A REVIEW OF RESEARCH ON THE EVALUATION OF HERBAGE CROPS AND NATURAL GRASSLANDS IN NIGERIA

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ABSTRACT

Work in Nigeria on the evaluation of improved pastures and natural grasslands is reviewed. Yields of up to 20,300 kg (20 tonnes) dry matter per ha have been recorded with the tall grasses in the south but these grasses rapidly deteriorate in nutritive value as they mature. The productivity of natural grasslands in the north can be improved by over-sowing with drought-resistant legumes. Grass-legume mixtures have been successful in improving herbage productivity, livestock performance and soil fertility. Dry matter intake may constitute a more serious limitation to animal production than digestibility. There is an urgent need for more concerted effort to increase livestock productivity through pasture improvement.

INTRODUCTION

Nigeria is the largest country along the West Coast of Africa. It lies between latitudes 4° 20′ and 14° 00′ north and longitudes 2° 20′ and 14° 13′ east and covers a land area of over 92.5 million ha which extends northwards from the coastline for over 1,000 km. Its population of about 60 million is by far the largest in Africa.

There are three main vegetation regions in Nigeria: Forest, Savanna and Montane. The forest region is made up of mangrove forest in the coastal area, an extensive low rain forest zone and a derived savanna zone with relict forest resulting from intensive tree felling, bush clearing and shifting cultivation. The true savanna region which covers over three-quarters of Nigeria's land area is divided into the southern and northern guinea zones, the Sudan zone and the Sahel savanna in the north-eastern corner of the country (Figure 1). The montane vegetation, made up of mountain forest and grassland, is located on the Bauchi Plateau around Jos (Keay, 1953). The vegetation type is most affected by rainfall which varies from over 3,500 mm in the Atlantic coastal area to about 500 mm in the far north. Rainfall occurs every month near the Atlantic coast and diminishes to a two-season pattern inland with an extreme five-month drought in the northern one-third of the country (McKell and Adegbola, 1966).

TABLE 1

Estimated Livestock Population in Nigeria 1963/64.

	('000)
Horses	431.2
Donkeys	2,085.0
Camels	16.8
Cattle	10,858.6
Goats	21,205.7
Sheep	7,234.8
Pigs	680.4
Poultry	66,039.6

McIlroy (1962) has stated that the grasslands in Nigeria cover over 80% of its total area. With nearly 60 million ha of rangeland and the possible establishment of improved grassland in the derived savanna and rain forest zones, Nigeria has a high potential for grassland development and livestock improvement. This far, the livestock industry has received very little attention. F.A.O. (1966) has given the

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estimated livestock population in Nigeria in 1963/64 as shown in Table I. All the horses, donkeys and camels were located in the north while only 6% of the cattle, 32% of the goats and 39% of the sheep were found in the south. Therefore most of the livestock in Nigeria are found in the savanna areas of the north. The F.A.O.

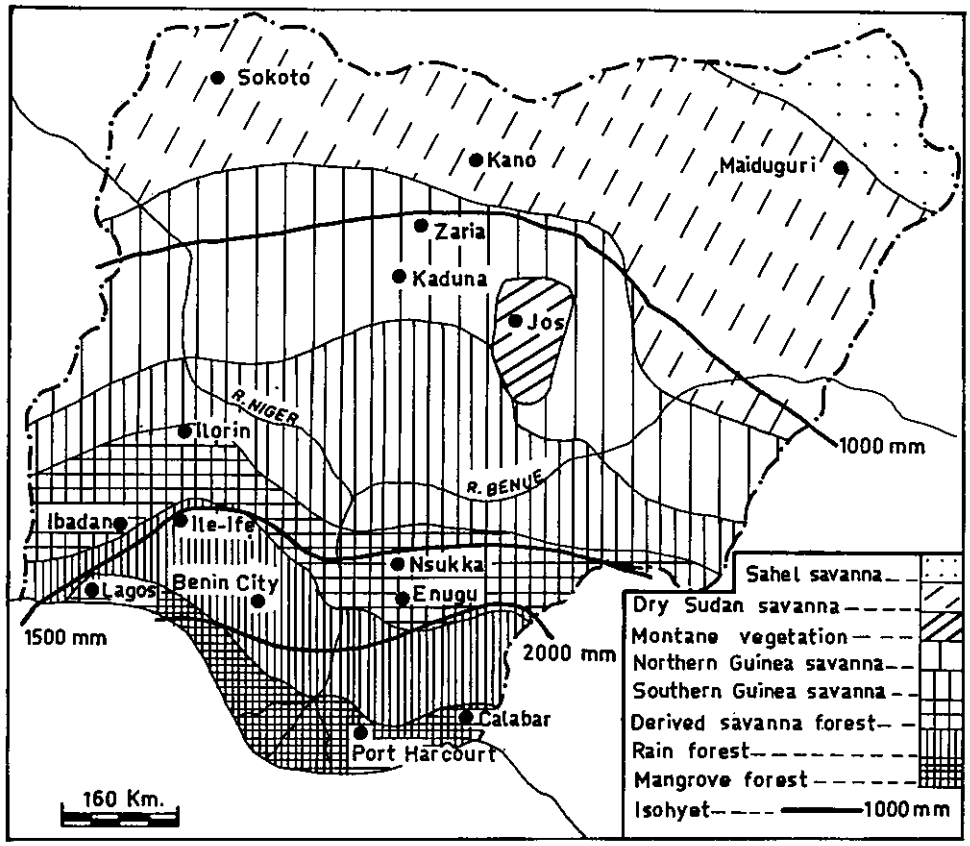

FIGURE 1
Main vegetation regions in Nigeria.

(1966) also indicated that only 13% (6.6 g) of total per caput protein intake in Nigeria was from animal sources in 1963/64. Thus there is a real need for increased animal production through grassland improvement, particularly in the savanna areas.

ADAPTED HERBAGE CROPS

A large range of both indigenous and exotic grass and legume species have been evaluated for growth and persistency in Nigeria (Oyenuga, 1957; Ahlgren *et al.*, 1959; Foster and Mundy, 1961; McIlroy, 1962; Rains, 1963; Adegbola, 1964; Adegbola and Onayinka, 1966; Oyenuga and Hill, 1966; Haggar, 1969 and Agishi, 1971). The main criteria which have been used to classify herbage crops as being adapted to an area are: 1. ease of establishment, 2. high productivity in a particular climate and soil type, 3. high palatability and nutritive value, 4. ability to survive a dry season, and 5. easy eradication of species used in leys.

The best adapted grasses and legumes in the main ecological zones in Nigeria are:

Grasses	*Legumes*
SUDAN SAVANNA	
*Andropogon gayanus**	*Alysicarpus glumaceus**
Aristida stipoides	*A. vaginalis*
Cenchrus biflorus	*Indigofera echinata*
Chloris virgata	*Stylosanthes erecta*
Hyparrhenia cyanescens	*S. gracilis**
*Pennisetum pedicellatum**	
P. ramosum	
P. setosum	
Sporobolus granularis	
GUINEA SAVANNA	
*Andropogon gayanus**	*Atylosia scarabaeoides*
*Brachiaria brizantha**	*Centrosema pubescens**
Cymbopogon giganteus	*Indigofera echinata*
*Cynodon dactylon**	*Stylosanthes gracilis**
Hyparrhenia cyanescens	
H. dissoluta	
H. rufa	
*Panicum maximum**	
*Pennisetum purpureum**	
Setaria sphacelata	
Sporobolus pyramidalis	
DERIVED SAVANNA	
*Andropogon gayanus**	*Calopogonium mucunoides**
*A. tectorum**	*Centrosema pubescens**
*Cynodon nlemfuensis**	
Hyparrhenia dissoluta	*Puereria phaseoloides*
H. rufa	*Stylosanthes gracilis**
Melinis minutiflora	
*Panicum maximum**	
*Pennisetum purpureum**	
RAIN FOREST	
*Andropogon gayanus**	*Calopogonium muconoides**
Axonopus compresus	*Centrosema pubescens**
Brachiaria brizantha	*Glycine weightii*
B. mutica	*Puereria phaseoloides**
*Cenchrus ciliaris**	*Stylosanthes gracilis**
*Chloris gayana**	
*Cynodon nlemfuensis**	
*Digitaria decumbens**	
*Melinis minutiflora**	
*Panicum maximum**	
Paspalum notatum	
*Pennisetum purpureum**	
Tripsacum laxum	

* Species of greatest value for grass-legume mixtures.

Tropical legumes play a particularly important part in increasing the productivity of Nigeria's grasslands. The ability of legumes to improve the nitrogen status of the soil and thereby increasing overall herbage yield and the nutritive value of the accompanying grass is being exploited in all regions. McIlroy (1962) showed that the annual contribution of fixed nitrogen to the sward by *Centrosema pubescens* (Centro) at Ibadan was about 280 kg N per ha. *Stylosanthes gracilis* (Stylo) has an advantage over centro in the savanna zones because it is more drought-resistant and remains green for most of the year whereas centro is a most valuable species in the wetter southern zones. *Centrosema pubescens* is one of the most widely used legumes in Nigeria and has been grown with grasses such as *Panicum maximum, Cynodon sp.* and *Melinis minutiflora* where it has been able to keep weeds down by its excellent covering ability, conserve moisture, improve the nitrogen status of the soil and the overall nutritive value of the accompanying grass. Stylo has been successfully oversown into natural grassland (Haggar, 1969; Agishi, 1971) and many successful grass-legume pastures have been grown, particularly when phosphatic fertilizers have been provided (Rains, 1963). The best grass-legume combinations are judged by their ease of establishment, preferably from seed, their ability to maintain at least a 2 : 1 grass : legume ratio, their capacity to recover from cutting or grazing as well as to be easily eradicated if sown in leys.

TABLE 2

Annual dry matter yield of some herbage crops at Agege (Lagos) (after Adegbola, 1964).

Species	*Dry matter yield (tonne/ha)*
Bunch type	
Andropogon gayanus	14.8
Pennisetum purpureum	20.8
Panicum maximum	5.8
Sod formers	
Cynodon nlemfuensis	6.3
Digitaria decumbens	4.8
Melinis minutiflora	6.5
Legumes	
Stylosanthes gracilis	10.2
Centrosema pubescens	4.4
Puereria phaseoloides	5.7
Calopogonium muconoides	2.8

YIELD AND INTERVAL OF HARVESTING

The numerous cutting trials which have been conducted in Nigeria show that pastures are capable of high herbage yields (Oyenuga, 1959a, 1959b, 1960a, 1960b; Ademosun, 1970b). The annual recorded dry matter yields from a number of grasses and legumes at Agege in the Lagos area measured by Adegbola (1964), are shown in Table 2. Yields increased markedly as the length of the cutting interval was increased (Ademosun, 1970b, 1972). However, there was an inverse relationship between yield and quality (Table 3).

Haggar (1970) in Zaria found with *Andropogon gayanus* that yield of dry matter increased during the wet season June to October, reaching a maximum of about 3.8 tons per ha in October, and declining during the dry season from October to February. Because of the decline in herbage quality and yield he recommended harvesting early in October in order to achieve a reasonable balance between herbage bulk and quality.

Cutting height and frequency of cutting can greatly influence pasture productivity. Experiments at Fashola Livestock Farm in the derived savanna zone have shown that *Cynodon nlemfuensis* (giant star grass) maintained good stand and productivity when cut fortnightly to a height of 2–3 cm whereas *Andropogon gayanus* required intervals of more than six weeks between cuttings and cutting heights of about 4 cm to maintain productivity and a good stand (Ahlgren *et al.*, 1959).

More intensive studies are required to determine the appropriate stage of maturity for harvesting or grazing in the different ecological zones in order to achieve the optimum yield of digestible nutrients.

TABLE 3

The effect of stage of maturity on the yield of dry matter and digestible nutrients by two varieties of Cynodon *(after Ademosun and Kolade,* 1972).

Variety	Age of herbage	Dry matter yield	Yield of digestible nutrients:			
			Crude protein	Acid detergent fibre	Cellulose	Energy
	(days)	(tonne/ha)	kg/ha	kg/ha	kg/ha	(Mcals per ha)
IB8	28	2.0	169	544	555	5,246
	49	3.8	236	973	903	7,564
	70	5.1	306	1479	1137	10,444
	91	8.1	ND	ND	ND	ND
Local	28	1.1	89	313	253	2,723
	49	4.2	220	1015	973	9,443
	70	7.2	385	1396	1312	12,384
	91	18.9	ND	ND	ND	ND

ND = Not determined.

FERTILIZER RESPONSE

Decline in nitrogen (crude protein) content of pasture grasses in the second, third and subsequent years is normal in unfertilized plots. Application of ammonium sulphate and superphosphate has been reported to lead to increases in the yield of dry matter and crude protein. Haggar (1967) found in Zaria with *Andropogon gayanus* that the application of increasing quantities of nitrogen as ammonium sulphate up to the equivalent of 112 kg per ha resulted in almost linear increase in dry matter production. Superphosphate also increased dry matter yields. Rains (1963) found that the annual application of 115 kg superphosphate per ha to a *Chloris gayana* (Rhodes grass)-stylo plot resulted in an increase in the crude protein content of the legume. Ahlgren *et al.* (1959) showed that giant star grass more than doubled its yield of dry matter with 45 kg nitrogen per ha applied in a split application, while *Centrosema pubescens* produced twice as much foliage and maintained good stand when supplied with 9 kg P_2O_5 and 27 kg K_2O also applied in split application. Hedrick (1961) concluded that at levels above 45 kg nitrogen application, phosphorus and potassium may become limiting to the production of *Panicum maximum* (guinea grass).

McIlroy (1962) found that the application of 125–250 kg per ha of superphosphate and good grazing management achieved a balance of 50% grass and 50% legume in a giant star grass-centro plot at the University of Ibadan farm. Oyenuga and Hill (1966) studied the effect of superphosphate applied at 250 and 500 kg per ha with and without the elements Mg, Cu, Mo, Zn, and B on the yield of a pasture sward made up of giant star grass, Rhodes grass, centro and stylo.

Dry matter yield was significantly improved by the addition of 500 kg per ha of superphosphate. The highest yield was from 250 kg per ha superphosphate plus Mg, Cu, Mo. The treatments did not affect the protein content of the pasture but total crude protein yield followed the same trend as dry matter yield. An application of 250 kg/ha of sulphate of ammonia applied to a mixture of *Chloris gayana-Alysicarpus glumaceus* in northern Nigeria stimulated the growth of grass but reduced the weight of legumes compared with unfertilized pastures.

Fertilizers are expensive in Nigeria, despite government subsidy, difficulties are experienced in transportation and distribution, and fertilizers may not be available when required. Nevertheless the response of herbage crops to fertilizer treatment needs more intensive investigation particularly now that there are government moves to manufacture nitrogen and phosphate fertilizers in the country. Fertilizer application to pastures will become more popular in future as land pressures increase in certain parts, even in the North where the Nomadic Fulani herdsmen will need to settle. Also increased demand for milk and the expansion of the dairy industry in the country call for the use of imported dairy breeds which are raised intensively in urban areas around Ibadan, Lagos, Zaria and Jos.

CHEMICAL COMPOSITION AND NUTRITIVE VALUE

The effect of stage of maturity, frequency of cutting, level and type of fertilizer application on the chemical composition of Nigerian herbage crops has been widely studied for a large number of species. Oyenuga (1957) published the proximate composition of twenty grasses and legumes each harvested at five stages of maturity starting three to four weeks after cut-back and harvested thereafter at monthly intervals. Some of the tall grasses had reached great heights after five and a half months of growth. For instance, *Andropogon gayanus* had reached a height of over 470 cm while *A. tectorum* was 360 cm and *Pennisetum purpureum* was 400 cm. These tall grasses are quite characteristic of the tropics. There are, of course, the short sod-forming grasses such as *Cynodon Sp., Melinis minutiflora* and *Paspalum notatum.* The protein content of most of the forages was quite low, being only about 12% at four weeks and decreasing sharply to as low as 4% at the time of the last harvest. *Centrosema pubescens* showed much higher protein values with a less rapid decline with advancing maturity.

More detailed studies on the yield and chemical composition of *Pennisetum purpureum* (Oyenuga, 1959a), *Andropogon tectorum* (Oyenuga, 1959b), *Panicum maximum* (Oyenuga, 1960a), and *Tripsacum laxum* (Oyenuga, 1960b) showed that the tropical tall grasses grow more rapidly than the temperate grasses producing high yields of up to 125 tons per ha of fresh material in one year. There are very rapid chemical changes as a result of the rapid growth rate. Thus crude protein content falls and crude fibre content increases quite rapidly. Studies with *Stylosanthes gracilis, Pennisetum purpureum, Cynodon nlemfuensis* and *Panicum maximum* have indicated increasing levels of lignin, acid detergent fibre and cell-wall constituents with advancing maturity. Lignification (lignin as per cent of acid detergent fibre) increased with advancing maturity and was 16.4% for *P. purpureum* harvested after twenty-three weeks of growth. *Cynodon nlemfuensis* was lower in lignin at comparable stages of maturity than *S. gracilis* (Ademosun, 1970b; Ademosun and Kolade, 1972). There is a very rapid decline in leaf-to-stem ratio.

Oyenuga (1957) showed that silica-free ash content of eighteen grasses decreased with advancing maturity. *Tridax procumbens*, a herbaceous plant belonging to the family Compositae, and usually relished by pigs and poultry, showed decreasing ash content with advancing maturity. *Andropogon tectorum* showed increasing calcium and decreasing phosphorus and magnesium content when harvested at 3, 6, 8 and 12 weeks intervals (Oyenuga, 1959b). Similar results were recorded for *P. maximum* and *T. laxum* (Oyenuga, 1960a, 1960b). *Panicum maximum*

was higher in calcium, phosphorus and magnesium when harvested at comparable stages than *A. tectorum* or *T. laxum*. *Andropogon tectorum* was particularly low in phosphorus. Ademosun and Baumgardt (1967) presented detailed analyses of the mineral content of twenty-three Nigerian pasture plants.

The *in vitro* digestibility technique has not been widely used in Nigeria but is currently being used at Ibadan and Ile-Ife. Ademosun and Baumgardt (1967) reported on the *in vitro* digestibility of sixteen Nigerian herbage crops. *Pennisetum purpureum* and *Panicum maximum* showed decreasing *in vitro* dry matter digestibility with increasing maturity. Generally, under good management with fertilizer, a reasonable number of herbage crops harvested at an early stage of growth have dry matter digestibility figures of over 60% (Ademosun 1970a, 1970b, 1972; Haggar and Ahmed, 1971).

Some of the earliest feeding trials with fresh and conserved herbage were carried out in Northern Nigeria at the Samaru Experimental Station, now the Institute of Agricultural Research of Ahmadu Bello University, Zaria (Miller, 1961; Miller and Rains, 1963; Miller *et al.*, 1963, 1964). The herbage crops they used included *Andropogon gayanus, Brachiaria brizantha, Chloris gayana, Cynodon dactylon, Hyparrhenia rufa, Panicum maximum, Pennisetum purpureum, P. pedicellatum, Centrosema pubescens, Desmodium acorpuria, Stylosanthes gracilis* and *Vigna sinensis*. These studies indicated that *A. gayanus* harvested at a height of 90–120 cm and fed in the fresh form to long-legged hair sheep and Zebu cattle was the most nutritious. However, when conserved as silage or hay, it had a lower nutritive value. Digestibility studies on artificially dried *A. gayanus* in Southern Nigeria also showed that the conserved grass has low nutritive value. Natural grassland containing 60% *A. gayanus* resulted in weight gain of 0.31 kg per day when grazed by N'Dama and Keteku cattle but when the herbage was conserved as silage the weight gain was 0.11 kg per day (Adegbola *et al.*, 1968). *Panicum maximum* on the other hand responded well to fertilizer application and did not decline in quality to the same extent when made into silage (Miller *et al.*, 1963). The legumes contained higher levels of crude protein and digestible crude protein than the grasses. Generally, positive nitrogen balance was obtained with the legumes.

Ademosun and Kolade (1972) compared two varieties of *Cynodon nlemfuensis–C. nlemfuensis* var *robustus* (local or IB1) and *C. nlemfuensis* var *nlemfuensis* (IB8) and found that when harvested at six weeks, both varieties yielded about 3 tonnes per ha and digestibility of dry matter by goats was about 60% for both varieties. The grass matures very rapidly, lignin content of both varieties at 13 weeks was 12.0% which was 25% of the acid detergent fibre content (Table 3). Thus it has been recommended that consideration be given to harvesting the grass at six weeks to obtain the optimum level of nutrients. There was no difference in the chemical composition of the aftermath harvested at between three and twelve weeks and the primary growth of comparable age. At all stages of maturity, the local variety was consumed to a greater extent by goats than the IB8 variety, although intake for both varieties did not vary with stage of maturity.

Dry matter intake of pasture is usually quite low, particularly when herbage crops are harvested for stall feeding. Miller and Rains (1963) recorded low dry matter intakes between 1 and 2 kg per 100 kg body weight for a number of grasses fed in the fresh form to sheep and cattle in northern Nigeria. Similar results were obtained with studies on silage or hay (Miller *et al.*, 1963, 1964). Results from work in the south also show low dry matter intake of forage by sheep and goats when stall fed. Ademosun (1970a) recorded intake values (g/W 0.75) of 43.4, 34.3, 38.3 and 35.5 with *P. purpureum* harvested at four stages of maturity and fed to sheep. Ademosun and Kolade (1972) recorded dry matter intake values of 1.59, 1.36 and 1.51 kg per 100 kg body weight for the IB8 variety of *C. nlemfuensis* harvested at 4, 7 and 10 weeks of age and fed to goats. The corresponding values for the local variety were 2.09, 2.26 and 2.20 kg per 100 kg body weight. Olubajo and Oyenuga

(1971) in a grazing trial involving grass-legume mixtures could not find any variation in herbage intake with advancing maturity. It appears that low herbage intake places a greater limitation on the nutritive value of tropical herbage crops than their digestibility.

HERBAGE CONSERVATION

One of the major problems of livestock production in Nigeria is to provide feed during the dry season. This is particularly the case in the north where the dry season is longer and more severe. Hay making in the south is not very feasible as the period of favourable herbage growth also coincides with the height of the rainy season. However, limited success has been reported in artificially drying herbage but the quantity produced is generally only sufficient for feeding trials. Some herbage species can be cut back towards the end of the rains and hay made from the aftermath. In the north this is not possible because of the limited rain. Miller *et al.* (1964) reported a feeding trial involving hay made from *A. gayanus*. The material was barn dried on wire racks but the grass had to be turned over daily to complete drying quickly and to avoid mouldiness. The resulting hay was of such a low nutritive value, with an organic matter digestibility of 44.9%, that they considered that the work involved in hay making was not justified. Standing hay, which is herbage remaining during the dry season, was found to be of very low feeding value. This material contained 1.5% crude protein and animals on this feed were in negative protein balance.

Very little is known about silage making in Nigeria; this is an area of herbage crop research that has been neglected. Miller *et al.* (1963) studied digestibility of silage made from a number of herbage species in northern Nigeria. They found that silage made from *A. gayanus* was of low digestibility and that pre-wilting the material did not improve the nutritive value. The pH of silage made from the pre-wilted grass varied from 7.0 to 9.5 as a result of insufficient consolidation and mould growth. *P. maximum* was ensiled alone and compared with the material ensiled with sorghum meal and sodium metabisulphite. The metabisulphite treated silage was greenish-yellow in colour and had a pleasant acid smell but was not as palatable as the ordinary silage.

There is need to carry out further investigations into the ensilage of such crops as *P. maximum*, *A. gayanus*, *P. purpureum*, maize and sorghum. Trench silos are most commonly used for ensilage because they can be used on a large scale without high capital cost. Other types of silos such as tower, bunker and pit also need to be investigated as well as the need to consolidate and seal such stored material. Further work is required on the most desirable stage of maturity for successful ensilage, the optimum moisture content, the effect of wilting and the use of additives.

GRAZING STUDIES ON NATURAL GRASSLANDS

There is very little information on the carrying capacity of the natural grassland. Gillet (1961) working in the Chad Republic estimated the stocking rate of the annual grass savanna at 8 ha per animal, with upper and lower limits of 4 and 14 ha, respectively. High stocking rates of less than one ha per animal can be achieved during the wet season in the forest reserves of north-western Nigeria without any overgrazing (Fishwick, 1954). Carrying capacity drops in the dry season to about 10–20% of this. Dry season fodder is mostly made up of low quality herbage, young grass regrowth after burning, flood plain and swamp grassland, leaves and fruit of trees and shrubs and stubble and crop residues (de Leeuw, 1965). Usually nomadic cattle owners move animals south to better grazing land but they still have difficulty in meeting their maintenance requirements.

Productivity of the uncleared natural grassland in the northern guinea savanna is usually below 2,800 kg dry matter and 80 kg crude protein per ha per year. Since

cattle require 2,300–2,700 kg dry matter per adult equivalent per year, the carrying capacity of this land is low. Density of canopy and the amount of browse species present affect carrying capacity and generally only one animal per 5.6 ha can be supported. Rains (1963) stated that in the northern guinea savanna, on average land cleared of scrub and following a suitable rotation, one semi-mature (320 kg) animal would require 2.8 ha on a year round basis. This stocking rate would allow for maintenance and production and allow areas to be burnt every third year.

Adegbola *et al.* (1968) studied natural grassland production at Fashola Livestock Farm, in the derived savanna zone of Western Nigeria. They found that the dominant grass species was *Andropogon gayanus* with small amounts of *Pennisetum pedicellatum* and *Imperata cylindrica*, the latter two species tending to increase in amount with grazing. Oyenuga (1957) noted that bush fallow around Ibadan was dominated by *Andropogon tectorum* and *Imperata cylindrica*. Nitrogen fertilizer (56 kg and 112 kg per ha) resulted in increased dry matter production and better utilization by livestock.

One of the greatest limitations to natural grassland productivity in northern Nigeria has been the provision of water. Sometimes cattle have to cover up to 10 km to be watered; in these circumstances it may not be advisable to water the animals daily. The quantity of water required by a 320 kg animal is about 10 litres per day during the rains and about 20 litres per day during the dry season; slightly more may be drunk with daily watering than with less frequent watering (Rains, 1963). In the middle belt areas where scarcity of water is not a major problem, the natural grassland lies in the tsetse fly zone and the Zebu cattle of the Fulanis easily succumb to trypanosomiasis.

There is an urgent need to study:

1. methods of natural grassland improvement and efficient utilization with livestock;
2. grass-legume species present as well as their distribution, seasonality of herbage production, seedling vigour and palatability;
3. the response of herbage species to management and other conditions imposed by the livestock grazier, such as rotational grazing, stocking rate, fertilizer application, burning and the length of the resting period;
4. the nutritive value of herbage species;
5. possible means of conserving herbage for dry season feeding.

GRAZING TRIALS ON IMPROVED PASTURES

Grazing trials involving various grass-legume mixtures have been carried out in the south of Nigeria. Mixtures made up of combinations of *Cynodon nlemfuensis*, *Centrosema pubescens*, *Digitaria decumbens*, *Chloris gayana* and *Stylosanthes gracilis* have been evaluated with grazing N'Dama cattle. *Cynodon nlemfuensis* was the most persistent and increased its cover in all plots throughout the trial period of five years. *Chloris gayana* and *Digitaria decumbens* however were almost eliminated by the end of the experimental period. Giant star grass is regarded as a maintenance grass in the derived savanna zone because of its low leaf-to-stem ratio. In the rainforest areas, however, good animal production can be obtained particularly if it is grazed at an immature stage of growth. White Fulani (zebu) cattle grazing giant star grass-centro pasture at one beast per 0.24 ha have gained 0.43 kg per day in the semi-dry season (October–December, 1956) whereas they barely maintained weight in the dry season (December, 1956–March, 1957). Live-weight gains at 0.58 kg per day were obtained in the subsequent rainy season (McIlroy, 1962). Oyenuga and Olubajo (1966) estimated dry matter intake by N'Dama cattle on giant star grass-centro mixture at 2.6 kg per 100 kg body weight per day for 1963–65. Giant star grass can withstand trampling and is liked by cattle, sheep and

goats. The tall grasses *Andropogon gayanus* and *Panicum maximum* cannot withstand heavy grazing until they are well established. *Pennisetum purpureum* is readily grazed even when fairly mature, but only leaves are eaten. Oyenuga (1957) reported that immature elephant grass grazed with milk cows at the Moor Plantation, Ibadan, gave higher milk yields than did *Cenchrus ciliaris*.

The grazing behaviour of Zebu cattle has been studied at Shika (Zaria) in the Guinea savanna zone. It was found that the animals grazed during the morning and late afternoon and tended to seek shade during the heat of the day. The grazing time of about seven hours per day during the rainy season was significantly reduced during the dry season when the quality and quantity of forage available was considerably reduced and as a result of the increased heat stress (Haggar, 1968). However, a further important factor was that supplements were fed.

Many more grazing evaluation trials are needed, particularly since more productive exotic breeds are being introduced.

CONCLUSIONS

Nigeria, with about 60 million ha of natural grassland, has enormous potential for increasing livestock production in both the savanna and rainforest zones. This should correct the present grossly inadequate animal protein intake of most Nigerian people. Range management practices have been severely limited by such obstacles as the land tenure system, availability of water for the grazing stock, severe and extensive dry seasons, diseases and parasitism. Natural grassland productivity can be improved by over-sowing with appropriate legumes and the use of fertilizers as has been done in Uganda (Stobbs, 1969).

The bunch-type grasses such as *Andropogon gayanus*, *Panicum maximum*, *Pennisetum purpureum* and *Tripsacum laxum* are high yielding in terms of dry matter but they are characterized by low protein contents and a rapid build-up of relatively indigestible fibrous material. Legumes have an important part to play in achieving greater productivity. *Centrosema pubescens* is a useful legume in the derived savanna and rainforest areas while the more drought-resistant *Stylosanthes gracilis* is more adapted to guinea and sudan savanna areas in the north.

There is a need for further studies of reactions of the adapted grasses to management practices such as fertilizer application, frequency of cutting or grazing and their ability to combine with adapted legumes. More studies are needed to measure animal production from grass-legume mixtures and to measure the ability of these swards to supply nutrients throughout the year as well as maintain or improve soil fertility.

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