Gene Testing for Production and Carcass Traits: What does it mean to a rancher?

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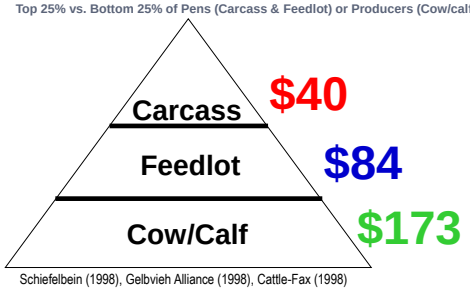
My Goal:

- Get us to think about:
  - What genetic tools are available?
    - Overview of gene markers
  - How we use those tools?
  - Why we use those tools?
  - When should we use those tools

Where's the Profit Opportunity?

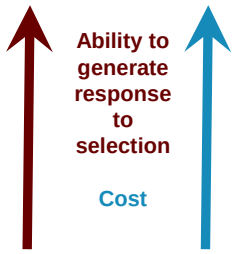
Top 25% vs. Bottom 25% of Pens (Carcass & Feedlot) or Producers (Cow/calf)



Schiefelbein (1998), Gelbvieh Alliance (1998), Cattle-Fax (1998)

Sire Selection Tools:

- DNA Markers
- EPD
- Ratios
- Adjusted weights
- Weights
- Visual Appraisal



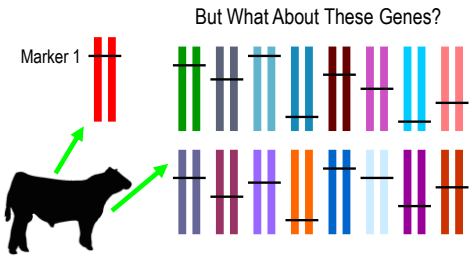
What is a DNA marker?

- Any of a number of different types of sequences of nucleotides that allow identification of alternate forms of a gene (allele). (marker = ear tag)
- Some changes in sequence cause change in gene function (causal)
- Other changes just help identify gene (non-coding) (association)

Single Nucleotide Polymorphism (SNP) DNA Marker Example

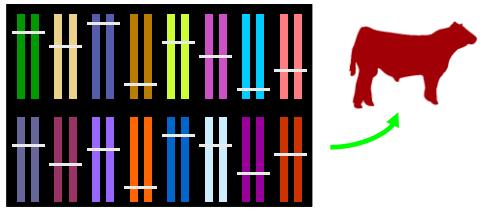
- Mutation may be in exon (coding sequence; possibly causal) or in intron (non-coding sequence) of gene

What a Marker Test Tells You:



What an EPD Tells You:

Cumulative effect of all genes and their interactions on a trait.



Many commercial companies now offering DNA-services to livestock producers

BOVIGEN LLC
GeneSTAR
SureTRAK
SireTRACE
igenity
ImmGen.
GENETICVISIONS
genmark
BIOGENETIC SERVICES, INC.
GENESEEK
Molecular Solutions for Breeding and Genetics
ANGUSURE
GENAISSANCE PHARMACEUTICALS
MMI Genomics, Inc.
BREED-REX
DNA VERIFIED
METAMORPHIX, INC.

Van Eenennaam, 2007

Use of DNA Markers

- Goal: explain variation in phenotype due to a specific genotype
- Examples…
  - Qualitative
    - Coat color (Red, Black, Wildtype)
    - Horned/Polled
    - Genetic based disease
  - Quantitative
    - Quantitative Trait Loci (QTL)/Nucleotide (QTN)
    - Carcass traits, feed intake/efficiency

Marker *Assisted* _____

Selection: Process of using DNA-marker test results to predict the genetic merit to aid in selection of animals as parents.

Management: Process of using DNA-marker test results to predict the phenotype of the animal and provision of specific management environments to achieve specific end-points.

Marketing: Using DNA marker information to merchandize bulls.

Traits that are most likely to benefit from MAS (descending order)

- Simply inherited genetic defects
- Carcass quality and palatability attributes
- Fertility and reproductive efficiency
- Maintenance requirements
- Carcass quantity and yield
- Milk production and maternal ability
- Growth performance

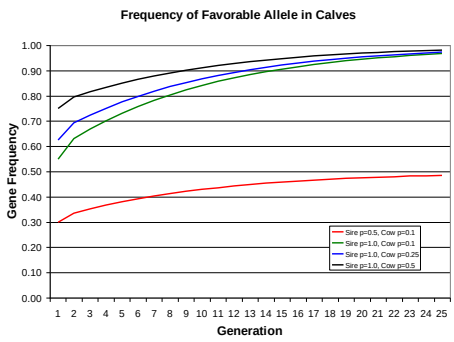
Van Eenennaam, 2007

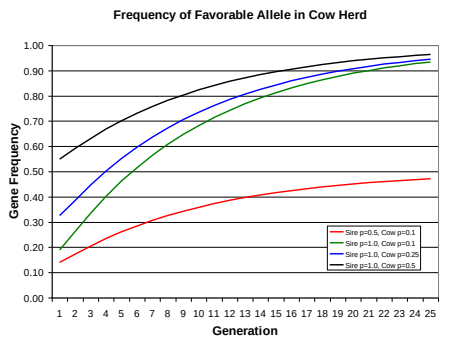
So When Are Markers Helpful?

- Traits that are hard/expensive to measure
  - Disease, reproduction,
- Qualitative traits with economic impact
  - Horned/polled, color
- Collectively account for large portion of genetic variation of trait, inexpensive to test
- Results incorporated into NCE programs
  - Markers are not a substitute for EPDs
- Very useful for parentage identification and pedigree validation (seedstock)

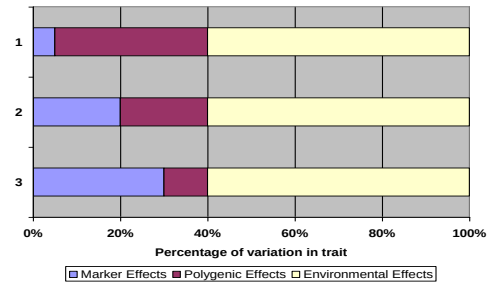
Marker Assisted Selection

- Considerations
  - Frequency of favorable allele
  - Magnitude of effect
    - Reported as haplotype, sire transmits ½ of that merit
  - Mode of inheritance
    - Dominant, co-dominant, recessive
  - Bang for Buck
    - Does it make economic sense: ROI
    - Or is it just 'sexy'





How much genetic variation does marker panel explain?



What Tests Are Available for Quantitative Traits?

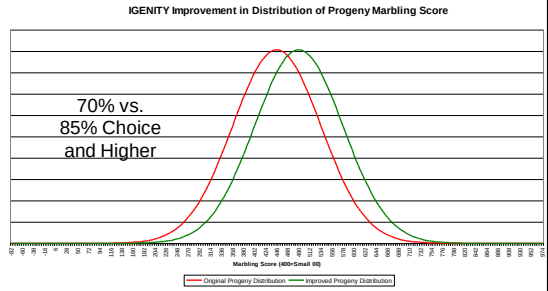
- NBCEC Validated Tests(http://www.NBCEC.org)
  - Bovigen Solutions
    - GeneSTAR Quality (TG5 and M2)
    - GeneSTAR Tenderness 2 (Calpain, Calpastatin)
  - IGENITY (Merial)
    - TenderGENE (Calpastatin, mu-Calpain)
- Un-validated Panels
  - Igenity Profiles
  - Bovigen
  - MMI Genomics

IGENITY Profile (pre-Dec 2007)

IGENITY Result	Yield Grade	% Choice Based on Quality Grade	Ribeye Area in Square Inches	Hot Carcass Weight lbs.	Back Fat Thickness in Inches	USDA Marbling Score	Tenderness in lbs. of WBSF
10	0.44	44.5	0.95	45.5	0.100	85.3	-2.27
9	0.39	38.9	0.85	39.8	0.085	76.6	-1.95
8	0.33	34.3	0.74	34.1	0.070	67.4	-1.85
7	0.28	30.3	0.68	28.7	0.060	57.9	-1.54
6	0.23	25.2	0.51	23.3	0.050	48.4	-1.22
5	0.19	19.9	0.41	21.8	0.040	39.0	-1.13
4	0.15	14.9	0.27	16.6	0.033	29.6	-0.79
3	0.11	10.2	0.21	11.4	0.025	20.1	-0.42
2	0.05	5.6	0.11	5.7	0.013	10.1	-0.21
1	0	0	0	0	0	0	0
Phen. SD	0.59		0.65	0.46	0.63	0.88	0.68

Data on file

Improvement in Progeny Marbling Score: 0 & 10 Profiles



A Selection Example

Bull ID	Marker Result	Marbling EPD/Acc*
A	2 Star	
B	2 Star	
C	0 Star	
D	0 Star	

*EPDs from Spring 2004 Am. Simmental Assn. MB-ICE

A Selection Example

Bull ID	Marker Result	Marbling EPD/Acc*
A	2 Star	+0.37 0.74
B	2 Star	-0.22 0.68
C	0 Star	+0.28 0.78
D	0 Star	-0.37 0.74

*EPDs from Spring 2004 Am. Simmental Assn. MB-ICE

What's the Problem?

- Marker only accounts for small percentage of genetic variation
  - ~10% of additive variation
- Quantitative traits are polygenic
  - Many genes at play simultaneously
  - Interactions among genes

DNA marker results are not replacements for EPDS!!

Genetic evaluation of commercial herd from DNA derived pedigree

Allows commercial producers to:

- Identify superior and inferior bulls
- Run several sires in pastures to improve reproductive rate and grazing management
- Monitor herd's genetic progress
- Separate herd bull battery into breeding groups to make the most of their genetic assets

Cow/Calf Producer: Dystocia Identification

Calf	Calving Difficulty #Most Likely
463N	118N
306J	118N
520N	118N
333Nb	118N
312K	118N
344L	118N
373L	2426M
322N	3Ma
323N	3Ma
16L	3Ma
293L	3Ma
131N	3Ma
188L	3Ma
46J	40N
77N	604N
281M	604N

- Identify bulls most likely to have sired calves associated with calving difficulties
- Develop EPDs for calving ease
- Make informed decisions on which bulls to cull

Genetic Evaluation

Sire ID		HCW EPD	YG EPD	Quality Grade EPD
11P		-7.003	0.069	0.041
	# Progeny	5	5	5
	Equiv# Prog	3.17	3.17	3.17
	Accuracy	0.087	0.087	0.087
3Ma		14.133	-0.097	-0.2
	# Progeny	32	32	32
	Equiv# Prog	27.83	27.83	27.83
	Accuracy	0.341	0.341	0.341
102P		0.119	-0.01	-0.013
	# Progeny	3	3	3
	Equiv# Prog	0.7	0.7	0.7
	Accuracy	0.013	0.013	0.013
118N		6.541	-0.071	0.027
	# Progeny	39	39	39
	Equiv# Prog	29.87	29.87	29.87
	Accuracy	0.359	0.359	0.359
182M		-10.95	0.105	0.141
	# Progeny	37	37	37
	Equiv# Prog	34.17	34.17	34.17
	Accuracy	0.393	0.393	0.393

- Same two bulls have larger HCW EPDs
- Number of calves sired are relatively high
- Informed decision
  - Cull?
  - Keep, but use only on mature cows?

Convergence: the future of quantitative and molecular genetics

The Future: Whole Genome Scan for QTL

- Massively parallel, high throughput genotyping (driven by human genome)
- Illumina iSelect Infinimum Bovine SNP Chip
  - 50,000 SNP genotypes per assay
  - 12 assay/chip; 16 chip/day; 10M genotypes/day
  - High density, even saturation ~60kb
  - Low cost discovery tool ~$200/sample
- Projects underway for growth, carcass, reproduction, health

Convergence

- Large marker panels or whole genome selection system
- Incorporate marker data into EPD calculation
  - Am. Simmental uses WBSF markers in computation of EPD
- Improves accuracy for young animals/selection candidates
- Reduces need to collect expensive phenotypes

Take Home Messages…

- EPD provides more information about net merit for a trait than gene marker result (today).
- EPD should continue to be principle genetic tools used for selection of commercial herd sires.
- Parentage testing can be useful in variety of settings
- DNA marker information maybe used by:
  - seedstock producers to identify unique gene combinations
  - commercial producers in the absence of EPD data.
- Convergence critical for continued growth and success via improved accuracy of EPD early in life


Thank You!