THE LIVEWEIGHT GAIN OF CATTLE AT PASTURE IN SOUTH SULAWESI SUPPLEMENTED WITH LOCALLY AVAILABLE BY-PRODUCTS

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Summary

Weaner heifers were set stocked at 4/ha on a grass-legume pasture in South Sulawesi, Indonesia, and either unsupplemented (Control) or for 338 days given daily supplements of one of, rice bran (RB) supplied at 1 kg/animal/d, molasses/urea (MU) or 0.5 RB + 0.5 MU (MURB) the amounts of which were adjusted to give similar energy intakes. There were 20 animals in each treatment. A drought resulted in low pasture availability for about half the supplementation period. The LWG per animal in the MURB treatment was 85 kg above that of the control and this was significantly greater ($p < 0.01$) than those for MU (62.0 kg) or RB (56.2 kg) although the economics favoured the gains from RB which returned over three times the cost of the supplement. Costs could be reduced by supplementing only at times of maximum undernutrition, but such a strategy is of doubtful value in this situation as there was no compensatory LWG and a similar rate of economic return was maintained throughout the period. The results suggest that additional benefits from the supplementation may be improved reproductive performance and more efficient use of pasture.
(**Key Words**: Cattle, Pasture, Supplementation, By-Products)

Introduction

The number of large ruminants in Indonesia has declined significantly over the past ten years. Of the many reasons for this decline, increased meat consumption and the rising demand for food crops are major factors. There are large areas of poor quality alang-alang (*Imperata cylindrica*) grasslands, some of which are the result of degradation by overgrazing and the "slash and burn" shifting agriculture, which have potential for improvement for livestock production. In small plot studies it was shown that some tropical legumes and fertiliser treatments could control alang alang (Blair et al., 1978). Preliminary results from studies on the effects of fertilisers and management on pasture productivity, plant community dynamics and cattle production (Till and Blair, 1982) showed that, on a per hectare basis, up to six times as much animal production could be obtained from pastures improved by oversowing with legumes relative to the natural pastures. However, the average annual liveweight gain (LWG) per animal was unacceptably low (< 0.3 kg/d) and peak rates of gain over a three-month period were only about 0.4 kg/d. The results suggested that the poor animal performance was most likely to be due to low quality of herbage rather than quantity. Samples collected from the rumen of the cattle in the trial showed low nitrogen levels (Leng and Till, unpublished) but gave no definitive answer as to whether the poor production was due to mineral, protein and energy shortages and/or imbalances. No detailed studies of the reasons for the poor animal performance have been made but the results presented in this paper describe attempts to increase cattle production by supplementing the pasture diet with locally available by-products.

Materials and Methods

Site

The experiment was sited on the Maiwa Ranch in South Sulawesi, Indonesia (119°48'E, 3°47'S) on hilly to undulating terrain with some steep

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Received December 21, 1989

Accepted January 14, 1991

jungle-filled gullies. In an attempt to increase cattle production some of this land was ploughed (1976) and sown with tropical legumes (Siratro, Centro and Stylo). Subsequent grazing and fertiliser mismanagement resulted in a loss of legume from the pasture such that by 1980 the legume content had declined to 36% with a further decline to 20% at the commencement of this experiment in 1982 (table 1).

In 1982 sixteen of the paddocks from a larger grazing trial were used for the supplementation trial described here. Eight 1.5 ha and eight 1.0 ha paddocks were selected to give four groups, with each group having a similar combination of previous treatments and containing two 1.5 ha and two 1.0 ha paddocks.

Animals

Weaner heifers (90-190 kg) were selected from a herd of seven-eighths Brahman cattle. The animals were weighed and sorted into eight groups of four, and eight groups of six, so that each group had a similar mean liveweight (LW) and range in LW. The groups were then randomly allocated to give a stocking rate of 4/ha and a total of 20 animals for each supplementation treatment. Preventative treatment was given at regular intervals for internal and external parasites.

The animals were weighed (unfasted) at intervals of six weeks.

At the conclusion of the supplementation period, animals were run in a single group with bulls fitted with chin-ball markers and the total number of animals in oestrus was recorded over three cycles.

Supplements

Supplements were obtained from local sources. The amount offered to each animal (table 2) was

TABLE 1. BOTANICAL COMPOSITION AND QUANTITY OF PASTURE ON OFFER

	Legume (%)	Grass (%)	Imperata and weed (%)	Feed on offer kg (green)/ha
January 1980	36	37	27	17,280
April 1982	20	10	70	15,740
November 1982	18	29	53	920
June 1983	42	35	23	3,900

TABLE 2. SUPPLEMENTS USED AND MEAN DAILY INTAKE OF CONSTITUENTS PER ANIMAL FOR EACH GROUP

Component	Supplement*		
	Molasses-Urea (MU)	Rice bran (RB)	Mol-U/Rice bran (MURB)
Digestible Energy (MJ/d)	13.4	14.2	13.8
Crude Protein (N x 6.25, g/d)	230	130	180
Fibre (g/d)	—	130	65
Ash (g/d)	100	130	115
Lipid (g/d)	—	150	75
Calcium (g/d)	17	18	9
Phosphorus (g/d)	15	16	8
Potassium (g/d)	60	20	40
Sulphur (g/d)	7.1	1.9	4.5

* Salt was available to all animals at 30 g/d.
C — Unsupplemented (control).
MU = Molasses (1.5 kg) + Urea (60 g) + triple superphosphate.
RB = Rice bran (1.0 kg) + limestone (42.5 g).
MURB = Molasses (0.75 kg), Urea (30 g), Rice bran (0.5 kg).

based on 1 kg rice bran per day which supplied approximately half the animal's daily energy requirement and would not be expected to reduce pasture intake substantially. The amounts of the other supplements were adjusted to supply a similar amount of energy. The supplements were molasses (M) and rice bran (RB). Molasses and RB have high and low Ca:P ratios respectively but when mixed in amounts containing approximately the same digestible energy, the Ca:P ratio is satisfactory (1.1:1). When fed separately the Ca:P ratio was adjusted to the value of the mixture by addition of ground limestone or triple superphosphate. A small amount of urea (4% W/W) was added to the molasses to ensure that the mixture (MU) contained sufficient N for microbial use of the energy supplied (Leng, pers. comm.). The composition of the raw materials varied slightly depending on the local source of supply and the mean daily intakes are shown in table 2.

The supplements were supplied daily, in long wooden troughs, to reduce competition between animals, and there were no unconsumed supplements.

Pasture

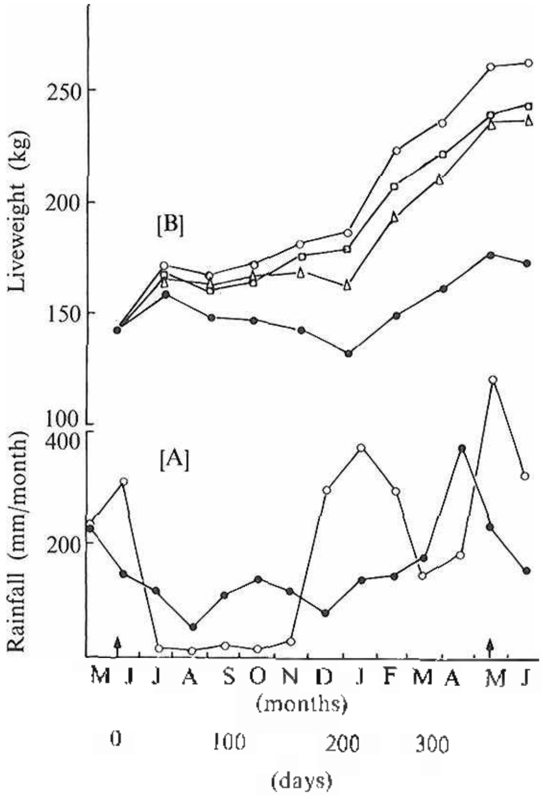
The amount and botanical composition of pasture on offer was estimated at intervals of approximately six months using a rank-score method ('t Mannetje and Haydock, 1963) modified as described in the MCPP report (1981).

Results

The experiment commenced in May 1982 under normal seasonal condition but unusually unreliable and low rainfall during the August-November period (figure 1A) resulted in severe drought conditions.

At each pasture sampling time there were no significant differences between treatments in the botanical composition of the pastures and the overall mean values are shown in table 1.

The drought imposed severe feed shortage on all groups of animals but those receiving supplements were better able to maintain liveweight (LW) (table 3) and those on the molasses/urea/rice bran (MURB) supplement only experienced one period of weight loss compared to five in the control group. The MU and RB supplements had varying effects during the year (figure 1B and table 3).



[A] Rainfall long term average (● – ●), this experiment 1982-83 (○ – ○).
[B] Control (● – ●)
MU (□ – □)
RB (△ – △)
MURB (○ – ○)
Period of supplementation ↑ ↑

Figure 1. Mean liveweights of animals measured at intervals of approximately six weeks. All supplements significantly better than controls ($p<0.001$). MURB significantly better than MU or RB ($p<0.01$) but MU and RB difference is not significant.

There was no significant difference in LW between replicates (four and six animals/plot), consequently, treatment means for LW and liveweight gain (LWG) are presented in figure 1B and table 3 respectively.

There was a substantial decline in the total

TABLE 3. MEAN LIVEWEIGHT GAIN FOR EACH SIX-WEEK PERIOD

Treatment	Time[1]								
	22	64	103	145	188	230	273	316	354
	LWG (g/d/kg$^{0.75}$)								
C	8.9	−6.3	−0.6	−2.2	−7.1	9.7	7.0	7.3	−3.2
U	11.4	−1.6	2.3	−1.0	3.1	14.8	7.5	9.0	0
RB	13.5	−3.8	2.2	3.4	1.0	12.6	6.0	7.3	1.5
MURB	14.8	−2.1	1.6	4.7	2.4	15.4	5.6	8.7	0.5

[1]Days after start of experiment to mid-point of weighing period. Supplementation ceased 338 days after the start.

quantity of pasture on offer during the experimental period (table 1) particularly between April and November, 1982, when rainfall was below average. There was no difference in pasture on offer and its botanical composition between the supplementation treatments, indicating little or no substitution of supplements for pasture.

Multivariate analysis showed a highly significant difference in LWG between the controls and all other groups ($p < 0.001$), and that the animals gained significantly better on the MURB than on RB ($p < 0.01$). There was no significant difference between RB and MU treatments.

The mean LWG in the first six weeks ranged from 386 g/d for the controls (C), to 659 g/d for those receiving the MURB mixture. Over the next three six-week periods all the unsupplemented animals lost weight because of the pasture shortage consequent upon the drought. After this there was some rain and during the next six weeks the C and RB supplemented animals lost weight while those on the other supplements gained. Pasture conditions continued to improve and all animals gained weight until the supplementation ceased after which the control animals again started losing weight. The highest liveweight gains recorded over any six week period were 395 g/d (9.7 g / d / LW$^{0.75}$) for the controls and 837 g/d (15.4 g / d / LW$^{0.75}$) for the MURB. For 60 days after supplementation ceased the proportion of the animals in each group that were regularly in oestrus and the group mean LW are shown in table 4.

Discussion

This experiment cannot resolve whether poor animal production of the unsupplemented cattle was due to limitations in the availability of protein, energy or minerals but it does show that positive responses can be obtained from modest amounts of readily available by-products. The highest observed rate of LWG, 837 g/d, is probably near the maximum that could be expected for an animal of this breed at about 220 kg.

Over the year, control animals at 4/ha gained about 30 kg while unsupplemented animals in a concurrent grazing trial gained 75 and 45 kg when stocked at two and three animals per hectare respectively. The combined results show the effect of stocking rate on the per animal production, but on a per hectare basis the range in LW gain was only 120-150 kg, which is less than one third of the gain by the MURB supplemented animals. These results suggest that no matter how low the stocking rate is the quality of the pasture would not be good enough to give LWG similar to that achieved by supplementation. Where pasture availability and/or digestibility are low, or where excessive water on the pasture limits intake by animals it would be expected that those receiving a supplement would maintain production better than those unsupplemented. The results supported this supposition but also showed that even when there was abundant pasture on offer supplemented animals had higher LWG than the controls. There was no compensatory weight gain on these pastures, again suggesting the limitation to production is pasture quality not quantity. There were variations in the botanical composition and amount of pasture on offer throughout the experiment (table 1). A visual inspection showed within and between treatment differences in the pastures but these were not quantified and were almost certainly due to variability in the site. In spite of these visual differences there were no differences between paddocks (replicates) in the LWG for any one supplement, which indicates that estimates of the capacity of a paddock to support animal production based on herbage availability estimates are subject to large errors in some tropical pastures. At the end of the supplementation there were differences between treatments in the percentage of animals showing oestrus (table 4), but because pregnancies were not confirmed and there were only 20 in each group the statistical significance could not be established. The low percentage of animals cycling in the control group

TABLE 4. EFFECT OF TREATMENT ON THE PERCENTAGE OF HEIFERS SHOWING OESTRUS AND THE MEAN LW OF EACH GROUP

Treatment	Cycling (%)	Average[1] LW (kg)
C	20	183
MU	50	247
RB	60	239
MURB	72	280

[1]Within each group there were no significant differences between the liveweights of the animals cycling and of the remainder in the group.

(20%) at a LW of 183 kg compared to over 50% at a LW greater than 247 kg in the other treatments suggests that the animals will be reproductively active at a LW similar to the 250 kg weight/oestrus relationship observed for Herefords (Cohen et al., 1980), and that an additional benefit from the supplementation would be earlier reproductive performance.

Difficulties in estimating the cost of operating a supplementation system and benefits that may emerge later, such as earlier maturity and increased frequency of calving, preclude an accurate economic assessment of the benefits of supplementation. However, an indication of the economic returns can be obtained by comparing the cost of the supplements with the value of the LW produced. Molasses and rice bran cost 85 and 35 Rupiah (Rp)/kg respectively and cattle were valued at about 750 Rp/kg LW. Using these figures the cost of supplement, on additional LWG and return are shown in table 5. Under the conditions of this experiment, the estimated return on LWG show a distinct cost advantage in favour of supplementation with RB. The cost of molasses varies and has been as low as 25 Rp/kg. The relative cost advantage using the 25 Rp/kg price is also shown in table 5. These costs, together with the ease of handling and relative feed value will determine which supplement or mixture is the most economic at any particular period.

During the time of severe pasture shortage the level of supplementation used in this experiment did not always prevent loss of weight. However, it is interesting to note that during the period 44-209 days, (figure 1B), the calculated returns on the supplements were: MU 1.39, RB 3.25 and MURB 2.24 times costs which are almost the same as those for the whole period (table 5). Consequently, although it may be possible to reduce total costs by strategic supplementation, the results showed that in this experiment a similar level of return on investment was maintained throughout the year.

TABLE 5. SUPPLEMENT COSTS, LWG, RETURNS AND FEED CONVERSION PER ANIMAL

Supplement	Total cost Rp (thousands)	LWG[1] (kg)	Return[2]	Feed conversion[3]
MU	43.1	62.0	1.08 (3.35)	5.7
RB	11.8	56.2	3.57 (3.57)	5.4
MURB	27.4	85.0	2.33 (4.76)	3.9

[1]Animals started at 144 kg and values shown are mean per animal excess over the controls after supplementation for 338 days.

[2]Calculated as value of LWG in excess of controls (750 Rp/kg) over cost of supplement. The figures in parenthesis show the result for molasses at 25 Rp/kg

[3]Feed conversion is the amount of supplement consumed divided by the corresponding LWG.

For beef cattle, a feed conversion value of six is good and the values in table 5, especially that for MURB (3.9), suggests that the supplement is also improving the pasture intake. Although not quantified the visual appraisal also suggested that the pastures of the MURB-supplemented animals were more uniformly grazed.

The supplements had similar total energy levels, but the superiority of the MURB suggests that there are some component(s) in the MU and RB that interact favourably to produce a better balanced diet. Phosphorus and calcium are unlikely to be implicated as both MU and RB had higher levels than MURB.

Further work is needed to evaluate other by-products for use as supplements and to investigate the components of MU and RB supplements that supported higher animal performance.

Acknowledgements

The study reported here was part of two bilateral Australian-Indonesian government aid projects - The Forage Research Project (ATA 201) and Project for Animal Research and Development (ATA 35). The authors wish to thank P. T. Bina Mulya Ternak for their support of this research which was carried out on their Maiwa ranch. We would also like to thank the staff of Balai Penelitian Ternak (BPT) Ujung Pandang, Professor Ron Leng for his valuable advice prior to the commencement of the trial and Dr. Ian Davies, University of New England, for his guidance with the statistical analysis of these data.

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