BRIEF COMMUNICATION: Ad libitum fodder-beet and pasture beef-finishing systems – intake, utilisation, grazing behaviour and liveweight gains

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Introduction

Traditionally, New Zealand (NZ) beef-production systems rely almost solely on pasture production. However, the seasonality of pasture growth, which affects quality and quantity, impacts the productivity of the system, with mean slaughter age of 26-36 months. In accelerated beef-finishing systems internationally, cereal grains are used to maintain energy intakes across the production cycle, at a lower cost than is possible in NZ. A recent NZ development in beef-production systems involves *ad libitum* intakes of fodder beet (FB; *Beta vulgaris*) with minimal supplement for 130 d from weaning to spring, and then 90 d of grazing on grass-based pasture before slaughter. This system, developed by Gibbs at Lincoln University, allows finishing of spring born animals at 12-18 months of age (Gibbs et al. 2015; Gibbs & Saldias 2014a). *Ad libitum* intakes after appropriate transition to FB are critical to system profitability, and prevention of rumen acidosis (Gibbs & Saldias 2014b). However, previous NZ crop-feeding experience with brassicas suggests that increased intakes require reduced utilisation of feed (Rugoho 2013). There is no published information on FB utilisation in *ad-libitum* systems, where high pasture residuals at 24 h post-allocation are used to ensure maximal intakes. Therefore, this study was designed to determine utilisation, grazing behaviour and intake patterns, and liveweight (LWT) gains, in steers grazing FB and then spring perennial ryegrass (*Lolium perenne*) and white clover (*Trifolium repens*) based pasture.

Materials and methods

The study was conducted on a commercial beef-finishing operation in Canterbury New Zealand from autumn to spring 2015. *Ad libitum* intakes, utilisation, grazing behaviour, intake patterns and liveweight gains were compared on a FB crop (cv. Brigadier, Seed Force-stocking rate (SR) 20/ha) and spring perennial ryegrass and white clover (cv. Impact, Heritage Seeds) based pasture (SR 6/ha) using 2014 September-born steers. A single group of 118 co-grazed steers was used, and mean LWT at introduction in April 2015 was 286 ±3 kg.

Intake and utilisation of allocation was assessed four times on the FB crop, and intake two times on the spring pasture. In each experimental period, a FB pre-yield assessment was carried out as described by Gibbs et al. 2015, and pasture mass was calculated using a rising-plate meter at each sampling day to quantify daily allocations. Samples of FB (bulb and leaf) and pasture samples were collected at each sampling period for dry matter (DM) and feed composition analysis. Duplicate samples for DM% assessment were oven dried at 65°C until constant weight, and samples for feed composition were freeze dried, ground to 1 mm and analysed by wet chemistry. The utilisation of daily FB allocation was measured four times between June and September 2015. Weights (total DM) at 24, 48, 72 h and then 30 d after grazing were obtained each time from five randomly selected replicates of 4 m^2 each, for each of the time periods after grazing. In spring, the process was repeated with steers on pasture with mass estimated by a rising-plate meter, using repeated, randomised, diagonal transects to generate between 150 and 200 individual estimates from each allocation plot before grazing and at each time period after grazing.

Grazing behaviour of 15 randomly selected and identified animals in the mob were recorded on two occasions each on FB and on pasture, 48 h apart. Grazing events were recorded every five minutes by visual observation using trained observers from 0600 to 1900 h and every 10 minutes from 1900 to 0600 h.

Fodder beet DM disappearance pattern was measured 6 h after grazing, on each of two separate days. All plants in five identified 4 m^2 replicates in the daily allocation were weighed and replaced, then re-weighed 6 h after grazing, for leaf and bulb independently. Live weights of all animals were recorded at the start and finish of both the fodder-beet-crop and spring-pasture-grazing periods.

Calculations

Dry matter utilisation of FB was calculated by the following formula:

$$\text{DM utilisation (\%)} = \left(\frac{\text{pre} - \text{post DM yield}}{\text{pre yield}}\right) \text{x } 100$$

Apparent DM intake was used to describe %DM disappearance pattern of total plant, bulb, leaf and spring pasture, calculated from the DM disappearance of each individual component of the FB plant or the total herbage mass of the pasture between pre- and post-grazing herbage mass at 6 h after grazing. Diurnal-grazing-behaviour means were calculated for all 15 identified steers, and LWT gains

were calculated by the entry and exit LWT to the fodder beet crop and the spring pasture.

Results and discussion

Utilisation, intake and grazing behaviour

The feed composition of both diet treatments is presented in Table 1. Cattle were stocked at 23.6/ha on FB and 6/ha on pasture for 130 d and 75 d, respectively. Dry matter utilisation of FB crop after 24 h was 72.7% ± 0.1, 83.7% ± 0.1 at 48 h, 94.1% ± 0.0 at 72 h and 97.6% ± 0.0 at 30 d, which accord with the intended 25% residual at 24 h that system is designed to provide (Gibbs & Saldias 2014a), to drive high intakes across the autumn and winter period. Fodder beet utilisation at 72 h reported in this study was higher than previous reports of final utilisation for alternative winter crops for cattle, in which intakes were not deliberately restricted, with reported kale utilisations of 75-84% (Stephen & McDonald 1978), 77-90% (Muir et al. 1995), and 86.8% (Rugoho 2013), and reported swede utilisation of 82% (Thompson & Stevens 2012) in dairy cows.

Table 1 Pre-grazing dry matter (DM) yield (t DM/ha) and chemical composition (%DM) by wet chemistry of fodder beet and spring pasture.

	Fodder beet		
	Bulb	Leaf	Spring pasture
t DM/ha	20±0.7		-
DM%	9.3	18.7	23
CP	8.4	21.3	24.6
NDF	12.2	36.2	39.6
ADF	7.9	19.6	19.9
WSC	56.4	10.8	16.2
OM	89.2	83.2	88.1

CP: crude protein; NDF: neutral detergent fibre; ADF: acid detergent fibre; WSC: water soluble carbohydrates; OM: organic matter.

Table 2 Percentage of dry matter (DM) utilisation of fodder beet crop at 24, 48, 72 h and 30 d after grazing, DM disappearance pattern of total plant, bulb and leaf and spring pasture at 6 h after grazing, grazing behaviour in the first 6 h of grazing and after 24 h grazing, and total liveweight gain on fodder beet crop and pasture system.

	Fodder beet	Spring pasture
Time after grazing	Utilisation (%)	
24h	72.7±0.1a	-
48h	83.7±0.1b	-
72h	94.1±0.0c	-
30 days	97.6±0.0d	-
DM intake pattern 6h after grazing	DM disappearance (%)	
Total	68.7±13.6	73.2± 0.05
Leaf	55.1±21.5	-
Bulb	62.5±17.6	-
Grazing behaviour	Time grazing (h)	
Total time grazing	7.1±1.2	7.8±0.7
Total time grazing within first 6h	3.4±0.6	3.5±0.6
Period	130 days	75 days
Liveweight gain (kg/day)	1.01±0.1	1.2±0.3

Means within a trial followed by a subscript letter (a, b, c or d) are significantly different (P<0.001) according to LSD test by ANOVA.

High intakes of fodder beet were observed, with mean daily intake calculated at 8.71+1 kg DM/steer at the final September assessment. With a mean LWT of 434 ± 2.9 this is approximately 2.02% LWT daily DM intake, and the corresponding 130 d mean daily LWT gain was 1.01 ± 0.1 kg. On pasture, the mean daily intake was 11.23 kg in October (approximately 2.25% LWT/day), and for 75 d the mean daily LWT gain was 1.2 kg ± 0.3. Mean daily grazing time on FB was similar at 7.1 h compared with pasture at 7.8 h, with almost half of this within the first 6 h (47.1 and 45.4%, respectively) in both treatments. Total LWT gain per hectare was calculated at 3295 kg in the FB period, and 527 kg in the pasture period.

Dry matter disappearance of fodder beet and pasture

Despite the similar proportions of daily grazing in the first 6 h, total DM disappearance of FB at 6 h was 68.7% of 24 h intake compared with 76.6% on pasture. For the FB, this is much lower than previous reports by Jenkinson (2013) (90 ± 5.4%) for dairy cows fed FB, and Rugoho (2013) (95.7-97.6%) for dairy cows fed kale, both on restricted allocations, but similar to other reports of strip-fed cattle on pasture (Dobos et al. 2009). While the previous methodology of daily allocation assessment of beet and kale crop does have significant flaws due to uncontrolled crop variation and may be unreliable, it seems unlikely this alone accounts for the strong differences. Unrestricted allocation of FB may result in a more diffuse diurnal grazing pattern, with evidence for this in the observed differences in grazing after and before twilight in FB (1h) and pasture (0.4h) treatments. In addition, the trained observers noted that the herd generally grazed the residuals in the beet paddock that were distant from the daily strip-allocation in the dark, In a concomitant study on the same fodder beet feeding system, using rumenally-fistulated, co-grazing steers (Prendergast & Gibbs 2015), similarly high intakes were associated with higher rumen pH than those in the pasture-fed control, and evidenced a different pattern of diurnal pH to steers fed restricted fodder beet intakes. This is the first report of this different distribution of intake diurnally, in satisfactorily transitioned cattle fed FB *ad libitum*, and may help explain both the high intakes and production, and the absence of rumen pH impact from a diet rich in rapidly fermentable sugars.

Conclusions

Weaner beef steers fed FB *ad libitum* over winter with 1 kg DM/steer of pasture daily were observed to achieve very high final utilisation (>95%) while maintaining daily intakes above 2% of LWT, daily LWT gains of 1.01kg and producing 3295 kg LWT gain/ha for 130 d from April to

September. *Ad-libitum* fodder beet intakes did not result in poor utilisation, and appear to extend diurnal grazing patterns.

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