-grazed vegetation at the end of the rainy season, but the mowing here was done from August until September. Thus the period of regrowth was shorter compared to that for normal biomass yields. There were significant differences between years, pasture types, deferment lengths (regrowth) and the interaction pasture type x regrowth length ($P < 0.05$). 1995 had higher DM yields than 1996. *Brachiaria* produced more than the native pastures ($P < 0.05$). 12 week deferments had the highest yield, 2232.4 kg and the 8 weeks the lowest, 1798.2 kg/ha. The value of the 10 weeks was intermediate but non significantly different ($P > 0.05$) from the 12 week deferred plots. There was no significant effect of year and pasture type or year and deferment length on the dependent variables. Only pasture type x deferment significantly influenced them ($P < 0.05$).

Percent DM of the hay after curing (at baling) was 86.7 %. There was no significant change in % DM between year, pasture type or regrowth length meaning that both forages were sufficiently dry after 4 days field curing. Such a hay crop has been found to have a good keeping quality, **(Collins, 1983; Rotz and Muck, 1994)**.

The CP content was non significantly affected by year as well as the interaction pasture type and regrowth length. There was a big difference (0.9%) between the CP contents of the *Brachiaria* and native pastures as well as between the 8 week (5.9%) and the 12 week deferments (4.8%). However, these CP values are less than the minimum 6.45% a forage should have in order to serve as a basal diet **(Demarquilly, 1970**). Percent crude fibre followed an opposite trend to crude protein. This was seen both for the native pastures as well as the deferments. The 12 week deferments were the most fibrous ($P < 0.05$). This is of nutritional significance because intake and thus productivity of ruminants is influenced by fibre content **(Orskov et al., 1997).** With respect to the 48 hour nylon bag percent degradation, there were significant effects of all main as well as the interaction effect pasture type x deferment length on this value. The trend here was similar to that for CP. 8 week deferments were significantly more degraded than the 10 and the 12 week plots ($P < 0.05$). There was a big difference in the nylon bag value on going from the 8 week deferment (54.5%) to the 12 weeks (38.8%) as well as a noticeable difference between the *Brachiaria* (52.1%) and the native pastures (49.8%) ($P < 0.05\%$). ELOS percent followed a similar trend to the nylon bag values. The difference between the *Brachiaria* (45.2%) and the native pastures (31.7%) was very large,(13.5%). As pointed out by **De Boever et al., (1986)**, ELOS content is positively correlated with voluntary DM intake of roughages and liveweight gain in growing cattle. *Brachiaria* therefore appears to be more suited for ruminant feeding than the native pastures.

Table 1 Effect of pasture type and deferment length on the yield and quality at cutting (grass), in DM (Nov. 1995 - April 1997)

Variables	N	DM Yield at cutting (kg DM/ha	% DM at Baling	% CP	% CF	48h nylon bag (%)	% ELOS
Year	72	***	ns	Ns	**	**	ns
1995		2104.7	88.2	5.32	32.6	51.5	38.1
1996		1929.0	85.2	5.28	33.4	50.5	38.8
Pasture Type	72	*	ns	*	*	***	*
NP	36	1926.3	87.9	4.8b	35.8	49.8	31.7
BR	36	2108.3	85.5	5.8c	30.2	52.1	45.2
Defement	72	*	ns	*	*	***	*
. 8 wk	24	1798.2	86.3	5.9	32.2	54.5	39.3
10 wk	24	2021.4	86.7	5.3b	32.8	51.6	38.4
12 wk	24	2232.4	87.0	4.8	34.0	46.8	37.7
Past. x Reg	72	*	ns	ns	ns	**	ns
NP x 8 wk	12	1751.7	85.0	5.2	34.7	52.6	32.7
NP x 10 wk	12	1911.6	85.6	4.9	35.6	51.0	32.1
NP x 12 wk	12	2115.5	85.9	4.3	37.2	45.8	30.4
BR x 8 wk	12	1844.5	87.2	6.6	29.7	56.4	45.9
BR x 10 wk	12	2131.1	88.0	5.8	30.1	52.1	44.7
BR x 12 wk	12	2349.2	88.5	5.2	30.8	47.9	44.5
Mean ± SEM	72	2017.3± 87.78	86.7 ± 0.25	5.3 ± 0.55	32.9 ± 1.25	51.0± 1.40	38.80 ± 2.04

Notes. N = number of observations; DM = dry matter, BR = Brachiaria; NP = native pasture; CP = crude protein CF = crude fibre, wk = week; 48h nylon bag = 48 hour *in situ* degradation rate, ELOS = solublility of the organic matter in cellulase solution ME = metabolizable energy.
*** p ≤ 0.001; ** p ≤ 0.01; * p ≤ 0.05; n s for not significant

Table 2 shows some measures of economic importance in cattle production enterprises. Main effects significantly influenced all the parameters shown (P < 0.05). All interaction effects had non significant effects on them (P < 0.05). This means that the variations in the parameters here were mostly explained by the fixed effects. The higher DM yield of 1995 caused higher digestible DM yields to be obtained for these parameters in 1995 compared with 1996 (P < 0.05). With respect to pasture type, *Brachiaria* had a higher digestible DM yield, CP yield, 48 hour digestible CP yield and ELOS yield compared with the native pastures. It corroborates findings by researchers here on the plateau and elsewhere that *Brachiaria* is more nutritive than native pastures anywhere it has been introduced, even when non fertilised as was the case of the pastures in this study **(Rippstein, 1985, CRZ Wakwa Annual Reports, 1985 – 1997; Ezenwa et al., 1996).**

Regrowth length significantly influenced these parameters with highest yields of 48 hour nylon bag DM yield being obtained on the 12 week and 10 week deferments (Table 2). With respect to CP yield, the 10 week had the highest yield followed by the 12 week and lastly by the 8 weeks, ($P > 0.05$).This non significance between all deferment lengths can be explained by the fact that the relatively high CP content of the 8 and 10 week deferments more than compensated for their lower DM yields compared with that of the 12 weeks (Table 1). The relatively high CP contents of the 8 and 10 week deferments also made the 8 week deferments to have the highest 48 hour digestible CP yield, (52.9 kg/ha). With respect to the ELOS yield, it was highest for the 12 week, then the 10 week and lastly the 8 week deferments. The high DM content once more favoured the 12 weeks' ELOS yield since the latter value is based on the DM yield.

In all, when all these parameters are considered, the values of the 10 weeks appear to the best overall especially given their highest CP content and intermediate ELOS yield. In the Adamawa plateau there tends to be a reduction in the rains as from early September. This makes plots mowed around this time not to accumulate a good enough biomass for hay making in early November **(Rippstein, 1985)**. As pointed out by **Van Soest (1994)** yield and good quality, have to be balanced to enable adequate consumption of low protein fibrous feeds by ruminants.
The 10 week deferments appear therefore to be most suited for feeding of cattle on the plateau from the point of view of total nutrient yield.

With respect to the hay samples, percent dry matter (% DM) during storage was an average of 88.85%, (Table 3). That means the hay got drier during storage (see Table 1). There was no effect of year or year x week interactions on this parameter. However, all the other main effects significantly affected percent dry matter. As for the forages, percent dry matter increased from the 0 to the 20 week of storage. It was highest for the 12 week deferred samples.

Table 2.Yield of some Measures of Economic Importance in the Pasture Samples.

Variables	N	Dig. DM Yield 48h (t/ha)	CP Yield (kg/ha)	Dig. CP Y 48h (kg/ha)	ELOS Yield (kg/ha)
Year	72	***	***	***	ns
1995		1079.2	112.4	49.0	808.1
1996		968.6	101.5	44.3	751.6
Pasture Type	72	***	***	*	*
NP	36	955.0	91.4	38.6	608.7
BR	36	1092.8	122.5	54.6	950.9
Deferment Length	72	***	ns	*	*
Def. 8 wk	24	981.5	106.2	52.9	709.3
10 wk	24	1043.7	107.9	45.8	780.9
12 wk	24	1046.4	106.7	41.3	849.2
Mean ± SEM	72	1023.9 ± 56.67	106.9 ± 12.87	46.6 ± 6.2	788.3 ± 61.8

Notes:

- Dig. DM Yield 48h = 48h digestible DM Yield , i.e. kg DM Yield x 48 h nylon bag disappearance rate(%). Dig. CP Yield 48h = 48h digestible CP Yield, i.e. 48h Dig. DM Yield x % CP ELOS Yield = DM Yield x % ELOS ME Yield = DM Yield x ME
- *** p ≤ 0.001; ** p ≤ 0.01; * p ≤ 0.05; n s for not significant

Average CP was rather low but significant differences existed between years, pasture type, regrowth length, week of storage and the interaction year with week of storage (P < 0.05). It should be noted that there is a sudden lowering of the humidity, an increase in wind velocity and high diurnal temperatures at the on set of the dry season on the plateau. This together with the stage of maturity at harvest helps to lower the nutritive value of standing forages as well as conserved hay in the tropics **(Van Soest, 1994; Ruck and Muck, 1994**). The CF content followed an opposite trend to the crude protein. The 12 week deferments were the most fibrous of all the deferments (P < 0.05) The same trend for the 48 hour degradation value and the % ELOS for the pastures was observed here (P < 0.05). Week of storage significantly influenced all parameters except CF. There was only a slight increase in CF content in going from week 0 to week 20 (P < 0.05). Year had no effect on storage length, CP, nylon bag or ELOS percentages. This means there was similarity in hay quality during storage in both years. Generally speaking, quality reduced during storage.

7. Conclusions and recommendations

This study has shown the great potential for making a good hay crop on the Adamawa plateau. There was a reduction in quality with increase in the deferment length before cutting the hay. Yields were highest for both the 12 week *Brachiaria* and 12 week native pasture samples, respectively. They were lowest for both pasture types on the 8 week deferred plots. Quality parameters followed an opposite trend. So it is confirmed that length of deferment has an influence on the yield and quality of native and introduced pastures. From this study the 10 week deferments appear to be most suited for hay preparation.

Table 3 Effect of pasture type and deferment length on the quality of stored hay at Wakwa, Cameroon, (Nov. 1995 - April 1997)

EFFECT	N	% DM	% CP	% CF	48h deg. (%)	% ELOS
Year	108	ns	**	***	*	***
Year1	54	90.1	4.2	37.7	47.0	30.1
Year 2	54	87.6	4.3	35.7	45.6	31.4
Past. Type	108	**	**	***	***	***
NP	54	89.8	4.2	38.2	44.9	24.3
BR	54	87.9	4.3	35.1	47.7	37.3
Regrowth	108	***	***	***	***	***
Reg. 8 wk	36	88.0	4.7	33.8	49.2	32.0
Reg 10 wk	36	88.9	4.2	36.7	43.0	31.0
Reg. 12 wk	36	90.3	3.7	39.6	42.6	29.3
Week	108	***	***	Ns	*	*
Week 0	36	88.0	4.4	36.4	47.6	31.5
Week12	36	88.8	4.3	36.8	45.9	30.8
Week 20	36	89.9	4.0	36.9	45.3	30.0
Year x Week	108	ns	ns	***	ns	ns
Y 1 wk 0	18	89.5	4.3	37.3	48.4	25.1
Y1 wk 12	18	90.1	4.2	37.9	46.8	24.2
Y1 wk 20	18	90.7	4.0	37.8	45.8	25.5
Y2 wk 0	18	86.7	4.6	35.0	47.0	38.0
Y2 wk 12	18	87.9	4.4	35.6	45.9	37.4
Y2 wk 20	18	88.2	4.0	36.7	44.7	36.4
Mean ± SEM		88.85 ± 0.24	4.2 ± 0.51	36.7 ± 0.30	46.3 ± 1.13	30.8 ± 2.03

Abbreviations as shown in other Tables above
*** $p \leq 0.001$; ** $p \leq 0.01$; * $p \leq 0.05$; n s for not significant

With respect to the quality during storage, there was a significant drop from the on set of storage to the 20th week for most parameters. Fibre content followed the opposite trend. The hypothesis that storage length under good in door conditions does not affect hay quality is therefore rejected.

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