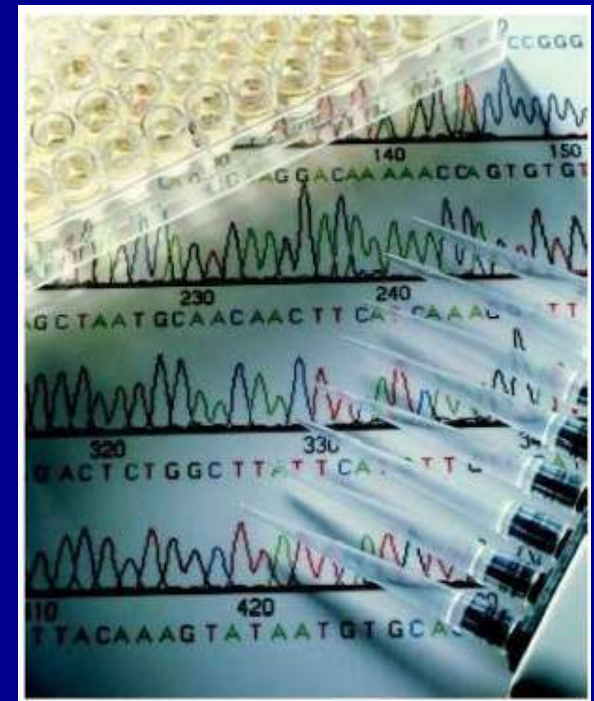# ECONOMICS OF USING DNA MARKERS FOR SORTING FEEDLOT CATTLE

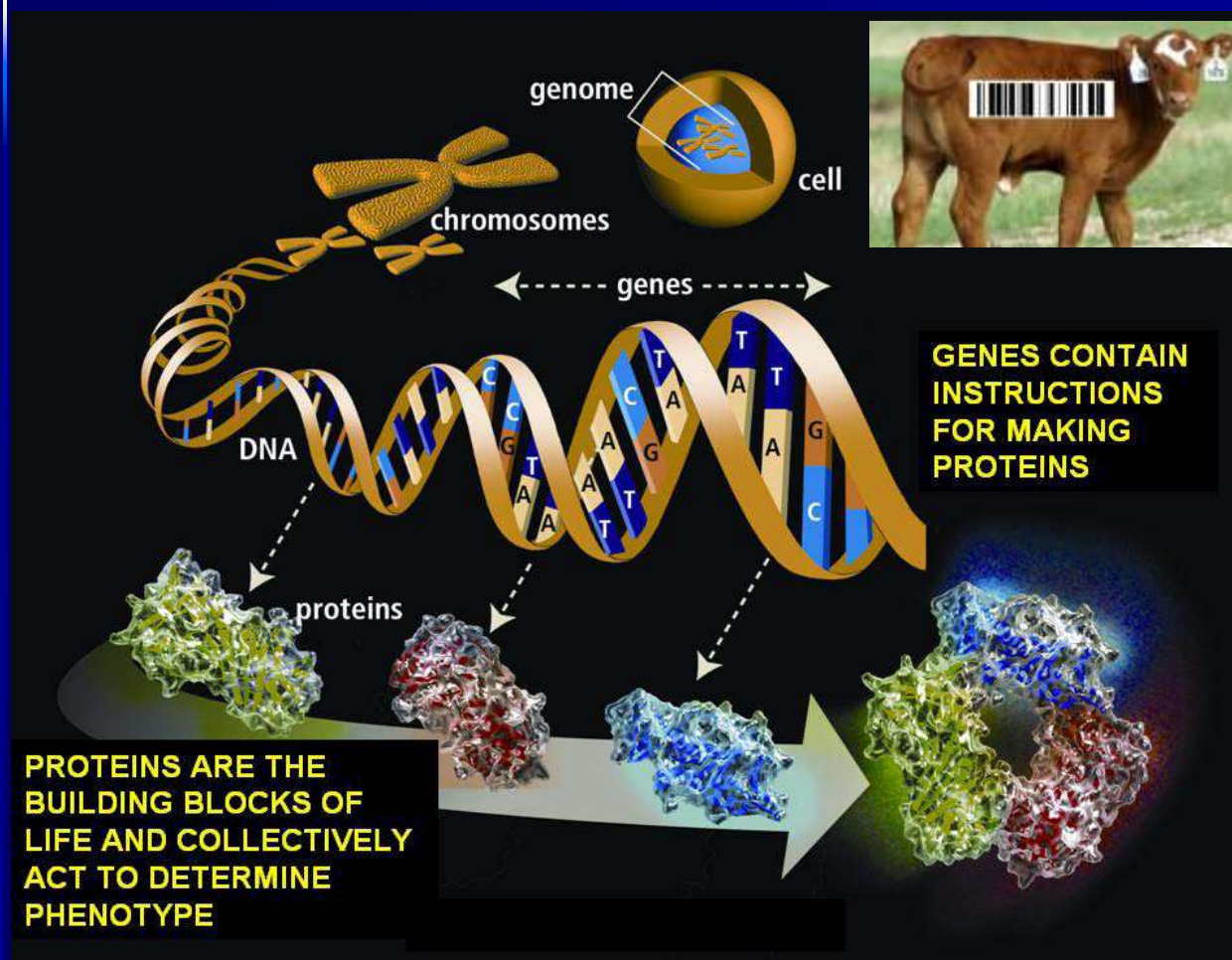## Alison Van Eenennaam, Ph.D.

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Animal Biotechnology and Genomics

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(530) 752-7942

animalscience.ucdavis.edu/animalbiotech

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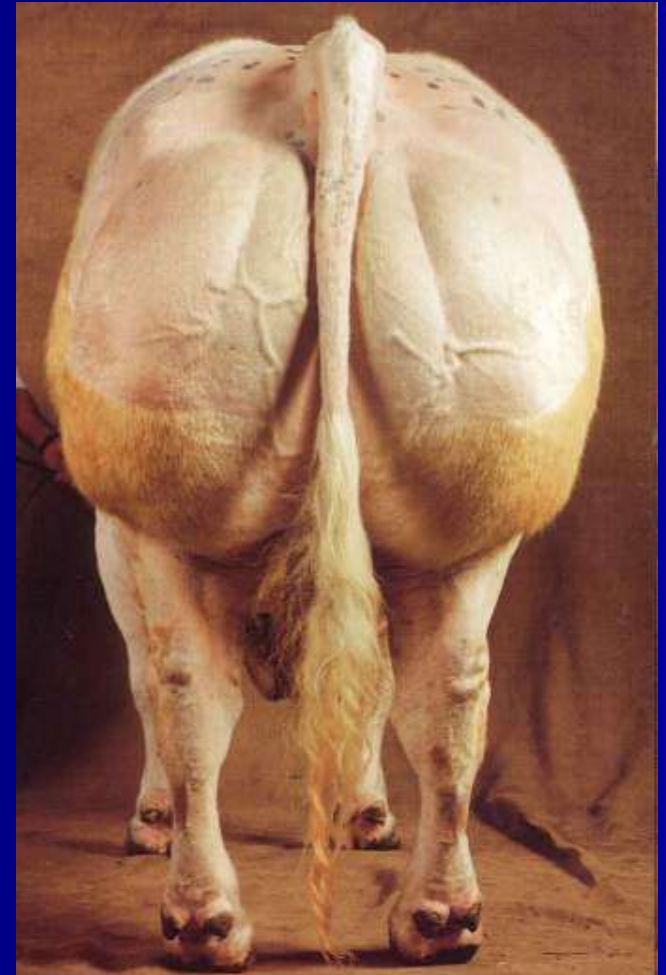

Human & cattle genomes are 83% identical

What is a Genetic Marker ?

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

SNPs = Single nucleotide polymorphisms (pronounced SNIPS)

SNPs are the most common and stable type of DNA marker in cattle and are ideally suited for automated, economical genetic testing

Carrier bull

CATGT
CACGT

½   ½
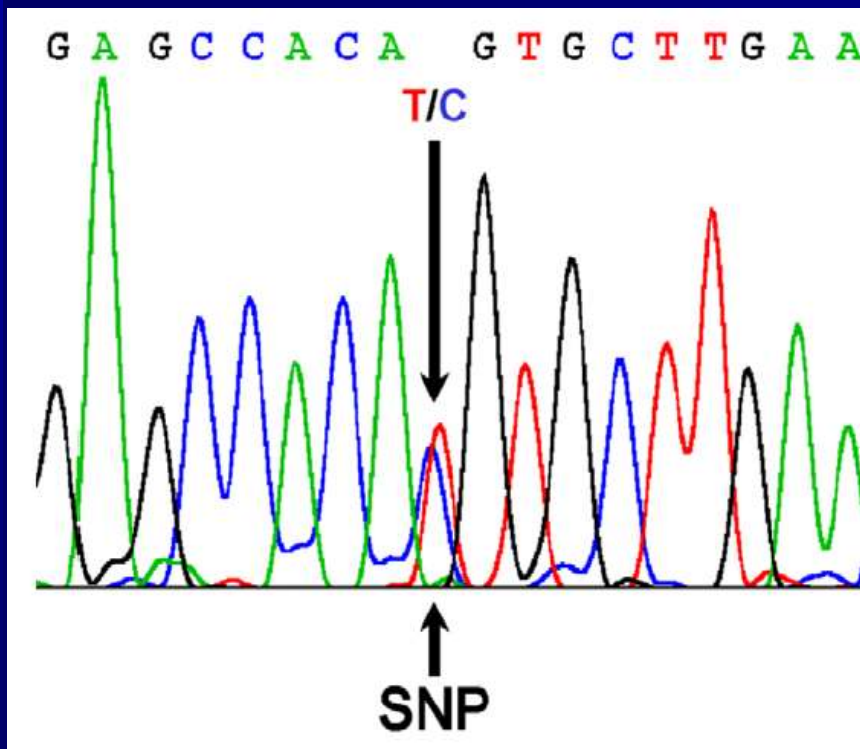
...CATGT…   …CACGT…

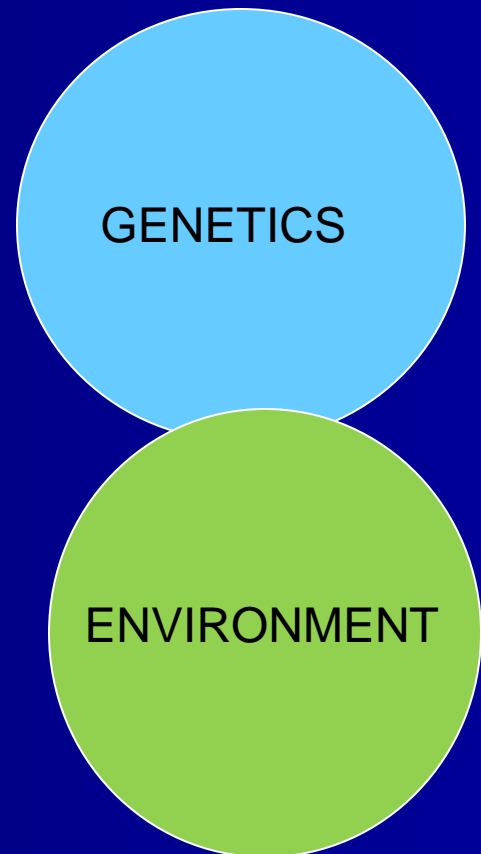# There are DNA-makers for simple (qualitative) traits

- Genotype = phenotype
  - Sex (male has XY, female has XX)
  - Coat color
  - Certain genetic diseases (e.g. AM)
  - Double muscling
  - Horns
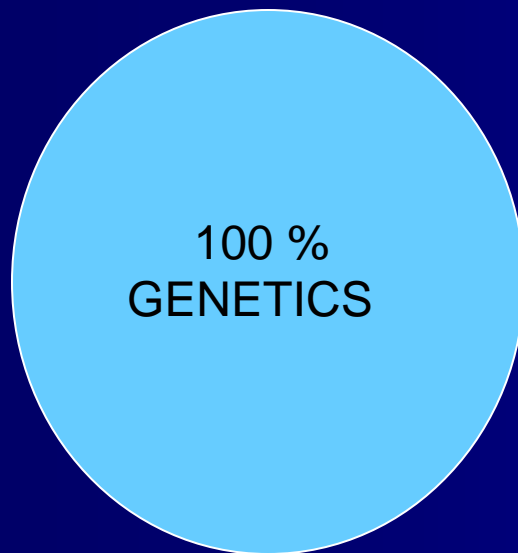
DNA tests also exist for complex traits that are controlled by many genes – to date DNA tests have involved 10-100 SNP markers

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

Who has the best test for Marker assisted management (MAM) of feedlot cattle and what is it worth?

Marker assisted management (MAM) is the process of using the results of DNA-marker testing to predict the future phenotype of the animal being tested and an application of MAM would be sorting individual cattle into **management** groups that are most likely to achieve specific end points (eg. Quality grade Choice or better).

VanEomics™

NEW!

■ GENDER BENDER™ TEST

USE: Sort pens into steers and heifers using the DNA-gender test – 100% accurate!!!!!

Do you have information to determine
– Whether it is Possible?
– Whether it is Practical?
– Whether it is Profitable?

VanEomics™

NEW!

GENDER BENDER® TEST

- Sort pens into steers and heifers using the DNA-gender test – 100% accurate!!!!!

Do you have information to determine
– Whether it is Practical?

VanEomics™

NEW!

GENDER BENDER® TEST

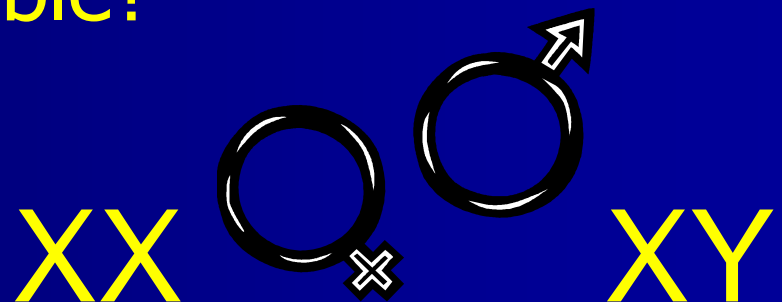USE: Sort pens into steers and heifers using the DNA-gender test – 100% accurate!!!!!

Do you have information to determine

– Whether it is Profitable?

VanEomics™

NEW!

CHOICE:SELECT SPREAD® TEST

USE: DNA test to determine value of choice:select spread at time of finish!!!!

Do you have information to determine
- Whether it is Possible?
- Whether it is Practical?
- Whether it is Profitable?

PRO-CHOICE® TEST

USE: Sort cattle into different marbling score groups

Do you have information to determine
– Whether it is Possible?
– Whether it is Practical?
– Whether it is Profitable?

VanEomics™

PRO-CHOICE® TEST

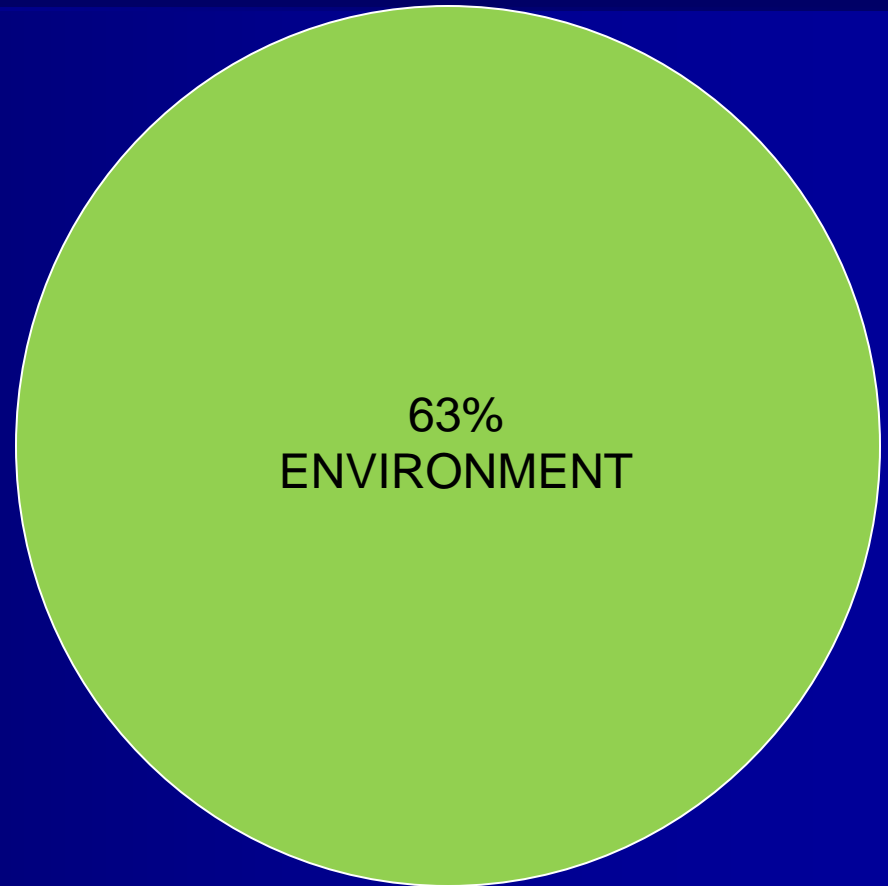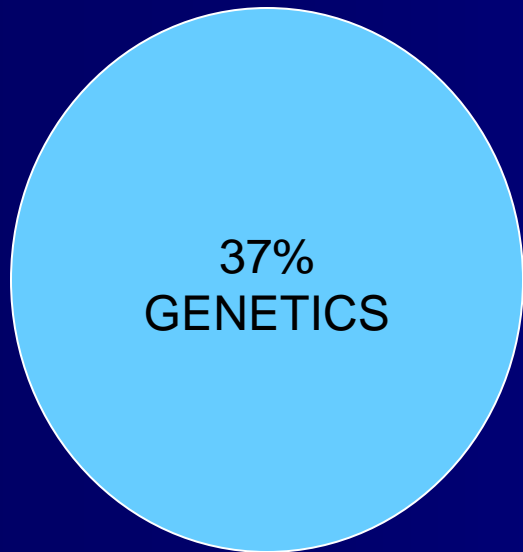# Is it possible?

Marbling score is ~ 37% genetic (h^2=.37)

So even a test that is 100% accurate will only explain 37% of the variation

MARBLING

37%
GENETICS

63%
ENVIRONMENT

VanEomics™

PRO-CHOICE® TEST

What two pieces of information are critical?

- How much does genetics affect the trait?
- How powerful is the test?

LETS LOOK AT A REAL LIFE EXAMPLE

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

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

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

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

FOR MARBLING and TRU-MARBLING

37% GENETICS

OTHER GENES

TEST ACCOUNTS FOR 70%

63% ENVIRONMENT
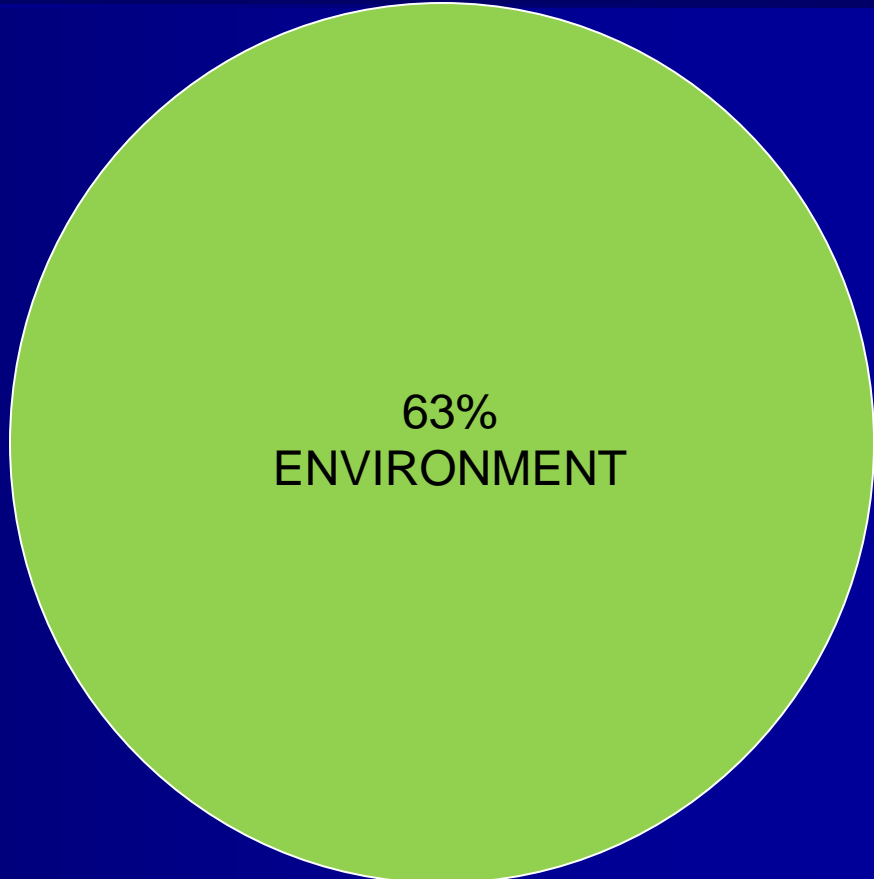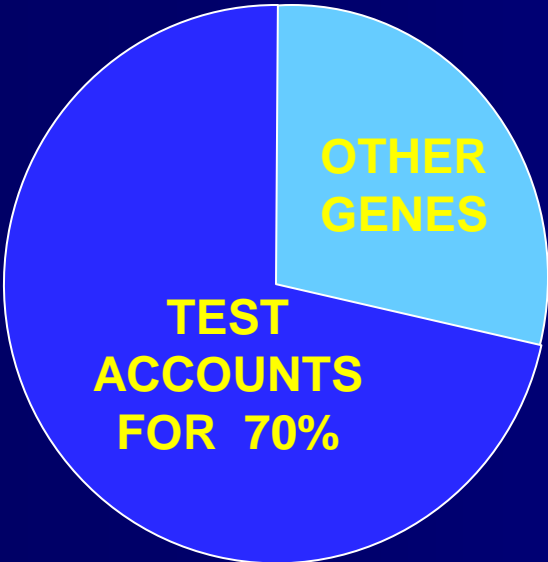
Characteristics of the four marker-assisted management sort groups

Table 1. Reimplant and Carcass Characteristics of the four sort groups.	Group 1	Group 2	Group 3	Group 4
Reimplant				
Weight	1109	1071	987	1096
Level of Fatness	+++	++	Avg.	+++
MS MGV	2.9	1.48	-1.59	23.0
Carcass				
HCW	831	883	908	863
REA	13.2	14.1	14.6	13.2
BF	0.47	0.45	0.43	0.53
MS	398	407	418	486
Yield	63.0	63.9	64.8	63.8
YG	3.0	2.9	2.8	3.3
% Choice	40.0	42.7	45.7	77.4
Data is based on 88,090 head.				

Data presented by Bill Kolath, Cargill Meat Solutions, BIF 2009
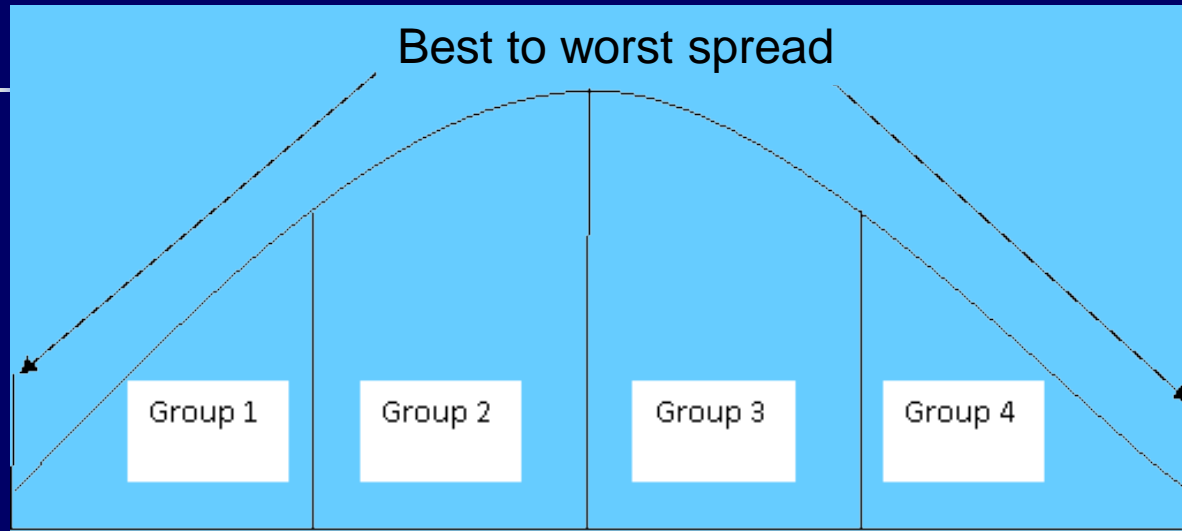
VanEomics™

PRO-CHOICE® TEST

USE: Lets you sort cattle into different marbling score groups

Do you have information to determine

– Whether it is Practical?

How will you use the information?

Possible Management Options
- Different days on feed
- Different cost rations
- Different implant strategy
- Target different markets

PRO-CHOICE® TEST

USE: Sort cattle into different marbling score groups

Do you have information to determine
– Whether it is Profitable?

VanEomics™

Is it Profitable?

If a DNA marker test is $10/head - to break even, the management measures implemented based on the DNA test results need to either save $10/head in costs or result in an extra $10/head

Table 1. Reimplant and Carcass Characteristics of the four sort groups.				
	Group 1	Group 2	Group 3	Group 4
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Weight	1109	1071	987	1096
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% Choice	40.0	42.7	45.7	77.4
Data is based on 88,090 head.				
AVERAGE GRID VALUE*	-15	-13.85	-12.70	-18.50
AVERAGE CARCASS VALUE	1122	1202	1247	1135

*Grid values based on a Choice/Select spread of $11; YG2/3 difference of $2.50; YG3/4 difference of $15
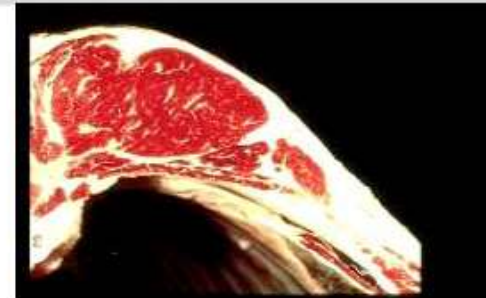
VanEomics

NEW!

New tests coming soon:

PRO-LIFE® TEST for feedlot survival

GOVENATOR® TEST for muscle growth

LEGALPOT TEST® for antibiotic residue avoidance

GLOBAL COOLER® TEST for minimizing green house gas emissions

What traits are we working on?

- Feed efficiency
- Feedlot health index
- Post weaning gain growth
- Temperament index
- Days to spec
- Immunological factors

- Ribeye area
- Carcass weight
- % Red meat yield
- Marbling/IMF
- Tenderness
- Fatty acid profile
- Healthfulness of beef

Pfizer Animal Health
Animal Genetics

GeneST★R®

What traits are we working on?

- Heifer fertility
- Cow maintenance efficiency
- Longevity/Productivity
- Calving ease
- Bull fertility / libido
- Cow profitability index

http://www.pfizeranimalgenetics.com/sites/PAG/aus/Documents/GeneSTAR_MVP_Presentation_AUS.pdf

The Power of the IGENITY® profile for Angus

The American Angus Association® through its subsidiary, Angus Genetics Inc.® (AGI), has a vision to provide Angus breeders with the most advanced solutions to their genetic selection and management needs.

Genomic-enhanced Expected Progeny Differences (EPDs) can now be calculated for your animals using the highly predictable American Angus Association database along with IGENITY® profile results to provide a more thorough characterization of economically important traits and improved accuracy on young animals.

Using the IGENITY profile for Angus, breeders receive comprehensive genomic results for multiple, economically important traits.

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

Additional tests available:

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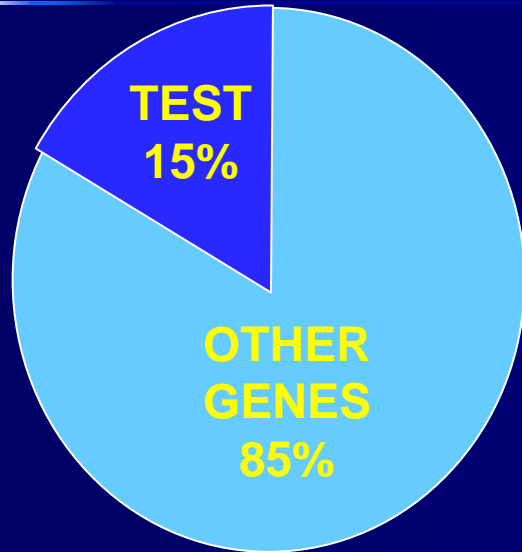- Bovine Viral Diarrhea – Persistently Infected (BVD PI)
- Coat Color

ANGUS
THE BUSINESS BREED

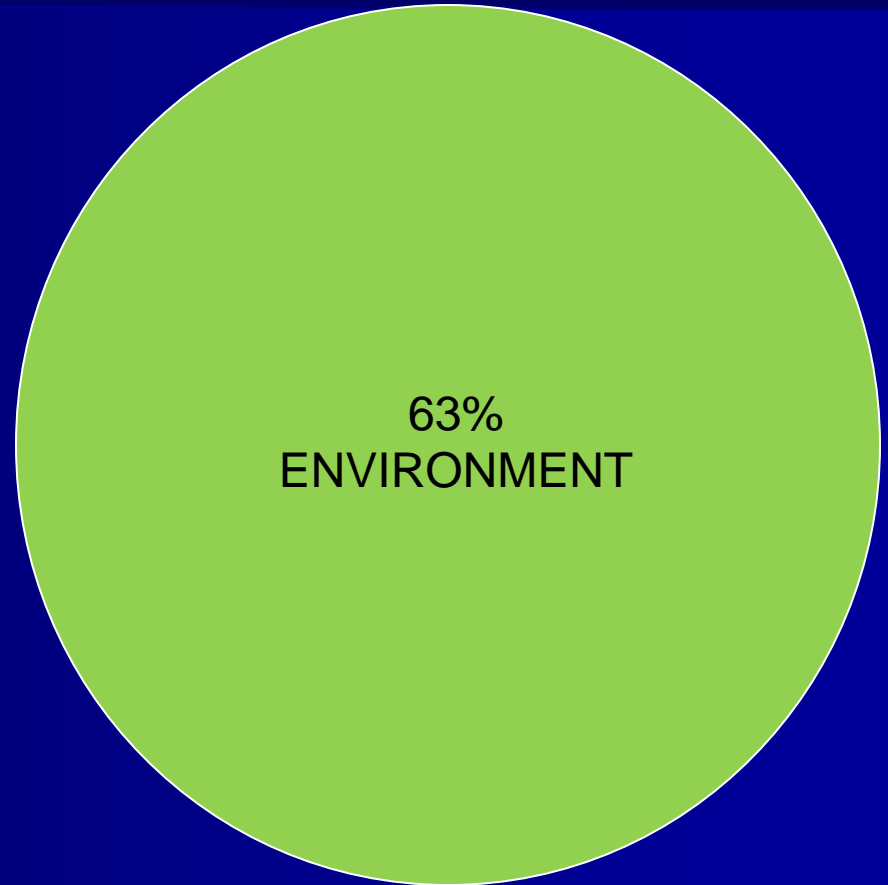| IGENITY PROFILE TRAIT	h²	Igenity Profile	% Genetic Variation explained by test
Average Daily Gain	0.28	X	?
Residual Feed Intake	0.25	X	?
Tenderness	0.37	X	?
Yearling Weight	0.3	X	?
Calving ease (maternal)	0.1	X	?
Heifer pregnancy rate	0.13	X	?
Docility	0.4	X	?
Stayability	0.1	X	?
Backfat thickness	0.36	X	?
Ribeye area	0.4	X	?
Marbling score	0.37	X	~ 15%*
Yield Grade	0.4	X	?
Percent Choice	??	X	?
Carcass weight	0.39	X	?

* MacNeil, M. D., J. D. Nkrumah, B. W. Woodward, and S. L. Northcutt. 2009. Genetic evaluation of Angus cattle for carcass marbling using ultrasound and genomic indicators. J. Anim Sci. *In press*

FOR MARBLING and IGENITY PROFILE

TEST
15%

OTHER
GENES
85%

37%
GENETICS

63%
ENVIRONMENT

15% x 37% = 5.5%
phenotypic variation

Lead Today with 50K

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

For more information about HD 50K:

HD 50K Overview

HD 50K Customer Reporting Overview

FAQs

HD 50K Television Ad

Post a Question

Order a Test Kit

Cost per test
1-24 $129
25 + $119
Existing samples reanalyzed
1-24 $ 79
25+ $ 69

PFIZER ANIMAL GENETICS Trait	h²	% Genetic variation explained			
		Pfizer MVP (2009)	Australian Validation (2009)	Pfizer 50K (2010)	Third party Validation?
Average Daily Gain	0.28			30%	
Net Feed Intake	0.39	9%	0-6%	12%	
Dry matter intake	0.39			11%	
Tenderness	0.37	24%	2-30%	26%	
Calving Ease (Direct)	0.1			22%	
Birth weight	0.31			28%	
Weaning Weight	0.25			32%	
Calving ease (maternal)	0.1			40%	
Milking Ability	0.25			27%	
Carcass weight	0.39			29%	
Backfat thickness	0.36			40%	
Ribeye area	0.4			29%	
Marbling score	0.37	7%	0-4%	34%	

Quantum Genetics Canada Inc. - Who/what are they?

Quantum Genetics Canada Inc. is a Canadian company created in 2003, located in Saskatoon, Saskatchewan, Canada at Innovation Place Research Park. It is devoted to activities related to research/commercialization and the genetic variation that exists within the populations of animals in the industry. Primarily the company is focused on the identification of variant forms of genes that affect phenotypes of economic importance, i.e. YG, QG, carcass wt, etc. Further understanding of how to manipulate these genotypes to achieve more consistent end products is also at the forefront of QGCI. QGCI has developed one such understanding about how to manipulate variation in the obese gene, such that Canada/USDA grades can be optimally achieved more consistently than have been done with existing technologies.

QUANTUM
GENETICS
CANADA INC.

FEATURES

- Contains 11 DNA markers where each marker is highly associated with expression of tenderness in meat products
- Measures the cumulative effects of all 11 markers associated with meat tenderness
- 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 tenderness
- Accounts for a significant proportion of total observed genetic variation for tenderness
- Results are easy to utilize and incorporate into any existing breeding program
- Can be used to make early and accurate 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

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. 84:599

100% accurate

Explains 100% of the genetic variation in marbling with 11 markers

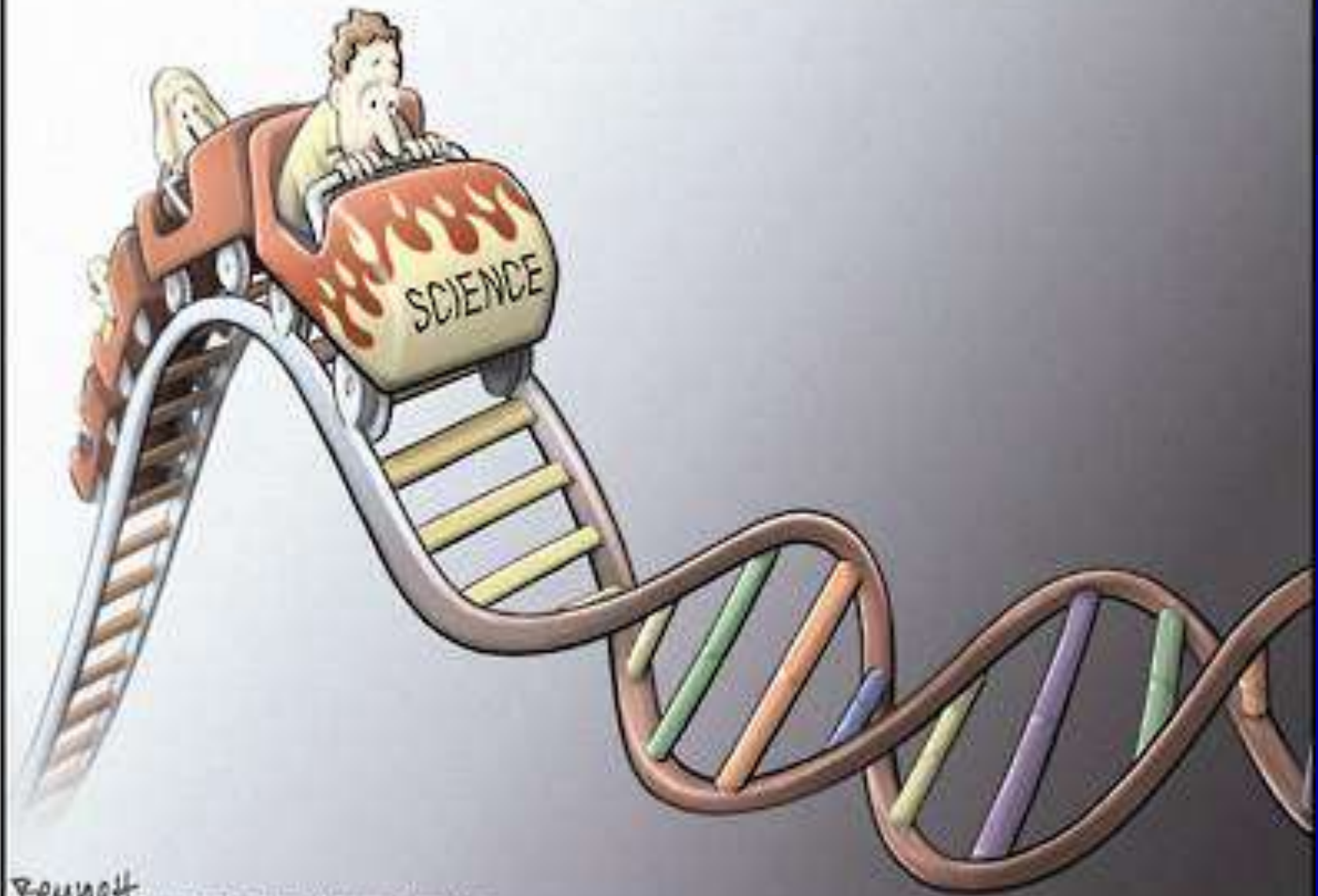*VanEomics*™

NEW!

■ **"FILL IN THE BLANK" TEST**

Do you have information to determine:

- Whether it is <u>Possible</u>? trait h^2, % genetic variation explained, whose numbers?

- Whether it is <u>Practical</u>? Can you use it to manage cattle in a useful way?

- Whether it is <u>Profitable</u>? Does the added cost generate a return on investment?

BOTTOM LINE

- Does it work?

- Is it useful?

- Does it pay?