



“Using Residual Feed Intake to Improve Lifetime Productivity of Beef Cows in Forage-Based Beef Cattle Production Systems”

FEED EFFICIENCY ON PASTURE

PROJECT NO.: 0010-002

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Background: Previous research has demonstrated that 56-71% of the total cost of cow-calf production can be attributed to feed, bedding and pasture. In addition, feed energy for cow maintenance represents 60-75% of total feed energy requirements. Currently, a 1% improvement in feed efficiency would save just the feedlot sector \$11.1 million annually. Various methods of quantifying feed efficiency exist, including feed conversion ratio (FCR) or feed:gain which is used most often.

Selection of breeding stock for feed efficiency using FCR leads to larger mature cows, as this measure of efficiency is directly tied to growth rate. Larger animals tend to consume more feed – a situation that may be undesirable in some production systems. However, measuring feed efficiency using residual feed intake (RFI) is independent of body weight, average daily gain and body fat composition. RFI is calculated as the actual feed intake of an animal minus the expected feed intake of that animal for its body size, body composition, and growth rate.

The bulk of RFI research has been conducted using feedlot animals that are actively growing. There is a distinct lack of research focused on RFI in forage-based feeding environments, including the impact of selection for feed efficiency on cow productivity and lifetime productivity.

Objectives:

- To compare the effect of diet (forage-based vs. grain-based diets) on RFI ranking
- To quantify performance and forage intake on pasture for low and high RFI replacement heifers
- To measure enteric methane emissions from high and low RFI heifers using laser technology during summer grazing
- Identify liver markers associated with feed efficiency in beef heifers
- To examine the relationship between heifer RFI and lifetime reproductive efficiency as mature cows
- To identify single nucleotide polymorphisms (SNPs) associated with female lifetime fertility and productivity, and their association with RFI
- Establish an education and outreach program for “Beef Cattle Feed Efficiency”

What they did:

Phase 1 – Impact of diet and environment on RFI ranking

120 bull calves (60 per year) ranging from 6-8 months of age were used. Each year, 15 bulls were fed one of the following diets:

- Forage-based for 152 days
- Forage-based for 76 days, 21-day transition

- period, then grain based for 76 days
- Grain-based for 152 days
 - Grain-based for 76 days, 21-day transition period, then forage based for 76 days

Intake was measured using the Growsafe system and RFI was calculated for all bulls. In addition, infrared thermography was used to measure eye and cheek temperature methane emissions were measured in all bulls.

Phase 2 – Quantify the relationship between RFI, first calf heifer fertility, and productivity
713 commercial beef heifers from the Lacombe, Kinsella and the Brandon Research Stations were measured for RFI, ultrasound backfat thickness, ribeye area, and marbling, body weight and average daily gain. Records were also maintained regarding body condition at pre-breeding, pregnancy check, and pre-calving, as well as whether the heifer was pregnant or open, reason and date culled (if any), calf liveliness at birth, calving ease, calf birth date and weight, and calf weaning weight and date. These records were used to determine a heifer's most probable producing ability (MPPA) which is a prediction of the performance (weaning weight) of future calves from a given cow, and includes maternal and direct genetic effects as well as permanent environmental effects.

A subset of these heifers were used to test the hypothesis that efficient heifers in a drylot situation would also consume less feed on pasture. Intake on pasture was measured using an innovative alkane marker technique which involved measured intake of alkane dosed pellets, intensive grazing on a meadow brome monoculture pasture, and fecal sampling to measure the amount of alkane disappearance to determine forage intake. Open path laser sensors also measured the methane emissions of the low and high RFI heifers on pasture as a group (this method does not measure individual animal methane emissions). Liver biopsies from another subset of ten high RFI and ten low RFI heifers were collected and analyzed for RNA (ribonucleic acid) markers.

Phase 3 – Relationship between heifer RFI and their RFI and lifetime reproductive efficiency as mature cows

From 2006-2013, over 450 crossbred replacement heifers were measured for RFI using the GrowSafe system. MPPA was calculated for birth weight and weaning weight

for each heifer kept as replacement. Lifetime productivity (LTP) was calculated using the MPAA for weaning weight multiplied by the number of calves weaned in the lifetime of the cow for each cow culled from the herd.

Phase 4 – Identify SNPs associated with female fertility and productivity

This part of the project used fertility and productivity traits collected from 785 heifers from Brandon, Kinsella and Lacombe. The heifers were followed from the 2005-2013 production cycle, or until they were culled. The traits included age at first calving, pregnancy rate, MPPA for weaning weight, and LTP (expressed as kg of weaned calf).

Phase 5 – Establish an education and outreach program for “Beef Cattle Feed Efficiency”

The research team put substantial efforts into extension activities for this project to encourage understanding of the concept of RFI and promote adoption.

What they learned:

Phase 1 – Impact of diet and environment on RFI ranking

As expected, RFI was not significantly correlated with growth or carcass traits, but was positively correlated with feed conversion ratio and dry matter intake, with low RFI animals eating about 2.4 lbs of dry matter per day less than their high RFI counterparts over both feeding periods. Regardless of diet, some bulls did re-rank for RFI through the testing period. This occurred even if animals remained on the same diet. Infrared thermography revealed that cheek temperature was more variable than eye temperature, and that accurate readings depended heavily on the environmental conditions when the readings were taken. No relationship between RFI and either eye or cheek temperature was found. Contrary to other studies, no significant difference was found in methane emissions from high or low RFI animals.

Phase 2 – Quantify the relationship between RFI, first calf heifer fertility, and productivity

RFI adjusted for effects of sexual development on feeding activity (which may disrupt feeding behavior) and fat was not related to age at first calving, pregnancy rate or MPAA for birth or weaning weight at first calving when examined over a nine-year period. There were also no differences in age at first calving, weaning

weight, MPPA birth or weaning weight in heifers ranked as low, medium or high RFI. These results indicate that RFI ranking will likely not affect first calving productivity.

High and low RFI heifers were similar in body weight, backfat and rump fat thickness, and average daily gain during most periods of the grazing trial. However, low RFI heifers consumed 5.3% less forage (dry matter) compared with high RFI heifers. RFI measured under drylot conditions in growing heifers was moderately and positively correlated to grazed RFI determined in pregnant heifers, indicating that beef heifers classified as low RFI during the post-weaning drylot period also consumed less forage as pregnant heifers grazing tame pasture.

Analysis of liver RNA revealed seven genes that had different expression patterns depending on whether the sample came from a low or high RFI animal. Three genes were down-regulated (suppressed), while four were up-regulated (expressed) in low RFI animals. Five of these seven genes were related to immune response. They also discovered consistent expression of candidate genes previously reported as associated with differences in feed efficiency.

Phase 3 – Relationship between heifer RFI and their RFI and lifetime reproductive efficiency as mature cows

When all calvings were included, there was no relationship between MPPA birth and weaning weight or lifetime average productivity. In addition, the differences between high and low RFI heifers in MPPA for birth and weaning weight, as well as lifetime productivity were not significant.

Phase 4 – Identify SNPs associated with female fertility and productivity

Numerous SNPs were identified that had significant effects on heifer pregnancy rate, age at first calving, MPAA for weaning weight and lifetime cow productivity. Significant SNPs had an effect of 1-2 percentage points on pregnancy rate and 1-2 days in age at first calving. For MPAA weaning weight and cow productivity, SNP effects varied between 28-77 kg of weaning weight and 134 to 258 kg weaning weight over the lifetime of the cow. As these results are preliminary, the significant SNPs must be screened against gene function libraries and more analysis before prediction equations can be developed.

Phase 5 – Establish an education and outreach program for “Beef Cattle Feed Efficiency”

A 107 page curriculum on “Feed Efficiency in Beef Cattle” has been produced in paper and USB formats, aimed at colleges, universities and industry. For a hardcopy of this curriculum, please contact Susan Markus.

Other extension activities included over 33 producer presentations and tours, over 30 press articles, newsletter items and YouTube videos, 12 presentations at scientific conferences and 16 publications in the forms of peer reviewed papers, abstracts and conference proceedings.

What it means: As RFI re-ranking occurred throughout the feeding period regardless of diet, other factors including stage of growth or environmental conditions may have an effect on a particular animal's ability to be feed efficient in particular situations.

Measures of RFI were not related to pregnancy rate, age at first calving, first calf weaning weight, Most Probably Producing Ability (MPPA) for birth and weaning weight, or lifetime MPPA, suggesting that selection for feed efficient (low RFI) replacement heifers would have little impact on their productivity as mature cows, provided that RFI is adjusted for backfat and feeding activity. A number of SNPs related to reproductive performance were identified and may aid in the development of prediction equations to determine the genetic contribution of an animal to these traits.

Heifers that were low RFI under drylot conditions consumed 5.3% less forage and produced 9% less methane than high RFI heifers, while maintaining growth and condition. Given that most RFI testing is done under drylot conditions, these results lend a degree of confidence to the theory that, for the most part, efficient animals in a drylot are also efficient on pasture.

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