

Opportunities for Selection in the Genomics Decade

Range Beef Cow Symposium
December 1, 2009




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Putting Genetics to Work

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Establish herd goals



Determine your target market



Apply selection tools




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Selecting for Maximum Benefit

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- What are your herd goals?
- How fast do you want to reach them?
- What traits do you focus on?



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Maximizing Response to Selection

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Accuracy
(How well is it measured?)


Intensity
(How much variation can I use?)

Generation Interval
(How long does it take?)

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Selection Information

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Evaluation Evolution


- Visual appraisal
- Pedigree information
- Performance data
- EPDs
- Multi-breed, international evaluations
- Economic indexes
- DNA markers and panels
- Molecular Value Predictions (MVPs) - derived from High Density panels
- Enhanced animal relationships
- MA-EPDs and ACCs, MA-Indexes

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What is the challenge?

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- Current selection information is incomplete and is subject to possible change - especially for young animals



BW	WW	205 Wt	NR	ADG	ADG Rat	365 Wt	YR	WDA	RFI	Fin Wt	MBT	Ind	Scrtl
82	645	623	88	3.77	114	1226	101	2.87	4.58	1110	95	34.5	
CED	BW	WW	Milk	Year	Scrotal	Marb	RE	Fat	SBV				
1+3	1+2.2	1+42	1+23	1+93	na	1+.21	1+.03	1+.012	33.25				

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Why do we need more information?

Trait	BW	WW	Milk	YW	SC
As calves*	4.4	36	19	63	.76

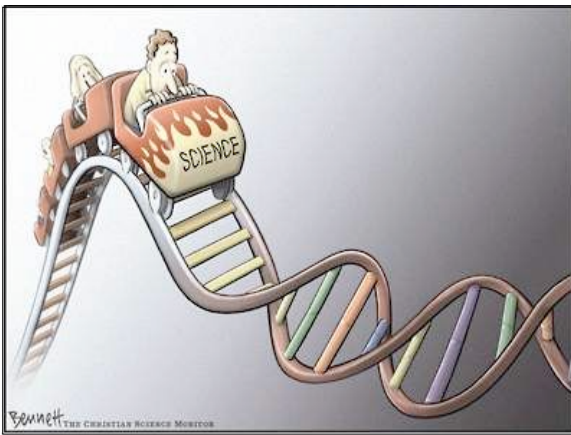
As calves, full sibs share the same pedigree EPD profile

Trait	BW	WW	Milk	YW	SC
TC Rancher	.4	20	14	42	.23
	.99	.99	.99	.99	.99
TC Stockman	8.6	42	9	82	.93
	.99	.99	.99	.99	.99

Here are their EPDs after many years of progeny data

Complexity = Opportunity

Key traits highlighted in the word cloud include: Tenderness, Yearling Weight, Feed Efficiency (NFI), Ribeye Area, Immune Response, Yield Grade, Fat Thickness, Cow Fertility, Calving Ease Maternal, Adaptability, Heifer pregnancy, Beef Healthfulness, Milk, Dry Matter Intake, Animal Health, Birth Weight, BRD, Docility, Longevity, Scrotal circumference, Yield Grade, Carcass Weight, Calving Ease, and \$B ADG.



Genome Sequencing = Innovation

Timeline of genome sequencing milestones:

- 2005: Honeybee
- 2004: Chicken
- 2007: Horse
- 2007: Cow
- 2009: Pig
- 2010: Sheep

Livestock Leading the Way

EDITORIAL June, 2009

nature biotechnology

The genome-assisted barnyard

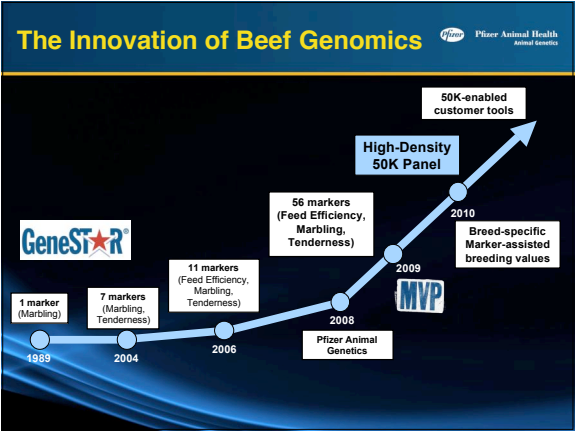
In contrast to the slow translation of human genome information into medicine, animal genomics is likely to have a rapid and tangible impact on agriculture.

The immediate impact of the human genome sequence on human health and welfare has been intense and ongoing. The sequence information has been used to identify disease-causing genes and to develop targeted therapies. In addition, the sequence information has been used to identify genes that are important for human health and to develop targeted therapies. In addition, the sequence information has been used to identify genes that are important for human health and to develop targeted therapies.

The Innovation of Television

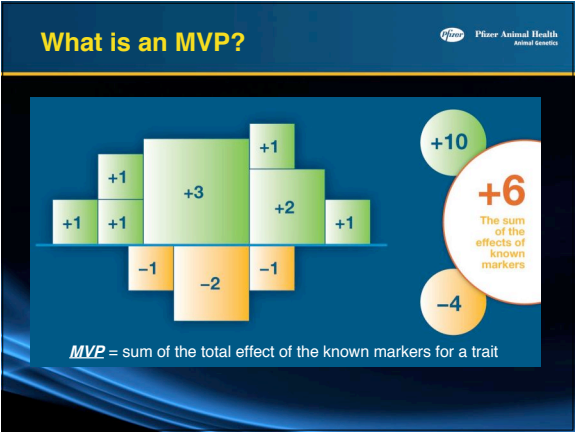
Timeline of television innovation:

- 1925: First basic functionality demonstrated
- 1935: First Commercially Viable Product: 48 lines, 1 channel
- 1939: 10x improvement in resolution: 480 lines
- 1941: 1 in 200 households own one
- 1946: 1 in 100 households own one
- 1951: 1 in 200 households own one
- 1962: 9 in 10 households own at least one
- 1962: First Live National "Program" available: 3 channels
- 1980: 100's of channels, Satellite, Portable, TIVO - DVR
- On-Demand Programming
- HD TV 2,000,000+ Pixels
- Interactive Entertainment, Communication, Education



Molecular Value Predictions (MVP)

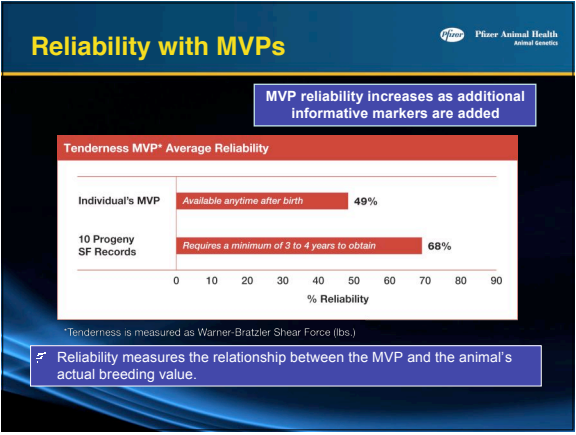
- Based on a panel of 56 DNA markers that predict feed efficiency, tenderness and marbling in beef cattle
- Incorporate sum total of marker effects on each trait to predict molecular breeding value in units of the trait



The Power of Accuracy

EPD – Accuracy increases from progeny data – Genes the animal actually transmitted

MVP – Reliability increases with additional informative markers – Genes the animal actually possesses



MVPs -- % Rank

Percentile Rank	Breed		
	NFP ^a	Marb ^b	Tend ^c
Top 1	-1.97	0.71	-0.76
Top 5	-1.42	0.50	-0.60
Top 10	-1.11	0.37	-0.50
Top 20	-0.67	0.25	-0.36
Top 30	-0.40	0.17	-0.26
Top 40	-0.21	0.11	-0.17
Top 50	-0.06	0.05	-0.09
Top 60	0.12	0.00	0.00
Top 70	0.35	-0.06	0.10
Top 80	0.60	-0.13	0.22
Top 90	0.86	-0.23	0.39

^a NFI is measured as net feed intake (lbs./day)
^b Marbling is measured as marbling score (0-9)
^c Tenderness is measured as Warner-Bratzler shear force (lbs)

Yearling Bull A

Birth Date: 2-23-2008 Cow 15994018 Tattoo: 8172

GT Shear Force (JAF-NE) #1 Bar Prime Time 0806 (JAF-NE) #1 Gardens Prime Time (JAF) PW +13.30
 14419184 #GT Siskin 106 #GT Mico Emulosa A04 #Plowman 1827 of Millbrae SAR (JAF-NE) PE -13.81
 #GT Rosalia 509 #1 Bar Emulation EXT (JAF-NE) PP -10.11
 Gardens Prime Star (JAF-NE) #1 Bar Prime Time 0806 (JAF-NE) P00 -17.20
 Monarch Rita Star S180 Green Garden Jlt C242 S1 (NF) #GARD Grid Maker (JAF-NE) P10 +4.13
 +15388887 #GAR Grid Maker 312 (JAF-NE) #GAR 6148 Emulation 1119 #B -143.88

REPO	WEPO	YEPO	MILK	MARB	RE
+4.1	-34	+58	25	+58	24
14	14	13			

	FE	Marb	Tend
MVP	+1.00	0.35	-1.01
% Rank	10%	20%	10%

Yearling Bull B

Birth Date: 8-30-2008 Cow 16128044 Tattoo: 8289

GAR Predistined (JAF-NE) #B/R New Design 036 (JAF-NE) #1GAR New Trend 315 (JAF-NE) PW +12.50
 #13395344 #GAR Ext 4206 #B/R Blackcap Empress 76 PE -14.70
 #GAR 0207 Traveler 1432 #1 Bar Emulation EXT (JAF-NE) PP -18.20
 #Gardens High Prime 093 (JAF-NE) #Gardens Prime Time (JAF) P00 -10.54
 SBP Precision Lady 4305 (JAF) #GARD Precision Missa 2125 #GARD Precision 1680 (JAF-NE) P10 -7.66
 +15026282 #HF Precision Lady 704 398 #GAR Ext 704 (JAF) #B -143.88

REPO	WEPO	YEPO	MILK	MARB	RE
+2.1	-33	+40	25	+52	19
14	14	13			

	FE	Marb	Tend
MVP	+1.00	-0.12	-0.61
% Rank	60%	60%	10%

The Beef Industry's first commercially available 50K MVPs

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High-Density 50K Platform

Single DNA Sample → Illumina SNP50 Analysis Only once

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Density is a Game Changer

Low-Density: What about when you need to predict more?
 High-Density: So many options, opportunity and power of prediction

- So vast
- So many genes
- So many traits
- So many interactions

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It's All About Coverage

Verizon Wireless—3G Broadband Coverage

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Growing 50K Marker Effect in Dairy

Reliability gains
 • Above parent average reliability of approx. 35%

	Holstein August 2009
Lifetime Net Merit	+24%
Milk Yield	+26%
Fat Yield	+32%
Protein Yield	+24%
Fat %	+50%
Protein %	+38%

USDA-ARS (VanRaden)

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Changing the Game with 50K MVP

- Expanded suite of traits 
- Building upon Molecular Value Predictions (MVPs)
- Initially Angus, followed by other taurus breeds
- High level of reliability and preciseness
- Validated in industry-relevant proven AI sires
- Demonstrated in industry leading herds
- Return on investment described in commercial industry
- One-time DNA submission for ongoing access to future unique traits and technology

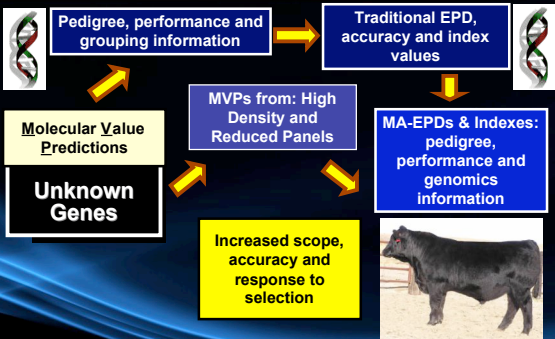
Available in January 2010

50K MVP Platform

Suite of Core Traits:

- Genomic-enabling
 - Feed Efficiency (NFI)
 - Dry Matter Intake
 - Tenderness
- Indexing
 - \$MVP
- EPD-enhancing
 - Birth Weight
 - Weaning Weight
 - Carcass Weight
 - Marbling
 - Ribeye Area
 - Fat Thickness
 - Yield Grade
 - Average Daily Gain*
 - *Related to Yearling Weight EPD

More Powerful Selection Tools



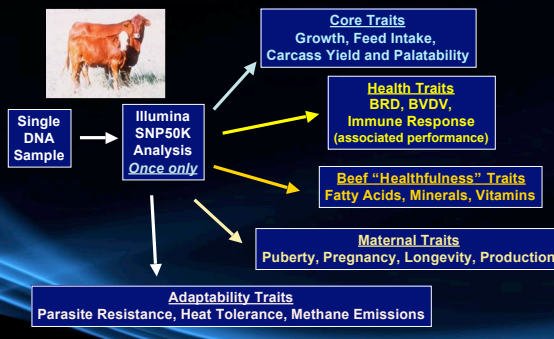
Traditional EPD, accuracy and index values

MVPs from: High Density and Reduced Panels

MA-EPDs & Indexes: pedigree, performance and genomics information

Increased scope, accuracy and response to selection

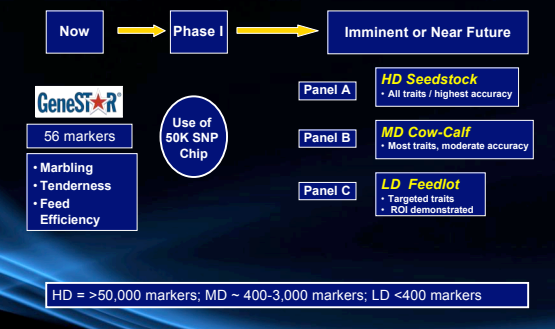
Beef Trait Landscape



Single DNA Sample → Illumina SNP50K Analysis *Once only*

- Core Traits: Growth, Feed Intake, Carcass Yield and Palatability
- Health Traits: BRD, BVDV, Immune Response (associated performance)
- Beef "Healthfulness" Traits: Fatty Acids, Minerals, Vitamins
- Maternal Traits: Puberty, Pregnancy, Longevity, Production
- Adaptability Traits: Parasite Resistance, Heat Tolerance, Methane Emissions

Conceptual Product Progression



Now → Phase I → Imminent or Near Future

GeneSTAR 56 markers

- Marbling
- Tenderness
- Feed Efficiency

Use of 50K SNP Chip

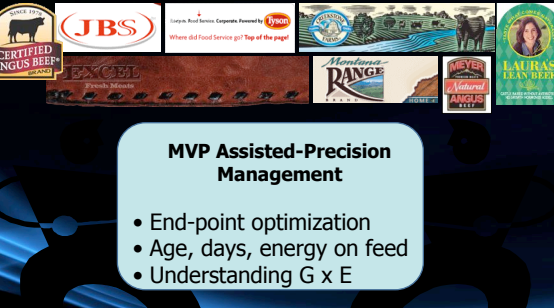
Panel A: **HD Seedstock** - All traits / highest accuracy

Panel B: **MD Cow-Calf** - Most traits, moderate accuracy

Panel C: **LD Feedlot** - Targeted traits - ROI demonstrated

HD = >50,000 markers; MD ~ 400-3,000 markers; LD <400 markers

Extending Beyond Seedstock



MVP Assisted-Precision Management

- End-point optimization
- Age, days, energy on feed
- Understanding G x E

