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Feed Efficiency in Beef Cattle: RFI and its Economic Benefits

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Production Efficiency in Beef Cattle: Why?

- Safe, affordable, nutritious and environmentally sustainable beef products

Production Efficiency: 1977 vs. 2007 (Capper 2011, Animal Frontiers)

Same amount of beef now required
- 70% of the animals
- 81% of the feed
- 88% of the water
- 67% of the land
- resulting in a 16% decrease in the carbon footprint of beef
Variation in the carbon footprint per kilogram of beef by region and beef production system (Basarab et al. 2012; Capper 2011)

CARBON FOOTPRINT: CO₂e/kg product

- Pork: 2.8-4.5 kg
- Chicken: 1.9-2.9 kg
- Dairy: 1.3 kg
- Beef: 18-36 kg
Maintenance requirements of beef cattle is largely unchanged over last 100 years (Johnson, Ferrell and Jenkins, 2003)

56-71% of total cost of production for cow-calf operations is associated with feed, bedding and pasture (ARD 2005)

65-75% of the total dietary energy cost in breeding cows is required for maintenance (Ferrell & Jenkins 1985; NRC 1996)

**Figure 1.** Average EPD (Mcal/yr) for mature cow maintenance energy requirements by birth year in Red Angus cattle (Evans et al., 2002).
Energetic Efficiency in growing beef cattle

1. Feed Intake, Partial Efficiency of growth, Relative Growth Rate, Kleiber Ratio

2. Feed Conversion Ratio: DMI/ADG;
   Coefficient of variation for DMI, 8-12%;
   Coefficient of variation for ADG, 16-20%

All measures are related to body size, growth and composition of gain
Energetic Efficiency in growing beef cattle

Residual Feed Intake (RFI) also called Net Feed Efficiency:

FEED INTAKE ADJUSTED FOR BODY SIZE AND PRODUCTION - growing cattle is the difference between an animal's actual feed intake & its expected feed requirement for maintenance of body weight, growth and changes in fatness.

moderately heritable  
(h² = 0.29-0.46)

reflects an animal’s energy requirement  
for maintenance.

Olds College: 96 British bulls (2003-05)
Cost difference: -RFI vs. +RFI  
3.0 kg as fed/day x $0.15/kg x 140 days = $63

Diet (as fed basis): 76% barley silage; 30% barley grain & 3% beef sup. (32 % CP)
Feed intake = live weight gain + heat production

\[ \text{MEI} = \text{NE}_g + \text{HP} \]
\[ \text{HP} = \text{NE}_m + \text{HIF} \]
\[ \text{NE}_m = 0.077 \text{ Mcal/EBW}^{0.75} \]

**Basic Hypothesis**: variation exists in net energy for maintenance (\(\text{NE}_m\)) among animals
Individual Animal Feed Intake Facilities

- body weight
- production
- gender
- age
- season
- temperature
- physiological status
- previous nutrition
148 steers from 5 genetic strains fed a finishing diet and gaining 1.52 kg/day. No relationship to slaughter weight, hip height and gain in hip height (Basarab et al. 2003).

Selection for low RFI will:
Have no effect on growth & animal size

Correlations ($r_p$ & $r_g$) are near zero

Arthur et al. 2001; Basarab et al. 2003; Crews et al. 2003; Jensen et al. 1992
Selection for low RFI will:

- Reduce feed intake by 10-12% at equal body size & ADG
  
  Moderate to high correlation with feed intake
  rp = 0.60-0.72;  rg = 0.69-0.79

- Improve Feed Conversion Ratio (FCR) by 9-15% at equal body size & average daily gain
  
  Moderate to high correlation with feed to gain ratio
  rp=0.53-0.70;  rg = 0.66-0.88
  Arthur et al. 2001; Basarab et al. 2003, Herd et al. 2002
## Effect of Sire RFI on Progeny Performance in the Feedlot (22 Sires, 376 Progeny, Basarab et al. 2012)

<table>
<thead>
<tr>
<th>Sire RFI</th>
<th>Progeny kg DM/day per sire</th>
<th>Progeny RFI</th>
<th>DMI kg/day</th>
<th>ADG kg/day</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>HIGH RFI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inefficient</td>
<td>15.3</td>
<td>0.131</td>
<td>10.53</td>
<td>1.80</td>
</tr>
<tr>
<td><strong>LOW RFI</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Efficient</td>
<td>19.6</td>
<td>-0.106</td>
<td>10.19</td>
<td>1.77</td>
</tr>
</tbody>
</table>

**Sign. Level**

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*  
NS

**Feed savings:** 0.237 to 0.333 kg DM/day x $0.30/kg DM x 150 days on feed = $10 to $15/feeder or $750 to $1125/bull
No effect on carcass quality provided RFI is adjusted for fatness (Basarab et al. 2003; Nkrumah et al. 2007)
Female Fertility and Productivity

LOW RFI cow J1042 (5 yr-old Hereford-Angus cow in the spring of 2004; RFI adj = -2.64 kg as fed/day; 2003 weight at weaning = 787 kg).

HIGH RFI cow E1245 (8 yr-old Hereford-Angus cow in the spring of 2004; RFI adj = 2.83 kg as fed/day; 2003 weight at weaning = 755 kg).

No effect on pregnancy, calving or weaning rates
No effect on birth and weaning weights (Arthur et al. 2005; Basarab et al. 2007, 2011)
Heifers: No effect on age at puberty, pregnancy & calving pattern

A. Levels of significance are given for cumulative percent of heifers reaching puberty by 9, 10, 11, 12, 13, 14 and 15 mo of age. B. Levels of significance are given for cumulative percent heifers pregnant by 2, 7, 12, 17, 22, 27, 32 and 37 d of the breeding season. Adapted from Basarab et al. (2011).
Basarab et al. 2011; improved early life survival possibly due to better uterine env. due to more available nutrients
Relationship between RFI_{fat} as a heifer and subsequent changes in body weight as a cow

Low RFI cows may be more adaptable to stressful conditions compared with high RFI cows.

- begin swath grazing at ~3.5-yr old
- backfat, 4.5 vs. 7.4 at 59 mo
- backfat, 10.0 vs. 12.0 at 68 mo
- reduces winter feeding costs by 47%
Repeatability of RFI in heifers to cows  
Preliminary data, Basarab et al. 2012

<table>
<thead>
<tr>
<th>Traits</th>
<th>High</th>
<th>Low</th>
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<tbody>
<tr>
<td>RFI, kg DM/day</td>
<td>0.365</td>
<td>-0.373</td>
</tr>
<tr>
<td>Number of females</td>
<td>12</td>
<td>11</td>
</tr>
<tr>
<td>8-12 mo old heifers</td>
<td>0.365</td>
<td>-0.373</td>
</tr>
<tr>
<td>4-7 year old cows</td>
<td>0.459</td>
<td>-0.375</td>
</tr>
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</table>

Heifers fed 90:10 barley silage:barley grain, free choice  
Cows fed 70:30% grass hay:barley straw cube, restricted to gain at 0.25-0.50 kg/day

**Feed savings:**  
Heifers: $0.74 \text{ kg DM/day} \times \$0.15/\text{kg DM} \times 365 = \$40/\text{heifer/yr}$  
Cows: $0.83 \text{ kg DM/day} \times \$0.15/\text{kg DM} \times 365 = \$46/\text{cow/yr}$
Infrared Thermography (IRT) and RFI in heifers and cows

IRT accuracy of grouping = 78%
Correlation coefficient = 0.75

Mean IR cheek temperature
Low RFI cows = 10.9 °C
High RFI cows = 14.5 °C
P < 0.05, n=18 cows

University of Manitoba
Source: Schaefer & Colyn

Infrared image of the orbital area
Source: Schaefer & Colyn

- IRT has utility in screening heifers & mature cows for low vs. high heat production (low vs. high RFI).
- Could reduce the time and expense to rank animals for RFI by 80-90%.
Selection for low RFI-fat will:

- Have no effect on growth, carcass yield & quality grade
- Reduce feed intake at equal weight and ADG
- Improve feed to gain ratio by 10-15%
- Reduce NE\textsubscript{m} and methane production
Selection for low RFI-fat will:

- Little if any effect on age at puberty
- No effect on calving pattern in first calf heifers
- No negative effect on pregnancy, calving or weaning rate
- Positive effect on body fatness/weight particularly during stressful periods
- Reduce feed costs - $0.07-0.10/hd/d feeders, $19-38 mil.
  - $0.11-0.12/hd/d in cows; $54-110 mil.