

Yield and composition of fodder banks on the Adamawa plateau of Cameroon

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Key words

Brachiaria ruziziensis - *Stylosanthes guianensis* - Natural pasture - Chemical composition - Cellulase - Digestibility - Yield - Adamawa - Cameroon.

Summary

In 1991 and 1992 some *Brachiaria ruziziensis* Germain and Evrard and *Stylosanthes guianensis* Aubl. cv. FAO 46004 fodder banks were established in the Adamawa province, located on the Adamawa plateau of Cameroon. A preliminary evaluation of their yields, crude protein (CP) and crude fiber (CF) contents revealed interesting results. In November 1996 and February 1997 another evaluation was carried out on some of these banks, and on similarly managed on-station banks. End of growing season yield, CP, CF, acid detergent fiber (ADF), and cellulase digestibility of the organic matter (CDOM) were 2556 kg of dry matter (DM)/ha, 3.74, 34.04, 38.22 and 39.93% for the on-station *Brachiaria* and 2700 kg DM/ha, 4.26, 33.44, 38 and 43.48% for the on-farm *Brachiaria*, respectively. The corresponding values for on-station native pasture fodder banks were 2485 kg DM/ha, 3.28, 38.19, 43.70 and 23.58%, whereas mixed (*Stylosanthes/Brachiaria*) banks had values of 3646 kg DM/ha, 9.33, 39.95, 42.10 and 42.82%, respectively. DM yields and CP of mixed fodder banks and native pasture banks were significantly different ($P < 0.01$). Native pasture banks had significantly lower yields ($P < 0.05$) than *Brachiaria* banks. However, there was a drastic drop in CP and CDOM as well as in the calculated net energy values of their respective hays. Farmers tended to neglect the banks a few years after their creation. It is recommended that livestock farmers try to stick to recommended stocking rates and above all weed out obnoxious species in order to make fodder banks useful to their livestock.

INTRODUCTION

Fodder banks are areas of pasture that are not utilized during the wet season when there is plenty of feed available, but are saved for times of scarcity (25). They, like crop residues, are reserves of forage which are left in the field until the animals need them. In the Adamawa plateau of Cameroon there is a heavy concentration of cattle in areas of luxuriant growth, which leads

to overgrazing and artificial shortage in a region where there is plenty of feed during the early rainy season. The cattle, however, lose weight and do not even produce enough milk for their young during the dry season (9, 13, 33). Two forages, namely *Brachiaria ruziziensis* Germain and Evrard and *Stylosanthes guianensis* Aubl. cv. FAO 46004, have been introduced (among many other plants) successfully on-station in the 1970's and since 1991, on-farm, by the researchers of the Wakwa Center of the Institute of Agricultural Research for Development (IRAD, formerly called IRZ). *Tripsacum laxum* and *Pennisetum purpureum*, two evergreen forages, succeeded in a similar sub-humid region in the western part of the country (10). However, they did not do well on the plateau as they require lowlands and a higher water table (37).

The Wakwa station is located 8 km south of Ngaoundere, the province main town. This province covers 75% of the Adamawa plateau, which is at an altitude of 900-1300 m. The plateau soils,

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climate, topography and natural conditions with regard to livestock rearing have been previously described (23). In brief, the province has a mean annual temperature of 22°C, 1600-1700 mm of rainfall mainly between April and October, a relative humidity of 40-60%, granitic and basaltic parent rock-based ferralsols, among others, and a sudano-guinean climate type. Grasses of the genera *Hyparrhenia*, *Panicum*, *Setaria* and *Loudetia* dominate natural pastures. The woody savanna is mainly composed of *Lophira* and *Daniella* spp. Livestock rearing is the main occupation of the 500,000 inhabitants who own more than 1.2 million cattle (28% of the national total) (35).

Brachiaria and *Stylosanthes* have been shown here and elsewhere to have yields of 5000 and 4600 kg DM/ha, respectively, even on non-fertilized plots (3, 4, 7, 11). These results were, however, obtained on swards that were less than 8 years old, a time when it is advisable to rejuvenate the plot by reploughing it. On the contrary, native pasture yields of 3500 kg DM/ha and less have been obtained from non-fertilized on-station and on-farm plots in the Adamawa (24). The IRAD Wakwa station recommended that a grazing management pattern be applied for these yields to be maintained. For *Brachiaria*, which resists trampling, a 25 to 30-day rest period between grazings under a rainy season stocking rate of 450-500 kg live weight per hectare has to be respected. Preferably, it should also be made into hay during the dry season (5). As for *Stylosanthes*, the FAO 46004 cultivar was the cultivar found to be anthracnose-resistant. However, like the other cultivars, e.g. cv. Schofield, it does not resist prolonged trampling. It remains green year round and should be grazed at a stocking rate of 350 kg live weight/ha and with a 60-day rest period. Its hay suffers from a lot of leaf loss and therefore should not be used as such during the dry season (1, 6, 7, 15). In a similar agroecological zone in Nigeria, 40 lactating zebu cows with 250 kg live weight maintained their milk yield during four months in the dry season (January to April) grazing 1.5 to 2.5 h daily on a 4-ha *Stylosanthes* plot (17). On-station at Wakwa, *Brachiaria* was used to feed the dairy herd, with higher milk yields obtained than when they were grazed on native pastures (26).

The first on-farm fodder bank that was reported on the plateau was established in 1979 (31). It was a *Stylosanthes guianensis* bank. It suffered from neglect and was later invaded by native pasture species. *Brachiaria ruziziensis* was introduced on-farm much later and was much appreciated by the pastoralists who wanted a crop with a high yield and one that could be made into hay when the pasture quality was low. The livestock owners strongly expressed their interest in it during the livestock system survey conducted province-wide in 1988 by a team of IRAD researchers and staff from the local delegations of livestock in all five divisions that make up the province (12).

The IRAD team set up one fodder bank on a cooperating farmer's farmstead at Likok village in July 1991, 50 km NE of Ngaoundere. It was made up of 1.2 ha of *Brachiaria* on one part and 1.5 ha of *Stylosanthes* on the other part of the plot. This was in accordance with the farmer's wishes who did not want a mixed bank or the two fodders established on separate plots. The local farmers were so impressed by this pilot bank that they asked the researchers to establish such banks in their farmsteads as well. They were told to bear some of the set-up cost and provide some labor, e.g. the installation of permanent fencing using *Ficus thonningi* and *Erythrina senegalensis*, the local readily available species commonly utilized for live fencing on the plateau. The pasture section staff of the Ngaoundere Delegation of Livestock was involved in identifying farmers or cooperatives, particularly

dairy cattle owners, that should benefit from the first wave of creation of the banks. The following year, IRAD succeeded in establishing four more 2-forage fodder banks on the plateau. Later on, the Delegation of Livestock, after seeing the results of these banks applied for funding for the creation of dozens more on-farm banks. Indeed, in 1997 there were at least 50 fodder banks in the vicinity of Ngaoundere alone, including the gigantic (over 20 hectares) mixed (*Stylosanthes* and *Brachiaria*) fodder banks of the Ngaoundere milk processing company, SOGELAIT.

The four fodder banks of 1992 were sown in April to May. All the fodder banks were established on basaltic rock substrata. Their yields were often higher than those based on granitic soils on this plateau (26). One of them failed to produce any crop. In retrospect, it came from the difficulties of making a proper seedbed on the undulating terrain on which the farmer insisted the bank should be established. The investment on a proper seedbed has been shown to result in proper seedling emergence, colonization of space, and ensure a good return on the investment (15, 17). The farmer later realized he had made the wrong decision. There was also the absence of a germination test since the viability of the seed was assumed to be good as it came from a "reliable" source. Inorganic fertilizers were used in all cases, the cost being borne by the farmers. Soils here are deficient in nitrogen and phosphorus because of leaching, particularly during the rainy season (19).

The first cuts for the yield and chemical composition of the banks were performed in early November of each year. This corresponds to the end of the rainy season and the beginning of the dry season. In November 1996, a few of them that had been reserved for hay production, as well as similar on-station banks, were sampled. In February 1997, another trip was made on-farm in order to sample the *Brachiaria* and *Stylosanthes* hay crop. Only a few farmers had succeeded in managing the fodders and producing hay as advised. The others, even including the pilot farmers, had been the victims of bushfires that were set to hunt game. However, they did not weed regularly either and were faced with an invasion of native grasses and legumes so that their farms could not be selected.

The present study is based on on-farm as well as on-station fodder banks, from farms typical of the plateau, that were created both by IRAD and the Delegation of Livestock, Ngaoundere, Cameroon. It is an account of the actual situation of the feed available from these banks during the winter (dry season) months.

■ MATERIALS AND METHODS

Each plot was ploughed using a disk plough supplied by the staff of the Wakwa research farm. A harrow then reduced the soil to a fine tilth. Seeding was done manually with sorted *Brachiaria* seeds. The seeds were mixed in local readily available drums at a rate of 7 l of seeds to 70 l of soil and sowed in lines 50 cm apart at a depth of 2-3 cm. They were lightly covered with soil afterwards. Ten kilograms of seed were needed per hectare. On another part of the plot, *Stylosanthes* was seeded at a rate of 20 kg/ha in rows 50 cm apart. Scarification was done by immersing the seeds contained in a fertilizer bag 20 to 30 times in hot water at a temperature of 60°C, i.e. for 6-7 min in all, spreading and drying. Sowing was done the same day. *Stylosanthes* seeds were mixed with soil at a rate of 10 kg of seed to 80 kg of soil prior to sowing. Each plot was given a dressing of 250 kg of N-P-K (20-10-10) fertilizer 1.5-2 months after

sowing and a week after weeding. Some farmers, who had earlier tried kraaling, had had mixed but mainly unsatisfactory results and therefore insisted on the readily available inorganic fertilizers. This is contrary to the preferred practice of kraaling in the sub-humid zone of Nigeria (20).

At the end of the 1996 rainy season, i.e. in November, a survey was carried out on these fodder banks. Most had been invaded by tall native pasture species of the genera *Hyparrhenia* and *Panicum* or had been partially burnt. Therefore, others established the same year by the Delegation of Livestock were also selected for evaluation, together with native pasture on-station fodder banks and the milk processing plant fodder bank. The end of the rainy season yields and botanical composition were done in early November 1996 from 1 x 0.5 m clipped samples using a quadrat that was thrown randomly into the plots 20 times per hectare, cutting all the vegetation therein, which was weighed on the field and taken to the station for species separation, re-weighed and dried (5). Farmers made circular hay bales (minimum weight 22.5 kg) with a rented baler from the dairy processing plant (SOGELAIT), Ngaoundere. The hay, unlike that of the research station, was stored on the field. Hay bales were all sampled by means of a coring device from the sides, the top and the bottom, in early February, one month after the beginning of hay feeding. Sampling was performed on bales of 2 on-station *Brachiaria*, 1 on-farm mixed and 2 on-farm native pasture plots that had similar histories and had not suffered from bushfires that year. Two hundred grams of coring were obtained from each of 10 bales per plot, then mixed, and 500 g were saved for dry matter determination and chemical analysis.

Initial laboratory analysis of the samples collected in 1991 and 1992 was done on 1 mm milled samples at the Department of Animal Science of the University of Ibadan, Nigeria. The 1996 and 1997 samples were analyzed at the Institute of Animal Science Laboratory of Humboldt University of Berlin, Germany. Proximate and fiber analyses, i.e. neutral detergent fiber (NDF), acid detergent fiber (ADF) and acid detergent lignin (ADL) were done according to the AOAC 1975 methods (2). Crude fiber (CF) was calculated by difference of ADF-ADL. The cellulase digestibility of the organic matter (CDOM) was done according to a modification of the method of pepsin-cellulase digestibility of De Boever *et al.* involving pre-incubation in water at 80°C for 45 min before the addition of cellulase (8, 16). Cellulase Onozuka R-10 from *Trichoderma reesei* with a cellulase activity of 1.0 U/mg (courtesy of Boehringer Ingelheim Co., Heidelberg, Germany) was used.

Net energy lactation (NE_l) values were calculated according to regression equations based on the solubility of the organic matter of tropical forages and hays in cellulase as proposed by Rhodehutsord *et al.* (27) as follows:

$$NE_l = 0.01 OM_c \times 0.0043 CP$$

where OM_c is the CDOM, CP is the crude protein (g/kg DM) and NE_l is the net energy lactation (MJ/kg DM).

A completely randomized (CRD) design was used in the selection of the banks. Only those with similar management were chosen. Treatment means were separated using Tukey's test (32).

■ RESULTS

The characteristics of the pilot fodder bank at Likok (Likok1) are shown in table I. Both forages grew vigorously, 0.5 m for *Brachiaria* and 0.75 m for the *Stylosanthes* after only three months of growth.

They colonized available space quickly, *Brachiaria* 80% or 1728 kg (DM) from a sward yield of 2160 kg DM/ha, and *Stylosanthes* 75% or 1500 kg (DM) from a total sward yield of 2000 kg DM/ha. Crude protein and crude fiber contents were 8 and 29.3% for *Brachiaria*, and 12.3 and 29.7% for *Stylosanthes* swards, respectively.

The performance of the three IRAD-created on-farm fodder banks of 1992 are shown in table II. They were evaluated in November 1992 at their different locations in the Vina division of the Adamawa province. They were Likok 2, Dibi dairy cooperative, and a private farmer's plot at Dibi village. The mean height for the *Brachiaria* on all plots was 1.08 m and there was a significant difference in height ($P < 0.05$) between the *Brachiaria* at the dairy cooperative on the one hand and Likok 2 and the private farm on the other. There was also a significantly lower height ($P < 0.05$) of the *Stylosanthes* of the dairy cooperative farm compared with that of the other two farms. With respect to the total vegetation yield, the dairy cooperative farm produced yields of 5124 and 5838 kg DM/ha for its *Brachiaria* and *Stylosanthes* sections, respectively. The percentage of the cultivated fodder in the total yield was also low for the dairy cooperative farm. This resulted in a significantly lower true fodder weight ($P < 0.01$) in the biomass for both *Brachiaria* and *Stylosanthes* compared with other farms (table II). The CP content followed a similar trend.

For the sampling of November 1996, average mean yields were 2556, 2700, 2485 and 3646 kg/DM for the on-station, on-farm *Brachiaria*, on-station native pasture and the on-farm mixed banks, respectively (table III). There was non-significance in yields between the three on-station *Brachiaria* plots and the on-farm *Brachiaria* plots. However, the latter had higher yields ($P > 0.05$) compared with the older (more than 8 years) on-station *Brachiaria* plots. The mixed on-farm plots were significantly higher ($P < 0.01$) in yield than the native pastures.

Ash contents were on average 7-8% in all instances (table III). With respect to CP content, the mixed plots had the highest mean value (9.33%), followed by the younger (4-year-old) on-farm *Brachiaria* (4.26%), the on-station *Brachiaria* (3.74%) and lastly the native pastures (3.28%). As for the CF, mean values ranged from 33.44 for *Brachiaria* to 39.95% for native pastures, while ether extract (EE) values ranged from 0.81 for the native pastures to 1.18%, respectively. NDF values ranged from 67.93% for the on-farm *Brachiaria* to 73.67% for the native pastures. Roughly the same trend for CF was obtained for ADF with the on-farm *Brachiaria* having the lowest mean value of 38%. Acid detergent lignin (ADF) was highest (8.76%) on the mixed plots compared with the other mainly grass plots. Cellulase solubility of the organic matter was as low as 15.31% on the native pasture plots and as high as 33.58% on the mixed plots. The same trend was observed for the CDOM. Net energy lactation calculated from the OM and CP (27) gave correspondingly low values for the native pastures (1.52 MJ/kg DM) when compared with those of on-farm *Brachiaria* plots (3.09 MJ/kg DM).

Average hay DM content was 88.66% (table IV). Ash was lowest (5.98%) in the mixed fodder and highest in the *Brachiaria* bales (7.10%) ($P < 0.01$). Crude protein content was only 1.98% in the native pasture bales and 4.35% in the mixed plot bales. With respect to CF the mixed plot bales had the highest value (49.09%) and the *Brachiaria* bales the lowest (37.07%). EE was lowest in the native pasture (0.59%) and highest in the *Brachiaria* on-station (1.04%) bales. NDF was highest in the native pasture and lowest in the *Brachiaria* on-station bales. The same NDF trend was obtained for ADF with mixed plots having the highest value (59.14%) and *Brachiaria* plots the lowest mean

Table I

Characteristics of first on-farm IRAD fodder bank at Likok village (Likok 1) as of 30.10.1991
(total surface area: *Brachiaria* part 1.2 ha; *Stylosanthes* part 1.5 ha)

No.	Item	<i>Brachiaria</i> part	<i>Stylosanthes</i> part
1	Height of sward (m)	0.5	0.75
2	Biomass of plot (kg DM/ha)	2160 ± 12.35	2000 ± 8.17
3	% space occupied	80.0	75.0
4	Cultivated forage crude protein (% DM)	8.0	12.3
5	Cultivated forage crude fiber (% DM)	29.3	29.7

Table II

Characteristics of other fodder banks in the Vina Division, Adamawa province, as of 02.11.92

Location	Fodder	Height of sward (m)	Total yields (kg DM/ha)	% of cult. fodder in sward	Weight of cult. fodder alone (kg DM/ha)	Cult. fodder CP (%)
Likok 2	B	1.12 ^a ± 0.011	5660 ^a ± 26.59	75 ^a ± 0.29	4,246 ^a ± 20.75	7.8
Dairy coop. at Dibi	B	0.89 ^b ± 0.009	5124 ^b ± 19.45	60 ^b ± 0.34	3093 ^c ± 15.61	5.9
Private farmer	B	1.23 ^a ± 0.023	4850 ^c ± 34.53	78 ^a ± 0.72	3778 ^b ± 29.76	8.3
Sub-mean		1.08 ± 0.020	5211 ± 34.52	71 ± 0.93	3705 ± 53.74	
Likok 2	S	1.03 ^c ± 0.014	5240 ^d ± 21.21	80 ^c ± 0.37	4189 ^d ± 20.47	12.2
Dairy coop. at Dibi	S	0.81 ^d ± 0.004	5838 ^f ± 15.12	55 ^d ± 0.40	3208 ^f ± 25.82	10.5
Private farmer	S	1.05 ^c ± 0.007	5560 ^e ± 10.4	82 ^c ± 0.24	4537 ^e ± 9.53	13.8
Sub-mean		0.96 ± 0.014	5546 ± 29.36	72 ± 1.29	4978 ± 60.36	

^{a,b} and ^{d,e} means within the same column and within the same species type are significantly different ($P < 0.05$)

^{a,c} and ^{d,f} means within the same column and within the same species type are significantly different ($P < 0.01$)

B = *Brachiaria ruziziensis*; S = *Stylosanthes guianensis*; cult. = cultivated; CP = crude protein; coop. = cooperative

value (44.18%). The same trend was observed for the ADL content. With respect to the cellulase solubility of the organic matter, it was as low as 16.52 and as high as 32.13% in native pasture and the *Brachiaria* bales, respectively. These rather low values led to correspondingly low values resulting in CDOM being lower than 50% even in the *Brachiaria* plots. Calculated net energy lactation values were as low as 1.57 and only as high as 3.06 MJ/kg DM for the native on-farm and the *Brachiaria* on-station bales.

DISCUSSION

For the establishment phase, the spectacular heights of both forages at the pilot fodder bank (table I) and at the private farmer's at Likok (Likok 2) (table II) were probably due to their location in lowlands. Pamo and Tarawali obtained similar heights in an on-station fodder bank at Wakwa in 1989, three months after establishment (22). Similar values have been obtained in similar agroecological zones (18, 20). The performances of the different banks varied according to the intensity of weeding and general care provided by their respective owners. The low yield of the fodders at the Dibi cooperative plot was due to poor post-

seeding weeding as evidenced by the presence of the original vegetation in the samples. On-station, values of 4-5 tons DM/ha and 4-6 tons DM/ha were obtained without fertilization, and 10-15 tons DM/ha and 7-10 tons DM/ha with fertilization in established plots of *Brachiaria* and *Stylosanthes*, respectively (26, 36, 37). The relatively high crude protein and low crude fiber values obtained here, just after establishment, compare favorably with similar values obtained elsewhere in the sub-humid zone of Nigeria (17). The above statistics on a successful establishment corroborate other authors' findings (1, 3, 4).

The yields obtained four years after establishment (table III) are less than the biomass yields obtained on-station (26, 34) and elsewhere (3, 15, 20). However, it should be recalled that the banks in the present study had been previously grazed during the rainy season and were sampled at the end of their growing phase. The values of these authors were obtained from cutting trials with cuts being made during the entire rainy season. Values obtained by such methods are higher, and they estimate the total potential yield (productivity) of a pasture and are used in calculating stocking rates (5, 21). The overall low CP values obtained here, even for the mixed fodder banks, were probably caused by: 1) untimely and prolonged grazing; 2) overstocking; and 3) lack of occasional weeding followed by fertilization of the swards between 1992 and 1996. It should also be pointed out that

Table III
Yield and chemical composition of some on-farm and on-station fodder banks sampled in November 1996 on the Adamawa plateau
(values expressed on the dry matter (DM) basis)

Location	Num. of plots	Yield (kg DM/ha)	Ash (%)	CP (%)	CF (%)	EE (%)	NDF (%)	ADF (%)	ADL (%)	CDOM (%)	NE _l (MJ/kg DM)
BR on-station	3	2556 ^a	8.31	3.74 ^a	34.04 ^a	0.90 ^a	68.14 ^a	38.22 ^a	5.27 ^a	39.93 ^a	2.64 ^a
BR on-farm	2	2700 ^a	7.71	4.26 ^a	33.44 ^a	1.18 ^b	67.93 ^a	38.00 ^a	5.11 ^a	43.48 ^a	3.09 ^a
NP on-station	2	2485 ^a	7.81	3.28 ^a	38.19 ^b	0.81 ^a	73.67 ^b	43.70 ^b	5.42 ^a	23.58 ^b	1.52 ^b
Mixed on-farm	2	3646 ^c	7.81	9.33 ^c	39.95 ^b	1.00 ^b	73.37 ^b	42.10 ^b	8.76 ^c	42.82 ^a	2.96 ^a
Mean		2814	7.93	5.00	36.14	0.96	70.48	40.25	6.03	37.06	2.56
SEM		104.31	0.82	0.42	1.29	0.02	0.82	0.76	0.36	2.76	0.24

Means within the same columns with different superscripts are significantly different (^{ab} P < 0.05, ^{a,c} P < 0.01)

BR = *Brachiaria ruzizensis*; NP = native pasture species; mixed = mainly *Stylosanthes* and *Brachiaria*
CP = crude protein; CF = crude fiber; EE = ether extract; NDF = neutral detergent fiber; ADF = acid detergent fiber; ADL = acid detergent lignin
CDOM = cellulase digestibility of the organic matter; NE_l = net energy lactation

Table IV
Nutritive value of some hays in various farms on the Adamawa plateau, Ngaoundere Region, sampled in February 1997

Location	Num. of plots	DM (%)	Ash (%)	CP (%)	CF (%)	EE (%)	NDF (%)	ADF (%)	ADL (%)	CDOM (%)	NE _l (MJ/kg DM)
BR on-station	2	87.88	7.10 ^a	3.22 ^a	37.07 ^a	1.04 ^a	70.75 ^a	44.18	6.33	42.61 ^a	3.06 ^a
Mixed	1	88.63	5.98 ^c	4.35 ^a	49.09 ^b	0.69 ^a	77.21 ^b	59.14	10.39	27.52 ^b	1.71 ^c
NP on-farm	2	89.46	6.69 ^a	1.98 ^b	41.92 ^b	0.59 ^b	78.85 ^b	49.15	7.28	16.9 ^c	1.57 ^c
Mean		88.66	6.31	2.95	41.41	0.77	75.28	49.16	7.52	30.97	8.19
SEM		9.41	0.41	0.17	0.94	0.05	0.66	3.24	0.77	3.76	0.05

Means within the same columns with different superscripts are significantly different (^{ab} P < 0.05, ^{a,c} P < 0.01)

NP = native pasture; BR = *Brachiaria ruzizensis* (the only hay stored in a shed, on-station); Mixed = *Stylosanthes* + *Brachiaria*
DM = dry matter; CP = crude protein; CF = crude fiber; EE = ether extract; NDF = neutral detergent fiber; ADF = acid detergent fiber; ADL = acid detergent lignin
CDOM = cellulase digestibility of organic matter; NE_l = net energy lactation

the fire protection bands that were supposed to be made around the banks were not always wide enough to prevent them from the yearly fires caused by hunters in search of game. If the seasonal workers were asked to increase them by a meter or so, no additional costs would be incurred since they are usually paid a flat rate at the end of the season. The rainy season stocking rate of 300-400 kg and 350-450 kg live weight per hectare recommended for native and *Brachiaria* pastures, respectively, were not also respected. *Stylosanthes guianensis*, in particular, is a species which does not support continuously high stocking rates and does best when the herd is allowed to graze it for 1.5-2.5 h during the dry season or with 60-day rest periods during the rainy season (4, 28, 30, 31). The higher values for DM yield, CP, CF, ADF and the calculated cellulase digestibility of the organic matter of the mixed plots reflected their legume content. The presence of legumes in native pastures in Australia has led to cattle being turned out earlier, at 2-3 years, instead of the usual 5-6 years (14, 29, 30).

Despite the high DM content of the hay (table IV), the very low CP, high CF and NDF values of the natural pasture hay compared with *Brachiaria* or mixed-crop hays showed there was a severe drop in the nutritive value of the native pasture swards, at a time (February), the so-called period of stress, when hays are most needed by the livestock (9, 13, 23, 26). Livestock farmers were therefore forced to buy costly protein concentrates to supplement the hay produced and avoid malnutrition and the certain death of their animals. The extremely low CP content of these hays was not surprising given the low values found in the vegetation. It showed the effect of years of non-fertilization of the pastures added to the recurrence of the original vegetation (26). The protein contents of less than the minimum 7% found in these hays were not enough for proper microbial growth, and this affects their digestibility and total energy intake (8). The relatively high NDF, ADF and ADL contents (all indicators of indigestibility) of the mixed banks resulted from the relatively low leaf content of the mixed swards that had *Stylosanthes* which, as already pointed out, produces hay with a lot of leaf loss. The results of this study showed that the hays from the mixed banks lost a lot of their leaf content during baling as well

as storage. Animals feed themselves by picking up all the leaves on the ground during the first few days but, after that, the quality of the remaining stems cannot cover their maintenance and production needs. The low net energy values found here may be due to the poor quality of the species invading native pasture in the fodder banks. This brings once more into focus the need for farmers to adhere to recommended stocking rates and management guidelines.

■ CONCLUSION

This study has shown that there is a great potential for the use of fodder banks to provide cheap protein and energy if management guidelines are adhered to. Something too should be done probably through government intervention to enact laws against the yearly bush burning that frustrates the owners of the banks. Management of the fodder banks studied is poor and does not allow for the true expression of the potential of these banks even though relatively high CP and yields were obtained at the onset. At present, researchers are looking for funding in order to implement on-farm trials. They would involve livestock farmers in the planning and execution of the project and thus eliminate the differences arising from too many types of management.

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Résumé

Enoh M.B., Yonkeu S., Pingpoh D.P., Messine O., Maadjou N.
Rendement et composition de banques de fourrages sur le plateau de l'Adamaoua au Cameroun

En 1991 et 1992 certaines banques de fourrages de *Brachiaria ruziziensis* Germain et Evrard et *Stylosanthes guianensis* Aubl. cv. FAO 46004 ont été établies dans la province de l'Adamaoua située sur le plateau Adamaoua au Cameroun. Une étude préliminaire de leur rendement, des teneurs en matières azotées totales (MAT) et en cellulose brute (CB) a fourni des résultats intéressants. En novembre 1996 et février 1997 une autre évaluation a été faite sur ces banques et sur des banques en station expérimentale de conduite similaire. Le rendement en fin de croissance, les teneurs en MAT, en CB, en lignocellulose et la digestibilité cellulosique de la matière organique (DCMO) ont été respectivement de 2 556 kg de matière sèche (MS)/ha, 3,74, 34,04, 38,22 et 39,93 p. 100 pour le *Brachiaria* en station, et de 2 700 kg MS/ha, 4,26, 33,44, 38,00 et 43,48 p. 100 pour le *Brachiaria* en milieu paysan. Les valeurs correspondantes pour les pâturages naturels en station ont été respectivement de 2 485 kg MS/ha, 3,28, 38,19, 43,70 et 23,58 p. 100 alors que des banques mixtes (*Stylosanthes/Brachiaria*) ont eu respectivement des valeurs de 3 646 kg MS/ha, 9,33, 39,95, 42,10 et 42,82 p. 100. Les rendements en MS et en MAT des banques fourragères mixtes et des pâturages naturels ont été significativement différents ($P < 0,01$). Les banques de pâturages naturels ont eu des rendements moins importants ($P < 0,05$) que les banques de *Brachiaria*. Toutefois, une chute brutale des teneurs en MAT et de la DCMO, ainsi que de la valeur calculée de l'énergie nette de leurs foins respectifs, a été enregistrée. Il est recommandé que les éleveurs respectent les charges préconisées et surtout qu'ils éliminent régulièrement les adventices afin que les banques de fourrages puissent assurer une bonne productivité du bétail.

Mots-clés : *Brachiaria ruziziensis* - *Stylosanthes guianensis* - Prairie naturelle - Composition chimique - Cellulase - Digestibilité - Rendement - Adamaoua - Cameroun.

Resumen

Enoh M.B., Yonkeu S., Pingpoh D.P., Messine O., Maadjou N.
Rendimiento y composición de los bancos de pastos en la meseta de Adamawa en Camerún

En 1991 y 1992, se establecieron algunos bancos de pastos de *Brachiaria ruziziensis* Germain y Evrard y *Stylosanthes guianensis* Aubl. cv. FAO 46004 en la provincia Adamawa, localizada en la meseta de Adamawa en Camerún. La evaluación preliminar de los rendimientos y los contenidos de proteína cruda (CP) y de fibra cruda (CF) revelaron resultados interesantes. En noviembre 1996 y febrero 1997 se llevó a cabo otra evaluación, en algunos de estos bancos y así como en bancos en estaciones experimentales con manejo similar. Los rendimientos al final de la período de crecimiento, CP, CF, fibra ácida detergente (ADF) y digestibilidad de la celulosa de la materia orgánica (CDOM) fueron, respectivamente, de 2556 kg de materia seca (DM)/ha, 3,74, 34,04, 38,22 y 39,93% para *Brachiaria* dentro de la estación experimental y 2700 kg DM/ha, 4,26, 33,44, 38 y 43,48%, respectivamente, para *Brachiaria* en bancos de pastoreo en fincas. Los valores correspondientes para los bancos de pastos nativos dentro de la estación experimental fueron, respectivamente, de 2485 kg DM/ha, 3,28, 38,19, 43,70 y 23,58%, mientras que los bancos mixtos (*Stylosanthes/Brachiaria*) presentaron valores de 3646 kg DM/ha, 9,33, 39,95, 42,10 y 42,82%. El rendimiento de DM y CP de los bancos de pastos mixtos y los bancos de pastos nativos fueron significativamente ($P < 0,01$) diferentes. Los bancos de pastos nativos presentaron rendimientos significativamente ($p < 0,05$) inferiores que los bancos de *Brachiaria*. Sin embargo, se observó una caída drástica de la CP y CDOM, así como en el valor de la energía neta calculada de los henos respectivos. Algunos años después de su creación, los finqueros tienden a descuidar los bancos. Se recomienda que los finqueros ganaderos traten de mantener las tasas de almacenaje recomendadas y principalmente deshierbar especies nocivas, con el fin de crear bancos de pastos útiles para el ganado.

Palabras clave: *Brachiaria ruziziensis* - *Stylosanthes guianensis* - Pastizal natural - Composición química - Celulosa - Digestibilidad - Rendimiento - Adamawa - Camerún.