SELECTION FOR FEED EFFICIENCY
PRECAUTIONS, CHALLENGES, AND SOLUTIONS

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Feed Accounts for 65-70% of Production Costs
Beef cattle are less efficient than other protein food sources

- Fish: ~1:1
- Chickens: <2:1
- Pigs: <3:1
- Cows: >6:1
Goal

Develop EPD to reduce use of feed in production of beef

Short et al., 1990
Ratios are not satisfactory measures of efficiency (Tanner, 1949; Weil, 1962; Atchley et al., 1976).

Koch et al. (1963) recommended use of gain adjusted for feed intake as the preferred measure of biological efficiency because it was considered the most accurate mathematical description of cause and effect.

Combining feed intake and growth to calculate a single measure of feed efficiency does not add additional information to that which can be obtained directly from the component traits (Kennedy et al., 1993).

Selection indexes require feed intake and growth (MacNeil et al., 1994; MacNeil and Herring, 2005).
Variation for feed efficiency

Daily dry matter intake
Mark Allen, AHA Young Guns Conf. 2007
Selection for feed efficiency can lead to increased leanness and improved efficiency as a result of fewer days required to reach market weight, thus reducing maintenance. It may be more economically feasible for breeders to improve feed conversion by selecting for gain rather than for efficiency.

Glaze and Schalles, 1995
Selection for Feed Efficiency

Selection for efficiency may increase fatness (Biondini et al., 1968; Jensen et al., 1991; Koch et al., 1963; Sutherland et al., 1970).

Or, it may result in better muscled animals (Crowley et al., 2011a); and increase age at puberty (Crowley et al., 2011b)
Residual feed intake addresses only that small portion of intake not required for maintenance or performance.

Residual feed intake is counter to usual mechanism of cause and effect.

Residual gain is more nearly reflective of reality – we decide how much an animal is fed and its performance is in response to that decision.

Much of the research ascribing no correlated response to selection lacks the necessary power-of-the-test to support that conclusion.
Trait Definition

Feed Intake

Indicator traits

Use in Indexes

It’s a bit messy

Different rations – with variable amounts of info

Helpful circumstances

Large number of animals in each contemporary group

Automated data collection with some quality control
Analysis Approach

BIF approach for normally distributed traits

Multiple trait models
   Indicator traits increase accuracy and number of animals evaluated
   Overcome selection bias

Standardize intake data within contemporary groups

Efficiency and index values, after primary trait analysis
ASA Data Description

825 Steers: Simmental, Angus, and Sim-Ang sires
2 years
3 Montana ranches
41 sires (progeny randomly assigned to diet.)
Individually fed, University of Illinois
## AAA Data Description

<table>
<thead>
<tr>
<th>Record Type</th>
<th>Records</th>
<th>Contemporary Groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>Feed Intake:</td>
<td>4,215</td>
<td>51</td>
</tr>
<tr>
<td>Weaning weight:</td>
<td>18,169</td>
<td>661</td>
</tr>
<tr>
<td>Post-weaning gain:</td>
<td>7,372</td>
<td>441</td>
</tr>
<tr>
<td>Ultrasound fat depth:</td>
<td>5,079</td>
<td>238</td>
</tr>
</tbody>
</table>

2039 animals have a complete record
Data Analysis

Pedigree 45,121 animals

4-trait animal model
- Contemporary group /trait
- Direct genetic effects
- ASREML
## Genetic Parameter Estimates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate 1</th>
<th>Estimate 2</th>
<th>Estimate 3</th>
<th>Estimate 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADG</td>
<td>0.37±0.16</td>
<td>0.00±0.28</td>
<td>0.10±0.42</td>
<td>-0.74±0.32</td>
</tr>
<tr>
<td>Mid-Wt</td>
<td>0.73±0.20</td>
<td>0.55±0.33</td>
<td>-0.56±0.25</td>
<td></td>
</tr>
<tr>
<td>FI</td>
<td>0.13±0.11</td>
<td>0.21±0.52</td>
<td></td>
<td>0.25±0.14</td>
</tr>
<tr>
<td>RFI</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

Large SE – need more data and larger contemporary groups.

RFI may not be genetically independent of ADG or Mid-Wt.

Genetic antagonism between growth and intake << than anticipated.

Selection for FI > 3x as effective in reducing FI as selection for RFI.

Selection for increased growth reduces RFI - selection for decreased RFI increases growth.
Heritability Estimates

- Weaning weight: $0.41 \pm 0.03$
- Post-weaning gain: $0.31 \pm 0.04$
- Ultrasound fat depth: $0.39 \pm 0.05$
- Feed Intake: $0.31 \pm 0.05$
<table>
<thead>
<tr>
<th>Genetic Correlations</th>
<th>Correlation Coefficient</th>
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</thead>
<tbody>
<tr>
<td>WWT, GAIN</td>
<td>0.41 ± 0.03</td>
</tr>
<tr>
<td>WWT, FAT</td>
<td>0.09 ± 0.09</td>
</tr>
<tr>
<td>GAIN, FAT</td>
<td>0.17 ± 0.10</td>
</tr>
<tr>
<td>WWT, FI</td>
<td>0.50 ± 0.08</td>
</tr>
<tr>
<td>GAIN, FI</td>
<td>0.61 ± 0.10</td>
</tr>
<tr>
<td>FAT, FI</td>
<td>-0.12 ± 0.13</td>
</tr>
</tbody>
</table>
Prediction of BV for FI

$r = 0.84$
## Genetic Evaluation

- **45,121 EPD for feed intake**

<table>
<thead>
<tr>
<th>Pedigree estimate</th>
<th>Accuracy</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaning weight, only</td>
<td>0.13</td>
<td>9,874</td>
</tr>
<tr>
<td>365-d weight, only</td>
<td>0.17</td>
<td>1,523</td>
</tr>
<tr>
<td>365-d weight + scan</td>
<td>0.19</td>
<td>2,838</td>
</tr>
<tr>
<td>Complete record</td>
<td>0.29</td>
<td>2,039</td>
</tr>
<tr>
<td>Weaning weight + feed</td>
<td>0.24</td>
<td>1,089</td>
</tr>
</tbody>
</table>
Options

Residual feed intake (Koch et al., 1963)
  Weaning weight, Gain
  Weaning weight, Gain, Fat depth

Residual gain (Koch et al., 1963)
  Feed Intake
  Feed Intake, Fat depth

Residual intake and gain (Berry and Crowley, 2011)

Selection index (Eisen, 1977)
Selection Index

Method of choice to improve efficiency

Formulate “stereotypic” ration

“De-standardize” intake EPD consistent with ration

Cost (long-term average) ration

Incorporate into appropriate indexes

Assuming $I = \Sigma a \cdot EPD$
Summary

Feed intake, gain... are the root data

NCE should analyze root data
  \- Data quality
  \- Model development

Single-trait selection is not advisable

Post-NCE analysis required to inform selection decisions

Be careful what you wish for...