RESPONSES OF BEEF CATTLE TO SUPPLEMENTS OF PROTEIN OR NON PROTEIN NITROGEN WHEN GRAZING NATIVE PASTURES OF THE NORTH COAST OF NEW SOUTH WALES

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SUMMARY

Five experiments are reported in which young growing or breeding cattle were offered supplements which contained non protein nitrogen (NPN) or protein during winter when grazing carpet grass pastures. Significant and economic increases in growth were obtained when a slowly degradable protein pellet (cottonseed, meat and fish meals) was offered twice-a-week when available pasture was in excess of appetite. Increased calving % and reconception, as well as increased weaning weight of calves, were recorded when protein pellet was offered to young breeding stock. A smaller but significant response occurred in another experiment when the more degradable linseed meal was offered. In one experiment, a NPN supplement improved calf weaning weight but not cow liveweight or fertility; in another, molasses plus NPN had no significant effect on cattle production.

INTRODUCTION

Beef production in northern coastal New South Wales is based on herds grazing unimproved pastures. These pastures are dominated by summer-growing grasses, many of which have the C4 photosynthetic pathway. This pathway gives the plants an advantage over those with the C3 pathway in dry matter growth during the summer months (600 mm rainfall, temperature range 15-40°) but, the material resulting from such growth has characteristics which permit only relatively low intakes by the grazing animal (Wilson and Minson 1980). However, the north coast is not truly a tropical environment which best suits the C4 grasses. In particular, the Clarence district has two other features which impose upon the summer environment in which most plant growth occurs. Firstly, the soils are derived from sandstone and shale parent material, are poorly draining and low in organic matter, nitrogen and phosphorus. This has enabled the predominance of carpet grass *(Axonopus affinus)* which can grow with competitive vigour under these conditions. At best, this grass provides a forage which has 52% digestibility and 1.5% N (organic matter basis) (Cohen 1978).

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Secondly, the district experiences a winter period, similar to temperate regions. During this period, temperatures range from -2 to 23° and frosts, fogs, heavy dew and rain occur. Under these conditions 'mature C4 plants and others persist in pastures as frosted, dead material which provide a forage with a digestibility as low as 34% and N as low as 0.4% (Cohen 1978). Therefore, the basic problem which cattle face during winter is whether they can meet their nutritional requirements from the base pasture. All surveys show they cannot,, but it is not clear whether one or more nutrients are responsible for poor production during winter. It is the. objective of this paper to discuss the findings of a number of grazing trials conducted on carpet grass pastures and in which cattle received supplements to assess which nutrient most limits production.

MATERIALS AND METHODS

Experiment 1: Ninety, three-year-old Hereford heifers were allocated to two groups and rotated between two 100 ha paddocks in the experiment reported by Want and Mears (1980). The pasture grazed was dominated by carpet grass with patches of blady grass. One' group of heifers was offered a commercial supplement which contained non protein nitrogen (NPN), minerals and molasses distillers solubles. The other group was not supplemented. From August the supplemented group had estimated intakes of NPN of 12 g N/head/day, which was restricted to 4 g N/head/day in April, and increased to 5 g N/head/day in July. One month after exposure to supplements (September) the heifers were joined to bulls, and again in the following spring.

Experiment 2: One hundred and twenty-nine Shorthorn x Devon heifers in the experiment of Sparke and Lamond (1968) were selected and classified' into four groups, based on ± 7 days of a mean birth date. Half (from 9-27 heifers) of each group was offered a supplement of linseed meal (33% crude protein) whilst all heifers grazed together on unfertilized carpet grass pasture. Supplemented heifers received equivalent daily rates of 520 g/head for 140 days during winter of the first year, when they were joined to bulls, and 170 g/head/day during the second year when'lactating'and pregnant, and 780 g/head/day during the third year.

Experiment 3: Seventy-two pregnant Angus cows and heifers were set to graze as four groups within five paddocks,' each of 40 ha of a carpet grass-dominant pasture in the experiment reported by Cohen (1976). In June, herds were given supplements of either, 1) nil 2) 10 g phosphorus (P) and 50 g molasses 3) 500 g molasses, 50 g urea and 10 g P or 4) 450 g linseed meal and 7 g P. Molasses was offered through a roller drum, and linseed meal in an open trough, both of which were raised to prevent access by calves. Supplements were offered twice-a-week over two years in which calving occurred twice.

Experiment 4: Thirty-six Hereford steers were allocated to four treatment groups and set grazed a carpet grass-dominant pasture in 12 paddocks in the experiment reported by Hennessy et *al.* (1981). A group wa's 'offered for 140 days from June either 1) a mineral supplement daily 2) 600 g/head/day of a pelleted protein meal mix 3) 2100 g/head/3.5 days of the pelleted meals and 4) 560 g/head/day of pelleted cracked sorghum grain. From late November, supplementation of group 3 continued until late March when the cattle were removed and set to graze on improved pasture for 12 months.

Experiment 5 : Forty-four Hereford heifers of 200 kg live weight were divided into three replicated groups and set to graze the carpet grass pasture area vacated by steers from experiment 4. From June, heifers were offered 1) access to a mineral supplement 2) 2800 g of the pelleted protein meal mix (see experiment 4) every 3.5 days and 3) same supplement as for group *2.* In November, bulls were placed with heifers of groups 1 and 2 for nine weeks at the end of which supplementation ceased.' In the following July, supplementation for groups 1 and 3 recommenced as for the previous winter. Only heifers in group *2* which were pregnant were supplemented; the non-pregnant heifers being given access to a mineral supplement. Supplementationin group *2* was on the basis of 1.6 g pellet/kg$^{0.75}$ liveweight. In Ndvember of the second year, all heifers were placed with bulls for mating. In the third year supplementation recommenced in July for pregnant cows on the basis' of. 16 g pellet/kg$^{0.75}$ liveweight, up to a maximum of 1.4 kg/head/day. Weaning was in March when calves were 200 days of age.

RESULTS

Experiment 1: At the end of the first 12 month of supplementation (June 1976) , cows were similar in liveweight (333 kg) to those unsupplemented but they weaned calves that were 12 kg heavier (97 v's 85 kg) than calves from unsupplemented cows. At the end of the second 12-month-period, supplemented cows were 13 kg heavier ($P<0.05$) and again had weaned heavier (98 kg v's 87 kg) calves than unsupplemented cows.

Experiment 2: Heifers that were supplemented with linseed meal during . the winter-period of three years were significantly ($P<0.01$) heavier and weaned more calves than unsupplemented heifers. Results of the final two years, 'when heifers were pregnant or lactating at joining are shown in table 1.

Experiment 3: There were no significant differences between groups of cows in mean live weight. However, mean maxima declined from 445 kg/ cow in June of the first year to 402 kg in the second year and 392 kg at the trial conclusion in March of the third year. Fertility was not changed significantly by supplements although there was a trend to higher percentages for calving when at least 7 g/day of phosphorus was included in the diet. However, calves when weaned from cows supplemented with linseed meal were significantly ($P<0.05$) heavier (13 kg) than calves from unsupplemented cows. However, this 13 kg advantage was lost shortly' after weaning due to more rapid growth of unsupplemented calves.

Experiment 4 : Protein meal supplements significantly ($P<0.01$) increased the live weight of young steers at the end'of their first winter, and the summer following, with the advantage persisting for a further 12 months after steers were placed onto an improved pasture. Results are presented in table *2.*

Experiment 5: As in experiment 4, live weight during the first winter of the heifers was increased substantially by supplements and this increased live weight enabled all heifers to be in oestrus during the joining . period of the first year. In contrast, only 20% of unsupplemented heifers cycled during their first year and none bacame pregnant (table 3). . Protein supplements to lactating heifers improved the weaning weight of calves (table 3) and the proportion of the group which went back into calf. Results are presented in table 3.

TABLE 1. Liveweight of supplemented and non-supplemented heifers at joining, and proportion of heifers becoming pregnant. Sparke and Lamond (1968).

	Supplemented				Non-supplemented			
Age group	A	B	C	D	A	B	C	D
Year 2								
Age at joining (mo)	20	19	18	17	20	19	18	17
live weight (kg)	236	203	208	178	165	147	153	132
pregnancy from joining (%)	74	60	50	22	4	0	0	0
Year 3								
Non-lactating								
live weight (kg)	336	295	272	249	278	249	227	204
pregnancy from joining (%)	100	100	100	100	92	77	71	17
Lactating								
live weight (kg)	280	249	227	204		0	0	0
pregnancy from joining (%)	44	22	0	0	0	0	0	0

TABLE 2. Mean live weight of young steers at the end of three consecutive periods

	i) At 140 days + supplement	ii) 130 days + supplement to one group†	iii) 290 days grazing, no supplement
	carpet grass pasture		improved pasture
	Live weight (kg)		
Control	160^{a}	198^{a}	317^{a}
Protein daily	229^{b}	250^{b}	356^{b}
Protein twice-a-week	216^{b}	$265^{b\dagger}$	357^{b}
Sorghum	174^{a}	209^{a}	
S.E. ±	4	5	12

Means within a column with an unlike superscript differ significantly ($P<0.01$).

TABLE 3. Live weight and proportion of heifers calving, and the weaning weight of their calves, when offered a protein supplement during the winter of consecutive years.

	Year			
	1978	1979	1980	1981
Joining live weight (kg)				
Controls	188	254	265	
Supplemented - 15 month joining (EJ)	247	300	330	
- 27 month joining (LJ)	247	361	390	
Calving				
Control		0	67	37†*
Supplemented - EJ		91	62†	64†*
- LJ			67	100†*
230-day calf weaning weight				
Control			0	119
Supplemented - EJ			150	160
- LJ			-	185

† as a percentage of previously lactating heifers or cows.

* as diagnosed at day 130 pregnancy.

DISCUSSION

The experiments have indicated clearly that additional protein in the diet of young cattle grazing carpet grass pastures, which are typical of much of the unimproved grazing land of north coastal New South Wales, improves live weight, and therefore fertility in heifers. However, it is not clear whether the totality of response is due to bypass protein or whether some response is due to soluble protein, minerals or other nutrients contained in the supplements. For example, there is a suggestion from the data of Cohen (1976) that low intakes of phosphorus may be responsible for some of the infertility in cattle. P supplements improved bone strength and skeletal P content in the cows of experiment 1 as reported by Want and Mears (1980) and may have allowed the expression of a higher milk production, but overall it is doubted whether P supplements to cows on these pastures would stimulate voluntary food intake and therefore production, because of the limitation imposed by low N intakes (Cohen 1972).

Small responses to a commercial supplement in which most of the N was in a non protein form occurred in the experiment of Want and Mears (1980) The cows received *ca* 5 g N/head/day and because only calves benefited it was assumed that milk production, was increased. Cohen (1976) reported a similar advantage to calves (13 kg at weaning) when cows were fed 450 g/head/day of linseed meal which supplied 24 g N, and again assumed that milk production was increased. The two nutritional factors that are most likely limiting milk production are energy and protein (Clark and Davis 1980). It is somewhat surprising therefore that responses in experiment 3, with linseed meal, were not greater than in experiment 1 in which little energy and mostly NPN as N, were supplied in a lick form. However, calves in experiment 3 were up to 180 kg at weaning compared to only 98 kg in experiment 1 which suggests that the nutrition from the pasture was better in the linseed meal experiment and also that mature Angus cows, which previously had grazed improved pastures, were used in the study.

Supplements of protein meal at pasture in experiments 2, 4 and 5 showed the benefits to growth for weaner cattle. For heifers in their first year, live weight increase-during winter was 270 g/day for those getting 520 g/head/day of linseed meal compared with 55 g/day for unsupplemented heifers (experiment 2). In experiment 4 supplemented steers grew at 370 g/day versus a 70 g/day loss in unsupplemented steers during winter and in experiment 5, supplemented heifers grew at 500 g/day compared to daily losses of 40 g in unsupplemented heifers. Food conversion ratios of supplement eaten:extra gain were 2.4:1 (experiment 2) and 1.5:1 (experiment 4 and 5); the differences due probably to differences between quality of protein meal and quantity of pasture available. Sparke and Lamond (1968) pointed out that pasture available was restricted in their experiment. because of the effects of drought. From unpublished data, we know that voluntary feed intake can be increased by 15-110% by adding up to 800 g/day of the protein meal, as used in experiments 4 and 5, to low quality hay rations for penned cattle. Because of the importance of protein in appetite control (Egan 1965) it is essential that there is' excess available pasture to allow expression of appetite when the protein restriction is removed:

The important consequence of removing the primary nutrient deficiency, by adding protein to the diet, is increasing liveweight and enabling the heifers to reach sexual maturity. In the case of experiment 5, 91% of heifers calved to a 15-month-old joining when supplemented, compared to 67% when unsupplemented and joined at 27 month. In experiment 2, from 22-74% of supplemented heifers became pregnant when joined at 17-20 months, whereas only 0-4% of unsupplemented heifers became pregnant.

The second consequence is in increasing pre-weaning growth of calves, presumably due to increased milk production. In experiments 1 and 2 it was a 13 kg gain. In experiment 5, it was a 30 kg gain.

The third consequence of removing the dietary restriction of protein is to maintain or reduce liveweight losses during lactation so that the heifer can go back into calf the following season. This is quite a problem in the northern coastal area of New South Wales. From experiment 1, it can be se'en that at liveweights of 280 kg only 44% of lactating heifers reconceived. In experiment 5, 62% of heifers at a mean liveweight of 300 kg reconceived, and 64% at a liveweight of 330 kg. Mature liveweights of lactating Hereford cows grazing carpet grass pastures, rarely exceed 350 kg (H. Hearnshaw *pers. comm.*) so that for these cattle, breeders should not 'expect greater than 64% reconception . unless they remove the nutritional restriction due to inadequate dietary protein.

The question asked now is as to whether protein or N or perhaps energy or minerals are the primary limitation to growth and production by cattle grazing carpet grass pastures innorthern New South Wales. An energy supplement, in the form of sorghum grain (+ minerals), (8.5% crude protein) did not alleviate the nutritional problem and in fact the supplement reduced voluntary intake of low quality forages by steers in pens (D.W. Hennessy, unpublished data). There is sime evidence, however, that P may be first-limiting in milk production, particularly during winter when intake of hay declines due to drop in protein content, and the P content of pasture drops below 0.05% (Cohen 1972). It then comes to the point that N or protein is the major limitation to production and what form of N is the most -effective or economic way to supplement cattle on carpet grass.

Non protein forms of N have not been assessed rigidly for their use with cattle grazing carpet grass pastures; In experiment 1, NPN did not improve liveweight of cows which had access from 4-12 g N/head/day. Nor did NPN improve Iiveweight of cows or calves in experiment 3 when cows had access to 23 g N/head/day. The ineffectiveness of NPN is probably a function of its very rapid solubilizing in the rumen together with the inability of the rumen fermentation to supply sufficient quantities of ATP to bacteria to metabolize much of the ammonium substrate. Under these circumstances much 'of the ammonia would be absorbed and excreted as urea in urine. We must not forget also that protein meals are not just a source of pre--formed protein but also a source of energy , in terms of readily or slowly fermentable starch, and of minerals. Sources of protein meals differ in their degradability in the rumen. One of the reasons for the poorer growth responses in experiment 2, compared with those in experiments 4 and 5 may be related to the degradability characteristics of the protein meal. Linseed meal is relatively unprotected (Ferguson 1975) compared to the pelleted meal used in experiments 4 and 5 (D.W. Hennessy, unpublished data) which was based on cottonseed, meat and fish meals. Depending on the degradability characteristics of the basal forage, twice-a-week feeding of linseed meal may be a less efficient way of increasing protein supply to the duodenum then a more frequent feeding of the meal. On the other hand, little penalty was attached to feeding protein meal pellets twice-a-week in experiment 4.

In conclusion, it would appear that young or lactating British breed cattle grazing carpet grass pastures suffer growth restriction because of a restriction on the supply of protein in the intestine, due to low dietary intakes. Because of the inherent low digestibility of the pasture, and presumably slow rate of fermentation, soluble forms of protein or NPN, when given infrequently to the grazing animal do not increase the supply of protein sufficiently to improve growth. Under these conditions, slowly degradable forms of protein, as used in experiment 4 and 5, appear to offer the best scope for improving growth and fertility of young and lactating cattle. However, the profitability of feeding young cattle for growth depends on prices for livestock and is independent of the cost of protein meal between prices of $250-350/ tonne. For these prices, profitability of slaughter cattle is increased when cattle prices exceed $75 ¢/kg liveweight, and for feeding to breeding cattle when prices exceed 94¢/kg liveweight (Smith and Hennessy 1981).

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