SUPPLEMENTARY FEEDING OF GRAZING BEEF CATTLE

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Summary

Some 60% of Australia's beef cattle are located in the tropics and sub-tropics, grazing, in general native pastures of low digestibility and N content. Production per head is low, as also are reproductive rates. The nutritional problem centres around the low contents of phosphorus, sulphur and nitrogen in pastures from June to December. This paper discusses responses in breeding cattle to supplements of protein meal, or to phosphorus when legumes have been oversown into native pastures.

Supplementation with protein meals improved reproductive rates in both Hereford and Brahman cross cattle but the growth of Hereford steers grazing native pastures from July to September was dependant on supplementation. At current prices, protein meal supplements can improve economic returns when only young breeding stock are supplemented.

I. INTRODUCTION

More than 60% of Australia% 23 million beef cattle graze pastures north of latitude 30°S, that is, in pastoral areas that are located in the subtropics and tropics. In general, cattle production per head is lower in these areas than from cattle in temperate areas of Australia. Consequently, because of the importance of cattle as a primary industry in Northern Australia, associated with the production problems, the discussion in this paper will centre on supplementation as it affects grazing beef cattle in the tropical areas.

By far the greatest proportion of beef cattle graze native pastures with little improvement from oversowing with legumes. Stocking rates are low, and in the wetter areas, from subtropical New South Wales to Northern Queensland, one beast per 4 ha is common. In such cases, pasture quality is the major constraint to improved animal production although in the drier, more drought-prone inland areas, pasture availabulity may be of greater importance. Typical data for northern Queensland Spear grass pastures near Townsville, are given for 1968 in Table 1 (Playne 1972).

Table 1. Dry matter yield and proximate analysis of a spear grass pasture, North Queensland (Playne 1972)

	Date					
	1 Feb.	7 Mar.	11 Apr.	16 May	10 July	10 Oct.
DM yield (kg/ha)	2160	5020	4810	4530	4360	4700
DM digestibility (%)	55	48	43	40	37	42
Nitrogen content (g/kg DM)	13	9	6	6	5	4
Phosphorus content (g/kg DM)	2	1	.8	.7	.5	.4
Sulphur content (g/kg DM)	2	2	1	.9	.8	.8

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Table 2. Dry matter yield and proximate analysis of a carpet grass pasture, Northern New South Wales (Grafton, Cohen 1978; Hennessy 1984)

	Feb.	Apr.	May	July	Sept.	Oct.	Dec.
DM yield (kg/ha)	4500	4050	3700	2800	2500	3000	3200
OM digestibility (%)	52	48	46	39	48	42	47
Nitrogen content (g/kg DM)	13	9	9	7	5	7	9
Phosphorus content (g/kg DM)	1	.8	.6	.5	.5	.4	.5
Sulphur content (g/kg DM)	1	1	.9	.8	1	1	1

At the peak of pasture quality (February), digestibility was between 52-55% and nitrogen content was c. 13 g/kg DM, values which are considerably less than spring values of grass-based pastures in temperate Australia. All values for digestibility, and the nitrogen and phosphorus contents, decline from February and are below the recommended requirements for maintenance and growth of cattle between May and November in the subtropics, and between April and December in the tropics. Of particular concern is the breeding cow. In the tropics, the normal practice is for uncontrolled mating with bulls having access to cows throughout the year with calves being born accordingly; the peak in calving time therefore depending on the previous wet season. With the poor nutritional conditions operating during the dry season, cows often calve only in alternate years. Consequently, annual reproductive rates are low (40-60%; Winks 1984). In the subtropics, the mating season is reduced, being from 12 weeks to 6 months. However, in this context because of the favourable market for weaner cattle from March to August producers attempt to supply young cattle by restricting calving between June and November, the period in which pasture quality is at its worst (Table 3).

Table 3. Seasonal growth pattern of unimproved pastures and cattle management, subtropical grasslands

	October-December	January-March	April-June	July-September
Pasture growth	New growth occurs following rainfall > 40 mm per month	Main rainy season, reliable growth	Pasture maturing. Frosts from May, showers	Matured pasture Frosts, days cool and dry
Quality	40-60% OMD 7-10 g N/kg DM	50-60% OMD 9-13 g N/kg DM	40-50% OMD 7-9 g N/kg DM	40-45% OMD 5-7 g N/kg DM
Cattle management and production	Main joining period, final phase of lactation	Reasonable liveweight gains in calves (0.5-0.75 kg/d) weaning from March	Weaned calves maintain liveweight	Calving and start lactation, liveweight losses in lactating cows (0.5 kg/d) and in dry stock (0.1 kg/d)

To illustrate the problem confronting a 400 kg pregnant, lactating cow grazing native pastures in the subtropics or tropics its requirements for energy, nitrogen, phosphorus and sulphur have been calculated (ARC 1980) and compared in Table 4 with the pasture contents given in Tables 1 and 2.

Table 4. Energy, nitrogen and mineral requirement of a pregnant 400 kg cow producing 4 L milk/d, the minimum content of nitrogen and minerals required to meet the requirements, and time of the year when this occurs, subtropics and tropics

	Requirements of a 400 kg cow, pregnant and lactating	Minimum content in pasture of ME 6.5 MJ/kg DM	Months available	
			Subtropics	Tropics
Metabolisable energy (MJ/d)	82	12.6 kg DMI	-	-
Nitrogen (g/d)	96	8	Dec.-May	Dec.-May
Phosphorus (g/d)	30	2.4	Insufficient	Insufficient
Sulphur (g/d)	7	0.6	All year	All year

Given that a cow can ingest 12.6 kg DM/day than calculations in Table 4 point to the importance of phosphorus and then nitrogen as being inadequate for the extra requirements of lactation and pregnancy. However, the responses of similar cattle to phosphorus supplementation has been variable.

II. SUPPLEMENTATION OF COMPONENTS

(a) Phosphorus supplementation

Phosphorus has long been recognised as a major essential mineral element for ruminants and is probably one of the most frequently given supplements to grazing cattle. Added to this is the feature that many of the soils in the subtropics and tropics of Australia are derived from a parent material that is low in phosphorus. Not only do low phosphorus soils support early maturing, low digestible'grasses but often they are senescent for up to half of the year, having especially low contents of nitrogen and phosphorus in this condition (Tables 1 and 2).

In spite of the low phosphorus contents in Australian pastures, the provision of additional dietary phosphorus has resulted in only small increases in growth and fertility of grazing beef cattle that could be attributed directly to dietary phosphorus (Cohen 1975; Winks 1984). This is because other factors, such as nitrogen,, are imposing a limitation on feed intake and responses to phosphorus supplements often occur in the wet season when the other factors are less severe. This comment applied to cattle grazing pastures on the non-calcareous soils of tropical Australia. However, on pastures on limestone-based soil types with wide calcium:phosphate ratios heifers have been reported as having low liveweight gains and developing rickets whereas other heifers on similr phosphorus intakes but lower calcium intakes grew normally (Theiler 1937). Responses to a phosphorus supplement given in the drinking water have been reported at Townsville (Gillard and Coates 1984). In this case, Droughtmaster heifers were grazing pastures containing *Stylosanthes* spp (cv. Verano and Seca) and *Urochloa mosambicensis*, either unfertilised or fertilised with 10 kg P/ha applied annually, or every second or fourth year. Supplements containing phosphorus were reticulated through the drinking water and the results for the first nine months are given in Table 5.

Table 5. The effects of phosphorus fertiliser or phosphorus supplements on liveweight gains (kg/nine months) of Droughtmaster heifers (Gillard and Coates 1984)

	Fertiliser applications	
Supplementation P rate	Nil	Annually/Biannually
Nil	80	130
Daily	150	156

Whilst compensatory gains can potentially negate the benefits of supplementation, over 12 months in the above study, the phosphorus supplemented heifers gained at a daily rate of 530 g compared with 260 g for the heifers not supplemented and grazing non-P fertilised pastures (D.B. Coates pers. comm.). Legumes comprised up to 40% of the pastures, irrespective of the fertiliser treatment, and the dietary forage intake of control heifers had wide ratios of calcium:phosphorus (17:1; D.B. Coates pers. comm.) which in this case predisposed them to hypophosphorosis (Cohen 1980). Ozanne et al. (1976) found that the voluntary intake of P fertilised forage was appreciably higher than that of supplemented unfertilised forage in sheep. The data of Gillard and Coates do not suggest that this was so in their experiment.

Low per cow production from carpet grass (*Axonopus affinis*) pastures in which a legume (*Aeschynomene falcata*) that persists well in low P soils has also been reported (Dicker and Garden 1984). Similarly, Kerridge and McLean (1985) have reported that animal production on low P soils was primarily related to P status of the pasture rather than to legume or grass productions. Responses to P supplements might occur in these situations where legumes allow higher Ca intakes by grazing cattle affecting P absorption (De Luca and Schnoes 1976) but where the legume provides little additional P to the grazing animal. Before costly P fertilisation is carried out it is necessary to determine whether there are differences between animal production of cattle grazing either fertilised pastures or when supplemented with P or S on unfertilised pastures (Hogan 1984), since the costs associated with supplementation would be lower.

(b) Dry matter (energy)

In the semi-arid inland areas of the tropics there are years and seasons within years in which forage is unavailable or is in short supply for cattle even lightly stocked. Under these conditions, supplementation for survival has to be considered, Generally, the aim is to supplement the breeding herd and to sell or agist non-breeding stock. Molasses and urea, with or without protein meals, was the most widespread and successful of supplements for cattle during the drought in Queensland from 1979-83 (Ernst and Wythes 1984). In the early phases of the drought, urea contents in molasses of 8% (w/w) were used in ad libitum feeding in central and north Queensland to restrict intake but this content was lowered progressively as pastoral conditions deteriorated. What has to be considered for the future is the reliability of supply of molasses in the light of "restructuring" of the sugar industry in Queensland and northern New South Wales, the economics and desirability of on-farm storage and the changes in price of molasses relative to grains, roughages and the capital cost of cattle. There is no economic incentive for supplementing cattle with grain to increase production when pasture is available and there is little evidence that this activity is practised in the tropics.

(c) Nitrogen or protein

The low nitrogen and protein contents of summer-growing grasses in the tropics and subtropics pose as the major limitation to animal production in these regions. More than 53% of tropical grasses reviewed by Norton (1982) contained less than 15 g N/kg DM nitrogen in the dry matter compared with 32% for temperate grasses, and as noted in Tables 1 and 2, unfertilised native grasses rarely reach this level at any stage of the year. This level if often used as a minimum level at which lactation and moderate growth can occur in young breeding stock.

For many years, intake and liveweight responses to urea or urea and molasses have been known from pen studies both in the north (Beames 1959) and in the south (Coombe and Tribe 1962). One of the earliest reported responses to molasses-urea supplements by grazing cattle occurred at Swan's Lagoon (near Townsville) (Winks et al. 1970). Part of the role of molasses was as a source of sulphur since sulphur supplements increased the intake of native grass hay (Kennedy 1974). The value of urea-sulphur dry licks was confirmed in the field (McLennan et al. 1981) and as a consequence graziers are encouraged to feed cattle these licks during the dry season (August-December) in preference to molasses-urea when standing forage is plentiful (Winks 1984). However, the feature of non-protein nitrogen supplements has been to reduce dry season mortalities (Winks 1984) rather than to increase production. Production responses, however, have occurred when protein meals have been offered to young grazing cattle during the winter or dry season (Burns 1964; Hennessy et al. 1981) although in some cases such gains might be negated by strong growth of cattle in the subsequent pasture growing phase.

Young lactating cows or heifers are the most vulnerable class of stock to the low intake of dietary nitrogen or protein that occurs each winter or dry season in the subtropics or tropics of Australia. At Grafton in a five-year study, output of saleable product (i.e. weaned calves) was increased by 135% with protein meal supplementation for 140 d during winter of each year (Hennessy [illegible]). As seen from the results in Table 6, pregnancy was increased markedly by supplementation and allowed an early joining of heifers (15 months-of-age) which was not possible in non-supplemented heifers.

Table 6. Liveweight at joining and pregnancy rate of Hereford heifers grazing native pastures, with or without protein meal supplements, Grafton 1978-83 (Hennessy 1984)

Age	Non-supplemented herd		Supplemented herd	
	Liveweight at joining (kg)	Calving rate (%)	Liveweight at joining (kg)	Calving rate (%)
15 mths	197	0	259	95
27 mths	263	58	292	60
3½ yrs	259	50	322	79
4½ yrs	329	67	378	100
5½ yrs	320	67	382	90

In addition, whilst only heifers were supplemented (800 g/d), or cows (maximum 1.5 kg/d), the weaning weight of calves was increased significantly each year (Table 7).

Table 7. Mean liveweight of calves at weaning (230 days), Grafton 1979-83

Year	Weaners from non-supplemented herd (kg)	Weaners from supplemented herd (kg)
1980	-	152
1981	120	162
1982	151	184
1983	146	192

The value of a protein meal supplement was attested to in a secondary trial on native pastures at Grafton. Thirty, 3-4 years-of-age Hereford heifers suckling their first calf were offered supplements of either cottonseed meal or a molasses-cottonseed meal-mineral mix, over 100 days from late winter to early summer (period 1), and 63 days in late summer (period 2) with the experimental period extending from September to May. Supplements were offered twice-a-week in open troughs, equivalent to a daily rate of 1.86 kg/heifer for the molasses mix* and 1.5 kg/heifer for meal. Brahman bulls were placed with heifers for nine weeks in each supplementation period and were rotated among paddocks every three weeks during the mating periods. Pregnancy was determined in any heifer at the end of both mating periods by ultrascan imagery (Vetscan®; B.C.F. Technology, Scotland)This technique can detect foetuses 28 days post implantation. The mean liveweight of heifers and the proportion pregnant are given in Table 8.

Table 8. Liveweight of heifers and the proportion pregnant at the end of supplementation periods for each treatment group, Grafton 1984-85

	Liveweight Period 1 (Dec.) kg	Liveweight Period 2 (Apr.) kg	Pregnancy Period 1 (Dec.) %	Pregnancy Period 2 (Apr.) %
Treatment group				
- Control	291	302	0	10
- Molasses mix	310	332	0	20
- Cottonseed meal	331	343	10	60

(d) Macro-minerals

Mineral deficiencies in grazing animals were reviewed by Siebert and Hunter (1982) and with particular reference to tropical pastures by Gartner et al. (1980). Playne (1970) reported low Na values for a number of tropical grasses (e.g. *Heteropogon* spp., *Urochloa* spp. and *Cenchrus* spp.) and legumes (e.g. *Macroptimium* spp.) and under these conditions lactating cows may respond to supplementation with salt licks. On the eastern Darling Downs, cows grazing native pastures had greater liveweight gains and weaned heavier calves when supplemented with salt (Murphy and Plasto 1973). In non-lactating cattle, few responses have been reported to salt supplementation in spite of finding low Na:K ratios in saliva, which is a measure of low sodium status in ruminants.

* molasses mix was 85% w/w molasses, 12.3% cottonseed meal, 1.7% urea and 1.0% monoammonium phosphate

(e) Trace elements

Responses to copper and cobalt supplementation have occurred in cattle grazing the coastal Wallum and wet tropics of Queensland (Gartner et al. 1980). Non-clinical hypocupraemia is commonly reported in coastal New South Wales but liveweight responses to copper supplementation rarely occur because of the overriding effects of parasites and general nutrition. However, the capacity of controlled release devices to provide elements (Ellis 1980) should play an important role in eliminating such deficiencies in grazing animals in the future (Siebert and Hunter 1982).

III. SUPPLEMENTATION OF DIFFERENT BREED TYPES

(a) Bos indicus

Improved growth rates of *B. indicus* x *B. taurus* cattle over *B. taurus* breeds have been reported in the tropics (Norman 1967 and Winks et al. 1977) and in the subtropics (Barlow and O'Neill 1978). Brahman x Hereford cattle are more productive than Hereford cattle on low quality pastures in the subtropics in terms of beef produced per 100 cows mated (Hearnshaw and Barlow 1984). In the Queensland tropics, 75% of females of breeding age contain *Bos indicus* blood (Anonymous 1983). Nonetheless, reproductive rates are still low.

(i) Tropics With judicious supplementation the low reproductive rates of *Bos indicus* cattle can be increased markedly as shown in a study at Swan's Lagoon. Brahman cross heifers were supplemented for 90 days from October with formaldehyde-treated cottonseed meal at a daily rate of 0.5 kg/head; The heifers were joined at 26 months of age in February which resulted in pregnancy rates of 92% compared with 57% for unsupplemented heifers (J.A. Lindsay *pers. comm.*). In the following season, supplementation (0.75 kg/head) was continued for 90 days and within the lactating heifers 75% of the supplemented heifers reconceived compared with 50% in the unsupplemented group (J.A. Lindsay *pers. comm.*).

(ii) Subtropics In a pilot study at Grafton during 1985, thirty 12-month old steers of three breed types (Brahman 260 kg liveweight, Hereford 220 kg, and Brahman x Hereford 235 kg) were compared during the winter when grazing native pastures and supplemented with 1 kg/head/d of urea-molasses (10% w.w) or 1 kg/head/d with cottonseed meal. The daily liveweight changes for each group during 60 days from July to September are given in Table 9.

Table 9. Liveweight change of steers of three breed types grazing native pastures and supplemented with urea-molasses or cottonseed meal, Grafton 1985

	Brahman	Hereford (g/day)	Brahman x Hereford
Non-supplemented	-450	-620	-345
Supplemented			
- urea-molasses	-160	-375	-320
- cottonseed meal	-100	125	40
Standard error ±	72	113	91

These data indicate the susceptibility of Hereford steers to weight loss during winter when grazing low N-low digestibility pastures. Conversely, the results also show the responsiveness of this breed type to protein meal supplements compared with the Brahman or first-cross steers. Brahman steers supplemented with cottonseed meal showed no advantage over those supplemented with molasses containing a high level of urea.

IV. EVALUATION OF SUPPLEMENTARY FEEDING PRACTICES

The foregoing has demonstrated the large production advantages to be gained from protein meal supplementation of cattle grazing pastures of low digestibility and low N content during winter. These advantages are of little value to beef producers unless profitability also is increased, either immediately or over a longer term. Hence, we have to assess the increases in the cost of inputs relative to the value of outputs. In this context it is relevant to examine the prices paid for cottonseed meal and prices received for Hereford weaners (160 kg liveweight) since 1978 adjusted to June 1985 values (Figure 1).

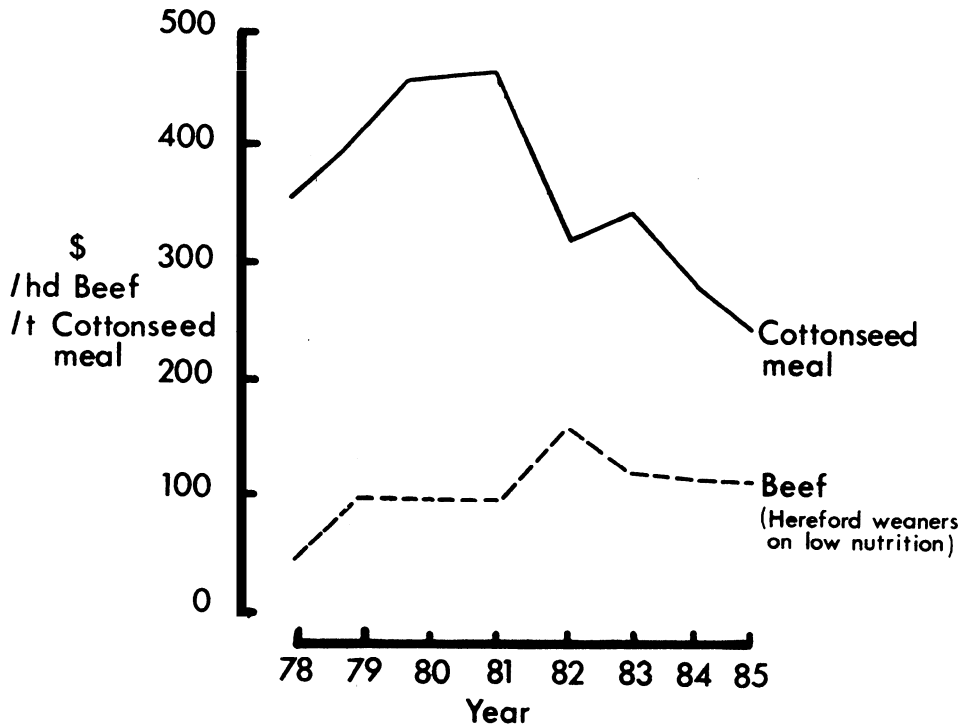

Figure 1. Prices paid for cottonseed meal and received for weaners, 1978-85, in 1985 values

Cottonseed meal prices have almost halved since 1980 with beef prices increasing, slowly, suggesting an increased incentive to increase production by providing cottonseed meal as a supplement. This can be compared in two budgets. The return from a property of 100 Hereford breeding cows is compared with the returns from that property when the heifers, and first-calf heifers are supplemented with cottonseed meal for 140 days through calving to the end of joining (80 days).

Table 10. Inputs and outputs for a 100 cow herd and the effects of cottonseed meal supplements on returns

	Inputs			
	Nil supplements		Supplements	
Breeding cows (no.)	100		100	
First joining (age)	2½		2½	
Last joining (age)	8½		8½	
Heifer replacement (no./year)	16		16	
Deaths (no./yr)	2		2	
Weaning rate (%)	52		60	
Weaning weight (kg)	126		133	
	Outputs			
	no.	$/hd	no.	$/hd
Steer weaners	23	123	27	139
Heifer weaners	6	110	11	131
Cast for age cows	7	220	7	220
Cull cows	7	220	7	220
Cottonseed meal	0	0	4.9 t	-220
Returns ($)	6569		7196	

Table 10 indicates that for prices prevailing in 1985, returns were increased by 9.5% by strategic supplementation of heifers and first-calf heifers. In retrospect, such a strategy in 1981 (see Figure 1) would have reduced the returns from the property. If the price trends evident in 1985 continue in future years, the supplementation would become an increasingly profitable management option. However, increased production comes largely from an increased voluntaryintakewhich for lactating cows can be 80% greater than for non-supplemented cows (Lee et al. 1985). Care is therefore required for careful grazing management such that vulnerable grass species are not eliminated from pasture through overgrazing.

V. CONCLUSIONS

Supplementation of grazing cattle with minerals, or nutrients, in shortest supply relative to production demands is an option available to producers in any year or series of years. In the subtropics and tropics there is inadequate intakes of nitrogen and protein by cattle grazing native pastures during winter for their growth and production. Protein meal supplementation, based on earlier results and using 1985 prices increased profitability; price trends suggest profitability might increase in subsequent years. Establishing legumes that survive on soils of low P content will increase N intakes in cattle but may predispose them to certain mineral deficiencies such as phosphorus. Under these conditions supplementation of specific minerals through the water supply appears to be a safe management approach and effective in increasing animal production.

VI. ACKNOWLEDGEMENTS

I wish to thank D.M. Vernon, Senior Economist for the use of Figure 1 and the budgets in Table 10.

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