STUDIES ON NATIVE AND IMPROVED NATIVE PASTURES IN SOUTH SULAWESI, INDONESIA-EFFECTS OF SULFUR FERTILIZER AND STOCKING RATE ON ANIMAL PRODUCTION

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Summary

The effects of S fertilization and stocking rate on cattle production from native and sown pastures were studied in South Sulawesi, Indonesia.

On the native pasture there was no effect of S application over the three years of the experiment. The per head production was lower at the higher stocking rate (1.0 hd/ha), but the overall production increased by an average of 49%.

There was no response to S applied to the clean seedbed pastures in the first year, but significant responses developed in the second and third years. There was an overall higher production from the higher stocked pastures (3.0 hd/ha), but the per head production was lower. There was a mean of about a two-fold increase in animal production from the highest native to the lowest improved pasture and a 3.4 times increase from the low stocking rate native to the high stocking rate sown pasture.

(Key Words: Cattle Production, Stocking Rate, Sulfur, Fertilizer, Pasture)

Introduction

In contrast with Java, the islands of Eastern Indonesia are not densely populated and large tracts of natural grasslands (often dominated by *Imperata cylindrica* or "alang alang") can be found. Estimates of such areas involved vary, but are generally in the vicinity of 20 million hectares (Schwaar, 1973). These grassland areas, together with annual crop residues, form the feed base for a rapidly increasing ruminant population in South Sulawesi. Falvey (1981), in reviewing *Imperata cylindrica* and animal production in South East Asia, concluded that while animal production is generally low on these pastures, opportunity and economics dictate that these natural grassland areas must continue to be utilized in the foreseeable future.

Assuming that the critical level for intake and maintenance is around 1% N (Siebert and Kennedy, 1972) the data from a cutting experiment in Papua New Guinea (Holmes et al., 1976) suggested that *Imperata* only provides adequate nitrogen until it reaches six weeks of age. Native species often found in association with *Imperata cylindrica* include *Themeda, Sorghum, Heteropogon* and *Chrysopogon* (as surveyed by Bonnemaison, 1961). A feature of these grasses is their rapid maturity and consequent loss of nutritive value.

In a field experiment in the Maiwa area of South Sulawesi the application of elemental S or sulfate increased the yield of centro from 9,023 to 22,526 kg green/ha, but there were no responses to P, K, Mo, Cu or Zn (Blair et al., 1978). Little is known of the productivity of natural pastures on those containing introduced species in Indonesia. For this reason a study was commenced to record animal production and pasture data in response to sulfur fertilizer application at a range of stocking rates on different pasture types.

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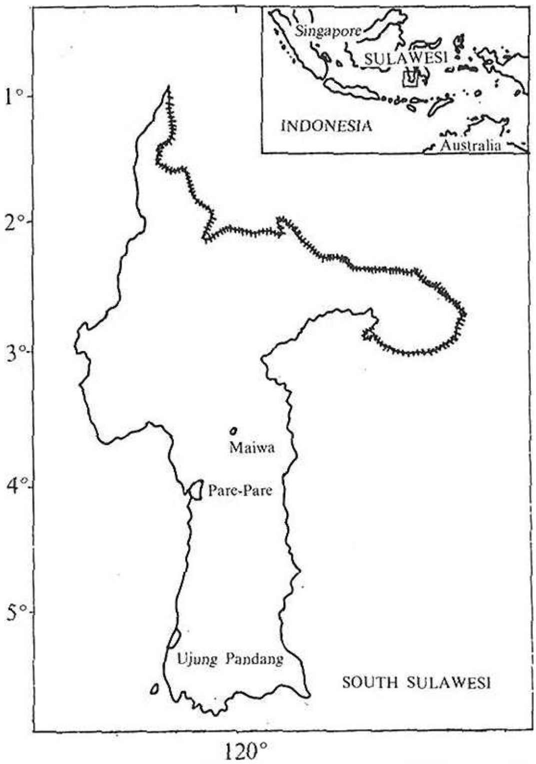

Figure 1. Map of Indonesia and South Sulawesi showing the location of the experiments.

Materials and Methods

The experiments were carried out on the Indonesian government livestock company (P.T. Bina Mulya Ternak) ranch located at Maiwa (figure 1) in South Sulawesi, Indonesia. This ranch is situated 8 km north-east of Rappang, latitude 3°47'S, longitude 119°48'E, at an elevation of 50 metres above sea level.

The topography of the research sites was undulating foothills broken by heavily forested, steep gullies. A representative native pasture was chosen supporting species similar to those described in the introduction. A second site was chosen from an area which had been cultivated and sown five years prior to the commencement of the experiment with the introduced species *Centrosema pubescens* (Centro) and *Stylosanthes guianensis* cv. Cook and Schofield (Stylo). At the commencement of the trial the feed on offer and botanical composition of the pastures, as determined by the rank score method of t'Mannetje and Haydock (1963), was as shown in table 1. The soil at the site is described as a glossudalf (McLeod, pers. comm.).

The experiment at each site consisted of a

TABLE 1. FEED ON OFFER AND BOTANICAL COMPOSITION OF PASTURES AT THE NATIVE AND OVERSOWN SITES PRIOR TO THE COMMENCEMENT OF THE EXPERIMENT IN SEPTEMBER, 1979

Pasture type	Feed on offer (t F wt/ha)*	Composition (%)		
		Legume	Grass	*Imperata*
Native	7.93	5	80	15
Clean seedbed	17.46	36	34	29

* Tonnes fresh weight per hectare.

TABLE 2. FERTILIZER AND STOCKING RATES USED ON TWO GRAZING EXPERIMENTS CONDUCTED AT MAIWA RANCH, SOUTH SULAWESI

Pasture type	Stocking rate (hd*/ha)	Treatment code	Elemental S application rate (kg/ha)			
			Year 1	Year 2	Year 3	Total
Native	0.5 and 1.0	S0	0	0	0	0
		S2	30	30	30	90
Clean seedbed	2.0 and 3.0	S0	0	0	0	0
		S1	15	15	15	45
		S2	30	30	30	90
		S3	45	30	30	105

*The animals were Brahman cross heifers, 110-160 kg body weight at the start of each grazing year.

factorial combination of S fertilizer and stocking rates as shown in table 2.

Stocking rates were selected based on local experience, anticipating a moderate and high level of pasture utilization, and with a view to achieving different nutrient cycling rates while subjecting the various pasture components to different selection pressures. Stocking rate was varied by altering plot size such that there were three animals per plot. The animals were Brahman cross heifers weighing 110-160 kg at the start of the grazing year, a new group being selected each year.

Plots were arranged in a completely randomized block design with four replicates during the first two research "years" (400 and 384 days) and two replicates only for the third grazing year (379 days).

Fertilizer (elemental sulfur) was broadcast by hand onto the surface of the pasture at the start of each grazing year.

As the sites were some 6 km apart no statistical comparisons have been attempted between sites. Liveweight data have been analysed as a split-plot in time with the individual animals as sub-samples within each plot.

Soil and pasture samples were collected for mineral analysis in each grazing year and non-fasted animal liveweights recorded at intervals of approximately three months. A new group of Brahman cross heifers was placed on the plots at the end of each grazing year. Animal health was maintained by a program of regular drenching for internal parasites and spraying for cattle tick. No supplements were fed other than salt which was available in bamboo "lick" tubes suspended in each plot. The average daily intake of salt was 30 g/hd/day.

Results

Rainfall

The annual rainfall received in each grazing year was 2828 mm in 1979/80, 3163 mm in 1981/82, and 2407 mm in 1982/83. These amounts compare with the 10 year average of 2791 mm recorded at Maiwa. Although the total annual rainfall was not too variable, monthly rainfall totals varied markedly between years.

Native Pasture

There was no effect of S fertilizer on animal performance in any of the three years and for this reason the data presented in figure 2 and table 3 are meaned over S fertilizer rates.

Large differences in liveweight gain were recorded between years (table 3) with the highest gain recorded in the year of lowest rainfall (1982/83). In each year low rainfall in August resulted in a slowing down in the rate of liveweight gain or a liveweight loss (1980) (figure 2).

In each year there was a significant effect of stocking rate on animal performance with liveweight gains per head being lower at the higher stocking rate (1 hd/ha). However, the lower per head performance at the higher stocking rate was more than compensated for by the increase in liveweight per unit area so that per hectare performance was higher at the higher stocking rate (table 3).

Clean Seedbed Pasture

Unlike the native pasture site the variation in liveweight gain between years was small at the prepared seedbed site (table 4, figure 3). Within each grazing year the pattern of liveweight gain was similar to the native pasture site with the exception of a liveweight loss in the 3 hd/ha treatment in the September to November period 1982. This weight loss was associated with an extremely dry period from June to November 1982.

There was no effect of S fertilizer on liveweight or liveweight gain in the 1979/81 grazing year so the results presented in table 4 and figure 3 are meaned over fertilizer rates. Liveweight gain was significantly higher at the lower stocking rate.

In the 1981/82 grazing year there was a significant fertilizer × stocking rate effect with no response to S at a stocking rate of 2 hd/ha but a significant response to all S application rates at 3 hd/ha. At 3 hd/ha there was no significant difference between the three treatments where S was applied and animal liveweights were not significantly different from those at 2 hd/ha.

In the third grazing year (1982/83) there was again a significant fertilizer × stocking rate effect on both liveweight and liveweight gain (figure 3 and table 4). As for the second grazing year S fertilizer had no significant effect on liveweight

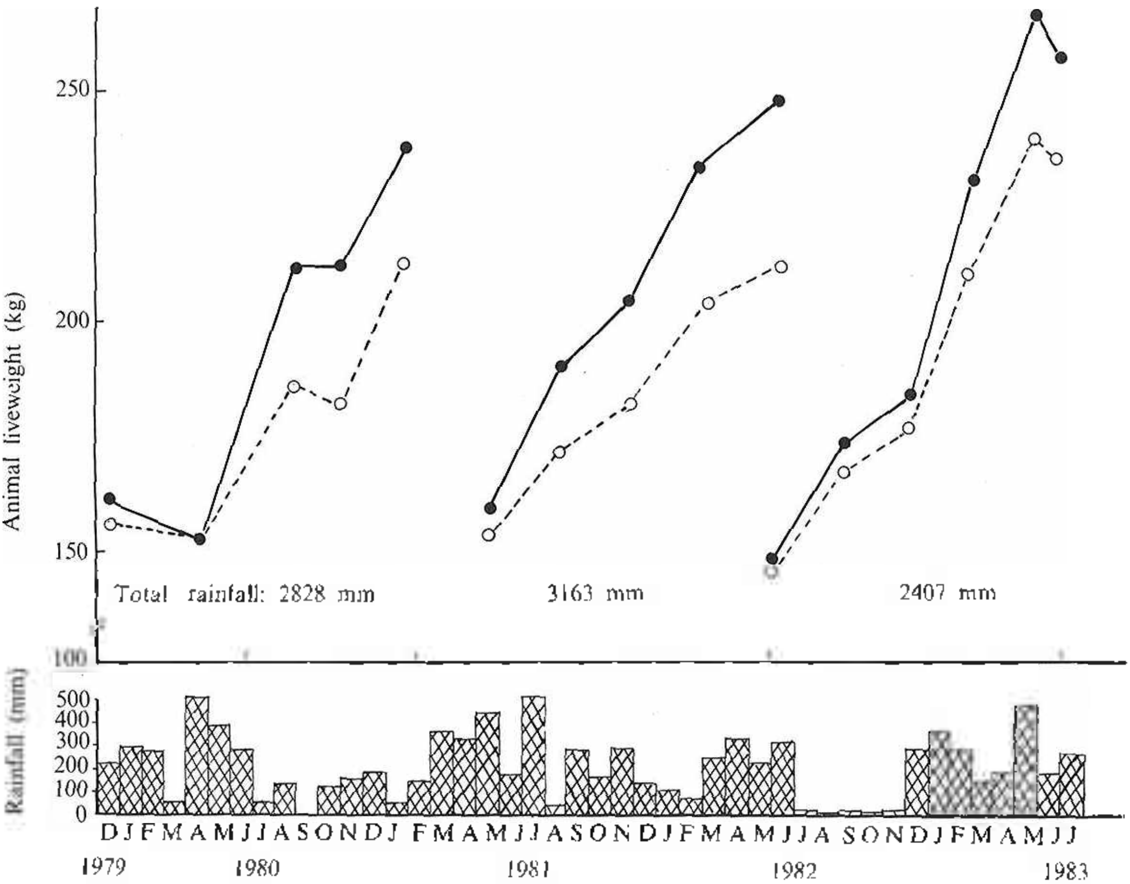

Figure 2. Liveweight of Brahman cross heifers stocked at 0.5 and 1.0 hd / ha on native pastures at Maiwa, South Sulawesi, Indonesia and monthly rainfall recorded at the site over the three-year experimental period. ●——● 0.5 hd / ha ○------○ 1.0 hd / ha

TABLE 3. LIVEWEIGHT GAINS OF BRAHMAN CROSS HEIFERS GRAZING NATIVE PASTURES AT MAIWA, SOUTH SULAWESI, INDONESIA

Grazing year	Stocking Rate (hd/ha)	Liveweight gains		
		kg/hd/day	kg/hd/yr'	kg/ha/yr'
1979/81	0.5	0.202[a]*	73.6[a]	36.8[a]
	1.0	0.147[b]	53.7[b]	53.7[b]
1981/82	0.5	0.239[a]	87.3[a]	43.7[a]
	1.0	0.160[b]	58.3[b]	58.3[b]
1982/83	0.5	0.301[a]	109.7[a]	54.9[a]
	1.0	0.244[b]	89.2[b]	89.2[b]

* Numbers within columns and within years followed by the same letter are not significantly different according to Duncan's Multiple Range Test.

' *Grazing period > 1 year weights adjusted to 365 days.*

TABLE 4. LIVEWEIGHT GAINS OF BRAHMAN CROSS HEIFERS GRAZING CLEAN SEEDBED PASTURE AT MAIWA, SOUTH SULAWESI, INDONESIA

Grazing year	stocking rate	S treatment S0	S1	S2	S3	Mean	Significance
			kg/hd/day				
1979/81	2					0.170	
	3					0.142	SR
1981/82	2					0.173	
	3	0.096	0.172	0.162	0.124	0.139	SR×S
1982/83	2					0.181	
	3	0.122	0.118	0.131	0.161	0.133	SR×S
			kg/hd/yr*				
1979/81	2	56	44	69	79	62	
	3	55	44	66	41	52	SR
1981/82	2	67	47	55	76	63	
	3	35	63	59	45	50	SR×S
1982/83	2	68	73	60	73	66	
	3	45	43	48	59	49	SR×S
			kg/ha/yr*				
1979/81	2					124	
	3					155	SR
1981/82	2					126	
	3	105	188	177	136	151	SR×S
1982/83	2					132	
	3	134	129	143	176	146	SR×S

* Grazing years have been corrected back to 365 days.

gain at a stocking rate of 2 hd/ha whereas at 3 hd/ha the highest rate of S was sufficient to maintain per head production at the same level as at 2 hd/ha. At this high stocking rate liveweight gain per animal decreased with decreasing S application rates.

Discussion

No response to fertilizer was obtained on the native pasture site because of the low incidence of legumes. At the clean seedbed site the addition of sulfur fertilizer had no significant effect on animal performance in any year at a stocking rate of 2 hd/ha. However, at 3 hd/ha animal liveweight was significantly increased by fertilizer sulfur applications in years two and three. This result confirms the S response obtained in cutting experiments by Blair et al. (1978) on this site. These results demonstrate the need to continue grazing experiments for sufficient time for the pastures to properly express the residual effects of previous additions of fertilizer and to study the longer term consequences of grazing pressure on pastures.

Limited data on ruminant production from pastures exists from South East Asia and for the tropics in general. Crowder and Chheda (1982) summarized the results of 21 experiments conducted throughout the humid tropics and indicated that over a range of breeds the liveweight gain from natural grazing land with improved grazing management averaged approximately 90 kg/ha. This production could be increased to 400 kg/ha when legumes were oversown and the pasture fertilized. Further increases to 600 kg/ha could be obtained when cultivated grass/legume pastures were used. The liveweight gains per hectare recorded in the study reported here

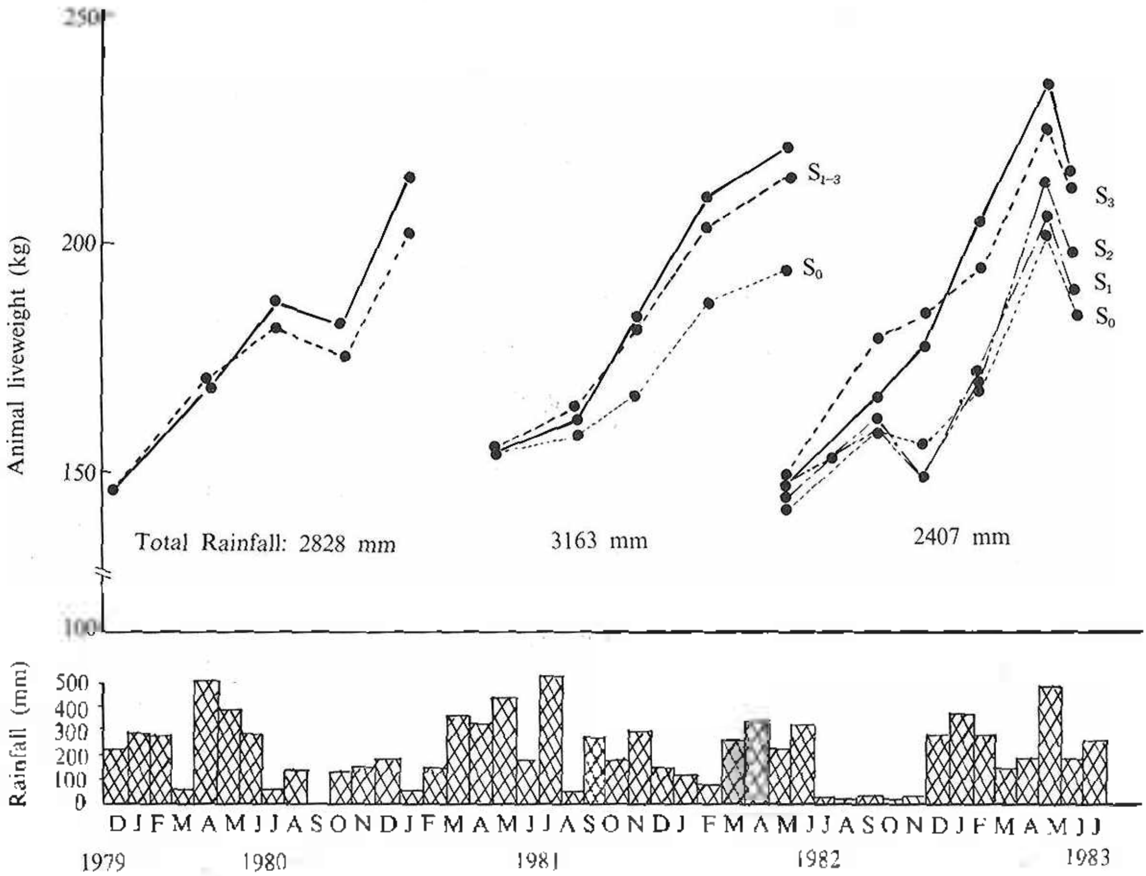

Figure 3. Liveweight of Brahman cross heifers stocked at 2 and 3 hd / ha on a clean seedbed pasture fertilized with varying S rates at Maiwa, South Sulawesi, Indonesia and monthly rainfall recorded at the site over the three year experimental period. ●——● means over fertilizer treatments at 2 hd / ha ●------● broken lines animals at 3 hd / ha. Where necessary the S fertilizer treatment are shown against the lines.

ranged from 36.8 to 89.2 kg/ha. The mean liveweight gain/hd/day of 0.174 kg at a stocking rate of 2 hd/ha on the clean seedbed pasture over the three-year period is considerably lower than the 0.342 kg/hd/day recorded by Eng (1981) in Malaysia when Droughtmaster cattle were stocked at two hd/ha on a native grass/Centro/Stylo/*Ovalifolium* pasture. Similarly, the liveweight gains recorded on the clean seedbed pasture ranged from 124 to 155 kg/ha per year. These are considerably lower than those mean figures reported by Crowder and Chheda (1982). They are also considerably lower than the 550 kg/ha liveweight gain recorded under coconuts in Bali at a stocking rate of five Bali cattle/ ha (Rika et al., 1981).

The liveweight gain per hectare recorded in this experiment is well below the potentials realized in Australia and Puerto Rico. Vincente-Chandler et al. (1974) recorded liveweight gain of 1740 kg/ha for Brahman cattle on fertilized elephant grass pastures in Puerto Rico. Norman (1974) recorded liveweight gains of 2760 kg/ha on irrigated Pangola grass rotationally grazed by shorthorn steers at 12.4/ha.

At both the native pasture and clean seedbed pasture sites, liveweight gain per animal was lower at the higher stocking rate. Liveweight gain per head declined 23.3 kg at the native pasture site when the stocking rate was increased from 0.5 to 1 hd/ha and 14 kg at the clean seedbed site when the stocking rate was increased from 2 to

3 hd/ha. These represented a decline in per head performance of 46.6 and 7.0 kg/hd at the native and clean seedbed sites respectively. The reduction in livewieght gain per animal with increased stocking rate recorded at the clean seedbed site is similar to the 8 kg/hd/ha recorded in an experiment conducted under coconuts in Bali (Rika et al., 1981). The reduction in liveweight gain with increased stocking rate at the native site is lower than the 146.6 kg/hd recorded by Valenzuela (1978) on a native grass/Stylo pasture in the Philippines.

The animal performance recorded in these field experiments are low when compared with those from similar climates throughout the tropics. Major factors which determine the productivity from pastures are the control of pests and disease in both animal and pasture, grazing management, and climatic factors. In the experiments reported here, adequate control of plant and animal pests and diseases was achieved so this factor can be discounted as a major contributor to the poor performance. Set stocking grazing management was used in the experiments reported here. This grazing management was employed because it more closely represents that situation the prevails in communally grazed pastures. At the high stocking rates used at the clean seedbed site rotational grazing may be expected to increase animal performance. In a comparison of rotational and set stocking grazing management, Conway (1963) found that at high stocking rates rotational grazing gave significant increases in liveweight gain per hectare. At low/medium stocking rates no effect on animal performance was recorded.

Evidence that the major factor determining animal performance in these experiments was pasture quality rather than quantity, comes from a supplementation experiment that was conducted as part of the studies reported here (Till et al., 1991). In these experiments supplementation with rice bran molasses and urea fed at the rate of 0.5, 0.75 and 0.03 kg/hd/day respectively significantly increased animal performance by 85 kg/hd on the clean seedbed pastures stocked at 4 hd/ha.

The results presented from this study indicate that the sowing of legume into native grasses in this environment can lead to substantial increases in animal production per unit area but that per animal performance remains low.

Further gains can be achieved by combining these strategies with supplementary feeding such as that outlined above (Till et al., 1991). The economies of such gains will depend on the costs of fertilizers, pastures establishment and maintenance, the cost of supplements and the maintenance of animal health and the return on livestock, The inputs necessary to calculate the economic return from the system are to date unavailable.

The other important feature of the results of the present study is the need to maintain grazing experiments for sufficient time for residual effects of previous fertilizer and management inputs to be properly evaluated.

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