

# Genetic Regulation of Feed Efficiency in Lactating Holstein Cows

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### Summary and Implications

Feed efficiency in dairy cattle represents the balance between milk production and feed intake. In the past, improvements in efficiency have been achieved through increased production with little emphasis on feed intake. However, dry matter intake (DMI) is a moderately heritable trait in lactating Holstein cows, suggesting that DMI may be altered through genetic selection. When efficiency is defined as milk energy output (MILKE) per unit of dry matter intake (DMI), high and low efficiency cows differ in MILKE but not DMI. However, considerable variation in DMI exists among cows with desirable MILKE. Thus, consideration of alternate definitions and selection strategies that include DMI may contribute to further improvement in efficiency of lactating dairy cows.

### Introduction

Feed efficiency in dairy cows is an important economic topic for dairy producers, as cows that produce more milk while consuming less feed would increase profitability. Additionally, efficient cows would contribute to improved environmental stewardship for the industry. Traditionally, genetic improvements in efficiency have primarily occurred as a result of selection for increased production, with little emphasis on feed intake. Interest in the genetic evaluation of dairy cows for dry matter intake (DMI) has been growing worldwide, in an effort to develop additional selection strategies for improving efficiency. Objectives of our research are to estimate genetic parameters for DMI and related traits, and to define phenotypic relationships among production, DMI, and efficiency in lactating Holstein cows at the ISU Dairy.

### Materials and Methods

Feed intake and milk production data were collected on 400 Holstein cows at the ISU Dairy in 2008 through 2010. There were 226 first parity cows and 174 cows ranging in parity from two to seven. Intake data were collected using the Calen Broadbent Feeding system. Cows were fed ad libitum, and feed intake was calculated as the difference between feed provided twice daily, and feed remaining each day, from approximately 4 through 150 days in milk (DIM). Daily intake was converted to DMI based on moisture content of feed as determined from weekly samples of the total mixed ration. Milk production was recorded at each milking (2X daily) and milk composition was determined

weekly during the first 30 DIM, and monthly throughout the remaining lactation. Body weight and body condition score (BCS) were recorded weekly. Heritability estimates for all traits were determined for each trait averaged over monthly intervals using an animal model as implemented by ASREML software. Feed efficiency was defined as MILKE per unit of DMI (Mcal/kg) from 4-150 DIM, and comparisons were made between cows representing the 10% high and low tails of the phenotypic distribution for primiparous and multiparous cows.

### Results and Discussion

Heritability estimates for dry matter intake (DMI), milk energy output (MILKE) yield, energy balance (EB), body weight (BW), and body condition score (BCS) averaged over monthly intervals were 0.27 to 0.63, 0.12 to 0.62, 0.12 to 0.49, 0.63 to 0.72, and 0.49 to 0.53, respectively. These results indicate DMI, MILKE, and EB are all moderately heritable traits likely to respond to selection pressure. Body weight and BCS have slightly higher heritability estimates.

A strong phenotypic correlation exists between MILKE and DMI (Figure 1), suggesting that on average greater DMI is associated with increased MILKE. To better understand phenotypic differences between high and low efficiency cows, the highest and lowest 10% of cows for efficiency were identified within primiparous and multiparous groups. The DMI of these two groups were similar from 4-150 DIM, but the high efficiency cows had greater MILKE (Figure 2). This result supports the concept that increased efficiency is achieved primarily through increased production, rather than reduced DMI. However, variation in DMI exists, even within high producing cows. To further investigate this variation in intake, the top 25% of primiparous and multiparous cows were selected. Cows within this group were ranked according to average daily DMI, from 4-150 DIM. Production and DMI were then compared between these high and low DMI, high producing cows. For primiparous cows, the 10% highest intake cows consumed 4.4 kg more DMI, and produced 1.94 Mcal more MILKE per day compared to the 10% lowest intake cows. In multiparous cows, the 10% highest intake cows consumed 8.7 kg more DMI, while producing only 0.65 Mcal more MILKE per day compared to the 10% lowest intake cows (Figure 3). These results are important because they demonstrate that high producing cows can vary in DMI by as much as 8 kg of DMI per day, even though increased DMI on average contributes to increased production. Additional research is underway to confirm these results in larger populations, and to develop genetic selection strategies for further improvement of feed efficiency in dairy cattle.

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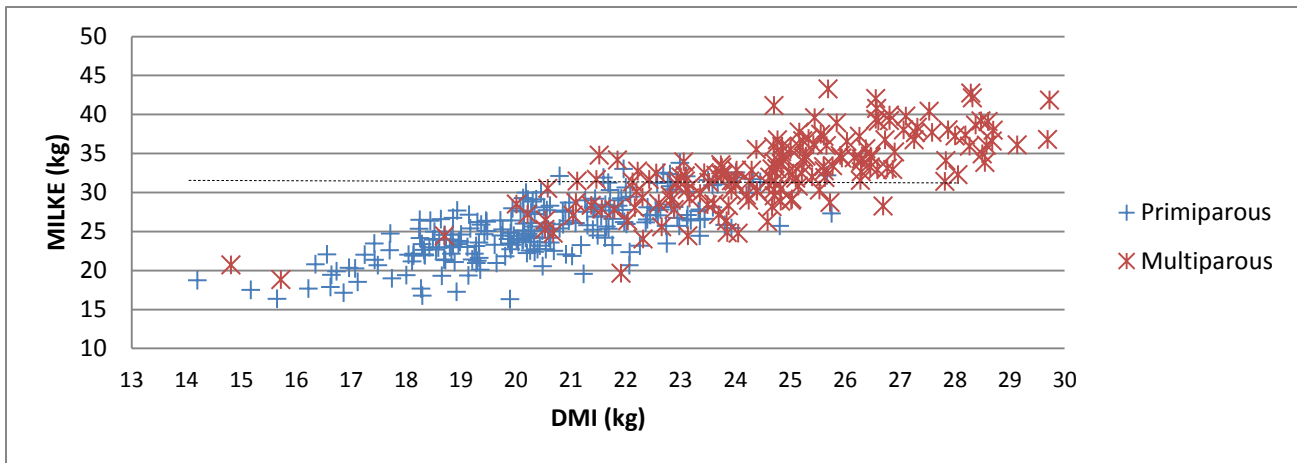


Figure 1. Milk energy output (MILKE) plotted against dry matter intake (DMI). Values are the average for each cow 4-150 day in milk (DIM). The reference line at 32 kg MILKE separates the top 25% milk producing cows.

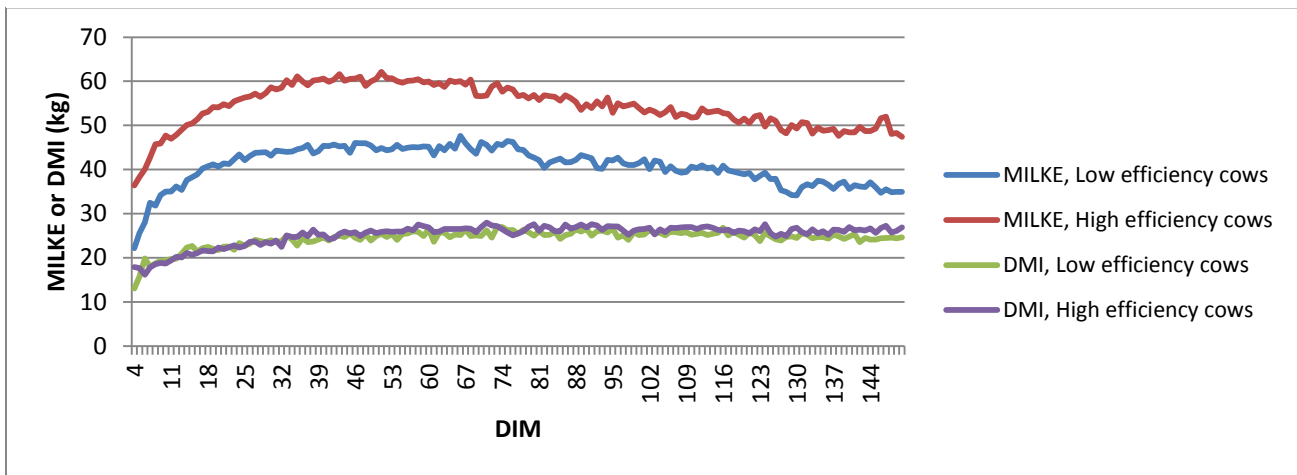


Figure 2. MILKE and DMI plotted against days in milk (DIM) for multiparous cows 4-150 DIM. Similar results were found in primiparous cows.

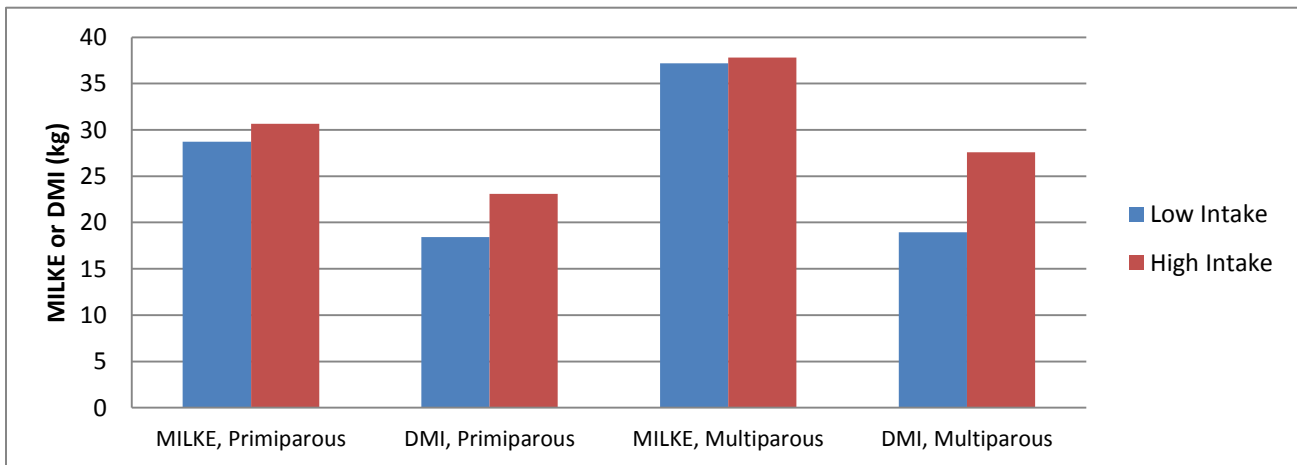


Figure 1. Comparison of MILKE and DMI for low intake and high intake cows of the top 25% MILKE producers.