# GENETIC IMPROVEMENT OF FEED EFFICIENCY: TOOLS AND TACTICS

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## 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

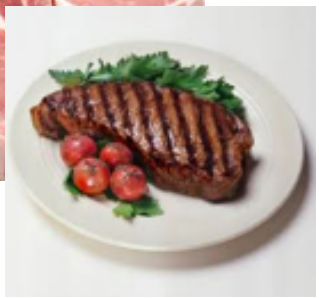
## Where We Rank (F:G)

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)

$$RFI = AFI - \widehat{FI}$$

$$\widehat{FI} = b_0 + b_1 ADG + b_2 MW^{0.75}$$

# Measuring feed efficiency

**Comparison of feed efficiency terms**

| Method | More Desirable | Less Desirable | Difference |
|---|---|---|---|
| **Raw F:G – Raw Feed Conversion:** usually on dry matter basis (lbs feed/ lb of gain) | Lower values Example: 4.5 lbs | Higher values Example 7.5 lbs | Example: 3.0 lbs of feed |
| **Adj. F:G – Adjusted Feed Conversion:** usually on dry matter basis (lbs feed/lb of gain) | Lower values Example: 4.5 lbs | Higher values Example: 6.5 lbs | Example: 2 lbs of dry matter |
| **RFI – Residual Feed Intake:** usually on dry matter basis | Negative values Example: -1.7 | Positive values Example: +1.5 | Example: 3.2 lbs of feed |
| **R-ADG – Residual Average Daily Gain:** usually on lbs gained per day | Positive values Example: +0.86 | Negative values Example: -.63 | Example: 1.49 lbs of average daily gain |
| **Adj. DMI – Adjusted Dry Matter Intake:** should be on dry matter basis | Negative values Example: -0.9 | Positive values Example: +0.8 | Example: 1.7 lbs of feed |

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

# Do We Need to Measure Feed Intake? Per Cow Basis

- [Dam Weight*Lean Value of Dam + **No. Progeny***Progeny Weight*Lean Value of Progeny] - [Dam Feed*Value of Feed for Dam + **No. Progeny***Progeny Feed*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 - [$Feed_M$ + $Feed_P$ + $Feed_U$] * 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

- [Calf Weight*Calf Weight Value + {Culling Rate * Cull Cow Weight*Cow Weight Value}] - {$Feed_M$(cow) + $Feed_P$(cow) + $Feed_U$(cow)}*Cow Feed Value - {$Feed_M$(calf) + $Feed_P$(calf) + $Feed_U$(calf)}*Calf Feed Value - {$Feed_M$(heifer) + $Feed_P$(heifer) + $Feed_U$(heifer)}*Heifer Feed Value
- Must reduce the feed being used for maintenance.
  - Efficiency is lost of 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.
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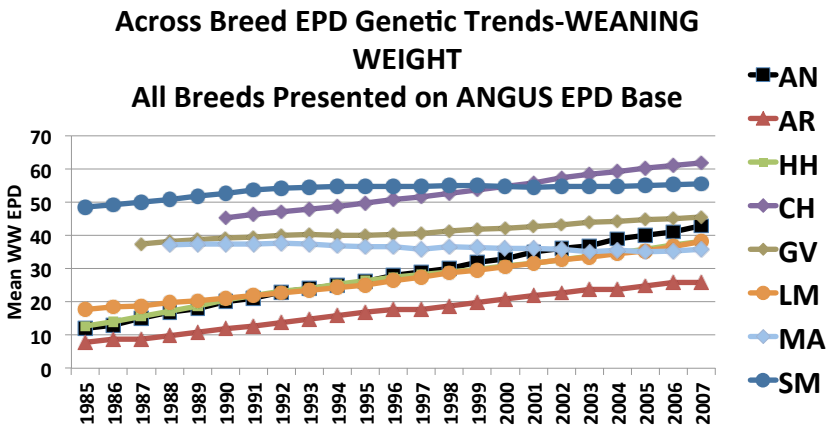
## WW Selection Success

12




Weaber and Fennewald, 2009

# YW Selection Success

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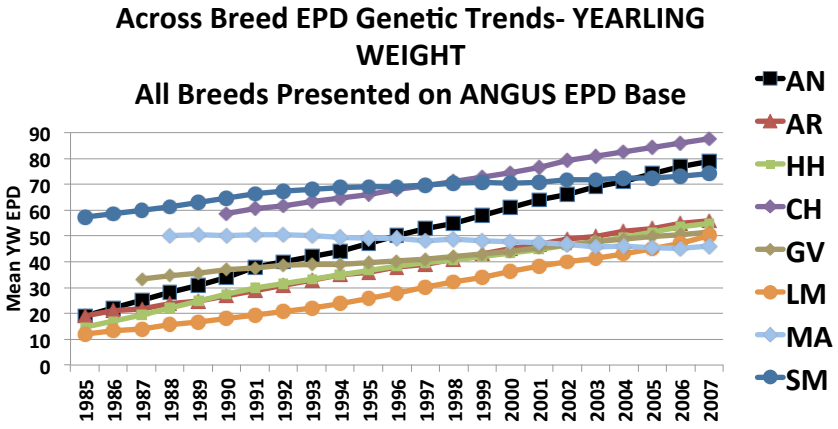
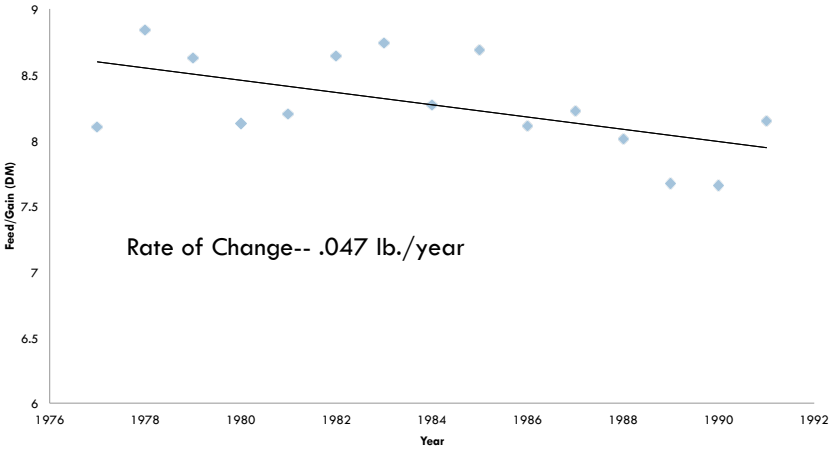


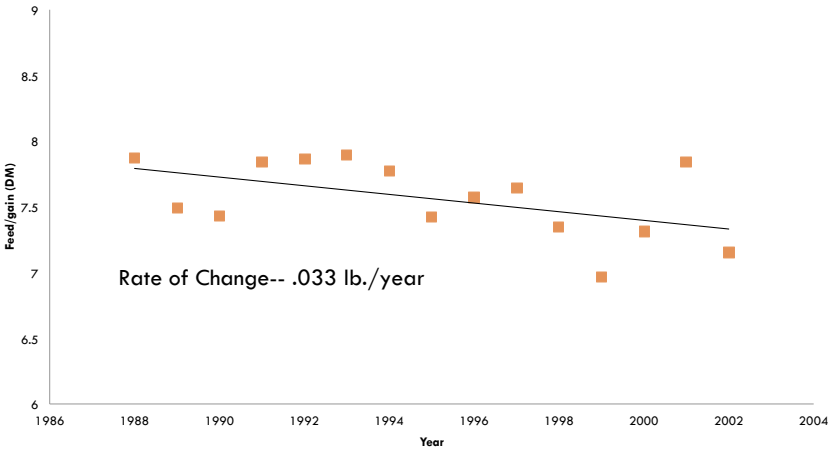

Weaber and Fennewald, 2009

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




Loy (1993)

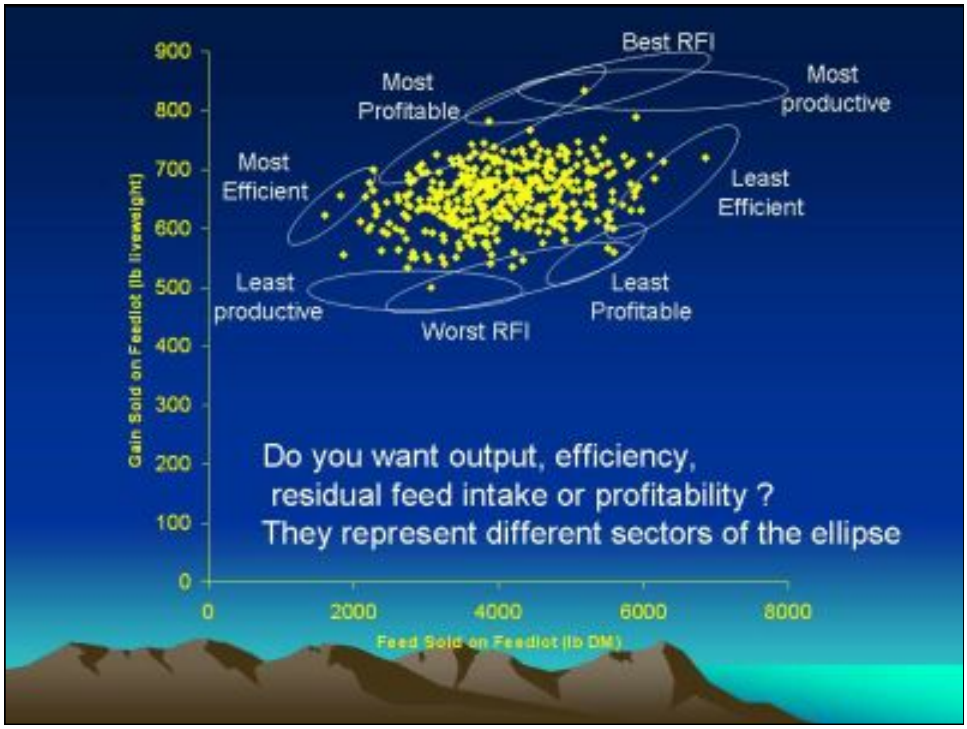
## Fifteen years of Midwestern Feedlot Closeouts (Feed Efficiency, 600-800 lb. steers, 1988-2002)




Loy (2004)

## What Role Does Genetics Play?

| | ADG | DMI | RFI | G:F |
|---|---|---|---|---|
| ADG | 0.26 | 0.56 | -0.15 | 0.31 |
| DMI | | 0.40 | 0.66 | -0.60 |
| RFI | | | 0.52 | -0.92 |
| G:F | | | | 0.27 |




## Index Based Selection
## Rolfe et al. (2011)

**Predicted responses per generation in dry matter intake for 140 days (DMI) and total body weight gain for 140 days (GAIN) following various selection criteria.**

| | | Response : units of intensity · kg | |
|---|---|---|---|
| Selection Criterion[1] | Direction | DMI | GAIN |
| DMI | Down | -56.7 | -5.4 |
| GAIN | Up | +26.3 | +7.5 |
| G:F | Up | -27.5 | +2.4 |
| $I_1$ | Down | -44.6 | +1.9 |
| $I_2$ | Down | -38.5 | 0 |
| $I_3$ | Down | -12.4 | +5.4 |
| $I_4$ | Down | 0 | +7.7 |

## 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

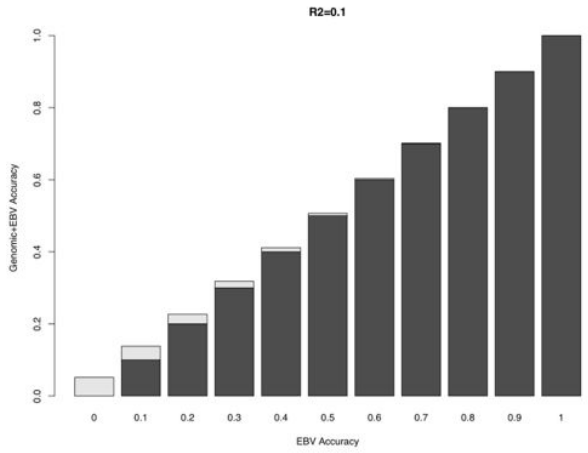
- Residual Gain
- Days to Finish

- Maternally oriented
  - ME
  - $W

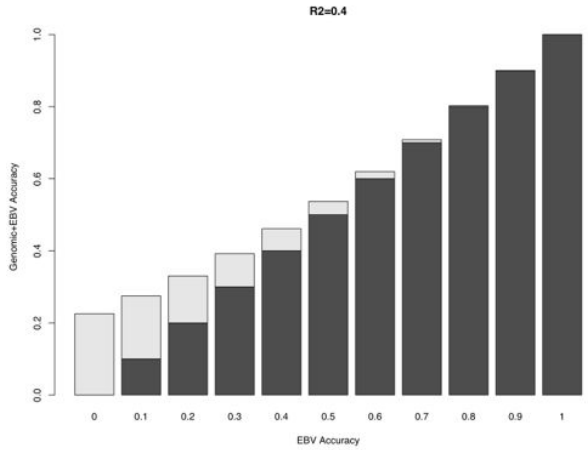
# Why a Genomic Approach?

- 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 need for discovery and validation
  - Here training is on adjusted phenotypes because no EPD exist

# Impact on Accuracy--%GV=10%



## Impact on Accuracy--%GV=40%




## "New Traits" In the Genomic Era

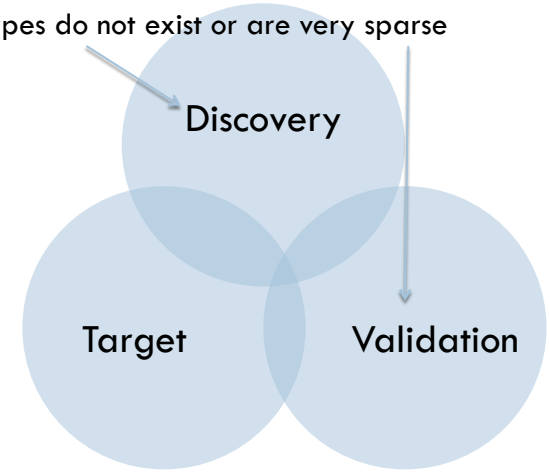
- Healthfulness of beef
- Disease susceptibility
- Tenderness
- Adaptation
- FEED INTAKE AND EFFICIENCY

- The list will continue to grow

- INFORMATION OVERLOAD!

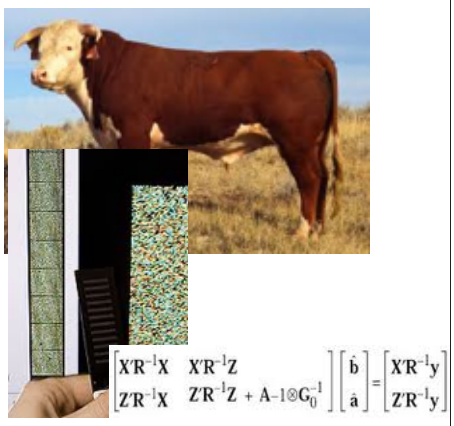
## Why didn't we start with these traits?

Phenotypes do not exist or are very sparse




## 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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Overview/Introduction
The sustainability of the beef industry continues to be a hot issue in agriculture today. 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 multi-disciplinary group of researchers from eight institutions to develop DNA-based technology to predict genetic merit for feed efficiency.
"Currently, we have no highly effective tools to improve feed efficiency, which can lead to an increase in greenhouse gas emissions and demand for additional land to produce feed," said Jerry Taylor, Wurdack Chair in Animal Genomics in the University of Missouri College of Agriculture, Food and Natural Resources, and project director. "Historically, the only way we have improved the efficiency of cattle growth was by selectively breeding cattle that grew fast. While this reduced the time it took to bring an animal to market, it did not tackle the fundamental issue of improving the efficiency of converting nutrients from feed into beef."
In this study, phenotypic data will be collected on 8,000 cattle representing eight breeds, including Angus, Red Angus, Simmental, Gelbvieh, Charolais, Hereford, Limousin and Wagyu. Researchers will evaluate intake, performance and carcass traits. In addition, they will collect DNA samples for gene mapping. After the data are compiled, the team's goal is to deliver tools and knowledge which enable genetic selection for feed efficiency.
News Articles.
BIF: Five Year National Feed Efficiency Study
Healthier and More Efficient Cows
UNL, Other Universities Get Cattle Feed Efficiency Research Grant
$5 million USDA grant targets feed efficiency in beef cattle
Iowa State Faculty Part of Feed Efficiency Study of Beef Cattle
Iowa State University Beef Center
http://www.beefefficiency.org/homepage.html