"Beef Cattle Industry Structure: Implications for whole genome selection"

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Should you use this bull?

Selection criteria – informal survey!

- Only if he looks right
- Only if he has marbling
- Only if he has the right DNA
- Only if he has the right pedigree

The basis of selection is the resemblance between relatives

What you would really like to know is the future performance of his unborn calves !!

Should you use this bull?

What if I told you these calves belonged to the bull?

What if I told you these were his daughters' calves?

Animal breeders use records of an animals own performance and that of its relatives to predict an animal's genetic merit or

ESTIMATED BREEDING VALUE (EBV)

Challenge for breeders is to identify those individuals that have the best breeding values at a young age

$\Delta G =$ *intensity of selection X*

accuracy of identifying the good ones X

genetic variation in the population /

generation interval

How can I increase my accuracy of identifying the good ones?

- Records, records, records (BREEDPLAN)
- Treating all animals in a group the same
- DNA testing???

What is a Genetic Marker ?

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

There are DNA-markers for simple traits

- DNA test result is highly predicitive
  - Coat color
  - Polled/horned staus
  - Certain genetic diseases (e.g. “curly calf”)
  - SCD (Prescribe Genomics, $90 per test)
  - “Exon 5” (Prescribe Genomics, $100/test)

Wagyu-specific DNA-makers

SCD - Stearoyl-CoA desaturase (AA, VA, VV)

- "the percentage of beef that is "not delicious" has increased as a result of increased fat of a high melting temperature
- ~ 18 % AA, 74% VA, 8% VV

Exon 5 – growth hormone (AA,AB,BB,BC,CC)

- Only found in Wagyu,
- Purportedly associated with marbling
- No more information on frequency

There are several different DNA sequences of the SCD gene in Japanese Black cattle. These are categorized into 2 groups, A & V. Some Japanese Black cattle carry a special mutation that changes the corresponding amino acid from Valine (V) to Alanine (A) which has a significant relationship to the melting point of fat. Alanine type has a lower melting point than valine type. Therefore the preferred type is AA. By using the SCD gene we can select the cattle which can deposit a soft and oleic acid rich fat that is delicious and healthy.

At this time no gene tests should be used as the single selection criteria that a cattle farmer would use. Rather they should be seen as part of the selection process when choosing cattle for breeding. Cattle that show preferred genotypes for both GH Exon 5 and SCD provide the most likely animals to improve a cattle herds performance BUT ONLY if all other factors are satisfactory.

Dr. Tadayoshi Mitsuhashi
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An increasing number of companies are starting to offer DNA tests for production traits

DNA-markers for production traits

- DNA test result may or may not be highly predictive of genetic merit

Commercial genetic test validations

Summary of NBCEC validations for commercially-available DNA-tests for complex (quantitative or multigenic) traits in beef cattle (note: validations do not include tests for "simple" traits such as coat color, horned/polled, AM status etc.)

Company	Test Name	Trait	Date of validation
Igenity www.igenity.com	Profile®	Fat Thickness	12/2008
	Profile®	Marbling Score	12/2008
	Profile®	Quality Grade (% ≥ Choice)	12/2008
	Profile®	Rib Eye Area	12/2008
	Profile®	Yield Grade	12/2008
	Profile®	Average Daily Gain	12/2008
	Profile®	Tenderness	12/2007
	Profile®	Residual Feed Intake (RFI) (for *Bos indicus* influenced cattle)	12/2007
	Profile®	Residual Feed Intake (RFI) (for *Bos taurus* cattle)	6/2008
	Profile®	Dry matter intake (DMI) (for *Bos indicus* influenced cattle)	12/2007
	Profile®	Heifer Pregnancy Rate	
	Profile®	Stayability (longevity)	
	Profile®	Maternal Calving Ease	
	Profile®	Docility	
Pfizer Animal Genetics (Bovigen) www.bovigen.com	GeneSTAR® Tenderness MVP	Tenderness	2/2009
	GeneSTAR® Marbling MVP	% IMF (Feedlot cattle)	2/2009
	GeneSTAR® Feed Efficiency MVP	Net Feed Intake (NFI)	2/2009
MMI genomics www.metamorphixinc.com	Tru-Marbling™	Marbling Score and Quality Grade	
	Tru-Tenderness™	Tenderness	

Australian beef DNA results - Beef CRC - Beef Genetic Technologies - Windows Internet Explorer

http://www.beefcrc.com.au/Aus-Beef-DNA-results

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The Cooperative Research Centre for Beef Genetic Technologies

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Success Stories

Beef CRC project aimed at improving beef industry profitability gains national recognition

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Australian beef DNA results

As part of its role in delivering DNA markers to the Australian beef industry, Beef CRC has agreed to independently test new panels of DNA markers as they are commercialised by companies such as Pfizer Animal Genetics, Igenity /Merial and Metamorphix Inc.

Results of all independent testing of commercially-available DNA markers undertaken by Beef CRC will be presented on this site, outlining the size and direction of effect and the amount of genetic variation that is accounted for by each panel of markers for the different traits (e.g. marbling, feed efficiency, tenderness etc).

Additional information is provided to help beef businesses interpret the results for themselves to determine the value to their own businesses from an investment in the particular panel of DNA markers.

Those decisions very much depend on the individual business' attitude to risk and can only be made effectively by the individual business.

It is possible that the panel of markers has also been independently evaluated in North American herds by the US National Beef Cattle Evaluation Consortium, so for further information on the size and direction of effect of the markers in those populations, please visit http://www.ansci.cornell.edu/nbcec/

Pfizer GeneStar results

Pfizer interpretation

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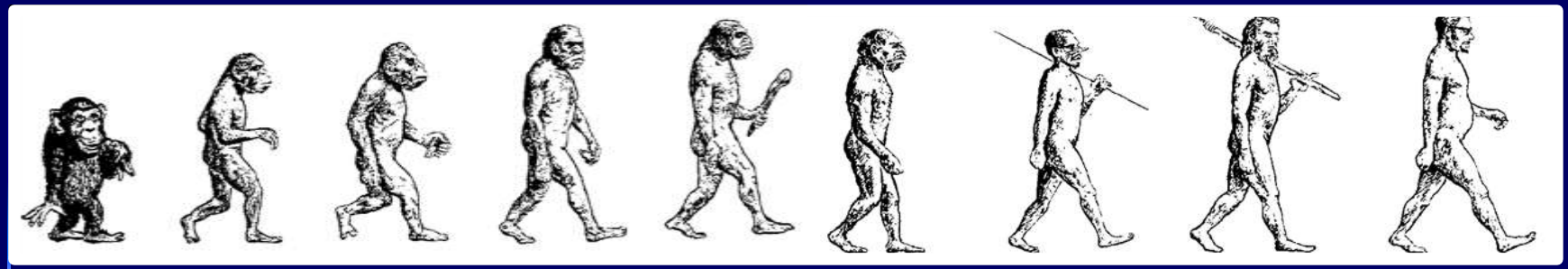
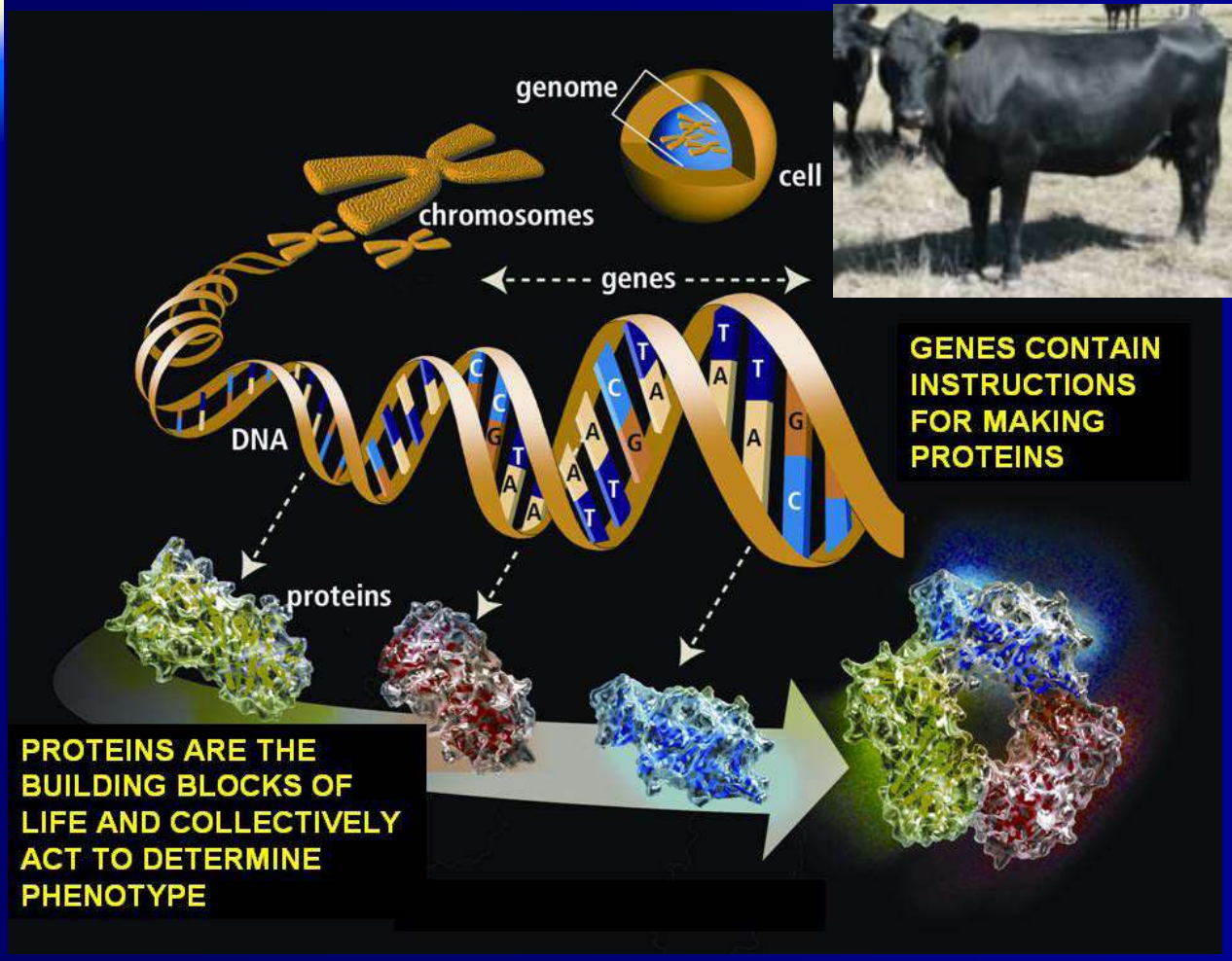
Genetic variation explained by DNA-tests that have been independently assessed by AGBU in Australia.

Population	IMF%	MSA Marble Score	SF (kg)	NFI (kg)
1. *Bos taurus*	0.3%	1.7%	2.9%	6.2%
2. *Bos indicus*	0.4%	0.9%	8.0%	5.4%
3. *Bos taurus* x *Bos indicus*	0%	0%	1.6%	0%
4. *Bos indicus* *X* Brahman	1.5%	3.6%	29.9%	0%



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

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

Whole genome-assisted selection (WGS)

- The sequencing of the bovine genome allowed for the development of a 50,000 marker chip!
- Can simultaneously test 50,000 markers

Whole-genome selection

Application of WGS in Dairy Cattle Has Been Successful

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Validation:
New Progeny Tested Bulls

Training Population:
5000 Progeny Tested Bulls

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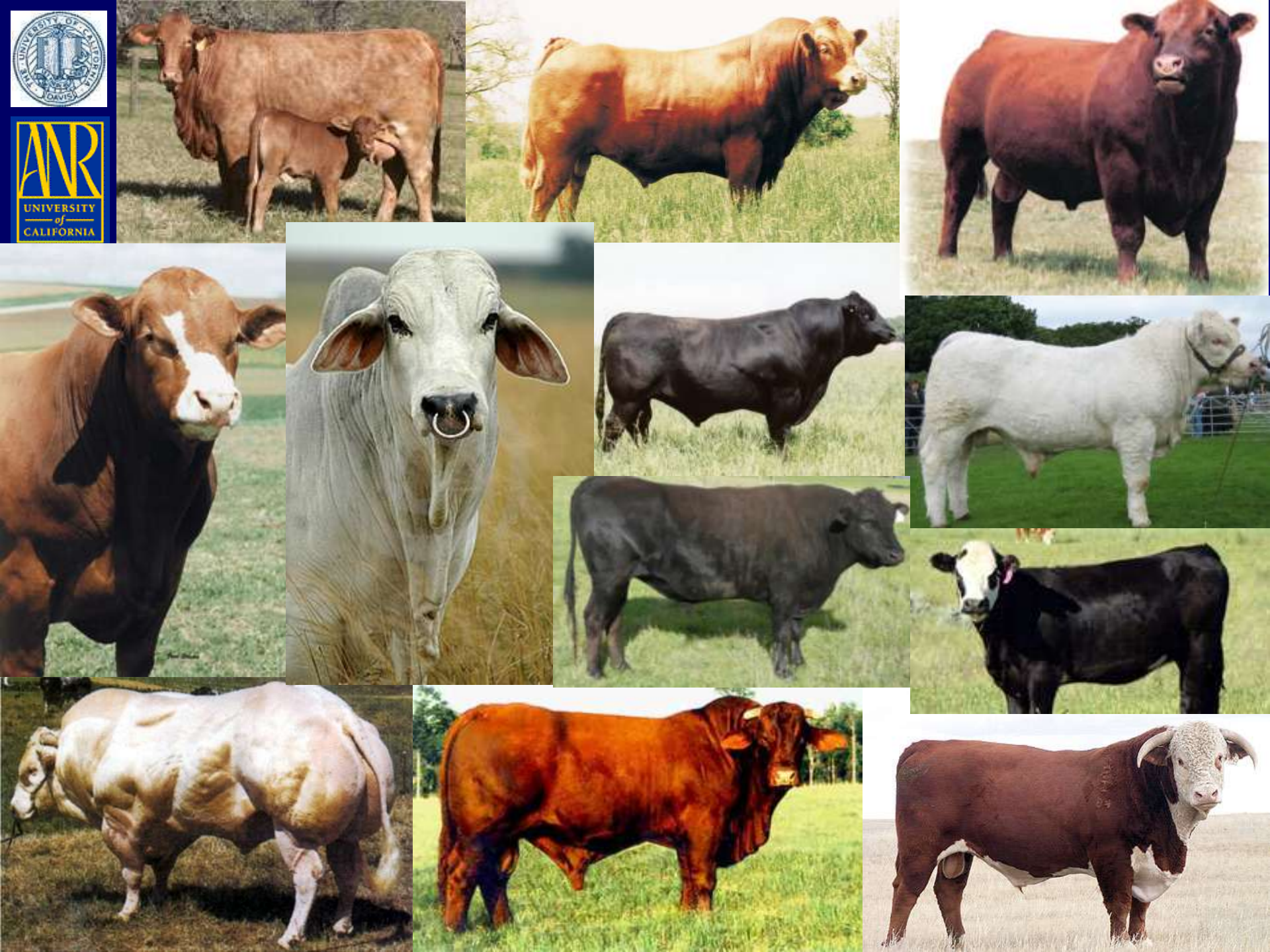
Application:
New Sire Candidates

Slide courtesy of Marc Thallman, US MARC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The beef cattle industry is different to dairy!

- Little use of AI
- Relatively few high accuracy sires for training
- Multiple competing selection goals – cow/calf, feedlot, processor – little data sharing between sectors
- Few/no records on many economically-relevant traits
- Crossbreeding is important
- Many different breeds

Whole genome selection in US beef cattle industry

r_0

Validation:
2,000 Bull Project

Training populations:
- US Meat Animal Research Center population
- Angus AI sires
- DNA Testing Companies

r_1

Application:
Seedstock Breeders

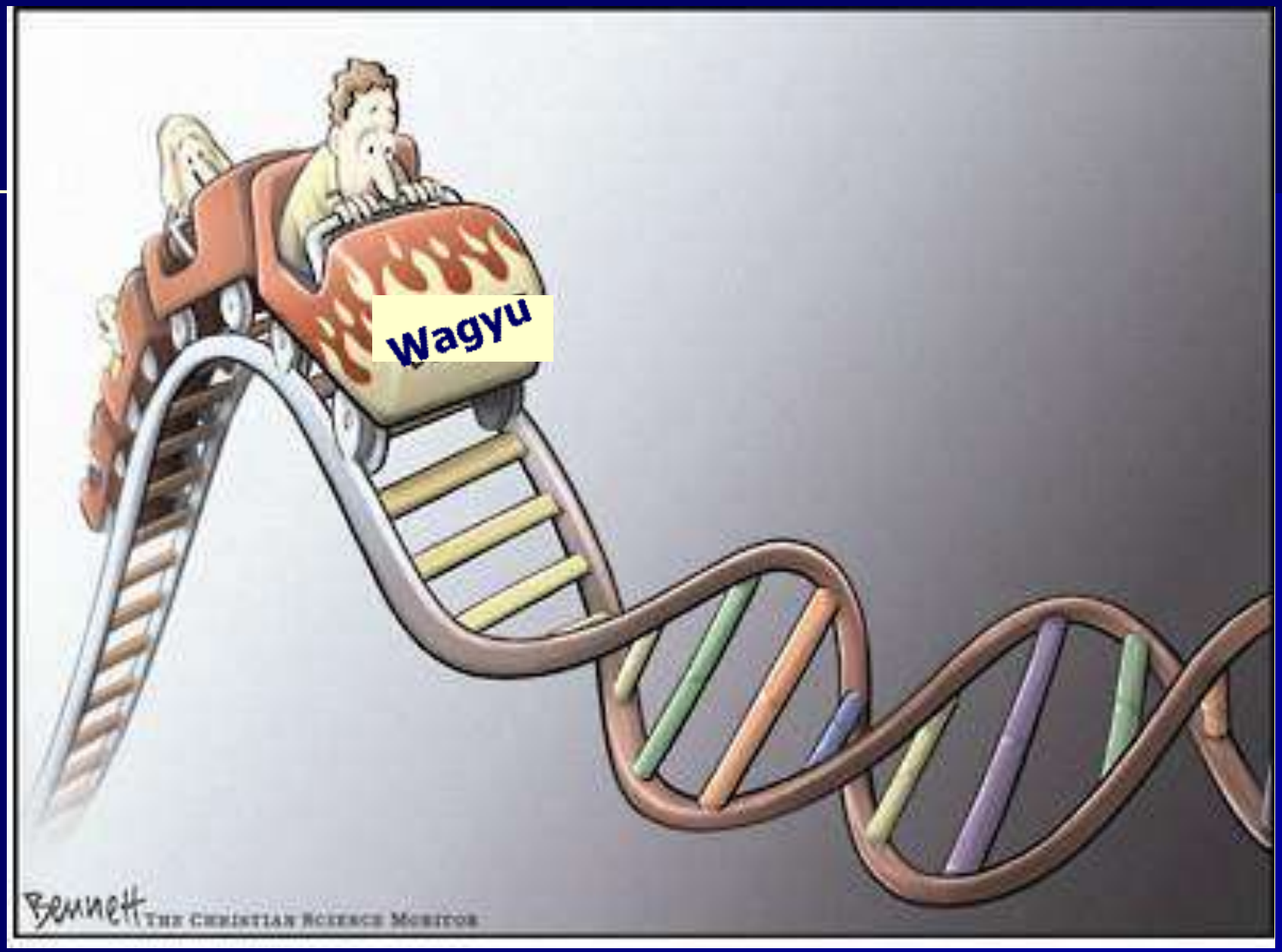
Slide courtesy of Marc Thallman, US MARC

Validation: Purpose is to estimate how predictive DNA tests are in different breeds

- Angus 402
- Hereford 317
- Simmental 253
- Red Angus 173
- Gelbvieh 136
- Limousin 131
- Charolais 125
- Shorthorn 86

- Brangus 68
- Beefmaster 64
- Maine-Anjou 59
- Brahman 53
- Chiangus 47
- Santa Gertrudis 43
- Salers 42
- Braunvieh 27


What
about
Wagyu?


Wagyu
Bennett
THE CHRISTIAN SCIENCE MONITOR

Questions ?