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## Effect of feeding level and diet type on the performance of crossbred suckler cows and their calves

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*Merja Manninen*  
*Ilmo Aronen*  
*Harri Huhta*



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Merja Manninen

*Agricultural Research Centre of Finland, Animal Production Research, FIN-31600 Jokioinen, Finland,  
e-mail: [merja.manninen@mtt.fi](mailto:merja.manninen@mtt.fi)*

Ilmo Aronen

*Agricultural Research Centre of Finland, Animal Production Research, FIN-31600 Jokioinen, Finland.  
Current address: Rehuraisio Ltd., PO Box 101, FIN-21201 Raisio, Finland*

Harri Huhta

*Agricultural Research Centre of Finland, Karelia Research Station, FIN-82600 Tohmajärvi, Finland.  
Current address: Agricultural Research Centre of Finland, Resource Management Research, Ecological  
Production, FIN-50100 Mikkeli, Finland*

A 2'2 factorial design experiment with 32 spring-calving Hereford-Ayrshire and 31 Limousine-Ayrshire suckler cows was conducted to compare the effects of diets based on hay (H) or urea-treated straw (US) at two feeding levels (moderate; M and low; L) on the performance of cows and their calves. For feeding level L, the amount of feed was restricted to 70% of that for feeding level M. Diet H was based on hay while for the US-diet, hay was replaced by urea-treated straw and barley (M:1.1 and L:0.8 kg dry matter, DM/day/animal). Urea-solution was included in the H-diet to balance protein intake with respect to US-diets. Untreated straw was also offered on all diets. Feeding *pre partum* commenced by offering 1.0 kg/day of a barley-rapeseed meal mixture from day 60 to 30 and 1.5 kg/day from day 30 to 0 *pre partum*. *Post partum* cows received 3.0 kg/day of the same mixture. All cows were in calf to Charolais sires. During the mating period, cows were inseminated after oestrus synchronisation and subsequently exposed to a bull.

Average daily intakes of the cows were on treatment MH 9.1 kg DM/day and 77.4 MJ metabolizable energy (ME), on treatment MUS 8.5 kg DM and 67.2 MJ ME, on treatment LH 6.9 kg DM and 58.9 MJ ME and on treatment LUS 6.7 kg DM and 53.7 MJ ME, respectively. Live weight gain (LWG) during the indoor feeding was lower ( $P<0.01$ ) for cows on feeding level L than M. Cows fed US-based diets lost more ( $P<0.05$ ) live weight (LW) during indoor feeding than those based on H-diets. Cows replenished LW losses at pasture and there were no differences in LW between treatments at the end of the grazing season. Imposed feeding treatments and the sex of the calf had no effect on the incidence of calving difficulty. There were no significant treatment effects on calf LWG or suckler cow milk production. During mating 69.3% of all experimental cows successfully conceived. The low level of feeding had no adverse effects on cow or calf health, but depressed

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reproductive performance. Cows replenished LW losses during the grazing period on sufficient good quality pasture. Urea-treated straw proved to be a suitable winter feed for spring calving suckler cows.

*Key words:* beef cows, calves, conception rate, intake, plane of nutrition, milk production, straw, urea

## Introduction

Feeding is the largest single cost in suckler cow production during the indoor feeding period. Due to geographical location the grazing period in southern Finland is at most only five months long. Therefore, the possibility to restrict the amount of winter feed without having detrimental effects on cow or calf performance is essential to reducing production costs and improving the profitability of suckler beef production.

The effect of a low plane of nutrition both *pre* and *post partum* has been widely reported and can potentially have a negative effect on the live weight of cows (Somerville et al. 1983), the incidence of calving difficulty (Absher and Hobbs 1968), calf performance (Houghton et al. 1990), suckler cow milk production (Bartle et al. 1984) and conception rate (Holness et al. 1978, Somerville et al. 1979). The effect of feed restriction is usually dependent on the stage of pregnancy, age and breed of the cow, the extent and duration of feed restriction and, in cold or marginal circumstances, the climatic conditions during feed restriction. The major factor influencing the effect of feed restriction on the performance of suckler cows is however, their initial condition score.

Feeding of suckler cows during the indoor period is usually based on cheap, non-marketable feeds such as timothy or cereal straws. Harvesting straw in autumn is often difficult due to inclement weather conditions. Thus, there is increased interest in preservation of straw using chemicals, the most popular of which is urea due to a low cost, convenience and safety (Ørskov et al. 1983, Williams et al. 1984, Block et al. 1989). Alaspää (1986) suggested that the pro-

tection of high moisture straw against mould is the most important function of ammonia-based treatments including urea, whereas the effects of urea treatment on diet digestibility have been moderate (Alaspää 1986, Aronen 1990). The possibility to increase nitrogen content of straw with inexpensive urea treatment is also a potential benefit.

The purpose of the present experiment was to study the effects of replacing hay with urea-treated straw and barley at two different feeding levels from the middle of November until the start of grazing at the end of May on the performance of crossbred cows and their calves. Live weight changes of cows and calves, feed intake, milk production, calving difficulty and conception rate are also discussed.

## Material and methods

### Animals and experimental design

Thirty-two Hereford-Ayrshire (HfAy) -cows 31 months of age and initial live weight (LW) on 16 November of 498 kg and 31 Limousin-Ayrshire (LiAy) -cows 30 months of age and initial LW of 487 kg were used in the current study. Experimental animals consisted of 54 second calving cows and 9 first calving cows, all of which were the same age. All cows were in calf to Charolais (Ch) sires. The experiment commenced on 17 November. At calving, cows were on average 36 months old. Four experimental treatments were evaluated according to a 2 $\times$ 2 factorial design and consisted of two feeding levels (low, L; moderate, M) and two diets (hay-

based, H; urea-treated straw -based, US). Animals were group-fed, once daily in the morning with eight animals per pen and two pens per treatment. All treatment groups contained an equal number of cows from each breed. The experiment consisted of two main parts, an indoor feeding period averaging 203 days and a grazing period averaging 106 days. The facilities in the barn have previously been described (Manninen et al. 1998).

The grazing season commenced on 24 May. A meadow fescue-timothy (*Festuca pratensis-Phleum pratense*) pasture of approximately 40 hectares was continuously grazed by cows and calves. Cows had free access to water and during grazing the only supplement was a mineral mixture rich in magnesium. The grazing season ended on 20 September and calves were weaned on 19 October. Calves were creep-fed milled barley from 14 August until weaning in order to facilitate adaptation to the post weaning diet. During the four week indoor period prior to weaning calves had free access to milled barley, hay and timothy straw. At this time cows had *ad libitum* access to hay and timothy straw.

## Feeds, feeding and feed sampling

Meadow fescue-timothy hay was harvested at the end of June and at the beginning of July, dried in the swath and baled. Field-dried barley and oat straw was harvested during the two last weeks of August and the first week of September and baled. Baling and treatment with the urea-solution was carried out simultaneously. The estimated dry matter (DM) content of straw was 600–750 g/kg when treated. The urea-solution was prepared using 100 kg fertilizer grade urea dissolved in 150 litres of hot water. Urea was applied at an average rate of 60 kg per tonne freshweight of straw during baling. After baling the urea-treated small bales were packed tightly in empty silage silos in a cold barn and covered with plastic.

Feed intake was recorded by group weighing of offered and refused feeds on a daily basis. On the MH-diet feed was offered to cows according to Finnish recommendations (Ojala 1987) that are based on those for dry dairy cows (Salo et al. 1982) documented as  $LW^{3/4}/500^{3/4} \approx 4.0$  fattening feed units (FFU) for maintenance and 0.4 FFU/kg fat corrected milk for milk production. The average LW of cows at the start of the experiment and estimated energy and protein values of experimental feeds were taken into consideration. For L-diets, the amount of feed was restricted to 70% on a DM basis of that of M-diets. On H-diets, feeding was based on hay, while for US-diets, hay was replaced by urea-treated straw and barley. The DM intake from hay and urea-treated straw was estimated to be equal for both diets at each feeding level. Barley was included in US-diets (M:1.10 and L:0.80 kg DM/day/animal) to balance energy intake with respect to H-diets. A urea-solution (M:45.0 and L:31.5 g urea/day/animal) was given to cows on the H-diets to balance crude protein intake with respect to US-diets. In addition, untreated straw was offered for all diets (M:2.50 and L:1.97 kg DM/day/animal). The *pre partum* concentrate feeding to all cows commenced by offering 1.0 kg/day of a barley-rape seed meal (ÖPEX®-rape seed meal, heat-moisture treated) mixture (70:30) from day 60 to 30 and 1.5 kg/day from day 30 to 0 *pre partum*. After calving, cows received 3.0 kg/day of the same concentrate mixture. During the indoor feeding period animals had free access to a mineral mixture rich in phosphorus (Fosfori-Hertta; Ca 145, P 115, NaCl 110, Na 55, Mg 35 g/kg), a salt lick and water. A vitamin mixture was given weekly at a rate of 50 g per cow. Two weeks before calving all cows were injected with an ADE-vitamin mixture and Selenium.

Feed sampling and calculation of energy and protein values for feeds other than urea-treated straw was conducted according to Manninen et al. (1998). Chemical composition of urea-treated straw was determined using standard procedures, while digestibility coefficients used for urea-treated straw were based on the studies of

Aronen (1990). Digestibility coefficients of urea-treated straw for protein, ether extract, crude fiber and nitrogen free extract used in the current study were 0.401, 0.475, 0.519 and 0.489, respectively and the calculated D-value was 47.7%. The DM content of urea-treated straw was determined by oven drying at 105°C for 24 hours and corrected for volatile losses according to Huuda et al. (1986). Fresh samples of urea-treated straw were analyzed for pH, volatile fatty acids, ammonia nitrogen (N), soluble and total N using the methods described by Manninen et al. (1998). To avoid a miscalculation of amino acids absorbed in the small intestine (AAT, g/kg DM) and protein balance in the rumen (PBV, g/kg DM) values assigned to urea-treated straw, the crude protein concentration of untreated straw offered at the same period of time during the experiment weeks was used to calculate degradable protein content of urea-treated straw. Digestible crude carbohydrate values for urea-treated straw were calculated by using crude fibre content and digestibility of urea-treated straw and nitrogen free extract content and digestibility of untreated straw offered at the same period of time.

## Live-weight and calving difficulties

Cows were weighed at the beginning of the experiment, 1–7 days *pre partum*, within 48 hours after parturition, at the beginning and end of the grazing season and at weaning. All information for one LiAy cow on the MUS-feeding was omitted from the final data due to an abortion two months after the start of the experiment. Calves were weighed immediately after birth, at 14 and 100 days of age, at the beginning and end of grazing and at weaning. One HfAy-cow gave birth to twins one of which was immediately given to a dam who lost her calf in an accident before turnout. All information concerning twin calves was excluded from the final data. One LiAy-cow abandoned her calf after birth and only the birth weight of this calf is included in the data. All the calvings were monitored and

assistance was given if calving was prolonged. The incidence of calving difficulties was recorded using the following classification scale: easy calving with no assistance (1), calving with a slight assistance (2), difficult calving (3) and very difficult calving requiring veterinarian assistance or caesarean section (4).

## Milk production and rebreeding

Milk production was assessed for six cows from each treatment group using the calf-suckling technique previously described by Manninen et al. (1998). Milk yield was measured on days 10, 50, 95 and 140 of lactation. At pasture an oestrus synchronisation procedure was carried out using PRID® (Progesterone Releasing Intravaginal Device, ABBOTT Laboratories) with 59 cows. Cows were subdivided into three groups according to calving date. Group 1 included 16 cows with PRID-coils being placed 24 May, removed 4 June and cows were inseminated using a double-fixed-time artificial insemination (AI) with Hereford-semen 6 and 7 June. Group 2 also included 16 cows, with the PRID-coils being placed 21 June, removed 3 July and cows were inseminated 5 and 6 July. Group 3 included 27 cows, the PRID-coils being placed 19, removed 31 July and cows were inseminated 2 and 3 August. A Hereford-bull ran with the cows after insemination from 6 August to 6 September. Pregnancy diagnosis was conducted on 1 October.

## Statistical analysis

The GLM procedure of the Statistical Analysis System (SAS 1989) was used for analysis of variance. Animals were in pens with eight animals per pen and two pens per treatment. Pen was used as an experimental unit (Gill 1989). Individual cow and calf data was used for testing cow and calf performance and milk production. Feed intake data was not statistically evaluated due to fixed experimental feeding regi-

Table 1. Chemical composition and feeding value of experimental feeds.

	Hay	Urea-treated straw	Straw	Barley	Rapeseed meal	Urea
Number of samples	8	8	8	8	5	1
Chemical composition						
Dry matter (DM, g/kg)	867	654	875	862	881	1000
In the DM						
Ash	42	35	35	22	74	
Crude protein	82	98	38	129	374	288
Ether extract	17	15	13	22	73	
Crude fibre	360	459	474	50	133	
Nitrogen free extract	499	393	440	777	346	
Feed value (/kg DM)						
ME, MJ	9.0	6.7	6.3	13.6	11.8	
AAT, g	75	56	55	107	152	
PBV, g	-46	5	-56	-46	141	2880

ME, metabolizable energy

AAT, amino acids absorbed in the small intestine

PBV, protein balance in the rumen

In urea-treated straw: pH 8.46

In DM (g/kg); acetic acid 14

In total nitrogen (g/kg): ammonia N 372, soluble N 766, urea N 272

mens.

Data for cows was analysed according to the following model

$$y_{ijkl} = \mu + b_i + d_j + bd_{ij} + p_k(bd_{ij}) + \epsilon_{ijkl}$$

where  $y_{ijkl}$  is the response variable,  $\mu$  is the general mean,  $b_i$  is the feeding level,  $d_j$  is the diet,  $bd_{ij}$  is their interaction,  $p_k$  is a random effect due to the pen within treatment and  $\epsilon_{ijkl}$  is the random error term. In the analysis, the  $p_k(bd_{ij})$  term with four degrees of freedom has been used as an error term.

Data for the calves was analysed using the same model with the exception that the effect of sex ( $s_m$ ) and interactions between sex and feeding level, sex and diet, and sex, feeding level and diet were included. In this analysis, the  $p_k(bds_{ijm})$  term with eight degrees of freedom has been used as an error term. Calf birth date was used as a covariate in the analysis of variance when interpreting calf performance data. Standard error of estimate (SEE) was used to interpret calf data due to the variable number of observations per treatment.

## Results

### Chemical composition of feeds and feed intake

Treatment of straw with the urea-solution succeeded technically well and increased the crude protein content from 38 to 98 g/kg DM (Table 1). Calculated energy and AAT values of urea-treated straw were little different than the corresponding values for untreated straw, except for the PBV value of urea-treated straw which was higher than that of the untreated straw (5 vs. -56 g/kg DM). Hay, barley and rapeseed meal had a chemical composition typical for each feed ingredient.

During the indoor feeding cows on the H-diet consumed numerically more DM/day than those on the US-diet (mean: H: 8.03 vs. US: 7.61 kg DM, Table 2). This was due to an overestimation of the DM content of urea-treated straw based on preliminary samples. In addition, on

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Table 2. 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 crossbred cows during indoor feeding.

Feeding level	Low		Moderate	
	Hay	Urea-treated straw	Hay	Urea-treated straw
Diet type				
Number of groups	2	2	2	2
DM intake, kg				
Hay	3.95		5.63	
Straw	1.97	1.98	2.50	2.49
Urea-treated straw		3.01		4.02
Barley	0.58	1.34	0.58	1.62
Rapeseed meal	0.25	0.24	0.25	0.22
Urea	0.0315		0.045	
Minerals	0.153	0.148	0.123	0.164
Total	6.94	6.72	9.13	8.51
ME	58.9	53.7	77.4	67.2
AAT	506	457	661	568
PBV	-166	-91	-234	-138

several cold days cows fed the US-diet did not consume all of the urea-treated straw offered since it was partially frozen. The proportion of hay accounted for 59.6% and the proportion of urea-treated straw 46.1% of the total DM intake for H- and US-diets, respectively. On the US-diet, the intake of DM and ME was 5.2% and 11.3% lower than that of the H-diet, respectively. The DM intake on the L feeding level was 77.4% of that on the M feeding level. The intake of ME supplied by MUS, LH and LUS diets accounted for 86.9%, 76.1% and 69.4% of that supplied by the MH-diet.

## Live weight of cows and calving difficulties

The live weight gain (LWG) from the start of the experiment to calving was higher ( $P < 0.01$ ) for cows fed the H-diet than for those fed the US-diet (Table 3). During this period cows on the M feeding level had higher ( $P < 0.01$ ) LWG than those on the L feeding level. Cows on the US-diet were 32 kg lighter ( $P < 0.01$ ) *pre partum*

than those on the H-diet and cows on the L feeding level were 24 kg lighter ( $P < 0.05$ ) *pre partum* than those on the M level of feeding. Both *post partum* and at the beginning of grazing season, cows fed either the H-diet or M feeding levels were heavier ( $P < 0.05$ ) than those fed US-diets or on the L feeding level. An interaction ( $P < 0.05$ ) in the LWG from calving to start of grazing between diet and feeding level was observed. On the LH-diet, cows lost more LW than those on the LUS-diet (-584 vs. -358 g/day) while the opposite occurred on the M diets (295 vs. -239 g/day). At pasture, cows on the L feeding level had a daily LWG of 828 g, which was 295 g higher ( $P < 0.05$ ) than for those previously fed the M feeding level. Also the daily LWG of 770 g at pasture for cows previously offered the US-diet tended ( $P < 0.10$ ) to be higher than that of 590 g observed for cows previously fed the H-diet. Cow diet, feeding level or sex of the calf had no effect on the incidence of calving difficulty (Table 4). One calving was classified as difficult and may have resulted from the small size of the dam, with a pre-calving LW of 366 kg. Nine calvings (14.5%) required slight assist-

Table 3. Live weight (LW) and live weight gain (LWG) of cows during indoor feeding and grazing.

Feeding level Diet type	Low		Moderate		SEM <sup>2</sup>	Statistical significance <sup>1</sup>		
	Hay	Urea-treated straw	Hay	Urea-treated straw		Feeding level	Diet type	Interaction
Number of cows	16	16	16	15 <sup>a</sup>				
LW, kg								
Initial	495	498	492	487	7.1	NS	NS	NS
Pre-partum	539	508	563	531	6.3	*	**	NS
Post-partum	478	446	501	475	8.7	*	*	NS
Beginning of grazing	467	440	505	472	7.7	*	*	NS
End of grazing	546	536	551	537	16.4	NS	NS	NS
Weaning	546	534	551	536	13.0	NS	NS	NS
LWG, g/day								
Start ∅ Calving	246	46	409	239	33.9	**	**	NS
Calving ∅ Grazing	-584	-358	295	-239	118.4	*	NS	*
Start ∅ Grazing	-140	-296	64	-74	39.0	**	*	NS
On pasture	757	898	424	643	76.7	*	o	NS
Start ∅ End of Grazing	167	123	192	162	39.7	NS	NS	NS

<sup>1</sup> o P<0.10; \* P<0.05; \*\* P<0.01; \*\*\* P<0.001; NS not significant.

<sup>2</sup> Standard Error of the Mean.

<sup>a</sup> Mean was based on 15 (Moderate – Urea-treated straw) rather than 16 observations. SEM given should be multiplied by 1.0351 when making comparisons with other mean values.

ance and the remainder of the calvings were classified as easy.

### Live weight of calves

No interactions in calf LW and LWG between feeding level, diet and sex were observed and therefore, only least squares means for the main effects are presented in Table 4. Feeding level and diet had no affect on the LW or LWG of calves. At 100 days of age and at the end of grazing season, male calves were heavier (P<0.05) than females. There were no significant differences between diets and feeding levels in LWG from birth to weaning but male calves grew faster (P<0.05) than females (1368 vs. 1282 g/day). Intake of barley creep-feed by calves was on average 0.44 kg/day at pasture and 0.54 kg/day indoors prior to weaning.

### Milk production and conception rate

Cow diet or feeding level had no affect on milk production which averaged 9.1 kg and 9.3 kg for L and M feeding levels and 9.6 kg and 8.8 kg for US- and H-diets, respectively (Table 5). On day 50 of lactation, cows on the US-diet tended to produce more (P<0.10) milk than those on the H-diet. On day 140 of lactation there was an interaction (P<0.10) between feeding level and diet. Cows on the LH-diet produced more milk than those on the LUS-diet while the opposite was true for the M feeding level. During the mating period, 71% of cows on the L feeding level and 68% of those on the M feeding level successfully conceived. The corresponding values for the H- and US-diets were 72% and 67%, respectively. Forty percent of experimental cows were in calf following double fixed time AI, 29% after natural service and 31% remained non-pregnant.



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Table 4. Effect of diet type, feeding level and sex on calving difficulty and calf performance.

	Diet type		Feeding level		Sex		SEE <sup>2</sup>	Statistical significance of the main effects <sup>1</sup>		
	Hay	Urea-treated straw	Low	Moderate	Male	Female		Diet type	Feeding level	Sex
Number of calves <sup>3</sup>	31	31	31	31	28	24				
Calving difficulty	1.11	1.19	1.21	1.09	1.16	1.15	0.312	NS	NS	NS
Average calving date <sup>4</sup>	123	134	127	129	128	128	29.2	NS	NS	NS
Live weight, kg										
Birth	42.3	41.3	41.6	42.1	43.1	40.6	4.30	NS	NS	o
Day 14	59.9	57.7	58.2	59.4	60.5	57.2	5.27	NS	NS	o
Day 100	172	177	174	175	180	170	10.4	NS	NS	*
Day 161	252	257	253	257	263	247	13.9	NS	NS	**
Start of grazing	76.9	69.0	72.4	73.5	75.3	70.6	15.49	NS	NS	NS
End of grazing	225	231	227	229	236	220	18.8	NS	NS	*
Weaning	252	257	252	257	263	246	15.5	NS	NS	**
Weaning age, days	169	157	165	162	164	163	27.7	NS	NS	NS
Live weight gain, g/day										
Birth Ø grazing	1241	1156	1175	1222	1217	1181	214.0	NS	NS	NS
On pasture	1411	1505	1459	1458	1510	1407	168.5	NS	NS	o
Birth Ø weaning	1305	1344	1311	1339	1368	1282	91.9	NS	NS	*

<sup>1</sup> o P<0.10; \* P<0.05; \*\* P<0.01; \*\*\* P<0.001; NS not significant.

<sup>2</sup> Standard Error of the Estimate.

<sup>3</sup> One female calf on low level-hay diet has only values for calving difficulty and birth weight.

One female calf on high level-urea-treated straw diet has only values for calving difficulty, birth weight and 14-day weight.

<sup>4</sup> Day 1 = 1 January.

## Discussion

### Feeds and feed intake

The health of cows and calves was good. The temperature during the indoor feeding period was lowest during the middle of January when indoor temperatures of  $-23^{\circ}\text{C}$  were recorded. The effect of urea-treatment is based on the hydrolysis of urea to ammonia which prevents the growth of fungi and undesirable bacteria such as *Clostridia* (Block et al. 1989). Earlier studies (Alaspää 1986, Aronen 1990) have shown that the treatment of straw with an urea-solution is an economical and practical method to preserve high moisture straw against mould. Treated straw and grass silage are usually not combined in

dairy cow diets due to a surplus of nitrogen in silage and the low energy content of straw. Diets for beef cows typically contain only small amounts of grass silage and therefore, treated straw can be considered to be a suitable feed-stuff for beef production.

Although the treatment and storage of straw was successful, the calculated feeding value of the urea-treated straw was not equal to hay. Alaspää (1986) reported an organic matter (OM) digestibility for urea-treated straw of 517 g/kg OM but the crude protein (CP) and DM content were higher relative to values observed in the current study. The moisture content of straw at the time of treatment, storage time and in the concentration of applied urea, influence the hydrolysis of urea to ammonia that has a direct effect on the efficacy of urea treatment (Sundstol

Table 5. Effect of feeding level and diet type on milk production (kg/day).

Feeding level Diet type	Low		Moderate		SEM <sup>2</sup>	Statistical significance <sup>1</sup>		
	Hay	Urea-treated straw	Hay	Urea-treated straw		Feeding level	Diet type	Interaction
Number of animals	6	6	6	6				
Day of lactation								
10	8.6	7.8	9.0	8.2	0.75	NS	NS	NS
50	9.9	12.6	9.2	11.1	0.96	NS	o	NS
95	9.7	9.8	10.7	10.0	0.94	NS	NS	NS
140	7.7	7.2	5.9	10.1	0.91	NS	NS	o
Mean	9.0	9.3	8.7	9.8	0.68	NS	NS	NS

<sup>1</sup> o P<0.10; \* P<0.05; \*\* P<0.01; \*\*\* P<0.001; NS not significant.

<sup>2</sup> Standard Error of the Mean.

and Coxworth 1984). At baling, the estimated DM content of straw was between 600 and 750 g/kg which is in good agreement with practical recommendations (500–750 g/kg). In contrast to the study of Alaspää (1986), moulding was not a problem in the current study. During the first weeks of the experiment freezing of urea-treated straw was problematic but, however, was eliminated by incubating bales in warm technical storage the day before feeding. Theoretically, the CP content of the urea-treated straw should have exceeded 200 g/kg DM rather than the recorded value of 98 g/kg DM. This apparent discrepancy may be explained by evaporation of urea as gaseous ammonia during baling and storage which Sundstol and Coxworth (1984) reported to be the greatest disadvantage of ammonia-based treatments.

On the M feeding level for both diets, metabolizable energy (ME) and AAT intakes exceeded the Finnish maintenance requirements of non-lactating dairy cows (Tuori et al. 1996). Crosses such as HfAy and LiAy in this experiment at second calving are still immature and have energy and protein requirements for growth. The AAT recommendation for maintenance is 3.25 g LW<sup>0.75</sup> for dairy cows which provides 344 g AAT/500 kg LW. The calculated PBV for each treatment was considerably lower than zero which may reflect on imbalance

between the availability of nitrogen and digestible carbohydrates for microbial protein synthesis in the rumen. On the other hand, the high AAT intake and low PBV may be due to an underestimation of protein degradability for the different feeds. On the US-diet the less negative PBV value compared to the value of the H-diet (–114 vs. –200 g/day) was due to urea which is easily degraded in the rumen. In this experiment the negative PBV value, if truly representative, had no effect on animal performance. Although barley was used as an energy supplement on the US-diet, the calculated energy intake remained below the energy intake of cows fed the H-diet. The CP content of urea-treated straw was overestimated at the beginning of the experiment which resulted in a higher CP intake for the H-diet as a result of additional urea supplementation.

### Live weight of the cows

Although the grazing period was only 106 days, cows successfully replenished the winter LW losses on good pasture. The importance of adequate good quality grass for grazing must be emphasized, particularly in Finnish circumstances with a long indoor feeding period, pro-

ducing young, high-producing animals fed at a restricted feeding level during winter. This suggestion is supported by Drennan (1991) who reported that severe winter feed restriction could not be tolerated when available pasture is limited during spring. With good quality and adequate supplies of grass, growing crossbred cows can rapidly increase their intake capacity leading to accretion of LW even during a short grazing period (Petit et al. 1995). Probably at the end of the indoor feeding period, cows on the LUS feeding had fewer body reserves to mobilize than those fed the LH-diet or receiving the M feeding level. On the MH-diet, LWG during the entire experiment was 59 kg but only 36 kg for the LUS-diet. Such a difference in LW may affect subsequent reproductive performance, although this was not assessed in the current study. The plane of nutrition during the subsequent indoor feeding period may have to be increased for cows previously overwintered a lower plane of nutrition, such as diet LUS fed in the current study.

Although the treatment of straw with urea is quite common, studies on the suitability of urea-treated straw for suckler cows are extremely limited. In contrast to the results observed in this experiment, Turner et al. (1983) reported that LW losses during the indoor feeding were acceptable during pregnancy indicating that ammonia-treated barley or wheat straw with adequate mineral supplementation may provide sufficient nutrient intake to meet the requirements of pregnant suckler cows. In the present experiment 1 kg of barley was given daily to cows as an energy supplement on the US-diet from the beginning of the experiment but it was apparently insufficient to provide a total energy intake similar to that cows fed the H-diet. The energy content of urea-treated straw may have been lower than expected or the energy content of hay may have been underestimated. However, the use of urea-treated straw for immature, cross-bred suckler cows at a low feeding level may have longer term effects on cow performance and reproduction efficiency which were not measured in the current study.

### Calving difficulties and live weight of calves

The treatments imposed had no effect on the incidence of calving difficulty and no cow even on M feeding level was obese *pre partum*. The low liveweight gains of the cows during pregnancy may explain the high number of easy calvings. It may be possible that the condition of the cows, although not measured, had an important effect on the easiness of the calvings in this experiment. Alternatively these findings may be explained by the use of sires which result in a low incidence of difficult calvings. High calf losses at or shortly after birth result in a major reduction in the subsequent calf crop. Most calf losses result from dystocia which is caused by disproportionate calf and dam sizes. Studies with different *pre partum* feeding levels (Corah et al. 1975, Drennan and Bath 1976a) have indicated that in many cases a high *pre partum* feeding level does not result in a higher incidence of calving difficulties than a low *pre partum* feeding level. Suckler cows fed ammonia-treated-straw (Turner et al. 1983) has been shown to calve normally which is consistent with the current data.

Feeding level had no effect on the LW of calves in the current experiment, which is in agreement with the findings of Absher and Hobbs (1968), Drennan and Bath (1976b), Nicol (1977) and Baker et al. (1982). However, in many studies (Hight 1968, Tudor 1972, Hodgson et al. 1980, Houghton et al. 1990) either a low *pre* or *post partum* feeding level of the dam has reduced the LWG of calves pre-weaning. Hight (1968) reported that calves from cows offered a low plane (small paddocks, previously grazed with sheep) of nutrition were 22% lighter at birth than those from cows fed at a higher plane of nutrition (autumn-saved pasture, hay to appetite). Hodgson et al. (1980) observed that calves from cows receiving a low plane of nutrition (from calving until grazing hay for maintenance and concentrate sufficient for 2.25 kg milk) grew more slowly and were lighter at

turn-out than those from cows with a higher nutrient intake (from calving until grazing hay for maintenance and concentrate sufficient for 9.00 kg milk) but the final calf LW was not significantly different. Turner et al. (1983) reported that treated straw plus minerals provided sufficient nutrient intake for mature suckler cows based on calf birth weights and subsequent calf performance. In the current study, LW of calves at 161-days of age was similar for all heifers and bulls, and the small differences observed between treatments are of minor or no practical importance.

## Milk production and conception rate

In accordance with the findings of the current experiment are consistent with other reports (Baker and Barker 1976, Drennan and Bath 1976a, Russel et al. 1979) that have demonstrated that a low plane of nutrition either *pre* or *post partum* has no effect on the milk yield of suckler cows. However, in other studies a low plane of nutrition has been associated with a decrease in suckler cow milk yield (Nicol 1977, Chestnutt 1980, Hodgson et al. 1980, Petit and Micol 1981, Baker et al. 1982, Bartle et al. 1984). Baker et al. (1982) reported that a low plane of nutrition during the first 8 weeks of lactation reduced milk energy secretion and milk protein concentration, but Lowman et al. (1979) did not find any effect of plane of nutrition during the first 150 days of lactation on milk composition. Information concerning the effect of treated straw on the milk production of suckler cows is limited. The observed significant interaction in milk production between treatments on day 140 of lactation may due to the observed value of 2 kg/d of cow on the MH feeding. In an experiment with mature May-calving suckler cows, Turner et al. (1983) found that ammonia-treated barley or wheat straw plus small amount of concentrate as winter feed for cows had no influence on calf birth weight and calf performance. Somerville et al. (1983) suggested that energy-

deficient beef cows will attempt to maintain milk production at the expense of body reserves. The situation may be more critical in the case of crossbred, high-producing, young suckler cows that are still growing.

Rebreeding suckler cows within 90 days *post partum* is economically important. In the present experiment only 69.4% of the cows were pregnant. The low conception rate may have resulted from oestrus synchronisation followed by double fixed-time AI and an attempt to inseminate the repeats due to practical difficulties to adequately detect oestrus with nearly invisible signs. The type of diet offered or feeding level had no affect on conception rate. A further possible explanation for poor reproductive efficiency may be related to the LW of cows at the beginning of the experiment. Cows may have lost too much condition between calving and mating in an attempt to maintain a relatively high milk yield. Osoro and Wright (1992) and Richards et al. (1986) suggested that body condition at calving is the most significant factor affecting reproductive performance. Hight (1968), Holness et al. (1978) and Somerville et al. (1979) reported reproductive failure in cows fed a low plane of nutrition which is in disagreement with the studies of Baker et al. (1982) and Drennan and Bath (1976a). According to Somerville et al. (1979) reproductive failure is most common in cows which have calved late during the calving period and were offered a low plane of nutrition.

## Conclusions

Urea-treated straw proved to be suitable winter feed for suckler cows. The main observation in the present study was the ability of the cows to replenish LW losses during a relatively short grazing period, and that the restricted levels of feeding still permitted a gain in LW during the 12 month feeding period. With a low plane of nutrition during indoor housing it is essential to

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have adequate amounts of pasture to facilitate a recovery of LW losses occurred during winter housing. In the current study the low level of feeding had no negative effects on cow or calf health but reproductive efficiency was poor. Condition scoring should be used in further studies to provide a more accurate measure of suckler

cow body reserves.

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## SELOSTUS

### Ureoidun oljen soveltuvuus risteytysemojen talviruokintaan kahdella eri ruokintatasolla

Merja Manninen, Ilmo Aronen ja Harri Huhta  
*Maatalouden tutkimuskeskus*

Tutkimuksessa selvitettiin heinään (H; heinää 59,6 % kokonaiskuiva-aineen (KA) syönnistä, keskimäärin 4,8 kg KA/d) ja ureoituu olkeen perustuvan (US; ureoitua olkea 46,1 % kokonais-KA:n syönnistä, keskimäärin 3,5 kg KA/d) ruokinnan soveltuvuutta emolehmien talviruokintaan. US-ruokinnalla eläimet saivat ohraa 1 kg/d kokeen alusta lähtien. Kaikki eläimet saivat käsittelemätöntä olkea sisäruokintakauden ajan ja ohra-rypsirouhe -seosta ennen ja jälkeen poikimisen. H-ruokinnalla eläinten valkuaisen saanti tasapainoitettiin US-ruokintaa vastaavaksi urealisällä. Hereford-ayrshire ja limousine-ayrshire -risteytys-

emoilla seurattiin näiden ruokintojen vaikutuksia kahdella eri ruokintatasolla (M; keskinkertainen, L; matala) elopainon kehitykseen, poikimiseen, maidontuotantoon, tiinehtymiseen ja niiden Charolais-sonneista syntyneiden vasikoiden kehitykseen syntymästä vieroitukseen.

Heinän energiapitoisuus (ME; muuntokelpoinen energia, MJ) oli keskimäärin 9,0, ureoidun oljen 6,7, oljen 6,3, ohran 13,6 ja rypsirouheen 11,8 MJ ME/kg KA. Ohutsuolesta imeytyvää valkuaista (OIV) heinä sisälsi keskimäärin 75, ureoitu olki 56, olki 55, ohra 107 ja rypsirouhe 152 g/kg KA. MUS-ruokin-

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nalla eläinten kuiva-aineen syönti oli sisäruokintakaudella päivittäin keskimäärin 8,5 kg, LUS-ruokinnalla 6,7 kg, MH-ruokinnalla 9,1 kg ja LH-ruokinnalla 6,9 kg. M-tason ruokinnoilla kotimaiseen lypsylehmien ruokintasuositukseen perustuva suositus energian ja OIV:n minimitarpeeksi täyttyi. Ureoidun oljen jäätyminen aiheutti ajoittain ongelmia, jotka poistuivat, kun ureaalkipaalit otettiin ennalta lämpiämään hyvin tuuletettuun tekniseen tilaan.

L- tai US-ruokinnalla olleet emot menettivät elopainoaan ennen poikimista enemmän ( $P < 0,01$ ) kuin M- tai H-ruokinnalla olleet emot, mutta kuntoutuivat hyvällä laitumella tehokkaasti. L-ruokintatasolla olleet emot kuntoutuivat laitumella paremmin ( $P < 0,05$ ) kuin M-tasolla olleet emot (828 vs. 533 g/d). Myös US-ruokinnalla olleiden emojen kuntoutuminen laitumella oli parempaa ( $P < 0,10$ ) kuin H-ruokinnalla olleiden emojen (590 vs. 770 g/d). Laidun-

kauden päättyessä eri käsittelyillä olleiden emojen elopainoissa ei ollut eroja. Koetekijät eivät vaikuttaneet poikimisiin eivätkä vasikoiden kehitykseen. Sonnisvasikat kasvoivat ennen vieroitusta paremmin ( $P < 0,05$ ) kuin lehmävasikat (1368 vs. 1282 g). Koetekijät eivät vaikuttaneet päivittäiseen maitotuotokseen, joka oli keskimäärin 9,2 kg. Ainoastaan 69,3 % emoista tiinehtyi, 40,3 % synkronoinnin jälkeiselle keinosiemennykselle ja 29,0 % sonnille. Koetekijät eivät vaikuttaneet tiinehtyvyyteen.

Tutkimuksen perusteella vielä kasvavat risteytysmot pystyvät korvaamaan sisäruokintakauden aikana tulleet huomattavatkin elopainon menetykset hyvällä laitumella. Alempi ruokintatase ei aiheuttanut emoille ja vasikoille ongelmia, mutta tiinehtymistulos oli heikko. Ureoitu olki soveltui risteytysemojen talvikauden rehuksi.



Photos: Merja Manninen