
VOLUME 62 2002

Grain supplementation of finishing beef cattle

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ABSTRACT

Low pasture quality in summer-autumn and feed deficits during winter are major constraints to achieving consistently high growth rates in beef cattle finishing systems. Two experiments were run to investigate the tactical use of grain supplementation as a tool to overcome performance constraints during these seasons.

The first experiment was conducted during January-March (8 weeks) and involved 4 supplementation treatments: 0, 2, 4, and 6 kg grain supplement/hd/d. The second experiment was conducted during July-August (8 weeks) and also involved 4 supplementation treatments: 0, 1, 2, and 4 kg/hd/d. Rising 2 year steers were used in these experiments and pre- and post-grazing herbage masses were similar for all treatments within each experiment. During the summer experiment, steer liveweight gains were 0.05, 0.43, 0.65 and 0.80 kg/hd/d for the 4 supplementation levels respectively. During the winter experiment, average liveweight gains were 0.89, 1.08, 1.30 and 1.35 kg/hd/d. After grain supplementation ceased, liveweight advantages were eroded by compensatory gain occurring in the lower supplementation treatments.

The average liveweight response to grain was similar in both experiments (0.18 kg liveweight gain/kg DM supplement), but was highest and most consistent at the 2 kg/hd/d supplementation rate. Acidosis was evident in 1 replicate of the highest supplementation treatment in each experiment. The use of a grain supplement can give reliable weight gain responses and could be valuable as a tactical tool to ensure that time and market bound supply contracts are fulfilled during difficult seasons. The use of this practice in systems that supply to commodity markets is unlikely to be economic.

Keywords: beef cattle; pasture quality; grain supplementation; liveweight gain.

INTRODUCTION

Within most New Zealand beef finishing systems there are 2 seasons during which it is difficult to achieve satisfactory and/or predictable growth rates of cattle. These are late summer, when pasture quality limits animal performance and winter, when pasture quantity is limiting (Nicol and Nicoll, 1987). For farmers to be able to plan and enter into supply contracts with some certainty, there must be a knowledge of their normal performance during these seasons; and also an understanding of the options available to improve that performance, should targets not be obtainable.

There has been considerable research into grain supplementation to beef finishing cattle which are concurrently grazing pasture (Perry *et al*., 1972; Griebenow *et al*., 1997). However, because of a focus on either drought feeding or feedlot finishing the applicability of this research is unknown for the pasture conditions encountered in New Zealand beef finishing systems.

A study was conducted to explore the strategic use of grain to eliminate energy deficiencies and reduce seasonal variations in production within a beef finishing system.

MATERIALS AND METHODS

Treatments

Two experiments investigating grain supplementation of beef cattle were run at Whatawhata Research Centre during 1997. The first experiment was conducted from 13 January to 10 March (8 weeks) and involved 4 supplementation treatments: 0, 2, 4 and 6 kg of grain supplement/hd/d. Two replicates were used in the experiment, but they differed in pasture quality due to previous grazing management. The second experiment also ran for 8 weeks from 30 June to 26 August. Treatments were: 0, 1, 2 and 4 kg grain supplement/hd/d and there were 2 replicates. These replicates had similar conditions of pasture quality and quantity.

Stock and grazing management

Three weeks before the start of the first experiment, 18 month steers (progeny of Simmental bulls and Hereford x Friesian cows) were randomised into 8 mobs. Three weeks before the start of the winter experiment, these same steers (as rising 2 year olds) were re-randomised into the 8 mobs required. There were 12 and 11 steers per mob for the summer and winter experiments respectively. The experiments were run on rolling hill country (5 - 25 degree slope). Paddocks were categorised into sets according to slope and aspect and then allocated for use in 2 weekly time periods. Grazing during both the summer and winter experiments was managed so that the pre- and post-graze pasture masses did not differ between either replicates or treatments. Because pasture substitution occurred as a result of grain supplementation, smaller land areas were allocated to the supplemented treatments. Paddock grazing durations averaged 3.5 days.

Grain feeding

Rolled maize was used as the principal component of the grain supplement (88% DM, 13.5 MJ ME/kg DM; 8.5% crude protein). During the summer experiment, heat treated soybean meal (13.6 MJ ME/kg DM; 51.5% crude protein) was added to the ration to ensure protein was not limiting. The soybean meal made up 10% of the ration by dry weight, thereby increasing the feed ration to 12.9% crude protein. Protein was not added during the winter experiment as levels in the pasture were considered high enough to ensure no likely limitation to animal growth. To assist in the control of acidosis, virginiamycin was added at 40 g/tonne of supplement for both experiments; and sodium bicarbonate (at 1.5%) was added during the introductory periods. Limestone flour was also added at 1% throughout the experiment.

Before the start of both experiments a 2 week introductory period was conducted where cattle were initially introduced to the feed at 1 kg/hd/day. This rate increased by 0.5 kg every day during the summer and every 2 days for the winter experiment until final supplementary feeding levels were reached. Grain was fed in troughs and residue left after 24 hours was removed and weighed.

Observations of grain consumption were made every alternate day during the introductory period and weekly during the experimental periods. These involved observing and recording which animals were consuming grain immediately after grain was offered at 1 minute intervals until all grain was consumed or up to a maximum of 15 minutes.

Measurements

Pre- and post-graze pasture masses were measured for each grazing using calibrated, visual estimation techniques. Pastures were sampled to ground level for pre- and post-graze conditions and then dissected into green leaf, dead leaf and stem fractions. Dissected fractions and undissected bulk samples were analysed for energy and protein by NIRS feed analysis (Ulyatt *et al*., 1995). Pre-graze herbage was also sampled by plucking pasture to intended grazing height in order to simulate cattle intake and analysed by NIRS. During the winter experiment these same samples were also assessed for total non-structural carbohydrate content. Apparent pasture intakes were estimated by herbage disappearance calculations plus pasture growth. During the winter experiment, soil treading damage was also measured and pasture mass trodden into the soil during grazing was estimated (Sheath and Boom, 1997) and used to adjust apparent intake.

During the experiments, steers were weighed fortnightly. The start and finish weights were a double weigh, 3 days apart. At the completion of the summer supplementation period, the steers were randomised into 4 grazing groups for assessment of carry-over compensation. This compensation period lasted 90 days. At the completion of the winter experiment, steers from the second replicate were slaughtered while the other was randomised into 4 grazing groups and grazed a further 65 days.

RESULTS

Summer experiment

Pasture conditions (i.e., mass and quality) during the summer experiment are given in Table 1. Taking into consideration the pre-graze masses and allocated areas, average pasture allowances ranged from 4.84 kg DM/100 kg Lwt/d for the no grain treatment to 2.85 kg DM/100 kg Lwt/d for the 6 kg grain treatment. While average values are presented replicates differed in terms of quality, i.e., 54% and 35% green leaf fraction in replicates 1 and 2 respectively. From an energy and crude protein perspective, this resulted in pre-graze ME values of 10.6 and 9.9 MJ/kg DM and protein levels of 15.9% and 13.2% for the 2 replicates.

TABLE 1: Mean pasture mass (kg DM/ha) and green leaf herbage fractions (%) for the summer and winter experiments

Grain Treatment	Pre Graze Mass	Post Graze Mass	Pre Graze Green Leaf	Post Graze Green leaf
Summer Experiment				
0	4386	2255	44	29
2kg	4280	2218	45	29
4kg	4170	2213	45	31
6kg	4193	2260	45	34
SED	68	39	1.7	0.4
Winter Experiment				
0	2536	1036	90	83
1kg	2572	1053	90	82
2kg	2572	1057	90	84
4kg	2513	1050	89	84
SED	41	18	0.8	1.9

During the summer experiments except for the 6 kg treatment, apparent pasture intakes were higher in replicate 1 (Table 2). This would be expected given the higher pasture quality of this replicate. Pasture intakes decreased as grain supplementation increased, leading to an average pasture substitution rate of 0.79 kg DM for each kg DM of grain supplemented. During the latter half of the summer experiment, signs of acidosis were noticed in the 6 kg treatment of replicate 1. The result of this condition is evident in the grain consumption observations (Table 3) affecting their consumption of both grain and pasture.

Given the pasture conditions during the summer experiment, steer growth rates for the no grain treatments were low and matched expectations. The generally lower performance of replicate 2 cattle reflected lower pasture quality, but this did not cause any significant interaction with the response to the grain treatments. The effect of acidosis in the 6 kg, replicate 1 treatment is clearly evident by the relatively lower growth rate. Overall the liveweight gain response (LWG-kg/d) to supplementation (S-kg grain/d) can be described as:

$$LWG = 0.04 + 0.20\ S - 0.013\ S^2 \ ...\ r^2 = 0.56$$

During the supplementation period, the average liveweight response to supplement consumed was 0.17 kg Lwt/kg DM supplement. Once supplementation ceased liveweight gain was inversely related to supplementation rate. After 90 days, only the liveweights of the no grain treatment remained significantly different than the other treatments.

TABLE 2: Apparent pasture and grain intakes and liveweight responses in the summer and winter experiments.

Grain Treatment	Pasture intake kgDM/hd/d	Grain Consumed kgDM/hd/d	Pasture Subsituion kgDM/kgDM Grain	Treatment Lwt (kg)	Treatment LWG (kg/d)	LWG/kgDM Grain	Carryover Lwts (kg)	Carryover LWG (kg/d)
				Summer Experiment				
Rep 1, 0	10.8	0	–	422	0.16	–	445	0.23
2kg	8.6	1.8	1.24	440	0.46	0.17	457	0.13
4kg	7.6	3.5	0.89	452	0.62	0.15	466	0.12
6kg	5.5	5.2	1.01	451	0.71	.10	460	0.08
Rep 2, 0	9.2	0	–	407	–0.05	–	428	0.25
2kg	8.4	1.8	0.43	431	0.37	0.24	447	0.23
4kg	6.9	3.5	0.63	446	0.60	0.18	449	0.06
6kg	6.1	5.3	0.56	461	0.89	0.18	453	-0.01
Rate SED	0.68	–	–	3.8	0.06	–	4.7	0.04
RatexRep SED	–	–	–	5.4	0.08	–	6.6	0.05
				Winter Experiment				
Rep 1, 0	10.4	0	–	506	0.88	–	608	1.57
1kg	11.2	0.9	–0.86	527	1.16	0.32	613	1.33
2kg	10.7	1.8	-0.15	537	1.34	0.26	615	1.22
4kg	8.5	3.5	0.55	528	1.21	0.09	606	1.22
Rep 2, 0	10.9	0	–	507	0.90	–	–	–
1kg	10.5	0.9	0.45	514	1.00	0.11	–	–
2kg	9.7	1.8	0.61	532	1.26	0.20	–	–
4kg	9.1	3.5	0.53	545	1.48	0.17	–	–
Rate SED	0.51	–	–	4.0	0.07	–	7.3	0.09
RatexRep SED	–	–	–	5.7	0.10	–	–	–

Winter experiment

Pastures in the winter experiment were of high quality, i.e., 90% green leaf fraction, 11.3 MJ ME/kg DM, 13.4% total non-structural carbohydrate content and 25% crude protein (Table 1). Average pasture allowances ranged from 4.0 kg DM/100 kg Lwt/d for the no grain treatments to 3.3 kg DM/100 kg Lwt/d for the 4 kg grain treatments. Apparent pasture intakes were not as strongly influenced by supplementation as in the summer experiment, with average pasture substitution being 0.19 kg pasture DM/kg DM supplement.

Except for the 4 kg treatment in replicate 1, liveweight gain increased as the level of supplementation increased. Signs of acidosis were noted in this treatment. The relationship between liveweight gain and supplementation was:

$$LWG = -0.17 + 0.26\ S - 0.015\ S^2 \ ...\ r^2 = 0.73$$

Overall, the average liveweight response to the amount of supplement consumed was 0.19 kg Lwt/kg DM. Again, once supplementation ceased, liveweight gain was inversely related to supplementation rate so that by the end of the 65 day carry-over period, no significant liveweight differences remained between the previous supplementation treatments.

Acceptance of supplements

A relative measure of the acceptance or rejection of supplements by individual animals was made during the introductory and treatment periods (Table 3). In both experiments, the levels of acceptance achieved by the second introductory week were generally maintained through the subsequent treatment periods. The exception was in the highest supplementation treatment of the summer experiment where acidosis caused an increase in rejection rates towards the end of the treatment periods.

These results would suggest that at any one time approx. 20% of animals were not consuming grain. In most cases these were animals that had stopped consumption for a short duration only. Over the experiment there were only 3 steers that showed near complete rejection of supplement. These were all within either the 1 or 2 kg treatments where aggression at feeding was high.

TABLE 3: Relative acceptance of supplements by individual animals (average % of mob consuming during measurement period)

Grain	Week -2	-1	1 + 2	3 + 4	5 + 6	7 + 8
			Summer Experiment			
2kg	53	65	70	67	73	83
4kg	57	71	92	89	93	86
6kg	63	72	78	86	85	67
SED	7.5	6.4	4.4	7.3	7.4	7.5
			Winter Experiment			
1kg	57	83	89	91	87	62
2kg	66	78	84	77	80	71
4kg	69	77	83	83	82	77
SED	8.3	8.2	6.9	6.7	6.8	7.5

DISCUSSION

The purpose of these experiments was to determine the liveweight response of beef cattle where the seasonal constraints of inadequate metabolic energy were removed. In the majority of New Zealand beef finishing systems, the level of green leaf herbage and the resultant pasture quality is typically low in permanent pastures during summer (Waghorn and Barry, 1987). Pasture conditions in the summer experiment were typical of this scenario, with average pre- and post-graze energy levels being 10.3 and 9.3 MJ ME/kg DM. Given these pasture conditions, liveweight responses were lower than those reported by Nicol and Nicoll (1987). However, there were significant liveweight gain responses to grain supplementations. Excluding the mob which experienced acidosis, the average increase in daily liveweight gain was 0.18 kg per kg DM supplement offered. This was in a situation where control treatments (i.e., no grain) were offered a high level of pasture quantity (i.e., 4.8 kg DM/100 kg Lwt/d) but quality constraints dominated.

In contrast to summer, pasture quantity can be a dominant constraint in beef finishing systems during winter. As experienced in the winter experiment, feed quality can be high, i.e., 11.3 and 10.1 MJ ME/kg DM for pre- and post-graze situations. It was therefore surprising that significant liveweight gain responses to supplementation were recorded in this experiment and that they were of a similar magnitude to those in the summer experiment. The pre- and post-grazing masses, pasture allowance levels and actual weight gain (0.89 kg/day) of the no grain treatment would all suggest that these control animals were well fed.

The combined results of these 2 experiments indicate that there is weight gain opportunity through grain supplementation under both high and low pasture quality situations even when cattle are being well fed from a quantity perspective within a systems context. Interestingly, the average conversion rate of grain to liveweight gain was 0.22 kg Lwt/kg DM grain for the 2 kg treatments that were common to both experiments.

Within a feedlot situation, the conversion rate of grain to liveweight gain usually ranges from 0.10 - 0.15 kg Lwt/kg DM grain (Perry *et al*., 1976; Muir *et al*., 1995). The average conversion in these experiments was 0.18 kg Lwt/kg grain, indicating a higher level of conversion efficiency. In reviewing other studies of grain supplementation on pasture, Griebenow *et al*. (1997) report responses of 0.14 - 0.21 kg LWG/kg DM supplement. The most reliable and efficient responses were within the lower supplementation levels (i.e., 1-2 kg treatments). As indicated by the occurrence of acidosis in both experiments, there is clearly a risk if high levels of grain supplementation (4-6 kg/hd/d) are pursued, especially in situations of high feed quality.

While considerable research has been undertaken with grain supplementation of beef cattle grazing pastures, the interactions of different pasture conditions on supplement responses are not well understood (Griebenow *et al*., 1997). At an experimental level, there is often a confounding between pasture quantity and quality being offered and consumed due to the effects of substitution. Within the experiments reported in this paper, pre- and post-grazing conditions were similar for all treatments in order to avoid such confounding. Because of the effects of pasture substitution, supplementation within a farm system results in either reduced competition for the available pasture and therefore animals may select higher quality and quantity of pasture, or the opportunity to increase stocking rates. Thus the liveweight responses from this experiment may not fully reflect the response possibilities within a farm system.

In both experiments, much of the additional liveweight advantage that resulted from grain feeding disappeared once supplementation ceased. This was most evident in spring when cattle grew at a high rate (1.2 - 1.6 kg Lwt/d) during the carry-over period. This type of compensation has been noted by Perry *et al*. (1972) and it would question the viability of using grain supplements to cover regularly occurring, poor performance periods.

The results of these experiments would suggest that the practice of feeding grain to beef cattle which are concurrently grazing pasture is most appropriate when tactically used to overcome unpredictable seasonal variations in forage supply. Economic advantages may lie in the ability to supply cattle to fixed supply contracts; or to quickly move the finished animals into a more valuable market segment. In contrast, supplementary grain feeding is most likely to be uneconomic when dealing with a seasonal supply, commodity market. For example, the current cost of rolled maize grain is approximately $280/tonne. Based on our results this would translate to a cost of $1.50 per additional kg of liveweight. In situations where tactical grain supplementation is considered to be of value, then feeding rates of 2-4 kg/h/d would be most effective.

The pasture treatments during these experiments would be typical of a large range of beef finishing areas within New Zealand, with quality limitations in summer/autumn and quantity limitations during winter. These experiments show the reliability of improving animal performance with low levels of grain supplementation.

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