Feed Efficiency for Breeding Cattle

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Improving Efficiency in a Cattle Operation

- **Economic efficiency**
  When the cost of producing a given output is as low as possible

- **Biological efficiency**
  Capacity to convert feed into beef
Need to know what you expect a cow to do?

- Calve by 24 or 36 months of age
- Cow must have a calf every 365 days
- Cow must calve without assistance
- Cow must provide sufficient resources for the calf to reach its genetic potential
- Calf must be genetically capable to perform
- Cows must maintain their body condition score
- Must not be crazy (disposition)
Planning for the future

- Beef cattle have long generation intervals (4 to 6 years)
- You cannot make genetic progress by altering directions every year to five years
- Set specific selection goals
Feeding costs comprise 50 to 70% of total annual beef cow enterprise costs!!!!
Factors that Affect Nutrient Requirements

- Body Weight
- Breed or Genotype
- Age
- Temperature
- Physiological State
- Previous Nutrition
Energy Requirements in a Herd

- Energy for milk production: 14%
- Energy for fetal growth: 5%
- Energy for slaughter progeny: 30%
- Energy for cow maintenance: 51%
Factors Contributing Female Efficiency

- Nutrition
- Reproduction
- Management
Feed Efficiency Facility (FEF)

Capacity: 480 head

No. of pens: 24 pens
Feed Efficiency Facility and Equipment

GrowSafe Feed and water intake system
### Top 25 Active ABS Sires for Feed Efficiency

<table>
<thead>
<tr>
<th>Name</th>
<th>Feed Efficiency Index</th>
<th>Feed Efficiency Rank</th>
<th>ADG EPD (lb/day)</th>
<th>ADG Rank</th>
<th>Intake EPD (lb/day)</th>
<th>Intake Rank</th>
</tr>
</thead>
</table>
| ABS sires currently range from a high of +$26.38 to a low of -$20.19.
Residual Feed Intake and ADG of Angus Bulls

RFI, lb/day

ADG, lb/day

Calf A

Calf B
## Differences between Calf A and Calf B

<table>
<thead>
<tr>
<th>Item</th>
<th>CALF A</th>
<th>CALF B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial wt, lbs</td>
<td>819</td>
<td>819</td>
</tr>
<tr>
<td>Final wt, lbs</td>
<td>1,051</td>
<td>1,051</td>
</tr>
<tr>
<td>ADG, lbs/d</td>
<td>3.32</td>
<td>3.32</td>
</tr>
<tr>
<td>Daily intake</td>
<td>22.86</td>
<td>25.76</td>
</tr>
<tr>
<td>Feed consumed in 70 d, lbs</td>
<td>1,600</td>
<td>1,803</td>
</tr>
<tr>
<td>Difference in Feed consumed in 70 d, lbs</td>
<td></td>
<td>203</td>
</tr>
</tbody>
</table>
Herd Efficiency - Example

Cow weight

Herd 1

Herd 2

Calf weaning weight

Herd 1

Herd 2

BCS = 4.8

BCS = 5.6

Calf wt, lbs

543

465

1175

1280
Herd Efficiency

Weaning Efficiency = Calf weaning wt/Cow wt x 100

Herd 1: 48.1
Herd 2: 37.1

Cost:
- Herd 1: $510
- Herd 2: $450
PHENOTYPE = Genotype + Environment + Random variation
Using Genetic Markers as Selection Tools
Reliability of Gene Markers?

<table>
<thead>
<tr>
<th>GeneSTAR MVP Range and % Reliability Described</th>
<th>MVP Range</th>
<th>% Reliability</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed Efficiency (kgs)</td>
<td>2.52</td>
<td>30%</td>
</tr>
<tr>
<td>Marbling (0 – 9)</td>
<td>2.11</td>
<td>26%</td>
</tr>
<tr>
<td>Tenderness (kgs)</td>
<td>1.33</td>
<td>49%</td>
</tr>
</tbody>
</table>

MVP = Molecular Value Predictions
## Measuring Feed Efficiency

<table>
<thead>
<tr>
<th>Trait</th>
<th>Definition</th>
<th>Formula</th>
<th>Favorable phenotype</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross efficiency</td>
<td>Weight gain per unit DMI</td>
<td>( \frac{\text{ADG}}{\text{DMI}} )</td>
<td>High</td>
</tr>
<tr>
<td>Feed Conversion Ratio (FCR)</td>
<td>Actual DMI per unit gain</td>
<td>( \frac{\text{DMI}}{\text{ADG}} )</td>
<td>Low</td>
</tr>
<tr>
<td>Residual feed intake (RFI)</td>
<td>Actual DMI net expected DMI based on MBW and ADG</td>
<td>Expected DMI from linear regression of DMI on MBW and ADG</td>
<td>Low</td>
</tr>
</tbody>
</table>
Breed differences exist in cow maintenance efficiency:

- Dairy breeds >
- Beef Bos taurus breeds >
- Bos indicus breeds
- Genetic antagonisms between maintenance energy requirements and level of productivity (e.g., growth, milk)

Taylor et al. (1986)
Between-breed variation in RFI of growing bulls

Residual feed intake, kg/d

-1.2
-0.8
-0.4
0
0.4
0.8
1.2

Riley et al. (2007)
Purebred Angus vs Purebred Brahman heifers

-1.08

Randel et al. (2008)
F₁ Bos taurus vs F₁ Bos indicus heifers

0.46
0.36
-0.70
Response to selection for postweaning RFI in Angus cattle

Direct selection response (high vs low line) = 0.25 kg/d per year

Arthur et al. (2001)
**Performance and efficiency traits for Brangus heifers with low and high RFI phenotypes**

<table>
<thead>
<tr>
<th>Trait</th>
<th>Low RFI</th>
<th>High RFI</th>
<th>SE</th>
<th>High vs Low RFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of heifers</td>
<td>150</td>
<td>142</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Weaning BW, lbs</td>
<td>530</td>
<td>519</td>
<td>5.7</td>
<td>---</td>
</tr>
<tr>
<td>Initial BW, lbs</td>
<td>598</td>
<td>596</td>
<td>6.8</td>
<td>---</td>
</tr>
<tr>
<td>ADG, lbs/day</td>
<td>2.22</td>
<td>2.22</td>
<td>0.04</td>
<td>---</td>
</tr>
<tr>
<td>DMI, lbs/day</td>
<td>19.3(^a)</td>
<td>22.7(^b)</td>
<td>0.20</td>
<td>18.4%</td>
</tr>
<tr>
<td>RFI, lbs/day</td>
<td>-1.72(^a)</td>
<td>1.83(^b)</td>
<td>0.08</td>
<td>3.55 lbs/d</td>
</tr>
<tr>
<td>Feed:gain ratio</td>
<td>8.75(^a)</td>
<td>10.42(^b)</td>
<td>0.13</td>
<td>19.1%</td>
</tr>
</tbody>
</table>

\(^{a,b}\)Means differ at P < 0.001

Lancaster et al. (2007)
Nutrient digestibilities of Brangus heifers with divergent RFI phenotypes

Low RFI heifers:
✓ Excreted 32% less (P < 0.05) fecal DM
✓ Excreted 36% less (P < 0.05) fecal nitrogen

(Krueger et al., 2008)
Associations between feed efficiency in feedlot progeny and mature forage-fed cows

- Calves ranked by RFI phenotype on fed high-grain diet
- Intake of cows that produced calves with divergent RFI calves measured while fed high-roughage diet

<table>
<thead>
<tr>
<th>Trait</th>
<th>Calf RFI phenotype group</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Low (63)</td>
<td>Medium (83)</td>
</tr>
<tr>
<td>No. of calves tested</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>63</td>
<td>83</td>
</tr>
<tr>
<td>Calf RFI, kg/day</td>
<td></td>
<td>-0.78&lt;sup&gt;a&lt;/sup&gt;</td>
<td>-0.09&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>No. of cows tested</td>
<td></td>
<td>26</td>
<td>40</td>
</tr>
<tr>
<td>Cow DM intake, kg/day</td>
<td></td>
<td>&lt;u&gt;10.8&lt;sup&gt;a&lt;/sup&gt;&lt;/u&gt;</td>
<td>&lt;u&gt;11.3&lt;sup&gt;a&lt;/sup&gt;&lt;/u&gt;</td>
</tr>
</tbody>
</table>

<sup>a,b,c</sup>Means differ at P < 0.05.

Basarab et al., 2007
Associations between postweaning RFI and efficiency of grazing cattle

<table>
<thead>
<tr>
<th>Trait</th>
<th>RFI selection line&lt;sup&gt;1&lt;/sup&gt;</th>
<th></th>
<th></th>
<th>RFI phenotype group&lt;sup&gt;2&lt;/sup&gt;</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
<td>P-value</td>
<td>Low</td>
<td>High</td>
<td>P-value</td>
</tr>
<tr>
<td>No. of calves</td>
<td>22</td>
<td>31</td>
<td>--</td>
<td>9</td>
<td>9</td>
<td>--</td>
</tr>
<tr>
<td>ADG, kg/d</td>
<td>0.50</td>
<td>0.42</td>
<td>0.10</td>
<td>1.07</td>
<td>0.95</td>
<td>0.10</td>
</tr>
<tr>
<td>DMI, kg/d</td>
<td>9.2</td>
<td>9.8</td>
<td>NS</td>
<td>6.9</td>
<td>7.4</td>
<td>NS</td>
</tr>
<tr>
<td>Forage: gain ratio</td>
<td>10.8</td>
<td>12.2</td>
<td>0.10</td>
<td>6.6</td>
<td>8.2</td>
<td>0.05</td>
</tr>
</tbody>
</table>

<sup>1</sup>Steers from single generation of divergent selection for RFI (Herd et al., 2002)

<sup>2</sup>Steers previously ranked by RFI phenotype (0.5 SD); Forbes (unpublished)
Impact on cow reproductive traits

Data from 10 mating seasons for crossbred cows that produced calves with divergent RFI (Basarab et al., 2007)

Data from 3 mating seasons for Angus cows divergently selected for RFI (Arthur et al., 2005)
## Impact on reproductive traits in Brangus heifers

<table>
<thead>
<tr>
<th>Trait</th>
<th>Low RFI</th>
<th>Medium RFI</th>
<th>High RFI</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of heifers</td>
<td>112</td>
<td>138</td>
<td>98</td>
<td>n = 348</td>
</tr>
<tr>
<td>RFI, kg/day</td>
<td>-0.77(^a)</td>
<td>0.00(^b)</td>
<td>0.88(^c)</td>
<td>0.01</td>
</tr>
<tr>
<td>Age at puberty, days</td>
<td>279</td>
<td>273</td>
<td>271</td>
<td>Not different</td>
</tr>
<tr>
<td>No. exposed to breeding</td>
<td>94</td>
<td>119</td>
<td>82</td>
<td>n = 295</td>
</tr>
<tr>
<td>Overall pregnancy rates, %</td>
<td>89.4</td>
<td>85.7</td>
<td>79.3</td>
<td>Not different</td>
</tr>
</tbody>
</table>

Lancaster et al. (2008)
Relationships between RFI and other economically relevant traits

Cow and bull reproductive traits:

✓ Pregnancy rates—similar in cows with divergent RFI
✓ Postpartum return to estrus—shorter in Brahman cows selected for low RFI
✓ Age at puberty—similar in Brangus heifers with divergent RFI
✓ Age at puberty—inconsistent results in Brahman bulls with divergent RFI
Current challenges to adoption of feed efficiency technologies

- Measuring intake still expensive even with GrowSafe technology
- More test facilities to measure feed efficiency are needed
- Uniform guidelines (BIF) for measuring intake are needed
- Accurate EPDs for RFI are needed
- Multi-trait selection indexes that incorporate RFI are needed
Current challenges to adoption of feed efficiency technologies

- Validation of existing and future genetic markers for RFI across multiple breeds and production environments is needed
- Indicator traits for RFI (e.g., feeding behavior traits) are needed
- Additional research needed to examine associations between RFI and mature cow efficiency across multiple production environments
- More research is warranted that examines the associations between RFI and other economically relevant traits
Opportunities to Adoption of feed efficiency technologies

Incorporation of feed efficiency into balanced-trait selection programs:

- Reduce feed costs in all sectors of the industry
- Improve profitability of integrated beef production systems
- Minimal impact on other economically relevant traits
- Reduce manure N and P excretion
- Reduce greenhouse gases (carbon offset market?)
- Reduce stocking pressure on grazing lands
Vision for the Future

Cover Sheet
Overall Campus Plan
Thank You!

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