# Feed Efficiency of 3-Year Old Suckled Beef Cows after Establishment of Feed Efficiency as Replacement Heifers

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Selection for feed efficiency using residual feed intake (RFI) as replacement heifers did not affect subsequent changes in body composition of the same heifers when they were lactating with their second calf as 3-year old cows. However, replacement heifers that were more feed efficient required 13.2% less feed as 3-year old cows compared to replacement heifers that were less efficient. Milk production was greatest in cows determined to be least efficient (high RFI) as replacement heifers.

**Summary**

*Feed efficiency was measured in 74 replacement heifers that subsequently were retained until a second feed efficiency period after the same females gave birth to their second calf as 3-yr old cows. For both the heifer and cow phases, upon arrival into the feed efficiency facility, females were allowed a 14-d acclimation period before initiating a 70-d feed efficiency test. The diet for heifers was a forage-based growing diet (0.95Mcal ME/lb DM) formulated to meet requirements to support growth rates of approximately 2.2 lb/d, whereas the diet for cows was a forage-based diet consisting of 86.7% Tifton 85 Bermudagrass silage, 12.4% dried distillers grains plus solubles, 0.7% range mineral, and 0.2% salt, suitable for lactating beef cows (NRC, 1996). Milk production was established at d 28 and 84 of lactation for the cows. The average daily gain (ADG) for heifers and cows was calculated using the slope of the body weights collected weekly or biweekly, during the test and residual feed intake (RFI) was calculated by regressing mid-metabolic weight (MMW; weight halfway through the test raised to the 0.75 power), ADG, and dry matter intake (DMI) for each animal. Heifers were sorted and placed into Low (<0.5 SD; n = 24), Medium (<0.5 SD>; n = 24), and High (>0.5 SD; n = 26) feed efficiency groups based on their RFI values, with more negative values being efficient and positive values inefficient. Individual heifer RFI values ranged from -2.2 (most efficient) to 1.9 (least efficient) and Individual cow RFI values ranged from -4.9 (most efficient) to 7.4 (least efficient). Cows which were most efficient as heifers (those in the Low group) had significantly lower DMI than their counterparts and consumed 4.56 lb less feed per day than cows that were in the High group as heifers. Therefore, low RFI heifers subsequently became cows that consumed less feed than cows that were categorized as high RFI as heifers.*

## Introduction

As the cost of production within the beef industry continues to rise, producers are continuously searching for ways to reduce input costs. Because feed costs are directly associated with approximately two thirds of total inputs (Arthur et al., 2001; Basarab et al., 2002), many producers have broadened their trait selection criteria to include not only output traits (carcass yield and quality), but also input traits (feed efficiency). Residual feed intake (RFI) is one phenotypic trait used to determine feed efficiency that measures variation in feed intake independently of body weight or growth rate. Simply stated, it is calculated as the difference between actual intake and the animal's predicted intake for a given body weight and production level. Although it has been well established that

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RFI is a moderately heritable trait, there have been few published studies comparing an individual's RFI between two different physiological states, such as growth and lactation.

Our objectives were: 1) to determine the correlation of feed efficiency measured in replacement heifers, to that measured as mature, lactating cows; and 2) to determine the relationship between residual feed intake and milking ability.

## Materials And Methods

### *Phase 1.*

In November 2007, 102 Angus, Brahman, or Romosinuano crossbred heifers were randomly allocated into pens within the University of Florida-North Florida Research and Education Center's Feed Efficiency Facility (Marianna, FL). Upon arrival, heifers were fitted with electronic identification (EID) tags and weighed, and allowed a 14-d acclimation period before starting the 70-d feed efficiency test. Within each pen, heifers had ad libitum access to water and two GrowSafe feed bunks. The diet was a forage-based growing diet (0.95 Mcal ME/lb DM) formulated to meet requirements to support growth rates of approximately 2.2 lb/d (NRC, 1996). Once the 70-d test-period was initiated, weights were collected on d 0, 14, 28, 42, 56, and 70. Individual daily feed intakes were recorded using the GrowSafe System (GrowSafe Systems Ltd., Alberta, Canada) in order to determine each animal's average daily feed intake for the 70-d test. At the end of the test, the heifers were removed from the Feed Efficiency Facility, and were required to breed, calve, become pregnant, and calve again in order to be enrolled in phase two. The ADG for heifers was calculated using the slope of the body weights collected weekly or biweekly, during the test. RFI was calculated by regressing mid-metabolic weight (MMW; weight halfway through the test raised to the 0.75 power), ADG, and DMI for each animal. Heifers were sorted and placed into Low (<0.5 SD; n = 24), Medium (<0.5 SD>; n = 24), and High (>0.5 SD; n = 26) feed efficiency groups based on their RFI values, with more negative values being efficient and positive values inefficient.

### *Phase 2.*

Beginning in January 2010, 74 females from phase one were allowed to calve in pasture as second parity, 3-year old cows. Every 7 d, cows that had successfully delivered live calves were brought into the Feed Efficiency Facility. Upon entry into the facility, calves were fitted with EID tags and cows were checked to ensure their EID was intact. Cow-calf pairs within each group were then randomly assigned to pens consisting of no more than six pairs per pen. A 14-d acclimation period was allowed before initiating the 70-d test. Pairs in each pen had ad libitum access to water and two GrowSafe feed bunks. The forage-based diet consisted of 86.7% Tifton 85 Bermudagrass silage, 12.4% dried distillers grains plus solubles, 0.7% range mineral, and 0.2% salt, suitable for lactating beef cows (NRC, 1996). Weights of cows were collected on a weekly basis starting on d 0 of the test, and weights of calves were collected on d 0 and 70. Individual daily feed intake values for cows and calves were determined using the GrowSafe System (GrowSafe Systems, Ltd., Alberta, Canada).

Cows were milked on d 14 (lactation d 28 ± 7) and d 70 (lactation d 84 ± 7) of the test in order to determine individual energy corrected milk production. On the morning of milking, cows were separated away from the calves. Each cow was restrained in the chute and injected with 40 IU of oxytocin intravenously. Once milk let-down occurred, cows were milked immediately using a vacuum pump connected to a four claw milking machine. When all four quarters were dry, machine milking ceased and residual milk from all quarters was stripped by hand (procedure adapted from Marston et al., 1992). Following a minimum separation period of 6 h, cows were milked again as previously described. Collected milk was weighed, and daily production was estimated by calculating milk produced per minute, and extrapolating it over 24 h. Energy corrected milk (ECM) was determined using the equation: ECM = (0.327*lb of milk) + (lb of fat*12.95) + (lb of protein*7.2).

The ADG for cows was calculated using theslope of the body weights collected weekly or biweekly, during the test. RFI was calculated similar to that for heifers in phase I, but cows remained in the same RFI group (Low, Medium, or High) that they were categorized in phase I. The MIXED procedure of SAS was used to determine if differences existed between Low, Medium, and High groups for initial weight, final weight, ADG, DMI, and RFI of heifers and cows (also ECM for cows). PROC CORR was used to identify any Pearson correlations existing between performance as heifers and cows.

**Results**

Heifers performance at the beginning and end of the feed efficiency phase I did not differ among RFI groups (Low, Medium, High), as illustrated in Table 1. As expected, average heifer DMI was significantly lower for those placed in the Low RFI group compared to the High group. Individual heifer RFI values ranged from -2.2 (most efficient) to 1.9 (least efficient).

Cow performance data based on heifer RFI category (Low, Medium, High) is represented in Table 2. Initial weight as 3-year old lactating cows was significantly affected by heifer RFI ranking for the medium and high groups. Cows considered to be the least efficient as heifers (those in the High group), weighed 59 lb more than those in the Medium group, on d 0. Final weight and ADG of cows was not affected by RFI ranking as heifers. Cows which were most efficient as heifers (those in the Low group) had significantly lower DMI than their counterparts and consumed 4.56 lb less feed per day than cows that were in the High group as heifers. Individual cow RFI values ranged from -4.9 (most efficient) to 7.4 (least efficient). For heifers that were regarded as the least efficient they produced significantly greater quantities of energy correct milk than the Medium group, whereas the Low group was intermediate. This is consistent on d 28 and d84 of lactation.

Table 3 represents correlation coefficients of various traits of cows and heifers. There was a tendency ($P$ = 0.07) for a correlation to exist between RFI measured in heifers and that measured in mature, lactating cows. However, strong correlations exist between heifer and cow DMI intake and a strong correlation exists between heifer RFI and cow DMI. Therefore, heifers that have low RFI as replacement heifers likely will have lower DMI as mature cows. In addition, those females consuming more feed and gaining more as cows were those with higher ADG and DMI as heifers, as illustrated by moderate, significant correlations.

**Literature Cited**

Arthur et al. 2001. J. Anim. Sci. 79:2805.
Basarab et al. 2002. Alberta Agric. Food Rural Dev. Ctr. p. 12.
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**Table 1.** Heifer performance statistics (± standard error) for Low, Medium, and High RFI ranked animals (Phase 1)

| | RFI Classification[a] | | | |
|---|---|---|---|---|
| Trait | Low | Medium | High | p-value |
| No. of heifers | 24 | 24 | 26 | |
| Initial Weight, lb | 573.3 ± 12.8 | 558.1 ± 12.8 | 571.8 ± 12.3 | 0.63 |
| Final Weight, lb | 689.6 ± 13.7 | 677.8 ± 13.7 | 690.7 ± 13.2 | 0.76 |
| ADG[b], lb /d | 1.78 ± 0.07 | 1.85 ± 0.07 | 1.81 ± 0.07 | 0.76 |
| DMI[c], lb /d | 17.8 ± 0.51[x] | 20.3 ± 0.51 | 22.8 ± 0.48[y] | <0.0001 |
| RFI[d], lb /d | -2.49 ± 0.18[x] | -0.04 ± 0.18 | 2.36 ± 0.18[y] | <0.0001 |

[a]Heifers were sorted and placed into Low (<0.5 SD), Medium (<0.5 SD >), and High (>0.5 SD) efficiency groups based on their RFI values, with more negative values (Low) being efficient and positive values (High) inefficient.
[b] ADG = average daily gain.
[c] RFI = residual feed intake
[d] DMI = dry matter intake.
[xy] Values within a row differ (P<0.05)

**Table 2.** Cow performance parameters based on heifer rankings considered as Low, Medium, and High feed efficiency catgories (Phase 2).

| | RFI Classification[a] | | | |
|---|---|---|---|---|
| Trait | Low | Medium | High | p-value |
| No. of cows | 24 | 24 | 26 | |
| Initial Weight, lb | 933.7 ± 18.2[xy] | 918.5 ± 18.3[x] | 979.3 ± 17.6[y] | 0.05 |
| Final Weight, lb | 954.8 ± 19.6 | 969.6 ± 19.6 | 986.5 ± 18.7 | 0.51 |
| ADG[b], lb/d | 0.66 ± 0.22 | 1.19 ± 0.22 | 1.04 ± 0.22 | 0.24 |
| DMI[c], lb/d | 30.0 ± 1.32[x] | 34.1 ± 1.32 | 34.6 ± 1.32[y] | 0.02 |
| RFI[d], lb/d | -2.40 ± 1.19 | 1.65 ± 1.19 | 0.68 ± 1.12 | 0.05 |
| d 28 ECM[e], lb/d | 13.0 ± 0.93 | 11.23 ± 0.93[x] | 15.4 ± 0.88[y] | 0.01 |
| d 84 ECM[e], lb/d | 10.95 ± 0.81 | 9.58 ± 0.81[x] | 12.6 ± 0.77[y] | 0.04 |

[a]Heifers were sorted and placed into Low (<0.5 SD), Medium (<0.5 SD >), and High (>0.5 SD) efficiency groups based on their RFI values, with more negative values (Low) being efficient and positive values (High) inefficient.
[b]ADG = average daily gain.
[c] RFI = residual feed intake.
[d] DMI = dry matter intake.
[e] ECM = energy corrected milk.
[x,y] Values differ (P<0.05)

**Table 3.** Pearson correlation coefficients among cow and heifer feed efficiency performance parameters[a]

| | Heifer ADG | Heifer DMI | Heifer RFI |
|---|---|---|---|
| | ----------Correlation coefficient (P-value)---------- | | |
| Cow DMI | 0.444 (0.0001) | 0.633 (0.0001) | 0.299 (0.0098) |
| Cow RFI | 0.358 (0.0017) | 0.422 (0.0002) | 0.214 (0.067) |
| d 28 ECM | 0.116 (0.326) | 0.243 (0.036) | 0.223 (0.0561) |
| d 84 ECM | 0.141 (0.230) | 0.299 (0.0123) | 0.21 (0.0728) |

[a] ADG = average daily gain; DMI = dry matter intake; ECM = energy corrected milk