Introduction

- The major objective (aim) of all beef cattle producers should be to increase genetically the producing ability of cattle in their herds

Importance of Sire Selection

- Most genetic progress is made through sire selection
- Decisions have long-term impact
- In herds where replacements are saved, 87.5% of the genetic makeup of each calf results from the last three sires used

Overview

- Introduction/importance of sire selection
- Selection emphasis
- Evolution of beef cattle evaluation
- Use of genetic tools (EPDs, indexes, etc.)
- DNA information
Introduction

- Tips for increased beef cow profits (BEEF, 2013)
  - Focus on the target – Donnell Brown
  - Select the cow that best fits your environment
  - Select the bull that best complements the cow to produce a calf that fits the market
  - Select breeding and mating systems that fits your management

Use of Genetic Tools in Selection

<table>
<thead>
<tr>
<th>Information type</th>
<th>Used in last 5 years (%)</th>
<th>Use in the future (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual measurements</td>
<td>16.4</td>
<td>6.7</td>
</tr>
<tr>
<td>Ratios</td>
<td>21.6</td>
<td>13.8</td>
</tr>
<tr>
<td>Expected progeny differences (EPDs)</td>
<td>29.9</td>
<td>12.4</td>
</tr>
<tr>
<td>Genomically enhanced EPDs</td>
<td>5.6</td>
<td>12.6</td>
</tr>
<tr>
<td>Productivity of relatives</td>
<td>16.4</td>
<td>14.3</td>
</tr>
<tr>
<td>Comments by seller</td>
<td>17.6</td>
<td>11.4</td>
</tr>
<tr>
<td>DNA marker results</td>
<td>2.8</td>
<td>15.4</td>
</tr>
<tr>
<td>None of above</td>
<td>31.0</td>
<td>42.5</td>
</tr>
</tbody>
</table>

(Weaber et al., 2014)

Traits of Interest – Bull Selection (BEEF, 2014)

<table>
<thead>
<tr>
<th>Trait</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual birth weight*</td>
<td>72.9</td>
</tr>
<tr>
<td>Birth weight EPD</td>
<td>68.6</td>
</tr>
<tr>
<td>Calving ease – direct EPD*</td>
<td>58.5</td>
</tr>
<tr>
<td>Actual weaning weight</td>
<td>55.3</td>
</tr>
<tr>
<td>Weaning weight EPD</td>
<td>52.9</td>
</tr>
<tr>
<td>Milking ability EPD</td>
<td>51.2</td>
</tr>
<tr>
<td>Yearling weight EPD</td>
<td>45.7</td>
</tr>
<tr>
<td>Calving ease – maternal EPD*</td>
<td>43.3</td>
</tr>
<tr>
<td>Adj. yearling scrotal measure</td>
<td>41.5</td>
</tr>
<tr>
<td>Actual yearling weight*</td>
<td>40.2</td>
</tr>
<tr>
<td>Adj. weaning weight*</td>
<td>39.4</td>
</tr>
</tbody>
</table>

* = traits with percentages that increased from 2010

Traits of Interest – Bull Selection (BEEF, 2014)

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<td>68.6</td>
</tr>
<tr>
<td>Actual weaning weight</td>
<td>55.3</td>
</tr>
<tr>
<td>Actual yearling weight</td>
<td>40.2</td>
</tr>
<tr>
<td>Adj. scrotal measures</td>
<td>41.5</td>
</tr>
<tr>
<td>Actual disposition score</td>
<td>30.3</td>
</tr>
</tbody>
</table>

* Producers requiring actual data versus EPDs
* Producers may not always use best source of information for selection
Components of Performance

Performance = Genetics + Environment

- Measurement on a given animal
- Sum of the management and climatic factors that influence the measurement
- Sum of the genetic factors that influence the measurement

Evolution of Beef Cattle Evaluation

- Visual Appraisal
- Actual Performance Measures
- Adjusted Measures & Within Herd Ratios
- Expected Progeny Differences
- Bioeconomic Values
- Genomic-Enhanced EPD & Indexes

Expected Progeny Difference (EPD)

- EPD – genetic merit of an animal, as a potential parent, in comparison with other animals in the same breed
  - Expressed in trait units (lbs, in, cm, in², etc.)
  - Supplied by breed associations
  - Published in sire summaries, catalogs, etc.
EPD: Accuracy (ACC)

- EPD are estimates – accuracy indicates how closely the estimates are to the true values
  - Provides measure of reliability or certainty
  - Ranges in value from zero (poor estimate) to one (good estimate)
  - Increases with additional data (information)
  - Does not indicate progeny variability

EPD: Accuracy Categories

<table>
<thead>
<tr>
<th>Accuracy</th>
<th>Meaning</th>
<th>Risk Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; .40</td>
<td>Very likely to change as information is added</td>
<td>High</td>
</tr>
<tr>
<td>.40 to .60</td>
<td>Some changes likely; records on few progeny</td>
<td>Moderate</td>
</tr>
<tr>
<td>.60 to .80</td>
<td>Small changes possible; records on numerous progeny</td>
<td>Low</td>
</tr>
<tr>
<td>&gt; .80</td>
<td>Not likely to change much as information is added</td>
<td>Very Low</td>
</tr>
</tbody>
</table>

EPD: Possible Change (PC)

- Values are standard deviations
- PC = standard error of prediction

- PC is associated with accuracy (ACC)
  - Higher ACC = less chance of change
  - Smaller PC values
  - Lower ACC = greater chance of change
  - Larger PC values

EPD: Accuracy and Possible Change

<table>
<thead>
<tr>
<th>Possible Change Table</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACC</td>
</tr>
<tr>
<td>-----</td>
</tr>
<tr>
<td>0.00</td>
</tr>
<tr>
<td>0.10</td>
</tr>
<tr>
<td>0.20</td>
</tr>
<tr>
<td>0.30</td>
</tr>
<tr>
<td>0.40</td>
</tr>
<tr>
<td>0.50</td>
</tr>
<tr>
<td>0.60</td>
</tr>
<tr>
<td>0.70</td>
</tr>
<tr>
<td>0.80</td>
</tr>
<tr>
<td>0.90</td>
</tr>
<tr>
<td>1.00</td>
</tr>
</tbody>
</table>
### Possible Change Table

<table>
<thead>
<tr>
<th>ACC</th>
<th>CE</th>
<th>BW</th>
<th>WW</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.00</td>
<td>7.8</td>
<td>3.0</td>
<td>16.3</td>
</tr>
<tr>
<td>0.10</td>
<td>7.0</td>
<td>2.7</td>
<td>14.7</td>
</tr>
<tr>
<td>0.20</td>
<td>6.2</td>
<td>2.4</td>
<td>13.0</td>
</tr>
<tr>
<td>0.30</td>
<td>5.4</td>
<td>2.1</td>
<td>11.4</td>
</tr>
<tr>
<td>0.40</td>
<td>4.7</td>
<td>1.8</td>
<td>9.8</td>
</tr>
<tr>
<td>0.50</td>
<td>3.9</td>
<td>1.5</td>
<td>8.2</td>
</tr>
<tr>
<td>0.60</td>
<td>3.1</td>
<td>1.2</td>
<td>6.5</td>
</tr>
<tr>
<td>0.70</td>
<td>2.3</td>
<td>0.9</td>
<td>4.9</td>
</tr>
<tr>
<td>0.80</td>
<td>1.6</td>
<td>0.6</td>
<td>3.3</td>
</tr>
<tr>
<td>0.90</td>
<td>0.8</td>
<td>0.3</td>
<td>1.6</td>
</tr>
<tr>
<td>1.00</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>0.00</td>
<td>7.8</td>
<td>3.0</td>
<td>16.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Sire</th>
<th>CE</th>
<th>ACC</th>
<th>Possible Change</th>
<th>“True” EPD Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>10.0</td>
<td>0.10</td>
<td>7.0</td>
<td>3.0 to 17.0</td>
</tr>
<tr>
<td>B</td>
<td>10.0</td>
<td>0.90</td>
<td>0.8</td>
<td>9.2 to 10.8</td>
</tr>
</tbody>
</table>

- **Sire CE ACC Possible Change “True” EPD Range**
  - A: 10.0 0.10 7.0 3.0 to 17.0
  - B: 10.0 0.90 0.8 9.2 to 10.8

### Genomic Enhanced EPDs

**Genomic Enhanced Expected Progeny Differences (GE-EPDs)**

- **Pedigree**
- **Performance**
- **Progeny**
- **Genomic Testing**

- Provide ability to better characterize cattle in a breed
- Provide improved accuracies (ACC) on non-parent animals
- Provide better overall breeding values
  - Better estimates of an animal’s genetic worth

### Genomics Influence on Accuracy

- Genomic test results are incorporated into EPD calculations
- Accuracy impacts are dependent on the proportion of the additive genetic variance explained by genomic results
  - Most traits ~15 – 50%
- Depending on the trait, genomic results are similar to 8-20 progeny records

### Genomic Enhanced EPDs

![Genomic Enhanced EPDs](image-url)
Example: EPD Use and Interpretation

<table>
<thead>
<tr>
<th>SIRE</th>
<th>Expected Progeny Difference (EPD)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>CE (ACC)   BW (ACC)  WW (ACC)  YW (ACC)  MILK (ACC)</td>
</tr>
<tr>
<td></td>
<td>4.7 (0.38) 3.9 (0.75) 46 (0.72) 92.5 (0.72) 6.7 (0.59)</td>
</tr>
<tr>
<td>B</td>
<td>CE (ACC)   BW (ACC)  WW (ACC)  YW (ACC)  MILK (ACC)</td>
</tr>
<tr>
<td></td>
<td>11.2 (0.49) -1.8 (0.75) 20.4 (0.72) 62.9 (0.71) 27.7 (0.50)</td>
</tr>
</tbody>
</table>

Difference | 6.5 | 5.7 | 25.6 | 29.6 | 21 |

*Abbreviations: CE = Calving ease  
BW = Birth weight  
WW = Weaning weight  
YW = Yearling weight  
MILK = Milk  
ACC = Accuracy

Example: EPD Use and Interpretation

<table>
<thead>
<tr>
<th>SIRE</th>
<th>Expected Progeny Difference (EPD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>CE (ACC)   BW (ACC)  WW (ACC)  YW (ACC)  MILK (ACC)</td>
</tr>
<tr>
<td></td>
<td>-1.1 (0.78) 3.2 (0.91) 42.1 (0.85) 78.2 (0.81) -1.1 (0.52)</td>
</tr>
<tr>
<td>B</td>
<td>CE (ACC)   BW (ACC)  WW (ACC)  YW (ACC)  MILK (ACC)</td>
</tr>
<tr>
<td></td>
<td>16.7 (0.29) -2.9 (0.65) 17.3 (0.41) 28.4 (0.39) 2.8 (0.27)</td>
</tr>
</tbody>
</table>

Difference | 17.8 | 6.1 | 24.8 | 49.8 | 3.9 |

Sire A’s progeny are expected to be, on average:  
- 6.1 pounds heavier at birth  
- 24.8 pounds heavier at weaning  
- 49.8 pounds heavier at a year of age

EPD: Indexes

- Index – a combination and weighting of multiple traits and their relative economic impact into one value that can be used to rank animals  
  - Challenging to develop  
  - Simplistic too use  
  - Provides directional change in multiple traits  

\[
\text{Index} = \text{yearling weight} - (3.2 \times \text{birth weight})
\]

On average, when mated to heifers, 17.8% less of Sire B’s calves should require assistance compared to Sire A’s calves.

Sire B’s daughters are expected to wean calves that are 3.9 pounds heavier than calves from daughters of Sire A.
Economic index (Index EPD) – referred to as $value indexes

- Combine EPD for traits affecting an overall measure of production, value of that production, and the cost to obtain it
- Mathematical weightings are applied to input traits and the value and costs of production are assigned
- Usually reported in net dollar return

Index EPD Examples

- Angus
  - Cow Energy Value
  - Weaned Calf Value
  - Feedlot Value
  - Grid Value (QG, YG)
  - Beef Value
- Charolais
  - Terminal Sire Profitability Index
- Limousin
  - Mainstream Terminal Index
- Gelbvieh
  - Feedlot Merit Index
  - Carcass Value Index
- Hereford
  - Baldy Maternal Index
  - Calving EZ Index
  - Brahman Influence Index
  - CHB Index
- Simmental
  - All-Purpose Index
  - Terminal Index
Angus - $Value Indexes

- **Weaned calf value ($W)** – expected difference in future progeny for preweaning merit
  - Expressed in dollars per head (↑ = favorable)
  - Traits: BWT, WWT, maternal milk, mature cow size

- **Cow energy value ($EN)** – expected difference in cow energy needs in daughters of sires
  - Expressed in dollars savings per cow per year (↑ = favorable)
  - Traits: lactation energy requirements, energy cost, mature cow size

---

Example: EPD Use and Interpretation

<table>
<thead>
<tr>
<th>SIRE</th>
<th>Expected Progeny Difference (EPD)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>$W</td>
</tr>
<tr>
<td></td>
<td>39.29</td>
</tr>
<tr>
<td>B</td>
<td>$W</td>
</tr>
<tr>
<td></td>
<td>21.16</td>
</tr>
<tr>
<td>Difference</td>
<td>18.13</td>
</tr>
</tbody>
</table>

*SAbbreviations: $W = Weaned calf value, $F = Feedlot value, $G = Grid value, $B = Beef value, $EN = Cow energy value

Example: EPD Use and Interpretation

- Sire A's progeny are expected to have, on average:
  - $18.13 advantage in pre-weaning value

- Sire B's daughters are expected to have, on average:
  - $42.50 per cow, per year energy cost savings

---

EPD: Indexes

- **Index EPDs allow for simultaneous selection for more than one trait**
- **Index EPDs are to be used within breed**
- **Index EPDs lack published accuracies**
  - Caution with young sires – index can change
- **Index EPDs should be used within specific production goals**
  - Terminal versus maternal
Index EPD Examples

- **Maternal**
  - Cow Energy Value (AN)
  - Weaned Calf Value (AN)
  - All Purpose Index (SM)
  - Baldy Maternal Index (HP)
  - BR Influence Index (HP)
  - Calving EZ Index (HP)
  - Herdbuilder (RA)
  - $Cow Index (GV)

- **Terminal**
  - Beef Value Index (AN)
  - Feedlot Value Index (AN)
  - Grid Value Index (AN)
  - Terminal Index (SM)
  - CHB$ Index (HP)
  - Mainstream Terminal (LM)
  - Terminal Sire Index (CH)

DNA Testing

1. Collect Sample
2. Extract DNA
3. Genotype
4. Analyze
5. Interpret/Consult

Genetic markers

- SNPs – most common type of genetic variation in animals
- SNPs represent a difference in a single nucleotide
- SNPs occur normally in an animal's DNA
  - Occur every 300 nucleotides = ~10 million SNPs

DNA Test Results
### DNA Test Results

<table>
<thead>
<tr>
<th>Animal</th>
<th>Score</th>
<th>CED</th>
<th>HP</th>
<th>RFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td></td>
</tr>
</tbody>
</table>

#### Genetic Effects

<table>
<thead>
<tr>
<th>Animal</th>
<th>Score</th>
<th>CED</th>
<th>HP</th>
<th>RFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>21.2</td>
<td>11.6</td>
<td>1.8</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>8.0</td>
<td>4.4</td>
<td>0.7</td>
<td></td>
</tr>
</tbody>
</table>

**Difference**

<table>
<thead>
<tr>
<th>Score</th>
<th>CED</th>
<th>HP</th>
<th>RFI</th>
</tr>
</thead>
<tbody>
<tr>
<td>13.2</td>
<td>7.2</td>
<td>1.1</td>
<td></td>
</tr>
</tbody>
</table>

CED: A is expected to have 13.2% more unassisted calves

HP: A is expected to have daughters with 7.2% higher probability of conceiving

RFI: B progeny is expected to require 1.1 lb/d less feed for same ADG

---

### How do you define efficiency?

- Pounds of calf weaned per cow - (18%)
- Percent of cow weight weaned - (14%)
- Pounds of calf weaned per cow exposed - (21%)
- Pounds of calf weaned per unit of feed - (14%)
- Pounds of calf weaned per acre - (7%)
- Pounds of beef produced per cow - (21%)
- None of above - (4%)

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### Importance of Reproduction

- In the past 25 years or so, the beef industry has made great strides in improving performance related traits
- Genetic improvement programs for reproductive traits have been slower to develop
- Reproductive performance is the most important economic trait in a beef cow herd
Importance of Reproduction

- In relative economic terms, reproduction has been reported to be:
  - 5 times more important than production traits
  - 4 times more important than end-product traits

Historically, producers have experienced difficulty in selecting for reproduction:
- Reproduction is a complex trait with many inputs
- Limited agreement on how reproduction is defined or expressed
- Limited genetic control

Reproductive Trait EPDs

- **Scrotal Circumference (SC) EPD**
  - Expressed in centimeters and represents sire's ability to transmit scrotal growth
  - Larger numbers = larger scrotal circumferences
  - Larger numbers = improved semen traits, decreased age of puberty

- **Heifer Pregnancy (HP) EPD**
  - Expressed as a difference in % of a sire's daughters conceiving to calve at two years of age
  - Greater numbers = more pregnant heifers
Reproductive Trait EPDs

- Stayability (STAY) EPD
  - Expressed as a difference in % of a sire’s daughters remaining in herd until at least six years of age
  - Greater numbers = more cows staying in herd for longer periods

Efficiency EPDs

- Dry Matter Intake (DMI) EPD
  - Expressed in pounds per day; predicts the difference in transmitting ability for feed intake during postweaning period
  - Lower numbers = less DM consumed per day

Efficiency EPDs

- Residual ADG (RADG) EPD
  - Expressed in pounds per day; predicts a sire’s transmitting ability for postweaning gain given a constant amount of feed consumed
  - Greater numbers = more ADG

Genetic Antagonisms / Correlations

- Genetic antagonism – situation in which favorable genetic change in one trait is accompanied by unfavorable genetic change in another trait
  - Causes: pleiotropy, genes closely linked in the genome
  - Identified (measured) with genetic correlations
Genetic Correlations

- Can be positive or negative
  - (+) When one trait changes, other trait changes in same direction
  - (-) When one trait changes, other trait changes in opposite direction

- Can be favorable or unfavorable
  - Provides a desirable outcome
  - Provides an unfavorable outcome

Genetic Correlations - Examples

- Selection for postweaning gain
  - Increased age and weight at puberty, increased mature weight
  - Improved fertility
  - Reduced maternal gestation length and calving difficulty
  - Increased birth weight and reduced pre-weaning gain

- Selection for reduced fat thickness
  - Increased age and weight at puberty, increased mature weight
  - Reduced fertility and pre-weaning gain
  - Reduced maternal gestation length, BW and calving difficulty

Genetic Correlations - Examples

- Examples of genetic correlations:
  - Calving ease & birth weight (-, unfavorable)
  - Growth traits & SC (+, favorable)
  - Milk & maintenance energy (+, unfavorable)
  - WW & fat thickness (-, favorable)

- Selection for increased RP or CW
  - Increased age and weight at puberty, increased mature weight
  - Improved fertility
  - Increased gestation length and BW
  - Reduced calving difficulty and maternal pre-weaning gain
Selection Strategies

- Define goals and objectives, identify strengths and weaknesses
- Identify, and select for, traits of economic importance
- Utilize EPDs as a selection tool
- Utilize visual appraisal to ensure sire can contribute his genetic characteristics
- Track herd performance and match to environment and markets
- Take steps to positively impact end product acceptability