

"DNA testing — Does it Work and Where is it Headed?"

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http://animalscience.ucdavis.edu/animalbiotech/ CCA Pfizer Cattlemen's College 11/21/08 Animal Biotechnology and Genomics Education



It seems appropriate that the application of DNA testing to beef cattle production is undergoing an evolutionary process....

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Let's visit the past

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



The basis of selection is the resemblance between relatives







Breeders can influence the rate of genetic gain by altering components of the following equation:

ΔG = intensity of selection X

accuracy of selection X

(vgenetic variance in population)

generation interval)

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Challenge for breeders is to identify those individuals that have the best true breeding values

ΔG = intensity of selection X



(vgenetic variance in population)

generation interval)

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The value of accuracy





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
+6	+3.1	+42	+92	+.3	+.07	+9	+18	1378	+84	+.8	



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
I +6	1+3.3	1 +45	1 +83	1+.1	1+.19	1+9	1+32		1 +55	1+.7	

Carcass					\$Values						
Cwt Acc	Mrb Acc	RE Acc	Fat Acc	C Grp C Prog	U Grp U Prog	Wean Value	Feedlot Value	Grid Value	QG Value	YG Value	Beef Value
+22	+.22	+.48	+.006	[14.59	34.28	21.71	14.59	7.12	50.7

Fall 2008 EPD

Tehama Bando 155 G A R Precision 1680 #11520398 9J9 G A R 856

S S Traveler 6T6 W C C Blackcap C9 +11911768 R Premier Blackcap 6276A

Q A S Traveler 23-4 S S Miss Power Play 4A4 Brusco

Band 234 of Ideal 3163

Tehama Blackcap G373

Rito 9J9 of B156 7T26

Blackbird G A R 833

Premier Lady Blackcap 2861U

		C	arcass					\$Val	ues		
Cwt Acc	Mrb Acc	RE Acc	Fat Acc	C Grp C Prog	U Grp U Prog	Wean Value	Feedlot Value	Grid Value	QG Value	YG Value	Beef Value
l +15	I +.45	I +.44	I +.015			24.69	24.18	29.86	22.95	6.91	51.99
					Fall 20	08 EPC)		<u>.</u>		

Tehama Bando 155 G A R Precision 1680 9J9 G A R 856 C A Future Direction 5321 S A F Power Fix C A Miss Power Fix 308 C A Lady Eight 1015 V D A R Shoshone 548 A A R New Trend Donna A A R 74 Boyd Forever Lady 7120 S V F Forever Lady 57D Leachman Right Time

S V F Forever Lady 1128



What is the value of accuracy?

Twin Valley Precision E161



Reg. No.: 12346200 Calved: 5/16/1995 Semen: \$250 Centificates: \$35



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
+6 .92	+3.1 .97	+42	+92 .95	+.3 .94	+.07 .94	+9 .90	+18 .94	1378 4501	+84 .89	+.8 .89	71

Carcass						\$Values						
Cwt Acc	Mrb Acc	RE Acc	Fat Acc	C Grp C Prog	U Grp U Prog	Wean Value	Feedlot Value	Grid Value	QG Value	YG Value	Beef Value	
+22	+.22 .67	+.48 .67	+.006	16 35	3465 8164	14.59	34.28	21.71	14.59	7.12	50.7	
		0.00							1		hy .	

Fall 2008 EPD



Premier Lady Blackcap 2861U

Boyd Heritage 6078



Boyd Heritage was not only Champion sale bull in Denver, he was the high selling bull at \$55,000. As Champion of the North American International he displayed flawless structure and confirmation. Heritage stems from the cow family behind bulls like Traveler 004, New Day, On Target, Beef Maker, and Poundmaker. This low 6 frame bull promises excellent growth, thickness, maternal strength and carcass merit. BW 87 lb., WW 744, YW 1,288.

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
I +6 .05	l +3.3 .05	1 +45 .05	1 +83 .05	l +.1 .05	l +.19 .05	l +9 .05	1+32 .05		1 +55 .05	1+.7 .05	-7.82

Carcass					\$Values						
Cwt Acc	Mrb Acc	RE Acc	Fat Acc	C Grp C Prog	U Grp U Prog	Wean Value	Feedlot Value	Grid Value	QG Value	YG Value	Beef Value
l +15 _05	l +.45 .05	l +.44 .05	l +.015 .05			24.69	24.18	29.86	22.95	6.91	51.99

Fall 2008 EPD





What is a Genetic Marker ?

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







Companies that are offering DNA tests for marker-assisted selection for beef cattle traits





Companies that are offering DNA tests for marker-assisted selection for beef cattle traits

Marker-assisted selection is the process of using the results of DNA testing to assist in the selection of individuals to become parents in the next generation.

GeneSTAR



GeneST

SureTRAK



METAMORPHIX, INC.

igenity



Beginning of an avalanche







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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Gene markers available October 2003

Gene

Thyroglobulin

Leptin

mu-Calpain

Calpastatin

Trait

Marbling (GeneStar Marbling) http://www.frontierbeefsystems.com/ Marbling (Merial) Press release 7/2003 Tenderness (TenderGENE) Press release 9/2003 Tenderness (GeneStar Tenderness) http://www.frontierbeefsystems.com/









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



Igenity L

Know, Now,

Igenity" L. 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.

· 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:







) igenity

A lot of detail about the marker

Igenity" L. Know. Now.

Igenity L. Know. Now.

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[™] I. 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, glucocorticolds 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 gens 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 after metabolism

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.

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:



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No signal

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-ctTM cattle produce both types of leptin some normal, some difficult to recognize.
 - 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.



Igenity[™] L. 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.

For the dairy producer.

The science behind IGENITY L lets you identify genetic ability for:

- increased dry matter intake (DMI)
- greater peak and overall lactation yield with increased protein solids
- improved body condition scores
- superior energy utilization
- quicker return to positive energy balance.

In trials, L-tt cows outperform L-cc cows:1

- entire lactation 3.3 lbs more milk/day
- first 100 days 5.38 lbs more milk/day.





Use IGENITY L to:

- Select bulls to improve the leptin profile of your herd.
- Select cows and replacement heifers with the greatest potential.
- Sort and feed for optimum early lactation performance.

For the beef producer.

The IGENITY L Test helps you identify genetic potential for:

- greater DMI
- superior marbling ability
- more efficient energy utilization.

In trials through to slaughter:

- Cattle with higher leptin concentrations had higher marbling scores.²
- Cattle with L-tt leptin were up to 5 times more likely to grade Choice than cattle identified as L-cc.³

Effect of Geno	t of Genotype on Carcass Quality							
	L-cc	L-ct	L-tt	P-value				
Trial 1 - % Choice	11	29	62	0.03				
Trial 2 - % Choice	0	19	48	0.01				
Trial 3 - % Choice	38	45	58	0.07				

Trial 1: AzTx Feeders (Charolais/Angus steers), Trial 2: Doerksen Feedlot (Hereford steers), Trial 3: University of Saskatchewan (Charolais steers) SOURCE: Quantum Genetics, Inc.

IGENITY L can help you:

- Buy L-tt bulls to improve your herd's potential for marbling.
- Retain cows and select replacement heifers with desired leptin genotype, along with other genetic traits.
- Breed, feed and sort cattle so they reach targeted endpoints uniformly and efficiently.

BOVIGE

GeneStAR™ Marbling is a DNA genetic marker test offered by Bovigen Solutions,™ LLC. 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	\mathbf{x}	太太	
Yearling Fed	58%	62%	74%	16%
Calf Fed	34%	41%	53%	19%
NBCEC Trial	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.

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

LEGEND

The results of the GeneSTAR³⁰ tests are reported as:

"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^w 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.

	M	ating Des	sign	
Sire is	Dam is	۶ ۵	of Proge	ny
0.00	0 ≛≛	100% 50%	50% 100%	
***	0. **	50% 25%	50% 50% 50%	25% 50%
****	0. ***		100% 50%	50% 100%



CALIFORNIA

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





CALIFORNIA

Leptin Genotype Effects on Marbling Score (NBCEC Data)



Data provided by R. I. Quass. Cornell



Recap

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 single trait and 100% accurate
 The need for third party validation of

The need for third-party validation of commercial tests becomes evident



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 Senetic Progeny Difference



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.

CIDE	DAM	% 0	% of Progeny					
IS	IS	**	*	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, ttc 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[®] 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.







Now, know even more about the genetic potential of your cattle.

igenity

Know, Now





/19/2006

For Immediate Release

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Merial Reveals New Multiple-Marker DNA Profile Technology

IGENITY MultiMARK™ provides greater confidence in selection and management decisions

Duluth, Ga. — February 20, 2006 – Merial announces an important step forward in genomic testing with the introduction of the beef industry's most comprehensive DNA testing profile — IGENITY MultiMARK[™].

"By identifying multiple genetic markers, then integrating them into a single profile, IGENITY MultiMARK increases the confidence of selection and management decisions within an operation," says Jim Tate, global beef strategy manager for MERIAL[®] IGENITY[™]. "This new approach to DNA testing — unique to IGENITY — helps create greater efficiencies in testing for producers and the industry."

The comprehensive multiple-marker profile approach of IGENITY MultiMARK makes it a userfriendly and cost-effective method for producers to learn more about an animal's genetic potential.

"Our goal is to give producers the tools to improve the efficiency and profitability of their operations," Tate says. "By providing a broad range of analyses – and integrating them into profiles that are simple to use and understand – IGENITY MultiMARK allows producers to profile animals for traits that matter most, and to more rapidly improve the genetics of a herd."

Panel testing uses the latest DNA technology and is a next step toward producing more consistent products that are heavily demanded by consumers. IGENITY MultiMARK helps producers make better-informed decisions, which can open doors to profit apportunities.

"Marker-Assisted Selection is the next level of predictability for producers and may actually eliminate some of the guesswork at times," Tate notes. "Progressive producers will see these additional options as a means to enhance the tools they already utilize to make breeding, purchasing and other management decisions."









Practical ways to profit from the IGENITY® profile.





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
- Carcass composition traits
 - Tenderness
 - Ribeye area

- Hot carcass weight

- Fat thickness
- Marbling
- 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.

Animal Biotechnology and Genomics Education

- Yield grade

- Stayability

- Quality grade







(NA Tes	st Resu	Its		
	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 !!!

Ge	DNA	Test Re	esults		
	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 Tendemess that virtually eliminates the "unsatisfactory eating experience" that plagues nearly 25% of all carcasses compared to an animal devoid of these genes.

	GeneStatik	DNA Tes	st Result	S	c.,	
	QG1	QG2	QG3	QG4	Total	GPD
Quality Grade	志大	*	<u></u>	*	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





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.

					IGEN	ITY	Prof	file					
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	М	-	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	

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 breading program
- Can be used to make early selection and breeding decisions
- Provides accurate and reliable results for ranking and/or selection of animals



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TRU-MARBLING

One in a series of break-through products that will advance breeding practices in the cattle industry, *Tru-Markling*[™] 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-Morbing[®] is a DNA-based genetic test shar contains a panel of 128 unique DNA markers, each one highly associated with the expression for marbing score and quality grade. By measuring the cumulative effects for each of these 128 markers. Tru-Morbing[®] accounts for a significant proportion of the total genetic variation for this complex metabolic trait—the first DNA-based product to do sol

Tru-Morbing[™] is an advanced and revolutionary tool that will allow cattle producers to make aerly 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 desermine 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 *Thu-Marbling*TM 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	0.476

** estimated from a model that included contemporary group and MGV

Tru-Marbiing^m 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	and the second	H	EIFERS	
Quality Grade	Number	Seltotal	Arg.MGV	Number	ter total	Avg. MGV
Frime	9	0.1%	14	5	0.1%	14
High Chaice	93	1,1%	-20	78	1.3%	12
Medium Chaice	475	5.8%	-14	423	7.0%	9
Low Chaice	2006	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	#255	100.0%	-	6950	100.0%	

14,305 head tested from 6 commercial feediots

Unlike other products, Tru-Matbling¹⁹ MGVs account for a highly significant amount of variation for marbling score.

TRU-TENDERNESS

One in a series of break-through products that will advance breeding practices in the cattle industry, *Tru-Tenderness*²⁶ 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-Tendemess¹⁴ is a DNA-based genetic test that contains a panel of 11 unique DNA markers, each one highly associated with expression for tender meet. By measuring the cumulative effects for each of these 11 markers, Tru-Tendemess¹⁴ accounts for a substantial proportion of the total genetic variation for this complex metabolic trait.

Since tendemess can only be measured in harvessed cattleat is difficult, time consuming and expensive to make genetic progress for this trait using traditional genetic improvement tools. The Tendemess " changes this paradigm by allowing produces to accurately assess the genetic potential of their breading stock to produce tender meat. In addition, The Tendemess " also shortens the interval for making genetic progress because it can be used to test animals of any sge.

The Tendemess¹⁴ 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 tendemets within herds and the ability to determine the "Tru" genetic potential of animals.

PROVEN RESULTS

The-Tendemess⁷⁷ 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-Tendemess⁷⁷ 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 * as estimated in Minick et al. 2004, Can. J. Anim. Sci. 84:389	100%
** estimated from a model that included contemposory processes	e MiGV

noteennorder



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	ORIGINAL REPORT	08/23/2006
	Aguilar, CO	CASE ID	MT-0059302S
	91020	CUSTOMER	LWAF - Legends of the West Angus Farm

CONTACT Wes Johnson, Foreman

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

TRU-MARBLING and TRU-TENDERNESS REPORT

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

Feed Efficiency

GeneSTAR' Feed Efficiency is based on Net Feed Intake (NFI). NEI 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.

Colves that earlies than expected will have a negative NFI Negative NFI = Superior Feed Efficiency Colves that earl more than expected will have a positive NFI Positive NFI = Inferior Feed Efficiency

GeneSTAR' GPD'

	a series and a series of the	and the second second second
THE GPD	725 GPD	1234 GPD
-1.95	10000-000	41.77
3.74	1000 1-100	1 2 2 4 -2.55
4 1 2 0 -3.53	1 2 2 1 -2.31	#####400
1 3 1 3 4 3 102	10.10	0.0 0 0 -2.53
1111 33	1.011 1 2.03	1.211 1 2.11
2 1 1 1 1 1 1 1 1	0.010 0.210	0 2 5 6 42.09
2 2 8 2 110	1111 121	1111-0.25
3383 436	1211-200	1 2 1 1 4247
128.00 334	1.2.1.1 (2.44	312310 4143
3122 2144	10.000 -2244	8191212 -1255
3 5 2 5 200	1 1 1 1 42.22	B 1 4 1 -141
10000	11111-220	A 1 3 4 51701
1 1 1 1 -2.75	1112 22	- 1.1 T. 1.1 -1.4
1111 2.57	1110 -150	11 111 -140
10.00 200	1 1 1 1 -1-10	1 0 1 0 -1.10
21122-285	1.102 -1.98	0.000 -1.30
1 1 1 1 2211	1107 -124	ALC: NO. 1 POINT
2211	1 1 1 1 -132	U + 0 0 -0.02
2 8 2 7 2 2 11	101100	8832 442
2821 119	1321 14	1111-07
0.000-007	1 1 7 1 -1.05	0.48
READ -LAT	1 0 1 3 -127	
20110 -1.45	-1/05	-0.46
3 1 1 1 1 143	1000 40	-0.34
11111-1011	-1,43	1003 444
3030-141	C 000 - 441	- 422
10100-000	1000 400	0.000 0.0

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

Generality

T1	T2	T3	GPD Lbs. Shear Force
	***	**	-2.2 1.8 -1.4
杰杰	*	**	(1,B -7,4 -1,0
	.0.	**	-1.5 -1.1 -0.7
	**	11 1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-1-	-1.8 -1.4 -1.0
*	*	**	-1.5 -1.1 -0.7
6.000 ·	.0.	**	-1.1 -0.7 -0.3
	志志	11 4 5	-1.5 -1.1 -0.7
.	*	11 1 1	-1.2 -0.8 -0.3
	.0	44	-0.8 -0.4 -0.0

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 animat's unique combination of markers.

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 TGS, 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.

Gene Quali	STAR	GPD ade	Improvement in Percent Choice or Batter						
OliMories Nexalts	GPD NCMAR	00 Mailar 12314	NOSAN	GisMator Brisite 1234					
1111	23.86	10.13	28.57	61.82	22.28				
1221	28.86	1221	23.37	9.8.8.9	18,22				
1114	23.86	1211.00	18.57	0.2.2.0	13.38				
2212	28.66	1212	33.37	1110	18.87				
2211	23.66	3.2.1.5	18.37	9.90111	13.08				
22.10	18.66	1210	13.37	0.1.1.8	8.08				
	23.46	1.0 11.0	18.17	11112	12.88				
1111	12.46	17.0.1	18.37	0.1.0.1	7.88				
23.84	13.00	12.0.4	8.17	0.3 9.6	2.68				
1121	13.43	1.1.1.1	37.19	11.23	31.84				
ACTA	37.AI	1 2 2 1	32,13	0.1.1.1	10.84				
1150	12.A1	10.00	87.13	0116	11.84				
6114	33.33	1111	31.93	9.4.9.2	16.64				
2244	33.22	1000	16.91	1111	11.64				
	17.77	1000	11.111		6.64				

11.34 10.64 11.64 144 1 1 1 1 1 18.73 11.44 22.82 41.43 2.5.6 17.42 111.1.1.1.15.73 4110 6.44 12.92 1111 4.73 3.44 30.98 35.68 25.39 1621 1031 30.68 0.0 1 1 15.40 25.88 20.98 15.88 1.11 3 4 18.00 **** 18,20 10.48 25.78 15.48 50.18 20.78 10.00 10.48 3.24 15.78 1010 1.1.1.1 18.00 20.58 1000 15.26 0.0.01 5.00 15.58 10.38 0.00 10.58 5.38

* Values derived from independent validation Population



ISI

VERIFIED

Pfizer



Pfizer Animal Genetics

1.877 BEEF DNA www.bovigen com

A S Preserve Sample Identification Repeatable Genetic Analysis: Genetic Markers for Animal Quality & Management

> Genetic Markers for Beef Quality & Management Parentage DNA Traceability







Companies that are offering DNA tests for marker-assisted selection for beef cattle traits



	ts for qu	antitativ	e traits		
UNIVERSITY CALIFORNIA	Pfizer	Igenity	MMI		
	Results reported as # of stars/GPD	Results reported on scale 1-10	Results reported as "MGV"		
Quality Grade	GeneSTAR Quality Grade	Igenity Profile – Quality Grade	Tru-Marbling		
Tenderness	GeneSTAR Tenderness	Igenity Profile - Tenderness	Tru-Tenderness		
Other Validated by NBCEC	Feed Efficiency	Igenity Profile – Marbling, Yield Grade, Fat thickness, Hot carcass weight, Ribeye area, Heifer pregnancy rate, stayability, calving ease, docility	Average daily gain (not commercially available yet)		

Van Eenennaam – 11/2008



Recap

- Multigenic marker panels are the norm
- Number of traits and markers growing exponentially
- It is not important to know which genes the markers are associated with, or how those genes function
- Some unvalidated tests are available and more are coming
- Multiple different reporting systems that do not allow interchange (1-10, MGV, GPD, Number of Stars) or interpretation



What is wrong with the current model ?

- A few markers are not sufficient to account for much (>10%) of the additive genetic variation

 so little obvious relationship between phenotype and DNA-test results and little genetic progress likely to result from MAS
- Markers do not exist for many important traits
- Early adopters of genotyping for MAS in livestock have not experienced sufficient value capture i.e. they are too expensive !



And DNA data is not being used in national cattle evaluation

- Only a small proportion of the population is being genotyped
- Individual producers may be reluctant to share results for animals that are shown to have inherited unfavorable marker alleles.
- There is no national structure, at the breed association or any other level, to routinely capture genotypic information in a consistent form for the purpose of national evaluation.



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 different breeds and environments, and assess them for correlated responses in associated traits



Should I use DNA-tests in my breeding program?

- Will marker-assisted selection make you money?
 For marker-assisted selection to be profitable, it must either increase revenue or decrease expenses by the cost of the test
- What impact does the test have on the trait? The genetic gain that can be achieved by using marker-assisted selection depends on the amount of additive genetic variation that is accounted for by the test, and also the heritability of the trait
- What are you giving up to use animals that are carrying the marker of interest?

How do you select for it now, & what emphasis do you give it now?

Could good progress in that trait be achieved without the expense of marker assisted selection?
 Will markers increase the accuracy of your selection decision sufficiently to justify the expense of running it?"



CALIFORNIA

	Production						Maternal					
	CED	BW	WW	YW	YH	SC	CEM	Milk	MkH	MW	MH	\$EN
BIF Accuracy \longrightarrow	Acc	Acc	Acc	Acc	Acc	Acc	Acc	Acc	MkD	Acc	Acc	
	+12	1	+49	+91	+.4	+.30	+6	+32	166	+23	+.7	-3.08
	.87	.96	.94	.92	.91	.91	.71	.79	543	.63	.64	
AI DUII	Larcass											
	CW		Marb		RE		Fat		Carc		Usn	d
	Acc		Acc		Acc		Acc		Grp/Pg		Grp/Pg	
	+22		+.40		+.19)	+.054		15		116	2
	.65		.69		.68		.64		57		2801	
	CW Marb Acc Acc +22 +.40 .65 .69		b ;)	RE Acc +.19 .68		Fat Acc +.054 .64		Carc Grp/Pg 15 57		Usn Grp/F 116 280	d ² g 1	

Yearling bull with own records and ultrasound

Production					Maternal						
CED	BW	WW	YW	YH	SC	CEM	Milk	MkH	MW	MH	\$EN
Acc	Acc	Acc	Acc	Acc	Acc	Acc	Acc	MkD	Acc	Acc	
+6	+2.1	+44	+80		+1.00	+7	+32		I +31	I +.5	-6.50
.30	.36	.27	.26		.33	.20	.21		.05	.05	
	Carcass										
CV	V	Mar	b	RE		Fat		Carc		Usn	d
Ac	c	Acc	:	Acc		Acc Grp/Pg Grp/		g			
+	5	+.48	3	+.04	+	+.016	;				
.1	8	.23		.26		.20					

Yearling bull with no records

.05

.05

Production							Mate	ernal			
CED	BW	WW	YW	YH	SC	CEM	Milk	MkH	MW	MH	\$EN
Acc	Acc	Acc	Acc	Acc	Acc	Acc	Acc	MkD	Acc	Acc	
I +6	I +2.3	I +42	I +84	I +.2	I +.29	I +7	I +21				+2.09
.05	.05	.05	.05	.05	.05	.05	.05				
Carcass											
C\	N	Mar	b	RE		Fat		Carc		Usn	d
Ac	c	Acc	:	Acc		Acc		Grp/Pg		Grp/F	g
I +	15	I +.2	7	I +.3	1	I +.007					

.05

.05



High-throughput SNP genotyping on 50,000 SNP CHIP (50K Chip)



The sequencing of the bovine genome allowed for a collaboration between MARC, BARC, UMC and UA to develop a set of 50,000 SNPs that are located throughout the entire genome

Animal Biotechnology and Genomics Education

Van Eenennaam - 11/2008



Whole genome-assisted selection (WGS)

The use of these dense markers across the entire genome enables an estimation of the genetic merit of every chromosome fragment contributing variation in a population with phenotypic observations Can simultaneously test 50,000 markers Can be used to predict merit for all traits for which phenotyped populations exist







WGS effectively estimates an EPD for every chromosome fragment in the genome





2003







2020

• single marker/ single trait reported genotypes single marker accounted for very 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
 mandatory, seamless submission of genotype data to national genetic evaluation/breed associations

 cost is low and industry uses DNA information for herd management feedyard sorting, and breeding.



Closing thought

"As with the implementation of genetic evaluation systems in livestock over 25 years ago, the industry will experience growing pains. However, these growing pains will give way to more accurate genetic selection of young animals, molecular breeding values for traits that can only be measured in a research setting, and decreased numbers of animals needed for progeny testing."

Allan, M. F. and T. P. L. Smith. 2008. Present and future applications of DNA technologies to improve beef production. Meat Science 80:79-85.



California to host BIF 2009! Mark your calendars!

http://www.calcattlemen.org/bif2009.html

2009 Beef Improvement Federation Annual Research Symposium and Annual Meeting



CALIFORNIA

BEEF RUSH '09



Sacramento, California April 30 – May 3, 2009









CALIFORNIA CATTLEMEN.

CCA

SINCE 1917

Wednesday April 29th Thursday April 30th

Friday May 1st Saturday May 2nd Sunday May 3rd Early Registration Registration and Evening Reception

Eastern Tour "Foothill Bovines, Equines and Fine Wines" Convention, Family/Spouse Tour, Evening Dinner Convention and Evening on your Own in Sacramento Western Tour "Ocean Wines and Bovines"













Questions ?





Accuracy: the correlation between an estimate and its true value (the correlation will lie between 0 and 1)

		Number of progeny records required			
A. Correlation (r)	B. BIF accuracy	BIF accuracy Low (0.1)			
		heritability	heritability		
.1	.01	1	1		
.2	.02	2	1		
.3	.05	4	2		
.4	.08	8	3		
.5	.13	13	5		
.6	.20	22	7		
.7	.29	38	12		
.8	.40	70	22		
.9	.56	167	53		
0.99	.93	1921	608		
0.995	.99	3800	1225		

CCA Pfizer Cattlemen's College 11/21/08