Importance of Feed Efficiency

- Feed costs = 66% in calf feeding systems
- Feed costs = 77% in yearling finishing systems
  - Anderson et al. 2005

- 10% improvement in gain = +18% profit
- 10% improvement in efficiency = +43% profit
  - Fox et al. 2001

- Efficiency increases 7-8 times the economic impact of comparable increases in gain
  - Okine et al. 2004
Why Improve Efficiency?

- A feed efficiency improvement of approximately 10% (2 pound reduced RFI) across the entire feedlot sector would reduce feed costs $1.2 Billion in 2011 (Weaber, 2011)
- Fewer resources used = improved global food security
- “Efficiency” = Output/Input or visa versa
  - Inherent multiple-trait selection

Where We Rank (F:G)

- 1:1
- 2:1
- 3:1
- 6:1
Defining Feed Efficiency

- Average daily gain (ADG)
  - Amount of weight gained per day, on average during feeding period
- Average daily feed intake (AFI)
  - Highly accurate measure of average daily feed intake
  - Collect with GrowSafe® system or Calan gates
  - Used to calculate RFI
- Residual feed intake (RFI; Koch et al. 1963)
  \[
  RFI = AFI - \bar{FI} \\
  \bar{FI} = b_0 + b_1 ADG + b_2 MW^{0.75}
  \]
Measuring feed efficiency

Dahlke et al (www.iowabeefcenter.org/Docs_cows/IBC41.pdf)

Do We Need to Measure Feed Intake? Per Cow Basis

- \[\text{[Dam Weight} \times \text{Lean Value of Dam} + \text{No. Progeny} \times \text{Progeny Weight} \times \text{Lean Value of Progeny}] - \text{[Dam Feed} \times \text{Value of Feed for Dam} + \text{No. Progeny} \times \text{Progeny Feed} \times \text{Value of Feed for Progeny}]\].

- By simply increasing number of progeny per dam through either selection, heterosis from crossing, or better management, we will increase efficiency of production.
Do We Need To Measure Feed Intake?

Growing Calf Basis

- Calf Weight Gain * Calf weight value - \([\text{Feed}_M + \text{Feed}_P + \text{Feed}_U]\) * Feed value

- Given the same start date and end weights, the faster gaining calf is more efficient due to less maintenance.

- The same is true for cows. More output per day means more efficient.
  - No difference in cow size and in partial costs for maintenance.

Reproducing Cow Herd Basis

- \([\text{Calf Weight}^*\text{Calf Weight Value} + \{\text{Culling Rate} * \text{Cull Cow Weight}^*\text{Cow Weight Value}\}] - \{\text{Feed}_M(\text{cow}) + \text{Feed}_P(\text{cow}) + \text{Feed}_U(\text{cow})\}^*\text{Cow Feed Value} - \{\text{Feed}_M(\text{calf}) + \text{Feed}_P(\text{calf}) + \text{Feed}_U(\text{calf})\}^*\text{Calf Feed Value} - \{\text{Feed}_M(\text{heifer}) + \text{Feed}_P(\text{heifer}) + \text{Feed}_U(\text{heifer})\}^*\text{Heifer Feed Value}\)

- Must reduce the feed being used for maintenance.
  - Efficiency is lost if output is reduced.

- Yearling bull buying decisions must consider the implications of making selection decisions in a multiple-trait context.
### Should We Measure Feed Intake?

- We can not explain all the variation in individual-animal intake from knowledge of body weight maintained and level of production.

- From a total life-cycle perspective, energy costs for maintenance are estimated to be about 70% of the total energy intake in the beef production system.

### WW Selection Success

**Across Breed EPD Genetic Trends - WEANING WEIGHT**

All Breeds Presented on ANGUS EPD Base

- AN
- AR
- HH
- CH
- GV
- LM
- MA
- SM

Weaber and Fennewald, 2009
YW Selection Success

Across Breed EPD Genetic Trends - YEARLING WEIGHT
All Breeds Presented on ANGUS EPD Base

Mean YW EPD
Weaber and Fennewald, 2009

Fifteen years of Iowa Feedlot Enterprise Records (Feed Efficiency, 1978-1992)

Rate of Change-- .047 lb./year

Loy (1993)
Fifteen years of Midwestern Feedlot Closeouts
(Feed Efficiency, 600-800 lb. steers, 1988-2002)

Rate of Change—.033 lb./year

Loy (2004)

What Role Does Genetics Play?

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<th>DMI</th>
<th>RFI</th>
<th>G:F</th>
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Index Based Selection
Rolfe et al. (2011)

<table>
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<th>Selection Criterion</th>
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<th>GAIN</th>
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<tr>
<td>I4</td>
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<td>0</td>
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</table>
Most Desirable Index?

- Phenotypic RFI
- Genetic RFI
- Economic index of DMI and GAIN
- Economic index of RFI and Gain

EPD for Efficiency and Input do Exist

- Residual Gain
- Days to Finish

  - Maternally oriented
    - ME
    - $W$
Why a Genomic Approach?

- The components of FE are heritable
- The input side is expensive to measure
  - FI can be more expensive than HD genotypes
- Not feasible for routine phenotypes to enter NCE
- Phenotypes are still needed for discovery and validation
  - Here training is on adjusted phenotypes because no EPD exist

Impact on Accuracy -- %GV = 10%
Impact on Accuracy--\%GV=40%
Why didn’t we start with these traits?

Phenotypes do not exist or are very sparse

Discovery

Target

Validation

Visualization Aids in Technology Adoption

- Since the release of EPD to the beef industry some 30 years ago use is still lacking despite the efforts of many
Extension Field Project

Field demonstration project will demonstrate utility of molecular EPDs for FE and component traits and “test drive” the technology

Summary

- We need to think about efficiency in terms of economic returns
- Index values will require both inputs (FI) and outputs (WT) along with body composition
- Genomics could play a large role here
  - Not fully brought to fruition
  - A genomics approach is robust to the definition of efficiency
Overview/Introduction

The sustainability of the beef industry continues to be a major concern for policymakers. Will the industry be able to survive high feed and land prices? A $5 million USDA-NIFA Agriculture and Food Research Initiative grant has been awarded to a multidisciplinary group of researchers from Kansas State University and Colorado State University, along with the University of California, Davis, to examine new technologies in improving feed efficiency and meat productivity.

"Currently, we have no high-tech tools to improve feed efficiency, which can lead to an increase in greenhouse gas emissions and demand for additional land to produce food," said Jim Taylor, W. W. Wattles Jr. Animal Science Professor at Kansas State University. "This is not a small problem, as the only way we have to maintain the rate of cattle growth is by selecting breed that gain more. We need tools that can help us understand the science of feed efficiency and how it can improve the sustainability of the beef industry." 

In this study, researchers plan to collect about 1,000 cattle representing eight breeds, including Angus, Hereford, Simmental, Gelbvieh, Charolais, Montbeliarde, Limousin, and Brahman. Researchers will evaluate each animal's performance and carcass traits. In addition, they will collect DNA samples for gene mapping. After the data are combined, the team's goal is to deliver tools and knowledge which enable genetic selection for feed efficiency.