"Integrating DNA Information into Beef Cattle Production Systems"

Alison Van Eenennaam, Ph.D.

Cooperative Extension Specialist

Animal Biotechnology and Genomics

Department of Animal Science

University of California, Davis

alvaneenennaam@ucdavis.edu

(530) 752-7942

http://animalscience.ucdavis.edu/animalbiotech

Expert Predictions

"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"

Goddard, M. E., and B. J. Hayes. 2007. Genomic selection. Journal of Animal Breeding and Genetics 124: 323-330.

"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?**

- **<u>Research objectives</u>**: 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

- **<u>Extension objectives</u>:** 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

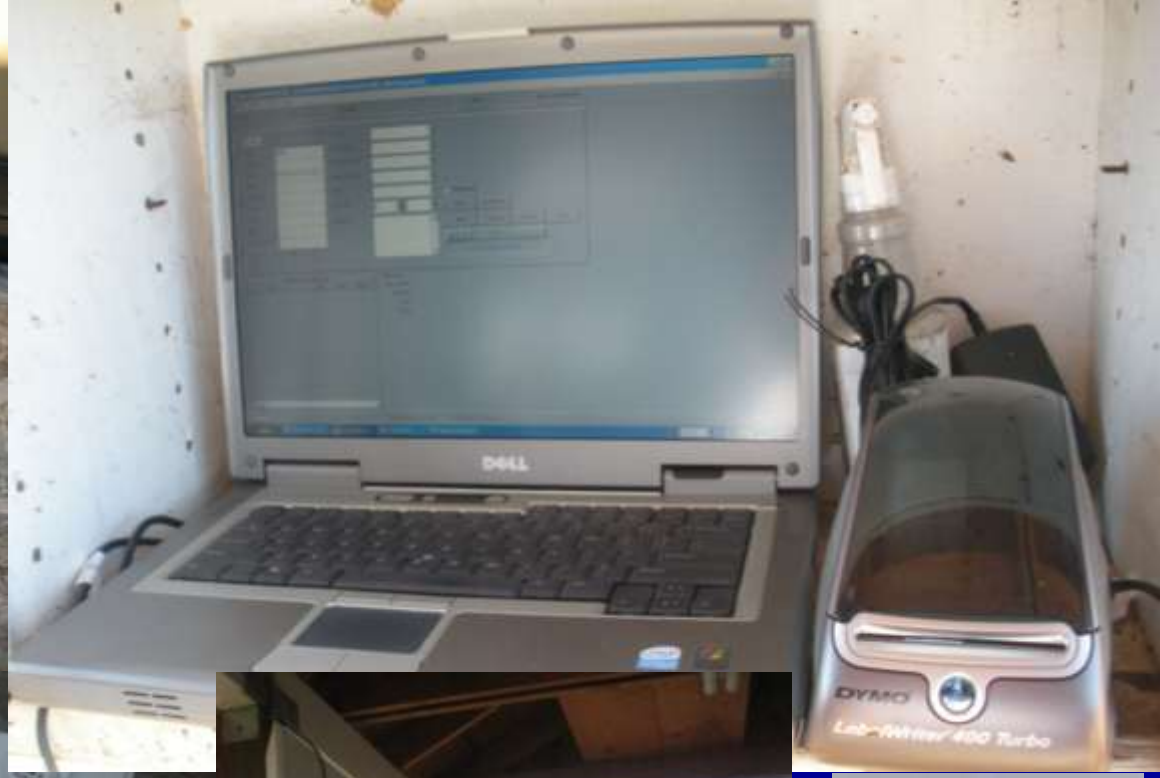
Kuck Ranch

Mole-Richardson Farms

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


DELL
DYMO


212
8400030048835 80
10/21/2008

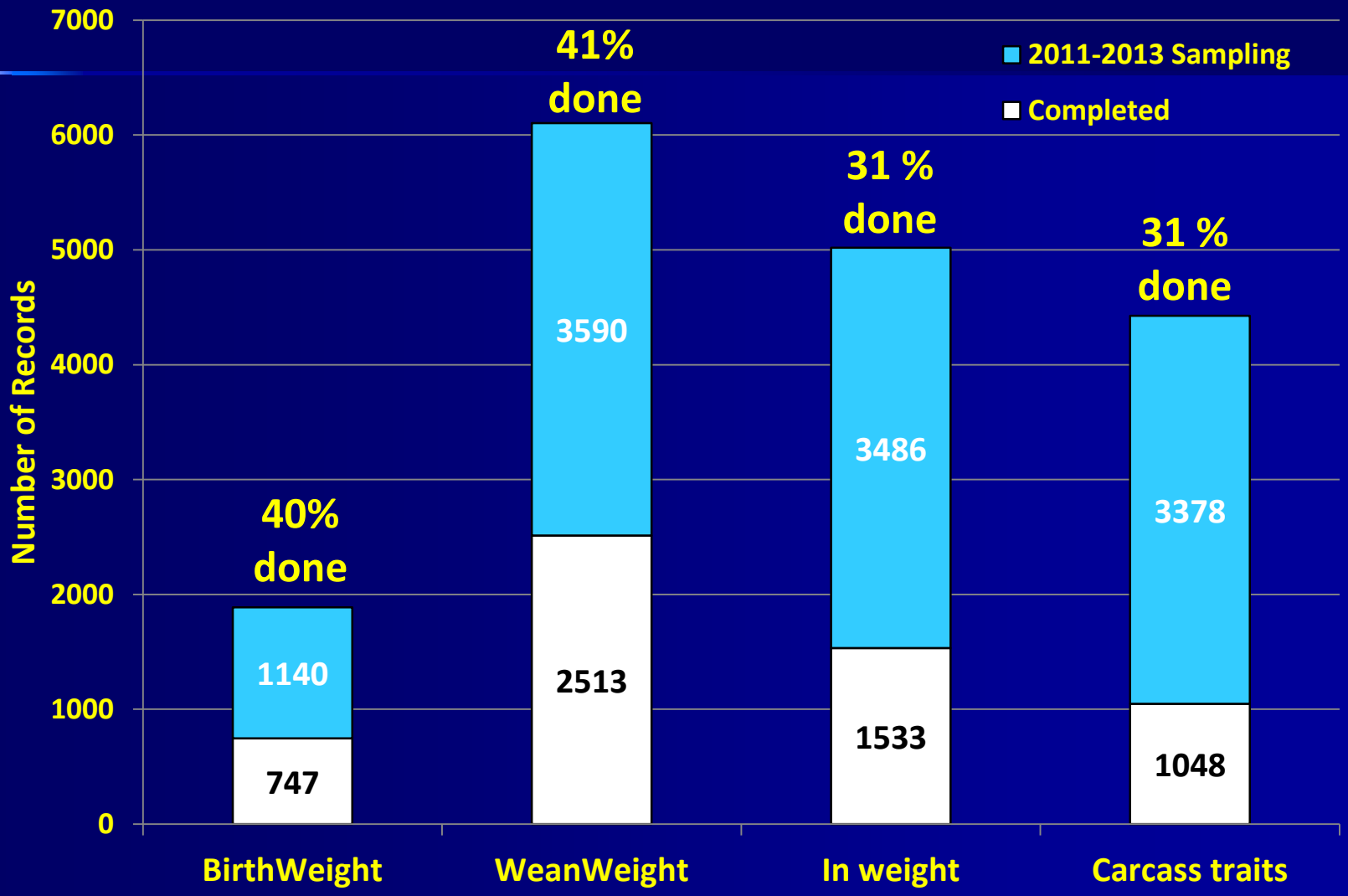
Commercial ranch applications

Problems experienced included

Sampling Summary by Herd: Data Collected to date

Herd	Season	Birth Weight	WeanWeight	In weight	Carcass traits
Cowley	1/4/2006	--	--	--	Completed
	9/1/2006	--	--	--	Completed
	1/1/2007	--	--	--	Completed
	9/1/2007	--	Completed	Completed	Completed
	1/1/2008	--	Completed	Completed	Completed
	9/1/2008	--	Completed		Completed
	1/1/2009	--	Completed		Scheduled 1/24/2011
	9/1/2009	--	Completed	Completed	
	1/1/2010	--	Completed		
	9/1/2010	--			
	1/1/2011	--			
	9/1/2011	--			
Kuck	1/1/2009	Completed	Completed	Completed	
	10/1/2009	Completed	Completed		
	1/1/2010	Completed	Completed		
	9/1/2010				
	1/1/2011				
	9/1/2011				
Mole-Richardson	9/1/2009	--	Completed	Completed	
	9/1/2010	--			
	9/1/2011	--			
UC Davis	8/15/2009	Completed	Completed		--
	8/15/2010				--
	8/15/2011				--

Sampling Summary by Herd: Total Number of Records



"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

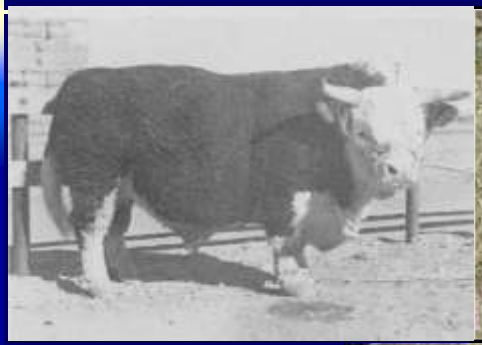
DNA-based tests for cattle

- **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

http://www.ag.ndsu.edu/williamscountyextension/livestock/genetic-defects-in-cattle



Compare dwarfism response in th 50s to the response to curly calf (AM)

An early '50's 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.mmigenomics.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.geneseek.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
- Stockman's Resource Center LLC
  2371 330th Street
  Eddyville, Iowa 52553
  stockmansresource@hotmail.com
  www.stockmansresource.com
  Office phone: 641-969-4111
  Mobile: 641-660-0771
- 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) **AMC x AMC =**
¼ affected (AMA): ½ carriers(AMC): ¼ 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
AMC x AMF = ½ carriers (AMC): ½ AM free (AMF)

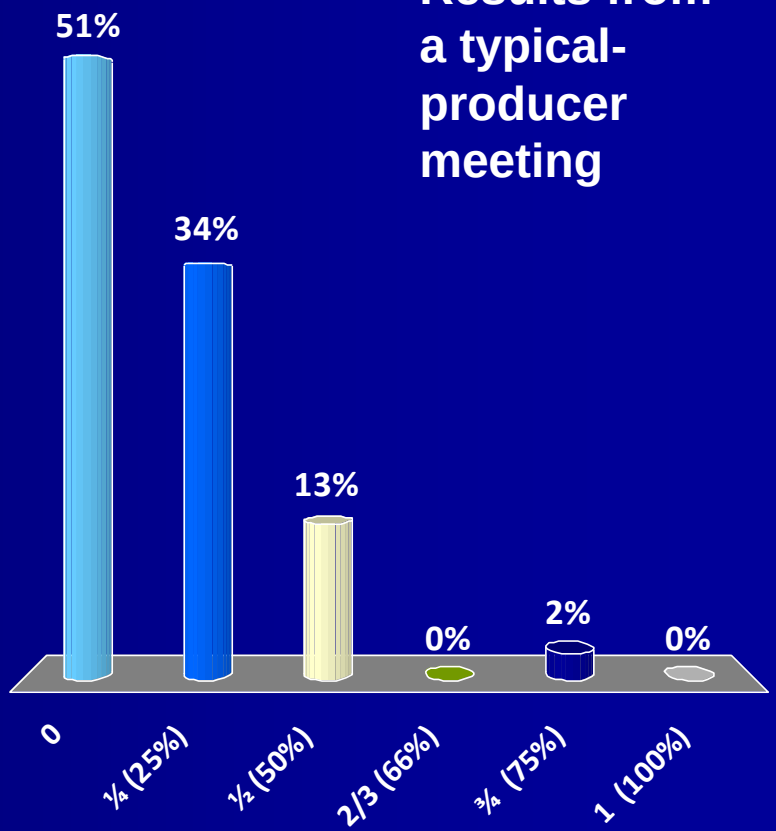
If neither parent is a carrier, **AMF x AMF =**
all AM free (AMF) even if have Precision in pedigree!

Early extension education about dwarfism explaining carriers and inheritance

Image from Special CollectionsUniversity Libraries, Virginia Tech:
http://spec.lib.vt.edu/imagebase/agextension/boxseven/screen/AGR3618.jpg

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. ¼ (25%)
3. ½ (50%)
4. 2/3 (66%)
5. ¾ (75%)
6. 1 (100%)



DNA-based tests for cattle

What is working well

- Identification of genetic defects
- **Parentage**

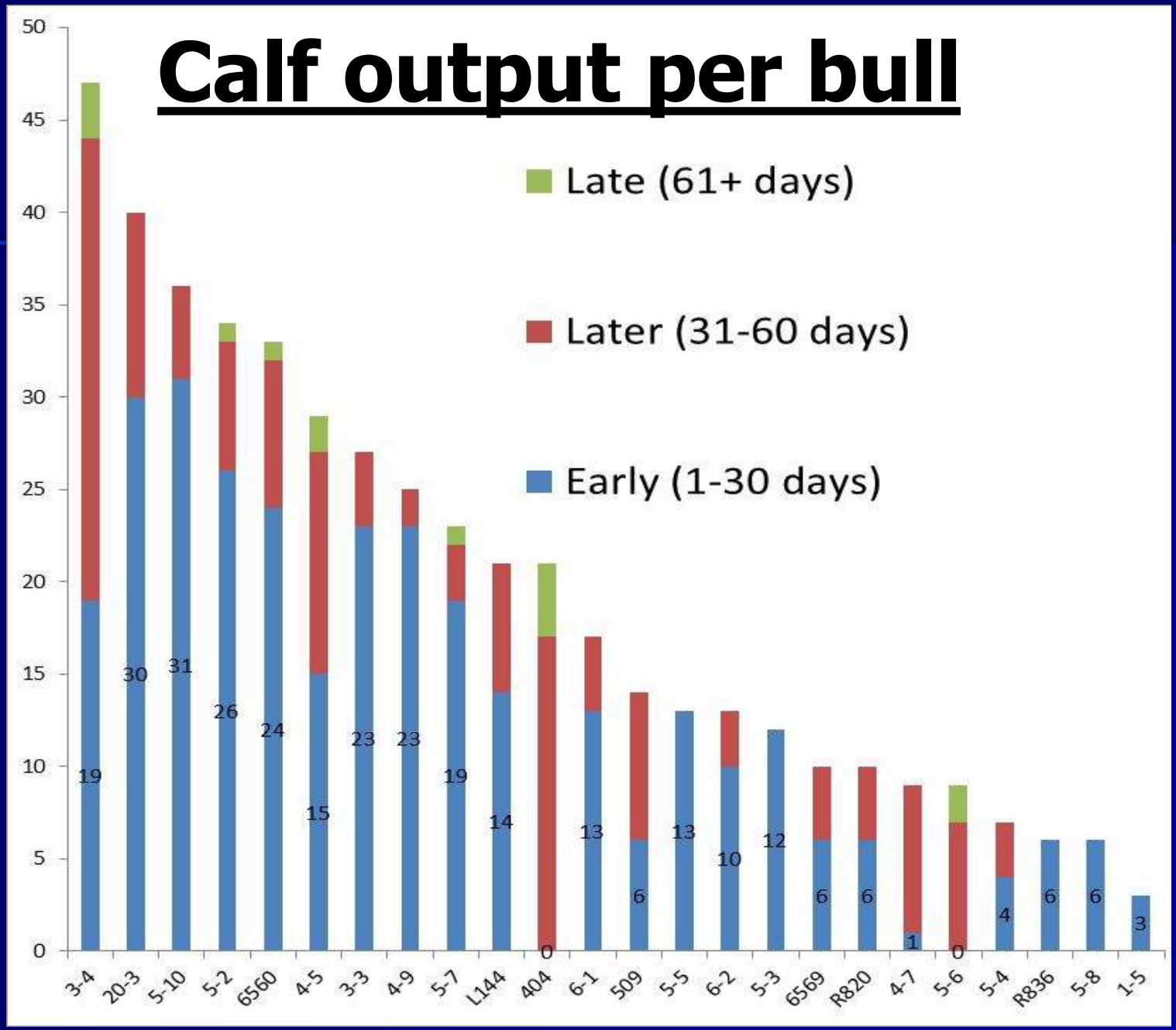
What is not working so well (at present)

- Genetic markers for quantitative traits
- Genomic selection in beef cattle

Benefits of DNA-based parentage identification

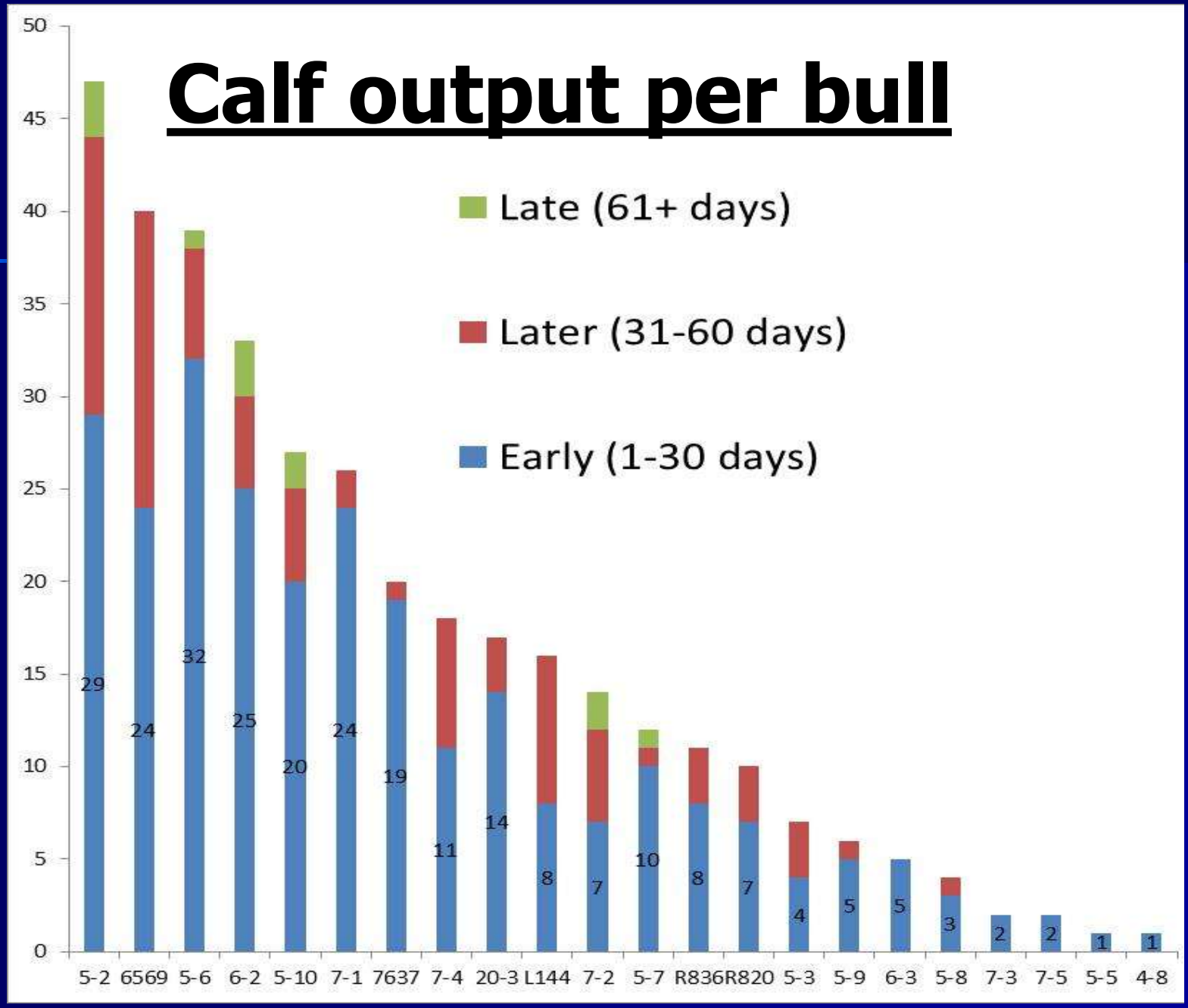
- Correct pedigree errors so improve the rate of genetic gain
- Enables the use of multi-sire breeding pasture
  - Higher fertility
  - Elimination of sire failure
  - Tighter calving season
- Reduces the need for different breeding pastures
  - Allows for better pasture management
  - Less sorting and 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



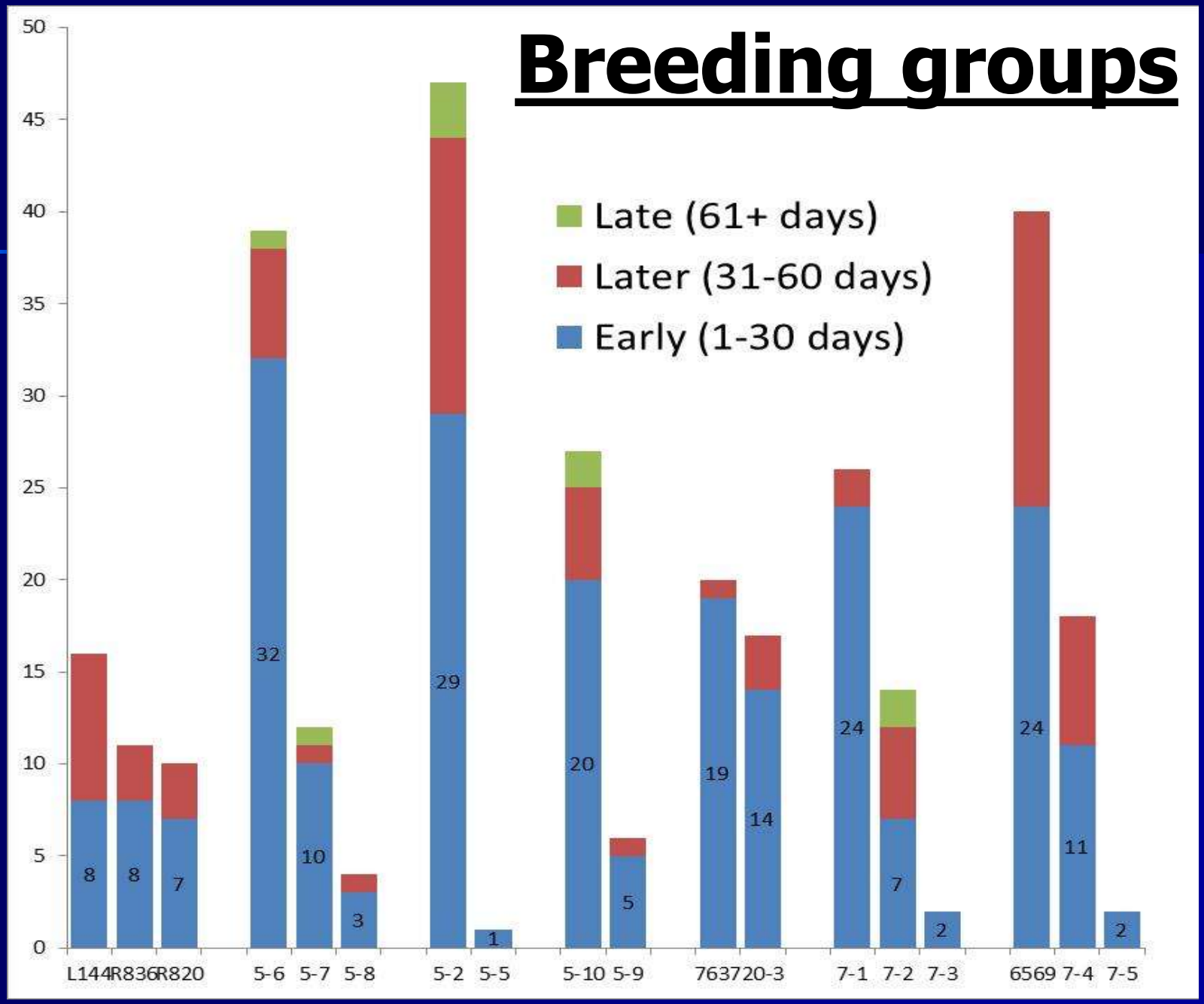
of calves born/bull – Spring 2009 calving

Calf output per bull

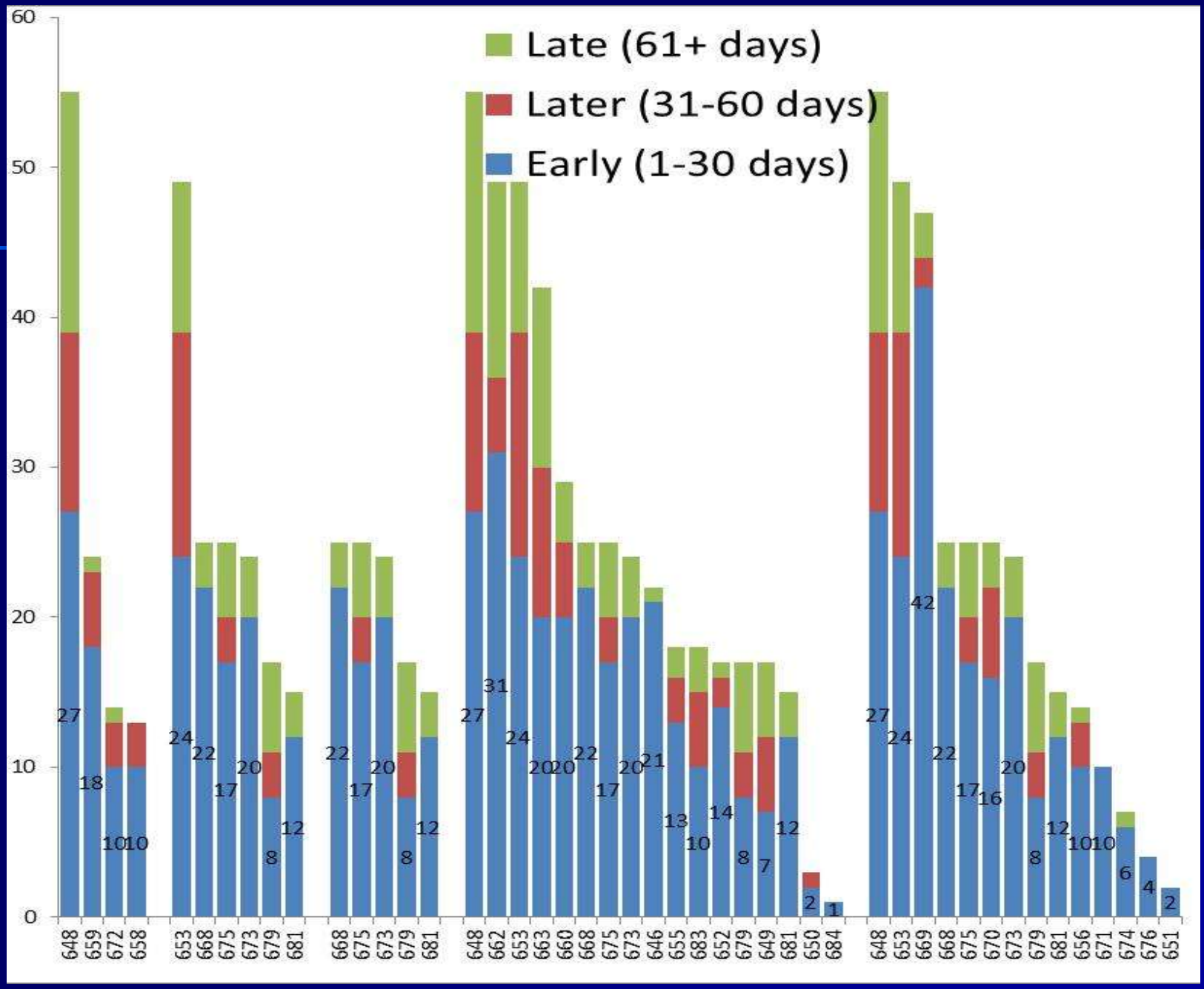


# of calves born/bull – Fall 2009 calving

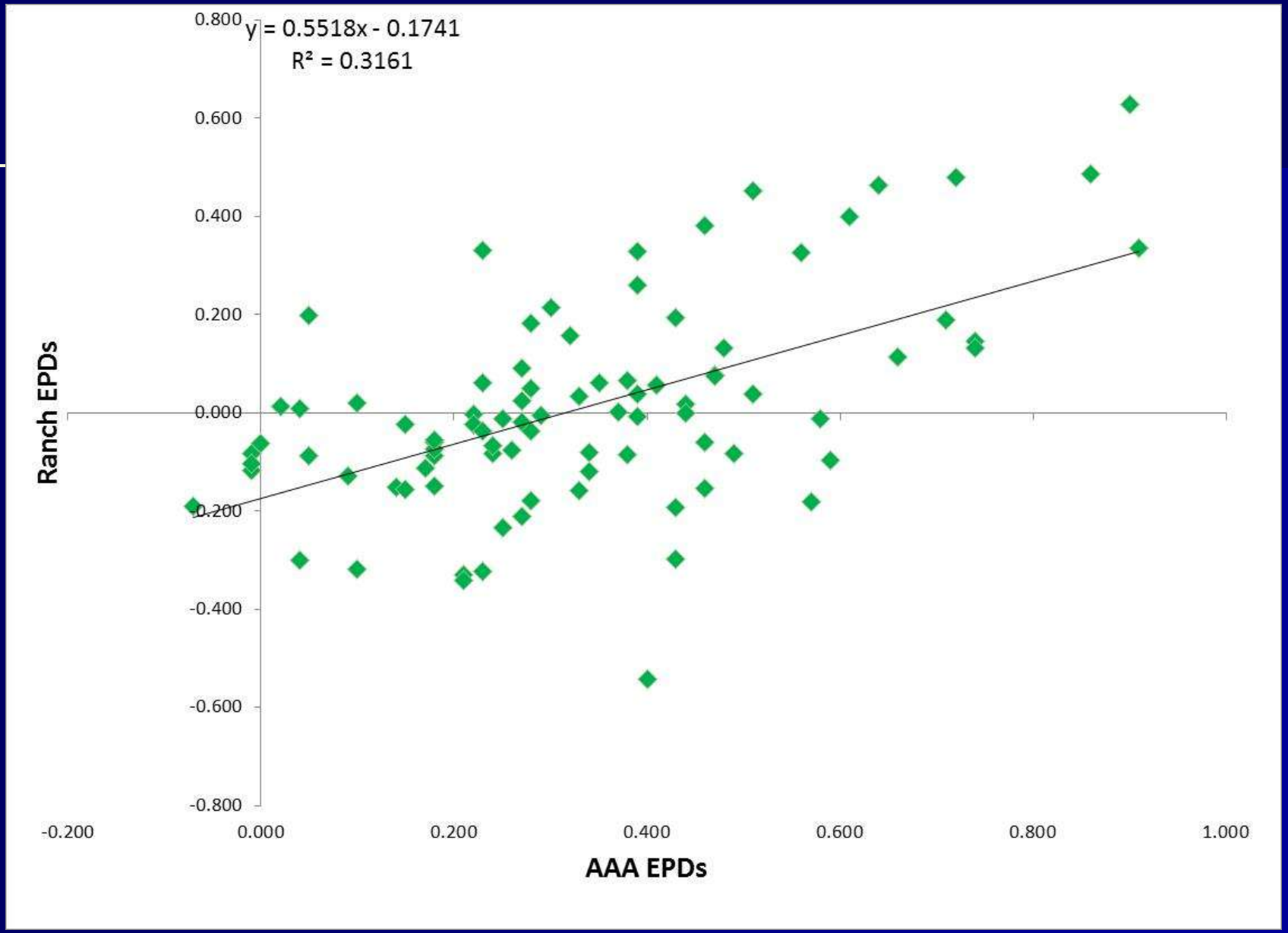
Breeding groups



of calves born/bull – Fall 2009 calving

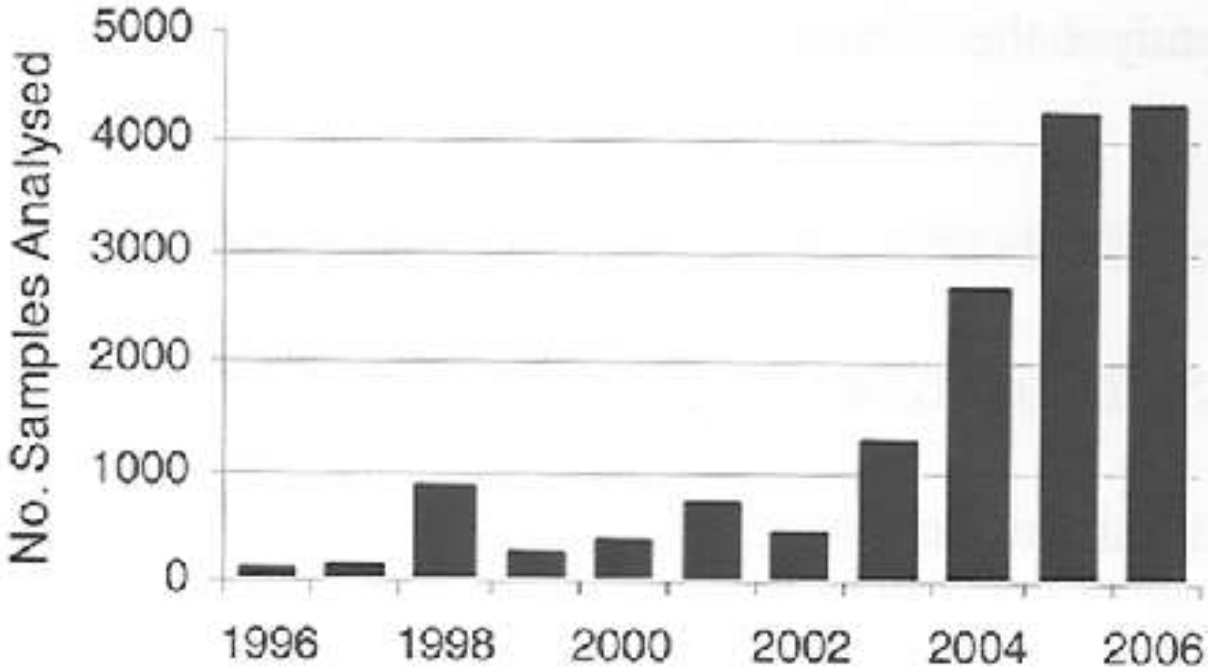


Preliminary correlation of EPDs



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.



Crawford, A. M., R. M. Anderson, and K. M. McEwan. 2007. Uptake of DNA testing by the livestock industries of New Zealand. Proceedings of the New Zealand Society of Animal Production 67:168-174

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

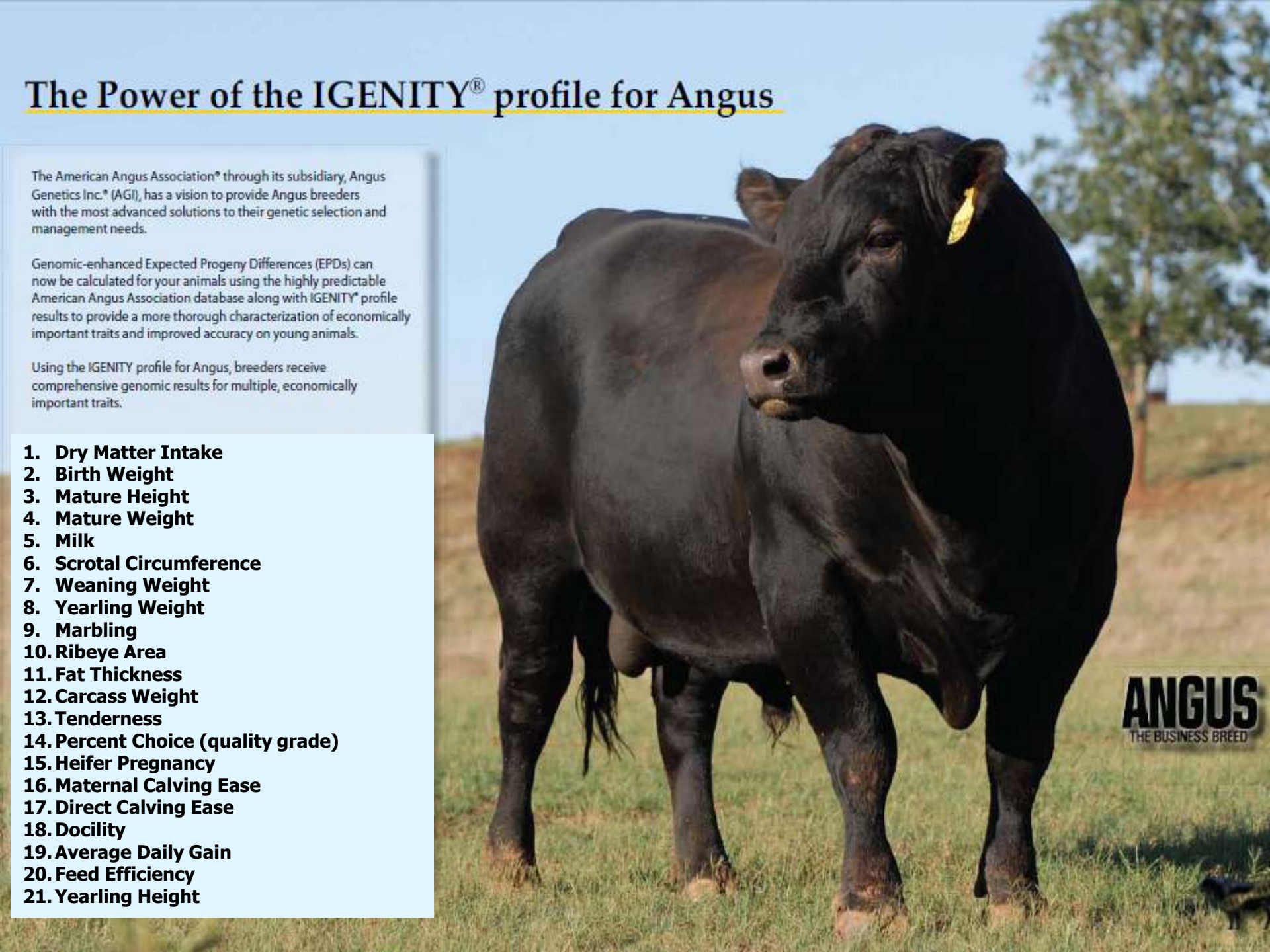
The Power of the IGENITY® profile for Angus

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

1. Birth weight
2. Weaning weight
3. Weaning maternal (milk)
4. Calving ease direct
5. Calving ease maternal
6. Marbling
7. Backfat thickness
8. Ribeye area
9. Carcass weight
10. Tenderness
11. Postweaning average daily gain
12. Daily feed intake
13. Feed efficiency (net feed intake)

Pfizer Animal Health
Animal Genetics

50K SNP chip assays
50,000 SNPs spread throughout genome

Black Angus Sire

G A R Predestined

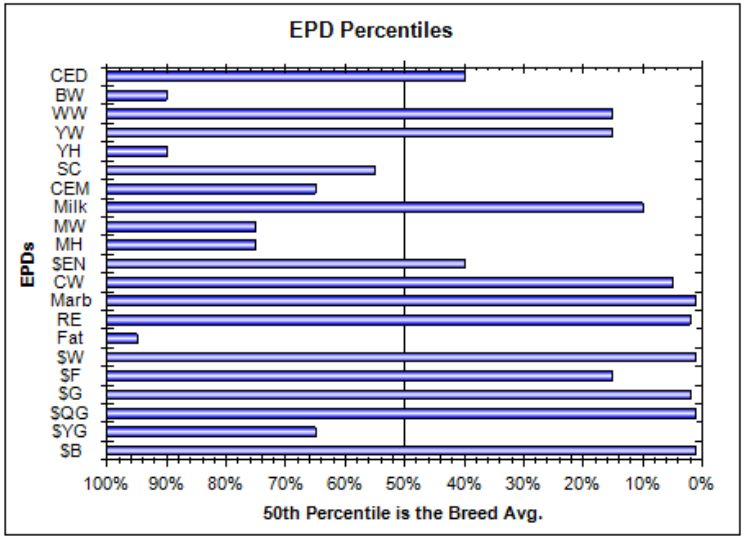
Reg. No.: 13395344
Calved: 8/16/1999
Tattoo: 5899
Semen: $25
Certificates: $20
Spring 2010 EPD

G A R 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.

Production						Maternal					
CED Acc	BW Acc	WW Acc	YW Acc	YH Acc	SC Acc	CEM Acc	Milk Acc	MkH MkD	MW Acc	MH Acc	EN$
+7 .84	+4.1 .97	+53 .96	+99 .94	+0 .96	+.31 .95	+6 .80	+28 .85	345 1135	+13 .81	+.2 .81	+5.24

Carcass					Usnd	$Values					
CW Acc	Marb Acc	RE Acc	Fat Acc	Grp Prog	UGrp UProg	Wean	Feedlot	Grid	$QG	$YG	Beef
+26 .82	+1.07 .84	+.59 .82	+.046 .81	47 261	4269 11990	37.39	37.08	38.21	35.04	3.17	69.78

GeneSeek										
QG1	na	QG2	na	QG3	na	QG4	na	QG GPD	
T1		T2	0	T3	0	-	-	T GPD	-0.35
FE1	na	FE2	na	FE3	na	FE4	na	FE GPD	



Current Sires Percent Breakdown

As of 03/22/2010

Multibreed version 2008

Registration #	Tenderness	Fat Thickness	Yield Grade	Ribeye Area	Carcass Weight	Percent Choice	Marbling
13395344	3	6	6	4	2	8	9

EPDs (CW, Marb, RE, Fat) are enhanced by genomic profiles generated by igenity.

G A R Predestined 13395344

	CED	BW	WW	YW	ADG	DMI	NFI	CEM	MA	CW	FAT	REA	MS	TND	$B/$MVP[FL]
EPD	7	4.1	53	99	-	-	-	6	28	26	0.046	0.59	1.07	-	69.78
ACC	0.84	0.97	0.96	0.94	-	-	-	0.8	0.85	0.82	0.81	0.82	0.84	-	-
EPD % Rank	**30**	**85**	**15**	**15**	**-**	**-**	**-**	**55**	**10**	**4**	**90**	**2**	**1**	**-**	**1**
MVP	13	1.0	37	-	0.45	0.97	0.04	8	33	55	0.07	0.92	1.52	-0.43	243
MVP % Rank	**3**	**70**	**10**	**-**	**30**	**90**	**90**	**4**	**1**	**1**	**90**	**1**	**1**	**80**	**1**

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)

Beef Improvement Federation (BIF)

"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."

Home | My Lab | Genomics | Biotechnology | Outreach | Fact Sheets | Marker Assisted Selection

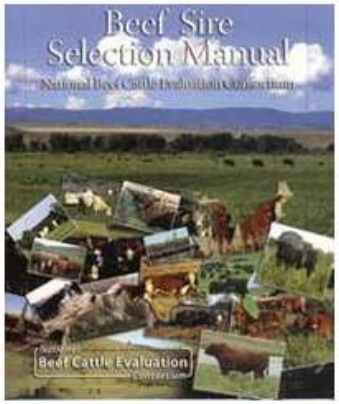
Animal Biotechnology

Marker-Assisted Selection and Breeding

UCDAVIS University of California, Davis

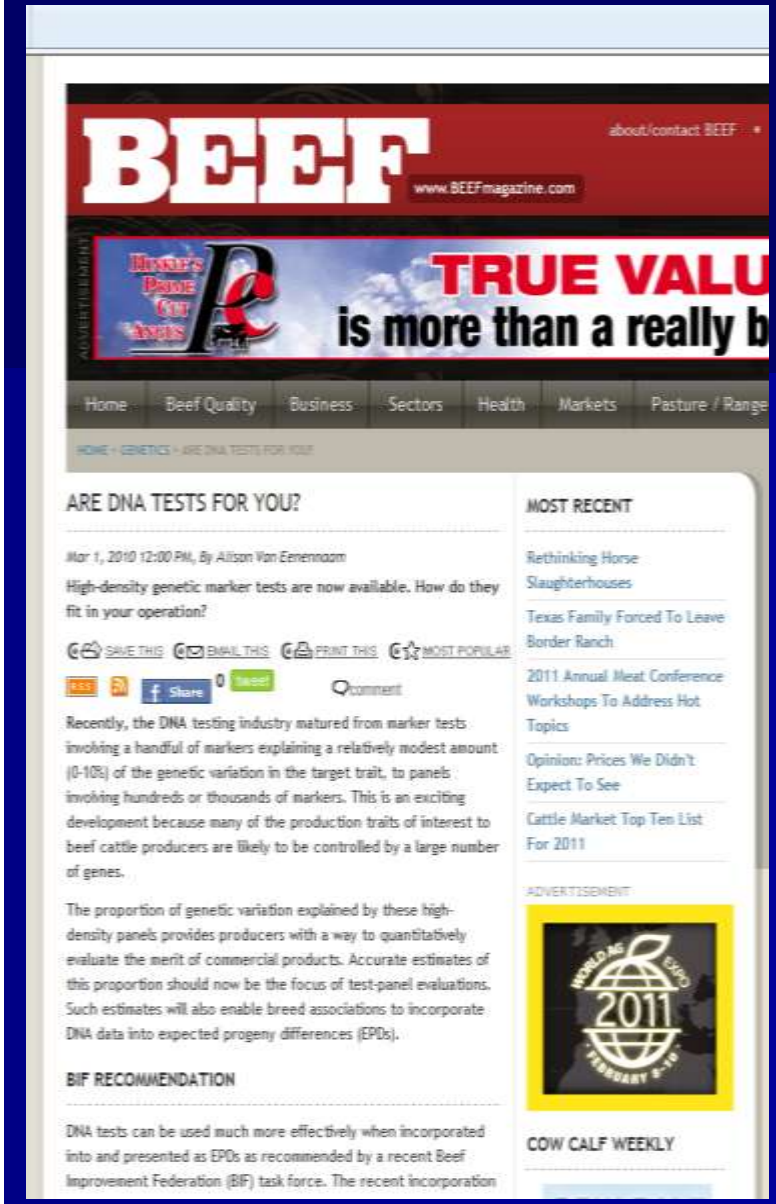
Alison L Van Eenennaam

Biotechnology | Cloning | Transgenics | Concerns | Marker-Assisted Selection | DNA Companies



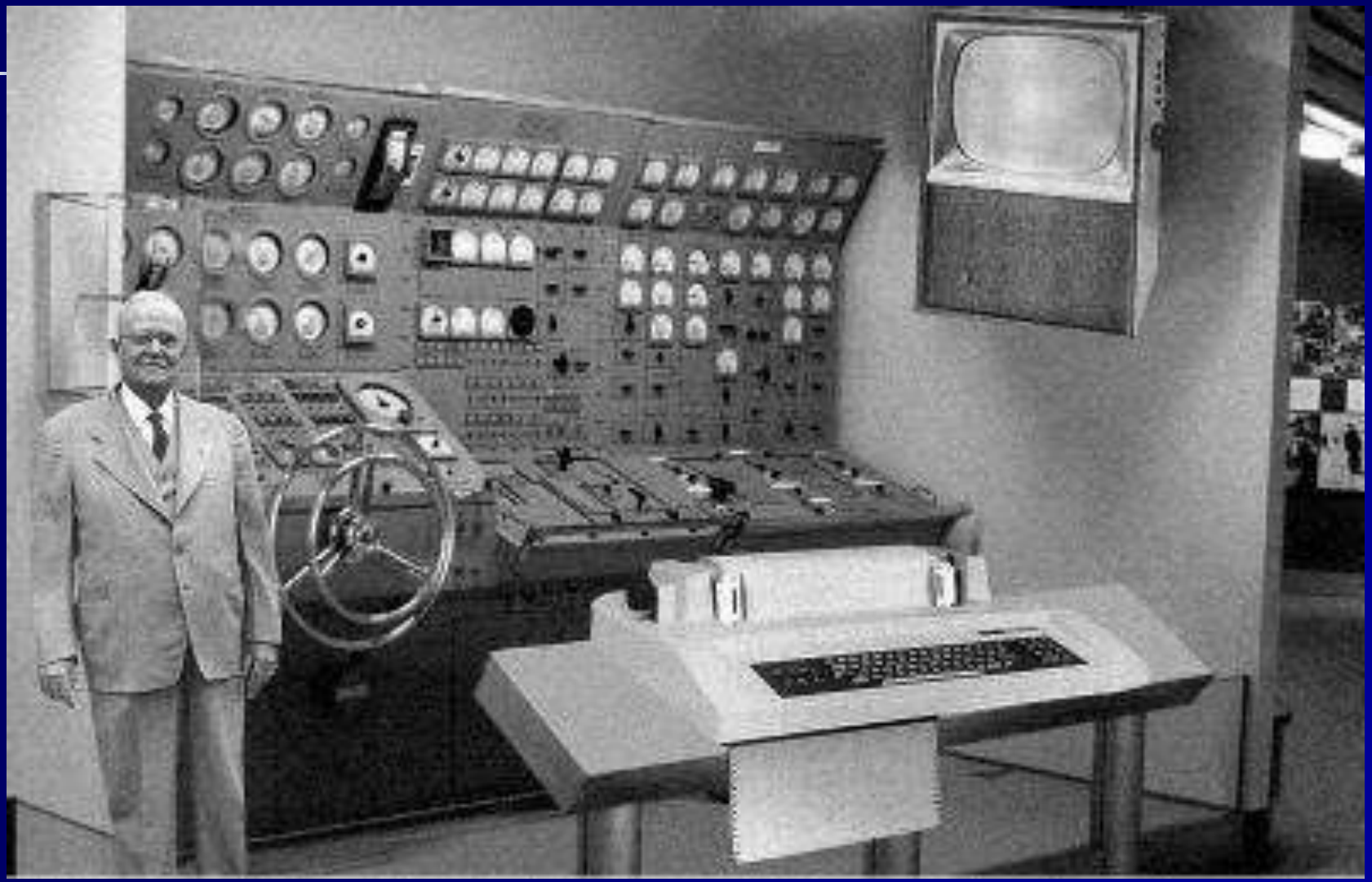
NBCEC Beef Sire Selection Manual - National Beef Cattle Evaluation Consortium (2010) ***UPDATED 2010***

- Commercially-available DNA Tests for Beef Cattle (06/10) NEW!
- Value of DNA Information for beef bull selection (6/10) NEW!
- Are DNA tests for you? *Beef Magazine* (3/10) NEW!
- 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 (5/08)
- "No Bull" Discussion on Genetic Markers (5/08)



http://animalscience.ucdavis.edu/animalbiotech/Biotechnology/MAS/index.htm

"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

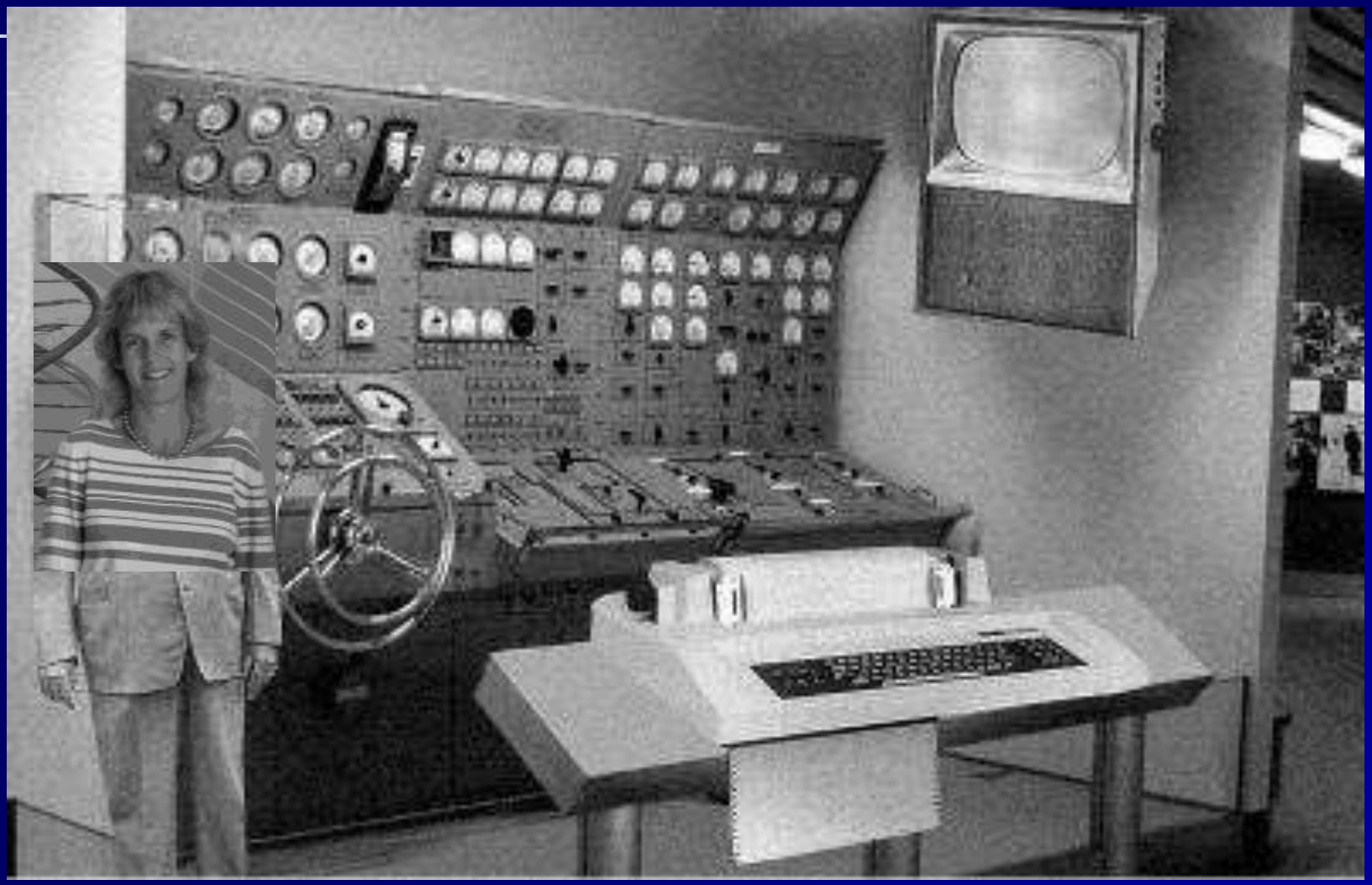
There is no reason anyone would want a computer in their home.

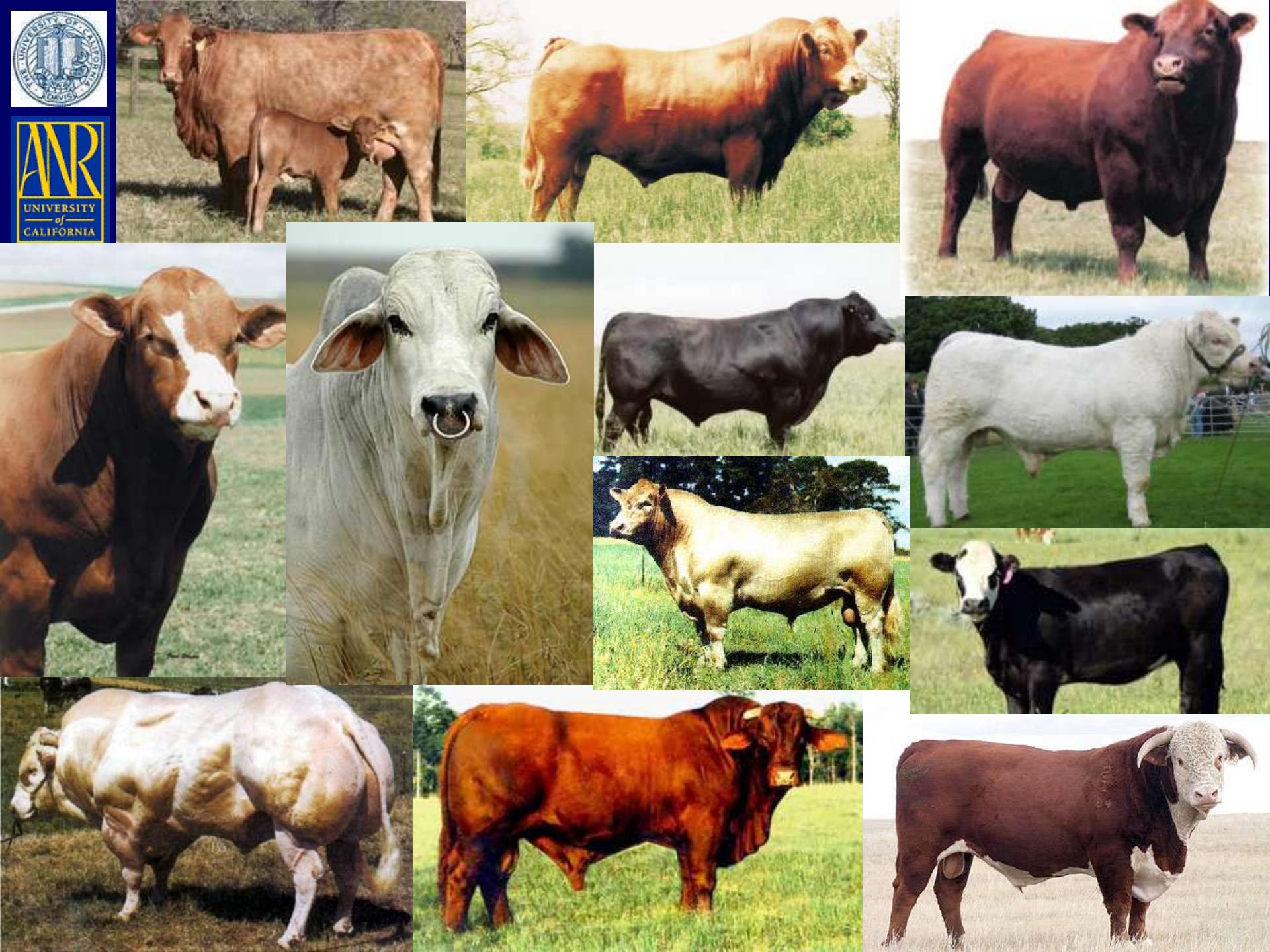
Ken Olson, president of Digital Equipment Corp. 1977

The cost for a "large" genome scan (defined as 18 chromosomes* 7 chromosome (i.e. 126 markers!) * $4/marker) = $504

Ben Hayes and Mike Goddard, 2003. Evaluation of marker assisted selection in pig enterprises. Livestock Production Science 81:197-211.

"what escaped their vision was that science might come up with new and different ways of commercializing and using new technologies."




UNIVERSITY
of
CALIFORNIA

"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


35
CITY CIRCLE
City Circle
728


Questions?