Crossbreeding Strategies: Terminal and Maternal Crossing

Bob Weaber

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Crossbreeding Strategies: Terminal and Maternal Crossing

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1. One Bull to Do It All...
   - Antagonisms
   - Retained Heterosis
   - Breed Complementarity
   - Selection tools/trait focus

2. Separate Maternal and Terminal Mating Decisions
   - More Flexibility

3. You get what you sow...
   - If you use terminal trait EPD or terminal indexes in selection, what do you get?
     You get response in terminal traits!
   - If maternal traits are important to you, put pressure on maternal traits
     — Think ‘optimization’
     — Traits: CE, CEM, DOC, HP, Stay (rebreeding), MW, ME, replacement indexes
   - Align traits used in selection with marketing endpoint/breeding objective

4. Having Your Cake and Eating it Too
   - Commercial cattlemen SHOULD care about BOTH additive and non-additive effects.
     — Selection index/EPDs
     — Hybrid vigor or heterosis
   - Seedstock producers SHOULD focus on additive genetic merit, and putting it in a package that helps clientele exploit non-additive effects.

5. Sire Selection in Two Steps
   1. Pick the right breed(s)
      - PLANNED Crossbreeding
      - Breeding objectives
      - Considerations
   2. Chose right individual in that breed
      - EPDs
      - Genetic risk management
      - Selection indexes

2015 Range Beef Cow Symposium, Loveland, Colo.
The Power of Crossbreeding

- Heterosis
  - Superiority of a crossbred animal as compared to the average of its straightbred parents
  - Especially maternal heterosis

- Breed Complementarity
  - Selection of breeds for core traits that fill the other breed(s) shortcomings
  - Maternal crossbreds-appropriate cow size/lactation for environmental fitness
  - Terminal crossbreds-add value to calves in market place

Benefits of Heterosis

- Heterosis increases production 20 to 25% per cow in Bos taurus x Bos taurus crosses; 50% in Bos indicus x Bos taurus crosses in subtropical regions
- More than half of this effect is dependent on use of crossbred cows

Jenkins, MARC

Heritability and Heterosis: Inversely Related

<table>
<thead>
<tr>
<th>Trait</th>
<th>Heritability</th>
<th>Heterosis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reproduction (fertility)</td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>Production (growth)</td>
<td>Moderate</td>
<td>Moderate</td>
</tr>
<tr>
<td>Product (carcass)</td>
<td>High</td>
<td>Low</td>
</tr>
</tbody>
</table>

Retained Heterosis

<table>
<thead>
<tr>
<th>System</th>
<th>% Max Heterosis</th>
<th>% Increase in Calf Wt./ Cow Exposed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pure breeds</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2 breed rotation</td>
<td>67</td>
<td>16</td>
</tr>
<tr>
<td>3 breed rotation</td>
<td>86</td>
<td>20</td>
</tr>
<tr>
<td>2 breed composite</td>
<td>50</td>
<td>12</td>
</tr>
<tr>
<td>4 breed composite</td>
<td>75</td>
<td>17</td>
</tr>
<tr>
<td>Rotating F1 AB</td>
<td>AD</td>
<td>67</td>
</tr>
<tr>
<td>Rotating F1 AB</td>
<td>CD</td>
<td>83</td>
</tr>
<tr>
<td>Term. Sire/purch. F1♀</td>
<td>100</td>
<td>23-28</td>
</tr>
</tbody>
</table>

Breeds Have Changed Overtime, Does Heterosis Still Exist? What About Complementarity?

Genetic Trends for Yearling Weight, lb

Adapted from Spring 2012 Genetic Trends from Breed Associations and 2012 AB-EPD factors (Keuhn et al., 2012)
Breed Complementarity

- Harvest the core strengths of breeds
  - Additive Traits (EBV)
  - Type or conformation/phenotype
  - Adaptation/Fitness Traits
- Crossing breeds to combine direct and maternal heterosis and breed effects to optimize performance levels
- Match cows to environment, calves to market...

Breed combinations that make sense

- Market weaned calf or retain ownership of cattle that sell live or on a ‘balance’ grid
  - 50% British:50% Continental
  - 75% British:50% Continental
- Retain ownership and sell in beef on grid that significantly rewards Quality Grade
  - British crosses
  - 75% British:25% Continental

Table 2. Estimates of biological type heterosis (SE) (British x British, British x Continental and Continental x Continental) for birth, weaning and yearling weight (Model 1)

<table>
<thead>
<tr>
<th>Covariate</th>
<th>BW1, kg</th>
<th>WT205D, kg</th>
<th>WT365D, kg</th>
</tr>
</thead>
<tbody>
<tr>
<td>B × B</td>
<td>0.47 (0.37)</td>
<td>6.43 (1.80)**</td>
<td>17.59 (3.06)**</td>
</tr>
<tr>
<td>B × C</td>
<td>0.75 (0.32)*</td>
<td>8.65 (1.54)**</td>
<td>13.88 (2.63)**</td>
</tr>
<tr>
<td>C × C</td>
<td>0.73 (0.54)</td>
<td>5.86 (2.57)*</td>
<td>9.12 (4.34)*</td>
</tr>
<tr>
<td>Maternal heterosis</td>
<td>0.41 (0.31)</td>
<td>0.54 (1.84)</td>
<td>3.44 (2.66)</td>
</tr>
</tbody>
</table>

*P < 0.05
**P < 0.01.

Schrimenti et al., 2015 JAS
Mating System Goals

1. Optimize the utilization of calf and maternal heterosis.
2. Utilize breed complementarity to match cows to their environment and their progeny to market targets.
3. Minimize variation in progeny phenotypes by stabilizing breed inputs.
4. Use Adv. Repro tech to help structure mating system (i.e. AI, gender sort semen)

Breeding Programs

- Terminal
  - F1, Hybrid, or Composite Seedstock
  - Rotational 2, 3, 4 breeds
    - if your operation is (very) large enough
  ◆ Retained Heterosis
  ◆ Stabilization of Breed Percentages

Systems, Benefits, Constraints

Table 7. Summary of crossbreeding systems by amount of advantage and other factors

<table>
<thead>
<tr>
<th>Type of System</th>
<th>% of Earthen</th>
<th>% of Artificial</th>
<th>Advantage</th>
<th>Retained Heterosis</th>
<th>Minimum No. of Breeds</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed Maternal</td>
<td>100</td>
<td>0</td>
<td>Advantage</td>
<td>Retained Heterosis</td>
<td>Minimum No. of Breeds</td>
</tr>
<tr>
<td>F1</td>
<td>100</td>
<td>0</td>
<td>Advantage</td>
<td>Retained Heterosis</td>
<td>Minimum No. of Breeds</td>
</tr>
<tr>
<td>F2</td>
<td>100</td>
<td>0</td>
<td>Advantage</td>
<td>Retained Heterosis</td>
<td>Minimum No. of Breeds</td>
</tr>
<tr>
<td>F3</td>
<td>100</td>
<td>0</td>
<td>Advantage</td>
<td>Retained Heterosis</td>
<td>Minimum No. of Breeds</td>
</tr>
</tbody>
</table>

How Do I Choose a Breeding Program

- Are you profit or premium focused?
  - Why not both?
- Herd size
  - Efficient bull utilization/manage variation in marketing groups
- How do I generate replacement heifers?
- How do I market calves?
- Constraints
  - Environment
  - Management

2015 Range Beef Cow Symposium, Loveland, Colo.
Crossbreeding Done RIGHT!

• Build a plan – set attainable goals
• Considerations
  – Marketing end points
  – Replacement females (cows must have heterosis)
  – Environment
  – Management
• Stick to it!

Selected References:

• Gelbvieh Alliance. 1998. Results of database analysis—Top 25% vs. Bottom 25% of pens for profitability. Westminster, CO.