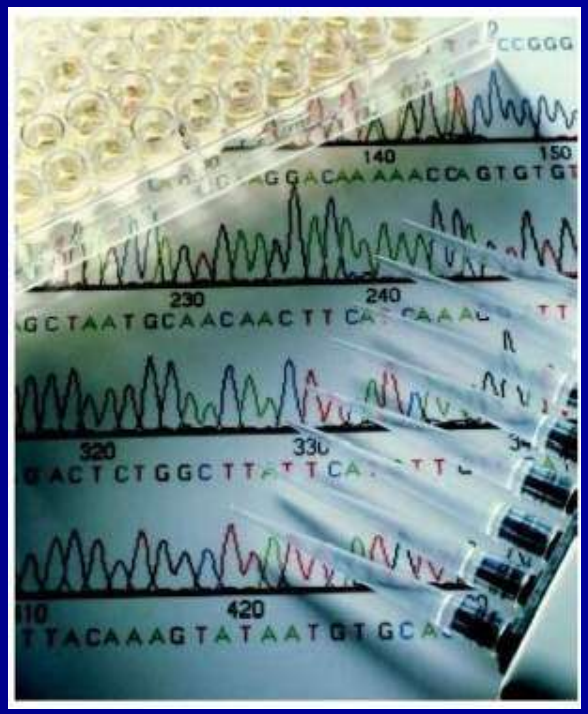
Technology Review

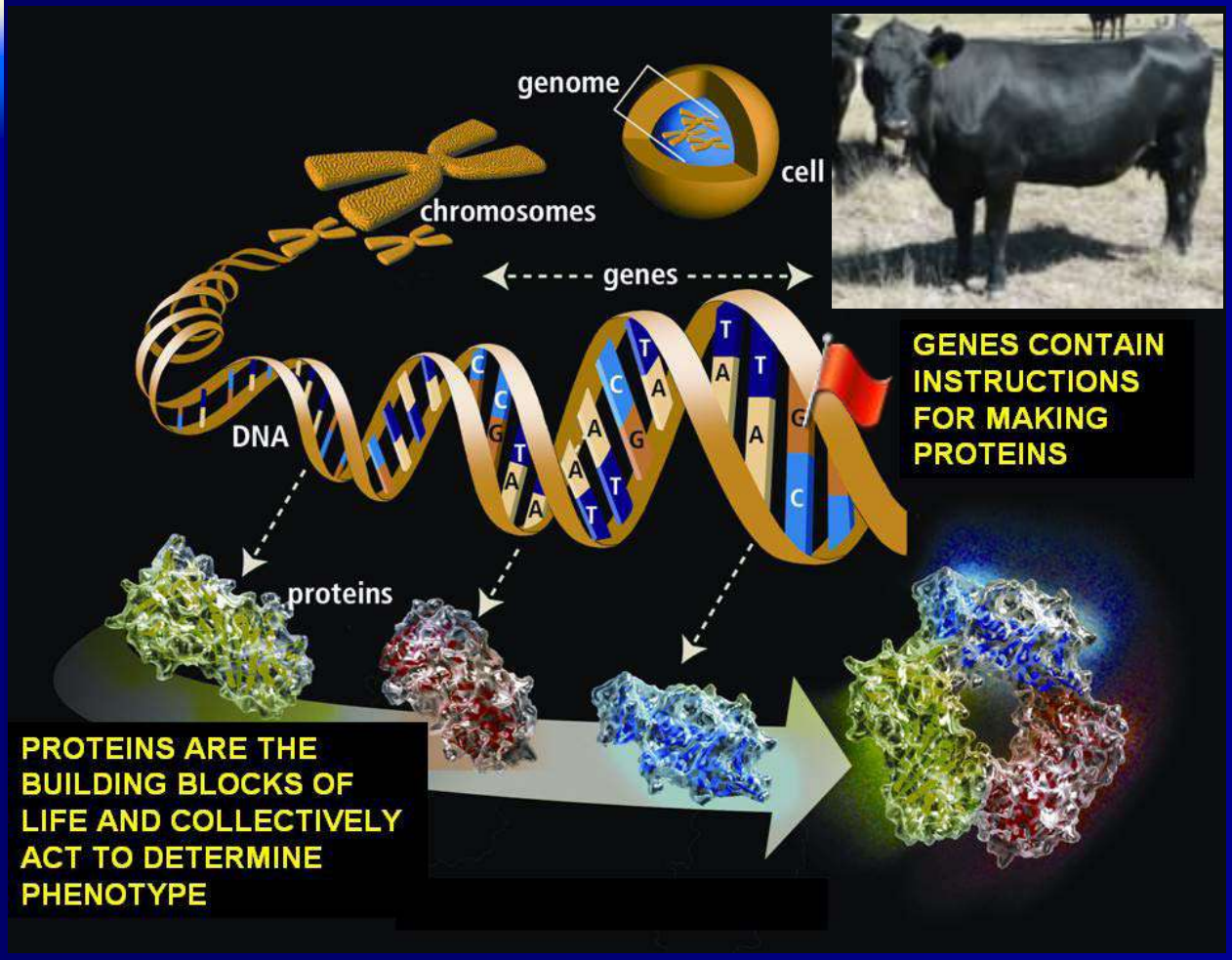
Alison Van Eenennaam, Ph.D.

Cooperative Extension Specialist
Animal Biotechnology and Genomics
University of California, Davis
alvaneenennaam@ucdavis.edu
(530) 752-7942



animalscience.ucdavis.edu/animalbiotech

The bovine genome is similar in size to the genomes of humans, with an estimated size of 3 billion base pairs.

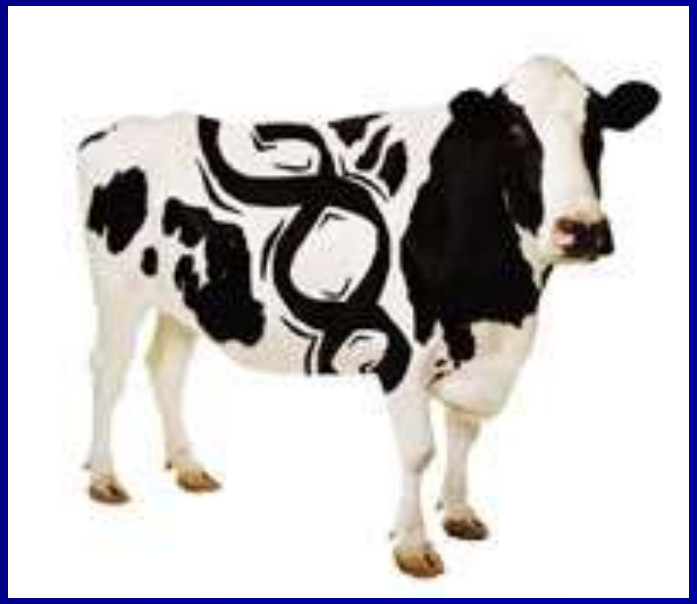


SNPS ("snips")

- Abundance – 30 million in cattle!
- Potential for automation
- Low genotyping error rates
- Ease of standardization between labs
- Low mutation rates
- 50,000 SNP chip available now
- 800,000 later this year
- Whole 3 billion bp sequencing likely

Testing for DNA-markers has a range of potential applications in cattle production systems

- Animal Identification and parentage identification
- DNA testing for genetic defects
- Marker-assisted selection
- Genomic-selection
  - increase the accuracies of EPDS at birth ???????



There are various companies offering DNA tests for marker-assisted selection/management in beef cattle

GeneSTAR
SureTRAK
GeneSTAR
SireTRACE
Pfizer
Pfizer Animal Genetics

igenity

ImmGen.

genmark

QUANTUM GENETICS
DNA Assisted Feedlot Management

GENETICVISIONS

GENESEEK
Molecular Solutions for Breeding and Genetics

ANGUSURE

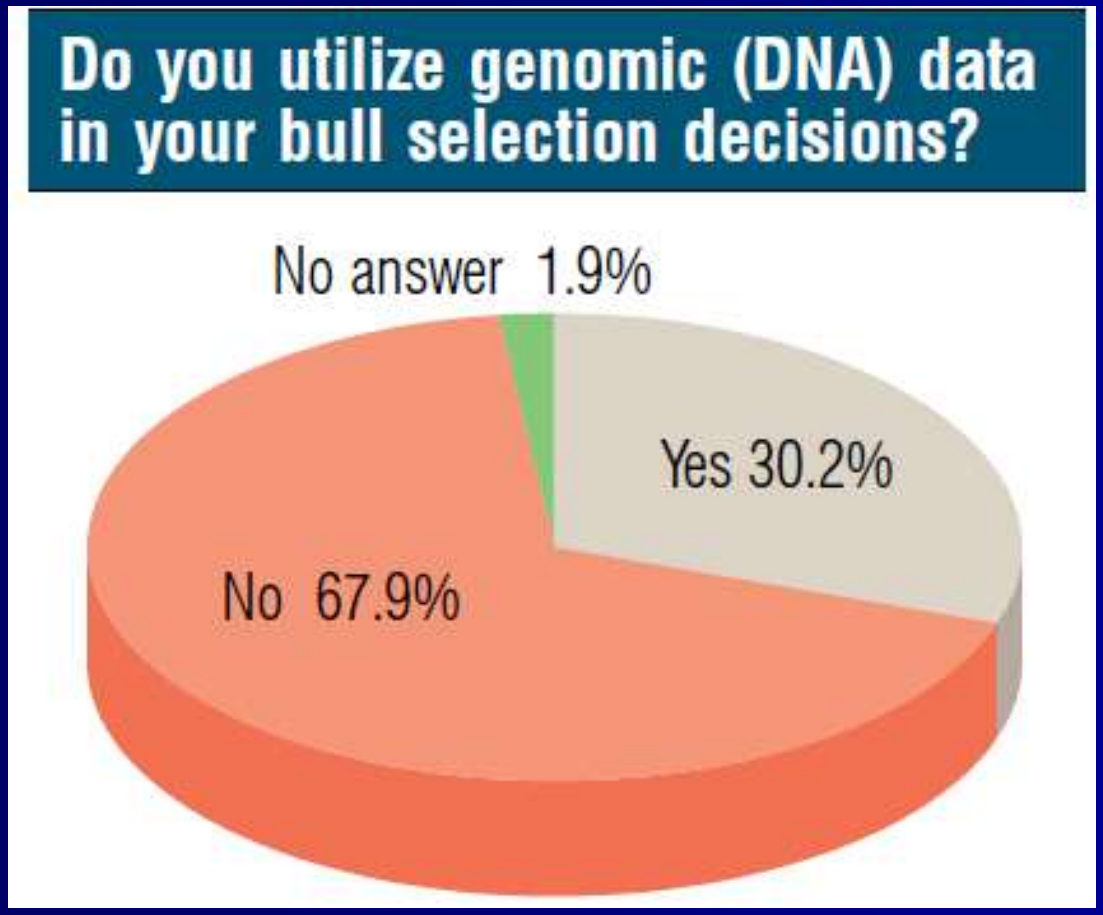
PRESCRIBE GENOMICS

MMI GENOMICS, INC.
BREED TRU
DNA VERIFIED

METAMORPHIX, INC.

March 1, 2010 Beef Magazine Survey

http://beefmagazine.com/genetics/beef-asked-answered-20100301

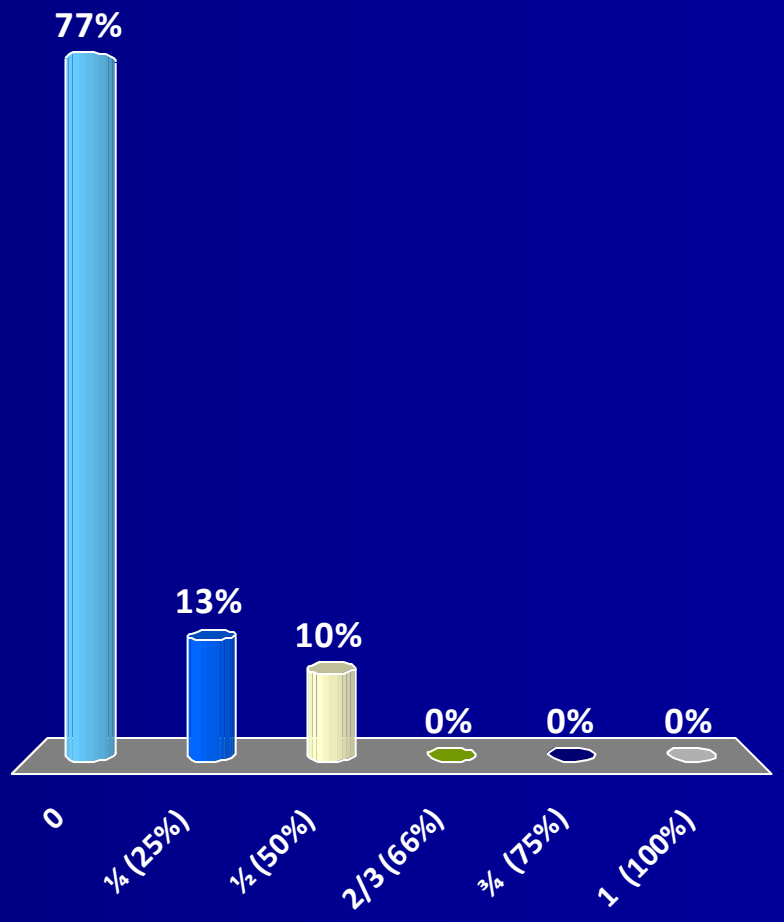


Base = 635 (All Cow-Calf Operations)

DNA testing has been successfully used to test for simple (qualitative) traits – genetic defects, coat color, polled/horned

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 tests also exist for traits that are controlled by many genes – DNA tests currently involve tens to 50,000 SNPs

- Meat Tenderness
- Quality Grade (Marbling)
- Beef Cattle Feed Efficiency
- Yield Grade
- Fat thickness
- Ribeye area
- Average Daily Gain
- (Heifer pregnancy rate, stayability, calving ease, docility)

IGENITY profile results and associated effects*

IGENITY Result	Residual Feed Intake (Indicus)**	Residual Feed Intake (Taurus)**	Average Daily Gain***	Tenderness in lbs. of WBSF	USDA Marbling Score	% Choice & higher	Yield Grade	Back Fat Thickness (in)	Ribeye Area (in²)	Heifer Pregnancy Rate (%)	Stayability (%)	Maternal Calving Ease (%)	Docility (%)
10	5.5	4.2	0.81	-2.3	161.4	64.4	1.35	.37	2.56	18.8	16.7	9.5	45.4
9	5.0	3.6	0.72	-2.0	141.3	57.2	1.21	.32	2.22	16.2	14.7	8.4	39.6
8	4.2	3.1	0.64	-1.9	123.6	50.1	1.07	.28	1.93	14.2	12.9	7.3	34.7
7	3.6	2.7	0.54	-1.5	106.4	42.9	0.92	.24	1.64	12.1	11.2	6.2	30.0
6	3.0	2.2	0.44	-1.2	88.4	35.8	0.76	.21	1.35	10.0	9.5	5.1	25.3
5	2.4	1.8	0.34	-1.1	70.6	28.6	0.61	.17	1.07	8.1	7.6	4.1	20.5
4	1.9	1.3	0.24	-0.8	53.3	21.5	0.46	.13	0.80	6.0	5.8	3.1	15.7
3	1.2	0.9	0.14	-0.4	35.5	14.3	0.31	.09	0.53	4.0	3.9	2.0	10.7
2	0.6	0.4	0.05	-0.2	17.7	7.2	0.15	.06	0.24	1.9	2.5	1.0	5.8
1	0	0	0	0	0	0	0	0	0	0	0	0	0
P-value	5.7E-13	8.04E-08	2.4E-19	1.9E-08	3.8E-18	1.0E-20	1.6E-16	3.9E-20	1.8E-14	2.6E-30	1.1E-34	4.2E-32	3.1E-19

*Data on file at Merial. Results expressed represent differences expected in animals compared to contemporaries with IGENITY Profile scores of 1.
**Lbs of feed per day.
*** Lbs of gain per day.
WBSF = Warner-Bratzler shear force

Profile versions : Multibreed (based on ? # of SNPs)
: Angus[1] (have to submit samples to AAA)
Coming soon : Angus[2] (SNPs selected based on 50K data)

igenity®

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MERIAL

http://us.igenity.com/pdfs/forms/Igenity%20Results%20Key%20Beef.pdf

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Angus Genetics Inc.® and IGENITY® to Introduce Industry's First Genomic-enhanced EPDs for Multiple Traits

Angus producers will have first access to breed-specific DNA profile

DULUTH, Ga. - July 14, 2009 - Angus Genetics Inc.® (AGI) and Merial have entered into an exclusive agreement to provide American Angus Association® breeders with genomic-enhanced expected progeny differences (EPDs) powered by IGENITY®. This will be the first time beef producers have access to genomic-enhanced EPDs for multiple traits at once - and from an Angus-specific DNA profile.

Bill Bowman, president, AGI, says this agreement joins two groups committed to advancing genetic improvement in the beef industry.

"AGI and IGENITY share a common vision to provide beef producers with the most advanced solutions to their genetic selection and management needs," Bowman says. "This represents a significant milestone for our industry - one our board has directed us to pursue aggressively for the past two years and supported with collaboration and research dollars."

The combination of a breed-specific DNA profile with the Angus National Cattle Evaluation (NCE) will result in higher-accuracy EPDs. This will be an especially powerful tool for evaluating young animals, as cattle will now have accuracies that were previously only possible once they had multiple progeny on the ground, Bowman says.

Dr. Stewart Bauck, executive director of research and development, IGENITY, commends AGI and its parent company, the American Angus Association, for leading this charge.

"The American Angus Association has set the standard in data collection and embracing cutting-edge technologies," he says. "We appreciate the work the Association has done to keep the breed at the forefront of the beef industry by helping bring this advancement to Angus breeders."

Bowman says the selection of a DNA technology partner was a logical decision.

"IGENITY has a robust profile of analyses, including the industry's only DNA analyses for reproduction and maternal traits in combination with all of the economically important carcass traits," he says. "Plus, the addition of the genomic tools from IGENITY into our NCE system provides us the ability to improve the accuracy of Angus EPDs - especially in young animals."

Dr. Bauck adds that genomic-enhanced EPDs for multiple traits have become a reality after years of collaboration among beef industry leaders.

"The industry agreed that genomic-enhanced EPDs were the next advancement in DNA technology," he says. "It was our responsibility as the leading DNA technology provider to take action and move the topic of genomic-enhanced EPDs from an industry discussion to a user-friendly solution."

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.

- Marbling
- Ribeye Area
- Fat Thickness
- Carcass Weight
- Tenderness
- Percent Choice
- Yield Grade
- Heifer Pregnancy
- Stayability
- Maternal Calving Ease
- Docility
- Average Daily Gain (ADG)
- Feed Efficiency
- Yearling Weight

Additional tests available:

- Arthrogryposis Multiplex (AM)
- Neuropathic Hydrocephalus (NH)
- Bovine Viral Diarrhea – Persistently Infected (BVD PI)
- Coat Color

ANGUS
THE BUSINESS BREED

igenity®

HOW TO USE GENOMIC-ENHANCED EPDS FOR ANGUS

Genomic-enhanced EPDs are to be used in the exact same way other EPDs are used, as a comparison between animals. These EPDs include all available records, including ultrasound, carcass, and genomic profile results. As data is added to an animal's record, the EPD is expected to change to reflect the animal's true genetic merit. Accuracy values associated with the EPD are the best indicator of the possible amount of change expected in the EPD and will increase as more information is added.

Carcass EPDs and Accuracy					
CW Acc	Marb Acc	RE Acc	Fat Acc	Carc Grp Acc	Usnd Grp Usnd Pg
+19 .13	+.64 .19	+.48 .24	-.011 .21		

DNA PROFILE SCORES

EPDs may not be currently available for all traits. Genomic results on animals are accompanied by categorical rankings, or Profile Scores. The profile scores from the IGENITY profile for Angus are reported on a scale from 1 to 10 to assist producers in understanding the relative value of an animal's genetic potential based on DNA analysis. Profile scores do not predict actual phenotypes. Higher scores reflect that the animal has more genetic potential for that particular trait based on the combination of DNA markers analyzed. The higher scores do not necessarily indicate that it is the most desirable.

DNA PROFILE SCORES													
HP	Stay	Mat CE	Doc	ADG	FE	YW	CWT	Marb	RE	Fat	%CH	YG	Tend
8	9	4	9	6	9	4	7	7	8	6	7	7	4

— by Sally Northcutt, American Angus Association director of genetic research

http://www.angus.org/AGI/GenomicEnhancedEpdsFactSheet.pdf

IGENITY® Price Guide

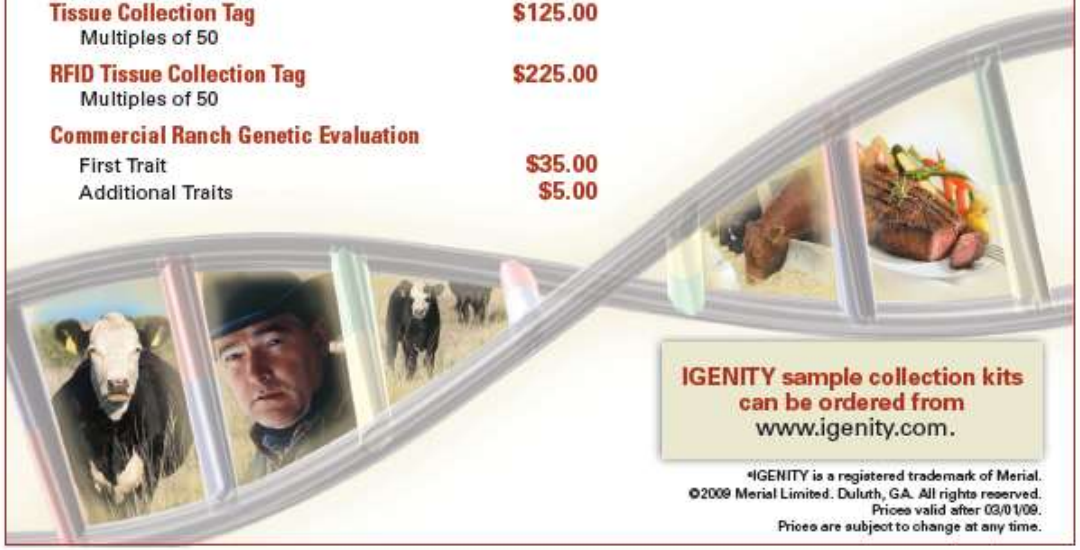
for beef

USD$

IGENITY® Profile	**$38.00**
Carcass Composition	
Tenderness, % Choice/Quality Grade, Yield Grade, Ribeye Area, Fat Thickness, Marbling.	
Maternal Traits	
Heifer Pregnancy Weight, Calving Ease, Stayability	
Docility	
Average Daily Gain	
Add BVD PI to the IGENITY Profile	**$3.00**
Available for tissue collectors only	
Add Coat Color to the IGENITY Profile	**$5.00**
Add Multi-Sire Parentage to the IGENITY Profile	**$10.00**
Add Myostatin to the IGENITY Profile	**$15.00**
Add Arthrogryposis Multiplex to the IGENITY Profile	**$26.00**
Add Feed Efficiency to IGENITY Profile	**$20.00**
Available for Bos indicus and Bos taurus.	
Add Horned/Polled to IGENITY Profile	**$50.00**
See the IGENITY Order Form for breed specifications.	
IGENITY Multi-Sire Parentage	**$25.00**
without the IGENITY Profile	
IGENITY Arthrogryposis Multiplex	**$26.00**
without the IGENITY Profile	
Tissue Collection Tag	**$125.00**
Multiples of 50	
RFID Tissue Collection Tag	**$225.00**
Multiples of 50	
Commercial Ranch Genetic Evaluation	
First Trait	**$35.00**
Additional Traits	**$5.00**

The IGENITY profile.

Inside information to help you achieve goals faster.



IGENITY sample collection kits can be ordered from www.igenity.com.

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Prices valid after 03/01/09.
Prices are subject to change at any time.

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

The tables below display the EPDs for each sire along with the HD 50K MVPs and % ranking for each. HD 50K results reinforce the power of this technology, as the MVPs closely reflect each sire's high-accuracy EPDs. HD 50K MVPs can help to more accurately predict genetic merit in young, unproven animals as early as four months of age, as compared to moderate or high-accuracy EPDs that require years of data.

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**

G A R Retail Product **13395329**

	CED	BW	WW	YW	ADG	DMI	NFI	CEM	MA	CW	FAT	REA	MS	TND	$B/$MVP^{FL}
EPD	6	2.6	47	93	-	-	-	7	25	16	0.003	0.47	0.42	-	55.08
ACC	0.92	0.98	0.96	0.95	-	-	-	0.87	0.91	0.7	0.7	0.73	0.74	-	-
EPD % Rank	**45**	**60**	**35**	**20**	**-**	**-**	**-**	**40**	**25**	**30**	**35**	**5**	**30**	**-**	**10**
MVP	8	1.1	26	-	0.43	0.44	-0.37	4	25	34	0.02	0.54	0.71	-0.43	167
MVP % Rank	**20**	**70**	**40**	**-**	**40**	**80**	**10**	**20**	**9**	**6**	**80**	**2**	**10**	**80**	**15**

H S A F Bando 1961 **13896250**

	CED	BW	WW	YW	ADG	DMI	NFI	CEM	MA	CW	FAT	REA	MS	TND	$B/$MVP^{FL}
EPD	2	2.4	55	97	-	-	-	7	27	20	0.037	0.08	0.25	-	41.51
ACC	0.89	0.96	0.94		-	-	-	0.59	0.71	0.42	0.44	0.53	0.49	-	-
EPD % Rank	**80**	**55**	**15**	**15**	**-**	**-**	**-**	**40**	**15**	**15**	**85**	**60**	**55**	**-**	**45**
MVP	-2.0	2.4	43	-	0.37	0.32	-0.28	4.5	29	40	0.03	-0.08	0.24	-0.54	105
MVP % Rank	**90**	**90**	**5**	**-**	**70**	**70**	**30**	**20**	**3**	**2**	**80**	**90**	**70**	**60**	**60**

Lead Today with 50K

Take selection and marketing decisions to the next level by taking advantage of HD 50K, the first commercially available predictions utilizing a High-Density panel of more than 50,000 markers. Available initially for Angus owners, a one-time sample submission provides the opportunity for ongoing access to MVPs for future unique traits and technology advancements. The suite of 14 genomic trait predictions, including the beef industry's first DNA-based economic index, provides MVPs for economically important traits not available as EPDs like average daily gain, dry matter intake, net feed intake and tenderness, as well as many that complement EPDs.

For more information about HD 50K:

HD 50K Overview

HD 50K Customer Reporting Overview

FAQs

HD 50K Television Ad

Post a Question

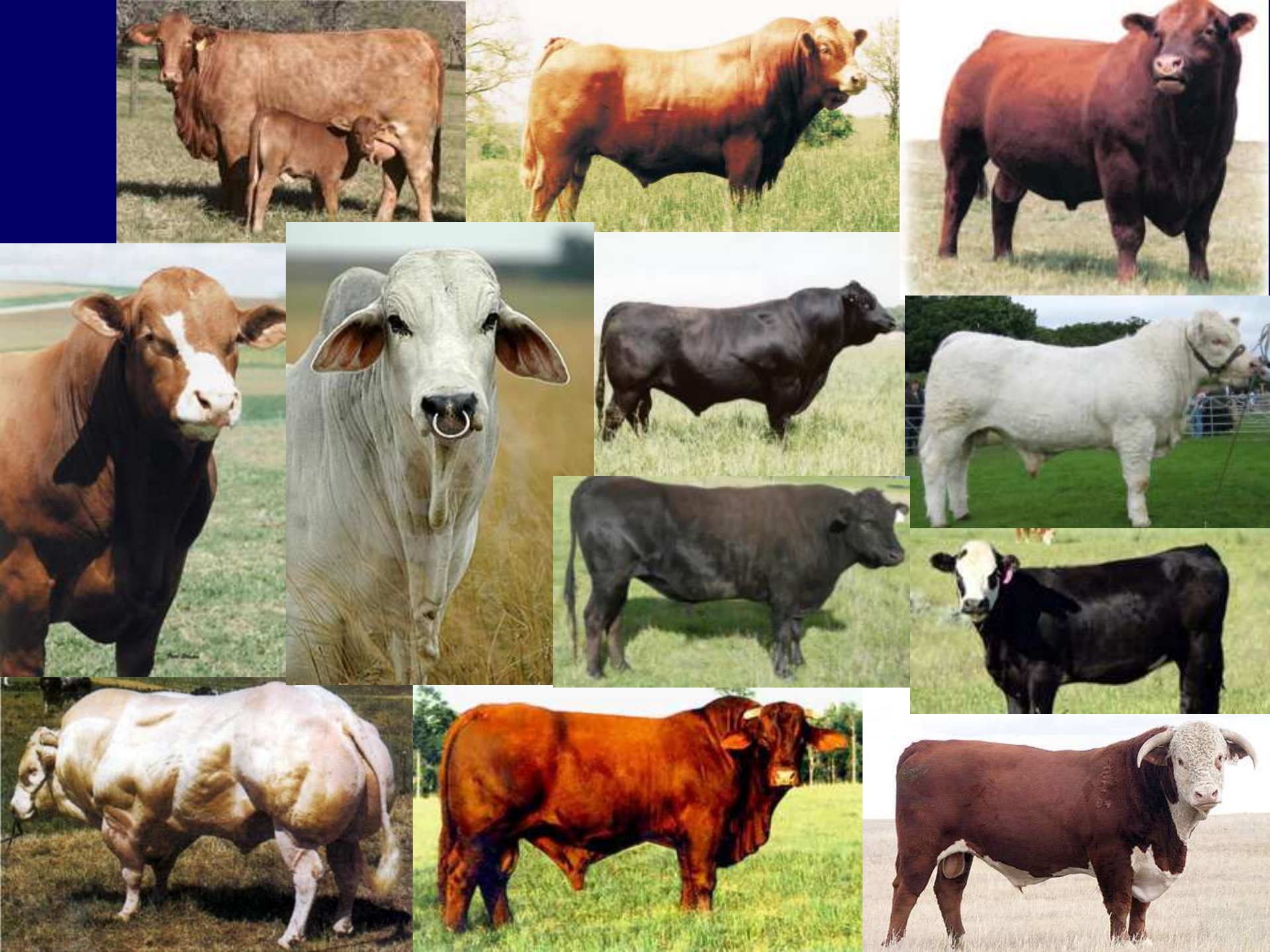
Order a Test Kit

Cost per test

1-24	$129
25 +	$119

Existing samples reanalyzed

1-24	$ 79
25+	$ 69



- Tru-Marbling™
- Tru-Tenderness™
- Tru-Back Fat™
- Tru-Rib Eye™
- Tru-ADG™
- Tru-Yield Grade™

MMI GENOMICS, INC.

BREED TRU™

DNA VERIFIED

Work in Your Best Genes

TRU-MARBLING™

FEATURES

- Contains 128 DNA markers where each marker is highly associated with expression of marbling score
- Measures the cumulative effects of all 128 markers associated with marbling
- Results are expressed as the Molecular Genetic Value (MGV) which can be utilized to rank animals by their genetic potential
- Animals can be tested at any age
- Validated in Angus (validation in other breeds is underway)

BENEFITS

- The most powerful and comprehensive DNA selection tool currently available for marbling
- Accounts for a significant proportion of total observed genetic variation for marbling
- Results are easy to utilize and incorporate into any existing breeding program
- Can be used to make early selection and breeding decisions
- Provides accurate and reliable results for ranking and/or selection of animals

One in a series of break-through products that will advance breeding practices in the cattle industry, *Tru-Marbling*™ is a powerful and comprehensive DNA selection tool that can determine the genetic potential of animals to express marbling. In a collaborative research program between Cargill and MMI Genomics, an innovative scientific approach was used on over 4000 feedlot animals to identify the majority of regions throughout the bovine genome that have an effect on this economically important trait.

Tru-Marbling™ is a DNA-based genetic test that contains a panel of 128 unique DNA markers, each one highly associated with the expression for marbling score and quality grade. By measuring the cumulative effects for each of these 128 markers, *Tru-Marbling*™ accounts for a significant proportion of the total genetic variation for this complex metabolic trait—the first DNA-based product to do so!

Tru-Marbling™ is an advanced and revolutionary tool that will allow cattle producers to make early breeding decisions that **increase the accuracy** of selection and **decrease the age** at which animals can be selected.

The results? Rapid improvement of marbling within herds and the ability to determine the "Tru" genetic potential of animals.

PROVEN RESULTS

Tru-Marbling™ has been validated in both commercial cross-bred feeder cattle populations and in Angus cattle.

The validation in Angus was conducted using samples from the National Carcass Merit Project, representing Angus sires bred to Angus-based commercial cows. While this is a small population of animals, the data indicate that *Tru-Marbling*™ **accounts for 70% of the genetic variation** observed in this population.

No. of samples:	**414**
Heritability*:	**0.36**
No. of markers:	**128**
Phenotypic variation explained (R^2):**	**0.25**
As a percent of Heritability	**70%**

** Angus National Cattle Evaluation, Spring 2007*
*** estimated from a model that included contemporary group and MGV*

Tru-Marbling™ has also been validated against commercial cross-bred feeder cattle populations.

TRAIT	Igenity Profile	Pfizer 50K	MMI
Average Daily Gain	X	X	X
Net Feed Intake		X	
Dry matter intake		X	
Residual feed intake	X		
Tenderness	X	X	X
Calving Ease (Direct)		X	
Birth weight		X	
Weaning Weight		X	
Yearling Weight	X		
Calving ease (maternal)	X	X	
Milking Ability		X	
Heifer pregnancy rate	X		
Docility	X		
Stayability	X		
Carcass weight		X	
Backfat thickness	X	X	X
Ribeye area	X	X	
Marbling score	X	X	X
Yield Grade	X		X
Percent Choice	X		
COST	**$58-78**	**$69-129**	**$65/145**

Black Angus Sire

G A R Predestined

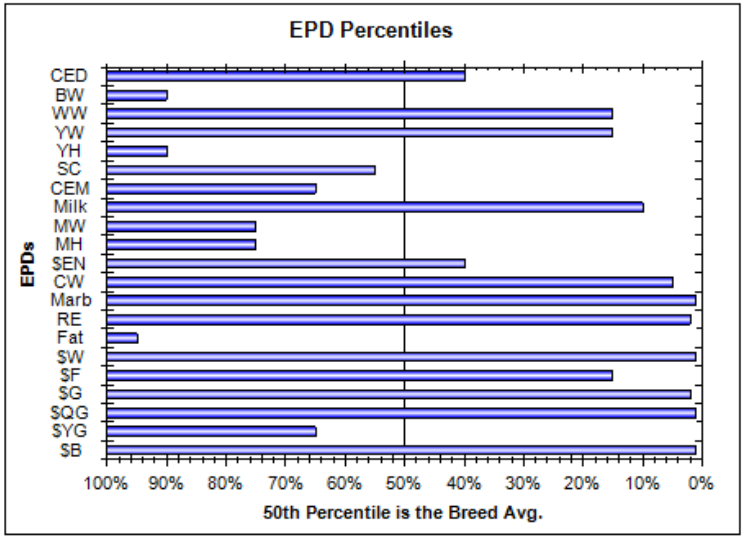
Reg. No.: 13395344
Calved: 8/16/1999
Tattoo: 5899
Semen: $25
Certificates: $20
Spring 2010 EPD

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

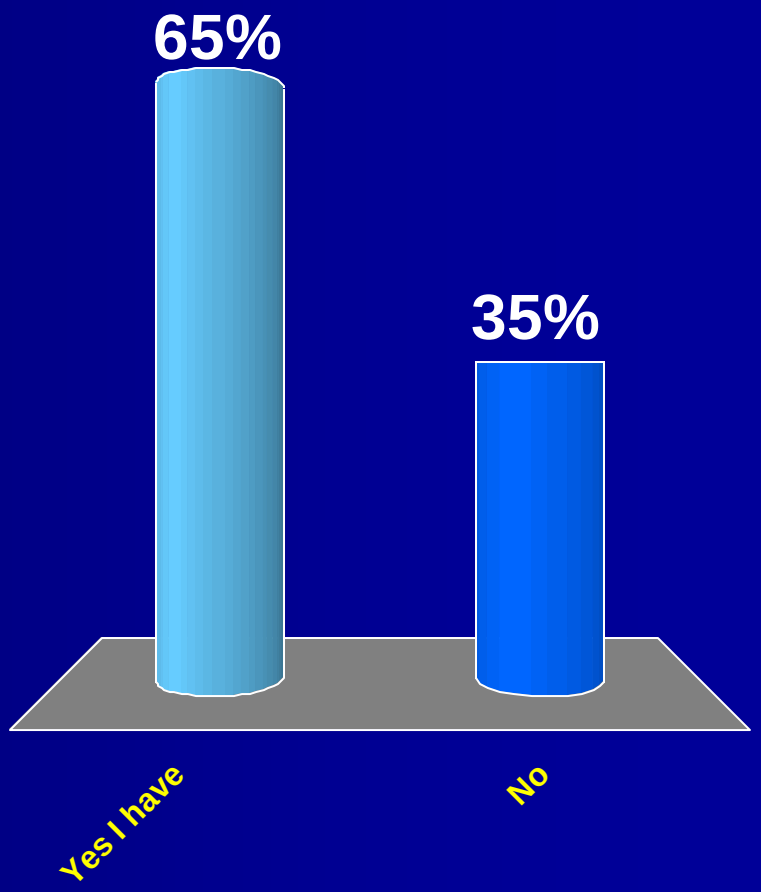
EPDs (CW, Marb, RE, Fat) are enhanced by genomic profiles generated by igenity.

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**

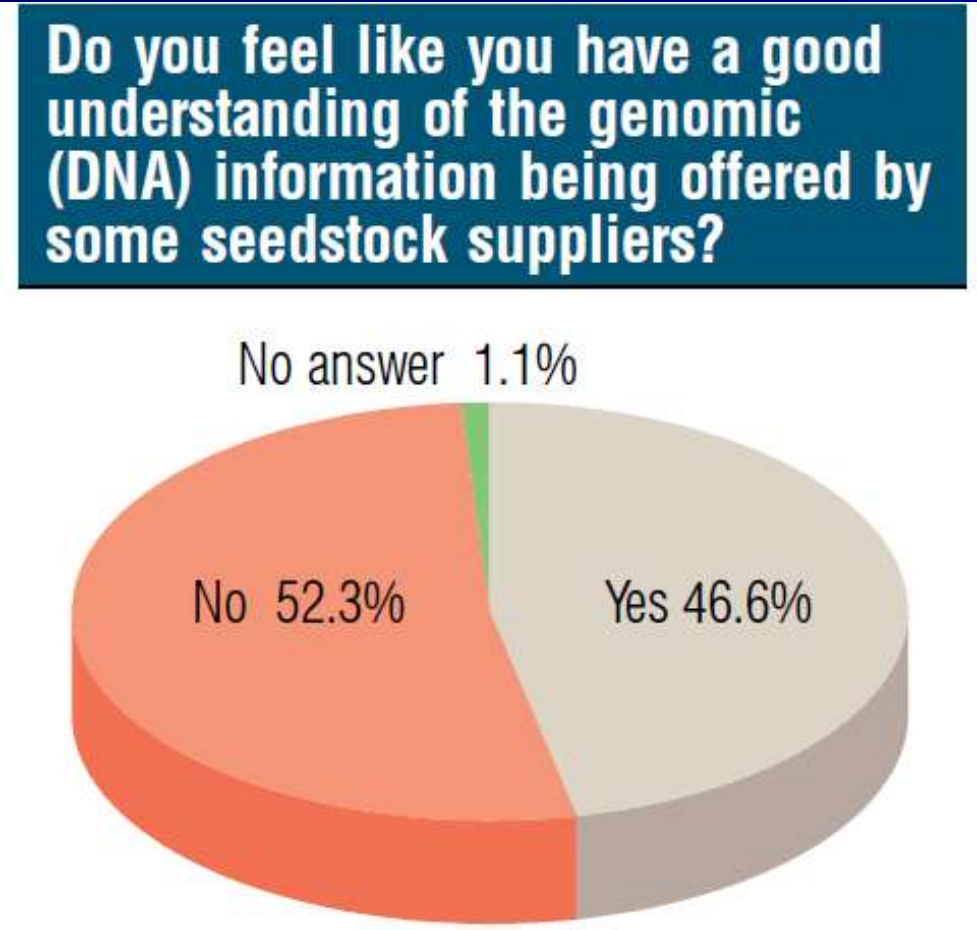
? Do you feel that you have a good understanding of the genomic (DNA) information being offered by some seedstock suppliers?

1. Yes
2. No



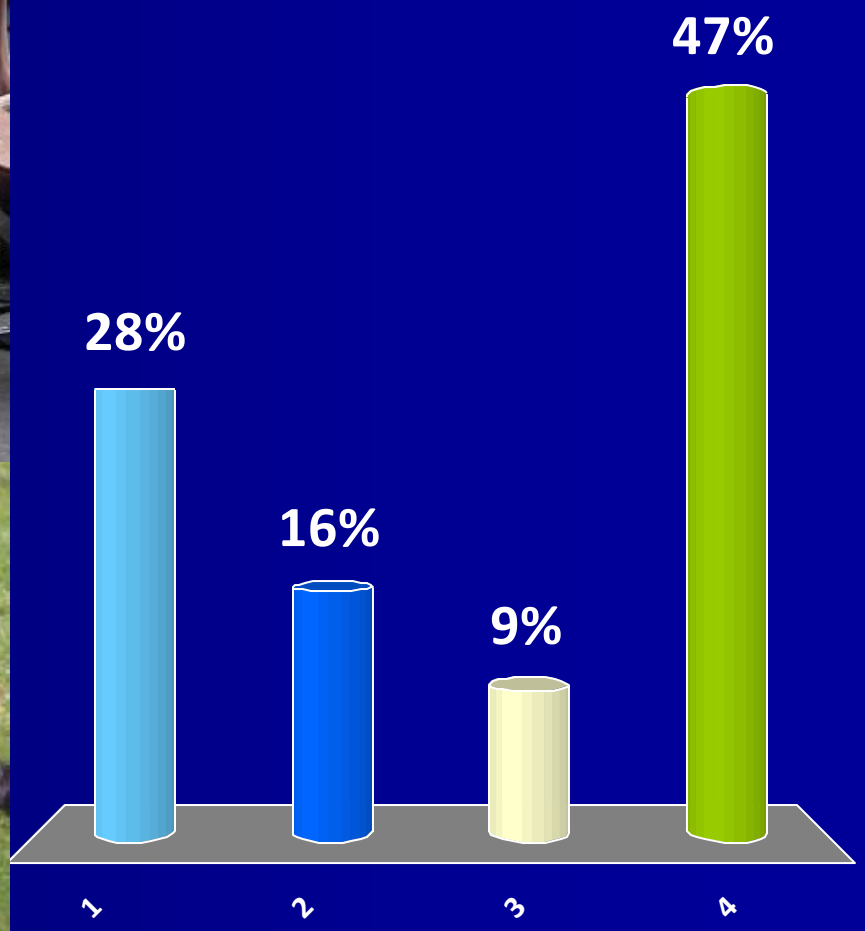
March 1, 2010 Beef Magazine Survey

http://beefmagazine.com/genetics/beef-asked-answered-20100301



Base = 635 (All Cow-Calf Operations)

Where we are in 2010

- Multigenic marker panels are the norm
- Number of traits, markers and versions of tests are growing exponentially
- Breed-specific panels (Angus) being marketed
- Companies looking to expand breed coverage
- Multiple different reporting systems (1-10, GPD, MVP, MBV), requires choice between marker data and EPDs
- Dual sources of information encourages the use of DNA results as a sales rather than a genetic improvement tool
- There is a need for "Marker-Assisted EPDs"
- Angus association has prototyped this with carcass traits

? Which do you think is Matt Spangler's dog?