The effects of pre- and early post-calving management on reproductive performance of beef cows

Dinah Boadi and M. A. Price[1]

Department of Agricultural, Food and Nutritional Science, University of Alberta, Edmonton, Alberta, Canada T6G 2P5. *Received 22 February 1995, accepted 15 April 1996.*

Boadi, D. and Price, M. A. 1996. **The effects of pre- and early post-calving management on reproductive performance of beef cows**. Can. J. Anim. Sci. **76**: 337–342. One hundred and thirty-four pregnant beef cows (liveweight = 544.3 kg ± 73.3 kg SD; condition score = 3.5 ± 0.3 SD), were randomly assigned in January to five management treatments (combinations of feed restriction and weaning time) to study the effects on calving and rebreeding performance. Twenty-seven were feed-restricted (54.7 MJ DE d^{-1}) for the last 3 mo of pregnancy then realimented (3REST); their calves were weaned in October. Thirty were feed-restricted for the last 3 mo of pregnancy (54.7 MJ DE d^{-1}) and the first 2 mo of lactation (99.6 MJ DE d^{-1}), then their calves were weaned and turned out to graze in June (5REST). The remaining 77 cows (UNREST) were supplemented on range with 153.5 MJ DE d^{-1} from January until calving. Their calves were weaned in either August (one group of 26 calves directly into a feedlot, a second group of 26 onto unsupplemented range) or October (25 calves directly into a feedlot). All cows grazed together on the range from June onwards. After calving, the restricted (3REST and 5REST) cows were significantly lighter (464.4 and 469.5 kg vs. 506.9 kg) and thinner (condition scores 2.5 and 2.6 vs. 3.0) than the UNREST cows, but the percentage of cows calving, calf mortality, assisted births, calving dates, udder scores and mean birth weight of calves were not affected ($P > 0.05$) by pre-calving nutrition. Catch-up growth was evident in both the 3REST and 5REST cows once exposed to higher energy feeding. There were no significant effects ($P > 0.05$) of the management (nutrition and weaning) treatments on the following year's breeding and calving performance. It is concluded that the combinations of nutrition and weaning used in this study did not necessarily impair calving or rebreeding performance of beef cows, which calved in condition score 2.5 or above.

Key words: Beef cows, feed restriction, reproduction, condition score, rebreeding, birthweight

Boadi, D. et Price, M. A. 1996. **Effets des modalités de conduite avant et juste après le vêlage sur les performances de reproduction des vaches allaitantes.** Can. J. Anim. Sci. **76**: 337–342. Cent-trente-quatre vaches à viande gestantes d'un poids moyen de 544,3 kg ± 73,3 kg (note d'état corporel 3,5 ± et 0,3) ont été réparties au hasard en janvier entre cinq traitements de conduite (combinaisons rationnement et date de sevrage), dans le but d'observer les effets sur les performances de vêlage et de remise à la reproduction. Vingt-sept vaches étaient rationnées à 54,7 MJED j^{-1}) dans les trois derniers mois de la gestation, puis remises à un régime énergétique normal dès le vêlage (3REST). Leurs veaux étaient sevrés en octobre. Trente autres étaient également rationnés à 54,7 MJED j^{-1} dans les trois derniers mois de la gestation, puis à 99,6 MJED j^{-1} dans les deux premiers mois de lactation (5REST), après quoi leurs veaux étaient sevrés puis mis à l'herbe en juin. Les 73 vaches restantes (NONREST) gardées en parcours, recevaient un complément alimentaire de 153,5 MJED j^{-1} de janvier jusqu'au vêlage. Les veaux étaient sevrés soit en août: 26 mis en parc d'engraissement et 26 mis en parcours sans complémentation ou en octobre (25 mis directement en parc d'engraissement). A partir de juin, toutes les vaches étaient mises à l'herbe en parcours. Après le vêlage, les vaches rationnées (3REST et 5REST) étaient significativement moins lourdes (464,4 et 469,5 kg contre 506,9 kg) et plus maigres (notes d'état 2,5 et 2,6 contre 3,0) que les vaches non rationnées mais le niveau nutritionnel de prévêlage n'avait pas d'effets significatifs ($P > 0,05$) sur le taux de vêlage, sur la mortalité vitulaire, le nombre de vêlages assistés, la date de vêlage, la notation du pis et le poids moyen des veaux à la naissance. On observait un rattrapage de la croissance chez les vaches rationnées une fois qu'elles étaient revenues à un niveau d'ingestion énergétique plus élevé. Le mode de conduite des vaches (alimentation et sevrage) n'avait pas d'effet significatif ($P < 0,05$) sur les performances de reproduction et de vêlage l'année suivante. Il appert donc que les combinaisons de régime alimentaire et de date de sevrage utilisées dans nos expériences n'ont pas nécessairement un effet négatif sur les performances de vêlage ou de remise à la reproduction des vaches, lesquelle au vêlage avaient une note d'état d'au moins 2,5.

Mots clés: Vaches d'élevage de boucherie, rationnement, reproduction, note d'état corporel, remise à la reproduction, poids à la naissance

Beef producers are concerned about appropriate nutrition for their cows, particularly during the last trimester of pregnancy. Undernutrition may lead to reduced birth weights (Bellows and Short 1978) and calf survival, prolonged postpartum anestrus and impaired lactation and rebreeding performance (Richards et al. 1986; Wright et al. 1992). Overfeeding may result in dystocia, and excess fat deposition in the mammary system (Harrison et al. 1983; Stelwagon and Grieve 1990), though clearly, this would depend upon the previous condition (fatness) of the cow.

Appropriate prepartum feeding levels are difficult to determine, since cows differ in their responses depending

Abbreviations: **3REST**, cows feed restricted for the last 3 mo of pregnancy then realimented; **5REST**, cows feed restricted for the last 3 mo of pregnancy and the first 2 mo of lactation then turned out to graze in June; **UNREST**, cows supplemented on winter range, free access to summer range

[1]*Author to whom correspondence should be addressed.*

upon age, size, body condition, and milking potential. Body condition score (e.g. Lowman et al. 1973) during pregnancy and at parturition can be an aid to determining appropriate nutrition to ensure optimal reproductive efficiency of the herd (Spitzer 1986). The following study was undertaken to determine the long-term effects of reduced feed intake during the last third of pregnancy and in early lactation combined with early weaning of calves, on the reproductive performance of healthy beef cows in good body condition.

MATERIALS AND METHODS

Animals and Feeding Treatment

One hundred and thirty-four Beef Synthetic cows (Berg et al. 1986) of four age groups (3 yr, n = 48; 4 yr, n = 19; 5 yr, n = 17 and 6+ yr, n = 50) entering the last third of gestation, were used in this study. They had all calved unassisted as 2 yr olds, and every year subsequently. Cows had been together on range since breeding in July/August 1989. On 26 January 1990, they were weighed and condition scored (Lowman et al. 1973) on a scale of 0 (emaciated) to 5 (grossly fat) in half-point increments and randomly assigned to three feeding treatments:

(i) from January until calving 77 cows (UNREST group; n for 3, 4, 5 and 6+ yr = 32, 6, 6 and 33, respectively) were kept on open range and group fed 1.9 kg barley grain, 10.7 kg alfalfa/brome hay and 1.42 kg oaten greenfeed daily with unlimited straw and trace-mineralized salt (calculated daily DE intake 153.5 MJ cow^{-1} d^{-1}, Table 1). As each cow calved she was moved to join the other nursing cows on open range and supplemented with 3.2 kg barley and 6 kg alfalfa/brome hay (109.5 MJ cow^{-1} d^{-1}) until 23 May when the range grasses, mainly alfalfa (*Medicago sativa*), brome (*Bromus* spp.) and fescue (*Festuca* spp.), were considered sufficiently nutritious to discontinue offering the supplement.

(ii) from January until calving, 27 cows (3 REST group; n for 3, 4, 5 and 6+ yr = 6, 7, 5 and 9, respectively) were kept in a 42.7-m × 35.9-m open pen and group fed once daily 2.91 kg barley and 0.96 kg alfalfa/brome hay (calculated daily DE intake 54.7 MJ cow^{-1} d^{-1}, Table 1); bedding straw, water and trace-mineralized salt were freely available. As each cow calved, she was moved to the range and fed the same as the UNREST cows.

(iii) from 26 January until calving 30 cows (5REST group; n for 3, 4, 5 and 6+ yr = 10, 6, 6 and 8, respectively) were kept in another 42.7-m × 35.9-m open pen and group fed once daily the same diet and ration as the 3REST group (54.7 MJ DE cow^{-1} d^{-1}). As each cow calved she was moved to join the other nursing 5REST cows in another open pen, where they were group fed 3.26 kg barley and 4.26 kg of alfalfa/brome hay once daily (99.6 MJ DE cow^{-1} d^{-1}). Bedding straw, water and trace mineralized salt were provided freely. These cows joined the others on range on 19 June for breeding.

Calves were identified and weighed within 24 h after birth; at the same time cows were also weighed, body condition scored, and scored for ease of calving on a scale of 0 to 5 (0 = no assistance, 1 = slight assistance, 2 = a puller used easily, 3 = a puller used with difficulty, 4 = veterinarian required and 5 = Caesarean birth). Udders were also scored (1 = small ideal teats, 2 = ideal teats, 3 = large teats, 4 = very large teats, 5 = pendulous udder, 6 = one or two blind teats, 7 = mastitis) within 24 h after calving.

The postcalving experimental design consisted of five management (cow nutrition combined with weaning strategy) treatments: (1) at the start of breeding on 19 June the 30 calves of the 5REST cows were weaned and given access to a calf ration from self feeders; (2) the 27 calves of the 3REST cows were weaned in October 1990 into the feedlot; (3) 26 of the UNREST calves were weaned in August 1990 into the feedlot; (4) 26 of the UNREST calves were weaned in August 1990 to pasture for 2 mo then moved into the feedlot in October 1990; (5) the final 25 UNREST calves were weaned directly into the feedlot in October 1990.

Fifteen of the original 134 cows (six UNREST; four 3REST; and five 5REST) were not exposed to bulls for breeding because of calving difficulty, udder scores of 4 or greater, death or loss of calves. From 19 June, (about 2 mo after calving) until 3 August, the remaining 119 cows were multiple-sired as a single group to six Beef Synthetic bulls (2 and 3 yr olds). Cows were pregnancy tested by rectal palpation in November 1990 (about 3–4 mo into gestation). Liveweights and body condition scores were recorded periodically until April/May 1991, the second calving season of the experiment. Record collection protocols for the second calving were the same as for the first. Cows and calves were cared for according to the guidelines of the Canadian Council on Animal Care.

Statistical Analyses

Rates of gain of individual cows during refeeding were calculated as the regression of liveweight on time. Liveweights, rate of liveweight gain, body condition scores and reproduction data were subjected to least squares analysis of variance to study the effects of feed restriction on reproductive performance of restricted-refed cows using the General Linear Model (Type III) procedure (SAS Institute, Inc. 1989).

The model used was:

$$Y_{ijk} = \mu + T_i + A_j + TA_{ij} + E_{k(ij)}$$

where Y_{ijk} = trait under consideration; μ = overall mean; T_i = treatment (I = 1... 3); A_j = age of cows (j = 1... 4, where 1 = 3 yr; 2 = 4 yr; 3 = 5 yr and 4 = 6$^+$ yr); TA_{ij} = treatment × age of cows interaction and $E_{k(ij)}$ = random error term. In considering birth weight and liveweight data of calves, sex was introduced into the model. Because of the experimental design, no attempt could be made to analyse separately the two components of the management treatments (cow nutrition and weaning age of calf).

Table 1. Composition of feed as fed to cows (kg animal^{-1} d^{-1})

	UNREST[z]		3REST[z]		5REST[z]	
	Precalving[y]	Postcalving[y]	Precalving[y]	Postcalving[y]	Precalving[y]	Postcalving[y]
Barley grain (kg)	1.90	3.20	2.91	3.20	2.91	3.26
Alfalfa/brome hay (kg)	10.70	6.00	0.96	6.00	0.96	4.62
Green feed(oats) (kg)	1.42	–	–	–	–	–
Calculated analysis[x]						
Dry matter (kg)	12.5	8.2	3.4	8.2	3.4	7.0
Digestible energy (MJ)	153.5	109.5	54.7	109.5	54.7	99.6

[z]See text for description of treatments.
[y]Precalving: 26 Jan. to 3 Apr.; Postcalving: 4 Apr. to 22 May for UNREST and 3REST and 4 Apr. to 20 June for 5REST.
[x]Calculations based on table values (NRC 1984)

Table 2. Least squares means ± SE for calving performance of feed-restricted and unrestricted beef cows

	Treatment groups (T)[z]				Age groups (A)					
Trait	UNREST	3REST	5REST	P(T)	3 yr	4 yr	5 yr	6[+] yr	P(A)	P(T×A)
1990 26 Jan.										
No. of cows	77	27	30	48	19	17	50			
Cow wt (kg)	539.7 ± 7.0	541.6 ± 8.8	545.7 ± 8.3	0.86	485.6 ± 8.1*a*	508.8 ± 10.3*a*	559.1 ± 10.9*b*	615.7 ± 7.7*c*	0.001	0.08
Condition score	3.3 ± 0.04	3.4 ± 0.05	3.4 ± 0.05	0.34	3.3 ± 0.05*a*	3.3 ± 0.06*a*	3.5 ± 0.07*b*	3.6 ± 0.05*b*	0.001	0.89
24 h post calving										
No.of cows (%)	77(100)	27(100)	29(96.7)	0.57	48(100)	18(94.7)	17(100)	49(98)	0.60	
Cow weight (kg)	506.9 ± 8.0*a*	464.4 ± 10.0*b*	469.5 ± 9.8*b*	0.001	424.9 ± 9.2*a*	445.8 ± 12.1*a*	495.1 ± 12.3*b*	555.2 ± 8.8*c*	0.001	0.10
Condition score	3.0 ± 0.1*a*	2.5 ± 0.1*b*	2.6 ± 0.1*b*	0.001	2.6 ± 0.1*a*	2.6 ± 0.1*a*	2.7 ± 0.1*a*	3.0 ± 0.1*b*	0.001	0.49
Udder score	2.4 ± 0.1	2.3 ± 0.1	2.1 ± 0.2	0.38	2.2 ± 0.2	2.1 ± 0.2	2.4 ± 0.2	2.3 ± 0.1	0.82	0.42
Calving date (d[y])	111.4 ± 2.0	111.5 ± 2.8	109.0 ± 2.7	0.84	108.7 ± 2.6*a*	107.0 ± 3.4*a*	107.8 ± 3.5*a*	120.0 ± 2.5*b*	0.002	0.81
Calf weight (kg)	36.7 ± 0.7	34.1 ± 0.9	34.7 ± 0.9	0.06	33.6 ± 0.8*a*	35.2 ± 1.1*a*	34.8 ± 1.1*a*	37.0 ± 0.8*b*	0.03	0.03
Calf mortality (%)	1(1.3)	1(3.7)	0.0	0.51	1(2.0)	1(5.3)	0.0	0.0	0.40	
Assist. births (%)	0.0	1(3.7)	1(3.5)	0.25	1(2.0)	1(5.3)	0.0	0.0	0.40	

[z]See text for description of treatments.
[y]Day of the year (day 1 = 1 Jan.).
*a–c*Means within a row followed by a different letter differ significantly ($P < 0.05$).

Significant differences among means were tested by pairwise *t*-test comparisons for unequal treatments and age group observations (Steel and Torrie 1980). Comparisons of the percentage of cows calving, calf mortality, assisted births and pregnancy rates were made using the Chi- square test (Steel and Torrie 1980). Significance was assessed at the 0.05 level.

RESULTS

Calving Performance

Mean liveweights and body condition scores of 3REST and 5REST cows, recorded within 24 h after calving, were significantly lower ($P < 0.001$) than those of UNREST cows (Table 2). The restricted cows lost about twice as much body weight (77.3 ± 5.4 kg and 77.7 ± 5.2 kg, respectively) as UNREST cows (32.7 ± 4.3 kg) between 26 January and 24 h after calving. Feed restriction during the third trimester of pregnancy had no statistically significant effect on birth weight of calves but this result is equivocal ($P = 0.06$; Table 2). The oldest cows were the heaviest, had the highest condition scores and had the heaviest calves ($P < 0.05$), as expected. Liveweights of male and female calves were similar ($P = 0.21$) at birth (35.9 ± 0.6 kg vs. 34.9 ± 0.7 kg, respectively). A significant feeding treatment × age group interaction was found for the birth weight of calves ($P =$ 0.035); the interaction means are shown in Table 3. With the exception of the 3 yr old/5REST combination, the 3- and 4-yr old restricted cows had lighter calves than the unrestricted cows. On the other hand birthweights from older (5 yr and 6+ yr) cows were not significantly affected by feed treatments. There was no significant interaction of sex of calf with feeding treatment or age of cow.

Table 3. The effects of feeding treatment and age of cow on the birth weight (kg) of calves

	Treatment groups[z]		
Age groups	UNREST	3REST	5REST
3 yr	35.4 ± 0.8*b*	30.5 ± 1.9*a*	34.9 ± 1.5*b*
4 yr	40.0 ± 1.9*b*	33.3 ± 1.7*a*	32.2 ± 2.0*a*
5 yr	35.3 ± 1.9*a*	35.2 ± 2.0*a*	33.8 ± 1.9*a*
6+ yr	36.0 ± 0.8*a*	37.3 ± 1.5*a*	37.8 ± 1.6*a*

[z]See text for description of treatments.
*a,b*Means within a row followed by a different letter differ significantly ($P < 0.05$).

The percentage of cows calving, udder scores and calving dates were not significantly ($P > 0.05$) affected by feeding level, however the 6+ yr cows calved later ($P < 0.05$) than the other age groups. Calf mortality within 24 h of birth and the incidence of calving difficulty were not affected by feeding treatments or age of cows ($P > 0.05$; Table 2).

Table 4. Least squares means ± SE of liveweights, condition scores, and gains of cows during refeeding

Trait	Treatment groups (T)[z]				Age groups (A)					
	UNREST	3REST	5REST	P(T)	3 yr	4 yr	5 yr	6+ yr	P(A)	P(T×A)
No. of cows	71	23	25		45	15	14	45		
19 June										
Liveweight (kg)	524.8 ± 7.0*a*	519.0 ± 9.1*a*	476.4 ± 9.6*b*	0.003	448.4 ± 8.2*a*	476.9 ± 11.5*b*	527.4 ± 11.8*c*	574.2 ± 7.7*d*	0.001	0.27
Condition score	3.4 ± 0.05*a*	3.4 ± 0.06*a*	3.1 ± 0.06*b*	0.006	3.0 ± 0.05*a*	3.1 ± 0.07*a*	3.3 ± 0.07*b*	3.5 ± 0.05*b*	0.001	0.16
21 August										
Liveweight (kg)	551.5 ± 7.2	552.9 ± 9.2	533.7 ± 9.7	0.27	495.1 ± 8.3*a*	517.5 ± 11.6*a*	557.0 ± 12.0*b*	614.6 ± 7.9*c*	0.001	0.15
Condition score	3.6 ± 0.05*a*	3.6 ± 0.06*a*	3.3 ± 0.06*b*	0.006	3.3 ± 0.05*a*	3.3 ± 0.07*a*	3.6 ± 0.07*b*	3.7 ± 0.05*b*	0.001	0.02
24 September										
Liveweight (kg)	572.2 ± 7.3	578.0 ± 9.4	578.2 ± 9.9	0.83	530.4 ± 8.4*a*	542.3 ± 11.8*a*	592.7 ± 12.2*b*	640.6 ± 8.0*c*	0.001	0.09
Condition score	3.7 ± 0.04*a*	3.8 ± 0.06*a*	3.5 ± 0.06*b*	0.006	3.5 ± 0.05*a*	3.4 ± 0.07*a*	3.7 ± 0.07*b*	3.9 ± 0.05*b*	0.001	0.07
ADG (kg d^{-1})										
Calving–19 June	0.33 ± 0.09*a*	1.02 ± 0.11*b*	0.06 ± 0.11*a*	0.001	0.37 ± 0.09	0.68 ± 0.14	0.47 ± 0.14	0.36 ± 0.09	0.23	0.94
19 June–21 Aug.	0.42 ± 0.04*a*	0.54 ± 0.05*a*	0.91 ± 0.05*b*	0.001	0.74 ± 0.04*a*	0.64 ± 0.06*a*	0.47 ± 0.06*b*	0.64 ± 0.04*a*	0.008	0.15
21 Aug.–24 Sept.	0.61 ± 0.07*a*	0.75 ± 0.09*a*	1.31 ± 0.09*b*	0.001	1.04 ± 0.08*a*	0.70 ± 0.11*b*	1.05 ± 0.11*a*	0.76 ± 0.08*a*	0.012	0.91

[z]See text for description of treatments.
*a–d*Means within a row followed by a different letter differ significantly ($P < 0.05$).

Table 5. Least squares means ± SE for reproductive performance of unrestricted and restricted and refed beef cows

Trait	Treatment groups (T)[z]				Age groups (A)					
	UNREST	3REST	5REST	P(T)	3 yr	4 yr	5 yr	6+ yr	P(A)	P(T×A)
No. of cows exposed	71	23	25		45	15	14	45		
Pregnant in Nov. (%)	66(93.0)	20(87.0)	21(84.0)	0.61	41(91.1)	13(86.7)	14(100)	39(86.7)	0.59	
1991 calving wt. (kg)	539.0 ± 7.5	536.6 ± 10.4	561.6 ± 12.0	0.22	496.0 ± 9.0*a*	517.6 ± 14.5*ab*	553.3 ± 12.7*b*	617.2 ± 9.6*c*	0.001	0.39
Condition score	2.8 ± 0.1	2.6 ± 0.1	2.9 ± 0.1	0.11	2.4 ± 0.1*a*	2.8 ± 0.1b	2.9 ± 0.1b	3.0 ± 0.1*b*	0.001	0.29
Udder score	2.1 ± 0.1	2.3 ± 0.2	2.2 ± 0.2	0.69	2.1 ± 0.2	2.2 ± 0.3	2.3 ± 0.2	2.3 ± 0.2	0.92	0.95
Calving date (d)[y]	107.2 ± 1.5*a*	109.3 ± 2.0*a*	101.2 ± 2.4*b*	0.03	106.4 ± 1.8	106.0 ± 2.9	105.5 ± 2.5	105.0 ± 1.9	0.90	0.88
Calf birth wt. (kg)	39.5 ± 0.8	39.2 ± 1.1	40.3 ± 1.2	0.80	40.4 ± 1.0	36.9 ± 1.6	39.8 ± 1.4	41.5 ± 1.0	0.11	0.38
Calf mortality (%)	0.0	0.0	1(5)	0.10	1(2.5)	0.0	0.0	0.0	0.33	

[z]See text for description of treatments.
[y]Day in the year (day 1 = 1 Jan.).
*a–c*Means within a row followed by a different letter differ significantly ($P < 0.05$).

Liveweight Changes during Refeeding

Refeeding the 3REST cows after calving resulted in liveweights and body condition scores which were not significantly different ($P > 0.05$) from UNREST cows by 19 June (Table 4). Daily gains were higher ($P < 0.05$) for 3REST than UNREST cows (1.02 ± 0.11 vs. 0.33 ± 0.09 kg d^{-1}) from calving to breeding (19 June). Refeeding and early weaning of the calves in the 5REST group from 19 June resulted in liveweight recovery by 21 August. They exhibited higher ($P < 0.05$) daily gains than the other groups from June to August and August to September (Table 4). Their body condition scores were however still lower ($P < 0.05$) than the UNREST and 3REST groups on 24 September (Table 4). There was a significant age × treatment interaction for August condition scores. Daily gains were not different ($P > 0.05$) among age groups from calving to breeding. The 5 yr olds grew more slowly ($P < 0.05$) than the others from 19 June to 21 August, while gains for 3 yr and 5 yr olds were higher ($P < 0.05$) than the other age groups from 21 August to 24 September.

Rebreeding Performance

The percentage of cows diagnosed pregnant in November 1990 did not differ significantly ($P > 0.05$) among management or age groups (Table 5). Birth weights of calves during the second calving period were not affected by the previous management (weaning age plus nutrition) treatment or by age of dam ($P > 0.05$). There were no significant differences among treatments with respect to liveweights, body condition scores or udder scores recorded within 24 h postnatally ($P > 0.05$). Liveweight and body condition score increased with age ($P < 0.05$). The 5REST cows calved significantly earlier ($P < 0.05$) than 3REST and UNREST, but there were no differences ($P > 0.05$) in calving dates among the age groups. There were no incidents of calving difficulty or any significant treatment × age group interactions for the reproductive data.

DISCUSSION

Feed restriction of cows during the final third of pregnancy in this study significantly ($P < 0.001$) reduced liveweight and body fatness (Table 2) but did not significantly affect the birth weight of their calves. The pregnant cow tends to buffer the adverse effects of undernutrition on her developing fetus by utilizing her body reserves (Spitzer 1986), resulting in weight and condition loss from her own body as observed in this study. Similar observations were reported by Whittier et al. (1988) with heifers. Conversely, Tudor (1972) observed that a sub-maintenance ration over the last third of gestation in cows significantly reduced birth weight and length of gestation compared to an above-maintenance ration. These differences in observations are assumed to be due to differences in breed, dietary treatments, the initial body condition and size of the cows.

Prior and Laster (1979) in studying the development of the bovine fetus found higher placental weight for low and medium, than for high maternal dietary energy levels. They suggested that development of fetal membranes increased on the lower maternal energy levels to compensate for the lower level of nutrients available to the placenta from maternal circulation. This might explain the greater loss of weight by 3REST and 5REST cows up to calving despite the comparable weights of their calves with the UNREST controls. The influence of age of dam and gestation length on birth weight has been reported by other workers (Anderson and Plum 1965; Koonce and Dillard 1967) with older and heavier dams tending to have heavier calves than younger ones. In the present study cows had condition scores averaging 3.5 in January 1990, and even the restricted cows had condition scores averaging 2.5 at calving. This indicates the presence of good fat reserves in all cows throughout the final trimester of pregnancy, and is assumed to be a major contributor to the similarities in calf birthweights.

Competition between younger, growing cows and their fetuses for nutrients would be expected to reduce the total nutrients available for fetal growth and result in lower birth weights of calves (Spitzer 1986). Generally, this was not seen in the present study, though the interaction means shown in Table 3 indicate that while older cows were able to shield their calves from nutritional restriction, the younger cows, presumably because of their smaller size, and immature stage of growth, did not do so.

Feed restriction prior to calving was followed by rapid catch-up growth during refeeding. The 3REST cows had been about 40 kg lighter than the UNREST cows immediately after calving, but by 19 June despite nursing a calf, had caught up. The 5REST cows were about 50 kg lighter than the others on 19 June, but caught up to them by 21 August. This is consistent with the literature on catch-up growth (Wright and Russel 1991; Yambayamba and Price 1991). The 5REST cows, which were restricted for a longer period and had their calves weaned at breeding, exhibited very high growth rates during realimentation.

Yambayamba and Price (1991) observed that during realimentation, growth rates of severely restricted heifers were greater than those of mildly restricted heifers. Butler-Hogg and Tulloh (1982) working with sheep suggested that when animals are realimented, those which have lost a greater proportion of their initial body weight are likely to make a more rapid recovery. However, the higher daily gains observed in the 5REST group in this study cannot be attributed solely to the longer feed restriction imposed; the added effect of early weaning must also have contributed. Saubidet and Verde (1976) and Ledger and Sayers (1977) have attributed this general trend in restricted-refed animals to the higher voluntary feed intake per unit of liveweight or metabolic body size during realimentation, and also to lower maintenance requirements of severely restricted animals, making a greater fraction of energy intake available for growth. Wright and Russel (1991) also showed that restricted-refed cattle initially accumulate a greater proportion of protein and water in the gain, but accumulate a greater proportion of fat in the later stages of refeeding. This might explain the lack of full recovery of body condition in 5REST cows by 24 September 1990. The significant age × treatment interaction in 21 August condition scores may also be a contributing factor to the later recovery of body condition.

Subsequent pregnancy rates showed no effects of previous feeding treatments, despite the fact that the 5REST cows entered the breeding pastures at significantly lighter body weight and poorer body condition than the others. Concurrent weaning of their calves and access to unrestricted nutrition from the beginning of the breeding season clearly combined to allow rapid recovery to the point of conceiving earlier than the other groups. Hill and Godke (1987) noted that suckling has an inhibitory effect on the return to ovarian cyclicity in cattle. Calf mortality occurring in the youngest cows was due to mal-presentation at calving and is assumed not to be a result of feeding treatment. The capability of the restricted-refed cows used in this study to calve satisfactorily and to reproduce subsequently was not impaired; however, the contribution of weaning treatment to subsequent reproductive performance in this study should not be overlooked. These findings agree with studies reported by Parks et al. (1987) and Whittier et al. (1988), though other workers have reported poor subsequent reproductive performance following restricted feeding prepartum (Dunn and Kaltenbach 1980; Richards et al. 1986). It is assumed that the differences between those studies and this one are the result of differences in body condition and age of the cows at the start of the experiments as well as the management (weaning age plus nutrition) treatments in this study.

CONCLUSION

It is concluded that cows may be allowed to lose condition during the last trimester of pregnancy, when feed is presumably relatively expensive, provided they are in condition score 2.5 or better at calving. It is clear that if they receive appropriate management, which may include a combination of early weaning and adequate nutrition, such cows can fully recover liveweight and condition score, without impairing reproductive performance. Feed restriction following calving need not impair reproductive performance provided cows are in condition score 2.5 or greater at calving and calves are weaned before breeding. This information could be translated into feed savings by beef producers.

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