Integrating biotechnologies for the beef cattle industry

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Animal Science Seminar 1/28/2008
Paternity analysis in large commercial cattle ranch setting

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http://animalscience.ucdavis.edu/animalbiotech/
2006 Cowley Parentage Trial

- Blood collected on FTA cards
- 213 calves
- 19 bulls
- Assigned 85.5%
- Number of calves per bull 1-22
- 2 bulls sired 23%
- 5 bulls sired 50%
Bull output varies a lot!

Calf Output per Bull

<table>
<thead>
<tr>
<th>Bull ID</th>
<th>No. Calves</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;1-8&quot;</td>
<td>22</td>
</tr>
<tr>
<td>&quot;01&quot;</td>
<td>20</td>
</tr>
<tr>
<td>&quot;614&quot;</td>
<td>17</td>
</tr>
<tr>
<td>&quot;292&quot;</td>
<td>17</td>
</tr>
<tr>
<td>&quot;1-6&quot;</td>
<td>16</td>
</tr>
<tr>
<td>&quot;0-5&quot;</td>
<td>15</td>
</tr>
<tr>
<td>&quot;1-7&quot;</td>
<td>14</td>
</tr>
<tr>
<td>&quot;302&quot;</td>
<td>13</td>
</tr>
<tr>
<td>&quot;9-3&quot;</td>
<td>11</td>
</tr>
<tr>
<td>&quot;1-11&quot;</td>
<td>10</td>
</tr>
<tr>
<td>&quot;616&quot;</td>
<td>8</td>
</tr>
<tr>
<td>&quot;174&quot;</td>
<td>7</td>
</tr>
<tr>
<td>&quot;1-3&quot;</td>
<td>5</td>
</tr>
<tr>
<td>&quot;1-2&quot;</td>
<td>4</td>
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<tr>
<td>&quot;0-6&quot;</td>
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<td>3</td>
</tr>
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<td>&quot;3-3&quot;</td>
<td>2</td>
</tr>
</tbody>
</table>
Carcass value varies a lot!
Gross income varies a lot!
Prather Ranch – Macdoel
Northern California
DNA Sample Collection

- Blood collected on FTA cards from 27 herd sires and 624 calves derived from a multiple-sire pasture
- DNA also collected from semen straws from 8 AI sires
- After AI, entire herd was run as one group with the 27 herd sires
Genotyping and paternity assignments based on microsatellites (STRs) were done by the UC Davis Veterinary Genetics Laboratory using a panel of 23 cattle markers ($P_E = 99.9\%$)

Genotyping based on SNPs were done by a commercial genotyping company using a panel of 28 loci $\$9.99/\text{sample}$ ($PE = 95.5\%$)
Results of the paternity analysis
**Animal Biotechnology and Genomics Education**

<table>
<thead>
<tr>
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<th>23 Microsatellite (STR) panel</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>One possible sire</strong></td>
<td>533*</td>
</tr>
<tr>
<td><strong>More than one sire</strong></td>
<td>4</td>
</tr>
<tr>
<td><strong>All excluded</strong></td>
<td>76</td>
</tr>
<tr>
<td><strong>Resubmits</strong></td>
<td>11</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>624</td>
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</table>

(PE=99.9%)

- DNA from more than one animal

* 10 assignments allowed a one locus mismatch
### Animal Biotechnology and Genomics Education

#### 23 Microsatellite (STR) panel (PE=99.9%) vs. 28 SNP panel (PE=95.5%)

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</tr>
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<td>420</td>
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<tr>
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<td>29</td>
</tr>
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* 10 assignments allowed a one locus mismatch

animal biotechnology and genomics education
Unambiguous Assignment of Calves to a Single Sire Using a 28 SNP Panel versus a 23 STR Panel

Number of bulls in pasture

% Offspring assigned

28 SNP PANEL (Prob. exclusion = 0.955)
23 STR PANEL (Prob. Exclusion = 0.999)
A number of the herd sires had no progeny – but SNP panel was not powerful enough to exclude them.
Many commercial companies now offering DNA-services to livestock producers.
Current listing of DNA companies maintained on “UC Davis Animal Biotechnology” website

http://animalscience.ucdavis.edu/animalbiotech
What is a Genetic Marker?

A DNA sequence variation that has been associated with a given trait in one or more populations.
Companies that are offering DNA tests for marker-assisted selection for beef cattle traits
Marker-assisted selection (MAS)

The process of using the results of DNA-marker testing to predict the genetic merit of the animal being tested and assist in the selection of individuals to become parents in the next generation. The word “assisted” implies that the selection is also influenced by other sources of information, such as animal’s observed performance and EPD.
Tests for quantitative traits – currently 10-100 SNPs

- Meat Tenderness
- Quality Grade (Marbling)
- Beef Cattle Feed Efficiency
- Meat Yield
- Disease Resistance
- Dairy Form
- Milk and Milk Component Yield
Producer outreach on MAS
Many unvalidated MAS tests are available and more are coming ....

- **Bovigen** – feed efficiency
  - “GeneSTAR® Feed Efficiency consists of four markers which together identify as much as a 15% difference in daily feed consumption with no effect on other traits like Average Daily Gain, Carcass Weight, Quality Grade or Yield Grade” according to company website

- **Igenity** - Yield Grade, Fat thickness, Marbling, Hot carcass weight, Ribeye area

- **MMI** – Average daily gain (not available yet)
“MAS is about to go nuclear”

- 58,000 SNP bovine CHIP array is now available (Illumina 58k bovine panel)
- This single enormous test panel which costs ~ $500 per animal will immediately characterize the entire genome and estimate the value of every chromosome fragment contributing variation in a population with phenotypic observations.
USDA Announces New Funding for Whole Genome Animal Selection

CSREES announced November 7 that $5 million will be available in Fiscal Year 2008 for a 4-year research project to investigate methods of using whole genome enabled animal selection. This research will enable animal breeders to use genetic information to predict what an animal's physical makeup will be and what genes will be passed to the next generation.

To capitalize on this exciting area of science, CSREES and the Agricultural Research Service developed the *Blueprint for USDA Efforts in Agricultural Genomics 2008-2017*. Whole genome enabled animal selection was identified as a high-priority research focus. This program is expected to take advantage of recent advances in genomics and translate these basic discoveries and knowledge to practical applications. CSREES is funding this project under the National Research Initiative's 2008 Request for Applications. Peter Burfening, CSREES national program leader for animal genomics in Competitive Programs Unit, developed this new project and will coordinate the new funding opportunity. Visit the CSREES Newsroom to read USDA Announces New Funding for Whole Genome Animal Selection release.
This is a young industry....
An animal is born and tagged...
DNA from uniquely IDed calf will be run through a 50000 SNP panel of

- unique permanent genetic fingerprint,
- genetic tests for 50,000 markers linked to economically relevant traits, and to
- confirm parentage.

Genotype data then stored for future traceback of products derived from that animal, and incorporated into herd and breed EPD calculations.
...and animal is then managed according to genetic potential.

Results are used to make decisions regarding:

- Markets
- Feeding strategies
- Health product requirements
- Breeding decisions – guide selection and replacement choices. Which bulls are producing good calves, no calves? Which bull should be used with each heifer calf to maximize her offspring’s performance.
Development of an Integrated Animal Identification and Tracking System for Research and Extension Education

$80,000 ANR Core Issues Grant
The animal identification does not go with the animal – lost at processing
Sierra Cow-Calf Operation

DNA Tag too
UC Davis Feedlot Operation
Los Banos Processing Plant
Carcass Data
Psion reader scans EID and carcass data is entered
Questions?