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IMMEDIATE AND LONGER TERM RESPONSE OF DAIRY COWS TO LEVEL OF NUTRITION IN EARLY LACTATION

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SUMMARY

The first of two grazing trials was of 26 weeks and involved five groups of 12 cows that, on average, had calved 30 days earlier. A control group was well fed throughout. Other groups were offered restricted grazing during weeks 1 to 3, 1 to 6, 7 to 9 or 7 to 12 so as to reduce daily DM intake by about 20%.

The second trial involved three sets of twins in the first year and six in the second. One member of each set was well fed throughout, whereas the other was offered restricted grazing during weeks 1 to 6 of lactation so that DM intake was reduced by 48%. Measurements were for 24 weeks and included estimation of energy balances.

In both trials the yield of milk and constituents was reduced during underfeeding, but total effects following underfeeding were small and generally not significant.

Alterations in energy partitioning measured during weeks 8 to 18 in the second trial represented an advantage to the well-fed control equivalent to 7.9 MJ ME/day. Although this was small, it could account for 72% of the differences in milk production observed during that time.

INTRODUCTION

Many reports emphasize the importance of level of feeding in early lactation in determining dairy cow performance. The earlier New Zealand work has been summarized by Geering and Young (1961); this and other work by Broster (1972, 1974). Nutrition that results in a decline in current yield may, on occasions, be followed by residual effects that persist throughout lactation. Broster (1974) concluded on the basis of available evidence that these residual effects were about four times the immediate effects.

More recent work in New Zealand (Campbell, 1968; Bryant and Cook, 1977; Bluett, 1977), Ireland (see Gordon, 1977), and elsewhere (see Broster and Strickland, 1977) indicates that residual effects are not invariably present.

These residual effects in particular warrant detailed study since their presence or absence influences the outcome of a number of decisions concerning the grazing management of dairy cows during winter and spring.

This paper reports on two experiments in which residual effects from underfeeding in early lactation were studied. The first was concerned with the influence of severity, duration and timing of underfeeding on current and subsequent production, the second primarily with the effects of underfeeding on subseqent energy utilization.

EXPERIMENTAL

Experiment 1

Sixty mixed-age cows of Jersey and Friesian origin were subjected to common grazing management from calving until the start of the experiment on September 22, 1977. Liveweight, 7-day fat yield, days in milk, and condition score on September 22 were (mean ± SD) 389 ± 49 kg, 5.96 ± 0.95 kg, 30 ± 8 days, and 4.7 ± 0.8, respectively. Groups of 12 cows were assigned to the following treatments, where week 1 refers to the first week of the experiment, which was of 26 weeks' duration.

Control: Well fed throughout.
E3: Restricted for 3 weeks early in the trial (weeks 1 to 3).
E6: Restricted for 6 weeks early in the trial (weeks 1 to 6).
L3: Restricted for 3 weeks later in the trial (weeks 7 to 9).
L6: Restricted for 6 weeks later in the trial (weeks 7 to 12).

Similar pasture (2500 to 3500 kg DM/ha) was offered to each group each day, with the area offered to group C providing an allowance of about 50 kg DM/cow/day. Half this area was offered where feeding was restricted. All cows were uniformly treated during weeks 13 to 26, with a grazing intensity similar to that on a farm stocked at about 3.5 cows/ha.

All cows were condition-scored at the start of the trial and thereafter at 3-week intervals. Liveweight change was assessed as the difference between weights at the end and 1 week after the start of restriction. In each case weighings were before the morning milking on two consecutive days. When restricted feeding was imposed, the amount of DM present before and after grazing on the areas grazed by group C and those groups being restricted was measured on three occasions each week (Bryant and Cook, 1977). The yield and composition of milk were also measured as described therein.

Effects of treatment were assessed by covariance analysis. Milk yield and composition during the 7 days preceding week 1 were used as covariates. The residual coefficient of variation was 9 to 12%.

Experiment 2

Sixteen sets of monozygous twins in their third or later lactation were used in a 3-year experiment designed to quantify the effects of underfeeding in early lactation on energy partitioning and milk production. Some data from only nine sets (three in the first and six in the second years) are presented here, since measurements are not completed on the remaining seven sets.

One animal from each set was grazed for 42 days from the fourth day after calving (day 1, week 1), so daily intake was severely restricted (L). The other set member was well fed during this time, being offered a daily allowance of 50 to 60 kg DM/cow (H). All animals were then offered generous grazing for the remainder of lactation except when confined indoors for nutrient balance measurements and offered fresh pasture herbage as the sole ration. The facilities and procedures described by Bryant *et al.* (1977) were used to derive 84 complete energy balances during the first 2 years. Other procedures were essentially as described for Experiment 1.

RESULTS

Experiment 1

Reducing the area grazed each day, and hence the daily DM allowance, to half that grazed by the control group consistently increased the severity of grazing and percentage of DM removed at each grazing (Table 1). These effects were less pronounced in weeks 7 to 12 than in weeks 1 to 6. The data indicate that the restriction reduced DM intake by 17, 29, 23 and 22% in the successive 3-week periods.

The reduction in yield of milk and its constituents within times of restriction (Table 2) was consistently highly significant, amounting to about 10 and 20% during the first and second 6 weeks of restriction, respectively. The relative reductions in yields of protein and lactose were generally greater than that for fat, since restricted feeding also reduced the concentrations in the milk of protein and lactose but not fat (Table 3).

TABLE 1: DRY MATTER OFFERED PER COW, YIELD AFTER GRAZING AND PERCENTAGE UTILIZED

	Weeks			
	1 to 3	*4 to 6*	*7 to 9*	*10 to 12*
DM allowance (kg/cow/day)				
C[1]	55	53	46	44
R	23	20	21	19
SE	1.3	1.5	0.8	0.9
Post-grazing yield (kg DM/ha)				
C	1920	2180	2490	2210
R	1310	1450	1900	1750
SE	56	45	75	66
Utilization (%)				
C	22.6	28.2	25.4	21.8
R	46.5	53.1	43.0	39.4
SE	1.7	1.4	1.6	1.5

[1]C = control; R = restricted.

TABLE 2: YIELDS OF MILK CONSTITUENTS DURING RESTRICTION (kg/cow[1])

	Weeks			
	1 to 3	*1 to 6*	*7 to 9*	*7 to 12*
Milk				
C[1]	410	817	381	734
C − R	40	68	59	149
SE(d)	6.6	19.2	12.7	29.5
Fat				
C	18.8	28.5	18.4	35.2
C − R	1.3	3.4	3.3	7.6
SE(d)	0.4	0.6	0.7	1.5
Protein				
C	14.1	28.7	13.4	26.4
C − R	2.0	3.7	2.5	6.5
SE(d)	0.3	0.7	0.4	0.9
Lactose				
C	20.6	41.0	18.9	36.3
C − R	2.2	3.9	3.1	7.9
SE(d)	0.4	1.1	0.7	1.5

[1]C = control, groups C + L3 + L6, weeks 1 to 3 and 1 to 6; C, 7 to 9 and 7 to 12.

R = groups E3 + E6, weeks 1 to 3; E6, 1 to 6; L3 + L6, 7 to 9; L6, 7 to 12.

Liveweight and condition score measurements (Table 4) indicated substantial mobilization of body tissue.

Residual effects are shown by yield of milk and its constituents for the various treatments from when restricted feeding ceased until the end of the trial (Table 5). These were small and not significant, although effects that approached significance were evident for E3 (weeks 4 to 26). The results for this treatment appear inconsistent with those of the other three, and also, when the restriction was extended to 6 weeks (E6), residual effects

TABLE 3: PERCENTAGE OF CONSTITUENTS IN MILK DURING RESTRICTION

	Weeks			
	1 to 3	*1 to 6*	*7 to 9*	*7 to 12*
Fat				
C[1]	4.65	4.79	4.88	4.86
C − R	−0.16	0.02	0.12	0.03
SE (d')	0.08	0.09	0.12	0.14
	*	n.s.	n.s.	n.s.
Protein				
C	3.48	3.59	3.57	3.64
C − R	0.17	0.21	0.13	0.17
SE (d)	0.02	0.03	0.05	0.06
	**	**	**	**
Lactose				
C	5.04	5.03	4.98	4.97
C − R	0.05	0.07	0.04	0.94
SE (d)	0.02	0.02	0.04	0.45
	*	*	n.s.	*

[1] As in Table 2.

TABLE 4: CHANGE IN LIVEWEIGHT AND CONDITION SCORE DURING RESTRICTION

	Weeks			
	1 to 3	*1 to 6*	*7 to 9*	*7 to 12*
Liveweight gain (kg/cow/day)				
C	0.83	0.50	−0.55	−0.10
R	−1.61	−0.43	−0.87	−0.36
SE	0.12	0.13	0.08	0.08
Condition score				
C	0.0	0.17	−0.25	−0.29
R	−0.60	−0.15	−0.24	−0.66

TABLE 5: YIELD OF MILK CONSTITUENTS FOLLOWING RESTRICTION (kg/cow)

	Weeks 4 to 26	7 to 26	10 to 26	13 to 26
Milk				
C	2383	1972	1591	619
C – R[1]	168	–8	58	37
SE (d)	100	93	79	33
Fat				
C	116.2	96.4	78.0	61.6
C – R	9.3	2.0	3.8	4.1
SE (d)	5.3	4.8	4.1	3.4
Protein				
C	85.3	70.8	57.4	22.2
C – R	4.3	–1.6	0.9	0.9
SE (d)	3.1	2.9	2.5	1.1
Lactose				
C	117.3	96.5	77.6	30.1
C – R	9.2	0.7	3.9	2.2
SE (d)	5.2	4.8	4.1	1.7

[1]R = group E3, weeks 4 to 26; E6, 7 to 26; L3, 10 to 26; L6, 13 to 26

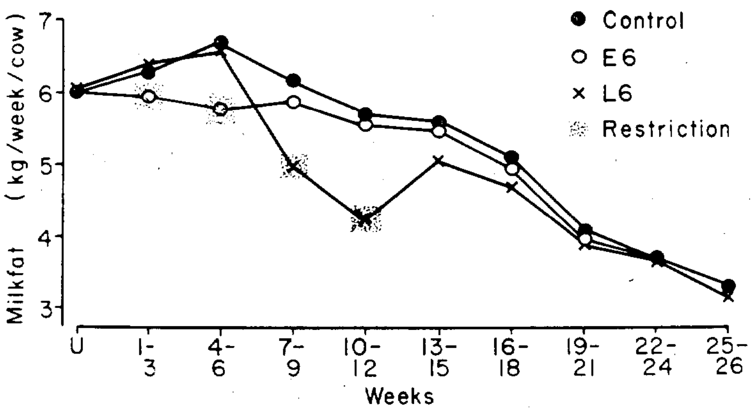

FIG. 1: *Average weekly milk fat yield during the uniformity (U) and experimental periods.*

were absent (weeks 7 to 26). Milk composition following restricted feeding was similar for all treatments. The effects on yield of milk and its constituents observed during restricted feeding had disappeared by the sixth week of improved feeding. Figure 1 shows this effect for fat yield from E6 and L6.

Liveweight at the end of the trial was similar for all groups and averaged 405 kg, 16 kg heavier than the mean starting weight 26 weeks earlier.

EXPERIMENT 2

During the 6 weeks following calving, the L treatment resulted in a 48% reduction in DM intake (Table 6), a 70 kg difference in liveweight, and a 40% reduction in milk yield.

Underfeeding also resulted in a significant reduction in milk fat and protein yields during weeks 1 to 6 (Table 7). As in

TABLE 6: LIVEWEIGHT, DRY MATTER INTAKE, MILK YIELD AND MILK COMPOSITION DURING 6 WEEKS OF UNDERFEEDING IN EARLY LACTATION

	H[1]	*L*	*SEm*
Liveweight (kg)			
Day 1	368	362	± 12.0
Day 42	374	300	± 12.8
DMI (kg/d)	13.1	6.7	± 0.38
Milk (kg/d)	21.2	13.8	± 0.41
Fat (%)	4.46	4.66	± 0.07
Protein (%)	3.36	3.33	± 0.04
Lactose (%)	4.88	4.81	± 0.01

[1]H = well-fed group, L = restricted group.

TABLE 7: EFFECTS OF UNDERFEEDING FOR 6 WEEKS IN EARLY LACTATION ON YIELD OF FAT AND PROTEIN

	Weeks			
	1 to 6	*7 to 12*	*13 to 18*	*19 to 24*
Fat (kg)				
H	36.7	35.0	27.8	24.6
H – L	10.7	5.7	2.6	–0.5
SE(d)	0.19	0.21	0.19	0.21
Sig.	***	*	n.s.	n.s.
Protein (kg)				
H	28.8	23.4	19.4	17.5
H – L	11.1	2.6	1.4	–1.0
SE(d)	0.20	0.19	0.20	0.20
Sig.	***	n.s.	n.s.	n.s.

Experiment 1, the effect on protein was more pronounced than that for fat because underfeeding also depressed the percentage of protein in milk. Residual effects on protein yield were small and were not present after 6 weeks of feeding (Table 7).

There was some indication of residual effects of underfeeding on milk-fat percentage. Thus during weeks 8 to 18 when energy balances were established, milk-fat percentage for the H cows was 5.08%, significantly higher ($P < 0.05$) than for the L cows (4.88%). Differences in protein and lactose percentages were not observed during this time.

Differences between treatments in cow liveweight had also disappeared by week 12, and after 24 weeks of lactation liveweight averaged 373 kg.

Energy balance studies during weeks 8 to 18 indicated that during this time the H cows partitioned more digestible energy to metabolizable energy (9 KJ DE/kg $LW^{0.75}$, $P < 0.05$) and more energy from tissue to milk (85 KJ ME/kg $LW^{0.75}$, $P < 0.01$) than did the L cows. This alteration in energy partitioning represents 7.9 MJ ME/day advantage to the H cows, equivalent to 57 g milk fat/day. During the 10 weeks the energy data were collected, the advantage in fat yield of H cows was 5.5 kg, suggesting that 72% of this difference in production could be accounted for by the observed alterations in energy partitioning.

DISCUSSION

The results of the two experiments are consistent in that the underfeeding imposed caused only a small transient reduction of subsequent production. This was so despite the severity of the underfeeding in Experiment 2.

The calorimetric data support this conclusion. Alterations in energy partitioning, though accounting for about 70% of the differences in milk-fat production observed during weeks 8 to 18, were the equivalent of only 52 g milk fat/day.

It is emphasized that the cows that were not underfed in early lactation achieved a daily production of about 0.9 kg fat/cow. This is high by N.Z. standards. They were in good condition at calving and, as evidenced by their weights at the end of the experiments, they were generously fed during the latter stages. Factors such as these may account for the conflict between these results and those reported earlier (Flux and Patchell, 1954; Wallace, 1957; Geering and Young, 1961).

Clearly, further investigations are warranted. If residual effects from underfeeding in early lactation are small, then considerable flexibility in the management of feed supply in early lactation is possible. It will be reflected, for example, in decisions concerning calving date, allocation of feed supply before and after calving, supplementary feeding in early lactation, and the timing and extent of conservation.

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