Trends in Beef Cattle Performance Record Collection and Genetic Evaluation Systems in the United States

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Overview

- US Beef Industry
  - Inventories
  - Production
  - Structure
- Trends
  - Genetic
  - Performance Recording
  - Breed Registrations
  - New trait development
  - New Technologies
**US Beef Industry Overview**

- US beef production is a big business
  - Largest segment in Ag sector of US economy
  - $61 billion in 2007 (USDA, 2007)
  - 32.8 million beef cows (USDA, 2007)
  - 765,000 beef farms/ranches (USDA, 2009a)

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**US Beef Cattle Inventories and Production**

![Graph showing beef production and inventories over time](image_url)
US Annual Calf Crop

Annual Calf Crop

Source: USDA
Projected 2009-2011

US Beef Cow Inventory Dispersion

1 Dot = 2,500 Beef Cows

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- Segmented business
  - Uncoordinated
    - Marketing
    - Breeding decisions/objectives
  - Undifferentiated products and market channels
  - ‘Island mentality’
US Beef Breed Registrations

Yearling Weight Phenotypic and Genetic Trend

Data Source: 2009 Am. Angus Sire Evaluation Report; Phenotypic and Genetic Trends
EPDs Work—Selection for increased growth

YW Line Fit Plot

\[ YW_{\text{Pheno}} = 910 + 3.38 \times YW_{\text{EPD}} \]

\[ R^2 = 0.96 \]

Data Source: 2009 Am. Angus Sire Evaluation Report; Phenotypic and Genetic Trends

Birth Weight Phenotypic and Genetic Trend

Data Source: 2009 Am. Angus Sire Evaluation Report; Phenotypic and Genetic Trends
**EPDs Work—Selection for Birth Weight**

**BW Line Fit Plot**

\[ BW_{Pheno} = 75 + 2.68 \times BW_{EPD} \]

\[ R^2 = 0.95 \]

Data Source: 2009 Am. Angus Sire Evaluation Report; Phenotypic and Genetic Trends

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**BW EPD Genetic Trends**

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

All Breeds Presented on ANGUS EPD Base

Weaber and Fennewald, 2009
**WW EPD Genetic Trends**

Across Breed EPD Genetic Trends - Weaning Weight
All Breeds Presented on ANGUS EPD Base

**YW EPD Genetic Trends**

Across Breed EPD Genetic Trends - Yearling Weight
All Breeds Presented on ANGUS EPD Base

Weaber and Fennewald, 2009
Across Breed EPD Genetic Trends - MILK
All Breeds Presented on ANGUS EPD Base

Mean Milk EPD

MILK EPD Genetic Trends

Weaber and Fennewald, 2009

Genetic Trends for Marbling and Ribeye Area

(Marl. Angus Association, 2009; Am. Simmental Association, 2009)
## US Genetic Evaluations

<table>
<thead>
<tr>
<th>Breed</th>
<th>Growth</th>
<th>Reproduction</th>
<th>Carcass</th>
<th>Ultrasound</th>
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<td>X</td>
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</table>

## Registration and Weaning Wt. Record Counts – Am. Angus Assn.

![Graph showing record counts and WW records as percentage of registrations from 1962 to 2007.](image_url)

- **AAA Registrations**
- **Weaning Weights Recorded**
- **WW Records as Percentage of Registrations**

(AM. Angus Association, 2010b)

(Am. Angus Association, 2010b)

Performance Record Counts as Percentage of Previous Years Registrations – Am. Angus Assn.

(Am. Angus Association, 2010b)
Evolution of Performance Record Systems

- Traditional – registration and performance systems separate ($ for each) – Pay as you go
- Cow or herd based systems
  - One fee for performance record processing, registration and transfer
  - Cow based system, per cow charge on entire inventory (AR, SM, GV)
  - Hybrid systems (decoupling of registration and performance record charges)
- Objectives – more performance record density and fertility/longevity data

Phenotype and Evaluation Development

- Calving Ease (Direct and Maternal)
  - DONE!
- Growth (BW, WW, YW, CW)
  - DONE!
- Carcass (Marbling, Yield, Fat Thickness, REA)
  - DONE!
**Phenotype and Evaluation Development**

- Maternal/Reproduction
  - Heifer Pregnancy
  - Stayability/LPL
    - SP(5|1)
    - S(5|1,2,3,4)
- Temperament.Docility
  - Chute Scores
- Feed Intake/Efficiency
  - FCR, FE, RFI, FI

**Why is multiple trait selection..**

- Difficult?
  - Lots of EPDs
  - Some for Economically Relevant Trait (ERT) some for Indicator Traits
- Important?
  - More than one trait is important for enterprise, operation or industry profitability
The Role of Economically Relevant Traits

- A trait that has a direct cost or return associated with it is an Economically Relevant Trait (ERT).
- Traits that are correlated to ERTs are indicator traits.
- Example: Is Birth Weight or Calving East the ERT? Why??
- Weaning Weight or Yearling Weight?

Relative Economic Weights for Integrated Beef Firm

Reproduction: Growth: End Product

2:1:1

(Melton, 1995)
Angus Selection Indexes

- \( W = \text{Weaning Value (\$ per head)} \)
  - BW, WW, Milk, Mature Wt.
- \( F = \text{Feedlot Value (\$ per head)} \)
  - WW, YW and correlations
- \( QG = \text{Quality Grade (\$ per head)} \)
- \( YG = \text{Yield Grade (\$ per head)} \)
- \( G = \text{Grid Value (\$ per head)} \)
  - Grade and yield components
- \( B = \text{Beef Value (\$ per head)} \)
  - \( F \) and \( G \) adjusted for weight and costs
- \( EN = \text{Cow Energy (savings/cow/year)} \)
  - Milk and Mature Wt. as they relate to maintenance energy requirements

New tools...rapidly changing

- New tools
  - Sequencing
  - SNP detection and characterization
  - High throughput genotyping platforms
    - 3K, 20K, 50K, 800K SNP per chips
- Bovine Genome Sequence
  - SNP identification
  - Additional SNP discovery to build BovineSNP50 chip
DNA Marker Testing

- Increased utility
  - Markers will describe a larger portion of additive genetic merit
    - Inclusion of many more marked QTL
  - Panels will be generated for a larger number of ERT and qualitative traits
  - Enhance selection response and elimination of deleterious genes
  - Incorporation of genomic data into genetic evaluation systems
- Rapid proliferation over next 12-18 months

Traditional vs. Genomic Relationships

- n=1,707 animals

(Adapted from Rolf et al., 2010)
**Bootstrap Correlations**

Correlation between NRM and subsets of GRM

Correlation between subsets of GRM and full GRM

(Adapted from Rolf et al., 2010)

**SNP50 Whole Genome Scan for RFI QTL Discovery**

\[ h^2 = 0.20; \%\sigma_A^2 = 50; \%\sigma_P^2 = 10 \]

(Rolf et al., 2009)
- Large marker panels or whole genome selection system
- Incorporate marker data into EPD calculation
  - Am. Simmental used WBSF markers in computation of EPD
  - Am. Angus Association debut of Genome Assisted Carcass EPDs
- Improves accuracy for young animals/selection candidates
- Reduces need to collect expensive phenotypes
- Eliminates discrepancies in MBV and EPD

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**MBV as additional correlated trait-MARB-IMF-MBV**

<table>
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<tr>
<th></th>
<th>MARB</th>
<th>IMF</th>
<th>MBV</th>
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<tbody>
<tr>
<td>MARB</td>
<td>~0.45</td>
<td>~0.60</td>
<td>??</td>
</tr>
<tr>
<td>IMF</td>
<td>~0.35</td>
<td></td>
<td>??</td>
</tr>
<tr>
<td>MBV</td>
<td>~1.00</td>
<td></td>
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</tbody>
</table>

Heritability on diagonal, genetic correlations off diagonal
“The BIF Commission believes that information from DNA test only has value in selection when incorporated with all other available forms of performance information for economically important traits in NCE, and when communicated in the form of an EPD with a corresponding BIF accuracy.”

--Tess 2008

- Development of ERTs
  - Phenotypic record collection is difficult and expensive
  - Expansion of herd/cow based recording systems to capture fertility/longevity data
  - Expansion of participation in performance system by seed stock and commercial producers
  - Implementation of genomic selection tools
    - ERT/defect focused
    - Adequately sized resource populations for training/QTL discovery
    - Evaluation and delivery platforms to handle genotype/MBV data
    - Cost vs. response to selection
Thank You!

Selected Citations:


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