PRODUCTION FROM STEERS GRAZING NITROGEN FERTILIZED IRRIGATED PANGOLA GRASS IN THE ORD VALLEY

C. G. BLUNT*

ABSTRACT

The effect on steer performance of stocking rate and nitrogen fertilizer level applied to irrigated pangola grass was studied over two years.

Increasing the N (urea) rate had no significant effect on pasture yield or liveweight gain over the range 310–800 *kg* ha^{-1} yr^{-1} *indicating that even the lowest N rate used was sufficient for maximum production.*

Pasture yields declined linearly with increasing stocking rate (885 ± 69 *kg DM* ha^{-1} *for each unit increase in stocking rate) over the range* 5.2 *to* 12.6 *steers* ha^{-1}. *Liveweight gains (LWG) per steer also declined linearly with increased stocking rate;* $Y = 229 - 9.84\ X$ ($r = 0.85$) *where* Y = *LWG (kg* $steer^{-1}$ yr^{-1}) *and* X = *stocking rate (steers* ha^{-1}). *Maximum LWG of* 1330 *kg* ha^{-1} yr^{-1} *occurred at* 11.5 *steers* ha^{-1} *but at this stocking rate gains per steer were low.*

Variations in total pasture dry matter yield and change in dry matter yield throughout the year accounted respectively for only 13% *and* 18% *of the total variation in seasonal liveweight change at the central stocking rate of* 8.9 *steers* ha^{-1}.

INTRODUCTION

The Kimberley region of Western Australia has, until recently, produced mainly manufacturing classes of meat. The development of the Ord Irrigation Scheme seemed to offer the opportunity to diversify meat production. As part of a program to investigate irrigated fodders pangola grass, *Digitaria decumbens*, was selected for study under grazing because of its excellent performance under irrigation in tropical Australia (Ebersohn and Lee 1972). Two factors, nitrogen fertilizer and stocking rate, were known to have a large influence on costs and productivity.

Two preliminary trials were conducted (Blunt unpublished). The first, a cutting trial, gave responses in pangola dry matter up to 1000 kg N ha^{-1} yr^{-1}. The second, a grazing trial, indicated that maximum liveweight gains of 1200 kg ha^{-1} yr^{-1} occurred at stocking rates between 10 and 12 steers ha^{-1} with 560 kg N ha^{-1} yr^{-1}.

With both factors apparently important in production from pangola grass an experiment was commenced which studied a range of nitrogen and stocking rates. Because of limited space a central composite design was used. As such a design requires accurate control of treatments for satisfactory statistical analysis, extreme treatments were avoided.

MATERIALS AND METHODS

The experiment was conducted at Kimberley Research Station (15° 39′S, 128° 43′E) where pangola grass (*Digitaria decumbens*) was planted on the main soil type, Cununurra Clay. This soil is a uniform, dark brown to very dark greyish brown (10 YR 3/3–3/2), medium to heavy clay with pronounced swelling and shrinking properties (Gunn 1969). Most of the 750 mm of rain falls between November and March during the hot summer. Winters are warm and dry (Lee *et al.* 1963).

*C.S.I.R.O., Division of Tropical Crops and Pastures, Kimberley Research Station, Kununurra, W.A. 6743. Present address: c/- Botany Dept., Australian National University, Canberra, A.C.T.

Experimental design

A central composite design, adapted from Cochran and Cox (1957) by using only 4 central points instead of the preferred 5, because of insufficient area of grass, was used. Treatments were:—

	kg N ha^{-1} yr^{-1}		steers ha^{-1}	
4 central points		556		8.9
Factorial	382,	728	6.3,	11.5
Extra points	311,	800 556	5.1,	8.9 12.6

Animals

Kimberley shorthorn steers that had been weaned from native pasture and were of initial mean weight 146 kg and 127 kg, were randomly allocated to treatments in November 1973 and 1974 respectively. They were set stocked on their treatment with two animals in each of the two lowest stocking rates and three animals in the rest. A single subcutaneous injection of "Nilverm" was used each year to control internal parasites. Steers were sprayed with "Asuntol" to control tick (*Boophilus microplus*) when necessary and were offered a mineral supplement containing 13.5% P, 23.0% Ca, 50 ppm Co and 250 ppm Cu. They were weighed each 6 weeks after 16 hours without feed or water.

Pasture management

An area of 3.9 ha of pangola grass was established in January 1970 on ridges one metre apart and furrow irrigated. It was grazed from May 1970 to June 1973 and received 560 kg N ha^{-1} yr^{-1}. Between June and September 1973 the area was forage harvested twice to increase uniformity and then fenced into paddocks.

All pastures were furrow irrigated every two weeks, except when rain occurred, to reduce net evaporation (since the previous irrigation) to less than 50 mm (calculated from pan evaporation less the rainfall that does not run off).

Urea was applied in equal dressings eight times each year, generally at about six-week intervals unless rain caused delays. The nitrogen fertilizer was dropped along the furrows and irrigated soon after.

A single surface application of superphosphate at 250 kg ha^{-1} was made in October each year.

Dry matter was estimated by sampling to ground level using ten 0.5 m square quadrats per paddock each four to six weeks.

Statistical

Data on animal gain were analyzed as in Cochran and Cox (1957) using recalculated coefficients because only four and not five central points were used. Regressions of gain on stocking rate were calculated for each year and for the combined data. Regressions were also calculated for each monthly liveweight gain on stocking rate.

The effect of pasture quantity on liveweight gain was determined using multiple linear regressions of liveweight gain for each paddock on the dry matter yield and with the change of dry matter yield between each weighing period. As the dry matter harvests did not coincide exactly with these periods the first, last and middle values were determined by interpolation from a graph with straight lines joining the points.

RESULTS

In both years there was no significant response in liveweight gain (LWG) to increased applications of nitrogen over the range studied.

In both years liveweight gain was linearly related to stocking rate ($P < 0.01$):—

1973/4 $Y = 240 - 11.2\ X$ ($n = 12$ $r = 0.89$)
1974/5 $Y = 218 - 8.48\ X$ ($n = 12$ $r = 0.83$)
Both years $Y = 229 - 9.84\ X$ ($n = 24$ $r = 0.85$)
Where Y = liveweight gain (kg $steer^{-1}$ $year^{-1}$)
X = stocking rate (steers ha^{-1})

There was no significant difference between slopes for the two years. Maximum gains per hectare were 1330 kg at 11.5 steers ha^{-1}.

The effect of increasing stocking rate on animal gain varied seasonally, but was always negative. The pattern of a small effect in summer followed by a large effect in winter was similar in both years, although in the second year the effect of increasing stocking rate was less marked in the November-April period (Figure 1).

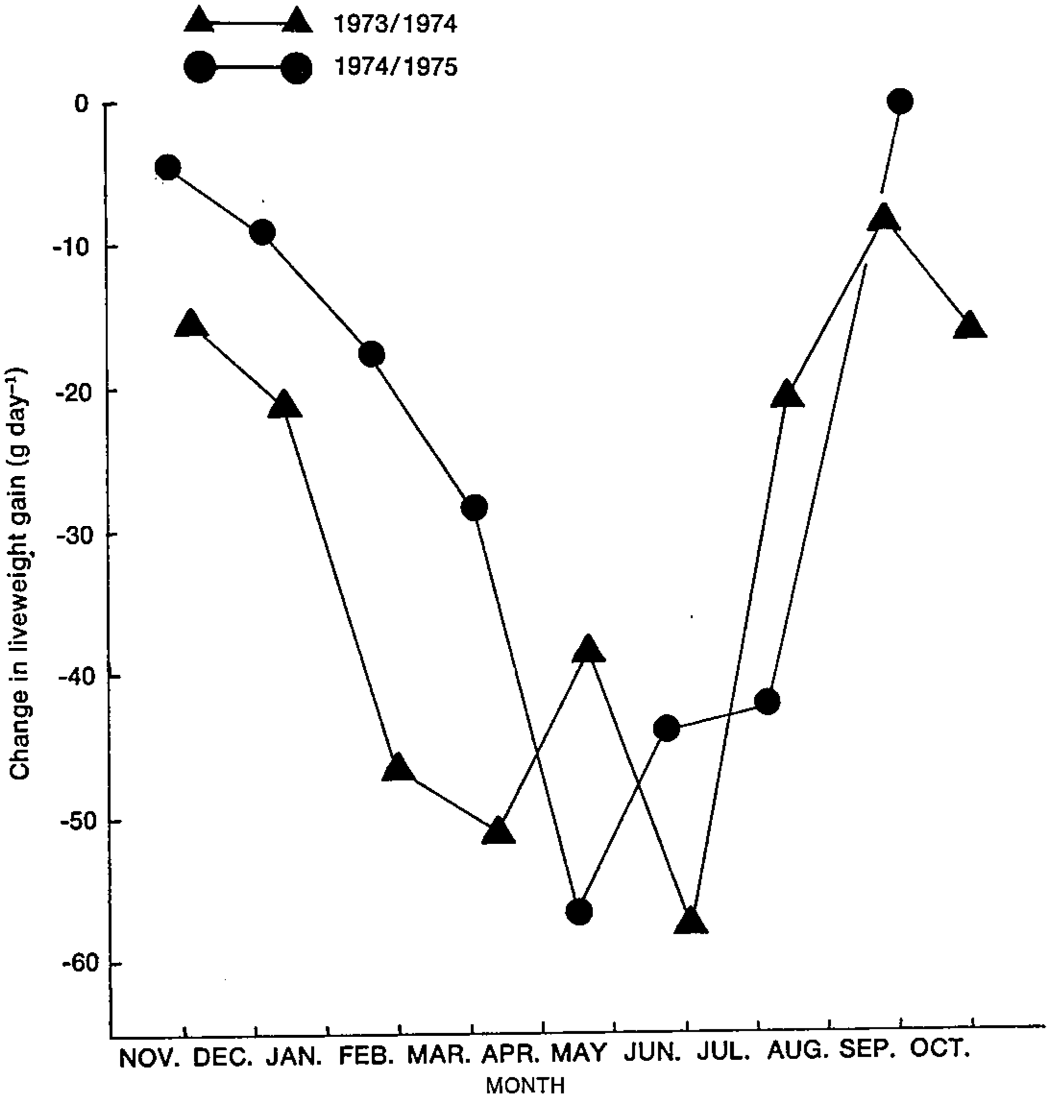

FIGURE 1
Seasonal effect on the response of liveweight gain to an increase in stocking rate of 1 steer ha^{-1}.

Seasonal changes in liveweight gain were large, with poorest gains in June and July and best gains in December to February (Figure 2). The general pattern of gain following the pattern of dry matter yield (Figure 3).

The effect of stocking rate on dry matter yield was highly significant ($P < .01$). All paddocks commenced the trial with the same amount of dry matter, but within four months an equilibrium was reached in which there was an average decline of 885 ± 69 kg DM ha^{-1} for each increase of 1 steer ha^{-1} (Figure 3). There was no significant effect of N on pasture dry matter production over the range studied.

The effect of total dry matter and change in dry matter on seasonal liveweight gain during the eighteen 4 to 6 week periods was studied at the central stocking rate only, because of the strong effect of stocking rate on these variables. There was a significant multiple linear regression:—

$Y = 186 + 3.35X_1 + 0.043X_2$ ($r^2 = 0.269$, $n = 108$) where Y = liveweight gain (g $head^{-1}$ day^{-1}), X_1 = change in dry matter (kg ha^{-1} day^{-1}) X_2 = dry matter at midpoint of each weighing period (kg ha^{-1}) indicating a significant but weak relation between pasture availability and gain at this stocking rate. Considered separately these two variables accounted for only 16% and 11% respectively of the total variation in seasonal LWG.

DISCUSSION

The liveweight gain obtained in this experiment was far less than the 2990 kg ha^{-1} yr^{-1} reported by Ebersohn and Lee (1972) for irrigated pangola fertilized with 672 kg N ha^{-1} yr^{-1} at Parada in North Queensland. However, in that experiment drafts of older steers and not weaners were used. The production of 1300 kg ha^{-1} yr^{-1} obtained is, however, similar to that reported by many other workers using pangola in the tropics and sub-tropics where a range of 1000–1300 kg ha^{-1} yr^{-1} is common (Motta 1963, Caro-Costas *et al.* Vincente-Chandler and Burleigh 1961, Caro-Costas *et al.* 1965, Evans 1969, Bryan and Evans 1971, Deans *et al.* 1976).

Since the levels of N applied in this experiment were adequate and moisture was non limiting, greater liveweight gains might have been expected. Low feed availability and low liveweight gains occurred in the 'winter' season (May-August) and it is apparent that even at this tropical site the temperatures in this period are low enough to reduce pasture production. In summer the high temperatures in the Ord Valley could also depress intake and weight gains compared with other sites (Vercoe *et al.* 1972).

The linear decline in liveweight gain per head with increases in stocking rate is similar to the findings of Jones and Sandland (1974). However the slope of −9.8 kg per unit of SR is less than those reported by Jones (1974) of −15.8 for nitrogen fertilized setaria, and Mears and Humphreys (1974) of −11.3 to −29.3 for Kikuyu grass, both in sub-tropical latitudes. This lower value may be associated with the adequate N fertilization since Mears and Humphries (1974) reported a decline in 'b' value with an increase in the N fertilizer rate. In addition the lack of moisture stress and higher temperatures would have enabled growth to occur throughout the year. Under such conditions high stocking rates can be sustained without seriously influencing gains per steer.

Whilst liveweight gain across stocking rates was related to pasture dry matter yield, pasture dry matter yield and changes in dry matter yield accounted for only 27% of the total variation in seasonal liveweight change at the one stocking rate of 8.9 steers ha^{-1}. There may be several reasons for this. The difficulty of accurately estimating true changes in bodyweight over intervals of one month by measurements of liveweight is well known. Furthermore, total pasture dry weight does not necessarily reflect the quality of the pasture and 't Mannetje (1974) has shown pasture dry weight to be a poor indication of seasonal liveweight changes compared with yield of dry green material. In pangola a large proportion of the yield may occur

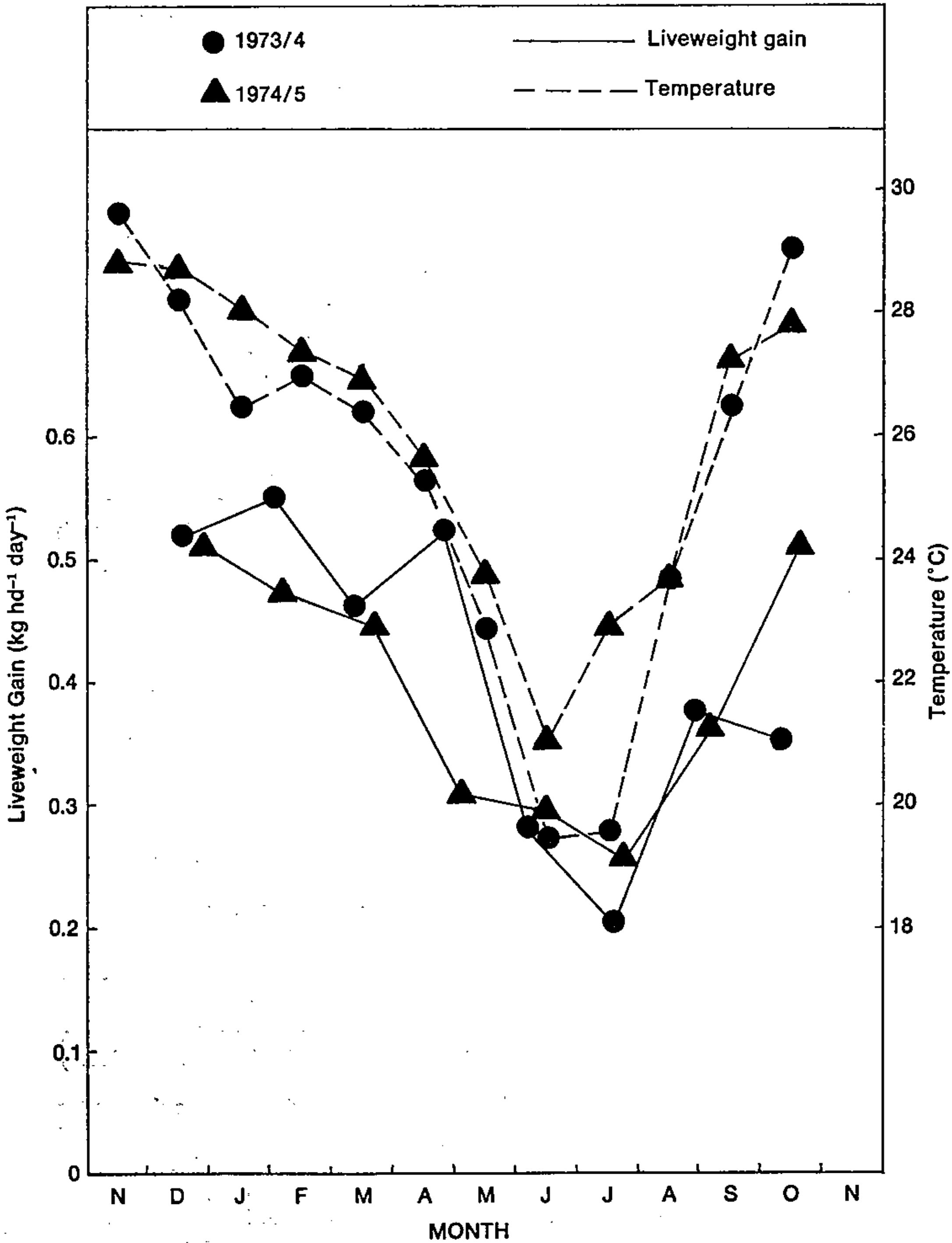

FIGURE 2

Seasonal variations in liveweight gain of steers grazing pangola grass (running means) and the mean monthly temperatures.

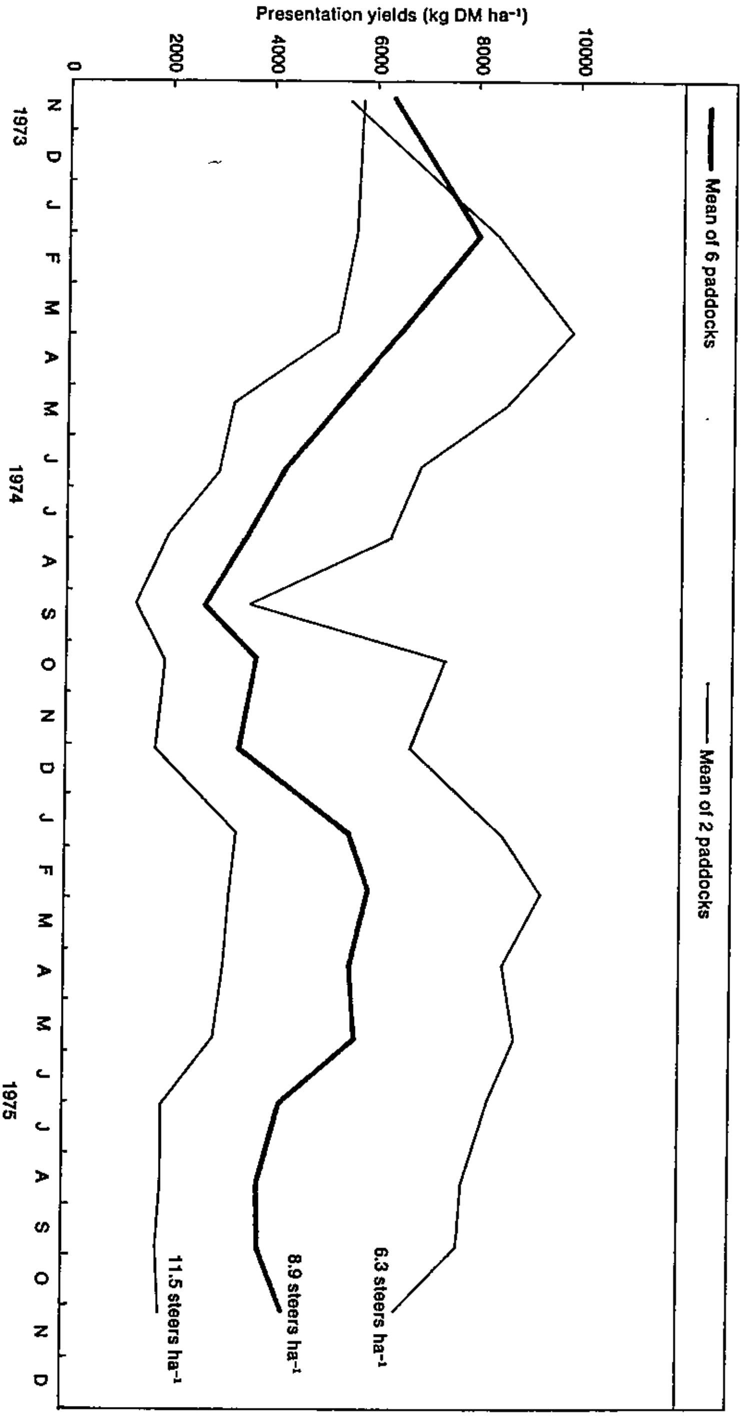

FIGURE 3

Seasonal changes in the dry matter yields of pangola grass at stocking rates of 6.3, 8.9 and 11.5 steers per hectare.

as mature stolons and culms of lower feeding value than green leaf. In addition to these quality factors in the pasture, climatic stress in summer could also have modified or even nullified any relation between pasture parameters and liveweight change.

The marked difference between the response in dry matter of pangola grass to nitrogen under a cutting regime and LWG under grazing is probably the result of returned nutrients in the grazing situation. A further trial at lower nitrogen levels is required to determine the LWG response curve at lower levels of N for a full economic study of pangola grass in the Ord Valley.

ACKNOWLEDGEMENTS

I would like to thank J. H. Hindmarsh, F. X. Syrch, J. P. Corfield and R. F. Seaward for technical assistance. R. B. Cunningham, B. G. Johnston and I. M. Wood helped in the design of the trial and Dr. W. T. Williams analyzed the data. My thanks must also go to A. L. Chapman and Dr. R. J. Jones for their encouragement and helpful criticisms of the manuscript. Hooker Pastoral Co. kindly lent the animals.

REFERENCES

BRYAN, W. W., and EVANS, T. R. (1971)—A comparison of beef production from nitrogen fertilized pangola grass and from a pangola grass—legume pasture. *Tropical Grasslands* 5: 89-98.

CARO-COSTAS, R., VINCENTE-CHANDLER, J., and BURLEIGH, C. (1961)—Beef production and carrying capacity of heavily fertilized, irrigated Guinea, Napier and pangola grass pastures on the semi arid south coast of Puerto Rico. *Journal of Agriculture of the University of Puerto Rico* 45: 32-6.

CARO-COSTAS, R., VINCENTE-CHANDLER, J., and FIGARELLA, J. (1965)—Productivity of intensively managed pastures of five grasses on steep slopes in the humid mountains of Puerto Rico. *Journal of Agriculture of the University of Puerto Rico* 49: 99-111.

COCHRAN, W. G., and COX, G. M. (1957)—*Experimental Designs* (Second Edition) John Wiley and Sons, Inc., New York, 611 pp.

DEANS, H. D., CHOPPING, G. D., SIBBICK, R., THURBON, P. N., COPEMAN, D. B., and STOKOE, J. (1976)—Effect of stocking rate, breed, grain supplementation, nitrogen fertilizer level and anthelminthic treatment on growth rate of dairy weaners grazing irrigated pangola grass. *Proceedings of the Australian Society of Animal Production* 11: 449-52.

EBERSOHN, J. P., and LEE, G. R. (1972)—The impact of sown pastures on cattle numbers in Queensland. *Australian Veterinary Journal* 48: 217-23.

EVANS, T. R. (1969)—Beef production from nitrogen fertilized pangola grass (*Digitaria decumbens*) on the coastal lowlands of southern Queensland. *Australian Journal of Experimental Agriculture and Animal Husbandry* 9: 282-6.

GUNN, R. H. (1969)—Soils of Kimberley Research Station, Kununurra, W.A. *C.S.I.R.O. Division of Land Research Technical Memorandum* 69/21.

JONES, R. J. (1974)—The relation of animal and pasture production to stocking rate of legume based and nitrogen fertilized subtropical pastures. *Proceedings of the Australian Society of Animal Production* 10 340-43.

JONES, R. J., and SANDLAND, R. L. (1974)—The relation between animal gain and stocking rate. Derivation of the relation from the results of grazing trials. *Journal of Agricultural Science (Cambridge)* 83: 335-42.

LEE, L. C., CHAPMAN, A. L., and BASINSKI, J. J. (1963)—Sugar cane trials at the Kimberley Research Station in north western Australia. *Australian Journal of Experimental Agriculture and Animal Husbandry* 3: 344-52.

MANNETJE, L. 't. (1974)—Relations between pasture attributes and liveweight gains on a sub-tropical pasture. *Proceedings XIIth International Grasslands Congress, Moscow* 3: 299-304.

MEARS, P. T., and HUMPHREYS, L. R. (1974)—Nitrogen response and stocking rate of *Pennisetum clandestinum* pastures II. Cattle growth. *Journal of Agricultural Science (Cambridge)* 83: 469-478.

MOTTA, M. S. (1963)—"Investigations 1958-9". Bulletin 58 (new series). Ministry of Agriculture and Lands, Jamaica, pp. 136-7.

VERCOE, J. E., FRISCH, J. E., and MORAN, J. B. (1972)—Apparent digestibility, nitrogen utilization, water metabolism and heat tolerance of Brahman cross, Africander cross and Shorthorn x Hereford steers. *Journal of Agricultural Science (Cambridge)* 79: 71-4.

(Accepted for publication January 3, 1978)