# Southeast Dairy Producer's Check-Off Program

# Research Summary

## Investigating mechanisms of divergent feed efficiency in dairy cows

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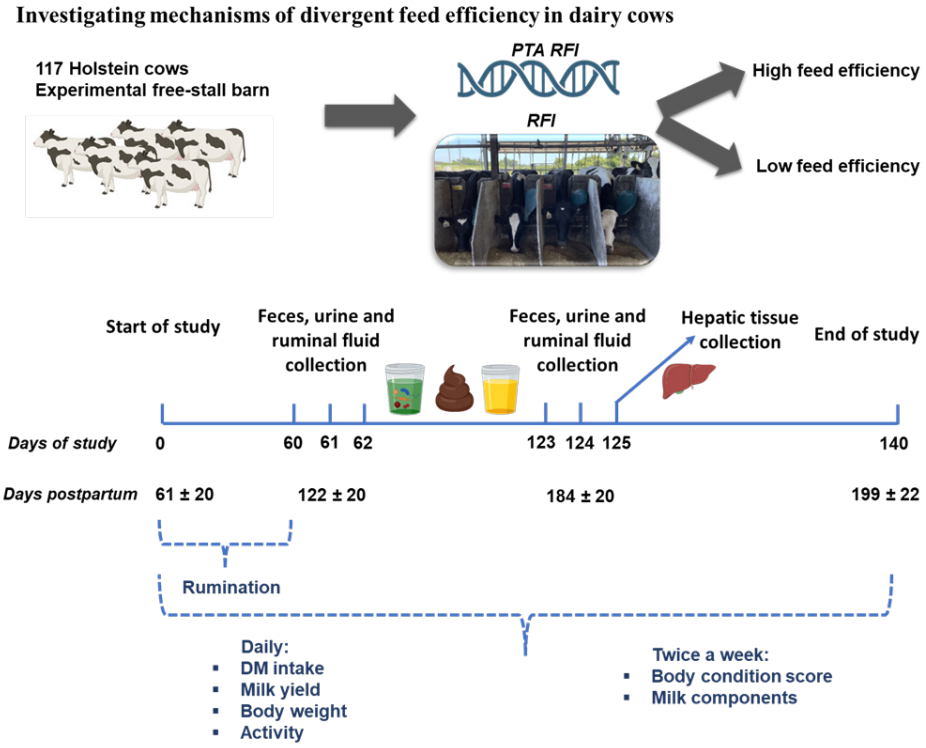
## Implications

Current results suggest that mechanisms underlying improved feed efficiency are associated with differences in ruminal factors such as the microbiome diversity and rumen digestion which affects pH and ammonia nitrogen concentrations, rather than total tract digestibility or hepatic mitochondrial respiration. It is possible that the site of digestion changed and more efficient cows had increased ruminal digestion than less efficient cows. These findings raise speculation about the potential role of rumen digestion in explaining the disparities observed in residual feed intake. It is worth noting that, although concentrations of short chain fatty acids in the rumen fluid did not differ among quartiles of RFI, the actual production of these acids in the rumen were unknown. Subsequent work should investigate the site of digestion and the role of the rumen microbiome on feed efficiency in dairy cows under different feeding regimens.

## Methods

The objectives were to quantify nutrient digestion, behavior, characterize the rumen microbiome, and assess mitochondrial oxygen consumption coupled with ATP synthesis in hepatocytes in cows phenotypically or genomically diverging for residual feed intake (RFI). Less efficient cows have positive values for RFI, whereas more efficient cows have negative values for RFI.

Seventy-three multiparous and forty-four primiparous Holstein cows were enrolled at (mean ± SD) 61 ± 20 days postpartum. Cows were fed complete diets for 140 days and individual dry matter intake, milk yield, body weight and activity were measured daily, whereas milk sampled from consecutive milkings twice weekly was analyzed for fat, protein, and lactose. The body condition was scored twice weekly. Rumination time was measured during the first 60 days in the study. The rumen fluid, feces, and urine were sampled twice, at (mean ± SD) 61 ± 1 and 124 ± 3 days in the study, corresponding to 122 ± 20 and 184 ± 20 days postpartum, respectively. Indigestible neutral detergent fiber (NDF) was used to estimate total tract digestibility. Liver tissue was sampled from a subset of 15 most and 15 least efficient cows at 125 ± 1 days in the study (184 ± 21 days postpartum), and mitochondria respiration assay was performed. Phenotypic RFI was determined as the residuals from the equation used to predict dry matter intake, the equation considered the major energy sinks measured during the 140 days of study. Genomic RFI was based on the predicted transmitting ability (PTA) of RFI from each cow.




## Results

Phenotypic and genomic RFI had a high degree of agreement and cows with negative PTA for RFI were also phenotypically more feed efficient. Hence, unless stated otherwise, the findings will encompass both traits.

Improving efficiency was not associated with total tract apparent digestibility of dry matter, organic matter, crude protein, NDF, starch and fat. Nevertheless, more efficient cows had reduced fecal and urinary nitrogen excretion and had improved the proportion of nitrogen intake recovered as milk nitrogen. Residual feed intake was not associated with the daily activity of each cow. More efficient cows, based on phenotypic RFI, had less rumination time, whereas efficiency calculated based on genomic PTA showed no differences in rumination time. Conversely, more efficient cows had increased rumination time per unit of dry matter or NDF intakes compared with less efficient cows. Although ruminal concentrations of short chain fatty acids were not affected by quartiles of RFI, more efficient cows had smaller ruminal pH and greater ruminal concentrations of ammonia nitrogen. Additionally, microbiome analysis resulted in differences among efficient groups based on alpha-diversity indexes, and more efficient cows had a more homogenous and less diverse ruminal microbiome community than less efficient cows. Lastly, hepatic mitochondrial respiration, represented by the rates of oxygen consumption coupled with ATP synthesis, did not differ among groups of efficiency.

## References of Published Work

Nehme Marinho et al. (2021). Assessing feed efficiency in early and mid-lactation and its associations with performance and health in Holstein cows. J. Dairy Sci. 104:5493–5507.

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