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Influence of *pre partum* and *post partum* plane of nutrition on the performance of crossbred suckler cows and their progeny

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The objective of the experiment was to study the effects of two *pre partum* and four *post partum* feeding levels on the performance of 28 Hereford-Ayrshire and 30 Limousine-Ayrshire spring-calving mature cows in calf to Limousin and their calves from the beginning of indoor feeding until the end of grazing under Finnish climatic conditions. A 2 × 2 factorial design experiment consisted of a low (L) and moderate (M) *pre partum* feeding levels based on hay and straw and two *post partum* concentrate feeding levels, 1.5 and 3.5 kg/d (1 and 2, respectively). The treatments were replicated across the genotypes. For feeding level L the amount of roughage offered was restricted to proportionately 0.7 on a dry matter (DM) basis of feeding level M. Milled barley was offered at 1.3 kg DM/d to all cows 72 days pre calving. The experiment was divided into two parts, an indoor feeding (215 days) and grazing period (114 days). The indoor feeding period included three periods, from start of the study to the beginning of additional concentrate feeding (P1) and feeding additional concentrate supplements both pre (P2) and post calving (P3).

On feeding level M cows had a daily intake of 9.1 and 10.4 kg DM during periods P1 and P2, respectively. During period P3 intake was 10.4 and 12.0 kg DM for 1 and 2. Corresponding values for feeding level L were 6.7, 8.0, 8.0 and 9.7 kg DM, respectively. At the onset of grazing, cows on feeding level M were 47 kg heavier ($P<0.05$) than those on feeding level L. At pasture, cows fed feeding level L had a higher ($P<0.001$) live weight gain (LWG) than those on feeding level M. Cows fed less concentrate lost more ($P<0.001$) live weight from calving to grazing than those receiving higher amounts (–1241 vs. –588 g/d) but compensated for these losses ($P<0.05$) at pasture. *Post partum* concentrate feeding did not affect cow condition. During indoor feeding cows receiving a lower level of feeding lost more ($P<0.05$) condition (–0.67 vs.–0.09 for L and M, respectively). *Pre partum* treatments did not lead to calving difficulties. Treatments had no effect on calf LWG pre weaning. Cows had a mean milk production of 11.8 kg/d and an average conception rate of 86.8%. Cows on diet L1 appeared to receive enough energy for satisfactory cow and calf performance. The

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current data indicates that feeding levels pre calving have a greater significance on cow and calf performance than the plane of nutrition post calving.

Key words: beef cows, calves, conception rate, condition score, milk production, plane of nutrition

Introduction

Approximately half of the total energy required for beef production is a result of energy costs for maintenance (Ferrell and Jenkins 1984). Two thirds of the annual energy and protein requirements of the beef cow are necessary for maintenance, requirements that are closely related to animal live weight. In fact, the efficiency of energy utilization for beef production is known to be poor. Approximately 65% of the total feed consumed in the typical life time of a beef cow, is needed to get calves to the age of weaning (Gregory 1972). For these reasons restriction on intake is often recommended in order to reduce feeding costs, especially in marginal areas such as Finland with long indoor feeding periods and short grazing periods.

However, reducing intake may have a detrimental effect on cow and calf performance, since during late pregnancy severe undernutrition may compromise calf survival and subsequent performance. Immature, young cows fed reduced levels of feeding tended to produce lighter calves than mature cows (Smithson et al. 1966) due to both direct intake effects and due to partitioning of energy towards growth rather than pregnancy. Undernutrition may also result in lower calf birth weights (Hight 1966, Houghton et al. 1990, Spitzer et al. 1995). Calf survival rates and growth are reduced due to greater calving difficulties, reduced quality and quantity of colostrum milk and reduced maternal properties. A low level of feeding may also affect suckler cow milk yield as well as calf growth rate (Hodgson et al. 1980, Bartle et al. 1984). However, the most important and immediate effect of undernutrition in the beef cow is a delay in cycling and ovulation and thus, depressed pregnancy rates (Holness et al. 1978, Somerville et al. 1979). Body condition at calving has a major role in reproductive performance of suckler cows, since it regulates the duration of *post partum* anoestrus (Wiltbank et al. 1962, Selk et al. 1988). A low level of feeding in marginal climatic areas did not affect cow or calf health but depressed reproductive performance (Manninen et al. 2000). However, cows replenished live weight losses during the grazing period on sufficiently good quality pasture.

The objective of the present experiment was to study under suckled-calf production in Finland and regions with similar climatic conditions the effects of two *pre partum* feeding levels based on hay and straw and four *post partum* feeding levels on the performance of Hereford-Ayrshire and Limousine-Ayrshire crossbred mature cows and their Limousin calves from the beginning of November until the end of grazing on September.

Material and methods

Animals and experimental design

The experiment was carried out at Tohmajärvi research station located in eastern Finland (62°14’N, 30°21’E). The temperatures recorded inside and outside the cowhouse are presented in Figure 1. Average growth period at Tohmajärvi is 155 days (base temperature +5°C) and grazing period 100–120 days.

Twenty-eight Hereford-Ayrshire (HfAy)-cows, initial live weight (LW) 613 kg and 30 Limousine-Ayrshire (LiAy)-cows, initial LW 577 kg were selected for the current experiment. Animals of both breeds were mature, four-year-old and in calf to a Limousin (Li) bull. A 2 × 2

Vol. 10 (2001): 3–18.

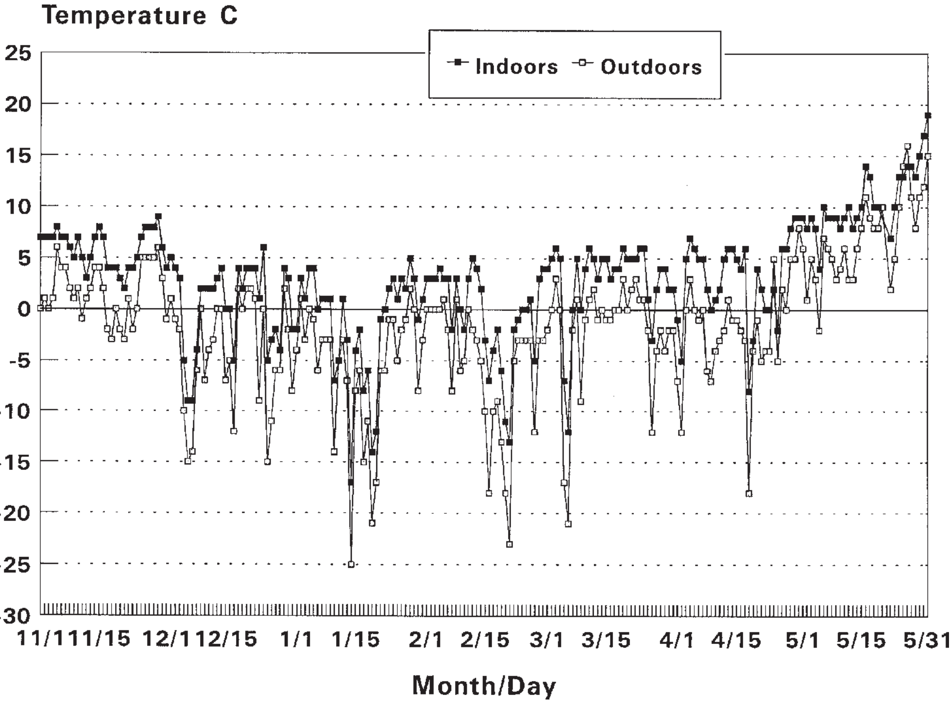

Fig. 1. Daily temperature (°C) inside and outside the barn during indoor feeding.

factorial arranged experiment consisted of two *pre partum* treatments of a low (L) and moderate (M) level of feeding based on hay and straw and two *post partum* concentrate feeding levels, (1.5 and 3.5 kg/animal/d, 1 and 2, respectively), subsequently refered as L1, L2, M1 and M2. Predicted calving date (= stage of gestation based on the ultrasonic scanning) and initial LW were used in order to allocate animals to experimental treatments. Animals were group-fed, once daily in the morning, six to eight animals per pen, four pens per treatment pre calving and two pens per treatment post calving. Each pen included one breed (Table 1). The treatments were replicated across the genotypes. The experiment commenced on 31 October and consisted of two main parts, an indoor feeding averaging 215 days and a grazing period averaging 114 days which commenced on 2 June. The indoor feeding was comprised of three periods: from the start to the beginning of extra concentrate feeding (P1 mean 97 days), additional concentrate feeding pre calving (P2 mean 72 days) and post calving (P3 mean 46 days). The grazing season ended and calves were weaned on 24 September. Details of the animal housing facilities have been documented previously (Manninen et al. 1998).

Feeds, feeding and feed sampling

During feeding at 0730, cows were tied for 2–3 hours to allow an equal opportunity to consume offered feed. The amount of feed offered and refused was recorded for each group daily. For feeding level M, feed was offered to cows according to Finnish recommendations (Ojala 1987) which are based on those for dry dairy cows (Salo et al. 1982) documented as $LW^{0.75}/500^{0.75} \times 4.0$ fattening feed units (FFU) for maintenance and 0.4 FFU/kg fat corrected milk for milk production. The feed evaluation system

Table 1. Length of feeding periods at each treatment.

Pen	1	3	2	4	5	7	6	8
Number of animals	6	6	7	7	8	6	6	7
Breed[1]	HfAy	LiAy	HfAy	LiAy	HfAy	LiAy	HfAy	LiAy
Pre partum feeding[2]	L	L	L	L	M	M	M	M
Post partum feeding[3]	1	1	2	2	1	1	2	2
Feeding period, days								
P1, from start to the onset of concentrate feeding	93		100		97		96	
P2, concentrate feeding pre calving	78		69		72		70	
P3, post calving	45		45		45		48	
Indoor period	216		214		214		214	
Grazing period	113		115		115		115	

[1] HfAy=Hereford-Ayrshire, LiAy=Limousine-Ayrshire.
[2] L=Low, M=Moderate.
[3] 1=1.5 kg/d, 2=3.5 kg/d.

changed in Finland from net energy based system into metabolizable energy (ME) based system after the present experiment was planned and thus, the results are calculated and reported in the present ME based system. In the present feed evaluation system (Tuori et al. 1996) energy requirement for maintenance for dry dairy cow is documented as 8.31 MJ ME + 0.0078 × LW and 5.15 MJ ME × kg energy corrected milk for milk production. Forage consisted of hay and straw offered as proportionately 0.75 and 0.25 on a dry matter (DM) basis. Cows received the same amount of roughage during the entire indoor feeding period. For feeding level L, the amount of roughage offered was restricted to proportionately 0.7 of feeding level M. The extent of restriction was based on initial animal liveweights and the protein and energy values of the experimental feeds. Milled barley was offered individually to all cows at 1.3 kg DM/d during period P2. After calving during period P3 cows received individually either 1.28 (diet 1) or 2.94 (diet 2) kg DM barley/d for both feeding levels. During indoor feeding, cows had free access to a mineral mixture rich in phosphorus (Suomen Rehu Ltd.: Fosfori-Hertta, Ca:P = 1.2:1; Ca 145 g/kg, P 115 g/kg, NaCl 110 g/kg, Na 65 g/kg, Mg 35 g/kg), salt lick and water. A vitamin mixture (Karja-Vitan and Karjan Teho-Vitan; A 2 000 000 I.U./kg, D_3 200 000 I.U./kg, E 2 000 mg/kg, Se 10 mg/kg) was given to cows at 200 g/week.

During the indoor period feed samples for chemical analyses were taken at every feeding and pooled over a four week period. Calculated energy values of hay, oats straw and barley are based on determined chemical composition and averaged digestibility coefficients reported by Tuori et al. (1996). ME values of feeds were calculated according to MAFF (1975, 1984). Hay ME content was calculated as 0.169 × digestible organic matter in the DM (DOMD) –1.05 and ME content of straw as 0.14 × DOMD. Published value was used for barley (Tuori et al. 1996). Amino acids absorbed in the small intestine (AAT) and protein balance in the rumen (PBV) were calculated using determined chemical composition of the feeds and published constant values according to Tuori et al. (1996).

Pasture comprised of a meadow fescue-timothy (*Festuca pratensis-Phleum pratense*) sward was continuously grazed, with an area of 49.5 hectares at the beginning and 58.0 hectares at the end of grazing season. Cows had free access to water with no additional feeds, except for a

Vol. 10 (2001): 3–18.

magnesium rich mineral supplement. Calves were creep-fed on pasture milled barley from 13 August until weaning in order to facilitate adaptation to the post weaning diet.

Live-weight, condition scoring and calving difficulties

Cows were weighed at the beginning of the experiment, 60 days prior to the estimated calving date, 1–7 days *pre partum*, within 48 hours after parturition and at the beginning and end of grazing. Cows were condition scored (Lowman et al. 1976) at the beginning of the experiment, 60 days before estimated calving, at calving and at the beginning and end of grazing. Data from one LiAy cow offered diet M1 was omitted due to an aborted pregnancy two months into the experiment, and that from another LiAy cow, fed diet L2 was omitted due to a fatal uterine torsion. Furthermore, data from a HfAy cow (diet M2) and two LiAy cows (diet L1) were omitted due to still-born calvings.

Calves were weighed immediately after birth, at 14 and 100 days of age, at the beginning and end of grazing, the latter also representing weight at weaning. One Li × HfAy-calf died due to bloating on pasture in September two weeks prior to weaning. Only birth weights are available of still-born calves. All calvings were monitored and assistance was provided as described by Manninen et al. (2000).

Milk production and rebreeding

Milk production was measured for six cows from each treatment group using the machine-milking technique. Milk yield was measured on 10, 20, 35, 50, 70, 100 and 130 days of lactation. Cows selected for assessing milk production were primarily the first six cows on a calving date basis per treatment, taking into account the sex of the calf. The cow and progeny were removed from the main group and the calf was separated from the dam. Cows were milked at 1200, 1800, 0600 and at 1200 hours, respectively. The aim of the first milking was to empty the udder and use the sum of the last three milkings as an estimate of milk production. At every milking, an intramuscular injection 3 ml of SYNOX-solution (oxytosin, 5 I.U./ml) was used to ensure complete emptying of the udder. Milking was started five minutes post injection. During milking the calf was in front of the dam. After milking, collected milk was given to the calf. Milk samples were collected during the last three milkings and pooled according to yield and analysed for fat, protein and lactose at the laboratory of Valio Ltd. using a Milcoscan 605 infrared analyser (Foss electric, 69 Slangerupgade, DK 3400 Hillerød, Danmark). A Charolais-bull (Ch) ran with the cows from 2 June to 27 August. Pregnancy diagnosis was performed by ultrasonic scanning. Interval from calving to conception was calculated on the basis of ultrasonic scanning results.

Statistical analysis

Data was subjected to Analysis of Variance using the MIXED procedure of the Statistical Analysis System (SAS 1989). Satterthwaite's formula was used to correct degrees of freedom when estimated variance of block (breed) or pen was non-positive. Animals were in pens, six to eight animals per pen, four pens per treatment pre calving and two pens per treatment post calving, and therefore pen was used as an experimental unit (Gill 1989). Breed was used as block effect. Individual cow and calf data was used for testing cow and calf performance, milk production and milk composition. Feed intake data was not statistically evaluated due to fixed experimental feeding regimens.

Milk production and cow performance data was analysed according to the following model (Morris 1999):

$$y_{l(ijk)} = \mu + p_k + b_i + d_j + bd_{ij} + pbd_{ijk} + \varepsilon_{l(ijk)}$$

where $y_{l(ijk)}$ is the observed value, μ is the general mean, b_i is the *pre partum* feeding level,

d_j is the *post partum* concentrate feeding level, bd_{ij} is their interaction, p_k is a random effect due to block (breed), pbd_{ijk} is a random effect due to pen and $\varepsilon_{l(ijk)}$ is the residual error term. In the analysis, the pbd_{ijk} term with four degrees of freedom has been used as an error term. *Post partum* concentrate feeding level was not included in the model when interpreting initial LW and condition score, LW and condition score 60 days *pre partum*, pre calving LW and live weight gain (LWG) and condition score changes from the start of the study to calving.

Data for calves was analysed using the same model in addition that the effect of sex (s_m) and interactions between sex and *pre partum* feeding level, sex and *post partum* concentrate feeding level, sex, *pre partum* feeding level and *post partum* concentrate feeding level were included. In this analysis, the $pbds_{ijkm}$ term with eight degrees of freedom has been used as an error term for comparisions related to sex. Calf birth date was used as a covariate in the analysis when interpreting calf performance data.

Results

Chemical composition of feeds and feed intake

Mean chemical composition of experimental feeds is given in Table 2. In general, only small amounts offered feeds were refused on some days. On feeding level L, hay comprised of 80.4% and straw 19.6% of the total amount of roughage offered during the indoor feeding period. The corresponding value for feeding level M was 84.4% and 15.6%, respectively. Average daily nutrient intakes during the indoor feeding periods P1–P3 are summarized in Table 3. During period P1 cows on feeding levels L and M consumed on an average 6.7 and 9.1 kg DM, respectively. For period P2, DM intakes were 1.3 kg higher for both levels due to barley supplementation. After calving cows on the M1- and M2-diets consumed 10.4 and 12.0 kg DM, respectively. Corresponding values for feeding level L during P3 were 8.0 and 9.7 kg DM, respectively. At pasture, the creep-fed barley intake of calves was on average 0.24 kg/d.

Live weight, condition score and calving difficulties of cows

No interactions in maternal LW, LWG, condition score (CS) and changes of condition score between *pre partum* and *post partum* feeding level were observed and therefore, only least squares means of the main effects are presented in Tables 4 and 5. The initial LW of cows averaged 590 kg. Sixty days before estimated calving there were no differences in LW between the *pre partum* feeding levels, but pre calving cows on feeding level M tended to be heavier ($P<0.10$) than those on feeding level L. At the onset of grazing, cows on feeding level M were 47 kg heavier ($P<0.05$) than those on feeding level L. Cows fed 1-diets lost more ($P<0.001$) LW from calving to grazing than those on 2-diets (–1241 vs. –588 g/d). At pasture cows overwintered on feeding level L had a higher 477 g ($P<0.001$) LWG than those on feeding level M. In addition, LWG was 157 g higher ($P<0.05$) on diet 1 than on diet 2 at pasture. At the end of grazing, cows had a mean 23 kg increase in LW compared to the beginning of the experiment and no differences were observed between treatments.

At the beginning of the experiment the average condition score of cows was 2.64. At calving cows on feeding level M had a better ($P<0.01$) condition score than those on feeding level L (2.72 vs. 2.36). In fact, cows on feeding level M were in better condition at calving than at the onset of the experiment. *Post partum* concentrate feeding did not affect the condition at the onset of grazing, but cows on feeding level M were in better ($P<0.05$) condition than those on feeding level L (2.47 vs. 2.03). During indoor feeding cows on feeding level L lost more ($P<0.05$) condition than those on feeding level M (–0.67 vs.–0.09), but compensated for these

Vol. 10 (2001): 3–18.

Table 2. Mean chemical composition of experimental feeds.

	Hay	Oats straw	Barley
Number of samples	10	8	6
Chemical composition			
Dry matter (DM),(g/kg)	860	849	867
In DM,			
Ash	47	57	23
Crude protein	91	37	135
Ether extract	19	16	22
Crude fibre	361	438	53
Nitrogen free extract	482	452	767
Feed value, (/kg DM)			
ME, MJ	8.8	6.1	13.1
AAT, g	75	54	105
PBV, g	–37	–55	–36

ME, metabolizable energy. AAT, amino acids absorbed in the small intestine. PBV, protein balance in the rumen.

Table 3. Mean daily intake of dry matter (DM), energy (metabolizable energy, ME), amino acids absorbed in the small intestine (AAT) and protein balance in the rumen (PBV) of cows during indoor feeding, periods P1[1], P2[2] and P3[3].

Pre partum feeding	Low		Moderate	
Post partum feeding	1	2	1	2
Number of groups	2	2	2	2
DM, kg				
Hay, P1-P3	5.29	5.29	7.54	7.56
Oats straw, P1-P3	1.29	1.29	1.42	1.37
Mineral mixture, P1-P3	0.15	0.15	0.15	0.15
Barley, P2	1.30	1.30	1.30	1.30
Barley, P3	1.28	2.94	1.28	2.94
Total P1	6.73	6.73	9.11	9.08
Total P2	8.03	8.03	10.41	10.38
Total P3	8.01	9.67	10.39	12.02
ME, MJ				
Total P1	54.2	54.1	74.6	74.5
Total P2	71.2	71.1	91.6	91.5
Total P3	70.9	92.5	91.3	113.0
AAT, g				
Total P1	465	465	640	639
Total P2	601	601	776	775
Total P3	598	771	773	945
PBV, g				
Total P1	–265	–264	–352	–351
Total P2	–312	–311	–399	–398
Total P3	–315	–378	–402	–466

[1] P1 = from start to beginning of feeding with barley, mean 97 days.
[2] P2 = feeding with barley pre calving, mean 72 days.
[3] P3 = *post partum* feeding, mean 46 days.

Table 4. Live weight (LW) and live weight gain (LWG) of cows during indoor feeding and grazing.

	Pre partum feeding		*Post partum* feeding		SEM[2] min – max	Significance[1]	
	Low	Moderate	1	2		*Pre partum* feeding	*Post partum* feeding
Number of cows	26	27	26	27			
LW, kg							
Initial	592	588			21.8–22.0	NS	
60 days *pre partum*	594	620			18.7–18.9	NS	
Pre calving	628	661			18.3–18.5	o	
Post calving	568	607	596	579	21.2–21.4	*	NS
Onset of grazing	523	570	543	550	13.9–14.2	*	NS
End of grazing	617	609	618	608	16.2–16.4	NS	NS
LWG, g/d							
Start → calving	205	435			28.9–29.5	***	
Calving → grazing	–1086	–744	–1241	–588	124.8–126.6	*	***
During indoor	–321	–87	–260	–147	48.3–48.9	*	NS
At pasture	826	349	666	509	45.8–46.8	***	*
Entire experiment	76	64	59	82	24.3–24.8	NS	NS

1 o P<0.10; * P<0.05; ** P<0.01; *** P<0.001; NS not significant.
2 SEM=Standard Error of the Mean.

Table 5. Condition, change at condition score of cows during indoor feeding and grazing and interval from calving to conception.

	Pre partum feeding		*Post partum* feeding		SEM[2] min – max	Significance[1]	
	Low	Moderate	1	2		*Pre partum* feeding	*Post partum* feeding
Number of cows	26	27	26	27			
Condition score							
Initial	2.71	2.56			0.186–0.187	NS	
60 days *pre partum*	2.49	2.68			0.128–0.129	NS	
Calving	2.36	2.72	2.58	2.50	0.116–0.117	**	NS
Onset of grazing	2.03	2.47	2.21	2.29	0.102–0.103	*	NS
End of grazing	3.16	3.07	3.16	3.08	0.180–0.181	NS	NS
Change at condition score							
Start → calving	–0.35	0.16			0.098–0.099	***	
Calving → grazing	–0.33	–0.25	–0.38	–0.20	0.070–0.071	NS	o
During indoor	–0.67	–0.09	–0.48	–0.29	0.147–0.149	*	NS
At pasture	1.13	0.58	0.94	0.78	0.176–0.177	o	NS
Entire experiment	0.46	0.51	0.47	0.50	0.113–0.115	NS	NS
Interval from calving to conception, days[3]	67	71	69	68	5.5–5.9	NS	NS

1 o P<0.10; * P<0.05; ** P<0.01; *** P<0.001; NS not significant.
2 SEM=Standard Error of the Mean.
3 Number of cows: low = 25, moderate = 21, 1 = 23, 2 = 23.

Vol. 10 (2001): 3–18.

losses ($P<0.10$) at pasture (1.13 vs. 0.58). At the end of the grazing season all cows were in good condition, mean condition score 3.12, and no between-treatment differences were observed. Most calvings were easy, with only six requiring slight assistance.

Live weight of calves

No interactions between treatments in calf LW and LWG were observed and therefore, only least squares means of the main effects are presented in Table 6. *Post partum* concentrate feeding had no effect on calf performance. The *pre partum* feeding level had no effect on calf birth weight, but male calves were heavier ($P<0.05$) at birth than females (44.8 vs. 41.1 kg). At weaning only sex affected calf LW, with male calves being 24 kg heavier ($P<0.001$) than females. Pre grazing, calves born to dams on feeding level M grew better ($P<0.05$) than those born to dams on feeding level L (1356 vs. 1226 g/d). Pre weaning calves born to dams fed feeding levels L and M, and diets 1 and 2 had a LWG of 1278, 1332, 1311 and 1299 g/d, respectively. Prior to weaning male calves grew better ($P<0.001$) than females (1369 vs. 1241 g/d).

Milk production, milk composition and conception rate

No interactions between treatments in milk production and milk composition were observed and therefore, only least squares means of the main effects are presented in Table 7. Treatments had no effect on mean milk production and milk protein content. Only on days 35 and 50 of lactation, did cows on the diet 2 tend to produce more ($P<0.10$) milk than those on diet 1 (12.1 vs. 10.4 kg/d and 12.5 vs. 10.8 kg/d). Milk fat content was higher ($P<0.10$) for cows on feeding level M than L (46.9 vs. 43.1 g/kg). In contrast, mean milk lactose content tended to be higher ($P<0.10$) for cows on feeding level L than M (50.1 vs. 48.9 g/kg). During the mating period 86.8% of cows conceived. All cows on diet L1 become pregnant, 13 out of 14 cows on diet L2 (92.9%), 11 out of 14 cows on diet M1 (78.6%) and 10 out of 13 cows on diet M2-diet (76.9%). However, conception rates were not statistically tested. Treatments had no effect on the interval from calving to conception averaging 69 days (Table 5).

Discussion

Feed value and feed intake

In general, the health of cows and calves was satisfactory during the experiment. One calf died in the present experiment due to bloating, and rather than directly due to experimental treatments. Two LiAy cows calved on the same night on 21 April in the outdoor exercise area and lost their calves due to unfavourable climatic conditions. Experimental hay had a low crude protein and high fibre content and therefore, calculated energy content (8.8 MJ ME/kg DM) was typical for late harvested hay. ME-based feed evaluation system was introduced in Finland after the experiment was done and thus, the results are expressed on ME-basis.

During period P1, cows on feeding levels L and M consumed on average 54.2 and 74.6 MJ ME/d, respectively. For dry, non-lactating dairy cows of LW 600 kg, an energy intake of 63.2 MJ ME/d is recommended (Tuori et al. 1996), which exceed the feeding level L by 9 MJ ME. Based on this value, feeding level M appeared to exceed maintenance recommendations for dry dairy cows by 11.4 MJ ME. For period P2 cows had an energy intake of 71.2 and 91.6 MJ ME/d for feeding levels L and M. For dairy cows in the last trimester of pregnancy respective (8th and 9th month of pregnancy) intakes of 81.9 and 97.1 MJ ME/d are recommended by Tuori et al. (1996), which is in good accordance with the energy level cows received on feeding level M pre calving. During period P3 cows on diet L1

Table 6. Mean treatment and sex effects on calf performance.

	Pre partum feeding		*Post partum* feeding		Sex		SEM[2] min–max	Significance[1]		
	Low	Moderate	1	2	Male	Female		*Pre partum* feeding	*Post partum* feeding	Sex
Number of calves	28[a]	28[b]	28[a]	28[b]	32[c]	24[d]				
Average calving date[3]	107	105	107	105	110	102	5.3–5.6	NS	NS	*
Live weight, kg										
Birth	43.4	42.5	42.6	43.3	44.8	41.1	1.04–1.20	NS	NS	*
14-day	60.8	60.1	60.8	60.0	62.9	58.0	1.34–1.51	NS	NS	*
100-day	173	182	178	176	185	170	3.1–3.6	o	NS	**
160-day[4]	248	255	252	251	264	240	4.1–4.7	NS	NS	***
Onset of grazing	101	104	103	102	105	100	2.2–2.5	NS	NS	NS
Weaning = End of grazing	249	255	253	251	264	240	4.0–4.6	NS	NS	***
Weaning age, d	159	163	160	162	156	166	6.1–6.3	NS	NS	*
Live weight gain, g/d										
Birth → grazing	1226	1356	1292	1290	1313	1269	40.4–45.8	*	NS	NS
At pasture	1299	1317	1317	1298	1390	1225	26.5–29.1	NS	NS	***
Birth → weaning	1278	1332	1311	1299	1369	1241	22.0–25.5	NS	NS	***

[1] o P<0.10; * P<0.05; ** P<0.01; *** P<0.001; NS not significant.
[2] Standard Error of the Mean.
[3] Day 1=1 January.
[4] Average weaning age of the calves.
[a] n=28 for calving difficulty and birth weight then n=26.
[b] n=28 for calving difficulty and birth weight, n=27 for calving difficulty, birth weight, 14-day and 100-day weight then n=26.
[c] n=32 for calving difficulty and birth weight then n=29.
[d] n=24 for calving difficulty, birth weight, 14-day and 100-day weight then n=23.

maintained their energy intake as that during period P2. Post-calving cows on the diets L2 and M1 had practically the same energy intakes (92.5 vs. 91.3 MJ ME/d). Post-calving cows on the diet M2 had a mean calculated energy intake of 113 MJ ME/d, a value consistent for lactating dairy cows with a mean daily milk yield of 10 kg (114.7 MJ ME) recommended by Tuori et al. (1996). Calculated AAT intakes exceeded recommended levels (Tuori et al. 1996) for dairy cows pre calving for all experimental diets. However, only diet M2 theoretically provided sufficient AAT for cows post calving based on Finnish recommendations.

Comparisions between recommendations for dairy cows and measured ME and AAT intakes of suckler cows in the present experiment is potentially compromised due to differences in housing conditions. Loose housing can increase the maintenance energy requirements of suckler cows by between 10 and 20% (Petit and Agabriel 1989) depending on shelter type during winter. In contrast, Ferrell and Jenkins (1984) reported that the maintenance energy required for beef cattle to be about 15% less than dairy cattle. However, other studies (Neville and McCullough 1969, Neville 1974, Petit and Micol 1981) have indicated higher than predicted requirements for non-pregnant dry beef cows. The NRC (1984) recommends an energy intake of 73 MJ/d for a 600 kg beef cow during the middle third of pregnancy, 84 MJ/d during the last third of

Vol. 10 (2001): 3–18.

Table 7. Effect of *pre partum* feeding level and *post partum* concentrate feeding level on milk production.

	Pre partum feeding		*Post partum* feeding		SEM[2]	Significance[1]	
	Low	Moderate	1	2		*Pre partum* feeding	*Post partum* feeding
Number of animals	6	6	6	6			
Milk yield, (kg/d)							
Day of lactation							
10	10.6	10.9	10.6	11.0	0.72	NS	NS
20	10.9	11.0	10.5	11.3	0.57	NS	NS
35	10.7	11.8	10.4	12.1	0.45	NS	o
50	11.3	12.0	10.8	12.5	1.11	NS	o
70	12.1	13.6	12.8	12.9	1.95	NS	NS
100	12.6	13.0	13.3	12.3	1.69	NS	NS
130	11.8	13.1	12.4	12.5	1.54	NS	NS
Mean	11.4	12.2	11.5	12.1	1.08	NS	NS
Milk composition, (g/kg)							
Fat	43.1	46.9	44.1	45.9	1.33	o	NS
Protein	30.3	31.7	30.5	31.5	1.03	NS	NS
Lactose	50.1	48.9	49.1	49.9	0.58	o	NS

[1] o $P<0.10$; * $P<0.05$; ** $P<0.01$; *** $P<0.001$; NS not significant.
[2] Standard Error of the Mean.

pregnancy and 107 MJ/d post calving with milk production of 9 kg/d. Energy intakes on diet M2 were consistent with these recommendations.

Live weight, condition of cows and calving difficulties

Based on a recommended condition score of 3.00 (Lowman et al. 1976) for spring-calving cows, the condition of the experimental cows at the beginning of the experiment of 2.64 could be considered to be too low. This may be a result from the previous grazing season and the late weaning of the calves. Achieving the correct condition score at each production stage is particularly important in marginal areas with extended indoor feeding periods. With crossbred cows with a high milk production potential it is extremely important to wean the calves before dam condition begins to decline or the availability of pasture is insufficient to support the energy requirements for maintenance and milk production.

During the indoor feeding period cows on feeding level M lost 18 kg while those overwintered on feeding level L lost 69 kg, consistent with a decline in condition score of –0.09 and –0.67, respectively. Loss of LW and condition on feeding level M relative to cow size was so marginal, such that in practice losses were negligible. The condition of cows (2.03) overwintered on feeding level L was in accordance with recommendations of 2.0 by Lowman et al. 1976 at the beginning of the grazing/mating season and no negative effects were observed in this study. However, the duration of grazing and indoor feeding periods are markedly different between the UK and Finland, and need to be taken into account in addition to such recommendations.

The effects of different feeding levels on cow LW during late pregnancy are widely reported (Hight 1966, Drennan and Bath 1976a, Russel et al. 1979, Manninen et al. 2000), although comparisions with earlier studies and current results are difficult due to markedly different conditions.

The post calving concentrate feeding level did not in fact affect cow condition or changes in condition which may be attributed to a relatively short period from calving to the onset of grazing. Condition at calving was obviously suitable for this stage of production for mature, crossbred cows, but inspite of this, cows on the diet 1 lost almost double the LW relative to those fed diet 2, but compensated for such losses on pasture. These results are in accordance with earlier results under Finnish conditions with similar non-mature cows (Manninen et al. 2000). Hodgson et al. (1980) offered spring-calving Hereford-Friesian and Blue-Grey cows hay and concentrate from calving until turnout sufficient for maintenance and either 2.3 or 9.0 kg milk/d and observed that cows on the lower level of feeding lost more LW (1730 vs. 1260 g/d), losses which are consistent with values observed in the current study.

Only six calvings required slight assistance indicating that cows were of suitable condition at calving for both pre calving feeding levels. This finding is in good accordance with previous studies with mature cows offered different pre calving nutrition levels (Tudor 1972, Drennan and Bath 1976a). However, nutrition prior to calving is more critical for first-calf heifers, although no differences were found between beef heifers fed at various pre calving planes of nutrition (Absher and Hobbs 1968, Bellows et al. 1972, Corah et al. 1975, Spitzer et al. 1995).

Live weight of calves, milk production and conception rate

Growth rate of all calves was at least satisfactory from birth to weaning which undoubtedly due to a mean milk production of 11.8 kg/d. However, pre calving feeding levels had no effect on calf birth weight. The period from calving to the onset of grazing was only on average 46 days and may potentially be too short to result in a calf LW response to the post calving concentrate feeding. Baker and Barker (1976) also observed that post calving feeding of Hereford-Friesian cows over a mean period of 54 days had no significant effect on calf growth rate. In contrast, Hodgson et al. (1980) reported that calves born to dams fed a low plane of nutrition post calving had a lower growth rate relative to a higher plane of nutrition. However, differences in post calving dam feeding had no significant effect on final calf weight, a finding consistent with the current study.

The effects of dam *pre partum* feeding level on calf performance were marginal, and therefore the only major difference was observed in LWG before grazing (L:1226 vs. M:1356 g/d). The results are in accordance with a previous study (Manninen et al. 2000). However, the effects of pre calving plane of nutrition level on calf performance are widely reported. Drennan and Bath (1976b) demonstrated that the plane of dam nutrition during late pregnancy had no effect on calf birth weight or subsequent LWG when the cows were fed silage to appetite (*ad lib.*) or 27.3 kg/d during late pregnancy. In an earlier experiment calves born to dams on low plane of pre calving nutrition were 20% lighter than calves born on the high plane of nutrition (Hight 1966). Calf LWG from various experiments that manipulated pre calving plane of nutrition are markedly different, possibly due to variations in the duration of feeding restriction, breed and condition score prior to calving. In accordance with the results of Rahnefeld et al. (1990) calf sex had the expected effect on calf performance in the current study.

Mean milk production was similar between treatment groups and was independent of *pre* and *post partum* feeding levels. A marginal increace in milk production was observed after day 50 of lactation which may due to turnout to pasture. It is also well documented that suckler cow milk production increases slowly after calving and reaches a maximum between 1 and 3 months of lactation depending on the balance between calf suckling capacity and dam milk production potential (Petit and Agabriel 1989). However, milk

Vol. 10 (2001): 3–18.

production in the current study was higher than previously reported for the same dairy-beef crosses (Manninen et al. 1998, 2000).

Several studies (Baker and Barker 1976, Nicol 1977, Lowman et al. 1979, Hodgson et al. 1980, Baker et al. 1982, Somerville et al. 1983) have demonstrated the effects of plane of post calving nutrition on milk production. The effects of pre calving feeding level on milk production tend to be less consistent. In some studies, milk production has been shown to be independent of pre calving plane of nutrition (Drennan and Bath 1976a, Russel et al. 1979), but not in all cases (Nicol 1977, Hodgson et al. 1980, Somerville et al. 1983).

Feeding level M tended to increase milk fat content, while the reverve was true for lactose. The current results are to some extent consistent with the findings by Lowman et al. (1979) who reported that the plane of nutrition in early lactation had no effect on milk composition. Obviously in the present experiment the cows fed low plane of nutrition maintained good milk production at the expence of body reserves supported by the negative change at condition score prior to grazing season.

The most immediate effects of undernutrition in the suckler cow is a delay in conception and reduced pregnancy rates. Body condition at calving is often considered to have a major role in the reproduction of beef cows, possibly by regulation of the duration of anoestrus (Richards et al. 1986, Osoro and Wright 1992). In general, reproductive performance in this study was satisfactory but no statistical evaluation was currently conducted. Furthermore, the sample population in the present study was too small to draw firm conclusions about the influence of plane of nutrition on conception rate. All cows on diet L1 became pregnant during the mating period while the worst reproductive performance occured on diet M2. In the present experiment the number of cows per one bull on the mating period was quite high and may have affected the conception rate. Unfortunately no evaluation of the period from calving to the first oestrus was measured in this study and thus, it should be used in the further studies to get more accurete information about reproduction performance.

Conclusions

A low plane of nutrition *pre partum* effected dam LW and condition, but cows compensated for those losses well at pasture. Low plane of nutrition *pre partum* had marginal effects on milk composition and only affected calf performance prior to grazing. *Post partum* feeding levels only influenced dam LWG before grazing. All feeding regimens maintained dam condition sufficiently to enable satisfactory conception rates. Based on cow and calf performance, diet L1 appeared to supply sufficient energy and therefore, the current data suggests that the plane of nutrition *pre partum* has a greater influence than that *post partum* in cases of limited periods of grazing. The findings of this study also indicate that low level of feeding can be recommended in Finland or regions of similar latitude for mature beef crosses with adequate condition at the onset on indoor feeding period if the cows can compensate the losses of condition at good and sufficient pasture.

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References

Absher, C.W. & Hobbs, C.S. 1968. Pre-calving level of energy in first calf heifers. *Journal of Animal Science* 27: 1130.

Baker, R.D. & Barker, J.M. 1976. Effect of plane of nutrition in early lactation on suckler cow and calf performance. *Animal Production* 22: 141.

– , Le Du, Y.L.P. & Barker, J.M. 1982. The influence of winter nutrition, grazing system and stocking rate on the performance of spring-calving Hereford × Friesian cows and their calves. 1. Winter nutrition. *Animal Production* 34: 213–224.

Bartle, S.J., Males, J.R. & Preston, R.L. 1984. Effect of energy intake on the postpartum interval in beef cows and the adequacy of the cow's milk production for calf growth. *Journal of Animal Science* 58: 1068–1074.

Bellows, R.A., Varner, L.W., Short, R.E. & Pahnish, O.F. 1972. Gestation feed level, calf birth weight and calving difficulty. *Journal of Animal Science* 35: 185–186.

Corah, L.R., Dunn, T.G. & Kaltenbach, C.C. 1975. Influence of pre partum nutrition on the reproductive performance of beef females and the performance of their progeny. *Journal of Animal Science* 41: 819–824.

Drennan, M. J. & Bath, I.H. 1976a. Single-suckled beef production. 3. Effect of plane of nutrition during late pregnancy on cow performance. *Irish Journal of Agricultural Research* 15: 157–168.

– & Bath, I.H. 1976b. Single-suckled beef production. 4. Effect of plane of nutrition during late pregnancy on subsequent calf performance. *Irish Journal of Agricultural Research* 15: 169–176.

Ferrell, C.L. & Jenkins, T.G. 1984. Energy utilization by mature, nonpregnant, nonlactating cows of different types. *Journal of Animal Science* 58: 234–243.

Gill, J.L. 1989. Statistical aspects of design and analysis of experiments with animals in pens. *Journal of Animal Breeding and Genetics* 106: 321–334.

Gregory, K.E. 1972. Beef cattle type for maximum efficiency "putting it all together". *Journal of Animal Science* 34: 881–884.

Hight, G.K. 1966. The effects of undernutrition in late pregnancy on beef cattle production. *New Zealand Journal of Agricultural Research* 9: 479–490.

Hodgson, J., Peart, J.N., Russel, A.J.F., Whitelaw, A. & MacDonald, A.J. 1980. The influence of nutrition in early lactation on the performance of spring-calving suckler cows and their calves. *Animal Production* 30: 315–325.

Holness, D.H., Hopley, J.D.H. & Hale, D.H. 1978. The effects of plane of nutrition, live weight, temporary weaning and breed on the occurrence of oestrus in beef cows during the post-partum period. *Animal Production* 26: 47–54.

Houghton, P.L., Lemenager, R.P., Horstman, L.A., Hendrix, K.S. & Moss, G.E. 1990. Effects of body composition, pre- and postpartum energy level and early weaning on reproductive performance of beef cows and preweaning calf gain. *Journal of Animal Science* 68: 1438–1446.

Lowman, B.G., Scott, N.A. & Somerville, S.H. 1976. *Condition Scoring of Cattle*. The East of Scotland College of Agriculture. Animal Production, Advisory and Development Department. Bulletin No. 6. 31 p.

– , Edwards, R.A., Somerville, S.H. & Jolly, G.M. 1979. The effect of plane of nutrition in early lactation on the performance of beef cows. *Animal Production* 29: 293–303

Manninen, M., Aronen, I. & Huhta, H. 2000. Effect of feeding level and diet type on the performance of crossbred suckler cows and their calves. *Agricultural and Food Science in Finland* 9: 3–16.

– , Aronen, I., Puntila, M.-L., Heikkilä, R. & Jaakkola, S. 1998. Effect of type of forage offered and breed on performance of crossbred suckler heifers and their calves. *Agricultural and Food Science in Finland* 7: 367–380.

Ministry of Agriculture, Fisheries and Food 1975. Energy allowances and feeding systems for ruminants. *Technical Bulletin 33.* Her Majesty's Stationery Office, London. 79 p.

– 1984. Energy allowances and feeding systems for ruminants. *ADAS Reference Book 433.* Her Majesty's Stationery Office, London. 85 p.

Morris, T.R.1999. *Experimental design and analysis in animal sciences.* CABI Publishing. Wallingford, Oxon. UK. 208 p.

Neville, W.E., Jr. 1974. Comparison of energy requirements of non-lactating and lactating Hereford cows and estimates of energetic efficiency of milk production. *Journal of Animal Science* 38: 681–686.

– & McCullough, M.E. 1969. Calculated energy requirements of lactating and non-lactating Hereford cows. *Journal of Animal Science* 29: 823–829.

Nicol, A.M. 1977. The influence of plane of nutrition immediately post-calving on the performance of beef cows. *Proceedings of the New Zealand Society of Animal Production* 37: 103–108.

NRC 1984. *Nutrient Requirements of Beef Cattle.* 6th ed. National Academy Press. Washington, D.C.

Ojala, M. 1987. Ravinnontarve ja ruokinta. In: *Lihakarjan kasvatus.* 1st ed. Otava. p. 47–75.

Osoro, K. & Wright, I.A. 1992. The effect of body condition, live weight, breed, age, calf performance, and calving date on reproductive performance of spring-calving beef cows. *Journal of Animal Science* 70: 1661–1666.

Petit, M. & Agabriel, J. 1989. Beef cows. In: Jarrige, R. (ed.). *Ruminant Nutrition. Recommended Allowances and Feed Tables.* INRA, Paris, 1989. p. 93–108.

– & Micol, D. 1981. Evaluation of energy requirements of beef cows during early lactation. *Livestock Production Science* 8: 139–153.

Rahnefeld, G.W., Weiss, G.M. & Fredeen, H.T. 1990. Milk yield and composition in beef cows and their effect on cow and calf performance in two environments. *Canadian Journal of Animal Science* 70: 409–423.

Richards, M.W., Spitzer, J.C. & Warner, M.B. 1986. Effect of varying levels of postpartum nutrition and body condition at calving on subsequent reproductive per-

Vol. 10 (2001): 3–18.

formance in beef cattle. *Journal of Animal Science* 62: 300–306.

Russel, A.J.F., Peart, J.N., Eadie, J., MacDonald, A.J. & White, I.R. 1979. The effect of energy intake during late pregnancy on the production from two genotypes of suckler cow. *Animal Production* 28: 309–327.

Salo, M.-L., Tuori, M. & Kiiskinen, T. 1982. *Rehutaulukot ja ruokintanormit*. Helsinki. 70 p.

SAS 1989. *SAS/STAT. User's Guide*. SAS Institute Inc., Cary, N.C., USA.

Selk, G.E., Wettemann, R.P., Lusby, K.S., Oltjen, J.W., Mobley, S.L., Rasby, R.J. & Garmendia, J.C. 1988. Relationships among weight change, body condition and reproductive performance of range beef cows. *Journal of Animal Science* 66: 3153–3159.

Smithson, L., Ewing, S.A. & Renbarger, B. 1966. Influence of level of nutrition of the dam on birth weight of beef calves. *Journal of Animal Science* 25: 909–910.

Somerville, S.H., Lowman, B.G. & Deas, D.W. 1979. The effect of plane of nutrition during lactation on the reproductive performance of beef cows. *Veterinary Record* 104: 95–97.

– , Lowman, B.G., Edwards, R.A. & Jolly, G. 1983. A study of the relationship between plane of nutrition during lactation and certain production characteristics in autumn-calving suckler cows. *Animal Production* 37: 353–363.

Spitzer, J.C., Morrison, D.G., Wettemann, R.P. & Faulkner, L.C. 1995. Reproductive responses and calf birth and weaning weights as affected by body condition at parturition and postpartum weight gain in primiparous beef cows. *Journal of Animal Science* 73: 1251–1257.

Tudor, G.D. 1972. The effect of pre- and post-natal nutrition on the growth of beef cattle. 1. The effect of nutrition and parity of the dam on calf birth weight. *Australian Journal of Agricultural Research* 23: 389–395.

Tuori, M., Kaustell, K., Valaja, J., Aimonen, E., Saarisalo, E. & Huhtanen, P. 1996. *Rehutaulukot ja ruokintasuositukset.* 2nd ed. Yliopistopaino, Helsinki. 99 p. *(Feed tables and feeding recommendations,* in Finnish*).*

Wiltbank, J.N., Rowden, W.W., Ingalls, J.E., Gregory, K.E. & Koch, R.M. 1962. Effect of energy level on reproductive phenomena of mature hereford cows. *Journal of Animal Science* 21: 219–225.

SELOSTUS

Sisäruokintakauden energiamäärien vaikutus risteytysemolehmien tuotantoon

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Tutkimuksessa selvitettiin poikimista edeltävän, heinään ja olkeen perustuvan ruokinnan (M; keskinkertainen ja L; matala) ja poikimisen jälkeisen väkirehuruokinnan (1: 1,5 ja 2: 3,5 kg ohraa/eläin/d) vaikutuksia Hereford-Ayrshire ja Limousine-Ayrshire risteytysemojen elopainoon, kuntoon, poikimiseen, maidontuotantoon, maidon koostumukseen ja tiinehtymiseen sekä niiden Limousin-sonneista syntyneiden vasikoiden kehitykseen syntymästä vieroitukseen. Ennen poikimista kaikki emot saivat 72 vuorokautta 1,5 kg väkirehua päivässä. Sisäruokintakausi jaettiin kolmeen jaksoon: kokeen alusta väkirehuruokinnan alkuun (P1, 97 d), väkirehuruokintajakso ennen poikimista (P2, 72 d) ja poikimisen jälkeinen väkirehuruokintajakso (P3, 46 d). Laidunkauden pituus oli 114 päivää.

Heinän energiapitoisuus (ME; muuntokelpoinen energia, MJ) oli keskimäärin 8,8, oljen 6,1 ja ohran 13,1 MJ ME/kg kuiva-ainetta (KA). Ohutsuolesta imeytyvää valkuaista heinä sisälsi keskimäärin 75, olki 54 ja ohra 105 g/kg KA. M-ruokinnalla eläinten kuiva-aineen syönti oli jaksolla P1 keskimäärin 9,1, jaksolla P2 10,4 ja jaksolla P3 joko 10,4 tai 12,0 kg KA. L-ruokinnalla KA-syönti oli vastaavasti jaksolla P1 6,7, jaksolla P2 8,0 ja jaksolla P3 joko 8,0 tai 9,7 kg KA. Laidunkauden alkaessa kesäkuun alussa M-ruokinnalla olleet emot olivat keskimäärin 47 kg painavampia kuin L-ruokinnalla olleet emot, jotka puolestaan kuntoutuivat laitumella tehokkaammin kuin M-ruokinnalla olleet emot. Poikimisesta laidunkauden alkuun 1-väkirehuruokinnalla olleet emot menettivät elopainoaan enemmän kuin 2-väkirehuruokinnalla olleet emot (–1241 vs. –588 g/d), mutta kuntoutuivat laitumella tehokkaasti. Poikimisen jälkeinen väkirehuruokinta ei vaikuttanut emojen kuntoon. Sisäruokintakaudella L-emojen kunto heikkeni

enemmän (–0,67 vs. –0,09) kuin M-emojen kunto. Poikimiset olivat helppoja. Koetekijät eivät vaikuttaneet vasikoiden kasvuun ennen vieroitusta. Sonnivasikat kasvoivat lehmävasikoita paremmin (1369 vs. 1241 g/d). Koetekijät eivät vaikuttaneet maidontuotantoon, joka oli keskimäärin 11,8 kg/d. M-emojen maidon rasvapitoisuus oli korkeampi kuin L-emojen (46,9, vs. 43,1 g/kg). Emoista 86,8 % tiinehtyi.

Tutkimuksessa poikimista edeltävä ruokinta vaikutti emoihin ja niiden vasikoihin enemmän kuin poikimisen jälkeinen ruokinta. Tuotantotulosten perusteella L1-ruokinta oli riittävä. Ajanjakso poikimisesta laidunkauden alkuun oli kuitenkin lyhyt, mikä lienee vaikuttanut saatuihin tuloksiin. Huomattavatkin elopainon ja kunnon menetykset korvattiin hyvällä laitumella lyhyen laidunkauden aikana. Tuotantokustannuksia voidaan vähentää vaarantamatta eläinten hyvinvointia ja tuotosta ruokintaa alentamalla, jos eläinten kunto on tuotantovaiheeseen sopiva.