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The effect of stage of lactation and season on milksolids response to supplementary feeding of dairy cows.

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ABSTRACT

A factorial design was used to determine the effect of offering cows (n=8) in early, mid, and late lactation 50 MJME/cow/day of rolled maize grain (T2) or a nutritionally balanced supplement (T3) in spring, summer, autumn and winter at a restricted pasture allowance. The average milksolids production of the early, mid and late lactation groups was 1.16, 1.10, and 0.96 kg MS/cow/day (± 0.013), respectively. When compared to a non-supplemented control (T1), offering T2 and T3 supplements increased MS production from 0.91 to 1.14 and 1.13kg MS/cow/day ($P<0.01$), respectively. The milksolids responses to T2 was 150g MS/cow/day greater in summer and winter than in spring and autumn ($P<0.05$). Stage of lactation, or form of supplement, had no effect on milksolids response ($P>0.05$). These results suggest that the milksolids response to supplementary feeding was determined by the extent supplementary feeding increased total ME intake.

Keywords: dairy cows; stage of lactation; supplementary feeding; season; maize grain; pasture.

INTRODUCTION

Research has suggested that little additional milk is produced when supplements are offered to pasture fed cows (Bryant and Trigg, 1982). It is often assumed the marginal milk response to supplements decreases as lactation progresses. In early lactation a higher proportion of consumed nutrients are partitioned toward milk production and less toward liveweight gain, with the opposite effect occurring in late lactation (Broster and Thomas, 1981). Stockdale and Trigg (1989) showed that the immediate response to supplements was greater in the spring than in the autumn. This has resulted in recommendations that the greatest responses to supplements are likely to occur when supplements are offered to seasonal calving dairy herds in early lactation.

In contrast to earlier work, recent farm systems trials have suggested that at moderate stocking rates the effects of supplementary feeding is negligible in spring, and improves as the season progresses (Penno *et. al.,* 1995). Clark (1993) demonstrated immediate responses to offering dairy cows pasture silage were greatest in late lactation. It is also known that large milksolids (MS) responses are likely when supplements are used to extend lactation in autumn (Pinares and Holmes, 1996). The supplementary feeding responses that have been measured may represent a change in the ability of high genetic merit cows to respond to additional feeding in late lactation. The experiments reported in this paper were designed to determine the effect of season and stage of lactation on the response of pasture fed dairy cows to supplementary feeds.

MATERIALS AND METHODS

The DRC No 3 Dairy non-seasonal calving herd was used to allow the effect of stage of lactation to be studied independent of seasonal changes in pasture quality and other environmental factors. The herd comprises four groups of cows, each calving over an 8 week period starting 15 July, 25 October, 20 January, or 15 April. The trial design was a 3 x 3 x 4 factorial involving 3 groups of 24 cows in early, mid, or late lactation, offered three nutritional treatments at four times of the year. Nutritional treatments were a restricted pasture allowance (T1), a restricted pasture allowance plus 50 MJME/cow/day (3.7 kg DM/cow/day) of rolled maize grain (T2), and a restricted pasture allowance plus 50 MJME/cow/day of a nutritionally balanced mixture of supplementary feeds and minerals (T3). The T3 supplements (Table 1) were formulated using the Cornell Net Carbohydrate and Protein System (Fox *et al*., 1992) to provide an appropriate balance of readily fermentable carbohydrate, fibre, and protein taking account of the predicted chemical composition of the pasture. The mineral content of the supplement was formulated by the same

TABLE 1: Feed composition of T3 supplement treatments during the Spring, Summer, Autumn, and Winter experimental periods (kg DM/cow/day).

	Maize grain	Barley straw	Chopped hay	Fish Meal	Soybean meal	MgO_2	NaCl	Ca_2PO_4	Lime Flour
Spring	3.0	1.5							0.08
Summer	2.7				1.0			0.13	
Autumn	1.7		2.0	0.5	0.5	0.03	0.03	0.10	0.04
Winter	3.0		1.0	0.3		0.05		0.12	0.01

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method using Spartan (van de Haar *et al*., 1992).

Experiments were conducted for 6 week periods commencing 23 September 1996, 20 January 1997, 7 April 1997, and 23 June 1997. Cows (n=24) in early, mid and late lactation were allocated to treatments groups balanced for age, genetic merit and liveweight. During the first week of each experimental period cows were grazed together in three groups according to stage of lactation and offered a pasture allowance of 40 - 50 kg DM/cow/day. Immediately after the uniformity period, cows were split into treatment groups and offered a pasture allowance sufficient to restrict pasture dry-matter intake (DMI) of the T1 groups to 75% of that measured during the uniformity period. Cows in the T2 and T3 treatment groups were offered the same pasture allowance as the T1 treatment groups. The supplement treatments were offered to cows individually in feeding stalls for 5 weeks. Production measurements began after a two week adjustment period.

Milk yield and content of fat, protein, and lactose were measured at two consecutive milkings each week. Cow liveweight and condition were measured weekly. Herbage intake was calculated weekly for each treatment group by DM disappearance, as estimated by calibrated visual assessment. Pasture samples were hand clipped to grazing height from the grazing area of each treatment group weekly during experimental period. Each sample was oven dried at 60°C, ground and analysed for chemical composition by NIRS (Ulyatt *et al*., 1995).

Pasture chemical composition, DMI, and milksolids MS data are presented for the final three weeks of each experimental period. The trial was analysed as a factorial testing for main effects of stage of lactation, season and nutritional treatments, and first order interactions, using the SAS 6.12 mixed models procedure. Both age and uniformity measurements were used as covariates, with uniformity covariates derived by adjusting animals within each stage of lactation.

TABLE 2: Crude protein, neutral detergent fibre (NDF), in vitro-digestibility and estimated metabolisable energy (ME) content of the pasture grazed in the final three weeks of the spring, summer, autumn and winter experimental periods.

	Crude Protein (g/100g DM)	NDF (g/100g DM)	*In vitro*-Digestibility (g/100g DM)	ME (MJ/kg DM)
Spring	21.8	42.0	79.0	12.5
Summer	18.8	54.1	76.2	12.0
Autumn	25.1	38.7	79.9	12.6
Winter	25.8	35.5	81.4	12.9

RESULTS

During each experimental period treatment groups were grazing high quality pasture of similar chemical composition (Table 2). Crude protein content of the pasture ranged from 18.8% during summer to 25.8% during the winter feeding experiment. Summer pasture had the highest fibre content and the lowest *in vitro*-digestibility and ME content. The restricted pasture allowance resulted in similar levels of pasture DMI across seasons (Table 3).

The average MS production of the early, mid and late lactation groups was 1.16, 1.10, and 0.96 kg MS/cow/day (± 0.013), respectively, representing a decline of 2.1% and 2.9%/month, relative to the early lactation cows. Despite similar DMI, mean daily MS production was 170g MS/cow/day higher ($P<0.01$) during the spring experimental period than the winter and summer periods, and 100g MS/cow/day higher ($P<0.01$) than during the autumn experimental period. Autumn MS production was higher than production in summer and winter ($P<0.01$).

At each stage of lactation, and at all times of the year, offering the T2 and T3 supplements increased daily MS production, and mean liveweight at the end of the experimental period compared to the T1 treatment (Table 3). Offering the T2 supplement increased MS production by

TABLE 3: Mean pasture dry-matter intake (DMI), daily milksolids production, and final liveweight for treatment groups during each experimental period.

Stage of lactation	Early			Mid			Late			sed
Treatment	T1	T2	T3	T1	T2	T3	T1	T2	T3	
Spring										
Pasture DMI (kg/c/d)	11.8	11.6	11.7	11.7	11.5	11.3	11.3	10.9	11.0	ND
Milksolids (kg/c/d)	1.27	1.47	1.36	1.01	1.21	1.20	0.99	1.07	1.00	0.06
Liveweight (kg)	442	449	447	421	433	430	450	466	459	4.5
Summer										
Pasture DMI (kg/c/d)	13.1	12.9	12.9	12.5	12.5	12.5	12.4	12.4	12.4	ND
Milksolids (kg/c/d)	0.89	1.22	1.14	0.99	1.19	1.24	0.71	0.95	0.89	0.05
Liveweight (kg)	429	436	435	477	484	482	492	497	505	5.2
Autumn										
Pasture DMI (kg/c/d)	13.4	12.8	12.7	11.9	11.2	11.3	11.6	11.0	11.1	ND
Milksolids (kg/c/d)	0.99	1.17	1.15	0.99	1.14	1.16	0.87	1.12	1.09	0.07
Liveweight (kg)	429	445	435	426	435	438	474	486	477	5.0
Winter										
Pasture DMI (kg/c/d)	12.4	11.4	11.6	12.8	11.6	11.9	11.4	10.3	10.6	ND
Milksolids (kg/c/d)	0.89	1.15	1.22	0.86	1.00	1.10	0.76	1.06	1.02	0.08
Liveweight (kg)	391	408	411	401	422	423	436	451	451	7.3

230g MS/cow/day, and the T3 supplement produced an extra 210g MS/cow/day, representing responses of 4.6 and 4.2 g MS/MJ ME respectively. Mean liveweight of cows in the supplemented groups was 11 kg (± 1.1) heavier at the conclusion of feeding treatments than cows in the non-supplemented groups. The MS response to maize grain was 150g MS/cow/day (40%) greater in summer and winter than in spring and autumn ($P<0.05$). Stage of lactation, or form of supplement, had no effect on the MS response to the feeding treatments ($P>0.05$).

DISCUSSION

The restricted pasture allowance resulted in low levels of MS production during each experiment, particularly during the summer, autumn and winter periods. Stockdale and Trigg (1989) demonstrated that as pasture allowance declines the response to supplementary feeds is likely to increase. In these experiments the average response to the T2 treatment was 62 g MS/kg DM maize grain. This response is smaller than those reported by Kellaway and Porta (1993) who reviewed experiments where cereal grain supplements had been offered to dairy cows grazing temperate pasture and showed an average response of 55 g milkfat (approximately 95 g MS/kg DM). However, in contrast to the experiments of Stockdale and Trigg (1989), the response did not decline as lactation progressed.

Offering supplementary feeds to grazing dairy cows causes differing amounts of additional milk production, pasture substitution, and changes in body condition (Kellaway and Porta,1993). The increase in milk production that occurs within a few days of starting to feed supplements is known as the immediate response. Over a longer period, extra milk may be produced as a result of improved cow condition, or better pasture availability because of substitution. This is know as the "carry-over" effect. Typically the carry-over effect is equal to, or greater than the immediate effect when supplements are used (Byant and Trigg, 1982). As reported, these experiments only measure the immediate response.

In a grazing trial Clark (1993) reported immediate responses of 26, 16 and 66 g MS/kg DM when 5 kg pasture silage DM/cow/day was offered for 30 days in spring, summer and autumn, respectively. Carry over responses of 46 and 45 g MS/kg DM were measured between the conclusion of the spring and summer silage feeding periods and the end of the season. The small immediate responses measured in spring agrees with the work of Clark (1993). However, in these experiments offering maize grain in summer resulted in a large immediate effect of 73 g MS/kg DM. Bryant (1989) reported typical responses to the use of supplementary feeds in summer of only 25 g MS/kg DM, leading to the recommendation that supplementary feed should not be used during summer feed deficits. The large milksolids responses resulting when supplements were offered in summer and winter correspond with the period of lowest milksolids production. This suggests that the magnitude of response to additional feed is affected by the level of milksolids production of cows relative to their potential production at any given time. Within seasonal dairy farm systems the level of underfeeding is often greatest during summer and autumn (Penno *et al*., 1995), providing a possible explanation for the large responses that have been reported in farm systems experiments.

Offering supplementary feeds which were specifically formulated to meet the nutrient requirements of the cows did not improve milksolids yield relative to offering maize grain supplements. This supports recent farm systems research where offering large quantities of nutritionally balanced rations did not result in improved annual milksolids yields when compared to offering maize grain supplements (Penno *et al*., 1996). These experiments suggest the increase in milksolids production is relative to the amount of ME supplied.

CONCLUSIONS

High genetic merit dairy cows are equally responsive to supplementary feed across stage of lactation. It is likely that the largest increase in milksolids production will occur at times of greatest underfeeding. During periods of feed deficit it is likely the response will be primarily to the additional ME supplied. Dairy farmers should make supplementary feeding decisions based on the level of underfeeding at different times of the year, and the likelihood that carry-over milksolids responses will be captured within the farm system. The best form of supplementary feeds are those that supply the greatest amount of ME at the least cost.

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