What are herd bulls accomplishing in multiple sire breeding pastures?

D. J. Drake, UCCE Livestock Farm Advisor
K. L. Weber, Ph.D. graduate student
Alison Van Eenennaam

Animal Genomics and Biotechnology
Cooperative Extension Specialist
Department of Animal Science
University of California, Davis, CA
Ph: (530) 752-7942
alvaneenennaam@ucdavis.edu

animalscience.ucdavis.edu/animalbiotech
Outline

- Overview of CA Commercial Ranch Project
- Herd bull performance and calf output
- Modeling the value of this information
California Commercial Ranch Project

Four ranches:
- Cowley (900 cows)
- Kuck (500 cows)
- Mole-Richardson (700 cows)
- UC Davis (300 cows)

Approximately 100 Angus bulls, and 2,400 cows per year on project

Assessment of DNA-enabled approaches for predicting the genetic merit of herd sires on commercial beef ranches
What does a California Commercial Ranch collaborator look like?

Photo taken in 1949 at Red Bluff Bull Sale, CA
Generously provided by Cathy Maas from Crowe Hereford Ranch, Millville, CA.
Cowley Ranch

~20 bulls/season
~10 bulls/season
You choose the bull for the following ranch environment

- Predominantly Angus cows
- Multi-bull breeding pasture
- All bulls appeared sound and passed BSE
- All bulls had acceptable semen quality
- Approximately 25:1 cow to bull ratio
- Fenced relatively flat breeding pastures
- Calves sold shortly after weaning
Here are your choices

<table>
<thead>
<tr>
<th>No.</th>
<th>Bull Id &amp; Breed</th>
<th>Age</th>
<th>CED EPD</th>
<th>CED ACC</th>
<th>WN WT EPD</th>
<th>WN WT ACC</th>
<th>Sire</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7183 HH</td>
<td>3.4</td>
<td>0.9</td>
<td>0.12</td>
<td>51.5</td>
<td>0.29</td>
<td>Go Excel</td>
</tr>
<tr>
<td>2</td>
<td>2523 AN</td>
<td>4.4</td>
<td>11</td>
<td>0.3</td>
<td>43.0</td>
<td>0.27</td>
<td>New Frontier</td>
</tr>
<tr>
<td>3</td>
<td>5374 AN</td>
<td>4.3</td>
<td>8</td>
<td>0.05</td>
<td>37.0</td>
<td>0.05</td>
<td>Integrity</td>
</tr>
<tr>
<td>4</td>
<td>8557 AN</td>
<td>4.3</td>
<td>1</td>
<td>0.29</td>
<td>39.0</td>
<td>0.26</td>
<td>Bushwacker</td>
</tr>
<tr>
<td>5</td>
<td>9958 AN</td>
<td>2.4</td>
<td>12</td>
<td>0.31</td>
<td>40.0</td>
<td>0.26</td>
<td>Premium Beef</td>
</tr>
<tr>
<td>6</td>
<td>9956 AN</td>
<td>2.4</td>
<td>12</td>
<td>0.31</td>
<td>41.0</td>
<td>0.27</td>
<td>Premium Beef</td>
</tr>
<tr>
<td>7</td>
<td>9511 AN</td>
<td>3.4</td>
<td>6</td>
<td>0.29</td>
<td>53.0</td>
<td>0.26</td>
<td>Mytty In Focus</td>
</tr>
<tr>
<td>8</td>
<td>8219 AN</td>
<td>2.8</td>
<td>5</td>
<td>0.3</td>
<td>40.0</td>
<td>0.27</td>
<td>Premium Beef</td>
</tr>
<tr>
<td>9</td>
<td>0442 AN</td>
<td>1.9</td>
<td>6</td>
<td>0.29</td>
<td>41.0</td>
<td>0.27</td>
<td>New Design</td>
</tr>
<tr>
<td>10</td>
<td>4594 AN</td>
<td>2.4</td>
<td>7</td>
<td>0.29</td>
<td>45.0</td>
<td>0.28</td>
<td>Mytty In Focus</td>
</tr>
<tr>
<td>11</td>
<td>3954 AN</td>
<td>3.3</td>
<td>9</td>
<td>0.24</td>
<td>35.0</td>
<td>0.26</td>
<td>Broadcast</td>
</tr>
<tr>
<td>12</td>
<td>7166 HH</td>
<td>3.4</td>
<td>-1.5</td>
<td>0.11</td>
<td>45.5</td>
<td>0.32</td>
<td>Go Excel</td>
</tr>
<tr>
<td>13</td>
<td>4677 AN</td>
<td>2.4</td>
<td>8</td>
<td>0.29</td>
<td>35.0</td>
<td>0.27</td>
<td>Total</td>
</tr>
<tr>
<td>14</td>
<td>4935 SD</td>
<td>4.3</td>
<td></td>
<td></td>
<td>55.8</td>
<td>0.51</td>
<td>Rider's Dream</td>
</tr>
<tr>
<td>15</td>
<td>8553 AN</td>
<td>4.3</td>
<td>0</td>
<td>0.3</td>
<td>44.0</td>
<td>0.27</td>
<td>Bushwacker</td>
</tr>
<tr>
<td>16</td>
<td>2694 AN</td>
<td>4.3</td>
<td>6</td>
<td>0.05</td>
<td>45.0</td>
<td>0.05</td>
<td>Destination</td>
</tr>
<tr>
<td>17</td>
<td>0240 SDX</td>
<td>4.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>0239 SDX</td>
<td>4.3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>2553 AN</td>
<td>4.4</td>
<td>11</td>
<td>0.3</td>
<td>38.0</td>
<td>0.27</td>
<td>New Frontier</td>
</tr>
<tr>
<td>20</td>
<td>2695 AN</td>
<td>4.3</td>
<td>6</td>
<td>0.05</td>
<td>45.0</td>
<td>0.05</td>
<td>Destination</td>
</tr>
</tbody>
</table>

* EPDs adjusted to Angus for non-Angus bulls
Weaning weight EPDs (---)

Wean Wt EPD

Wean wt EPD adjusted to Angus for non Angus

0 10 20 30 40 50 60

7183 HH 2523 AN 5374 AN 8557 AN 9958 AN 9956 AN 9511 AN 8219 AN 0442 AN 4594 AN 3954 AN 7166 HH 4677 AN 4935 SD 8553 AN 2694 AN 0240 SDX 0239 SDX 2553 AN 2695 AN
Actual 205 day weight performance of calves (---)

Difference from average actual 205d weaning weight

Wean wt EPD adjusted to Angus for non Angus

-40 -20 0 20 40 60

-40 -20 0 20 40 60

7183 HH 2523 AN 5374 AN 8557 AN 9958 AN 9956 AN 9511 AN 8219 AN 0442 AN 4594 AN 3954 AN 7166 HH 4677 AN 4935 SD 8553 AN 2694 AN 0240 SDX 0239 SDX 2553 AN 2695 AN 2553 AN 2695 AN
Average number of calves born per breeding season

Average number of calves born in a breeding season

Difference from average actual 205d weaning weight

Number of calves

Difference in 205d wean wt
Total 205d weaning weight, no. of calves, and difference from 205d weaning weight mean (Figure 2)
Total 205d weaning weight, number of calves, and difference from 205d weaning weight mean (Figure 3)
Table 1. Average bull age at the beginning of the breeding season, and number of calves produced per bull that sired at least one calf on 3 commercial ranches in Northern California in 2009 and 2010.

<table>
<thead>
<tr>
<th>Ranch</th>
<th>Year</th>
<th>Season</th>
<th># of sires</th>
<th>Bull Age (Min Max)</th>
<th>Mean bull age</th>
<th>Total # of calves</th>
<th>Number of calves per bull (Min Max)</th>
<th>Aver # of calves per bull/season</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2009</td>
<td>Spring</td>
<td>13</td>
<td>1.5 3.1</td>
<td>2.5 ± 0.6</td>
<td>246</td>
<td>6 40</td>
<td>18.9 ± 12.5</td>
</tr>
<tr>
<td>1</td>
<td>2009</td>
<td>Fall</td>
<td>19</td>
<td>1.6 3.8</td>
<td>2.9 ± 0.9</td>
<td>345</td>
<td>1 47</td>
<td>18.2 ± 13.9</td>
</tr>
<tr>
<td>1</td>
<td>2010</td>
<td>Spring</td>
<td>19</td>
<td>2.1 5.2</td>
<td>3.4 ± 0.9</td>
<td>366</td>
<td>5 36</td>
<td>19.3 ± 10.7</td>
</tr>
<tr>
<td>2</td>
<td>2009</td>
<td>Spring</td>
<td>8</td>
<td>0.7 9.2</td>
<td>3.5 ± 2.7</td>
<td>139</td>
<td>1 44</td>
<td>17.4 ± 16.6</td>
</tr>
<tr>
<td>2</td>
<td>2009</td>
<td>Fall</td>
<td>9</td>
<td>1.4 8.8</td>
<td>4.4 ± 2.2</td>
<td>196</td>
<td>10 48</td>
<td>21.8 ± 11.4</td>
</tr>
<tr>
<td>2</td>
<td>2010</td>
<td>Spring</td>
<td>8</td>
<td>1.7 5.3</td>
<td>2.9 ± 1.2</td>
<td>129</td>
<td>3 28</td>
<td>16.1 ± 9.1</td>
</tr>
<tr>
<td>3</td>
<td>2009</td>
<td>Fall</td>
<td>30</td>
<td>1.6 5.6</td>
<td>3.3 ± 10</td>
<td>639</td>
<td>2 54</td>
<td>21.3 ± 13.8</td>
</tr>
<tr>
<td>3</td>
<td>2010</td>
<td>Fall</td>
<td>27</td>
<td>1.6 5.2</td>
<td>3.7 ± 1.3</td>
<td>568</td>
<td>1 52</td>
<td>21.0 ± 13.1</td>
</tr>
</tbody>
</table>

3.3 2628 19 ± 2

Additionally, 7.3% sires failed completely (i.e. no calves sired) in any given breeding season.
No obvious phenotype associated with the bulls that sired no offspring
Ranch 1 single season calf output per bull

- Early (1-30 days)
- Later (31-60 days)
- Late (61+ days)

# of calves born/bull – Fall 2009 calving
Calf output was moderately repeatable, and correlated with Scrotal Circumference EPD

Using the 20 bulls that were in use for 2 or 3 breeding seasons (Figure 2), on Ranch 1 and 2 calculated the repeatability of 5 traits between their 1st and 2nd breeding season.

Repeatability

- total adjusted weaning weight $r=0.50$
- number of calves $r=0.50$
- mean adjusted weaning weight $=0.675$

Also analyzed calf output repeatability between the same bulls from the single Fall calving group on Ranch 3 in years 1 and 2 (Figure 3).

Repeatability

- number of calves $r=0.33$

Sire output as total adjusted weaning weight and number of calves were not well correlated to Angus Association growth EPDs but had moderate correlation to scrotal circumference EPDs ($r=0.42$ & $0.38$; $n=5$), respectively.
BUT DOES IT PAY?
Modeled the savings from using DNA information to cull non-prolific bulls

Assumptions

- Bulls used for 4 years (bought at 18 months of age, used until culled for age at 5 ½ years old)
- Average prolificacy of bulls which do produce calves: 20 ± 2 calves/bull (i.e. average prolificacy across the battery is 18.6 calves/bull)
- Percent of bulls which produced no calves: 7%
- 1 breeding season per year
- Bull premature death rate: 1%
- Bull injury rate: 3%
- Average age at injury: 4 years
- Annual vet costs: $75/year, $25 if bull died prematurely mid-year
- Salvage value
  - Non-injured $2000
  - Injured $1000
- Cost of trucking bull to sale: $50
- Selling commission: $20
What was modeled?

- Paternity test
  - Performed once on the entire bull battery (all bulls and calves tested)
  - Paternity test price (/head): $10, $15, or $20
  - Bulls are not replaced if they are culled for poor prolificacy
- Bull Purchase price: $3500, $4500, or $5500
- Annual feed costs per bull: $425, $525, or $625
- Bulls sired an average of 20 calves per year
Bull costs

In a herd with 7% of bulls consistently producing no calves and the rest of the bulls producing 20 calves/calf crop on average:

The average bull will be used 3.94 years (3 years, 11 months) and produce a total of 73 calves over his productive life.

<table>
<thead>
<tr>
<th>Bull Purchase Price</th>
<th>Annual Feed Costs/ Bull</th>
<th>Average Lifetime Bull Costs (Total)</th>
<th>Average Lifetime Bull Costs/ Calf Produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>$3500</td>
<td>$425</td>
<td>$3,583.18</td>
<td>$48.96</td>
</tr>
<tr>
<td>$3500</td>
<td>$525</td>
<td>$3,976.71</td>
<td>$54.33</td>
</tr>
<tr>
<td>$3500</td>
<td>$625</td>
<td>$4,370.25</td>
<td>$59.71</td>
</tr>
<tr>
<td>$4500</td>
<td>$425</td>
<td>$4,583.18</td>
<td>$62.62</td>
</tr>
<tr>
<td>$4500</td>
<td>$525</td>
<td>$4,976.71</td>
<td>$68.00</td>
</tr>
<tr>
<td>$4500</td>
<td>$625</td>
<td>$5,370.25</td>
<td>$73.37</td>
</tr>
<tr>
<td>$5500</td>
<td>$425</td>
<td>$5,583.18</td>
<td>$76.28</td>
</tr>
<tr>
<td>$5500</td>
<td>$525</td>
<td>$5,976.71</td>
<td>$81.66</td>
</tr>
<tr>
<td>$5500</td>
<td>$625</td>
<td>$6,370.25</td>
<td>$87.04</td>
</tr>
</tbody>
</table>
Additional cost of paternity testing

In a herd with

- 7% of bulls consistently producing no calves
- The rest of the bulls producing 20 calves/calf crop on average
- Purchase price $3500 - Average annual feed costs $425

For cull rates up to 25% (1 in 4 bulls tested) and paternity tests costing $10-$20/head, the cost of testing is always greater than the $ saved by culling low prolificacy bulls.
What does it take to make paternity testing pay?

Assumptions:

- 7% of zero prolificacy bulls
- Other bulls producing 20 calves/calf crop on average
- Purchase price $4500
- Paternity test price $15/head
- Testing the whole battery and all calves once

What paternity test price would it take to reach break-even at 7% and 25% cull rates?

<table>
<thead>
<tr>
<th>Cull Rate</th>
<th>Annual Feed Costs/Bull</th>
<th>Paternity Test Cost/head</th>
</tr>
</thead>
<tbody>
<tr>
<td>7%</td>
<td>$425</td>
<td>$0.76</td>
</tr>
<tr>
<td>7%</td>
<td>$525</td>
<td>$0.89</td>
</tr>
<tr>
<td>7%</td>
<td>$625</td>
<td>$1.01</td>
</tr>
<tr>
<td>7%</td>
<td>$825</td>
<td>$1.28</td>
</tr>
<tr>
<td>25%</td>
<td>$425</td>
<td>$4.05</td>
</tr>
<tr>
<td>25%</td>
<td>$525</td>
<td>$4.62</td>
</tr>
<tr>
<td>25%</td>
<td>$625</td>
<td>$5.18</td>
</tr>
<tr>
<td>25%</td>
<td>$825</td>
<td>$6.32</td>
</tr>
</tbody>
</table>
There are other advantages of DNA-based paternity testing. The use of multi-sire breeding pasture is desirable because:

- Higher fertility
- Elimination of sire failure
- Tighter calving season

- Reduces the need for different breeding pastures
  - Allows for better pasture management
  - Less sorting and working of animals into different groups

**DNA testing enables**

- Can use it determine which bull is causing calving problems
- Enables the development of commercial-ranch genetic evaluations
Summary and some learnings along the way

1. Bulls produced average of 19 calves (large variation)
   - Calf output was moderately repeatable (~0.33-0.5)
   - Prolific bulls tended to remain prolific, low tended to stay low
2. 7% of bulls had no calves – 1 in 14
3. Do not use yearling bulls in with older bulls - older bulls will be dominant and chance of injury goes up
4. Heifer bulls (low CED) often ended up as mature cow bulls despite having been selected on CED!!
5. There are few EPDs for selection on reproduction
6. Crossbreeding still works! And would be expected to improve reproduction traits also
7. Paternity testing on commercial ranches for sire failure needs to be inexpensive to be cost-effective
USDA Integrated Grant Collaborators

“Integrating DNA information into Beef Cattle Production Systems”

Producer Collaborators:
- Jack Cowley, Cowley Rancher, Siskiyou County, CA
- Dale, Greg, and Richard Kuck, Kuck Ranch, Siskiyou County, CA
- Matt Parker, Mole-Richardson Ranch, Siskiyou County, CA

Processor Collaborators:
- Harris Ranch Beef Company, Coalinga, CA
- Los Banos Abattoir, Los Banos, CA

Graduate Students
- Kristina Weber, Ph.D. Candidate, UC Davis, CA

Other Contributors/Collaborators
- Dr. Jerry Taylor, University of Missouri, MO
- Dr. Mike Goddard, University of Melbourne and Victorian DPI, Australia
- Dr. Darrh Bullock, Extension Professor, University of Kentucky, KY
- Dr. Leslie “Bees” Butler, Extension Marketing Specialist, UC Davis, CA
- Dr. Daniel Drake, University of California Cooperative Extension Livestock Advisor, CA
- Dr. Dorian Garrick, Professor, Iowa State University, IA
- Dr. John Pollak, US Meat Animal Research Center, Clay Center, NE
- Dr. Mark Thallman, US Meat Animal Research Center, Clay Center, NE

Software Collaborators:
- Jim Lowe, Cow Sense Herd Management Software, NE
“This project is supported by National Research Initiative Grant no. 2009-55205-05057 to AVE from the USDA National Institute of Food and Agriculture.”
Additional cost of paternity testing

In a herd with

- 7% of bulls consistently producing no calves
- The rest of the bulls producing 20 calves/calf crop on average
- Purchase price $3500 - Average annual feed costs $425

For cull rates up to 25% (1 in 4 bulls tested) and paternity tests costing $10-$20/head, the cost of testing is always greater than the $ saved by culling low prolificacy bulls.