Improving EPD accuracy by combining EPD information with DNA test results

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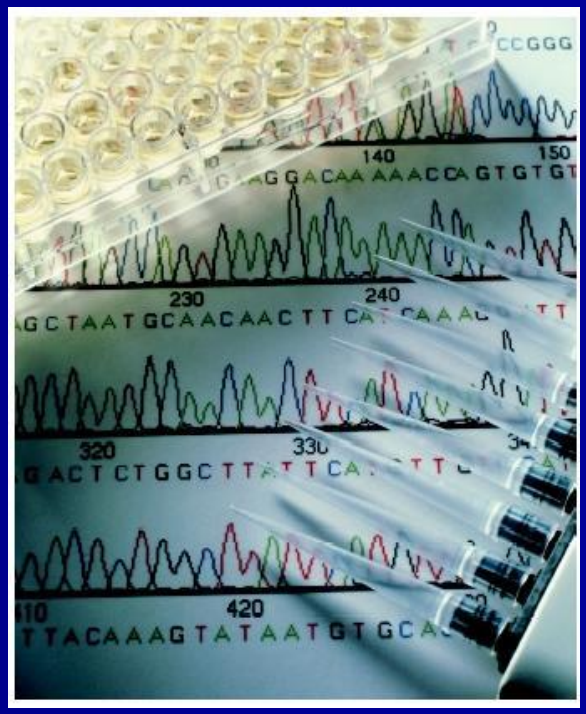


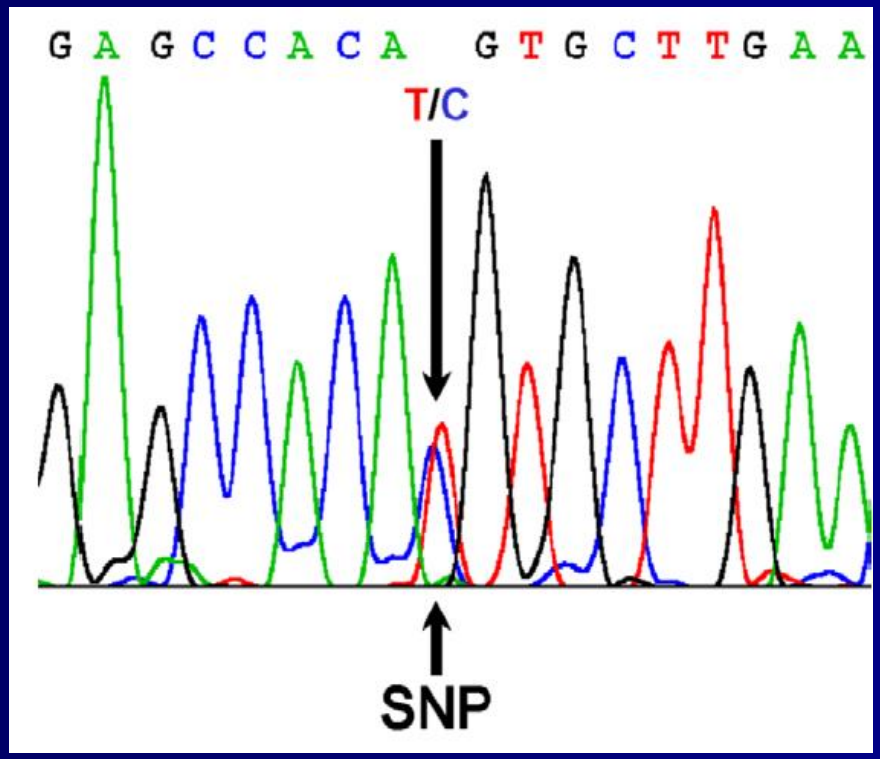
animalscience.ucdavis.edu/animalbiotech

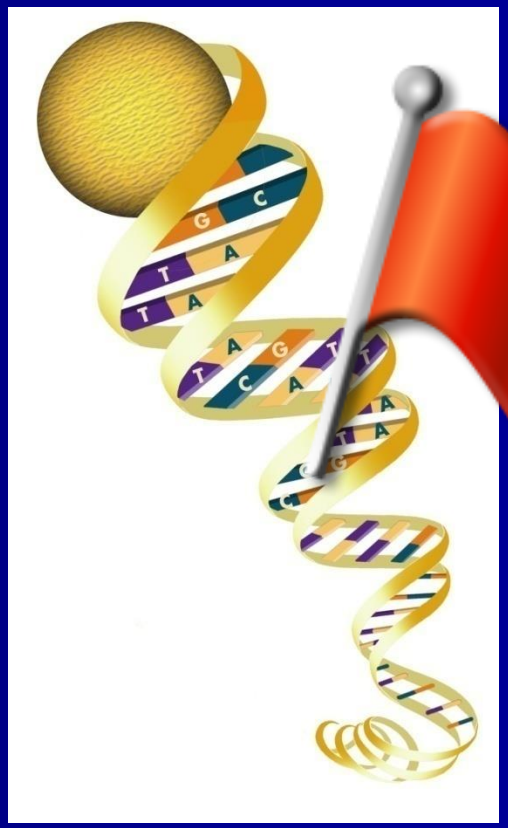
Animal breeders have used the resemblance between relatives to select parents of the next generation and make genetic change

Rate of change is accelerated when breeders can accurately identify those individuals that have the best genetics i.e. breeding value

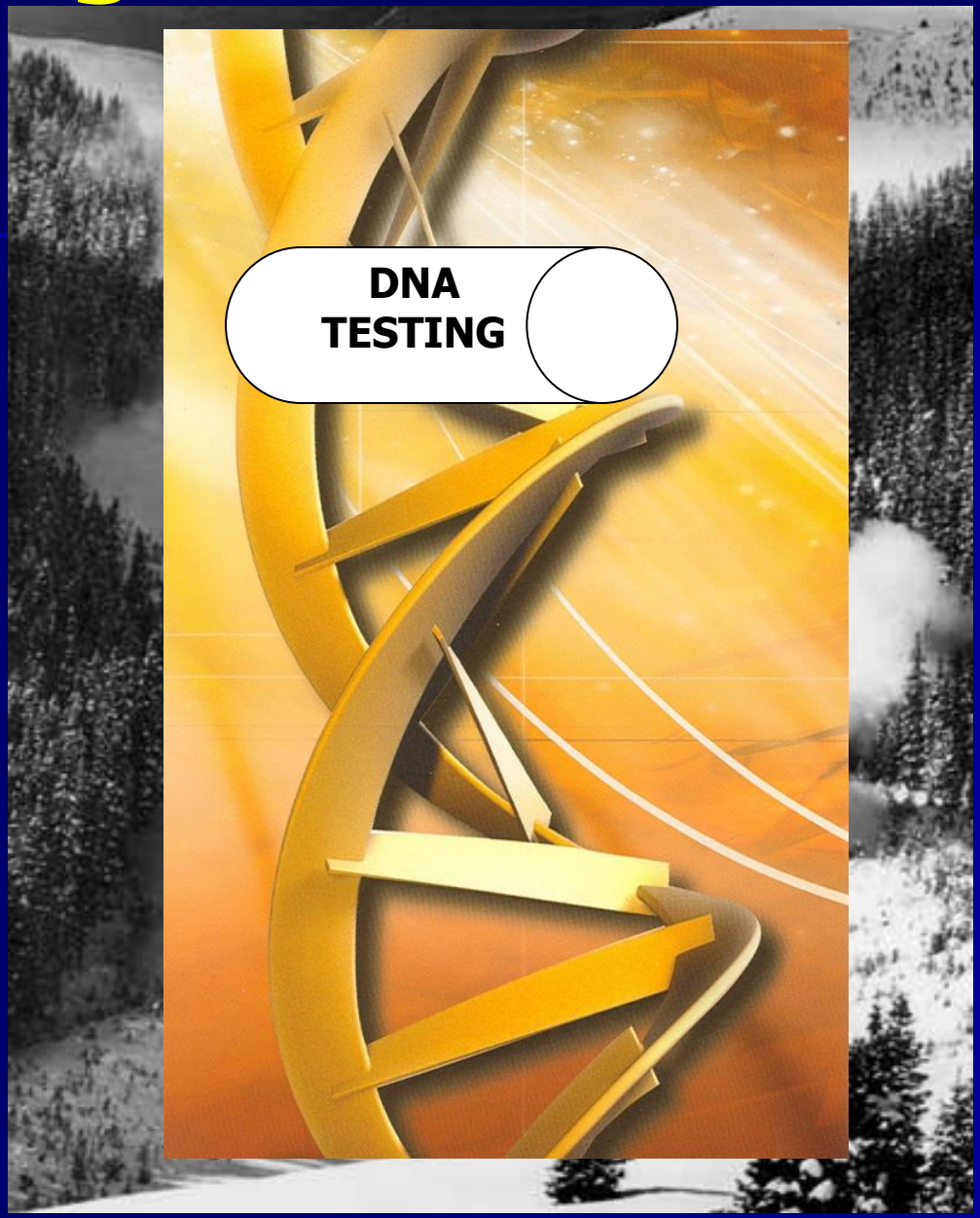
$$\Delta G = \frac{\textit{intensity of selection } X \textit{ accuracy of selection } X \sqrt{\textit{genetic variance in population}}}{\textit{generation interval}}$$

Now we want to use DNA variations (SNPs) in addition to pedigree information to help us select the best animals





The genomics avalanche



Let's visit the past

- What is DNA?
- What is a genetic marker (DNA test?)
- Where have we been?
- First tests on the market
- Marker panels
- Reporting of results to producers
- Where we are now
- Where we are headed

The genome age

genome

cell

chromosomes

genes

DNA

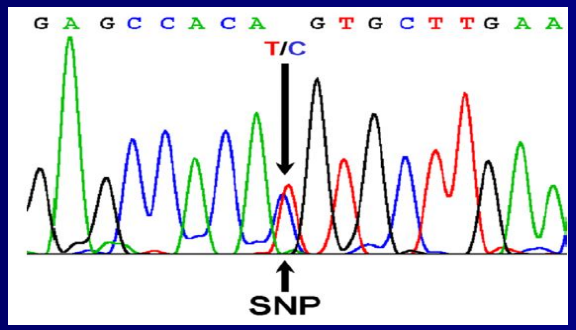
proteins

GENES CONTAIN INSTRUCTIONS FOR MAKING PROTEINS

PROTEINS ARE THE BUILDING BLOCKS OF LIFE AND COLLECTIVELY ACT TO DETERMINE PHENOTYPE

What is a Genetic Marker ?

A DNA sequence variation that has been associated with a given trait in one or more populations



SIMPLE TRAITS
e.g. Coat Color
Double muscling

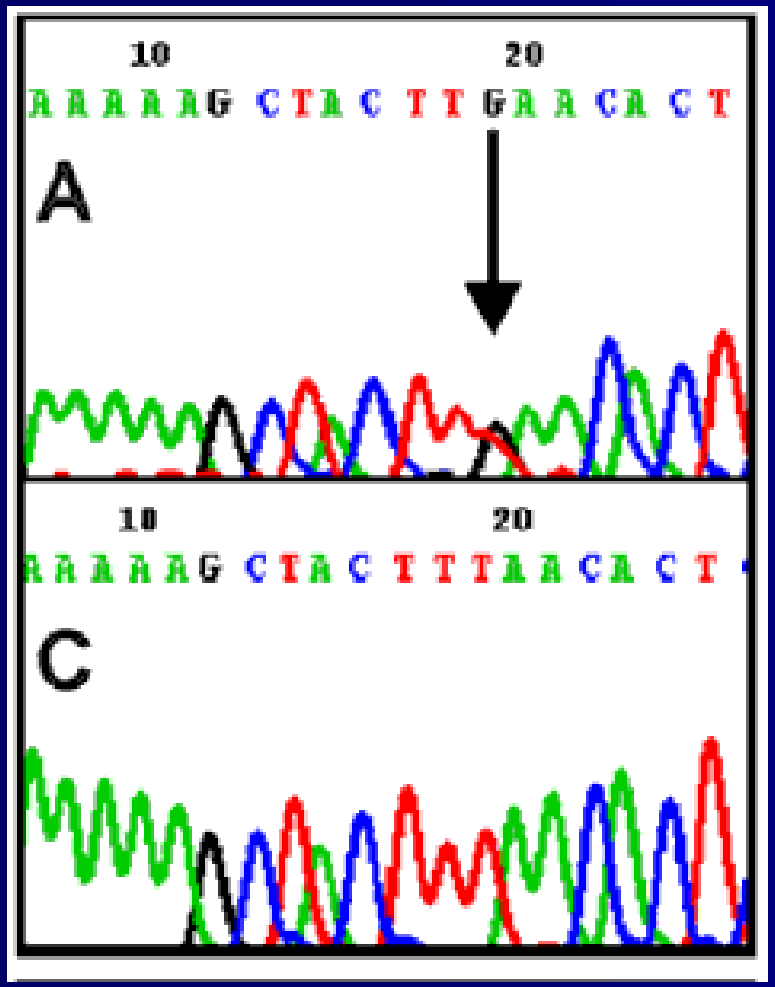
100 %
GENETICS

COMPLEX TRAITS
e.g. Marbling (h^2 = 0.37)

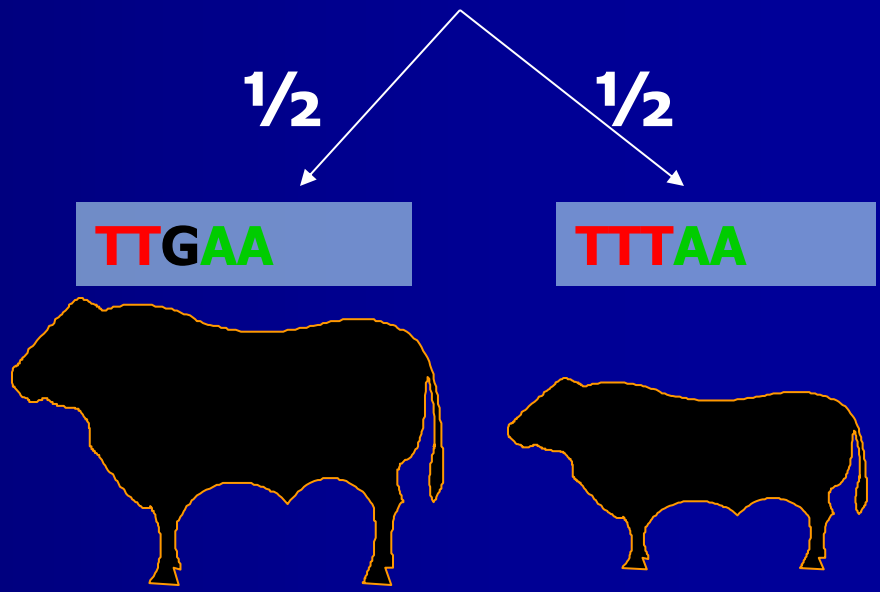
37%
GENETICS

63%
ENVIRONMENT

Genotyping



Heterozygous bull



Merial, Quantum sign leptin test pact.(Business Report)

Publication: Feedstuffs

Publication Date: 04-AUG-03

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B-Bridge International ELISA Assays for Metabolic Studies Adipocytokines, esRAGE, HGF

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SASKATOON, SASK., and DULUTH, GA. -- Quantum Genetics Inc. and Merial Ltd. announced July 23 that they have entered into a global marketing agreement to provide Merial with exclusive rights to market Quantum's new patent-pending DNA test to determine an animal's leptin genotype.

The leptin protein has been demonstrated...

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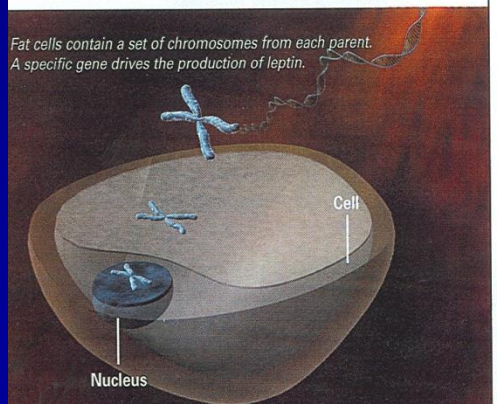
A lot of detail about the marker

Introduction to the Leptin Protein in Cattle

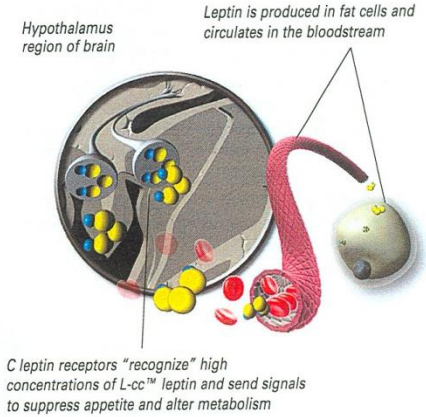
- Leptin is a protein that influences appetite and metabolism (energy storage and utilization).
- Leptin is produced by fat tissue stored by the body as energy reserves. The more fat tissue, the higher the leptin concentration circulating in the blood.
- High concentrations of leptin normally signal the brain to suppress appetite and draw on stored energy for maintenance.
- Certain types of leptin are not easily recognized by the brain, so appetite and metabolism are not changed.
- The IGENITY™ L Test can identify the genetic variation that determines what type of leptin an animal will produce.

The function of leptin.

- Leptin is the centerpiece of an important negative feedback system involving key metabolic regulators, including insulin, glucocorticoids and the sympathetic nervous system.
- The word "leptin" comes from the Greek word *leptos*, meaning "thin."
- Genotype determines what type of leptin is produced by fat tissues and, to a lesser extent, the type of leptin receptors that operate in the hypothalamus.



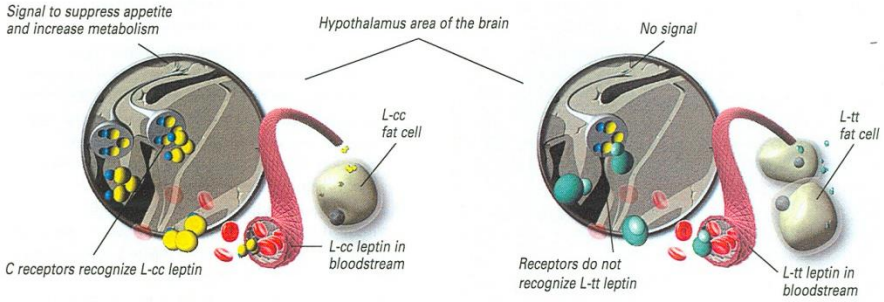
- Leptin is involved in a feedback system involving the hypothalamus region of the brain:
  - When leptin receptors recognize high concentrations of leptin, they send signals to suppress appetite and increase metabolism.
  - If high leptin levels are not recognized, the animal senses hunger and the system focuses on storing energy in many forms, including intramuscular fat.
- The gene that carries the code for leptin production has been called the "obese" gene or "marbling" gene because of leptin's association with appetite and fat deposition.
- When cytosine (c) is present at the gene sites for leptin production, normal leptin results. When thymine (t) is present, this changes the amino acid structure of leptin – disguising it.
- If an animal has one chromosome with a "c" at the critical site and one containing a "t," then it creates both types of leptin.
- The science behind the IGENITY L Test identifies leptin genotype and provides valuable knowledge for feeding and breeding decisions.



C leptin receptors "recognize" high concentrations of L-cc™ leptin and send signals to suppress appetite and alter metabolism

Igenity™ L. Know. Now.

Not All Leptin is Created Equal



Activity of L-cc™ Leptin and Receptors

- As L-cc leptin proteins reach the blood-brain barrier, receptors recognize them.
- If concentration is high, a signal is sent to suppress appetite.

Activity of L-tt™ Leptin and Receptors

- The L-tt leptin is structurally different and is more difficult for receptors to recognize. As a result, there is no signal to reduce appetite.
- L-ct™ cattle produce both types of leptin – some normal, some difficult to recognize.

Leptin Genotype. It pays to know now.

- Identifying leptin genotype – and selectively breeding for desired leptin genotype – can have a great impact on a dairy or beef operation.
- The benefits can extend beyond increased milk production or beef marbling to greater management options for ration selection and transition cow nutrition, or beef finishing and marketing strategies.
- The beneficial result is that cattle with the L-tt genotype remain in a "hunger" mode and are predisposed to consume more feed:
  - In dairy cattle, this can result in greater dry matter intake (DMI), greater peak lactation, improved body condition scores and improved energy utilization (less time spent in negative energy balance).
  - In beef cattle, this can result in greater DMI and superior marbling.
- On the other hand, L-cc genotype cattle will tend to have lower DMI at critical phases, such as the first 100 days of lactation in dairy cows, or the final 60 days on feed for beef cattle.
- The science behind the IGENITY L Test provides a simple DNA test to identify leptin genotype with 100% accuracy.

MERIAL
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igenity L™
Know. Now.

9/19/03

BOVIGEN....

GeneSTAR®

MARBLING

GeneSTAR™ Marbling is a DNA genetic marker test offered by **Bovigen Solutions,℠ L.L.C.** for a major gene (Thyroglobulin) associated with marbling. This marker provides beef producers the opportunity to determine an animal's potential for improved marbling more accurately and at an earlier age.

Marbling Results (% Choice) Difference

	0	★	★★	★★ & 0
Yearling Fed	58%	62%	74%	16%
Calf Fed	34%	41%	53%	19%
NBCEC Trial[1]	47%	54%	64%	17%

In independent trials on over 1500 head, 2-STAR animals produced 16-19% more choice carcasses than 0-STAR animals. Equally important was the effect that the proportion of carcasses qualifying for premium Quality Grades doubled (21% vs. 10%) in 2-STAR carcasses versus 0-STAR.

[1] Trial was a study conducted by an independent third party.
- National Beef Cattle Evaluation Consortium.

LEGEND

The results of the GeneSTAR™ tests are reported as:

★★ 2-STARS = two copies of the desired gene

★ 1-STAR = one copy of each form of the gene

0 0-STARS = no copies of the desired gene

BOVIGEN SOLUTIONS, LLC℠

"DNA technology, although in its infancy in the beef cattle industry, can help us by identifying genes that effect marbling and tenderness. Tenderness seems to be one that interests many who produce and have concerns for improving end product value for our consumers. The GeneSTAR™ testing at Summitcrest has identified a number of cattle homozygous for marbling and tenderness genes. Having done that, we added market value to our cattle and new customers, even from other breeds of cattle, with tenderness concerns."

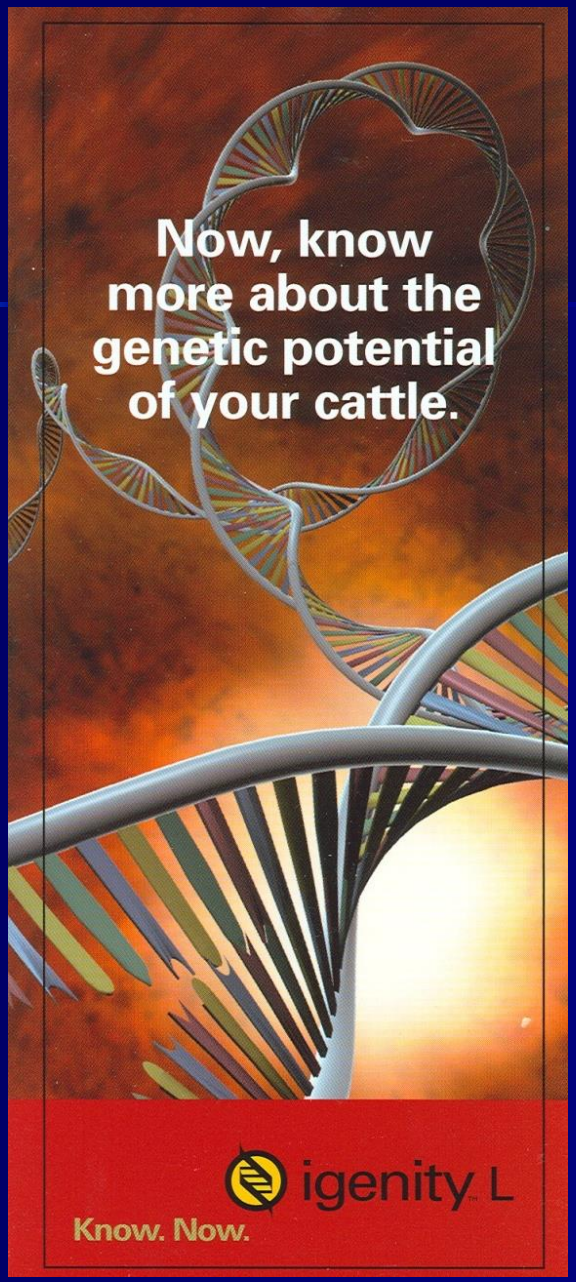
- Henry Bergfeld, Summitcrest Farms

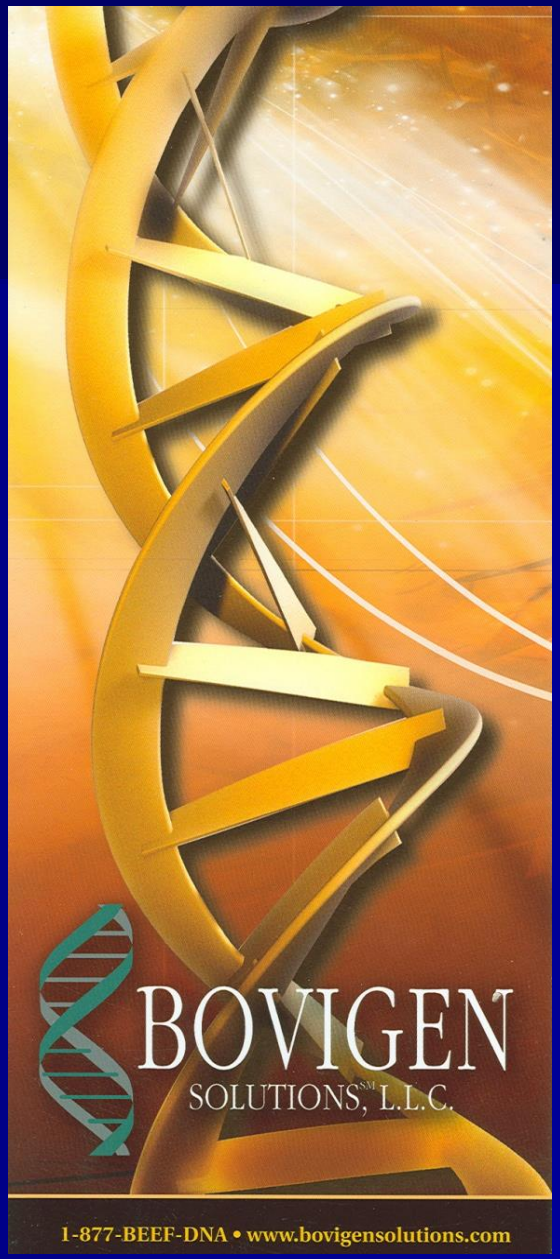
HOW DO I USE THIS IN MY BREEDING PROGRAM?

Using 2-STAR sires is the quickest way to influence the presence of these genes in a herd. In addition, selecting 2-STAR females will more rapidly increase the frequency of the positive forms of these genes. Overall, selecting 2-STAR animals with appropriate EPDs and good structural and breeding soundness is the recommended way forward.

Mating Design

Sire is	Dam is	% of Progeny 0	★	★★
0	0	100%		
0	★	50%	50%	
0	★★		100%	
★	0	50%	50%	
★	★	25%	50%	25%
★	★★		50%	50%
★★	0		100%	
★★	★		50%	50%
★★	★★			100%


Now, know more about the genetic potential of your cattle.
igenity L
Know. Now.


BOVIGEN
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1-877-BEEF-DNA • www.bovigensolutions.com

Igenity L was a single T/C SNP test for Leptin

igenity™

Know. Now.

Advanced technology. Advanced knowledge.

What if there was a test that could tell you – in advance – an animal's genetic potential for energy utilization or carcass quality? You'd have the advantage of knowing an animal's potential now, instead of discovering it later through success or failure in the milk string or when the animal goes to market.

Researchers have discovered the specific gene that carries the code for the production of a protein called *leptin*. Leptin is associated with an animal's potential for appetite and energy utilization, among other things.

- For *dairy cattle* this translates directly into maximum dry matter intake (DMI) and peak milk production.
- For *beef cattle* it relates to days on feed and carcass quality.

The IGENITY™ L Test identifies leptin genotype (L-tt™, L-ct™ or L-cc™). Now you have another important resource to help you breed, feed, sort, manage and market cattle at an optimum level.

Igenity™ L. Know. Now.

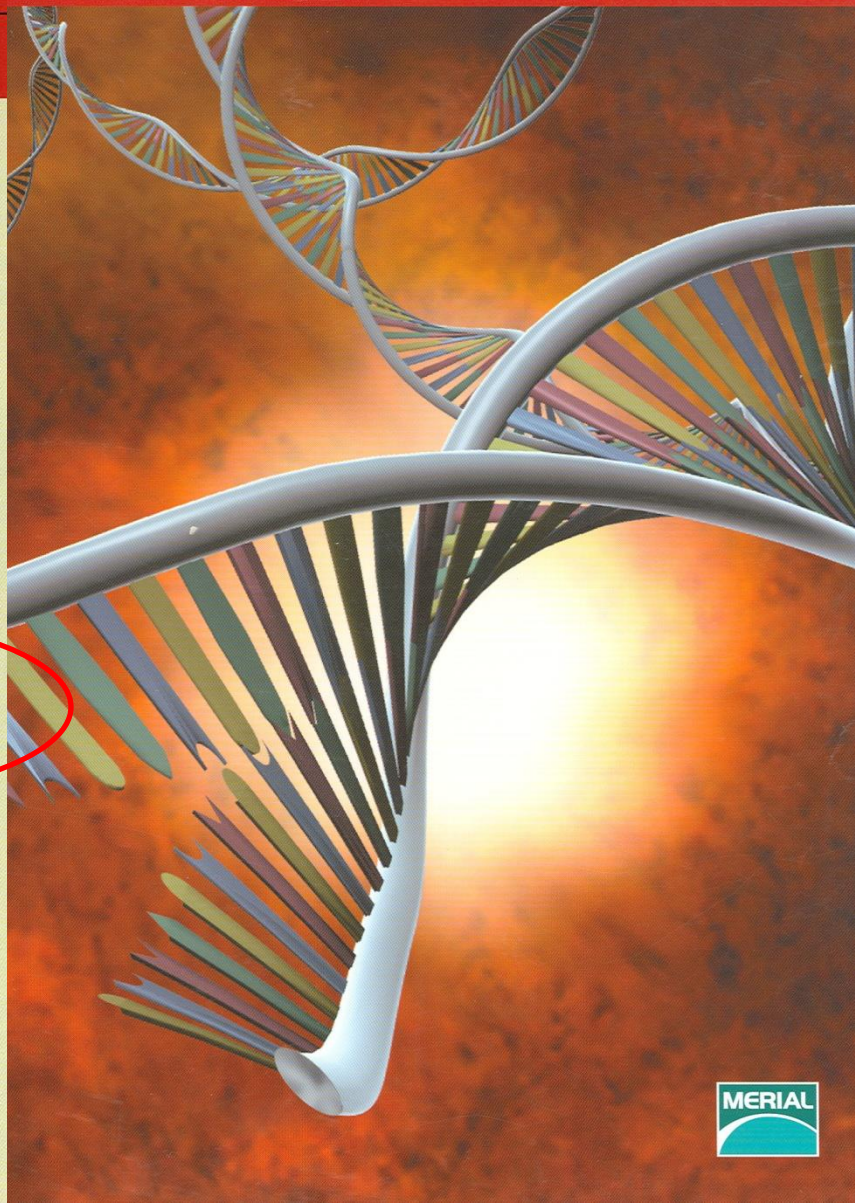
- Leptin is involved in the regulation of feed intake, energy balance, milk production, milk components, marbling scores, puberty, fertility and immune functions.
- Knowing an animal's leptin genotype empowers you to make more informed, strategic management decisions regarding breeding and nutrition.
- The IGENITY L Test identifies an animal's leptin genotype at the DNA level, with 100% accuracy.

Market your cattle with the IGENITY L logo system:

L-tt™

L-ct™

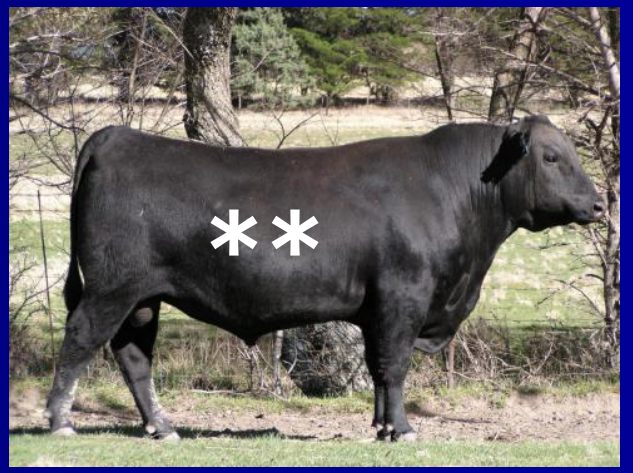
L-cc™



MERIAL

Which would you rather have???

- A bull that is ‘homozygous’ for a positive genetic variant with a low-accuracy EPD of +3, or

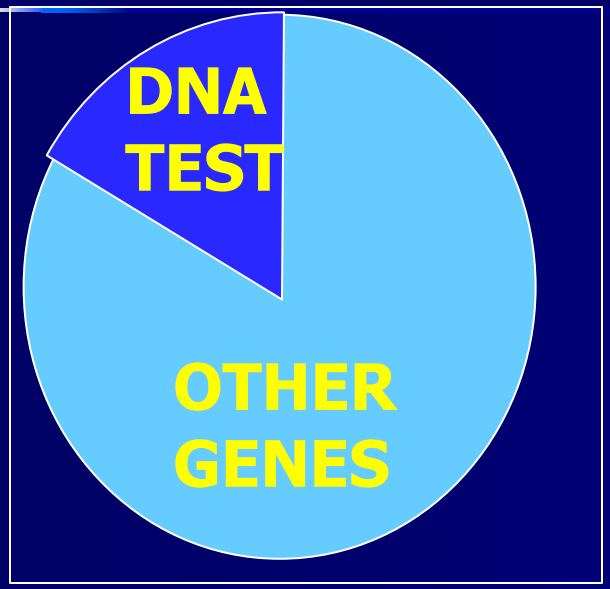


- Or an unrelated bull carrying no copies of that genetic variant with a low-accuracy EPD of +3

Both are important!!

- The 'homozygous' bull is a source of favorable alleles (genetic variant) of the gene. Can eventually be used to create homozygous calves
- The other bull contributes favorable unmarked alleles of other genes, which will improve the frequency of other desirable alleles for the trait.
- Breeding the marker-associated form of the gene into the bull that has no copies should improve the trait by combining all of the good forms of the genes together in one animal

DNA TEST FOR MARBLING EXPLAINS SOME % (r^2) OF GENETIC VARIATION



37% GENETICS

63% ENVIRONMENT

EPD estimates all genes

Validation

Prior to moving genetic markers from discovery populations to commercialization, it is important to validate their purported effects on the trait(s) of interest in the target population and different breeds and environments, and assess them for correlated responses in associated traits

Independent validation of DNA tests http://www.nbcec.org/nbcec/

NBCEC - Windows Internet Explorer

http://www.ansci.cornell.edu/nbcec/

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NBCEC

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Home Page

National Beef Cattle Evaluation Consortium
Colorado State University-Cornell University-University of Georgia

Home | Background | Sample Populations | Marker-Assisted Selection | Glossary

Commercial genetic test validations

GeneSTAR | IGENITY profile | MMI Genomics | Ancillary Results

The purpose of the NBCEC commercial DNA test validation is to independently verify associations between genetic tests and traits as claimed by the commercial genotyping company using phenotypes and DNA from reference cattle populations

The validation process is a partnership of the owners of DNA and phenotypes (e.g., breed associations) and genomics companies, facilitated by the NBCEC

Home

Background

Sample Populations

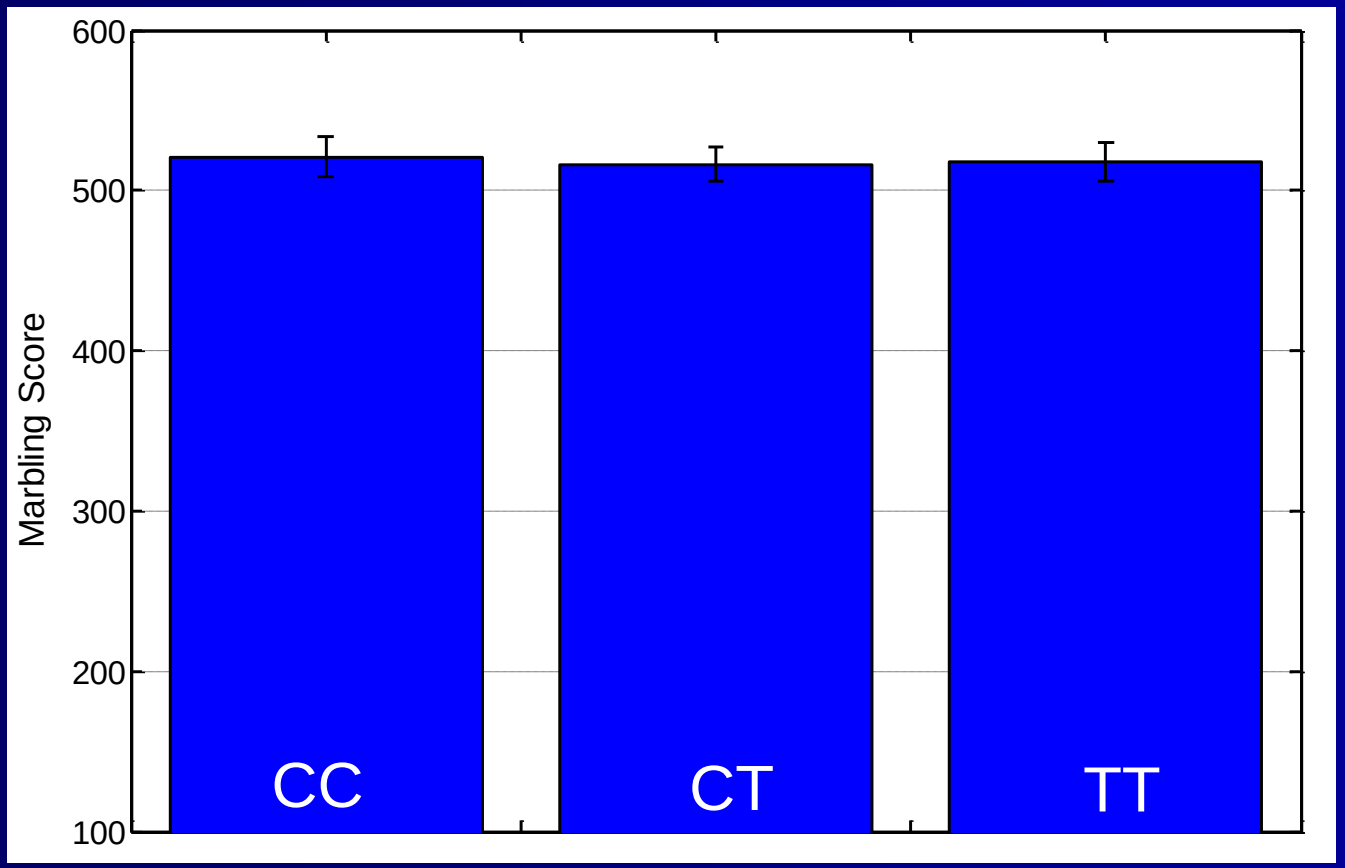
Marker Assisted Selection

Glossary

A. L. Van Eenennaam, J. Li, R. M. Thallman, R. L. Quaas, M. E. Dikeman, C. A. Gill, D. E. Franke, M. G. Thomas. 2007. Validation of commercial DNA tests for quantitative beef quality traits. Journal of Animal Science. 85:891-900.

Leptin Genotype Effects on Marbling Score (NBCEC Data)

National Beef Cattle Evaluation Consortium
Colorado State University-Cornell University-University of Georgia



Data provided by R. L Quaas, Cornell

Recap of early product offerings

- Single gene tests reported as actual results of genotyping (** or AT)
- Great deal of explanation of what the gene was and how it had its effect
- DNA-test billed as 100% accurate
- The need for third-party validation of commercial tests becomes evident
- A lot of emphasis was put on a single SNP

First multi-gene test arrives

TENDERNESS

GeneSTAR® Tenderness was the first multi-gene single trait DNA test commercially available to the beef industry. It combines test results for several markers and genes for the same trait. The test is based, in part, on two genes involved in the post-mortem tenderization process: Calpastatin and Calpain. Calpain is an enzyme which weakens muscle fibers thereby making the fibers more tender. Calpastatin is an enzyme which inhibits the post-mortem tenderization process by inhibiting the effects of Calpain.

GeneSTAR® Tenderness Genetic Progeny Difference*

T1	T2	T3	GPD™ Lbs. Shear Force
★★	★★	★★	-2.2
		★	-1.8
		0	-1.4
	★	★★	-1.8
		★	-1.4
		0	-1.0
	0	★★	-1.5
		★	-1.1
		0	-0.7
★	★★	★★	-1.8
		★	-1.4
		0	-1.0
	★	★★	-1.5
		★	-1.1
		0	-0.7
	0	★★	-1.1
		★	-0.7
		0	-0.3
0	★★	★★	-1.5
		★	-1.1
		0	-0.7
	★	★★	-1.2
		★	-0.8
		0	-0.3
	0	★★	-0.8
		★	-0.4
		0	-0.0

** Values derived from Independent Validation Population*

MATING DESIGN

As an added tool to GPDs™, the Mating Design table shows the predictable results which can be obtained through planned breeding decisions utilizing DNA test results from Bovigen.

SIRE IS	DAM IS	% of Progeny ★★	★	0
★★	★★	100%		
★★	★	50%	50%	
★★	0		100%	
★	★★	50%	50%	
★	★	25%	50%	25%
★	0		50%	50%
0	★★		100%	
0	★		50%	50%
0	0			100%

This Mating Design illustrates Mendelian Heredity and the probability of results from mating a 0,1 or 2 STAR Sire and Dam.

DNA tests should be considered additional information to be used in conjunction with available performance data for each animal. When comparing two bulls with similar EPDs, GeneSTAR® GPD™ results can be used to further evaluate an animal's true genetic potential.

BOVIGEN COMPANY PROFILE

Bovigen, LLC is an innovative-driven genomics company developing a portfolio of world class DNA technological products. Our mission is to promote excellence in the beef industry through

IGENITY® TenderGENE™

A practical, powerful tenderness selection tool.

What do you bring to the table?

igenity®

IGENITY® TenderGENE.™

The inside track to tender beef.

IGENITY® TenderGENE™ profiles the tenderness potential of an animal and is:

- A powerful and comprehensive tenderness selection tool
- Fully validated by the National Beef Cattle Evaluation Consortium (NBCEC)
- Informative in all breed types, including *Bos indicus*

IGENITY TenderGENE analyzes multiple markers associated with the calpain and calpastatin genes. Both of these genes are important for profiling an animal's potential for tenderness:

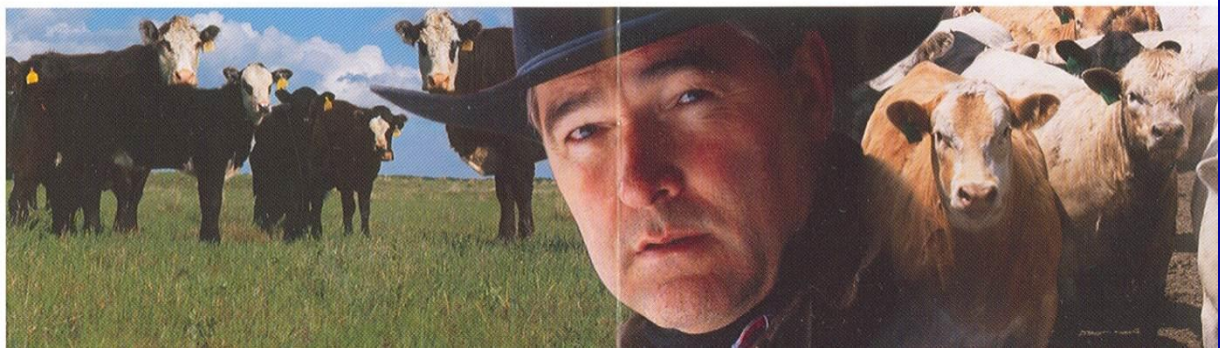
- Calpain enzymes weaken muscle fibers during the post-mortem aging process.
- Calpastatin interacts with the calpain enzymes to impact overall tenderness.

Together they have a significant effect on tenderness as measured by Warner-Bratzler Shear Force (WBSF). In fact, in independently validated research, the calpain and calpastatin markers included in IGENITY TenderGENE are associated with **improving tenderness as much as 2.3 lb.**

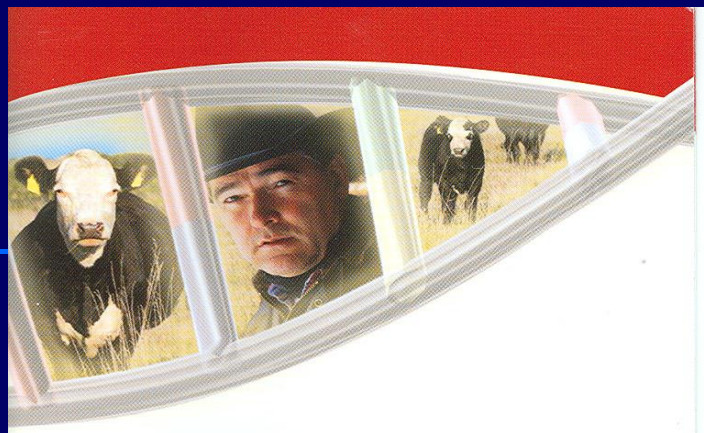
The benefits of IGENITY TenderGENE are proven.

- IGENITY TenderGENE includes markers discovered by researchers at the U.S. Meat Animal Research Center (MARC) and the University of Guelph.
- IGENITY TenderGENE is a powerful tenderness test that is fully validated by the NBCEC.
- Validation work involved cattle from the NCBA National Carcass Merit Project.
- Research included more than 1,200 animals, representing all breed types.
- Because of the favorable effect on WBSF of **up to 2.3 lb**, selecting for tenderness using IGENITY TenderGENE can help ensure a quality eating experience for consumers.

Learn how this inside information can give you a competitive edge. Call 1-877-IGENITY.



First multi-trait test arrives



Practical ways to profit from the IGENITY® profile.

igenity®

A DNA test is just a test — but IGENITY is a comprehensive profile.

Here are a few of the traits that are analyzed to create the genetic potential expressed in an IGENITY profile.*

- **Maternal and reproductive traits**
  - Heifer pregnancy rate
  - Calving ease
  - Stayability
- **Carcass composition traits**
  - Tenderness
  - Ribeye area
  - Fat thickness
  - Marbling
  - Yield grade
  - Hot carcass weight
  - Quality grade
- **Docility**
- **Coat color**
- **Parentage in multiple-sire settings**
- **Breed-specific horned/polled**
- **Commercial Ranch Genetic Evaluation** option for calculating in-herd EPDs
- **BVD-PI status**

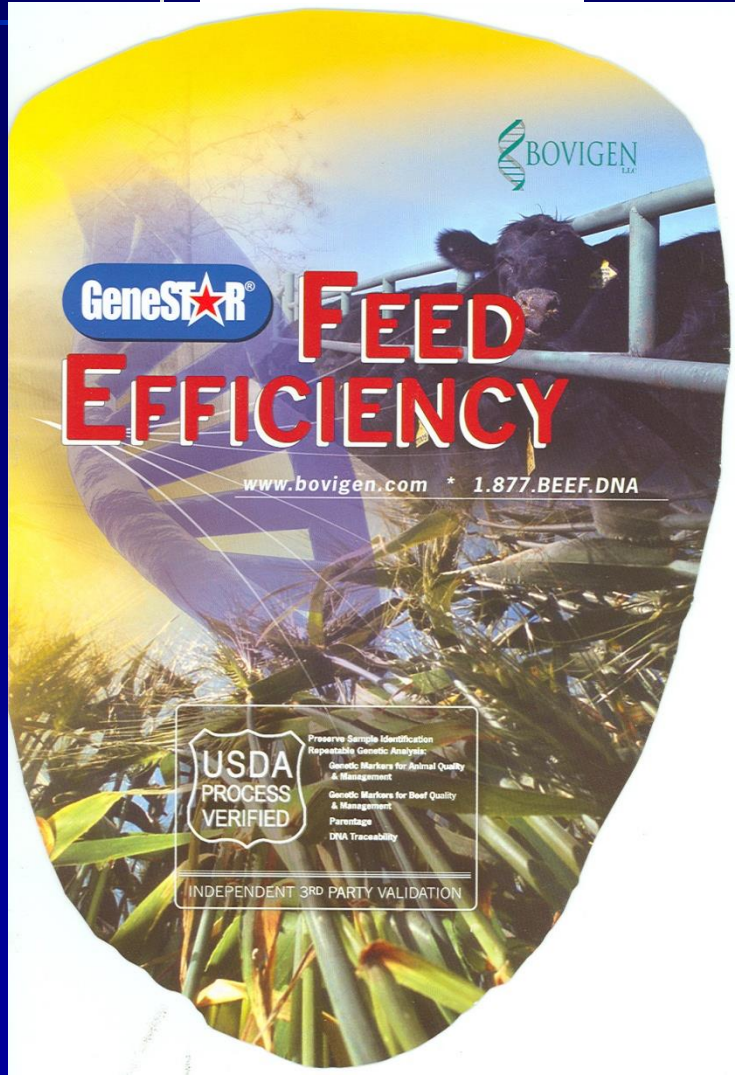
*For the most current list of economically important traits included in the IGENITY profile, please visit www.igenity.com.

The IGENITY profile is the most comprehensive and researched tool of its kind. Each of the DNA analyses are validated in a minimum of four separate commercial populations with different environments and breeds. The effects of the IGENITY profile also are confirmed in a landmark project involving 50,000 head of DNA-profiled cattle.

GeneSTAR®

★★ Tenderness

★★ Marbling



GeneSTAR® DNA Test Results						
	FE1	FE2	FE3	FE4	Total	GPD
Feed Efficiency	★★	★	★	★★	6	-3.2

In this example, the results describe an animal for Feed Efficiency. The genes identified for Feed Efficiency thus far, identify cattle with lower Net Feed Intake (NFI). Cattle with lower NFI will eat less without sacrificing ADG or any other performance trait. The animal in this example will consume 3.2 lbs less feed per day and still have the same ADG and Marbling potential as the rest of his contemporary group. Simply put, the more STARS for Feed Efficiency, the less feed consumed without sacrificing any performance!!!

GeneSTAR® DNA Test Results					
	T1	T2	T3	Total	GPD
Tenderness	★★	★	★★	5	2

In this example, the results describe an animal for its Tenderness potential. Nationwide, tenderness is measured by Warner-Bratzler Shear Force, or the pounds needed to cut a core sample from a ribeye. The animal in this example will produce a ribeye that is 2.0 pounds more tender than an animal without the STARS for tenderness.

The GeneSTAR Tenderness panel continues to lead the industry in identification of markers for one of the most valuable traits for producing a quality eating experience. GeneSTAR animals that are homozygous for all the Tenderness markers (T1, T2, T3) show a difference in Tenderness that virtually eliminates the "unsatisfactory eating experience" that plagues nearly 25% of all carcasses compared to an animal devoid of these genes.

GeneSTAR® DNA Test Results						
	QG1	QG2	QG3	QG4	Total	GPD
Quality Grade	★★	★	★★	★	6	27.42

In this example, the results describe an animal for Quality Grade. The genes identified thus far for Quality Grade work across all breeds and identify animals with a greater chance of grading Choice or higher. The animal in this example has a 27.42% greater chance of grading Choice or higher than an animal with out the STARS for Quality Grade.

1.877.BEEF.DNA www.bovigen.com
250 Plauche St. Harahan, LA 70123

USDA PROCESS VERIFIED

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

MMI Genomics, Inc.

BREED TRU

DNA VERIFIED

PROVEN TECHNOLOGY
PROVEN RESULTS
PROVEN PROFITS

1756 Picasso Avenue
Davis, CA 95618
1.800.311.8808
www.breedtru.com

MMI Genomics, Inc. is a wholly-owned subsidiary of MetaMorphix, Inc.

Work in Your Best Genes

TRU-MARBLING™

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*

Explains 70% of the genetic variation in marbling with 128 markers

Tru-Marbling™ has also been validated against commercial cross-bred feeder cattle populations. This study utilized 89 marbling markers that are a subset of the 128 markers used in the purebred Angus population. The data clearly demonstrates the relationship between quality grade and average Molecular Genetic Value (MGV).

	STEERS			HEIFERS		
Quality Grade	**Number**	**% of total**	**Avg. MGV**	**Number**	**% of total**	**Avg. MGV**
Prime	9	0.1%	14	5	0.1%	14
High Choice	93	1.1%	20	78	1.3%	12
Medium Choice	475	5.8%	14	423	7.0%	9
Low Choice	2008	24.3%	7	1526	25.2%	0
High Select	3989	48.3%	-6	2835	46.9%	-9
Low Select	1344	16.3%	-14	915	15.1%	-20
No Roll	337	4.1%	-20	268	4.4%	-23
Totals	**8255**	**100.0%**		**6050**	**100.0%**	

14,305 head tested from 6 commercial feedlots
Unlike other products, Tru-Marbling™ MGVs account for a highly significant amount of variation for marbling score.

Work in Your Best Genes

TRU-TENDERNESS™

One in a series of break-through products that will advance breeding practices in the cattle industry, *Tru-Tenderness*™ is a powerful and comprehensive DNA selection tool that can determine the genetic potential of animals to produce tender meat. 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 valuable consumer trait.

Tru-Tenderness™ is a DNA-based genetic test that contains a panel of 11 unique DNA markers, each one highly associated with expression for tender meat. By measuring the cumulative effects for each of these 11 markers, *Tru-Tenderness*™ accounts for a substantial proportion of the total genetic variation for this complex metabolic trait.

Since tenderness can only be measured in harvested cattle it is difficult, time consuming and expensive to make genetic progress for this trait using traditional genetic improvement tools. *Tru-Tenderness*™ changes this paradigm by allowing producers to accurately assess the genetic potential of their breeding stock to produce tender meat. In addition, *Tru-Tenderness*™ also shortens the interval for making genetic progress because it can be used to test animals of any age.

Tru-Tenderness™ 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 tenderness within herds and the ability to determine the "Tru" genetic potential of animals.

PROVEN RESULTS

Tru-Tenderness™ has been validated in Angus 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-Tenderness*™ accounts for 100% of the genetic variation observed in this population as measured by Warner-Bratzler shear force.

No. of samples:	407
Heritability*:	0.35
No. of markers:	11
Phenotypic variation explained (R^2):**	0.38
As a percent of Heritability	100%

** as estimated in Minick et al, 2004, Can. J. Anim. Sci. 84:59*
*** estimated from a model that included contemporary group and MGV*

Explains 100% of the genetic variation in tenderness

Results reported on 1-10 scale

The IGENITY profile. Comprehensive. Practical. Powerful.

It's easy to understand an IGENITY profile.

One of the greatest values of the IGENITY profile is that all results are integrated and provided in one single profile, similar to the report shown here.

IGENITY Profile

Animal ID	M/F	Breed	Sample Barcode #	Tenderness	Red/Black Coat Color	Heifer Pregnancy Rate	Yield Grade	Ribeye Area	Hot Carcass Weight	Quality Grade	Stayability	BVD-PI	Polled
701	M	-	nv011507_01	10	ED/ED	9	8	8	8	8	8	POS	Homozygous
702	F	-	nv011507_02	6	ED/ED	3	4	6	5	7	6	NEG	
704	F	-	nv011507_04	10	ED/E	7	3	8	6	6	6	POS	
705	F	-	nv011507_05	6	ED/D	3	4	6	5	5	3	NEG	

Results reported as a MGV

MOLECULAR GENETIC VALUE (MGV) REPORT

NAME	Legends of the West - Angus Farm	REPORT DATE	08/23/2006
ADDRESS	13457 Trujillo Creek Road Aguilar, CO 81020	ORIGINAL REPORT	08/23/2006
		CASE ID	MT-0059302S
		CUSTOMER	LWAF - Legends of the West Angus Farm
CONTACT	Wes Johnson, Foreman		

TRU-MARBLING and TRU-TENDERNESS REPORT

BREED	NAME	REG #	TAG/ TATTOO	SEX	BORN	SAMPLE ID	MARBLING MGV	TENDERNESS MGV
Angus	AF Paul Bunyan	19352178	AZ-105	M	06/14/2004	0539812G	-28.61	0.92
Angus	AF Casey Jones	19352211	AZ-112	M	05/29/2004	0539813G	-19.41	-3.98
Angus	AF Alamo Rising	19352385	AZ-146	M	06/19/2005	0539814G	42.79	-0.75
Angus	AF Geronimo	19352448	AZ-175	M	12/20/2004	0539815G	70.15	-4.40

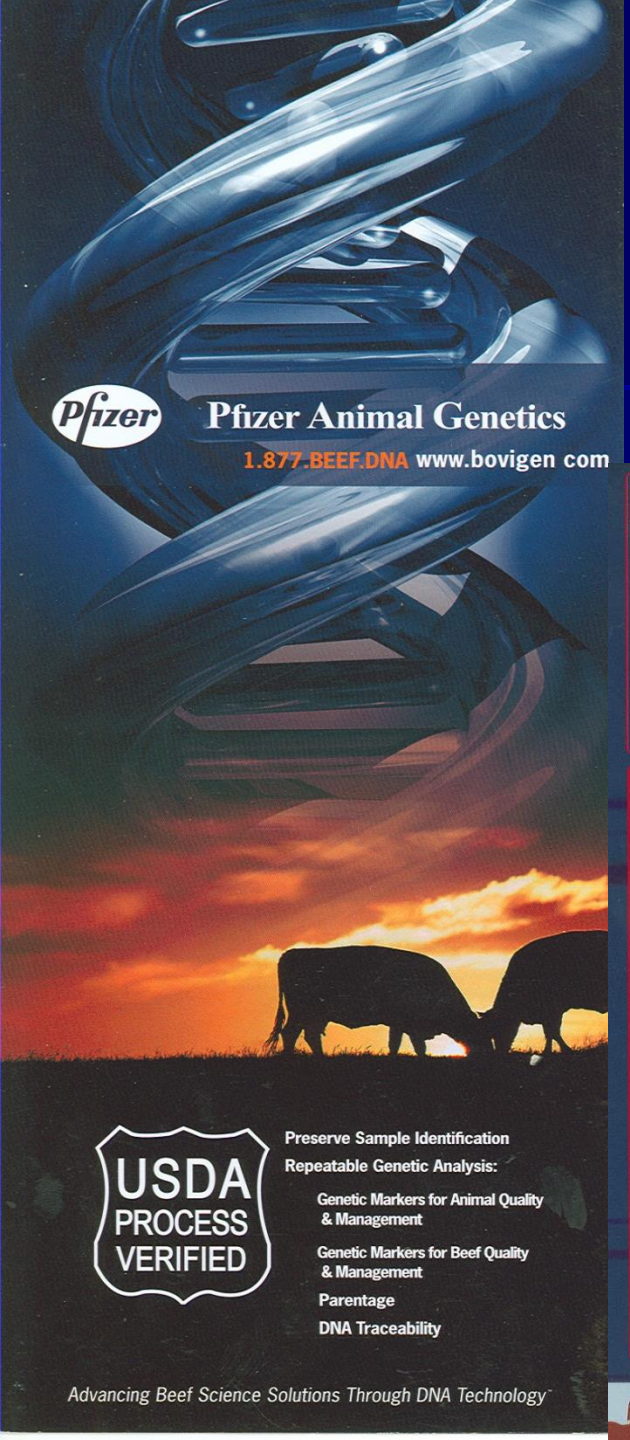
All four animals represented in the above test result have *Tru-Marbling*™ and Tru-Tenderness™ MGVs. All MGVs within a trait have the same accuracy because every animal has the same number of markers in the prediction of genetic potential.

Paul Bunyan and Casey Jones are predicted to grade in the low Select and No Roll USDA grades because of their large negative marbling MGVs. Alamo Rising and Geronimo are predicted to grade in the USDA grades of high Choice and Prime because of their high MGVs for marbling. MGVs near 0 are expected to grade in the high Select USDA grading category.

Paul Bunyan is predicted to produce tough meat with the larger MGV for *Tru-Tenderness*™. Casey Jones and Geronimo are predicted to produce very tender meat. Alamo Rising is predicted to produce acceptable tenderness, bordering on slightly tough.

These results can be used to rank bulls for their genetic potential for marbling and tenderness.

Pfizer Animal Genetics aquired Bovigen – results reported as GPD



GeneSTAR® Feed Efficiency

GeneSTAR® Feed Efficiency is based on Net Feed Intake (NFI). NFI is the difference between an animal's actual feed intake and the amount of feed an animal is expected to eat based on its size, composition and growth rate.

Calves that eat less than expected will have a negative NFI
Negative NFI = Superior Feed Efficiency
Calves that eat more than expected will have a positive NFI
Positive NFI = Inferior Feed Efficiency

GeneSTAR® GPD® Feed Efficiency

Difference between Actual and Expected Lbs consumed per day

FE 1	FE 2	FE 3	FE 4	GPD	FE 1	FE 2	FE 3	FE 4	GPD	FE 1	FE 2	FE 3	FE 4	GPD
2	2	2	2	-3.96	1	2	2	2	-3.37	0	2	2	2	-2.77
2	2	2	1	-3.74	1	2	2	1	-3.15	0	2	2	1	-2.55
2	2	2	0	-3.52	1	2	2	0	-2.93	0	2	2	0	-2.33
2	2	1	2	-3.72	1	2	1	2	-3.13	0	2	1	2	-2.53
2	2	1	1	-3.5	1	2	1	1	-2.91	0	2	1	1	-2.31
2	2	1	0	-3.28	1	2	1	0	-2.68	0	2	1	0	-2.09
2	2	0	2	-3.48	1	2	0	2	-2.88	0	2	0	2	-2.29
2	2	0	1	-3.26	1	2	0	1	-2.66	0	2	0	1	-2.07
2	2	0	0	-3.04	1	2	0	0	-2.44	0	2	0	0	-1.85
2	1	2	2	-3.04	1	1	2	2	-2.44	0	1	2	2	-1.85
2	1	2	1	-2.82	1	1	2	1	-2.22	0	1	2	1	-1.63
2	1	2	0	-2.6	1	1	2	0	-2.0	0	1	2	0	-1.41
2	1	1	2	-2.79	1	1	1	2	-2.2	0	1	1	2	-1.6
2	1	1	1	-2.57	1	1	1	1	-1.98	0	1	1	1	-1.38
2	1	1	0	-2.35	1	1	1	0	-1.76	0	1	1	0	-1.16
2	1	0	2	-2.55	1	1	0	2	-1.96	0	1	0	2	-1.36
2	1	0	1	-2.33	1	1	0	1	-1.74	0	1	0	1	-1.14
2	1	0	0	-2.11	1	1	0	0	-1.52	0	1	0	0	-0.92
2	0	2	2	-2.11	1	0	2	2	-1.52	0	0	2	2	-0.92
2	0	2	1	-1.89	1	0	2	1	-1.3	0	0	2	1	-0.7
2	0	2	0	-1.67	1	0	2	0	-1.08	0	0	2	0	-0.48
2	0	1	2	-1.87	1	0	1	2	-1.27	0	0	1	2	-0.68
2	0	1	1	-1.65	1	0	1	1	-1.05	0	0	1	1	-0.46
2	0	1	0	-1.43	1	0	1	0	-0.83	0	0	1	0	-0.24
2	0	0	2	-1.63	1	0	0	2	-1.03	0	0	0	2	-0.44
2	0	0	1	-1.41	1	0	0	1	-0.81	0	0	0	1	-0.22
2	0	0	0	-1.19	1	0	0	0	-0.59	0	0	0	0	0.0

GeneSTAR® Tenderness

GeneSTAR® Tenderness was the first multi-gene single trait DNA test commercially available to the beef industry. It combines test results for several markers and genes for the same trait. The test is based, in part, on two genes involved in the post-mortem tenderization process: Calpastatin and Calpain. Calpain is an enzyme which weakens muscle fibers thereby making the fibers more tender. Calpastatin is an enzyme which inhibits the post-mortem tenderization process by inhibiting the effects of Calpain.

GeneSTAR® GPD® Tenderness

T1	T2	T3	GPD® Lbs. Shear Force
★★	★★	★★	-2.2
		★	-1.8
		0	-1.4
	★	★★	-1.8
		★	-1.4
		0	-1.0
	0	★★	-1.5
		★	-1.1
		0	-0.7
★	★★	★★	-1.8
		★	-1.4
		0	-1.0
	★	★★	-1.5
		★	-1.1
		0	-0.7
	0	★★	-1.1
		★	-0.7
		0	-0.3
0	★★	★★	-1.5
		★	-1.1
		0	-0.7
	★	★★	-1.2
		★	-0.8
		0	-0.3
	0	★★	-0.8
		★	-0.4
		0	-0.0

** Values derived from Independent Validation Population*

Results are reported as 0-2 STARS per marker for use in mating decisions along with the GPD® which reflects the "true" value of the animal's unique combination of markers.

GeneSTAR® Quality Grade

GeneSTAR® Quality Grade is a DNA genetic marker panel test offered by Pfizer Animal Genetics which identifies the presence of multiple major genes associated with quality grade. These markers provide beef producers with a quicker and more accurate test to determine an animals potential for improved quality grade. GeneSTAR® Quality Grade includes TG5, which was the first gene marker for a production trait in beef cattle. This panel of markers is the only marbling or quality grade test to have passed an independent validation by the National Beef Cattle Evaluation Consortium.

GeneSTAR® GPD® Quality Grade

Improvement in Percent Choice or Better

QG Marker Results 1	2	3	4	GPD % Choice	QG Marker Results 1	2	3	4	GPD % Choice	QG Marker Results 1	2	3	4	GPD % Choice
2	2	2	2	33.86	1	2	2	2	28.57	0	2	2	2	23.28
2	2	2	1	28.86	1	2	2	1	23.57	0	2	2	1	18.28
2	2	2	0	23.86	1	2	2	0	18.57	0	2	2	0	13.28
2	2	1	2	28.66	1	2	1	2	23.37	0	2	1	2	18.07
2	2	1	1	23.66	1	2	1	1	18.37	0	2	1	1	13.08
2	2	1	0	18.66	1	2	1	0	13.37	0	2	1	0	8.08
2	2	0	2	23.46	1	2	0	2	18.17	0	2	0	2	12.88
2	2	0	1	18.46	1	2	0	1	13.17	0	2	0	1	7.88
2	2	0	0	13.46	1	2	0	0	8.17	0	2	0	0	2.88
2	1	2	2	32.42	1	1	2	2	27.13	0	1	2	2	21.84
2	1	2	1	27.42	1	1	2	1	22.13	0	1	2	1	16.84
2	1	2	0	22.42	1	1	2	0	17.13	0	1	2	0	11.84
2	1	1	2	27.22	1	1	1	2	21.93	0	1	1	2	16.64
2	1	1	1	22.22	1	1	1	1	16.93	0	1	1	1	11.64
2	1	1	0	17.22	1	1	1	0	11.93	0	1	1	0	6.64
2	1	0	2	22.02	1	1	0	2	16.73	0	1	0	2	11.44
2	1	0	1	17.02	1	1	0	1	11.73	0	1	0	1	6.44
2	1	0	0	12.02	1	1	0	0	6.73	0	1	0	0	1.44
2	0	2	2	30.98	1	0	2	2	25.69	0	0	2	2	20.39
2	0	2	1	25.98	1	0	2	1	20.69	0	0	2	1	15.40
2	0	2	0	20.98	1	0	2	0	15.69	0	0	2	0	10.40
2	0	1	2	25.78	1	0	1	2	20.49	0	0	1	2	15.20
2	0	1	1	20.78	1	0	1	1	15.49	0	0	1	1	10.19
2	0	1	0	15.78	1	0	1	0	10.49	0	0	1	0	5.20
2	0	0	2	20.58	1	0	0	2	15.29	0	0	0	2	10.00
2	0	0	1	15.58	1	0	0	1	10.29	0	0	0	1	5.00
2	0	0	0	10.58	1	0	0	0	5.29	0	0	0	0	0.00

** Values derived from Independent Validation Population*

LEGEND
★★ 2-STARS = two copies of the desired gene
★ 1-STAR = one copy of each form of the gene

Pfizer Animal Genetics

Recap of next generation of products

- Multigenic marker panels start to become the norm
- Number of traits and markers grow exponentially
- No longer any emphasis on which genes the markers are associated with, or how those genes function
- No independent validation of many tests
- Multiple different reporting systems that do not allow interchange (1-10, MGV, GPD, Number of Stars) or interpretation relative to EPDs
- DNA information still being presented separately from EPDs

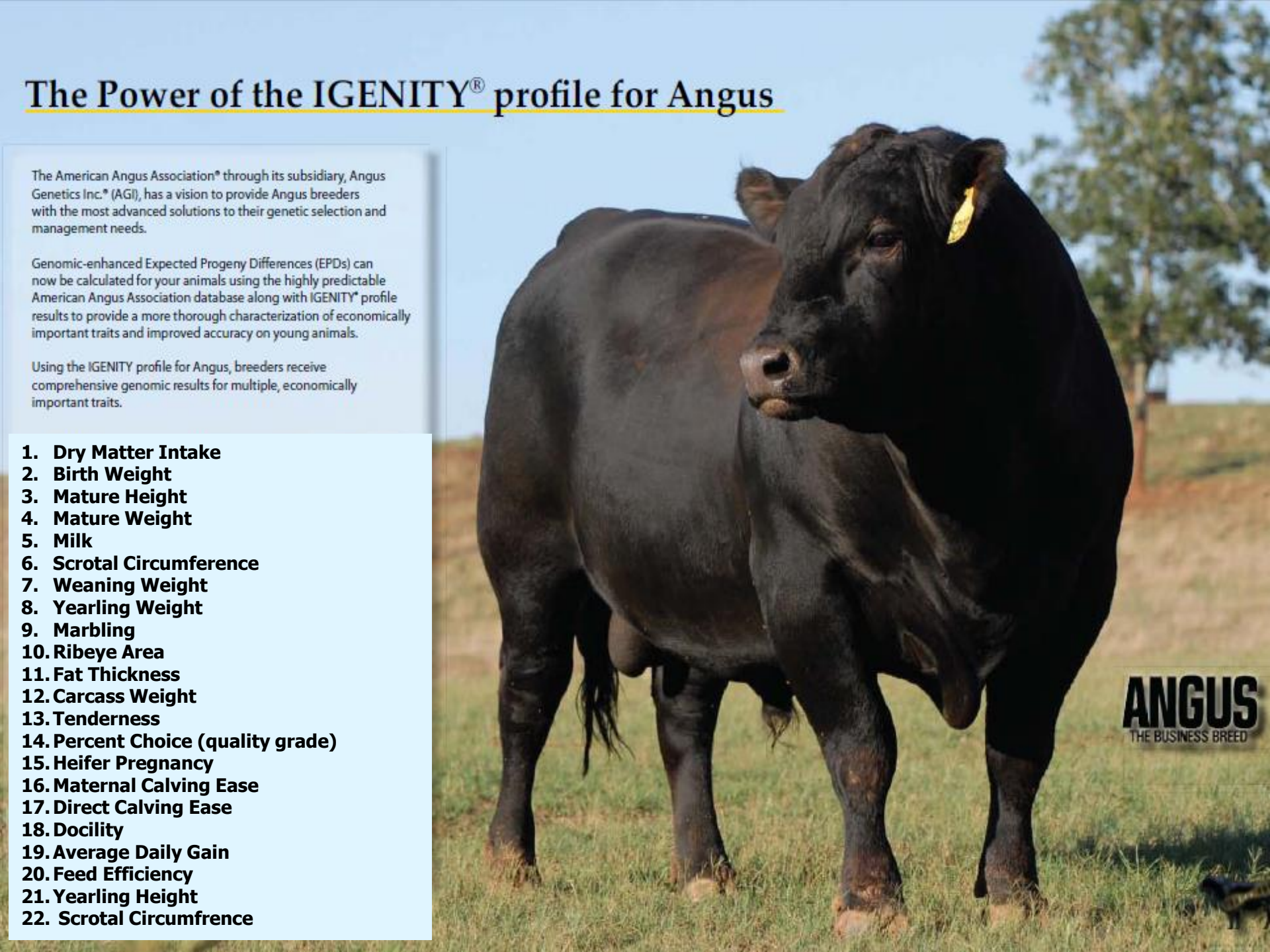
The Power of the IGENITY® profile for Angus

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**
22. **Scrotal Circumfrence**



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)

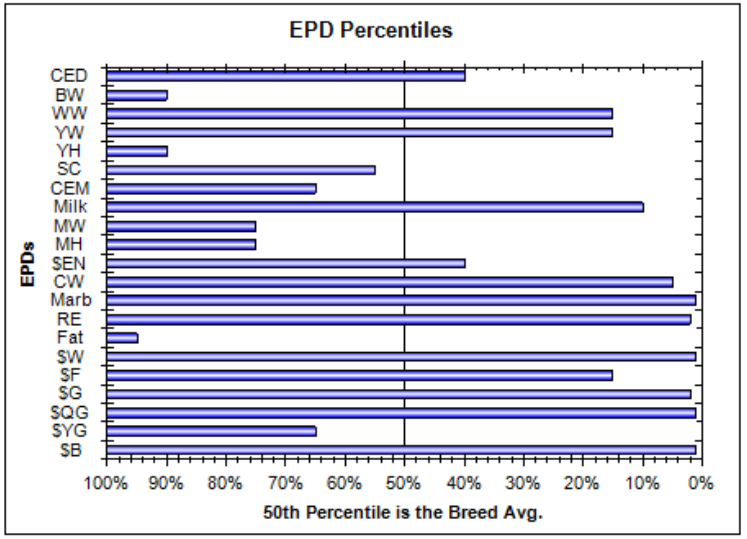
Pfizer Animal Health
Animal Genetics

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



Current Sires Percent Breakdown

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

GeneStar	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	

As of 03/22/2010

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

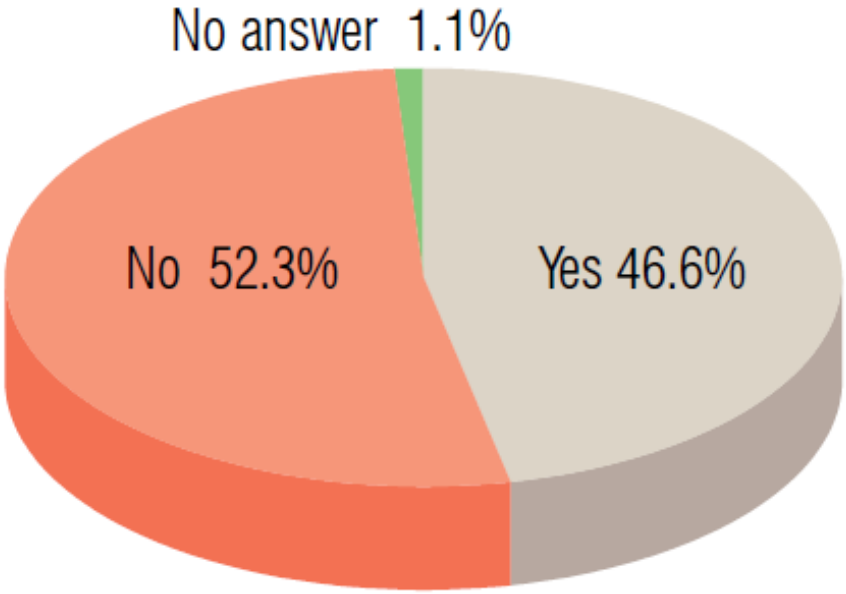
G A R Predestined 13395344

	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**

March 1, 2010 Beef Magazine Survey

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

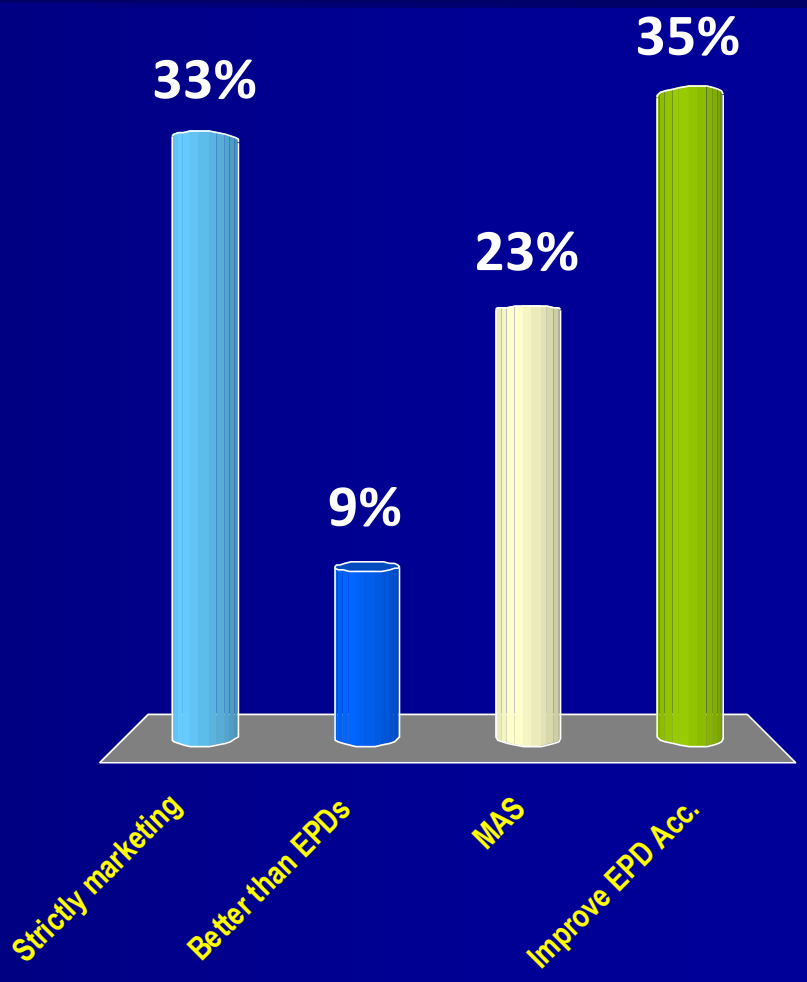
Do you feel like you have a good understanding of the genomic (DNA) information being offered by some seedstock suppliers?



Base = 635 (All Cow-Calf Operations)

Why do you use DNA tests? (Audience Response BIF 2009)

1. Strictly marketing
2. Better than EPDs
3. Marker-Assisted Selection
4. Improve accuracy of EPDs



Need to integrate DNA information into National Cattle Evaluation (NCE)

"*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. For some economically important traits, information other than DNA tests may not be available. Selection tools based on these tests should still be expressed as EPD within the normal parameters of NCE*" (Tess, 2008).

Information sources for EPDs – DNA tests are another source of information to improve the accuracy of EPDs

Pedigree Information

Individual Performance Data

+/- Progeny Performance Data

igenity

DNA test Information

HD 50K

EPDs

Time, Money and increased generation interval

Modified from slide from Kent Anderson, Pfizer Animal Genetics, presented at BIF 2011

American Angus Association performs weekly evaluations with genomic data

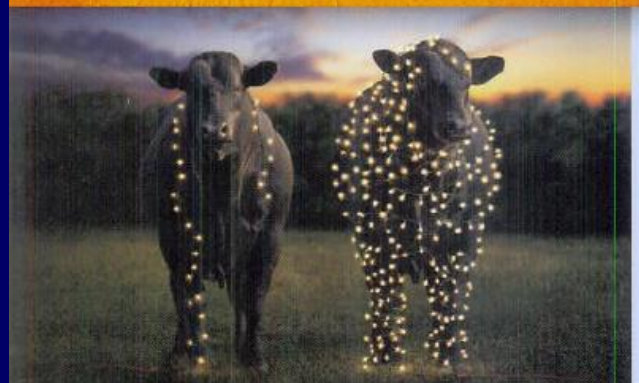
	Igenity	Pfizer
Calving ease (CED)	✓	✓
Growth (BW WW YW Milk)	✓	✓
Residual Average Daily Gain (RADG)	✓	✓
Docility (DOC)	✓	✓
Yearling Scrotal/Height (SC,YH)	✓	✓
Mature Weight (MW)	✓	✓
Carcass (CWT MARB RIB FAT)	✓	✓

http://www.angus.org/AGI/GenomicChoice11102011.pdf (updated 11/18/2011)

So the question I get asked a lot is:

Pfizer Animal Health
Animal Genetics

Which Genomic Test is Best?



Lower-density tests with just 384 markers (left) do not provide the reliability across the full spectrum of traits as HD 50K, with more than 54,000 markers (right).

Now, thanks to High-Density (HD) 50K genomic technology for Angus, you can more dependably predict the genetic merit of young animals, before progeny information is available. But, what makes this genomic test superior?

High density vs. low density

The HD 50K platform includes more than 54,000 DNA markers, significantly more than IGENITY®, which utilizes only 384 markers. With greater coverage of the genetic makeup of Angus animals, no other DNA test provides more dependable predictions of genetic potential than HD 50K.

Genetic Correlations (r) by company	384 SNP Igenity	50K SNP Pfizer
Calving Ease Direct	.47	.33
Birth Weight	.57	.51
Weaning Weight	.45	.52
Yearling Weight	.34	.64
Dry Matter Intake (component of RADG)	.45	.65
Yearling Height	.38	.63
Yearling Scrotal	.35	.65
Docility	.29	.60
Milk	.24	.32
Mature Weight	.53	.58
Mature Height	.56	.56
Carcass Weight	.54	.48
Carcass Marbling	.65	.57
Carcass Rib	.58	.60
Carcass Fat	.50	.56

http://www.angus.org/AGI/GenomicChoice11102011.pdf (updated 11/18/2011)

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Carcass Rib	.58	.60
Carcass Fat	.50	.56

How much do DNA tests help increase accuracy of EPDs? (Table 4)

	AGI Heritability	AGI HD 50K Correlation	Avg. 50k Change in ACC - from .05[1]	Approximate Progeny Equivalents
BW	0.42	0.51	0.25	**8**
WW	0.20	0.52	0.23	**16**
YW[2]	0.20	0.64	0.27	**20**
RADG[3]	0.31	0.65	0.27	**13**
Milk	0.14	0.32	0.15	**12**
CW	0.31	0.48	0.17	**7**
Marb[4]	0.26	0.57	0.24	**12**
RE[4]	0.32	0.60	0.23	**9**
FAT[4]	0.26	0.56	0.23	**11**

[1]These changes are less for higher initial accuracy values
[2]Post-weaning ADG
[3]Dry matter intake
[4]Carcass progeny, not scanned progeny

Data from Kent Anderson, Pfizer Animal Genetics, presented at BIF 2011

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Hereford taking a global leadership role to develop genetic evaluation tools

American Hereford Association | Updated: September 27, 2011

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KANSAS CITY, Mo. — The American Hereford Association (AHA) has positioned itself to incorporate genomic technology and to discover the genomic markers that are economically relevant to the Hereford breed.

Sept. 19-20 the AHA hosted a media event sharing information about Hereford genomics, Hereford research projects and the National Reference Sire Program (NRSP). The highlight of the event was touring one of the NRSP test sites, Olsen Ranch, Harrisburg, Neb.

During the tour, AHA's chief operating officer and director of breed improvement, Jack Ward, explained the organization has taken a proactive approach testing and validating the tools available, ensuring a Hereford genomic product that is reliable and useful to AHA members when it is released.

"As an Association we aligned ourselves with researchers and worked collaboratively with the National Beef Cattle Evaluation Consortium (NCBEC), U.S. Department of Agriculture (USDA) Meat Animal Research Center and other global Hereford associations, to discover the genomic markers that are economically relevant to the Hereford breed," says Craig Huffhines, AHA executive vice president.

Ward explained that AHA has been working with Dorian Garrick of NBCEC on genotyping. "Today we have more than 1,200 high-accuracy sires 50K genotyped," Ward said. "This population has been used to train and validate a Hereford-specific panel."

Matt Spangler, University of Nebraska assistant professor and beef genetics Extension specialist, said, "The AHA has taken a large and much needed step in the implementation of marker-assisted EPDs (expected progeny differences). Their approach of working with the NBCEC allows them flexibility in how they specifically incorporate the information into their genetic evaluations.

"In order to continue to evolve and further develop their genomic predictions, it will be critical that Hereford producers continue to collect phenotypes and genotype-influential animals within their respective herds," Spangler added. "They should be proud of what they have accomplished and capitalize on this inertia to continue forward."

Ward explains that the Agricultural Business Research Institute (ABRI) has developed the software to add genomic information into the Hereford Pan-American Genetic Evaluation and AHA staff is currently working on a research run with introduction to be in Spring 2012.

AHA also plans to continue to 50K genotype Hereford sires with support from partner countries. It will also maintain a database repository for future genomic research.

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- U.S. cattle: Futures lower on caution over demand, cash trade
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- Mosaic: Food demand outweighs broader economic slowdown
- CBOT corn outlook: Down sharply on USDA surprise supply estimate

Industry's most cost-effective DNA product for replacement heifer selection[1]

IGENITY®, a division of Merial, announces the introduction of the most cost effective DNA product on the market — the IGENITY profile for replacement heifers. It is designed specifically for cow/calf producers committed to the long-term success of their herd. The IGENITY profile for replacement heifers is available for $20 per animal.

Through the new cost-effective DNA offering from IGENITY, cow/calfproducers can receive analyses on five economically important traits:

- Fertility
- Maternal Calving Ease
- Average Daily Gain
- Percent Choice
- Tenderness

"In the example of percent choice, the IGENITY profile for replacement heifers is the equivalent of having information on up to five progeny from a yearling heifer," says Dr. DeHaan. "For producers who do not have pedigree documents on their heifers, this information is especially valuable."

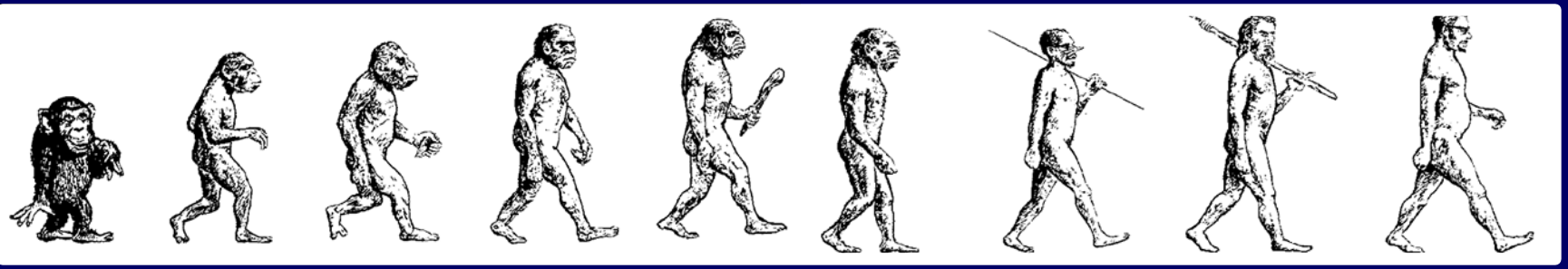
Cow/Calf Producers can Improve Profitability with Genetics Management and Selection Tools

Pfizer Animal Health
Animal Genetics

Are you leaving dollars on the table? There is no doubt that in the beef industry, more information equals better decisions. And, better management and selection decisions equal greater profits. Start making better decisions today with world-leading DNA-marker technology from Pfizer Animal Genetics.

With a robust offering of genetic technologies, Pfizer Animal Genetics can help you gain information early in an animal's life that will help you make more precise decisions resulting in faster genetic progress and a healthier bottom line. And, these products come from the animal health company you already know and trust.

The Future
NEXT EXIT



2003	2008	2013	2020
• single marker/ single trait • reported genotypes • single marker accounted for small amount of genetic variation • limited adoption • technology oversold	• multimarker tests for a few traits reported in a variety of formats • no tie between DNA test results and national genetic evaluation or breed associations • tests accounted for < 10% additive genetic variation • limited validation • technology not in a form producers could use	• panels with hundreds of markers for many traits • results reported in units of the trait • incorporation of DNA information into national genetic evaluation • DNA-based evaluations improve accuracy of EPDs • large numbers of genotyped populations are available for validation	• universal marker panel used by worldwide beef cattle community • seamless submission of genotype data to national genetic evaluation/breed associations • cost is low • DNA information used for traceability, parentage, genetic defects, selection, marker-assisted management, product differentiation

What will the future look like?

"It is perhaps the cumulative value derived from using DNA test information for multiple purposes (traceability, parentage, genetic defects, selection, marker-assisted management, product differentiation), in combination with the rapidly-declining cost of genotyping, that will ultimately push the economics of DNA-based technologies over the tipping point towards more widespread industry adoption"

Van Eenennaam, A. L. 2011. Beef translational genomics: Lessons from the literature Association for the Advancement of Animal Breeding and Genetics. 19. 19: 271-278.

Summary

- DNA test results are now being combined with other sources of information in Angus Association EPDs
- DNA information is most useful to improve otherwise low accuracy EPDs (i.e. parent-average EPDs from animals with no records)
- Other breeds are working to develop tests that work for their breed – none available at this time
- It is hoped in the future there will be multibreed tests for traits which are not currently in National Cattle Evaluation e.g. feed efficiency and disease resistance – will need LOTS of phenotypes!

This work was supported by National Research Initiative competitive grant no. 2009-55205-05057 ("Integrating DNA information into beef cattle production systems") from the USDA National Institute of Food and Agriculture.

Questions?