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THE RELATION OF ANIMAL AND PASTURE PRODUCTION TO STOCKING RATE ON LEGUME BASED AND NITROGEN FERTILIZED SUBTROPICAL PASTURES.

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Summary

The relation between stocking rate (SR), gain per animal and gain per ha on three continuously grazed pastures:- (i) Nandi setaria - plus greenleaf desmodium, (ii) Nandi setaria plus Siratro and (iii) Nandi setaria plus 336 kg N/ha/yr was studied over a three year period.

On all pastures there was a linear decline ($P < 0.01$) in gain per animal with increasing stocking rates, but the rate of decline for the legume pastures was greater (50 kg per unit increase in SR) than that on the nitrogen fertilized pastures (16 kg per unit increase in SR). Maximum gains/ha for the three pastures were 256, 256 and 491 kg/yr at stocking rates of 2.1, 2.4 and 5.6 animals/ha respectively. Although the nitrogen fertilized pastures carried more than twice as many stock as the legume pastures at optimum stocking rate, the gains per animal were lower. Legume yield and percentage contribution to the pasture declined with increasing stocking rate. At lower stocking rates animal performance was better on the desmodium pastures than on the Siratro pastures.

I. INTRODUCTION

It is well established that nitrogen fertilized tropical grasses produce more dry matter than tropical grass-legume pastures in subtropical Australia. Published results from cutting trials have been reviewed by Colman (1971). However, only a few studies have been made to compare animal production from these two pasture systems within the same experiment. Bryan and Evans (1971) compared legume based pastures with nitrogen fertilized grass pastures and showed that beef production from N fertilized grass exceeded that from the legume based pastures. In their study, each pasture was only stocked at one rate and so the response to stocking rate was not measured. An understanding of the production - stocking rate relation would greatly facilitate economic analysis of the two systems as well as providing data on the stability of the pastures in agronomic terms.

II. MATERIALS AND METHODS

(a) Pastures

The experiment was conducted at the C.S.I.R.O. Pasture Research Station, Samford, near Brisbane. The climate and soils have been described elsewhere (Beckmann 1957, Stirk 1963). The site was a 3-4% hill slope. The soils varied from red and yellow podzolics on the upper slope to gleyed podzolics on the lower slope to a narrow band of alluvial soil at the base of the slope. Average annual rainfall is 1070 mm.

The area was cleared from open forest in 1967 and fertilized with the equivalent of 314 kg Ca, 48 kg P, 50 kg S, 125 kg K, 2 kg Cu, 1.8 kg Zn and 155 g Mo/ha when sown to a break crop of Japanese millet (*Echinochloa crusgalli* var. *frumentacea*) and *Lablab purpureus* cv Rongai. The break crop was grazed in 1968 and the area cultivated and fertilized with 250 kg single superphosphate and 60 kg KCl/ha prior to sowing the pasture mixtures on December 6th 1968.

The three pasture treatments were: (i) *Setaria anceps* cv Nandi plus *Desmodium intortum* cv Greenleaf (desmodium), (ii) *Setaria anceps* cv Nandi plus *Macroptilium atropurpureum* cv Siratro, (iii) *Setaria anceps* cv Nandi plus 336 kg N/ha/annum. The seed was drilled into the prepared seedbed using seeding rates of 4, 3 and 6 kg/ha of setaria, desmodium and Siratro respectively. Paddock sizes were varied to achieve stocking rate treatments of 1.11, 1.73, 2.35, and

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2.96 animals/ha on the legume treatments and 2.96, 3.58, 4.20, 4.82 and 5.44 animals/ha on the nitrogen fertilized treatment. The paddocks ran up and down the slope to encompass the soil variation and all treatments were allocated at random. Treatments were not replicated, there were 13 paddocks and the experiment occupied approximately 18 ha. In the establishment year the pastures were grazed intermittently and mown to control weeds and to develop a dense sward.

Each spring all paddocks were top dressed with superphosphate at 250 kg/ha and KCl at 125 kg/ha. Nitrogen fertilized paddocks received ammonium nitrate in four equal dressings in early spring, late spring, summer and autumn. Each May a detailed botanical survey on a 10 m grid basis was made to assess botanical changes due to treatment and in May 1972 all paddocks were sampled for dry matter yield by cutting five random strips in each paddock with a forage harvester. The strips occupied about 1% of the paddock area.

(b) Animals

In November 1969, 1970 and 1971 new groups of yearling Herefords were used to stock the experiment. They weighed approximately 200 kg at the commencement of each period. The heifers were divided into three weight classes and one animal from each class allocated at random to each paddock. Ticks and helminths were controlled. No supplements of any kind were given and the stocking rates were maintained throughout the three year period. Fasted weights were recorded every four weeks.

(c) Analysis of the results

Linear regressions of gain per animal on stocking rate were calculated and compared. Optimum stocking rates were calculated using the 'half intercept' method of Jones and Sandland (unpublished data) and the gains/ha and gains/animal at these stocking rates were compared.

III. RESULTS

(a) Animal data

One paddock of desmodium (2.35 animals/ha) established poorly and had to be replanted the following year. Data from this paddock have been omitted.

For all pastures gain per animal decreased linearly ($P < 0.01$) with increasing stocking rate in every year. Mean data for the three years are presented in Figure 1.

The slopes of all three regressions differed significantly ($P < 0.05$ - $P < 0.001$). In particular the slope for the nitrogen fertilized grass pastures was far less than the slopes for the legume pastures. Stocking rates calculated to give maximum gain per ha for the desmodium, Siratro and nitrogen fertilized pastures were: 2.12, 2.42 and 5.58 animals/ha with maximum gains/ha of: 256, 256 and 491 kg/ha/annum respectively. The calculated values for treatment (iii) were slightly higher than those obtained in the experiment. Gains per animal at optimum stocking rates were 120, 106, and 88 kg for the desmodium, Siratro and nitrogen fertilized grass respectively.

(b) Pasture data

There was a trend for the percentage legume to decrease with increasing stocking rate and the percentage weed, mainly Queensland blue couch (*Digitaria didactyla*) to increase (Table 1). At the highest stocking rate the legume decreased with time for both desmodium and Siratro. On the nitrogen pastures the proportion of sown setaria increased with time at all stocking rates. Stocking rate had a very large effect on the available dry matter per animal as anticipated but on the legume treatments the reduction in total dry matter yield, and especially legume yield, was most dramatic (Table 1).

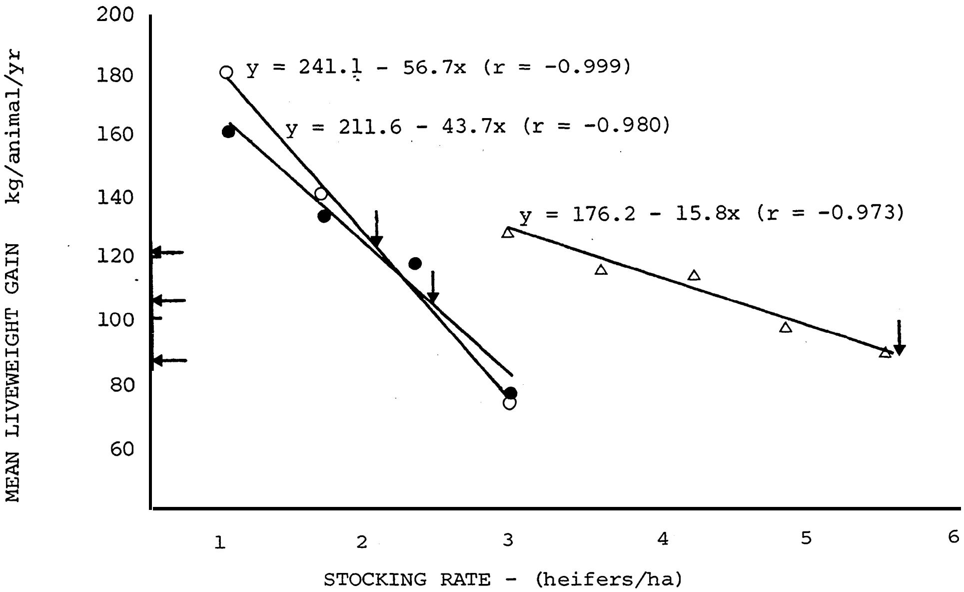

Fig. 1. The relation between animal gain and stocking rate for three tropical pastures over the three year period from November 1969 to November 1972. o-o, desmodium - setaria (D); ●-●, Siratro - setaria (S); △-△, setaria + 336 kg N/ha/yr (N).

(arrows indicate stocking rate for maximum gain/ha and the gain/animal at this stocking rate)

TABLE 1

The botanical composition of three tropical pastures at different stocking rates over a three year period. Values are the percentage contribution to total yield in May each year.

Pasture	Stocking Rate (animals/ha)	YEAR 1970		1971		1972		D.M. available per Animal in May 1972 (kg)
		LEGUME	GRASS	LEGUME	GRASS	LEGUME	GRASS	
Setaria/ Desmodium	1.11	30	44	43	53	49	48	9030
	1.73	20	36	27	45	20	56	3080
	2.96	23	46	15	46	6	48	740
Setaria/ Siratro	1.11	51	35	37	58	37	61	7600
	1.73	49	46	21	78	23	73	4430
	2.35	40	34	26	55	29	50	2700
	2.96	41	35	12	72	9	71	940
Setaria/ Nitrogen	2.96		66	-	80	-	90	2320
	3.58		65	-	80	-	85	1740
	4.20		89	-	98	-	98	1550
	4.82		75	-	80	-	86	1170
	5.44		54	-	63	-	73	820

IV. DISCUSSION

The higher carrying capacity of the nitrogen fertilized grass pastures compared with the legume-grass pastures (2.5:1) is a reflection of the higher DM yields achieved with nitrogen fertilized grass. Cutting experiments at Samford, (Jones, Davies and Waite 1967, Jones 1970) have shown that nitrogen fertilized grass out-yields grass-legume pastures by a factor of 1.5 to 1.8. Other cutting trials have shown that the superiority of the nitrogen system is greater under frequent cutting when the tropical legume component in the mixture is greatly reduced relative to the grass (Jones 1971).

Increasing the stocking rate, and hence the grazing pressure, has had a similar effect to increased cutting frequency - total yield, legume yield and the legume proportion have decreased. The more rapid decline in gain per animal with constant increase in stocking rate on the legume pastures compared with the fertilized grass pastures is associated with a more rapid decline in feed available per animal on the legume-grass pastures. Thus, at low stocking rate on the legume pastures DM available per animal was 3 to 4 times that available on low stocked nitrogen treatment, whereas at the highest stocking rates used, the yields of DM available per animal were similar for both systems. An even greater decline in legume yield occurred with increasing stocking rate and as a consequence a marked reduction in nitrogen input via the legume. This situation does not occur with the nitrogen fertilized grass since a constant level of nitrogen is applied in the fertilizer at every stocking rate.

Although the carrying capacity of the nitrogen system is 2.5 times that of the legume system the gain per ha at optimum stocking rate was only 1.9 times that of the legume system. This was due to the lower gains per animal for the nitrogen system at the optimum stocking rate. As a result, the turn-off rate would be lower from the nitrogen fertilized grass pastures. To attain slaughter weight at two years of age yearling cattle have to gain approximately 200 kg/yr. This was only achieved in two out of the three years at the lightest stocking rate on desmodium pasture. At the optimum stocking rates animals on these pastures will not be finished until they reach 2.6 to 3.2 yr.

The consistently better gains of cattle at the lighter stocking rates from desmodium based pastures were unexpected in the light of the much lower digestibility of this species compared with Siratro (Jones 1969, Stobbs 1971). It has been assumed that the 'tannins' in desmodium adversely affect feeding value - as reported with Sericea (Cope and Burns 1971), however, the presence of these compounds may confer benefits to the pasture or the animal which are not fully appreciated. In this connection the lower rate of mineralization of N in leaf and plant material from desmodium compared with Siratro has already been described (Vallis and Jones 1973).

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VI. REFERENCES

BECKMANN, G.G. (1957). Divl. Rep. Div. Soils C.S.I.R.O. 5.
BRYAN, W.W. and EVANS, T.R. (1971). Trop. Grasslds 5: 89.
COLMAN, R.L. (1971). Trop. Grasslds 5: 181.
COPE, W.A. and BURNS, J.C. (1971). Crop. Sci. 11: 231.
JONES, R.J. (1969). J. Aust. Inst. agric. Sci. 35: 62.
JONES, R.J. (1970). Trop. Grasslds 4: 97.
JONES, R.J. (1971). Ph.D. Thesis, University of New England, Armidale.
JONES, R.J., DAVIES, J.G. and WAITE, R.B. (1967). Aust. J. exp. Agric. Anim. Husb. 7: 57.
STIRK, G.B. (1963). Divl. Rep. Div. Soils C.S.I.R.O. Aust. 5/63.
STOBBS, T.H. (1971). Aust. J. exp. Agric. Anim. Husb. 11: 268.
VALLIS, I. and JONES, R.J. (1973). Soil Biol. Biochem. 5: 391.