Tropical Animal Production 1982 7:1-8

POTENTIAL ANIMAL PRODUCTION AND MANAGEMENT OF PASTURES ON ULTISOL SOIL IN COLOMBIA

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The results of a two year grazing trial are reported. The trial was carried out in paddocks of Star grass (*Cynodon nlemfuensis*), Brachiaria (*Brachiaria decumbens*), *Brachiaria humidicola*, *Andropogon gayanus*, *Hemarthria altissima* and associations of *Andropogon gayanus* with Centro (*Centrosema* sp CIAT 438) a mixture of *Pueraria phasoloides* (Kudzú) and Centro CIAT 438, and another Kuzú, Centro CIAT 438, *Stylosanthes capitata* and *Stylosanthes guisnensis* respectively under continual grazing with a variable stocking rate (put and take). Mean daily liveweight gains of between 480 - 520 g/animal /d were obtained for the paddocks of grass only, while liveweight gains of 680 g/animal/d were obtained with *Andropogon gayanus* with Centro. *A.gayanus* with a mixture of Kudzú and Centro gave gains of 480 g/animal/d. The mean daily liveweight gain/ha for the grasses was 3.12 kg *Hemarthria altissima*, 1.80 kg *A. gayanus*, 1.43 kg *B.decumbens* and *B.humidicola*, and 0.69 kg for Star grass (*Cynodon nlemfuensis*) with mean stocking rates of 5.1 animals/ha for deferred grazing and 3.5, 2.4, 2.45 and 1.25 animals/ha under continuous grazing respectively. The mean daily liveweight gain/ha was 2.24 and 2.41 kg for the associations of *A.gayanus* with Kudzú and Centro and Centro respectively, and 1.87 kg for *A.gayanus* and a legume mixture, with stocking rates of 3.1, 3.3 and 4 animals/ha, respectively. The stocking rate had an important effect on the productivity of each species and there was a significant correlation between the grazing pressure and the daily liveweight gains for *A.gayanus* by itself and associated with Kudzú and Centro, and for *H.altissima*. The potential animal production of the associations with adapted legumes is greater than from the grasses by themselves, but the management of the stocking rate seems to be more critical.

Key words: Ultisol, *Cynodon nlemfuensis*, *Brachiaria decumbens*, *Brachiaria humidicola*, *Andropogon gayanus*, *Hemarthria altissima*, *Pueraria phaseoloides*, *Centrosema* sp, *Stylosanthes capitata*, *Stylosanthes guianensis*.

A study carried out by the Corporación del Valle del Cauca (Revelo 1971) indicates the existance of around 30,000 ha of acid soils towards the south of the Department, whose agricultural potential is very low due to its low natural fertility; these soils were classified as Ultisols (Paleumult ortóxico) by Sánchez & Isbell (1979). The natural vegetation of the region is dry tropical forest with a mean temperature higher than 24°C and a mean annual rainfall of between 1000 and 2000 mm (Espinal 1968). There are two rainy seasons, one from March or April to May and another from September or October to December, with relatively dry periods the rest of the year. Natural pastures are composed of bahía or grama (*Paspalum notatum*) and are of very low animal productivity, especially during the dry season with live - weight gains of only 180g/animal/d, with a stocking rate of 3.13 heifers/ha under continual grazing (Escobar et al 1971).

The Tropical Pasture Programme of CIAT has considered it necessary to study the adaptation of species of grasses and legumes to acid soils in this region of low fertility, in order to identify promising germoplasm for similar soils (Oxisols and Ultisols) in other ecosystems of tropical America. Other investigations carried out in the area have identified the adaptation of different pasture species (CIAT 1979), the dry matter production of these adapted grasses and legumes (Urrea & Tergas 1979; Tergas & Urrea

1980), the behaviour of associations of legumes with *Andropogon gayanus* (Grof 1981), and the compatability and persistence of *A.gayanus* with *Centrosema* sp CIAT 438 under conditions of intermittent grazing (CIAT 1981). These studies have also contributed to: the development of methods of investigation in tropical pastures appropriate for similar regions in tropical America and, to the training of technical personnel and numerous institutions in the area.

Objectives of this study, as well as its methodological and training aspects, were to determine the potential animal production and the management of the stocking rate for species of tropical pastures adapted to acid soils of low natural fertility.

Materials and Methods

This study was carried out on the CIAT experimental stations, Quilichao and La Hacienda El Limonar, at a latitude of 30°06'N and a longitude 76°31' W, 40 km south of Cali at an altitude of 990m in an Ultisol (Palehumult orthoxico) of pH 4.1 - 4.6 (water), with 2-3 ppm. soluble phosphorus (Bray II), and with an interchangeable aluminium level of 3.7 - 4.0 me Al/100 g soil (Table 1). The mean annual rainfall over the last 5 years has been 1,579 mm most of which falls in two well defined rainy seasons: March to May and September to December (Table 2).

Table 1:

Results of an Ultisol soil analysis in Quilichao-CIAT and El Limonar, 1979

Locality	pH	Organic matter (%)	Phosphorous (Bray II) (ppm)	Interchangable cations				Sat.
				Al	Ca	Mg	K	Al
				(me/100g)				
CIAT-Quilichao	4.1	7.1	3.4	4.0	0.77	0.26	0.24	75
El Limonar	4.6	7.1	1.6	3.7	1.45	0.51	0.12	64

Table 2:

Distribution of rainfall in the CIAT experimental station-Quilichao: latitude 30°06'N; longitude 76°31'W; 990 m above sea level, 1977-81

Year	Months												Total
	J	F	M	A	M	J	J	A	S	O	N	D	
1977	79	99	116	182	121	65	32	76	199	256	193	91	1.509
1978	49	15	179	291	241	111	72	16	69	143	155	320	1.661
1979	96	30	86	140	169	28	82	139	205	156	297	58	1.486
1980	105	186	92	159	91	52	2	24	117	240	179	238	1.485
1981	82	153	141	310	209	63	67	56	27	213	331	103	1.755
Mean	82	97	123	216	166	64	51	62	123	202	231	162	1.579

In El Limonar the grazing trial was started in 1979 in a 4.75 ha paddock of Star grass (*Cynodon nlemfuensis*), a 9.82 ha paddock of Brachiaria (*Brachiaria decumbens*), a 5 ha paddock of *Brachiaria humidicola*, a 10 ha paddock of *Andropogon gayanus* CIAT 621 associated with Centro (*Centrosema* sp CIAT 438) and a 5 ha paddock associated with a mixture of *Pueraria phaseoloides*

(Kudzú) and Centro. All these paddocks were established from seed in 1977 and 1978 apart from the Star grass and the *B.humidicola*, with an initial fertilization with 50 kg of P_2O_5/ha utilising Escorias Thomas (Calfos 14% P_2O_5) with no subsequent fertilization associated with the management of pasture.

On the experimental station, due to the reduced area, in 1978 only 2 ha of pure *A.gayanus* CIAT 621, 0.75 ha *A.gayanus* CIAT 621 associated with a mixture of legumes including *P.phaseoloides* (Kudzú), Centro CIAT 438, *Stylosanthes capitata* CIAT 1019, 1078, 1405 , *Stylosanthes guianensis* CIAT 136 and 147, and 0.3 ha of *Hemarthria altissima* CIAT 663 in a floodable area. All the plots were established from seeds except for *H.altissima* and were fertilized at sowing with 50 kg P_2O_5/ha with Huila (phosphoric rock 22% P_2O_5) with no additional fertilization associated with the management of the pasture.

The animals used in the trial were crossbreds of Criollo and Zebu between 1 and 2 years of age with liveweights between 150 and 200 kg. The treatments were not replicated and the animals were weighed every 28 - 56 days directly from the field without a period of fasting. In order to assess the potential productivity of the pastures the animals were managed under a continual grazing system with continual adjustment of the stocking rate (put and take), in the wet season and the dry season depending on pasture growth and the liveweight gains of the animals during the period immediately before, in accordance with the reccommendations of Evans (1969) of increasing or decreasing the stocking rate when the mean daily liveweight gain of the experimental animals was greater or less than 0.5 kg respectively.

The quantity of pasture offered and the botanical composition of the paddocks were determined at various times during the year using the comparative yield method proposed by Haydock and Shaw (1975).

Results and Discussion

The mean liveweight gains obtained during the first year of the trial are shown in Table 3. In general, the liveweight gains of the animals grazing the adpated grasses, *A.gayanus*, *B.decumbens* and *B.humidicola* (Tergas & Urrea 1980), were very similar and the differences in production/ha were related to the adjusted stocking rates. In contrast, with the Star grass (*Cynodon nlemfuensis*) the productivity/ha was relatively low due to the low production of dry matter which resulted in an adjusted stocking rate of only 1.25 animals/ha. The animal productivity of *H.altissima* was excellent, with high stocking rates under continual grazing during the rainy season and part of the dry season due to the characteristics of the soil, and was much superior to 497 g/animal/d with 2.8 animals/ha reported by Michielín et al (1971) and 350 g/animal/d with 3,55 animals/ha (Ramírez et al 1971) with *Brachiaria mutica* in similar soils. Grazing had to be suspended during the second dry season because the stocking rate had reached a very low level and it was necessary to rest the pasture until the beginning of the rains.

During the second year the gains in weight on the grasses (Table 4) were greater than during the first year due to an increase in the amount, and a better distribution of the rains, and the dry seasons were not so marked as in the previous year.

Table 3:

Gains in liveweight of improved adapted pasture species in an Ultisol in Quilichao-CIAT and El Limonar, 1979-1980

Locality and species	Length of trial (d)	Stocking rate animals/ha[1]	Liveweight gains during the experimental period		Production of meat (kg/ha/d)
			g/an/d	kg/an	
CIAT-Quilichao					
A.gayanus 621	308	3.7	451	139	1.80
H.altissima	398	4.19	490	195	2.94
El Limonar					
C.nlemfuensis	212	1.25	557	118	0.69
B.decumbens	212	2.40	595	126	1.42
B.humidicola	417	2.45	516	215	1.44
A.gayanus + (Kudzú Centro)	417	2.92	652	272	2.12

[1] Means of winter and summer during continual grazing

Table 4:

Gains in liveweight on improved adapted species of pasture in an Ultisol in Quilichao-CIAT and El Limonar, 1980-1981

Locality and species	Length of trial(d)	Stocking rate animals/ha[1]	Liveweight gains during the experimental period		Production of meat (kg/ha/d)
			g/an/d	kg/an	
CIAT-Quilichao					
A.gayanus 621	300	3.27	507	152	1.80
A.gayanus + legume mixture	210	4.0	468	98	1.87
H.altissima	295	6.0	551	162	3.30
El Limonar					
A.gayanus + (Kudzú + Centro)	323	3.3	715	231	2.36
A.gayanus + Centro	323	3.3	730	236	2.41

[1] Means of winter and summer during continual grazing

The effect of the legumes in improving the animal productivity of *A.gayanus* can be seen in the same Tables. With mean stocking rates of 3 animals/ha, the liveweight gains/animal were greater in the first year than with pure grass pastures, due principally to the effect of the legumes in improving the quality of the pasture during the dry season (Table 5). During the second year the level of animal production on *A. gayanus* by itself was maintained but the stocking rate was reduced at

Table 5:

Characteristics of the pasture available in different paddocks in an Ultisol, Quilichac-CIAT and El Limonar, 1980 1981

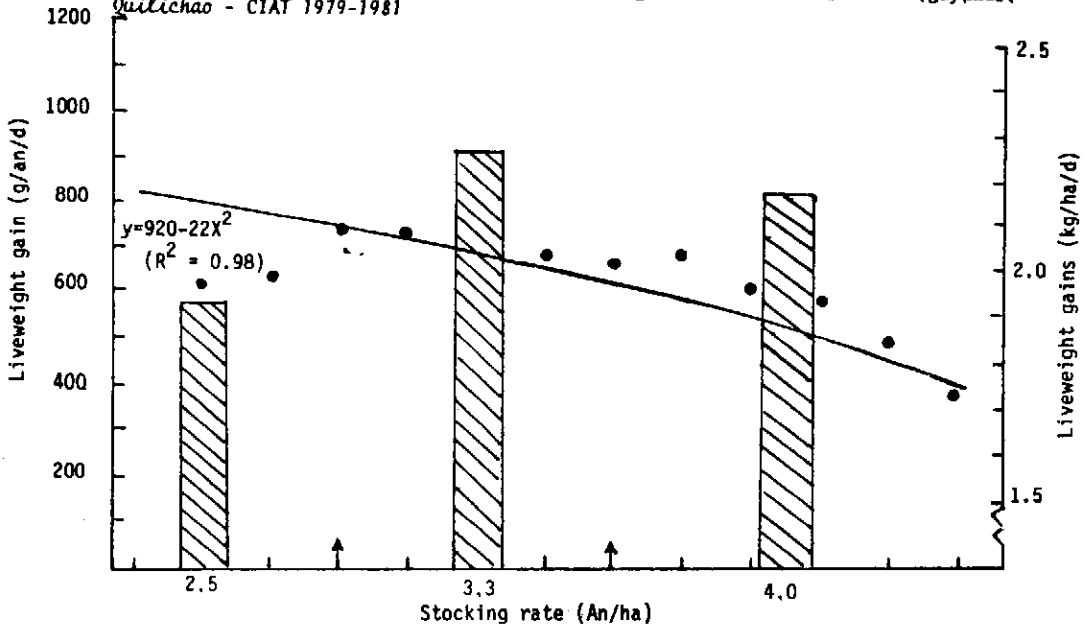
Treatment	Season	Pasture offered						
		Dry matter (kg/ha)	Botanical composition			Chemical composition		
			%grass	%legume	% weeds	%CP	%P	%Ca
A.gayanus	Dry	1,571	68	-	32	4.9	0.07	0.29
	Wet	2,780	65	-	35	9.4	0.15	0.45
A.gayanus + Centro	Dry	1,340	60	30	10	6.6	0.11	0.39
	Wet	3,278	50	20	30	12.4	0.14	0.47

the end of the experiment due to a lack of pasture availability in spite of the better distribution of rain in that year. In contrast, as in this year, the stress of the dry season was less, the gains in weight on the association with Centro and the mixture of Kudzú and Centro in El Limonar were even higher than the year before, and towards the end of the experiment the production of forage was similar to that at the end of the first year, even though the percentage of legumes in the pasture had been reduced to 12.9% and weed grasses accounted for 20%. The gains in weight on *A.gayanus* with mixtures of legumes at CIAT - Quilichao, were not better than those on *A.gayanus* by itself, only because, due to the smallness of the area, it was not possible to adjust the stocking rates well and the legumes *S.capitata* and *S.guianensis* suffered a lot due to over grazing in the dry season and trampling in the wet season when the stocking rates were greater than 3 animals/ha.

The stocking rate was an important management factor in determining the animal productivity of the species of pastures studied. In the case of *A.gayanus* a relationship between stocking rate, productivity/animal and/ha was found, similar to that proposed by Mott (1960), and an optimum stocking rate of 3.3 animals/ha was determined, (Figure 1). This effect of stocking rate could be modified according to the characteristics of the species studied; for example in *B.humidicola*, on increasing the stocking rate from 2 to 2.8 animals/ha there was an initial increase in liveweight gain/animal from 673 to 723 g, due possibly to the fact that managing this grass with low stocking rates, allowed it to mature, which in turn affected the consumption of it by the cattle, as was found in Carimagua in the western lowlands of Columbia (CIAT 1980), with this species and with *Hyparrhenia rufa* in Uganda (Stobbs 1970).

Figure 1:

Relationship between stocking rate, gain in weight/d/animal and /ha on A.gayanus, *Quilichao - CIAT 1979-1981*



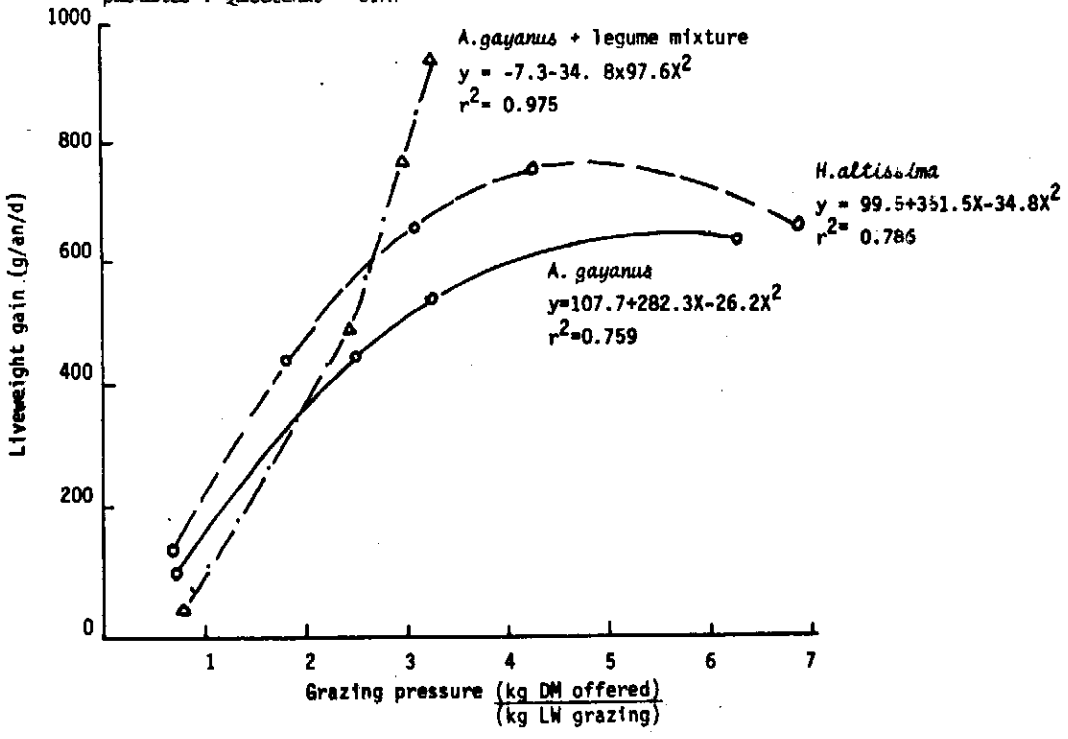
The effect of stocking rate can be explained much better when it is evaluated in terms of grazing pressure. In this trial a relationship was found between grazing pressure, calculated in terms of kg of dry matter of green pasture available/kg of liveweight grazing, and the daily liveweight gains/animal, as is shown in Figure 2. In the pure grasses the gains in liveweight/animal went up initially due to an increase in the pasture available, with a tendency to diminish when the quantity of pasture available was excessive in relation to the consumption of the animals, possibly because the quality of the grass could only decrease because of the effects of maturity. In contrast, in the case of the association of *A.gayanus* with legumes, the relationship was almost linear, possibly due to the effect of the legume in maintaining the quality of the forage even though there was a high level of pasture available. Other workers in the tropics have found similar relationships with improved adapted pastures, Winter et al (1977), Mannetje & Ebersohn (1980).

Conclusions

The results in terms of liveweight gain obtained in this region during the last two years show the potential animal productivity of paddocks composed of adapted species on Ultisols and especially show the effect of forage legumes in improving the quality of pasture during the dry season.

Figure 2:

Relationship between grazing pressure and the daily liveweight gains on improved pastures . Quilichao - CIAT



These results also show that the most important management factor in determining the productivity is the stocking rate, which seems to be specific for each species. The results cannot be totally conclusive especially where the associations with legumes are concerned, because their productivity in the long term is determined by management and some cases have been found where interactions exist between the stocking rates and the system of grazing employed, that could affect the the persistency of the desirable species (Blaser et al 1974; Riewe 1976). In El Limonar for example, the association of *A.gayanus* with Centrosema sp showed a decrease in the botanic composition of the pasture during the second year, that could be due not only to the stocking rate but also to the continuous grazing system employed. There are possible needs for additional fertilization in order that the legume might recuperate after two years of continuous grazing with relatively high stocking rates.

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Received 3 February 1982
Translated from the Spanish