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Effect of stocking rate on Rhodes grass-stylo pasture in the northern guinea savanna zone of Nigeria 2. pasture and sheep performance

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Abstract

Mixed pastures of Rhodes grass (Chloris gayana cv. Callide) and Stylo (Stylosanthes guianensis cv. Cook) were evaluated at five stocking rate, 12, 18, 24, 30 and 36 rams/ha over five grazing periods at Shika, Nigeria. The pastures were continuously grazed for 154 to 210 days beginning from late rainy into dry season (August to April). Dry matter yields of stem, leaf, stem + leaf of C. gayana, green material and total herbage declined (P<0.01) as stocking rate and grazing days increased. However, the differences in yields of green material and leaf of C. lgayana at 24 and 30 rams/ha were not significant over the grazing periods. Daily live weight gain (g/head/d) was negatively and linearly related to stocking rate. Mean live weight gains at the lowest and highest stocking rates were + 52 and -1 g/head/d in the second grazing season and 62 and 24 g/head/d in the fifth grazing period. Mean live weight production/ha and optimum stocking rates (OSR) in the first, second, third, fourth and fifth grazing periods were: 61.2kg, 17.8 sheep/ha; 155.5kg; 20.4 sheep/ha; 186.2kg, 24.9 sheep/ha; 129.4kg, 21.2 sheep/ha and 200.2kg, 26.0 sheep/ha, respectively. A curvilinear relationship was obtained between live weight gain/ha and stocking rate. This study indicated that sheep at the highest and lowest stocking rates will need supplementary feeds after 100 and 128 days, respectively, if grazing commenced just before the end of the rain.

Keywords: *Stocking rate; sheep; live weight gains; herbage yields; rhodes grass; stylosanthes*

Introduction

Sheep production in Nigeria is based mainly on roughages, agro-industrial by-products and natural pasture. However, an inadequate supply of feed both in quality and quantity especially in the dry season is a constraint to increase production form sheep (Ademosun, 1988). Among other feed resources, improved grass-legume pastures are invaluable in supplementary dry season grazing, thus cutting down on the use of concentrate feed during this critical period (Adu and Adamu, 1982). There

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legume pastures are invaluable in supplementary dry season grazing, thus cutting down on the use of concentrate feed during this critical period (Adu and Adamu, 1982). There are few evaluations of mixed pastures in grazing trials especially with sheep in Nigeria. This study was undertaken to provide basic information for small and large scale livestock farmers regarding the productivity of Rhodes grass - Stylo pastures grazed at different stocking rates.

Materials and methods

Experimental site

The trial was conducted at the National Animal Production Research Institute (NAPRI), Shika, Zaria between 1985 and 1990. Shika receives an annual mean rainfall of 1054 mm which falls mainly from May to September. The mean temperatures in the hottest and coolest months are April (29°C) and December (20°C) respectively. Prior to land preparation, the site was under fallow for five years.

Pasture management and yields

Two pastures were established using 5kg pure germinable seed/ha at a mixed Rhodes grass: Stylo seeding ratio of 3:7 in June 1984 and in August, 1985 (Table 1). The first pasture was grazed only in the first grazing period (GP) due to low proportion (5%) of Stylo. The second pasture was grazed from the second to the fifth grazing period. The pastures received 30kg P/ha (as single superphosphate) and 200kg N/ha (as calcium ammonium nitrate) in July before GP 1 and GP 5. At other periods 30kg P/ha was applied in July to the pasture because Stylo content was appreciable only in GP 2.

Forage dry matter (DM) yields were estimated every 43days beginning from the day grazing commenced in each period. The plants were cut 5cm above ground level. A sub-sample (approximately 500g) was sorted into green shoots (stem + Lead) of C. *gayana, Stylo*, dead material and other plant species (weed), oven dried at 70°C for 48h and weighed. Green material consisted of living portions of sown and weed species. Total herbage was determined as the sum of dead and green materials.

Animal management and live weight gains

Three yearling Yankasa rams averaging 20kg were set stocked on the pastures at the rate of 12, 18, 24, 30 and 36 animals/ha in a randomized-block design with two replicates. An ungrazed (control) plot was included in both replicates. The area for each treatment (paddock) varied form 0.24 to 0.083 ha for the lowest and highest stocking rates (SR) respectively. The trial was repeated over five grazing periods (Table 1).

The animals were not provided with shelter or supplementary feed but had free access to water and salt lick. Anthelminthic treatments and dipping to control ectoparasites were carried out at monthly intervals. The theoretical optimum stocking rate (OSR) which gave the maximum live weight gain (LWG)/ha in each grazing period was calculated as a/2b according to Jones and Sandland (1974) model:

$Y = ax - bx^2$

Where Y = LWG/ha, x = stocking rate; a and b are constants.

Statistical analysis

The data were analyzed as a split plot (in time) design with grazing days and stocking rates as main and subplots, respectively. Differences between means were compared with Duncan's New Multiple Range Test (Steel and Torrie, 1980).

Results

Herbage yield and composition

The proportion of Stylo to total herbage in GP 2 on days 0, 42, 84, 126, 168 and 210 were 11.2%, 13.1%, 10.8%, 4.3%, 2.0% and 1.5%

respectively. Total herbage and green material declined (P<0.01) as SR and grazing duration increased in all periods (Fig. 1 and 2). On the other hand, except in GPs 1 and 2 the yield of dead material was lowest in the control and highest for 12 sheep/ha. Dead material increased with advancing grazing days.

Table 1 *Grazing period, pasture utilized and fertilizer applied*

Grazing Period	Duration	No. of Days	Details of pasture grazed
1	23 October 1985 to 8 April 1986	168	Sown June 1984, 30kg P + 200kg N/ha
2	21 August 1986 to 20 March 1987	210	Sown Aug. 1985, 30 kg P/ha
3	25 August 1987 to 8 March 1988	196	Sown Aug. 1985, 30 kg P/ha
4	12 September 1988 to 14 Feb. 1989	154	Sown Aug. 1985, 30kg P/ha
5	5 September 1989 to 6 March 1990	182	Sown Aug. 1985 30 kg P ±200 kg N/ha

Increase in SR and grazing days reduced (P<0.01) leaf yield of C. *gayana*. Production at the lowest SR was significantly higher than at the highest SR. The corresponding values were 1.2, 0.8t/ha (GP1), 1.0, 0.7t/ha (GP2), 1.2, 0.9t/ha (GP 3), 0.9, 0.5t/ha (GP 4) and 1.4, 1.0 t/ha (GP 5). Reduction in yield from day 0 to 126 was consistent over the 5 grazing periods. Thereafter, yield was similar. Generally, yield declined from over 2.0 t/ha at the onset of grazing to 0.1 - 0.32t/ha at the end of the grazing period.

Liveweight gain per head (g/head/d)

Daily liveweight gain (LWG/head) showed a negative linear relationship to stocking rate (Table 2). Differences in LWG between stocking rates in the first grazing period were not significant. LWG for 24 and 30 animals/ha were similar in all grazing periods. Sheep at the lowest stocking rate recording better (P<0.05) LWG than those at the highest stocking rate.

Table 2 *Effect of stocking rate on daily live weight gain (g/head) of sheep during the five grazing periods*

Stocking Rate (sheep/ha)	Grazing Period 1	2	3	4	5
12	26.7^{a*}	52.4^{a}	60.6^{a}	60.1^{a}	61.8^{a}
18	20.0^{a}	38.7^{ab}	47.2^{ab}	47.1^{ab}	58.9^{a}
24	14.8^{a}	32.7^{ab}	$35,7^{ab}$	26.0^{bc}	44.7^{ab}
30	5.9^{a}	14.3^{ab}	30.6^{ab}	22.7^{bc}	37.1^{ab}
36	-0.7^{a}	11.3^{b}	23.0^{b}	16.2^{c}	24.0^{b}
SED	9.0	9.6	6.5	6.0	8.4

* Means in the same column with different superscripts differ at P<0.05

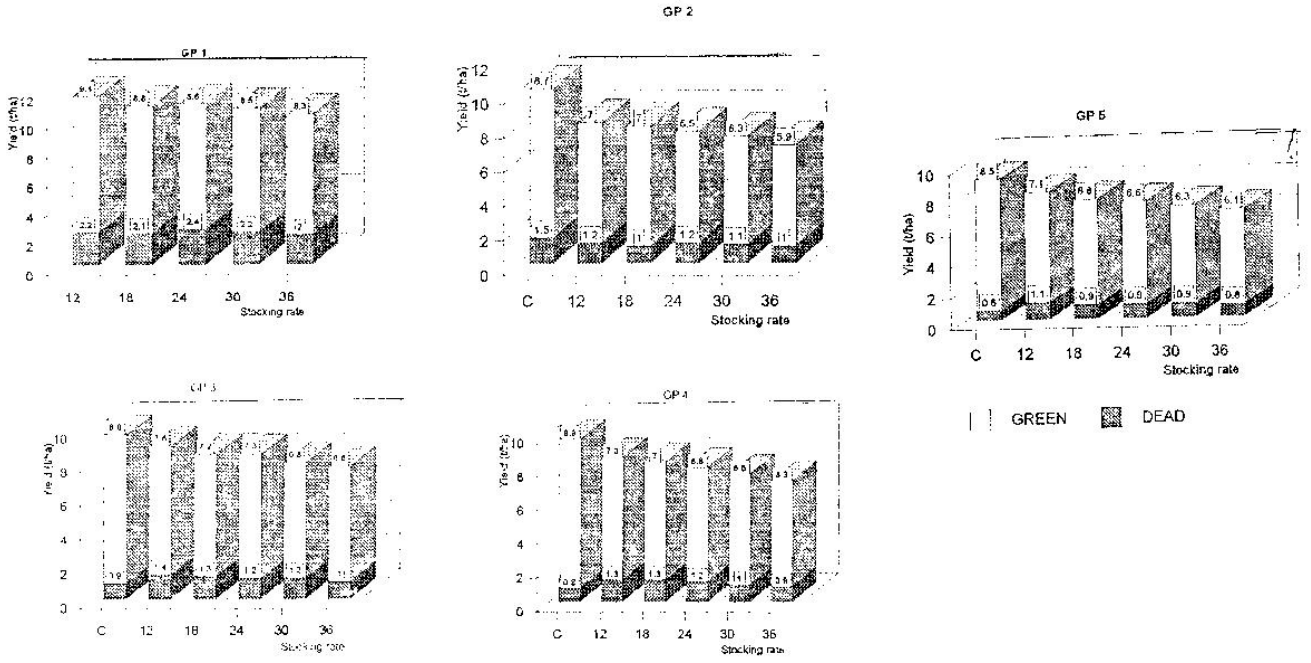

Figure 1. *Effect of stocking rate on yields (t/ha) green and dead materials during the five grazing periods.*

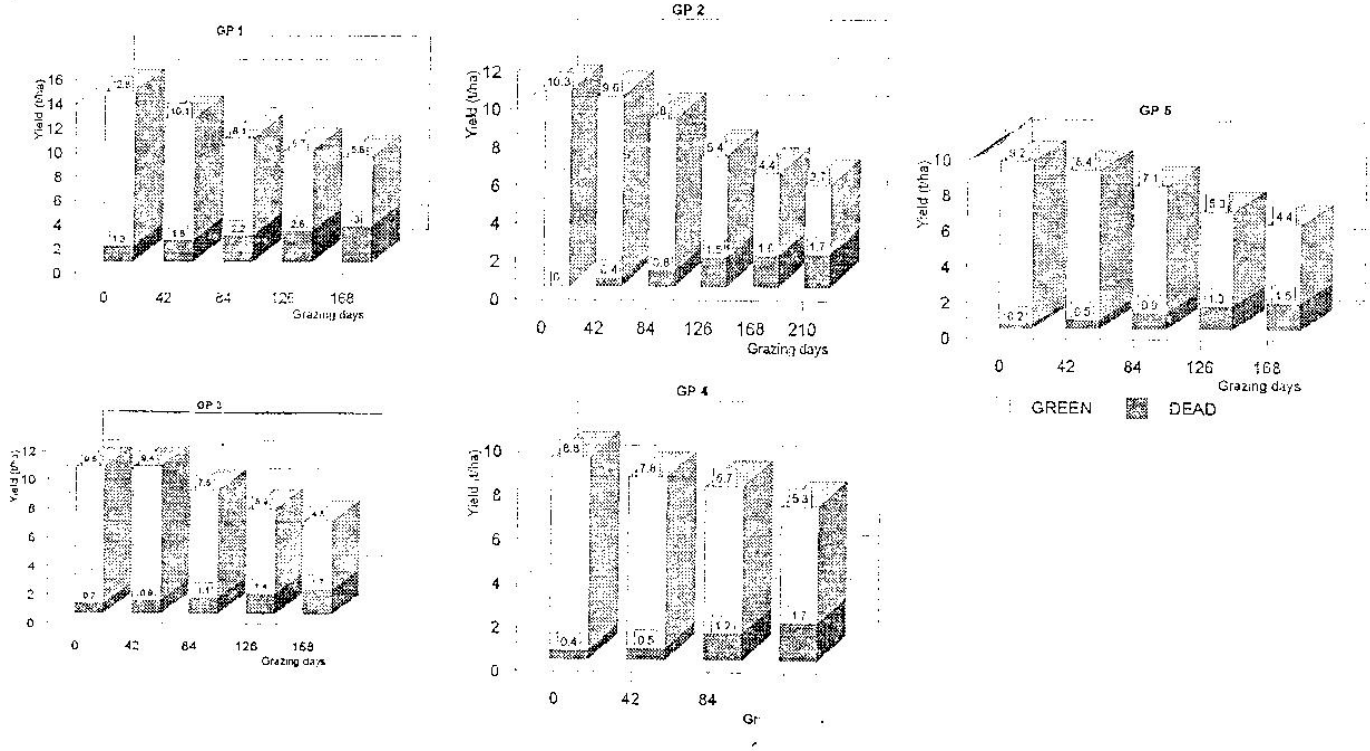

Figure 2. *Effect of grazing days on yields (t/ha) of green and dead materials during the five grazing periods.*

Table 3 *Daily liveweight gain (g/head) pf sheep during the five grazing periods)*

Grazing Days	Grazing Period 1	2	3	4	5
14	128.6 [a*]	117.9[a]	110.7[b]	150.0[a]	162.2[a]
28	71.4[b]	103.6[ab]	100.7[a]	85.7[b]	128.6[ab]
42	49.9[bc]	82.2[abc]	94.6[ab]	78.5[b]	103.[bc]
56	35.7[bcd]	66.0[bcd]	83.2[abc]	75.0[b]	82.1[cd]
70	42.8[bcd]	62.5[bcd]	69.6[bcd]	44.6[cd]	75.1[dc]
84	21.4[cd]	51.8[cde]	62.5[cd]	48.2[cd]	57.1[dc*]
98	7.1d[ef]	41.1[def]	57.1[cdc]	27.5[dc]	51.8[dc]
112	-24.9[efgh]	37.4[def]	44.6[dcf]	12.5[c]	32.1[cf]
126	-32.1[fgh]	30.4[def]	32.1[cf]	-21.4[ef]	14.3[fg]
140	-39.2[gh]	23.2[ef]	16.1[fg]	-48.2[fg]	-7.1[gh]
154	-39.2[gh]	3.6[fg]	-8.9[gh]	-73.9[g]	-19.6[ghi]
168	-60.6[b]	-30.3[gh]	-26.8[hi]		-41.4[hi]
182		-30.3 [gh]	-37.5[i]		-50.0[i]
196		-48.2[h]	-46.5[i]		
210		-50.0[h]			
SED	5.8	5.5	3.9	4.7	5.2

* Means in the same column with different superscripts differ at P<0.05.

Production became poorer with an increase in days spent grazing (Table 3). The highest live weight gains were recorded for each stocking rate within the first 4 weeks of grazing. In the fifth grazing period, these ranged from 107.2 to 203.6g/head/d for the rates of 36 and 18 sheep/ha, respectively.

Live weight gain (kg/ha)

Productivity of pasture was highest and lowest in the fifth and first grazing periods, respectively (Table 4). A curvilinear relationship was established and animal outputs at 18 and 24 sheep/ha were similar in all grazing periods.

The optimum stocking rates (OSR) in the first, second, third, fourth and fifth grazing periods were 17, 8, 20.4, 24 9, 21.2 and 26.0 animals/ha respectively. The corresponding outputs were 61.2, 155.4, 186.2, 129.4 and 200.2kg/ha. Animal output/ha declined with an increase in grazing days. The outputs at the 36 sheep/ha stocking rate were highest up to the 70th day in the first grazing period and up to 98 days in the last grazing period.

Cumulative live weight gain (kg/head)

At all stocking rates, the general pattern of animal growth in each grazing period was initiated by a period of weight gain, followed by no net gain and finally losses in weight (Table 5). Maximum LWG/head at the lowest stocking rate reached 12.5kg by the 154th day except in the first and fourth grazing periods. There was no difference in cumulative LWG between animals at 18 and 24 sheep/ha during the first three grazing periods. The growth of animals in the second, third and fifth grazing periods at the lowest stocking rate was >9.0kg/head. Growth at the highest stocking rate in the second and fifth grazing periods was >5.0kg/head.

By the end of grazing in the first three grazing periods, animals at the least had put on twice as

much weight as those at the highest stocking rate. There were differences ($P<0.05$) between weight of sheep at the beginning and end of all except in the first grazing period.

Discussion

Botanical composition

The germination and growth of Stylo in the initial pasture was poor. Ants and birds picked the seeds (due to cessation of rain 8 days) before they germinated. Thus, the application of N to the pasture, it didn't persist into the second year of utilization (GP 3) except in the ungrazed period which it eventually shaded out. In addition, the development of the legume was suppressed by continuous grazing (Blair Rains, 1963) and late stocking of the pasture. Without the addition of nitrogen, the sown grass remained stable for three growing seasons and dominated other plant species at all stocking rates.

Table 4 *Effect of stocking rate on live weight gain (kg/ha) of sheep during the five grazing periods*

Stocking rate					
(sheep/ha)	1	2	3	4	5
12	54.0	132.0^{b}	142.5^{b}	111.0^{ab}	157.6^{b}
18	60.8^{a}	146.6^{bc}	166.6^{a}	130.5^{a}	193.1^{a}
24	60.0^{a}	165.0^{a}	168.0^{a}	96.0^{b}	195.0^{a}
30	30.0	90.0^{c}	179.8^{a}	104.0^{ab}	202.4^{a}
36	-3.8^{c}	85.5^{c}	162.0^{a}	90.0^{b}	135.0^{b}
SED	3.1	2.0	1.6	2.5	2.0

Means in the same column with different superscripts differ at $P<0.05$

Table 5 *Cumulative live weight gain (kg/head) of sheep during the five grazing periods*

Grazing days	Grazing period				
	1	2	3	4	5
14	1.8^{i}	1.65^{i}	1.6^{h}	2.1^{g}	2.2^{h}
28	2.8^{h}	3.13^{h}	3.0^{g}	3.3^{f}	4.0^{g}
42	3.5^{ef}	4.28^{g}	4.3^{fg}	4.4^{e}	5.5^{f}
56	4.0^{cde}	5.20^{f}	5.5^{ef}	5.5^{d}	6.6^{e}
70	4.6^{abc}	6.08^{ef}	6.4^{de}	6.2^{cd}	7.6^{d}
84	4.9^{a}	6.80^{de}	7.3^{cd}	6.9^{abc}	8.4^{bcd}
98	5.0^{a}	7.38^{cd}	8.1^{abc}	7.3^{ab}	9.1^{ab}
112	4.7^{ab}	7.90^{abc}	8.7^{ab}	7.5^{a}	9.6^{a}
126	4.2^{bcd}	8.33^{ab}	9.1^{a}	7.2^{ab}	9.8^{a}
140	3.7^{def}	8.50^{a}	9.4^{e}	6.5^{bc}	9.7^{a}
154	3.1^{fg}	8.45^{a}	9.2^{a}	5.5^{d}	9.8^{ab}
168	2.3^{hi}	8.03^{abc}	8.8^{ab}		8.8^{abc}
182		7.43^{bcd}	8.3^{abc}		8.1^{cd}
196		6.78^{de}	7.7^{bcd}		
210		6.08^{ef}			
SEM	0.09	0.25	0.2	0.15	0.14

*Means in the same column with different superscripts differ at $P<0.05$

The decline in DM yield from the lowest to the highest SR and as days of grazing increased for the above measurements corroborated the reports of Mears and Humphreys (1974a) and Watson and Whiteman (1981). With an increase in SR, a reduction in yield of dead material was reported. This reduction could be attributed to the removal of high percentage of the green materials and the consequent restriction of the formation of dead material especially the leaf at high SR (Mears and Humphreys, 1974a).

Daily liveweight gain

Production per head was depressed as stocking rate increased (Jones and Sandland, 1974) for the pastures whether fertilized with P or N and P. Similar reports have been obtained in grazing studies with sheep (Marsh and Laidlar, 1978; Curll *et al.,* 1985; Watson and Whiteman, 1981) in both grass and grass-legume pastures. The greater amounts of green material, stem and leaf components of *C. gayana* in the least stocking rate offered the sheep better opportunity to select herbage higher in quality, hence higher liveweight gains. The differences observed in LWG between years could be adduced to varied duration of grazing and composition of the pastures over the grazing periods as well as climate conditions.

The lack of significance in LWG as stocking rate increased in the first grazing period could be due to grazing mainly in the dry season (October – March) in the northern Guinea Savannah zone of Nigeria. The time grazing commenced coincided with the period of high dry matter yield but low nutritive value in the grass species i.e. late seeding stage. Better LWG would have been achieved if grazing had commenced during June/July (vegetative stage) in all periods.

The reduction in nutritive value of the pastures as a result of advanced maturity (Onifade, 1992), lower leaf content (Laredo and Minson, 1973) and dry season (Okeagu and Akinola, 1982) contributed to the decline in LWG as grazing days increased. Sheep at the highest and lowest stocking rates recorded zero net weight gain after 100 and 120 days, respectively, when grazing commenced in August/September. This suggests the appropriate times to begin supplementary feeding to animals at the two stocking rates. Despite the very small paddocks used for this grazing trial, the results conformed with the linear relationship between stocking rate and daily LWG as postulated by Mott (1960) and supported by other grazing studies. Daily LWG per animal was negative at the highest stocking rate in the first grazing period in consonance with the report of Jones and Sandland (1974) for stocking rates greater than twice the OSR.

Liveweight gain (kg/ha)

Production per hectare was highest in GP 5. The higher daily LWG/ head was the major factor. A curvilinear relationship production per hectare and stocking rate as postulated by Mott (1960) and Jones and Sandland (1974) was confirmed in this study. Similar relationships were reported by Jones (1974), Curll *et al.* (1985) for grass-legume mixtures and by Mears and humphreys (1974b) and Silvey and Ferraris (1987) for N-fertilized grass pastures.

The higher optimum stocking rate and production per hectare in the fifth grazing period were indicative of better utilization of herbage by the sheep. The highest value of 202.4kg/ha at 30 sheep/ha during the last grazing period was close to the value of 218kg/ha recorded by Sumberg (1984) from a natural grass fallow in alleys of *Leucaena leucocephala* and *Gliricidia sepium* stocked at eight ewes/ha in the humid zone in Nigeria.

This study indicated that at the highest stocking rate, the pasture might not support maximum production per hectare beyond 70 days if grazing was delayed until early dry season as in the first grazing period. Furthermore, it would be necessary to give supplementary feed to animals when LWG declines to ensure increased production during the dry season.

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References

Ademosun, A. A. 1988. The potential of small ruminants in meeting the protein needed for Nigeria. *Paper presented at the 13th Annual Conferences of the Nigerin Society for Animal Production Calabar, Nigeria* 25 pp.

Adu, I. F. and Adamu, A. M. 1982. The nutritive value and utilization of three tropical grass hays by sheep. *Tro. Grassl.* 16: 29-33.

Blair Rains, A. 1963. Grassland research in Northern Nigeria, 1952-1962. Institute for Agricultural Research, Ahmadu Bello University, Zaria, Nigeria, Samaru misc. Paper No 1. 69pp.

Curll, M. L. and Wilkins, R. I., Snaydron, R. W. and Shanmu-Galingan, V. S. 1985. The effects of stocking rate and nitrogen fertilizer on a perennial ryegrass while clover sward. 1. Sward and sheep performance. *Grass and Forage Sci.* 40: 129-140.

Egy, L. A. Williams, W. T. and Winter, W. H. 1978. Seasonal relations between animal gain, pasture production and stocking rate on two tropical grass-legume pastures. *Aust. J. of Agric. Res.* 28\9: 103-113.

Greenwood, E. A. N and Arnold, G. W. 1968. The quantity and frequency of removal of herbage from an emerging annual grass sward by sheep in a set-stocked system of grazing. *J. Bri. Grassl. Soc.* 23: 144-148.

Jones, R. J. 1974. The relation of animal and pasture production to stocking rate on legume based and nitrogen fertilized subtropical pastures. *Proc. Aust. Sco. For Anim.* 10: 340-343.

Jones, R. J. and Sandland, R. I. 1974. The relation between animal gain and stocking rate. Derivation of the relation from the results of grazing trials. *J. Agric.,Sci. Camb.* 83: 335-342.

Laredo, M. A. and Minson, D.J. 1973. The voluntary intakea, digestibility and retention time b sheep of leaf and stem fractions of five grasses. *Aust. J. Agric. Res.* 24: 875-888.

Marsh, R. and Laidlaw, A. S. 1978. Herbage growth, white clover content and lamb production on grazed ryegrass-white clover swards. *J. Brit. Grassl. Soc,* 33: 83-92.

Mears., P.T. and Humphreys.,. L. R. 1974a. Nitrogen response and stocking rate of *Pennisetum clandestinum* pastures, 1 Pastures nitrogen requirement and concentration, distribution of dry matter and botanical composition. *J. Agric. Sc., Camb,* 83: 451-467.

Mott, G. O. 1960. Grazing pressure and the measurement of pasture production. In: Proc. Of 8th International Grassland Congress, Reading, pp 606-611.

Okeagu, M. U. and Akinola, J. O. 1982. Effect of nitrogen rate on liveweight gain of white Fulani steers continuously grazed and

on signal grass (*Brachiaria decumbens* Stapt.) *J. Anim. Prod. Res. 2:* 91-98

Onifade, O. S. 1992: Effect of stocking a *Chloris gayaria- Stylosanthes guianensis* pastures with sheep on plant and animal performance. Ph. D. thesis, Ahamadu Bello University, Zaria. 192 pp.

Onifade, O. S., Adu, I. F. and Akinola, J. O. 1993. The effect of stocking rate on Rhodes grass-stylo pasture in Norther Guinea Savanna of Nigeria. I. Herbage yield. In: Porc. 17th International Grassland Congress. New Zealand/Australia, No 863-864.

Silvey, M. W. and Ferraris, R. 1987. Sward productivity and seasonal animal production form perennial forage sorghum grazed at four stocking rates. CSIRO Australia Division of Tropical Crops and Pastures. Tropical Agronomy Technical Memorandum No. 56. 22pp.

Steel, R. G. D. and Torrie, J. H. 1980. *Principles and Procedures of Statistics.* 2nd edition, New York: McGraw-Hill Book Co. 633pp.

Sumberg, J. E. 1984. *Small ruminant feed production in a farming system context. In Sheep and Goat in Humid West Africa.* (Eds. J. E. Sumberg and K. Cassaday). Porc. Of ILCA Workshop on small ruminant production system in the humid zone of Westa Africa. Pp. 41-46 Ibadan (Nigeria).

Watson, S. E. and Whiteman, P. C. 1981. Grazing studies on the Guadalcanal Plains, Solomon islands 2 Effect of pasture of mixtures and stocking rate on animal production and pasture components. *J. Agric. Sc. Camb 8\97: 353-364.*

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