

Relationship between Mid-First Lactation Feed Efficiency and Late First and Early Second Lactation Body Condition Score

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Summary and Implications

The relationships between body condition score (BCS) observed during late first lactation and the first 45 days of second lactation and two measures of feed efficiency, residual feed intake (RFI) and gross efficiency (GE) defined as milk energy / DMI, measured during mid first lactation were assessed in 173 Holstein cows. Body condition score was compared between the 18 most and least feed efficient cows. When measured as RFI, feed efficient cows carried significantly more condition at dry off and tended to carry more condition at the start of second parity and at 45 days in milk (DIM), but there was no difference in change in BCS between feed efficient and inefficient cows. When measured as GE, efficient cows tended to carry less condition 30 days prior to dry off and lose more condition throughout the first 45 DIM. These findings suggest that selection based on RFI should not impact BCS change during late first lactation or early second lactation but selection based on feed efficiency measured as GE may result in greater BCS loss in early second lactation.

Introduction

Improving feed efficiency during mid-lactation when cows are at peak milk production and peak feed intake is becoming more important for economic and environmental sustainability of dairy farms. It is a concern that improvements in feed efficiency might cause increased body tissue mobilization, which has been associated with impaired cow health/ Residual feed intake is a measure of feed efficiency that is independent of change in body weight and relatively independent of change in BCS during the time frame over which the data collection for RFI occurs. However, RFI calculated during mid-lactation may not be independent of change in BCS during late lactation or in a subsequent lactation.

The goal of this study was to characterize the relationship between RFI measured during mid-first lactation and BCS observed during late first lactation and early second lactation. We compare these results to the relationship between GE, a traditional measure of feed efficiency, and BCS during the same time frame.

Materials and Methods

Beginning at 50 to 150 DIM and continuing for approximately 60 days, feed intake was recorded daily using a Calan Broadbent feeding system on 206 first lactation Holstein cows at the Iowa State Dairy farm during 2014 and 2015. During this time, daily milk weights along with weekly body weight, BCS, and milk component data were recorded. Once cows reached 235 DIM and were confirmed pregnant, weekly BCS were observed until dry off. At the initiation of second lactation, weekly BCS were observed until 45 DIM. In total, 173 cows had all of these data recorded.

Body condition scores were predicted for days during late first lactation and early second lactation on which it was not observed. Three traits were generated for late first lactation: BCS at 35 days prior to dry off, average daily change in BCS from 42 days prior to 7 days prior to dry off, and BCS at 7 days prior to dry off. During early second lactation, 5 traits were generated, BCS at 4 DIM, average daily change in BCS during the first 25 DIM, average daily change in BCS during DIM 25 to 45, average change in BCS during the entire first 45 DIM, and BCS at 42 DIM. We calculated RFI as the error term in the regression of DMI on milk energy, change in body energy, which reflects changes in body weight and BCS, and metabolic body weight. We calculated GE as the ratio of milk energy over DMI. Both measures of feed efficiency were corrected for fixed effects of replicate and DIM. For each measure of feed efficiency, the difference for each of the BCS traits between the 18 least and most feed efficient cows was estimated using a mixed model.

Results and Discussion

Mean RFI for the 18 most feed efficient cows was -1.87 kg/d and was 1.76 kg /d for the 18 least feed efficient cows (Table 1). Mean GE for feed efficient cows was significantly greater than for feed inefficient cows. Daily milk energy output, average daily body weight change, and average metabolic body weight did not differ between feed efficient and feed inefficient cows when measured as RFI. However, feed efficient cows when defined by GE produced significantly more milk energy, were significantly smaller, and carried significantly less body condition. Regardless of the feed efficiency measure, feed efficient cows ate significantly less DM per day but the difference between efficiency group was greater when measured as RFI (3.6 kg/d versus 1.4 kg/d).

When measured as RFI, feed efficient cows carried significantly more body condition at dry off (3.50) than feed inefficient cows (3.25; Figure 1A). Furthermore, they tended to carry more body condition at the beginning of

second lactation as well as at 42 DIM (Figure 1B). There was no difference in the change in BCS during late first lactation or in early second lactation between feed efficient and inefficient cows when measured as RFI. Thirty-five days prior to dry off, feed efficient cows when measured as GE tended to carry less body condition, but no difference was seen at calving (Figure 1C). In second lactation, change in BCS between feed efficient cows and feed inefficient cows differed during the first 25 DIM, during 25 through 45 DIM, and logically, over the entire first 45 DIM (Figure 1D).

This study showed that feed efficiency when measured as RFI during mid-first lactation is unrelated to change in

BCS during late first lactation and early second lactation but when measured as GE, improved feed efficiency is associated with increased, though still acceptable, BCS loss. In conclusion, we can suspect that selection for reduced RFI will not result in increased acquisition or mobilization of body tissue at the expense of the cow during late first lactation or early second lactation.

Acknowledgements

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Table 1. Means and standard errors (SE) for body condition score (BCS) traits for feed efficient and feed inefficient cows defined by residual feed intake (RFI) or gross feed efficiency (milk energy (Mcal)/dry matter intake (kg), GE).

Trait ¹	RFI				GE			
	Efficient(n=18)		Inefficient (n=18) ³		Efficient (n=18)		Inefficient (n=18)	
	Mean ²	SE	Mean	SE	Mean	SE	Mean	SE
Mid-lactation								
Milk energy, Mcal/d	24.9	0.71	25.8	0.71	27.9***	0.60	23.4***	0.60
Metabolic body weight, kg ^{0.75}	122	1.4	121	1.4	116*	1.6	123*	1.6
Change in body weight, Mcal/d	1.94	0.44	2.43	0.44	1.53 [†]	0.53	2.81 [†]	0.53
BCS	3.21	0.062	3.11	0.062	3.06*	0.059	3.26*	0.059
Dry matter intake, kg/d	19.4***	0.37	23.0***	0.37	19.9*	0.41	21.3*	0.41
Feed efficiency kg/d; no units	-1.87***	0.12	1.76***	0.12	1.40***	0.024	1.10***	0.024
Late first parity								
BCS (35 d prior to dry-off)	3.44 [†]	0.080	3.22 [†]	0.077	3.21 [†]	0.076	3.39 [†]	0.076
Change in BCS:-42 to -7 DIM, /d	0.0017	0.0008	0.00097	0.0008	0.0013	0.0014	-0.0005	0.0014
Dry-off BCS (7 d prior to dry-off)	3.50*	0.078	3.25*	0.078	3.27	0.067	3.39	0.067
DIM at dry-off	320*	7.2	298*	7.2	319	7.4	302	7.4
Early second parity								
BCS at calving (4 DIM)	3.50 [†]	0.061	3.33 [†]	0.061	3.38	0.063	3.36	0.063
Change in BCS: 25 DIM, /d	-0.011	0.0023	-0.014	0.0023	-0.015 [†]	0.0016	-0.010 [†]	0.0016
Change in BCS: 25 to 45 DIM, /d	-0.011	0.0018	-0.010	0.0018	-0.011 [†]	0.0018	-0.006 [†]	0.0018
Change in BCS: 45 DIM, /d	-0.011	0.0018	-0.012	0.0018	-0.0127 [†]	0.0016	-0.0083 [†]	0.0016
Post-transition BCS (42 DIM)	3.06 [†]	0.068	2.89 [†]	0.068	2.90	0.076	3.04	0.076

¹ –xx refers to number of days prior to dry-off

²Significance levels: [†]P < 0.10, *P < 0.05, **P < 0.01, ***P < 0.001

³Only 17 inefficient cows and only 16 each of feed efficient and inefficient cows had predicted values for BCS at 35 d prior to dry-off when defined as RFI and GE, respectively.

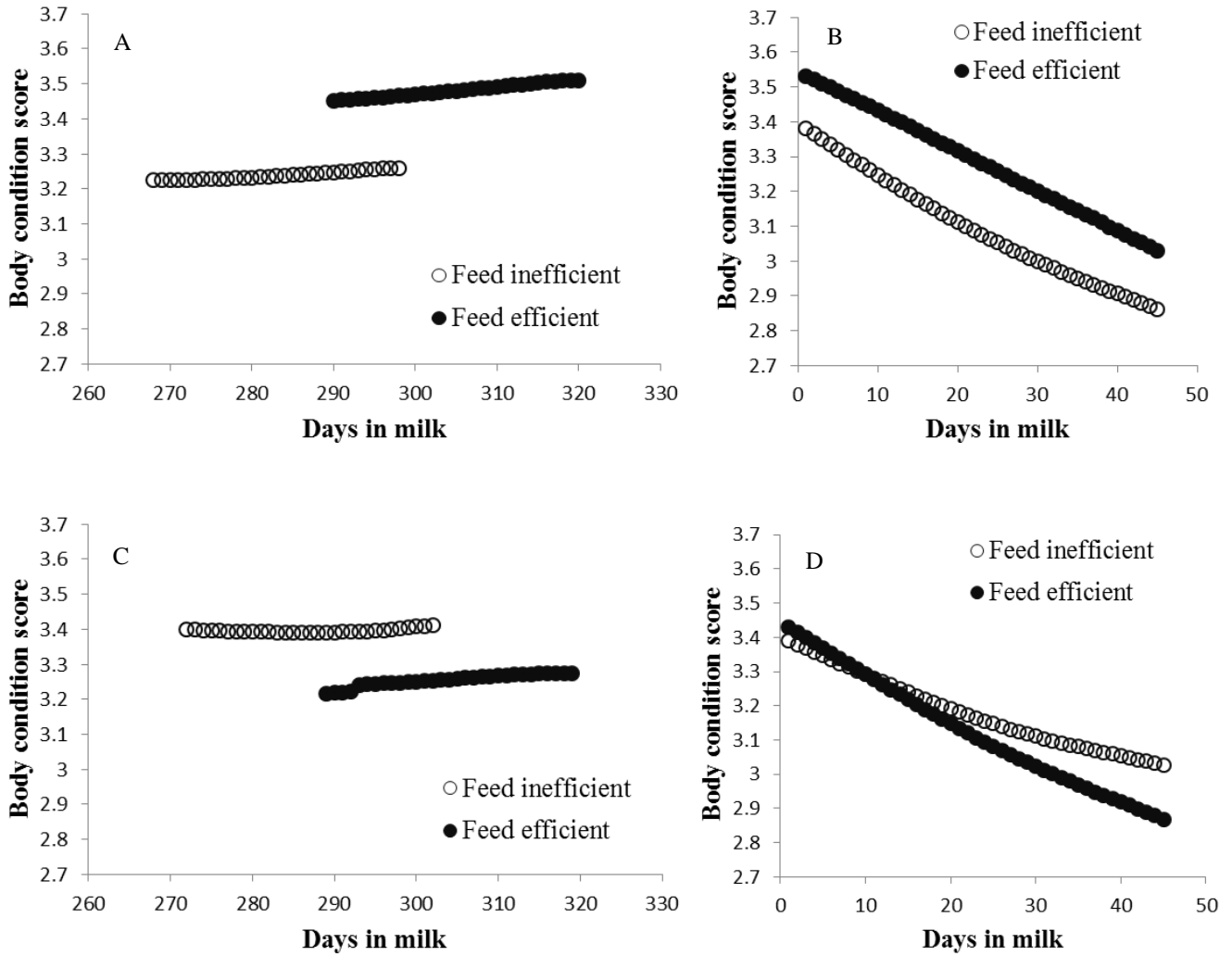


Figure 1: Mean predicted BCS for feed efficient and feed inefficient cows when calculated as residual feed intake during late first lactation (A) or early second lactation (B) and when calculated as gross feed efficiency (milk energy per kg DMI) during late first lactation (C) or early second lactation (D). Body condition score in late lactation is plotted according to the mean DIM at dry off for cows within each feed efficiency group.