EARLY SPRING FEEDING BUDGET FOR SPRING CALVING DAIRY COWS

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Abstract

Seventy-two spring calving Holstein Friesian dairy cows were randomly assigned to a six treatment grazing study (n=12). The 6 treatments comprised of 2 daily herbage allowances (DHA - 13 or 17 kg DM/cow/day) and 3 concentrate levels (0, 3 or 6 kg DM/cow/day) over a 77 day period. DHA and concentrate level had a significant effect on total milk yield and solids corrected milk. Results from the experiment indicate that grass silage can be removed from the diet of the spring calving dairy cow if a large proportion of grazed grass and 3kg concentrate is allocated in the early lactation period. This will result in high milk production and high herbage utilisation. Efficient use of grazed grass in early spring will allow dairy farmers remain competitive in the future.

Keywords: spring calving cow, grazing study

Introduction

Irish dairy production systems are predominantly grass based with mainly spring calving herds (Dillon et al., 1995). The current feed budget comprises of approximately 70% grazed grass, 20% grass silage and the remaining 10% is made up with concentrate. Previous authors including O'Kiely (1994) have shown that correctly managed grazed grass, is the cheapest feed available. Including grazed grass in the diet of spring calving dairy cows results in increased milk production and milk protein composition (Dillon et al., 2002; Kennedy et al., 2005). The financial costs associated with milk production can be reduced by increasing the proportion of grazed grass in the diet in either early spring or late autumn. Future projections on the costs of feed inputs such as concentrate and grass silage are predicted to increase. In preparation for this, dairy farmers need to adjust their grassland management practise in order to achieve a higher proportion of the overall feed budget from grazed pasture. The objective of this study was to investigate the effect of offering different levels of daily herbage allowance and concentrate in early lactation on milk production performance of spring calving dairy cows and the resulting impact on the feed budget.

Materials and Methods

The experiment was conducted at Moorepark Dairy Production Research Centre, Fermoy, Co. Cork, Ireland. The underlying soil type is a free draining acid brown earth of sandy loam-to-loam texture. The area used was under permanent pasture with a predominately ryegrass sward (Lolium perenne L.). The swards were on average four years old.

Experimental Design

This experiment was a randomised block design with a 2 × 3 factorial arrangement of treatments. Seventy-two Holstein Friesian dairy cows were selected from the Moorepark spring-calving herd. Twenty-four animals were in their first lactation (primiparous) and 48 animals were in their second or greater lactation (multiparous). From calving until treatment assignment all animals were offered ad-libitum pasture by day and housed by night where they were offered ad-lib grass silage. Animals were offered 4kg dry matter (DM)/ cow/ day concentrate in two equal feeds at each milking during this pre-experimental period. Animals had calved for at least ten days prior to treatment assignment.

Animals

Animals were balanced on calving date, mean 2 February (s.d. 9.4 days), lactation number 2.5 (s.d. 1.65), first 10 days milk yield of the present lactation 25.7kg (s.d. 4.67), bodyweight 541kg (s.d. 77.5) and body condition score 2.9 (s.d. 0.49). Animals were randomly assigned to a 6 treatment (n=12) grazing study. The six experimental treatments consisted of two daily herbage allowances (DHA) (>4cm) and three concentrate (conc.) levels. The treatments were: 13kg DM herbage/ cow/ day (Low – L) and no concentrate supplementation (L0); 13kg DM/ cow/ day and 3 kg DM concentrate (L3); 13kg DM/ cow/ day and 6 kg DM concentrate (L6); 17kg DM/cow/ day (High-H) and no concentrate supplementation (H0); 17kg DM/cow/ day and 3kg DM concentrate (H3) and 17kg DM/cow/ day and 6kg DM concentrate (H6). Animals grazed as six individual herds. The experiment was carried out over a 77 day period (20 February until 7 May, 2006).

Grazing management

Fresh herbage was allocated to each individual group on a daily basis after morning milking. No access to the previous days grazing area was allowed throughout the experiment. Half the paddocks were randomly assigned to the high DHA treatment and the remaining half assigned to the low DHA treatment. The low herbage allowance groups grazed as three separate groups adjacent to one another separated by a temporary electric wire, the same was true for the animals offered a high DHA. Concentrate was offered in two equal feeds at both morning and evening milking.

Herbage mass and sward density were measured by cutting two strips (1.2m × 10m) per grazing area twice weekly. Ten grass height measurements were recorded before and after harvesting on each cut strip using an electronic plate meter. All mown herbage from each strip was collected, weighed and sub-sampled (0.5kg approx.). A further sub-sample of 0.1kg fresh weight of the sample was dried for 16 h at 90° C in a drying oven for determination of the dry matter content. Based on these measurements it is possible to calculate the sward density [sward density = DM ha^{-1} / (pre-cutting height – post cutting height); kg DM/cm/ha). The remainder of each collected sample from each pair of cuts was bulked; a sub-sample of 0.2kg approximately was stored at -17° C. It was then freeze-dried, milled and bulked by treatment and week prior to chemical analysis.
Pre-grazing sward height was measured daily for the low and high DHA treatments (n=2), by recording approximately 30 heights across the two diagonals of each grazing area using an electronic plate meter. DHA was then calculated for each group by multiplying pre-grazing sward height by the sward density. Following grazing post-heights were also recorded for each of the six individual treatments (n=6).

Animal Measurements

Milking occurred at 07.00 h and 16.00 h daily. Individual milk yields (kg) were recorded at each milking. Milk fat, protein and lactose concentrations were calculated weekly from one successive evening (Tuesday) and morning (Wednesday) milking sample for each animal. Bodyweight was recorded weekly using an electronic portable weighing scale. Body condition score (BCS) was also recorded weekly throughout the experimental period on a scale of 1-5. Changes in bodyweight and BCS were calculated by subtracting the mean of the last two weeks of the study from the mean of the first two weeks of the study for the relevant measurement.

Statistical Analysis

All statistical analysis was carried out using SAS (SAS Institute, 2002). The factors in the model were DHA, concentrate level, interaction between DHA and concentrate level and the relevant pre-experimental covariates. Linear and quadratic effects of concentrate on milk parameters were also tested.

Results

Grass and Grazing Management

The first grazing rotation began on 20 February and was completed on 4 April (44 days), the second grazing rotation finished 26 days later. Table 1 shows the effect of treatment on sward measurements. Pre-grazing herbage mass (>4cm) was on average 1368kg DM/ha for the low DHA herds and 1447kg DM/ha for the high DHA herds throughout the experiment. Mean sward density was 230kg DM/ha (s.d. 3.3). Animals offered the high DHA received approximately 20% greater area than those on the low DHA treatments (101m^2/ cow/ day) throughout the experiment, this equated to a stocking rate of 2.3 cows/ ha for the low DHA treatments and 1.8 cows/ ha for the high DHA treatments. As the treatments were managed as six individual herds post-grazing sward surface height (PGSSH) ranged from 3.5cm to 5cm ($P<0.001$), with animals on the L0 treatment grazing to the lowest post-height. Animals on the high herbage allowance treatments had consistently higher PGSSH than those offered a low DHA. At both herbage allowances for every 1kg increase in concentrate DM offered, PGSSH increased by 0.1cm. Herbage utilisation was highest with the low DHA treatment (1.03), while the high DHA herd utilised 0.89 of the offered herbage.

Table 1: Effect of treatment on post grazing sward height, grazing area and total DM intake during Period I of the experiment.

	Treatment								
	L0	L3	L6	H0	H3	H6	SED	DHA	Conc.
Pre grazing (cm)	10.0	10.0	10.0	10.2	10.2	10.2	0.13	*	NS
Post grazing (cm)	3.5^a	3.8^b	4.1^c	4.4^d	4.6^e	5.0^f	0.08	***	***
Density	228^a	228^a	228^a	232^b	232^b	232^b	1.8	***	NS
Herbage Mass (>4cm)	1375^a	1375^a	1375^a	1439^b	1439^b	1439^b	31.2	**	NS
Area offered (m^2 cow^{-1} d^{-1})	101^a	101^a	101^a	125^b	125^b	125^b	34.9	***	NS
Herbage removed (kg DM)	13.8^a	13.2^b	12.4^c	15.7^d	14.9^e	13.9^a	0.23	**	***
Herbage utilisation	1.09^a	1.03^b	0.97^c	0.94^d	0.89^e	0.84^f	0.01	***	***

NS= Not significant, ***=P<0.001, **=P<0.01, *=P<0.05. abc values in the same row not sharing a common superscript are significantly different.

Table 2: Milk performance of spring calving dairy cows in early lactation, over a 77-day period (20 Feb - 7 May)

	DHA	Concentrate (kg)				

	13kg	17kg	0	3	6	SED	DHA	Conc.	***Lin.***
Milk (kg)	2128	2282	2046	2199	2370	89.3	**	***	***
Protein	32.8	33.5	32.7	33.2	33.6	0.69	0.07	NS	NS
Fat	37.3	37.2	37.4	37.7	36.7	1.76	NS	NS	NS
Lactose	46.5	46.5	46.0	46.8	46.7	0.47	NS	*	**
SCM kg/cow	1927	2069	1852	2004	2138	100.7	*	***	**
Bodyweight (kg)	510	523	506	524	519	8.78	*	**	**
BCS	2.72	2.82	2.75	2.83	2.74	0.097	*	NS	NS

BCS = body condition score. Lin. = Linear effect of concentrate. NS= Not significant, ***=P<0.001, **=P<0.01, *=P<0.05.

Total concentrate inclusion in the diet for the 3kg groups was 231 kg DM/cow; animals on the 6kg allowance were offered a total of 462 kg DM/cow. (Unsupplemented animals were offered 1kg DM/cow/ day for the first 5 weeks of the study (total 35 kg DM/ cow) to ensure adequate intake of essential minerals).

There was no interaction between DHA and concentrate allowance throughout the experiment. A significant linear response (P<0.05) to concentrate supplementation was recorded for milk yield, milk lactose concentration, milk fat yield, milk protein yield, milk lactose yield, solids corrected milk (SCM) and bodyweight. No quadratic effect was recorded. Increasing DHA significantly (P<0.05) increased daily milk yield (+1.8kg), protein (+79.5g), lactose (+86.8g) yields and protein concentration (+0.9g/kg). The high DHA treatments had a significantly higher (P<0.05) mean bodyweight (+12.3kg), mean BCS (+0.1) and endpoint BCS (+0.2)

There was a significant linear response (P<0.001) to concentrate, mean daily milk yields were 26.8, 28.6 and 31.0kg for the unsupplemented, 3kg and 6kg concentrate groups, respectively. Concentrate supplementation had a significant linear response (P<0.05) in terms of milk lactose concentration, milk fat yield, protein yield and lactose yield. Solids corrected milk increased significantly (P<0.001) from 24.2 kg (unsupplemented) by 1.8kg/day (3kg herd) and 3.74kg/day (6kg herd). There was a significant difference in mean bodyweight (P<0.01) as concentrate increased from 0 to 3kg (506 and 524kg, respectively), there was no further increase with the 6kg concentrate group. Concentrate supplementation level had no effect on mean BCS or endpoint BCS.

Discussion

The quantity of herbage offered in early lactation has a major influence on milk production per cow. In early spring, herbage is of high quality, but this is largely influenced by grassland management at closing the previous autumn (O'Donovan et al. 2000). Sayers and Mayne (2001) found improved animal performance on grass as opposed to silage based diets. This improved performance at grass was explained by greater DM intakes, higher UFL value of grass and improved rumen function.

Herbage production and quality

Herbage production from autumn closing to spring opening in Ireland is highly seasonal with little or no net growth between November and February (Hennessy et al., 2006), growth is dependant on weather conditions and soil characteristics and vary between years and sites. Extending the grazing season in autumn reduces the grass yield in the following spring (O'Donovan et al., 2002). Conversely, delaying grazing in spring has been show to reduce sward quality and result in inferior sward structure (Kennedy et al. 2006). The quantity of herbage available for spring grazing is highly variable and must be budgeted in early spring in order to identify target turnout date, herbage allowance available per cow and level of supplementation required while maintaining high utilisation rates. Kennedy et al. (2006) concluded that offering a low to medium DHA (13 or 16kg DM) to early lactation cows in spring will not compromise milk production or sward utilisation and supplementing with 4kg will significantly increase milk yield. This agrees with the findings in the present experiment, that at a low or high DHA the inclusion of a medium concentrate level is sufficient to achieve satisfactory levels of milk production and high herbage utilisation.

Sward utilisation

Total herbage offered in the current experiment was 982 (s.d. 0.49) and 1289 (s.d. 0.5) kg DM/ cow for the low and high treatments, respectively. Pre-grazing herbage mass (>4cm) tended to be low (<1500 kg DM ha^{-1}) during P1. Hoogendoorn et al., (1992) stated that low pre-grazing herbage mass swards (2000 kg DM ha^{-1}) contained higher proportions of grass leaf and lower proportions of stem and dead material, resulting in higher DMD values and consequently greater milk production per cow. High herbage utilisation in the spring period has been shown to have beneficial effects on the sward in following rotations (Kennedy et al., 2006; and Hoogendoorn et al., 1992).

The benefits of offering fresh herbage to the dairy cow in early spring are now well documented and include improved milk yields and increased milk protein yields. However, grass alone will rarely meet the energy requirements of the cow to allow her express her potential for milk production in early lactation. Delaby et al. (2001), has shown that supplementation of a grass based diet with concentrate will allow a dairy cow to express a larger proportion of her milk production potential, with reduced body weight losses. Results from this experiment agree with these findings, the unsupplemented animals on the low DHA had considerably greater body weight losses than the supplemented or high DHA treatments. Contrary to the studies of Dillon et al. (2002) and Kennedy et al. (2006), supplemented animals had no increase in bodyweight during the present experiment. Considering the intake restriction imposed on the L0 herd, they achieved relatively good milk yields. However, they had a significantly greater body weight loss (-37.6 kg). This indicates that in order to reach this level of milk production (25.7 kg/cow/ day) this herd was forced to mobilize a large proportion of body reserves. At a similar DHA, Kennedy et al. (2006) reported milk yields of 23 kg/ cow/ day for a similar point in lactation, with 19.8 kg bodyweight loss. Bargo et al (2002) offered a DHA of 25kg DM, and the unsupplemented group yielded 19.1 kg milk/day, with no effect on bodyweight or BCS.

Milk response

The average milk response to extra herbage was 0.46kg milk/kg DM herbage offered, during P1. This response is similar to the 0.43kg milk/ kg reported by Dalley et al. (1999), but lower than the 0.64kg milk/kg DM reported by Kennedy et al. (2006) at a similar point in lactation. Delaby et al. (1999) reported a lower milk response with of 0.25 kg/day/ kg increase in herbage allowance (from 12 to 20kg OM/cow/ day).

The inclusion of concentrate in the diet resulted in a milk response rate of 0.71kg milk/ kg concentrate offered up to 6kg DM. The milk responses achieved were 0.79 kg milk and 0.63 kg milk / kg concentrate offered at the low and high DHA, respectively. These results agree with previous studies which have reported greater milk response rates for animals offered low DHA's compared to higher DHA's (Kennedy et al. 2006 and Bargo et al, 2002).

Carryover effects

Kennedy et al. (2005) found a large increase ($P<0.001$) in milk protein yield and composition with animals turned out to pasture full time in spring, in comparison to an indoor feeding system, this was similar to the findings of Dillon et al. (2002). Previous authors (Kennedy et al., 2005; Dillon et al., 2002) have reported a carryover effect on milk protein composition when herbage is offered early in lactation. These previous studies made a comparison between indoor offered silage and grazing groups and highlight the benefits of replacing grass silage with fresh herbage in the diet of spring calving dairy cows. In this experiment DHA had no carryover effect on milk production, however, offering concentrate did have a significant ($P<0.05$) carryover effect in terms of milk yield and solids corrected milk, following the experimental period. This, difference was greater between the unsupplemented and supplemented groups, rather than the 3kg and 6kg supplemented treatments.

Conclusions

The amount of herbage available for spring grazing is highly variable between years and site. Early spring grass must be budgeted in order to identify target turnout date, herbage allowance available per cow and level of supplementation required while maintaining high sward utilisation rates. Early turnout to grass, displaces the requirement for grass silage in the diet of the spring calving cow. Allocating a large proportion of grazed grass combined with a medium concentrate level will achieve high milk performance. The results of this study indicate that at either a 13kg or 17kg DM DHA, a concentrate input of 3kg DM/ cow/ day will result in an economically efficient level of milk production combined with high herbage utilisation, this equates to a target of one tonne of herbage available per cow during the first two grazing rotations in spring.

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