"We believe DNA marker profiles will become widely used in livestock in the near future as the cost decreases and the benefits increase. In fact, a major research objective may be to make best use of this DNA data in commercial animal production."

“How do you make cost-effective use of DNA information in commercial animal production?”

GOAL: Determine how DNA-based information is best incorporated into commercial cattle production systems

1. Which of several incorporation methods is best?
2. Which is feasible for commercial ranches to use?
3. Which provides the most/any economic benefit?

- **Research objectives**: Determine association between breed-association genetic predictions (EPDs), and DNA-based genetic predictions (stars, scores, MBVs, MVPs, GEPDs) and evaluate their ability to predict the genetic potential of 125 commercial sires based on the performance and carcass records of their offspring.

- **Extension objectives**: Develop and deliver educational materials to a national audience on the integration of DNA information into beef cattle selection programs.
Ranch resources/collaborators on “Integrating DNA information into beef cattle production systems”

Four ranches on this project (UC Davis and 3 commercial cooperators in Siskiyou Co.)

- Cowley 900 (550 Spring; 350 Fall) 45
- Kuck 500 (200 Spring; 300 Fall) 16
- Mole-Richardson 700 (Fall) 40
- UC Davis 300 (Fall) 26

Approximately 125 Angus bulls, and 2,400 cows per year on project
Happy Cows come from Siskiyou County
Cowley Ranch
UC Davis – Sierra foothills
Work flow and collaborators

- DNA on all bulls goes for 50K whole genome scan – collaboration with Jerry Taylor (MO) and John Pollak (Meat Animal Research Center (NE))
- Molecular breeding value (MBV) prediction of genetic merit based on MARC training data set – collaboration with Dorian Garrick (IA) and Mark Thallman, U.S. Meat Animal Research Center (NE)
- Ranch data including sire groupings, birth dates and weaning weights on all calves, all EIDed, and “DNAed” for parentage determination – collaboration with Dan Drake and producers (CA)
- Steer feedlot in weights, treatments, and carcass traits (Hot weight, grading information and meat sample collected in the processing plant – collaboration with Harris Ranch (CA)
- Compile data and compare three sources of genetic estimates: breed EPDs (bEPDs), commercial ranch EPDs (rEPDs), and MBVs, Kristina Weber, UC Davis, PhD student
Commercial ranch applications
Problems experienced included
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Sampling Summary by Herd: Total Number of Records

- BirthWeight: 747 records, 40% done
- WeanWeight: 2513 records, 41% done
- In weight: 1533 records, 31% done
- Carcass traits: 1048 records, 31% done

2011-2013 Sampling Completed: 41%
“Integrating DNA information into Beef Cattle Production Systems”
USDA Integrated Grant Collaborators

- 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, Professor, Cornell University, NY
- Dr. Mark Thallman, US Meat Animal Research Center, Clay Center, NE

Graduate Students
- Kristina Weber, Ph.D. Candidate, UC Davis, CA and Krista Cooprider, MS Candidate, UC Davis, CA

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

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

Software Collaborators:
- Jim Lowe, Cow Sense Herd Management Software, NE

Other Contributors/Collaborators
- Dr. Jerry Taylor, University of Missouri, MO
- Dr. Mike Goddard, University of Melbourne and Victorian DPI, Australia
DNA-based tests for cattle

- **What is working well**
  - Identification of genetic defects
  - Parentage

- **What is not working well (at present)**
  - Genetic markers for quantitative traits
  - Genomic selection in beef cattle
Genetic Defects in Cattle
Images from an article by David S. Buchanan, Department of Animal Sciences, North Dakota State University
Compare dwarfism response in the 50s to the response to curly calf (AM)

An early '50s advertisement that superimposed a measuring stick in the picture of this bull who was nick-named "Short Snorter." Based upon his height and age, he was less than a frame score 1. The choice of a nick-name in this instance was unfortunate because "snorter" dwarfism would soon devastate the purebred beef industry.

Image from https://www.msu.edu/~ritchieh/historical/shortsnorter.jpg
In 2008, September 8 – November 3 researchers identified genetic problem causing curly calf, developed AM test prototype, and released carrier status of 736 bulls by the end of the year!

- In the 10 months following the release of the test, the AAA posted the results of tests for AM on about 90,000 cattle.

- Of these, almost 5,000 bulls and more than 13,000 heifers have tested as carriers of AM. That leaves more than 22,000 bulls and more than 50,000 heifers which tested as free of AM.

- These tests generally cost less than $30. While the total cost is substantial it is miniscule when compared with the cost of simply eliminating all descendants of the widely-used GAR Precision 1680 (AA Reg. No. 11520398), and his grandsire Rito 9J9 of B156 7T26, (AA Reg. No. 9682589) from the Angus breed.
AM test can be done at the following labs

The following labs are authorized for AM
AgriGenomics
2399 N. 1000 E. Rd.
Mansfield, IL 61854
217-762-9808
http://www.agrigenomicsinc.com

Click here for Important Notice about Genetic Testing with MMI
MMI Genomics
1756 Picasso Avenue
Davis, CA 95618
(800) 311-8808 ext 3016
http://www.mmgigenomics.com/AM.html

Pfizer Animal Genetics
333 Portage Road
Kalamazoo, MI 49007-4931
1-877-BEEF DNA
1-877-233-3362
Fax: 269-833-1197
http://www.pfizeranimalgenetics.com

IGENITY
4701 Innovation Drive, CB 101
Lincoln, NE 68521
1-877-IGENITY
1-877-443-6489
http://www.igenity.com

GeneSeek
4665 Innovation Dr. Suite 120
Lincoln NE 68521
402-435-0665
www.genesseek.com

The following groups collaborate with GeneSeek, Inc., to collect and provide samples for AM testing:
- SEK Genetics
  Don Coover
  9525 70th Rd.
  Galesburg, KS 66740
don@sekgenetics.com
  Phone: 800-443-6389

- Genex Cooperative, Inc.
  Headquarters:
  100 MBC Drive
  Shawano, WI 54166
  Phone: 888-333-1783
  Fax: 715-526-3219
  info@crinet.com
From a breeding standpoint there are different possible scenarios when considering this mutation

If both parents are carriers (AMC)  \( \text{AMC} \times \text{AMC} = \)

\( \frac{1}{4} \) affected (AMA): \( \frac{1}{2} \) carriers (AMC): \( \frac{1}{4} \) AM free (AMF)

If only one parent is a carrier, then all of the offspring will be normal appearing, but half of them will be carriers

\( \text{AMC} \times \text{AMF} = \frac{1}{2} \) carriers (AMC): \( \frac{1}{2} \) AM free (AMF)

If neither parent is a carrier, \( \text{AMF} \times \text{AMF} = \)

all AM free (AMF) even if have Precision in pedigree!
Early extension education about dwarfism explaining carriers and inheritance
If you breed a curly calf carrier cow (AMC) to an curly calf free bull (AMF), what is the chance that the offspring will be stillborn as a result of being curly calf?

1. 0
2. 1/4 (25%)
3. 1/2 (50%)
4. 2/3 (66%)
5. 3/4 (75%)
6. 1 (100%)

Results from a typical producer meeting
**DNA-based tests for cattle**

**What is working well**
- Identification of genetic defects
- Parentage

**What is not working so well (at present)**
- Genetic markers for quantitative traits
- Genomic selection in beef cattle
Benefits of DNA-based parentage identification

- Correct pedigree errors so improve the rate of genetic gain
- Enables the use of multi-sire breeding pasture
  - 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
- Reduces the need to disturb newborn animals
  - Labor savings so can focus on concentrate on offspring survival
  - Worker safety improvement
  - Better bonding of offspring with dam
  - Can determine which bull is causing calving problems
- Enables the development of commercial-ranch genetic evaluations
Calf output per bull

- Late (61+ days)
- Later (31-60 days)
- Early (1-30 days)
Calf output per bull

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

# of calves born/bull – Fall 2009 calving
Breeding groups

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

# of calves born/bull – Fall 2009 calving
Preliminary correlation of EPDs

\[ y = 0.5518x - 0.1741 \]

\[ R^2 = 0.3161 \]
In excess of 30% of animals in the sire breeding tier of some livestock industries in New Zealand are currently being DNA tested for parentage.

Figure 1: Annual number of Cattle parentage tests.

DNA-based tests for cattle

What is working well
- Identification of genetic defects
- Parentage

What is not working so well (at present)
- Genetic markers for quantitative traits
- Genomic selection in beef cattle
The Power of the IGENITY® profile for Angus

The American Angus Association® through its subsidiary, Angus Genetics Inc.* (AGI), has a vision to provide Angus breeders with the most advanced solutions to their genetic selection and management needs.

Genomic-enhanced Expected Progeny Differences (EPDs) can now be calculated for your animals using the highly predictable American Angus Association database along with IGENITY® profile results to provide a more thorough characterization of economically important traits and improved accuracy on young animals.

Using the IGENITY profile for Angus, breeders receive comprehensive genomic results for multiple, economically important traits.

1. Dry Matter Intake
2. Birth Weight
3. Mature Height
4. Mature Weight
5. Milk
6. Scrotal Circumference
7. Weaning Weight
8. Yearling Weight
9. Marbling
10. Ribeye Area
11. Fat Thickness
12. Carcass Weight
13. Tenderness
14. Percent Choice (quality grade)
15. Heifer Pregnancy
16. Maternal Calving Ease
17. Direct Calving Ease
18. Docility
19. Average Daily Gain
20. Feed Efficiency
21. Yearling Height
## Lead Today with 50K

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<td>2</td>
<td>Weaning weight</td>
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<tr>
<td>3</td>
<td>Weaning maternal (milk)</td>
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<td>Calving ease direct</td>
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<td>11</td>
<td>Postweaning average daily gain</td>
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<td>12</td>
<td>Daily feed intake</td>
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<td>13</td>
<td>Feed efficiency (net feed intake)</td>
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GAR Predestined:
From start to finish—conception to carcass—no other bull in the beef business today adds as much real value to cattle as Predestined. Ranking as the #1 bull for $B in the breed—our customers tell us that their Predestined-sired cattle return the most dollars to their pockets—they know that $B works. Unlike any other 036 son, Predestined tones down size, adds depth of flank, superior feet and legs and a pleasant disposition to his offspring. His conception rate is high and he’s been a standout in timed-AI programs. His progeny look good–his bulls are thick and his heifers are fancy—and they always display additional shape and capacity. He ended 2006 as our top-seller and rightfully so—Predestined’s many talents for creating value are for real.
DNA tests for selection

Bad News

- Tests are breed specific – only Angus
- Data reporting is varied and hard to interpret
- No independent estimate of test accuracy

Good News

- Larger SNP panel (700K) might help tests work across breeds
- DNA information is stating to get integrated into EPDs (Angus)
“BIF believes that information from DNA tests only has value in selection when incorporated with all other available forms of performance information for economically important traits in NCE, and when communicated in the form of an EPD with a corresponding BIF accuracy.”
Commercially available DNA Tests for Beef Cattle (06/10)

Value of DNA Information for beef bull selection (6/10)

Are DNA tests for you? Beef Magazine (3/10)

DNA markers... Revolution or Evolution? ABS Breeders Journal (Fall/Winter 2009)

Do DNA tests work? Beef Magazine (10/09)

Basics of DNA Markers and Genotyping (6/09)

DNA-Based Progeny Testing (6/09)

Fundamentals of Expected Progeny Differences (6/09)

Marker-Assisted Selection in Beef Cattle Handout (6/09)

The Value of Improving Accuracy of Yearling Bulls (6/09)

Validation of Marker Tests (6/09)

Whole Genome Selection (6/09)

2009 Beef Improvement Federation Conference Proceedings

Curly Calf Syndrome (Arthrogryposis Multiplex (AM)) Update (2/09)

Cattlemen to Cattlemen streaming video (5/09)

“No Bull” Discussion on Genetic Markers (5/08)

“1954 version of what 'home computers' might look like in 50 years time (i.e. 2004)”
Wrong Expert Predictions

I think there's a world market for about five computers.
Thomas J. Watson, chairman of the board of IBM. 1943

There is no reason anyone would want a computer in their home.
Ken Olson, president of Digital Equipment Corp. 1977

The cost for a “large” genome scan (defined as 18 chromosomes* 7 chromosome (i.e. 126 markers!) * $4/marker) = $504
“what escaped their vision was that science might come up with new and different ways of commercializing and using new technologies.”
“This project is supported by National Research Initiative Grant no. 2009-55205-05057 from the USDA Cooperative State Research, Education, and Extension Service Animal Genome program.”
Come to Melbourne, Australia !!!
2-5 May, 2011
Questions?