Understanding Applied Beef Genetics
Extension Educator Resources

- [www.nbcec.org](www.nbcec.org)
  - Beef Sire Selection Manual
  - Brown Bagger Webinar Series (Archive)
- eXtension-Beef Cattle Clearinghouse CoP
  - Webinars (archive)
    - [http://www.extension.org/beef_cattle](http://www.extension.org/beef_cattle)
- ASI K-State
  - Across Breed EPD converter
  - Adj BW, WW, YW calculator
    - [http://ksubeeef.org](http://ksubeeef.org)
Guiding Principles

- If you don’t measure it, you can’t manage it!
- The best way to know how much something weighs...is to weigh it!
- Not all traits should be measured...
- Populations respond to selection.
- Selection without an objective that includes profit is a hobby.
- Sire selection should address additive and non-additive merit.
Selection Tools for Beef Cattle Improvement

K-State
Research and Extension
Sire Selection Tools:

- DNA Markers
- EPD
- Ratios
- Adjusted weights
- Raw Weights
- Visual Appraisal

Ability to generate response to selection

Cost
Includes all sources of variation
- Management (i.e. feed)
- Differences in age
- Sex
- Age of dam
- Climate
- Genetics
Adjusted data

- What is the data ‘adjusted’ for?
  - Sex
  - Age of calf
  - Age of dam
- Why?
  - Compare ‘apples to apples’
A way of comparing animals within a contemporary group

- Contemporary group average = 500
- Animal = 550
- Ratio = 110
  - \((550/500)*100\)

Why not outside of that group?
- Different environmental influences
- Group averages may not be equal
EPD - Expected Progeny Difference

- Separates the ‘wheat from the chaff’
- What information is included?
  - Pedigree information
    - (Parents, grand-parents, half-sibs, etc.)
  - Individuals’ own record (very important)
  - Progeny information
  - Correlated traits (BW, WW, YW)
  - REMOVES ENVIRONMENTAL EFFECTS
  - Can be used across herds but only within a breed
EPDs Defined

**Expected**
- Future, average, mean

**Progeny**
- Offspring

**Difference**
- Implies comparison between animals
- NOT phenotypic performance

- Measure of relative merit among individuals
- Estimate of average effect of animal as parent
- Estimate of average gamete genetic merit
Average value of gametes

EPD = 40
10 lb. Difference in EPD of Two Bulls
What an EPD Tells You:

Cumulative (net) effect of all genes and their interactions on a trait.
### Using EPDs

#### Bon View New Design 878

<table>
<thead>
<tr>
<th>Trait</th>
<th>EPD</th>
<th>CED</th>
<th>BW</th>
<th>WW</th>
<th>YW</th>
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#### S A F Bronco 9015

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<th>WW</th>
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<th>MILK</th>
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<tr>
<td>EPD</td>
<td>5.5</td>
<td>0.8</td>
<td>51</td>
<td>91</td>
<td>24</td>
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</table>
How EPDs Are Computed: Contemporary Group

- Consists of animals that are:
  - Given equal opportunity to perform
  - Of similar age and sex
- Identify fair competition
- Formed from management information
- The basis of all genetic comparisons

\[
\text{Phenotype} = CG + \text{Genetics} + e
\]

\[
\text{Genetics} = \text{Phenotype} - CG
\]
Where EPDs fit in selection
EPD’s Work…

- 7-9 times more effective generating response to selection than phenotypic selection
- Can be used to:
  - Increase performance
  - Decrease performance
  - Optimize performance
- Do not select for maximum genetic expression w/o regard to other factors
  - Nutritional conditions
Data Source: 2009 Am. Angus Sire Evaluation Report; Phenotypic and Genetic Trends
EPDs Work—Selection for increased growth

YW Line Fit Plot

YW_{Pheno} = 910 + 3.38 \times YW_{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

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

\[ BW_{\text{Pheno}} = 75 + 2.68 \times BW_{\text{EPD}} \]
\[ R^2 = 0.95 \]
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


Weaber and Fennewald, 2009
# How Do I Make EPD Work for My Herd?

<table>
<thead>
<tr>
<th>Sire</th>
<th>WW EPD</th>
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<tbody>
<tr>
<td>A</td>
<td>40</td>
</tr>
<tr>
<td>B</td>
<td>49</td>
</tr>
<tr>
<td>C</td>
<td>52</td>
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**Average Adjusted 205 d Weaning Weight**

<table>
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<th>Avg.</th>
<th>47</th>
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560 lb.
Selection is challenging
Not all economically important traits have EPD
- Fertility
- Disease resistance
- Fescue fitness
- Conformation traits
- Mature weight
Use the right tool for job!
Multiple trait selection
Making the tools work together...
Our objective is to breed cattle that breed as yearlings, calve unassisted and rear a good calf for sale at weaning every year. We aim to breed functional cattle that flesh easily and can forage on the hills over winter but must have the temperament and soundness to be farmed intensively during calving and the breeding season.
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?
Reproduction:Growth:End Product

2:1:1

(Melton, 1995)
$W$ - One number to use in selection that summarizes five

- Appropriately weights each trait for its influence of profit
- Selection on ‘aggregate merit’ (Hazel, 1943)
- Value of each trait - increase in satisfaction with one unit change in a trait, all others held constant
- Selection index is formal statement of trade-offs among traits used to evaluate selection candidates (MacNeil et al., 1997)
What a Marker Test Tells You:

But What About These Genes?

Marker 1
Cumulative effect of all genes and their interactions on a trait.
EPD

- Sum of the additive effect of all genes that influence a given trait divided by two
- Genes are unknown
- Time delay in collecting phenotypes

Spangler, 2011

MBV (MVP, ETC.)

- Sum of the additive effect of SNP alleles (multiplied by copy number) that influence a trait
- These are not genes, but associated with genetic variance
- Can be collected at birth

Spangler, 2011
Integrated Information

EPD (index or interim)

MBV (correlated indicator trait)

MA-EPD

Spangler, 2011
Relationship Between Accuracy, %GV and BIF Acc.

**Relationship between Accuracy** ($r_{TI}$), **$R^2$ (%) Genetic Variance Explained** and BIF Accuracy

- $r(TI)$
- $R^2$ (%GV)
- BIF accuracy

Accuracy ($r_{TI}$)
Impact on Accuracy--
\(\% GV = 10\%\)

Spangler, 2011
Impact on Accuracy--
\(\%GV = 40\%\)

*Spangler, 2011*
Thank You!

Questions?
Overview

- Selection tools for beef cattle improvement
  - Measures used for selection
  - The basics of EPDs
  - Where EPDs fit in selection
  - EPDs work! (and not just to increase a trait)
  - What they can and can’t do
- EPDs – making the tools work together
- Multiple trait selection
- EPDs – Future
  - New sources of genetic information
  - Old and new living together – convergence
Cattle have 30 pairs of chromosomes
- 29 autosomes, 1 sex determining
- Diploid (2 copies of each chromosome)

Meiotic cell division forms gametes
- Eggs and sperm are haploid
- 1 chromosome from each pair; random
- Recombination or cross-over events

Fertilization restores diploid chromosome count

Two copies of each gene
- Alternate forms are called alleles

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

Mean BW EPD


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

Mean WW EPD

Weaber and Fennewald, 2009
Genetic Correlations

- BW – Mature Wt. 0.61
- WW – Mature Wt. 0.65
- YW – Mature Wt. 0.65
- Feed Intake – Mature Wt. 0.75
Did EPDs make big cows??

NO, people made big cows!

Selection works!
  - So does correlated response

We can use EPDs to:
  - Increase performance
  - Decrease performance
  - Maintain performance
Selection Index

- Two Step approach by Henderson (1950s)
  - Calculate predictions of merit (EPD) for each trait in selection objective
  - Weight each prediction by its Relative Economic Value (REV)
- Equivalent to Hazel (1943) approach

\[ H = a_1 \text{EPD}_1 + a_2 \text{EPD}_2 + \ldots + a_n \text{EPD}_n \]
Convergence

- 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 EPDs
- Improves accuracy for young animals/selection candidates
- Reduces need to collect expensive phenotypes
## MBV BIF Accuracy

<table>
<thead>
<tr>
<th>Genetic Correlation</th>
<th>% GV</th>
<th>BIF Accuracy</th>
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<tbody>
<tr>
<td>0.1</td>
<td>1</td>
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<tr>
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<tr>
<td>0.7</td>
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*Spangler, 2011*