



Responses in live weight change to net energy intake in dairy cows

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ABSTRACT

The objective of this analysis was to estimate the effect of increased energy intake on daily live weight changes during the first 100 days of lactation of primiparous and multiparous cows. A data set with 78 observations (treatment means) was compiled from 6 production trials from Denmark, Norway and Sweden representing the breeds Danish Holstein, Norwegian Red and Swedish Red. We had access to individual data for feed intake and live weight changes (every second week) during the first 100 days after calving. The data was grouped into sub datasets according to parity; either primiparous or multiparous. Feed ration energy values were recalculated by use of NorFor to obtain consistent energy expression in all trials as opposed to the varying feed evaluation systems used in original analysis of trials. Regression analysis with linear and quadratic effects were performed on live weight registrations for individual cows to stage of lactation, and daily live weight change was estimated from the slope at day 30, 60 and 90 after parturition. Data used for analyses were treatment means given as the mean for a group of cows at a given treatment in a trial. Response models for daily live weight change were made by linear mixed effects model with trial as random factor. For both primiparous and multiparous cows there was an increasing curvilinear response at a decreasing rate to increased net energy intake and the daily live weight change at day 30 was negative and at day 90 it was positive for all energy intake levels. There were no effects of diet composition on the responses. At low energy intake levels primiparous cows had lower live weight losses than the multiparous cows. At mean net energy intake level for primiparous cows (116 MJ) the daily live weight change at day 30, 60 and 90 were -0.37 , 0.06 and 0.48 kg/d, respectively and for multiparous cows at mean net energy intake (138 MJ) the daily live weight change day 30, 60 and 90 were -0.38 , 0.03 and 0.44 kg/d, respectively. Following the response functions the marginal responses to increased energy intake decreased.

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1. Introduction

Prediction of the response in live weight change (LWC) of lactating dairy cows to increased energy intake level is relevant for ration optimization and feeding economics. Economic optimization of the net energy intake for lactating cows is important and has gained focus by fluctuations in feed and milk prices during recent years. Although the actual energetic value of the LWC response is numerically small compared to the milk production response, the change in tissue mobilization and later deposition in early lactation is of both direct and indirect economic importance. Response in daily gain to increased net energy intake is therefore a necessary component for calculations of the total energy output for a given total energy input. Furthermore, excessive negative

energy balance during early lactation can cause serious health problems (Collard et al., 2000) and is claimed to be the main cause of decline in fertility (Walsh et al., 2011).

Comparable estimates for LWC are difficult to derive from literature because of the individual trials being on different parities, covering different lactation periods, with different breeds and based on different energy evaluation systems.

A review by Coulon and Rémond (1991) evaluated 66 feeding trials from 1956 to 1991 with three feeding levels for primiparous or multiparous cows. They found a negative LWC during early lactation (week 8–13 of lactation) for the primiparous cows on low and mid feeding level and a positive LWC on high feeding level. For the multiparous cows the LWC was negative on low, mid and high feeding levels, with the weight loss being highest on low feeding level and lowest on high feeding level. From more recent times two trials have shown the same pattern for the LWC to different feeding levels. For primiparous cows during early lactation (week 2–15 of lactation) the LWC was positive at high energy intake level

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and negative at low energy intake level but no breed differences in LWC were found between Holstein-Friesian and Norwegian cows (Yan et al., 2006). A less negative LWC was found for multiparous cows during first 8 weeks of lactation and during week 9 to 16 of lactation a higher positive LWC was found at high compared to low energy intake levels (Andersen et al., 2003).

The introduction of a semi-mechanistic non additive feed planning system (the Nordic Feed Evaluation System, NorFor) in Denmark, Iceland, Norway and Sweden (Volden and Gustafsson, 2011) requires live weight (LW) responses fitted to the actual energy evaluation system, as the old responses based on an additive feed evaluation system cannot be transformed to a non-additive system.

In early lactation the typical LW curve includes both a mobilization and a deposition period which makes it complicated to quantify the LW change during the early lactation period. Furthermore, daily LW measurements in cows are highly variable due to the daily changes in rumen and gut fill, and milk volume. To address this in our study we fitted time series LW curves at the individual cow level and analyzed the energy intake and LW change relationship at different days after calving.

Feed planning is often with focus on planning a ration to meet a certain net energy intake for groups of cows in the first part of the lactation, and here it is important to predict not only the change in milk yield but also LWC due to its effect on herd economy. By using individual LWC data we were able to quantify LWC at certain DIM rather than just LWC from start to end of the first part of the lactation period (0–100 DIM). Subsequently compiling the means over cows and periods of the net energy intake for each treatment group and the means over cows of LWC at certain DIM, enable us to quantify the predicted changes in LWC in response to a change in net energy intake at the group level, which is the case when planning a change in the feed ration for groups of cows.

The objective of this analysis was to estimate the effect of increased energy intake on daily LWC during the first 100 days of lactation of primiparous and multiparous cows.

2. Materials and methods

2.1. Dataset

A data set with 78 treatment mean observations was compiled

from original data of 6 trials from Denmark, Norway and Sweden, where individual live weight records were available. Prerequisites for a trial to be included in the analysis were that cows were fed ad libitum, the planned ration energy densities were independent of individually recorded milk yields, and that various energy levels were planned within each trial. Further, the trial period should cover early stage of lactation defined as DIM 1–100. Original trial design were all continuous designs and trials were conducted during the years 1998–2009 at research centers with registrations at cow level of feed intake of all offered feed, milk yield and LW. Data were from the breeds Danish Holstein (DH) (46%), Norwegian Red (NR) (46%) and Swedish Red (SR) (8%). The data were grouped into sub datasets according to parity; either primiparous (Primi) or multiparous (Multi). Summary of trials included in the data set is shown in Table 1.

Feeding principles in trials were TMR, partly mixed rations or separate feeding. Roughages were silages of grass, grass clover, corn, whole crop barley, or ammonia treated straw. Concentrates were various combinations of barley, oats, rapeseed cake, peas, dried beet pulp, molasses, or urea. Concentrate proportion in rations varied from zero to 85% on DM basis. Feed ration characteristics are shown in Table 2.

Treatment mean data from two additional trials were used as supplemental data sets for this analysis as our study period from parturition to day 100 was only covered partly by these two trials (Table 1). In the two trials DIM were from zero to 56 and from 20 to 70, respectively. The short trial periods were due to subsequent changes in feeding levels within treatments. These data were included as supplemental data to provide more evidence for the early part of the lactation.

2.2. Calculation of energy intake and milk production

Energy values of all feed rations used in the trials were calculated as NE lactation (NEL) by use of NorFor to obtain consistent energy expression in data opposed to the varying feed evaluation systems used in original analysis of trials. Input of animal parameter values to NorFor were breed, parity, activity (loose or tied up) and treatment mean for LW (mean of first and last LW of each cow in trial period) and DIM. Input of feedstuff parameter values to NorFor were chemical analyses of individual feedstuffs whenever available, otherwise appropriate feed table values (NorFor

Table 1
Summary of trials included in data set.

Year	Cows	Breed ^a	n ^b	Feeding ^c	Type of roughage	Reference
1998	63	DH	18	TMR	Grass/Whole crop/NH ₃ -straw	Kristensen et al. (2003)
1999	63	DH	18	TMR	Grass/Whole crop/NH ₃ -straw	Kristensen et al. (2003)
1998	36	NR	6	SEP	Grass	Schei et al. (2005)
2001	19	NR	8	SEP	Grass	Steinshamn et al. (2004)
2007	66	NR	22	SEP	Grass	Randby et al. (2012)
2009	53	SR	6	SEP	Grass cl.	Patel (2012)
2006 ^d	191	DH	6	PMR	Grass+Corn	Bossen et al. (2009)
		DR	6			
		DJ	6			
2006 ^d	87	DH	8	PMR	Grass+Corn	Weisbjerg and Munksgaard (2009)
		DR	8			
		DJ	7			

^a DH=Danish Holstein, DR=Danish Red, DJ=Danish Jersey, NR=Norwegian Red, SR=Swedish Red.

^b n=number of observations (treatment means). For example the study of Randby et al. (2012) includes 11 treatments times 2 parities (primiparous and multiparous), in total the 66 cows were distributed over the 22 treatment times parity means.

^c TMR=Total mixed ration, PMR=partly mixed ration with roughage ad lib and concentrate restricted, SEP=separate feeding of roughage and concentrates.

^d Trial only used as supplemental data for estimates of daily gain at DIM 30.

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