CHALLENGES TO ADOPTION OF MOLECULAR INFORMATION

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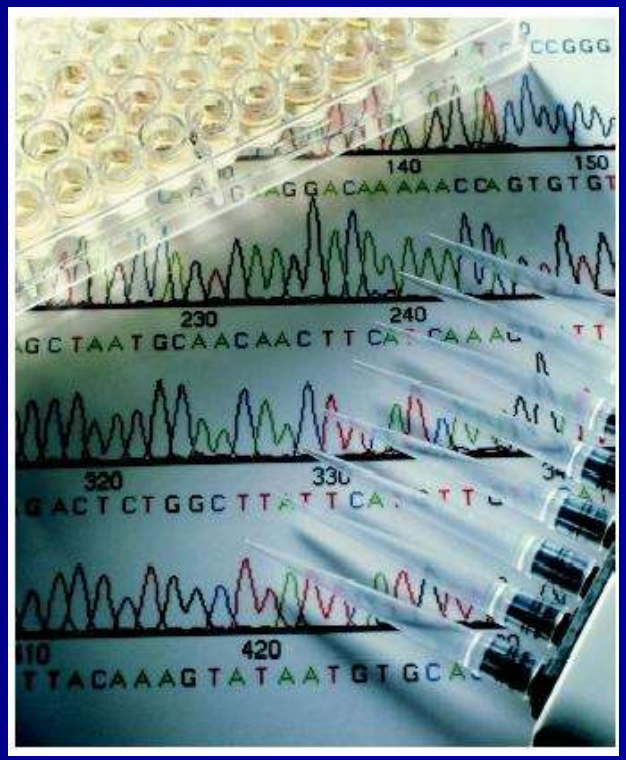


animalscience.ucdavis.edu/animalbiotech

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).

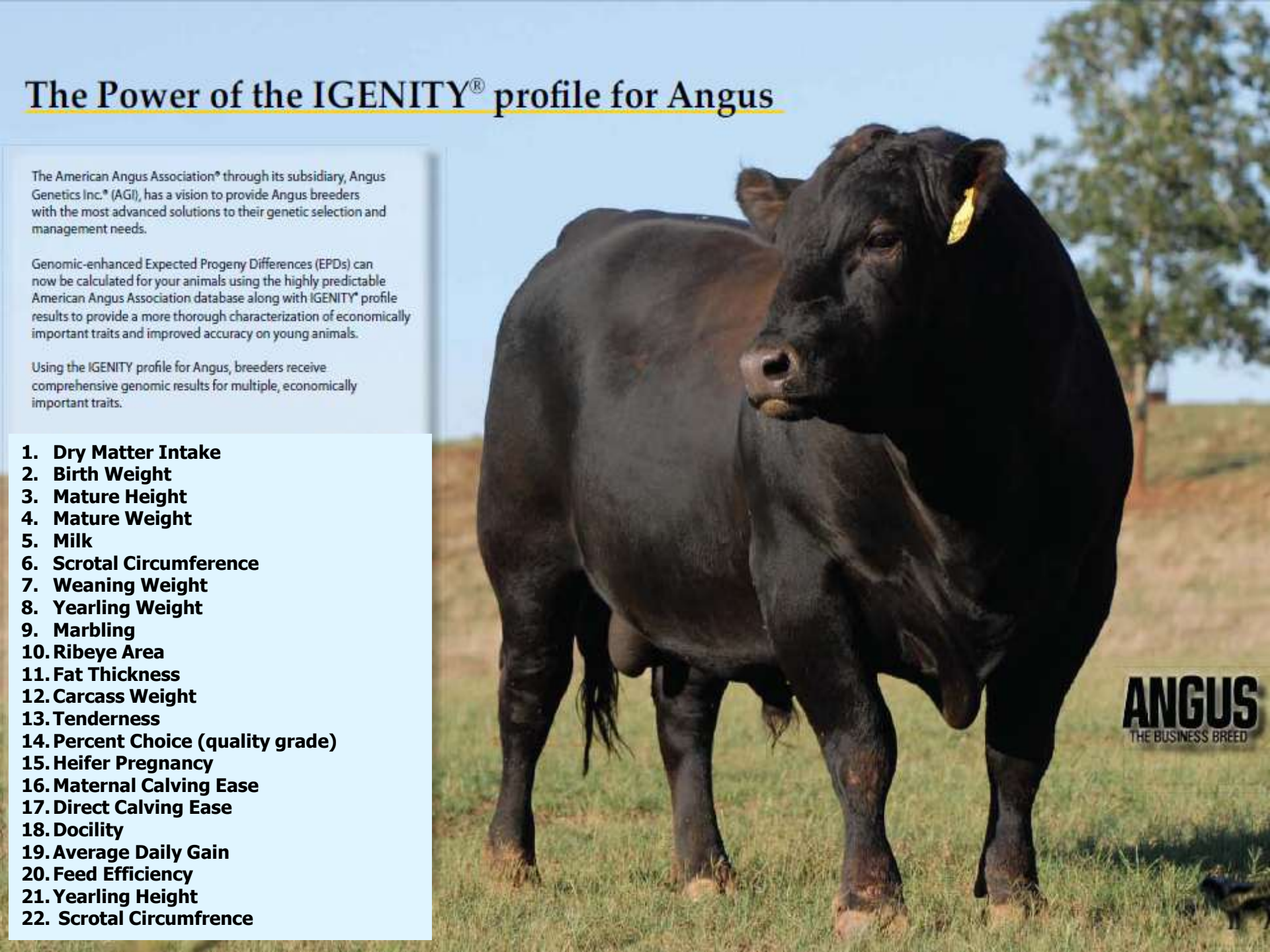
The Power of the IGENITY® profile for Angus

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)

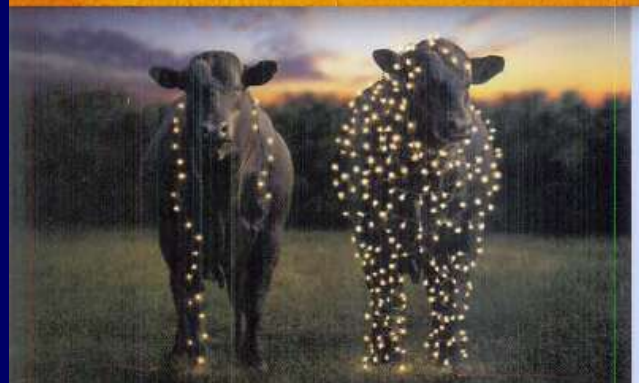
Pfizer Animal Health
Animal Genetics

50K SNP chip assays
50,000 SNPs spread throughout genome

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.

	384 SNP	50K SNP
Genetic Correlation (r)/(r^2%)	**Igenity**	**Pfizer**
Calving Ease Direct	.47 (22%)	.33 (11%)
Birth Weight	.57 (32%)	.51 (26%)
Weaning Weight	.45 (20%)	.52 (27%)
Yearling Weight	.34 (12%)	.64 (41%)
Dry Matter Intake (component of RADG)	.45 (20%)	.65 (42%)
Yearling Height	.38 (14%)	.63 (40%)
Yearling Scrotal	.35 (12%)	.65 (42%)
Docility	.29 (.08%)	.60 (36%)
Milk	.24 (06%)	.32 (10%)
Mature Weight	.53 (28%)	.58 (34%)
Mature Height	.56 (31%)	.56 (31%)
Carcass Weight	.54 (29%)	.48 (23%)
Carcass Marbling	.65 (42%)	.57 (32%)
Carcass Rib	.58 (34%)	.60 (36%)
Carcass Fat	.50 (25%)	.56 (31%)

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

American Angus Association performs weekly evaluations with genomic data – recently updated to include new traits

	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)

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

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

How much do DNA tests help increase accuracy of EPDs?

	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

Value of DNA information for beef bull selection

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Armidale, NSW, Australia

[3] Victorian Department of Primary Industries and University of Melbourne, VIC, Australia

Objective

Estimate the value of using DNA test information to increase the accuracy of beef bull selection in a seedstock breeding program

- The expected returns from using a **commercial** sire sourced from a seedstock herd using DNA testing
- Additionally, the value of marker information in the selection of replacement **stud** males to be mated in a seedstock breeding program was also estimated.

Van Eenennaam, A. L., J.H. van der Werf, and M.E. Goddard. 2011. The economics of using DNA markers for beef bull selection in the seedstock sector. Journal of Animal Science. 89:307-320.

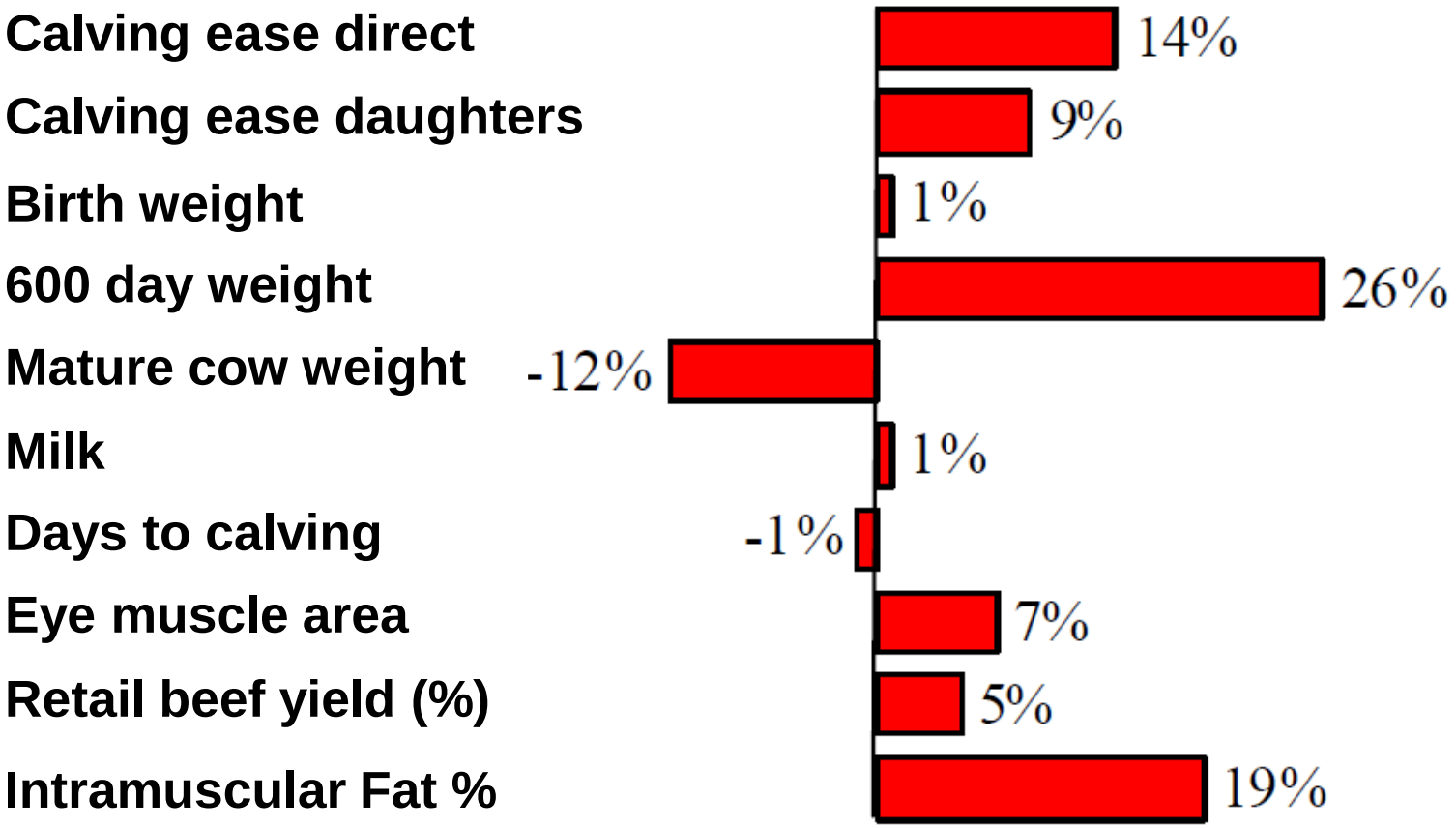
The following seedstock operation was modeled

Parameters	Value
Number of stud cows	600
Number of bulls calves available for sale/selection	**267 (all get tested with DNA test)**
Number of stud bulls selected each year	8 (~3%; i = 2.27)
Number of bulls sold for breeding (annual)	125 (~50%; i = 0.8)
Maximum age of commercial sire	5 (4 breeding seasons)
Commercial cow:bull ratio	25
Number of commercial females	9225
Planning horizon	20 years
Discount rate for returns	7%
Number of live stud calves available per exposure	**0.89**
Stud cow:bull ratio	**30**
Cull for age threshold of cow	**10**
Age structure of breeding cow herd (2-10 yr)	**0.2, 0.18, 0.17,0.15, 0.12, 0.09, 0.05, 0.03, 0.01**
Bull survival (annual)	**0.8**
Age structure of bulls in stud herd (2-4 yr)	**0.41, 0.33, 0.26**
Age structure of bulls in commercial herd (2-5 yr)	**0.34, 0.27, 0.22, 0.17**

Long Fed / CAAB $Index (Whole Industry Good index)

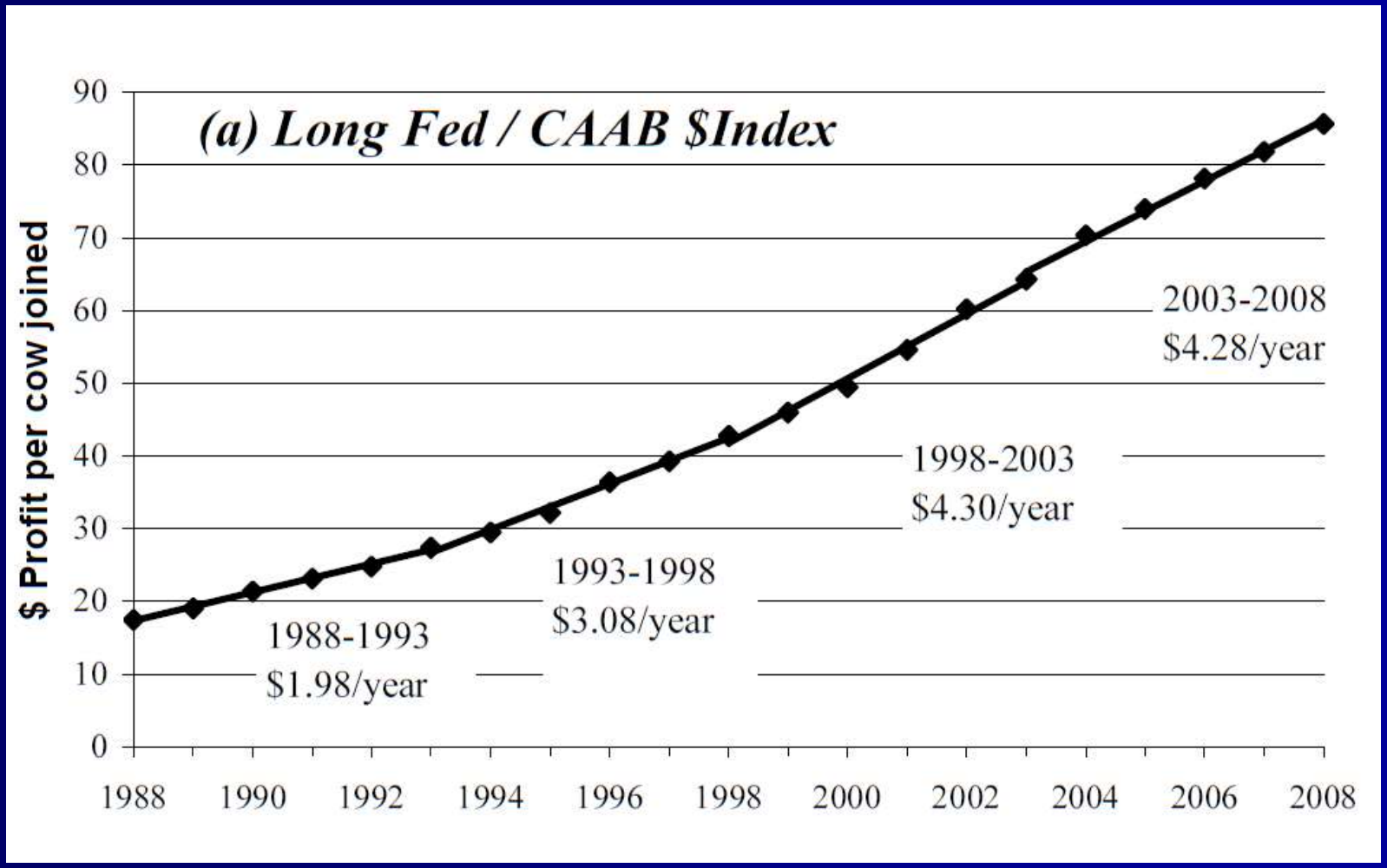
Suitable for a self-replacing commercial herd in temperate Australia targeting the production of steers for the long-fed markets that value marbling and 600 day growth.

ECONOMICALLY –RELEVANT TRAIT



Genetic trend for Angus Long Fed / CAAB $Index

Estimates the genetic differences between animals in net profitability per cow joined for a high fertility self replacing commercial Angus herd in temperate Australia targeting pasture grown steers with a 270 day feedlot finishing period for the high quality, high marbled Japanese export market. Steers are assumed marketed at 740 kg live weight (420 kg HSCW and 25 mm P8 fat depth) at 26 months of age. Significant emphasis is placed on marbling and 600 day growth



High (h^2) and intermediate (½ h^2) (proportion of genetic variation explained) DNA tests in all of the economically-relevant traits in the Angus Long Fed / CAAB $Index and selection criteria

Objective Trait	h^2
Sale liveweight – direct	0.31
Sale liveweight – maternal	0.04
Cow weaning rate	0.05
Cow survival rate	0.03
Cow weight	0.41
Calving ease – direct	0.10
Calving ease – maternal	0.10
Dressing Percentage	0.33
Saleable meat Percentage	0.56
Fat depth (rump)	0.41
Marbling score	0.38

Selection criteria	h^2
Birth weight	0.39
200 d Weight	0.18
400 d Weight	0.25
600 d Weight	0.31
Scrotal Size	0.39
Days to Calving	0.07
Mature Cow Weight	0.41
P8 fat	0.41
RIB fat	0.34
Eye Muscle Area	0.26
Intramuscular Fat	0.25

Van Eenennaam, A. L., J.H. van der Werf, and M.E. Goddard. 2011. The economics of using DNA markers for beef bull selection in the seedstock sector. Journal of Animal Science. 89:307-320.

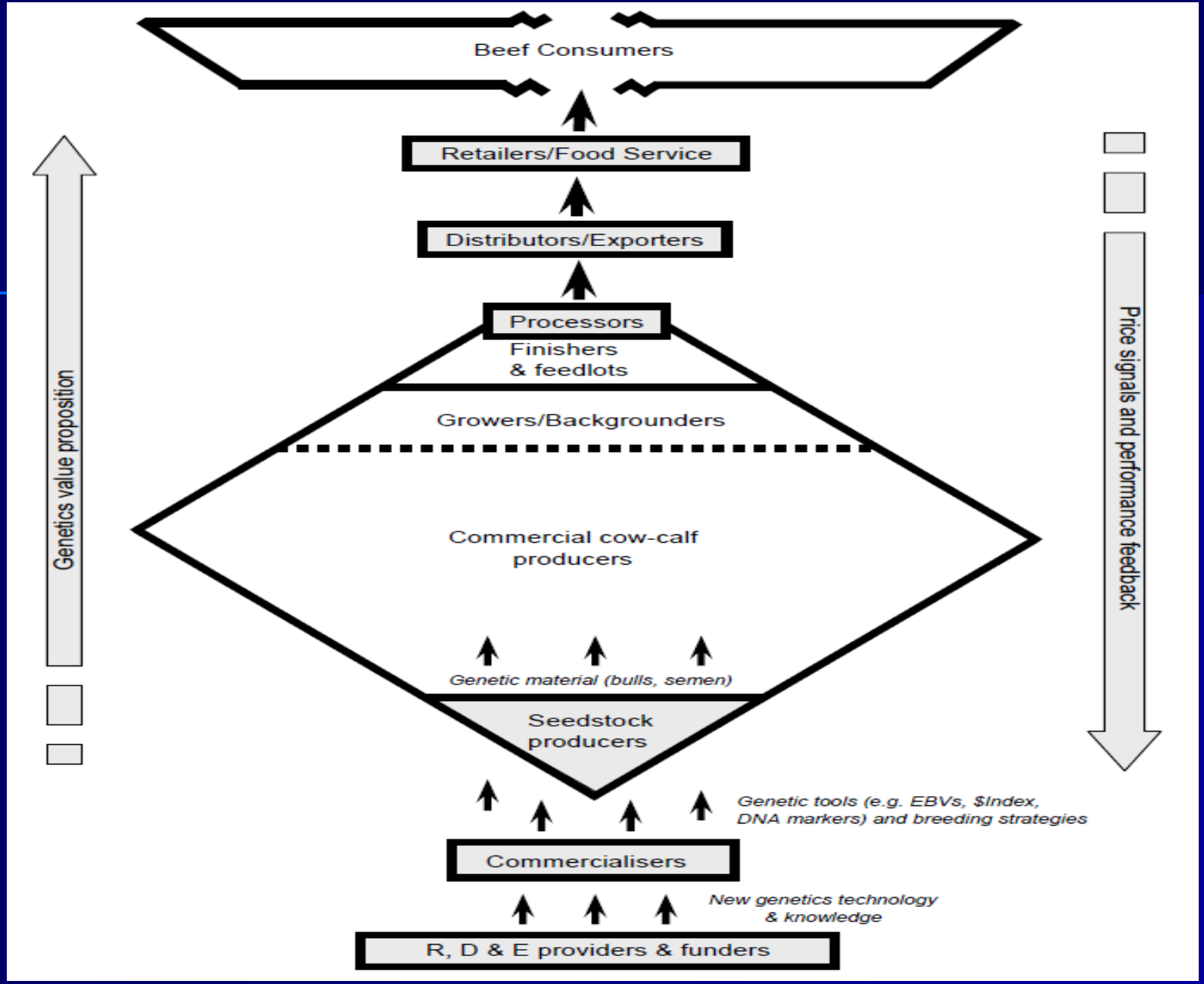
Materials and methods (continued)

- Long Fed/CAAB $Index and index accuracies were calculated when information source included DNA test information from one of the two DNA panels **and** performance recording, over that derived from performance recording alone.
- Discounted gene flow methodology (Hill, 1974) was used to calculate the value derived from the use of superior bulls selected using DNA test information **and/or** performance recording. Results were ultimately calculated as discounted returns per DNA test purchased by the seedstock operator.

Van Eenennaam, A. L., J.H. van der Werf, and M.E. Goddard. 2011. The economics of using DNA markers for beef bull selection in the seedstock sector. Journal of Animal Science. 89:307-320.

Value of improved selection response for stud bulls due to DNA-test increase in Long Fed / CAAB $Index accuracy

Variable	Unit	Accuracy of DNA test used	Long Fed / CAAB $Index
Increased value derived from ΔG in commercial sires	$/ bull	Intermediate	16,882
		High	27,901

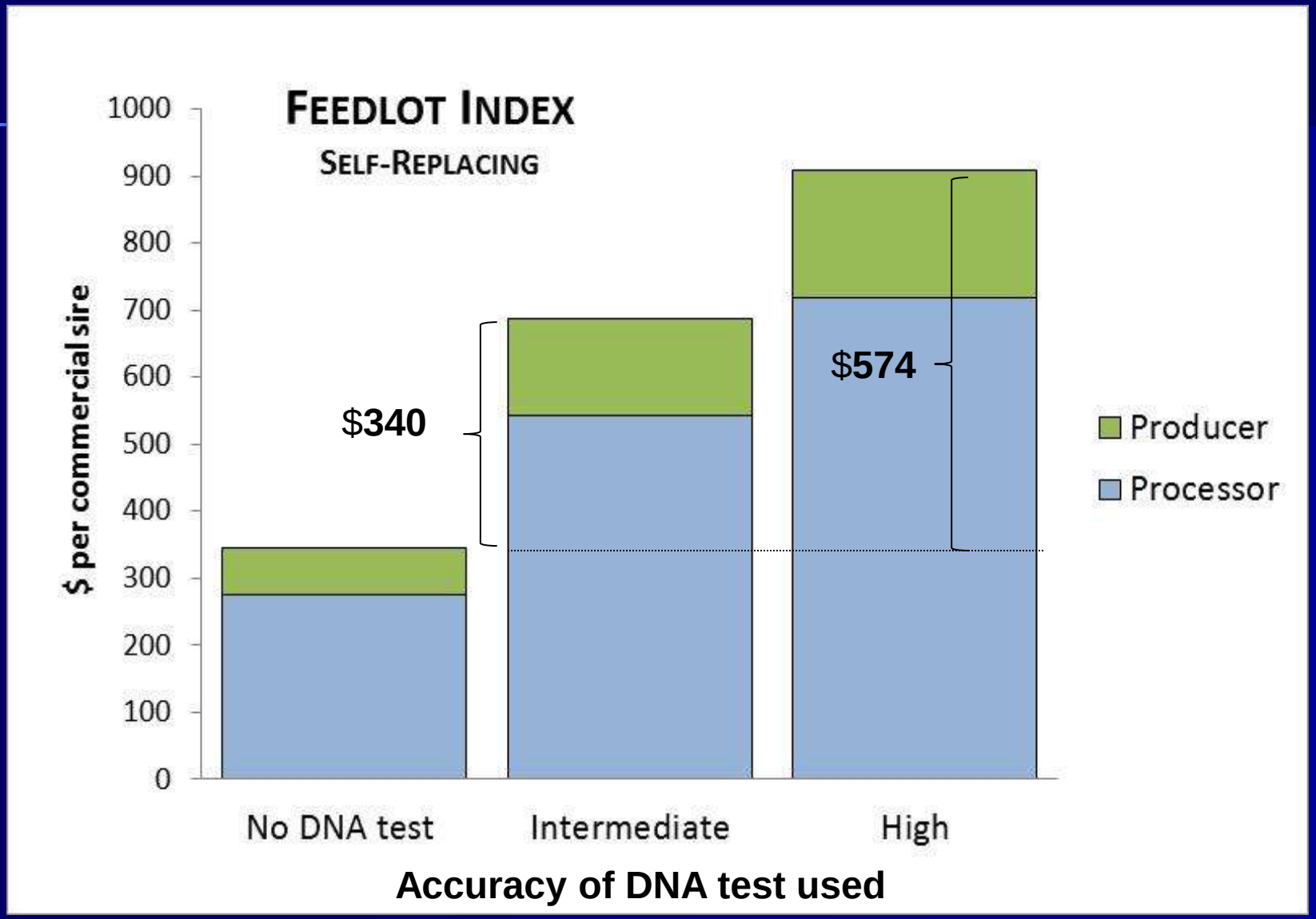


Parnell, P.F. 2007. *Effective value chain partnerships are essential for rapid adoption of beef genetics technology.* Association for the Advancement of Animal Breeding and Genetics. 18. 167-174 .

Value of improved selection response for commercial bulls due to DNA-test increase in Long Fed / CAAB $Index accuracy

Variable	Unit	Accuracy of DNA test used	Long Fed / CAAB $Index
Increased value derived from ΔG in commercial sires	$/ bull	Intermediate	340
		High	574

Where are returns from genetic gain (ΔG) realized?



Results: Value of genetic improvement (ΔG) per DNA test in commercial and stud sires

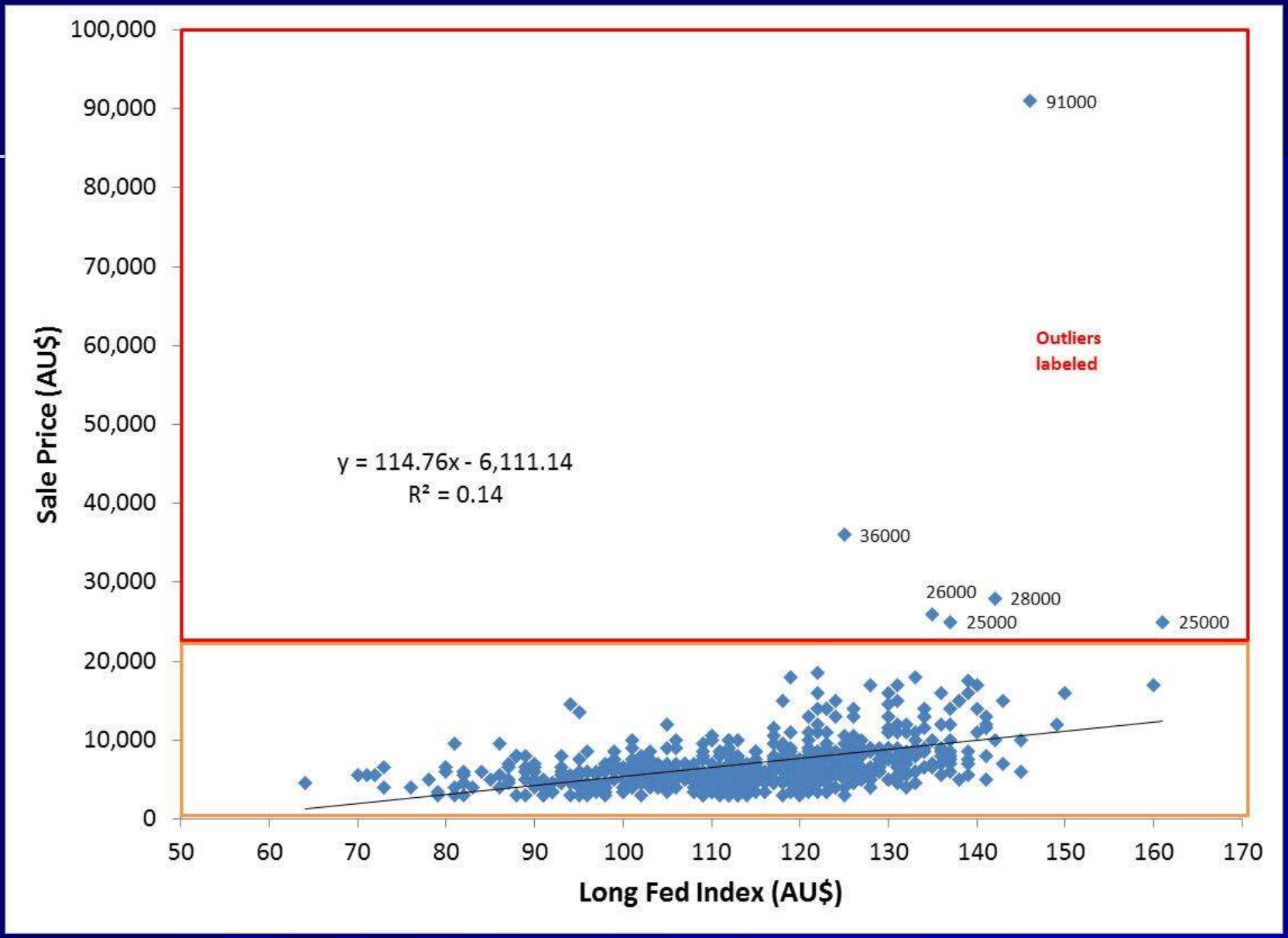
Variable	Unit	Accuracy of DNA test used	Long Fed / CAAB $Index
Increased value derived from ΔG in stud sires	$/ test	Intermediate	506
		High	836
Increased value derived from ΔG in commercial sires	$/ test	Intermediate	170
		High	282

Relationship between Long Fed/CAAB $Index and bull purchase price

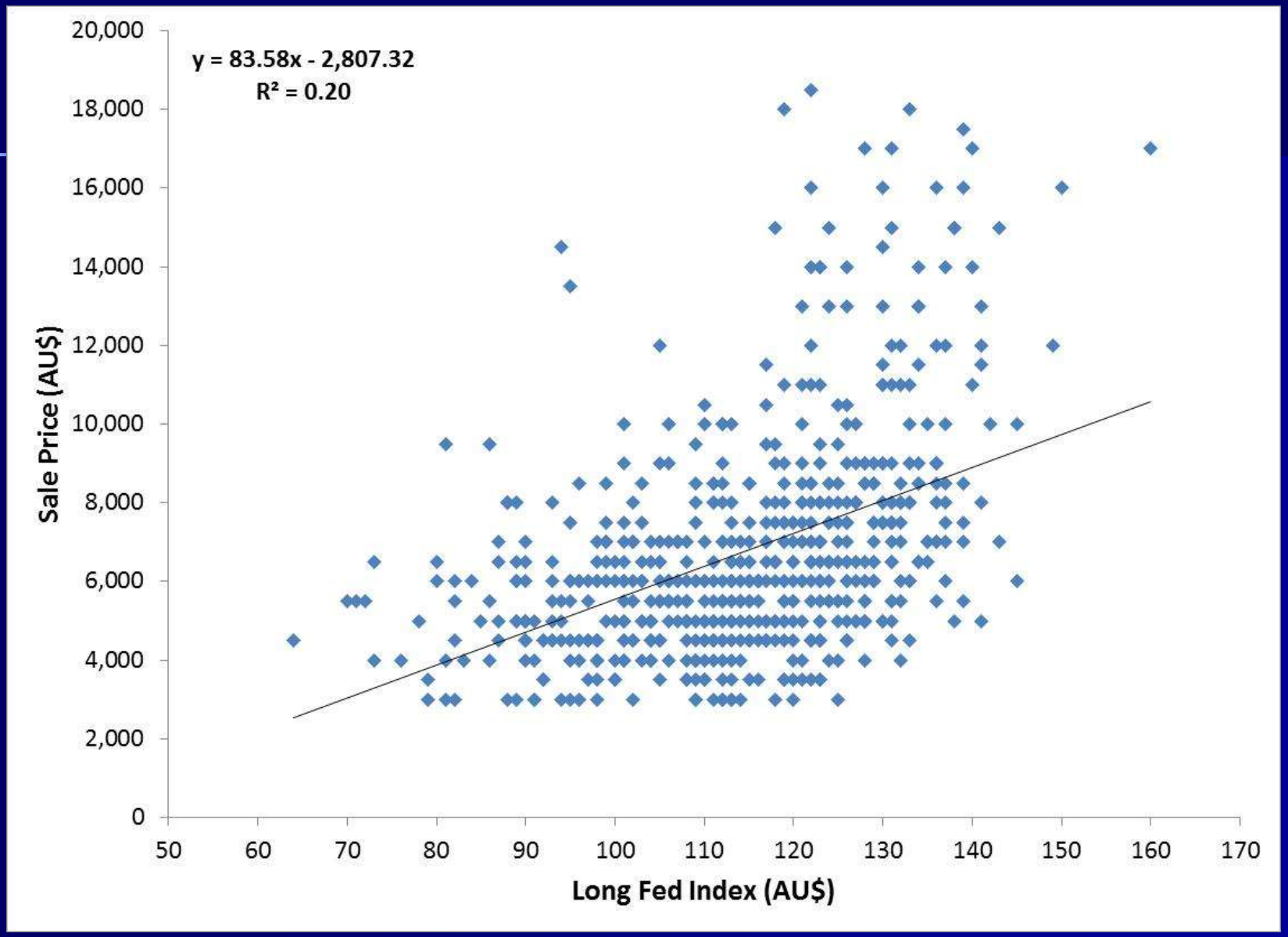
Long Fed/CAAB $Index value was compared to bull purchase price from 645 bulls sold in Australia in 2011/2012. Six sales were examined – four studs were included stud 1 (n=44), stud 2 (n=200), stud 3 (n=45); and Te Mania with 3 sales represented Southern 2011 (n=115), Northern 2011 (n=96), and Southern 2012 (n=145) – 2/29/2012!

Removed outlier bulls (>3 sd from average price)

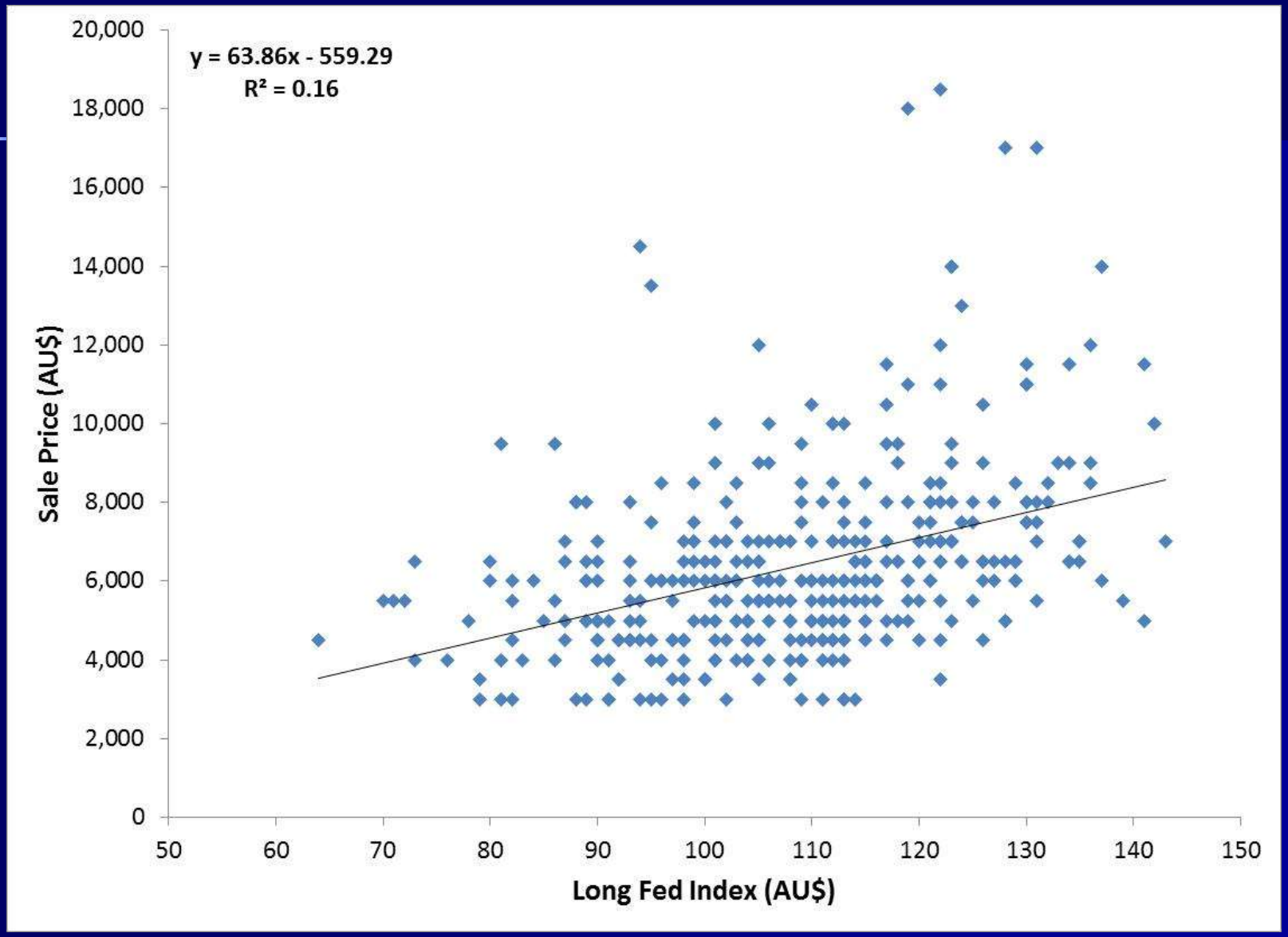
All bulls included

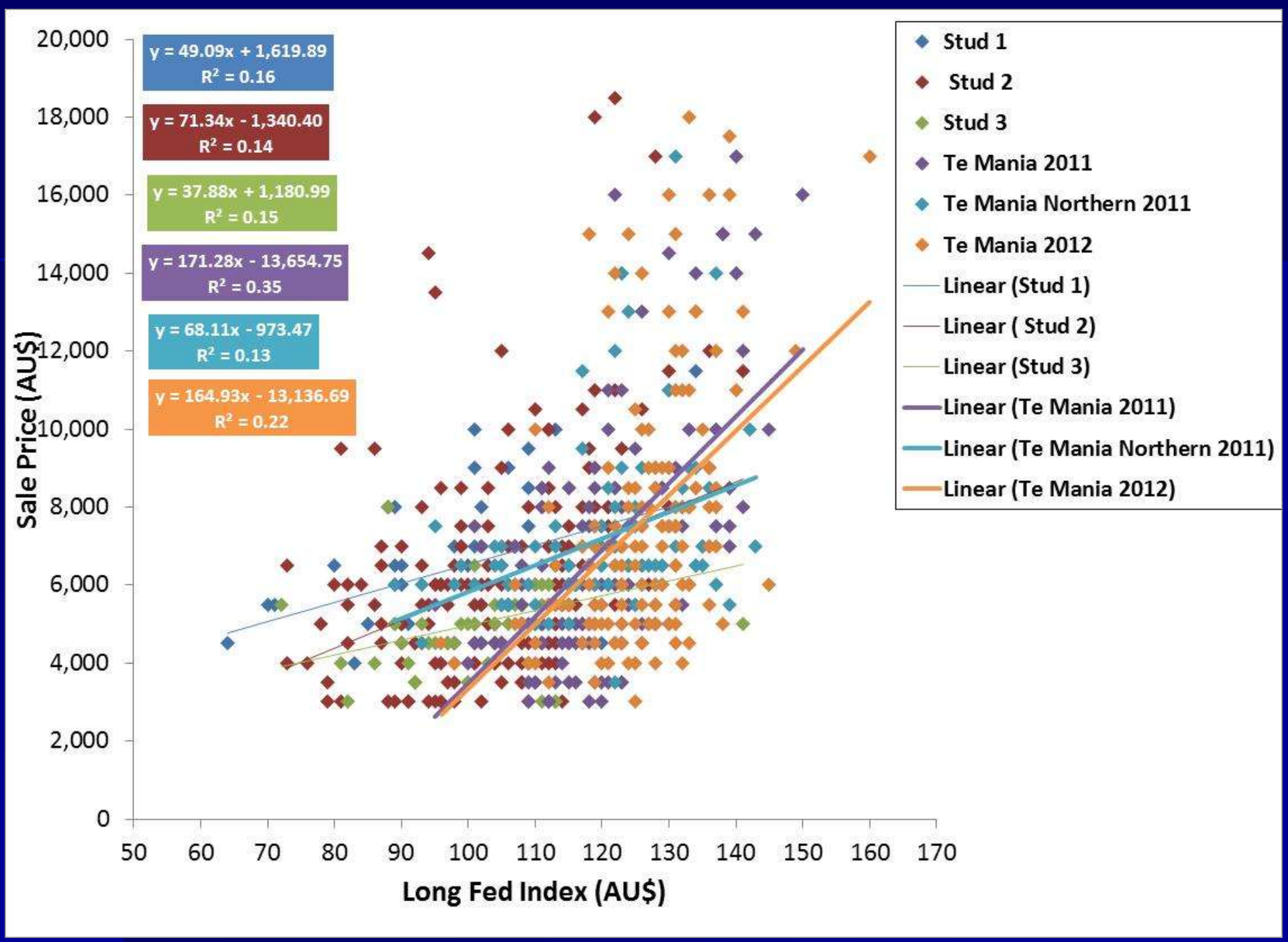


Outliers removed



Te Mania sales removed




y = 49.09x + 1,619.89
R² = 0.16
y = 71.34x - 1,340.40
R² = 0.14
y = 37.88x + 1,180.99
R² = 0.15
y = 171.28x - 13,654.75
R² = 0.35
y = 68.11x - 973.47
R² = 0.13
y = 164.93x - 13,136.69
R² = 0.22
Stud 1
Stud 2
Stud 3
Te Mania 2011
Te Mania Northern 2011
Te Mania 2012
Linear (Stud 1)
Linear (Stud 2)
Linear (Stud 3)
Linear (Te Mania 2011)
Linear (Te Mania Northern 2011)
Linear (Te Mania 2012)
Sale Price (AU$)
Long Fed Index (AU$)
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
20,000
50
60
70
80
90
100
110
120
130
140
150
160
170

UK model – using Genus DNA test

summary

The Better Beef Scheme offers technology, best practice and partnerships needed to improve the quality of beef for the consumer and the bottom line to dairy producers. Blade SW has commitments in place for over 10,500 finished cattle for 2006 with potential for many more. Because of the Better Beef Scheme the supply chain is more manageable and effective and offers Arla Foods Milk Partnership farmers a guaranteed market for their calves at a set price providing the industry and consumers with better quality beef.

Genus ABS

EBLEX
ENGLISH BEEF & LAMB EXECUTIVE

TESCO
Every little helps

McDonald's

blade farming
South West Ltd

Arla
ARLA FOODS
MILK PARTNERSHIP

"The Better Beef Scheme shows how everyone in the supply chain working closely together they can build a good working relationship that achieves a better quality and tastier product. This can only be better for consumers buying British beef in our stores but the scheme also shows how technology and working in partnership can achieve a better return for the producer."

JP Dorgan,
Producer Club Manager
Tesco

"Improving the quality of our beef is a priority for our business and as major purchasers of British milk and beef we are delighted to see the two industries working together in partnership for the benefit of all our customers to enjoy better beef."

Matthew Howe, Senior Vice-President and Chief Support Officer
McDonald's Restaurants Limited

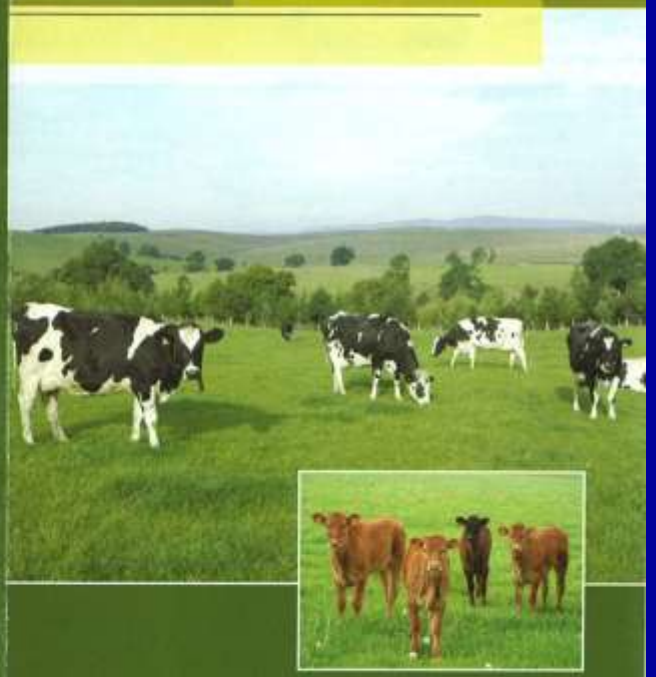
contact information

Blade Farming South West Limited
Tel: 0845 6013281

SCFF Limited
Tel: 01458 254552

Arla Foods Milk Partnership
Partnership office
Tel: 0113 382 7125

the **better beef** scheme



http://www.genusbreeding.co.uk/documents/upload/Better_Beef_Scheme_Leaflet_-_Side_1.pdf

the **better beef** scheme

Everyone knows that when working together, greater things can be achieved. In the beef supply chain this is certainly the case but the fragmented nature of the industry makes working together and achieving major steps forward difficult.

Now a number of key players within the industry are working together to integrate the beef supply chain in a way that has never been accomplished before.

Arla Foods Milk Partnership, Genus ABS, Southern Counties Fresh Foods, Blade Farming South West, Tesco and McDonald's have acted together to create what is known as the Better Beef Scheme.

Improving beef quality can result in improved returns to beef and dairy farmers. The scheme strives to improve:

- **Calf quality**
- **Costs of production**
- **Carcase quality**
- **Supply chain integrity**
- **Beef sales**

the **system**

Genetic Improvement Programme
Genus ABS

↓

Beef Sire

↓

Dairy Dam

↓

Highbred Calf

↙ ↘

Calf Contract | Direct Sale

Blade Calf Collection Centre

↓

Blade Contract Calf Rearing Unit

↓

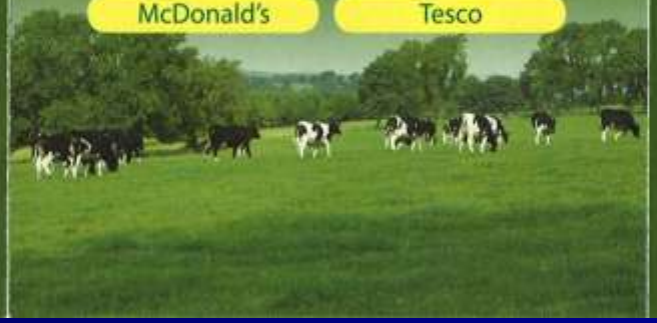
Blade Contract Finishing Unit

↓

Southern Counties Fresh Foods

↙ ↘

McDonald's | Tesco



calf **supply**

A guaranteed market for calves is now available to members of the Arla Foods Milk Partnership, enabling members to establish either a forward price contract for their calves or by trading calves into the scheme on a weekly basis.

The better beef scheme has been developed to add value to dairy calves by improving genetics by working together as a true partnership.

genetics

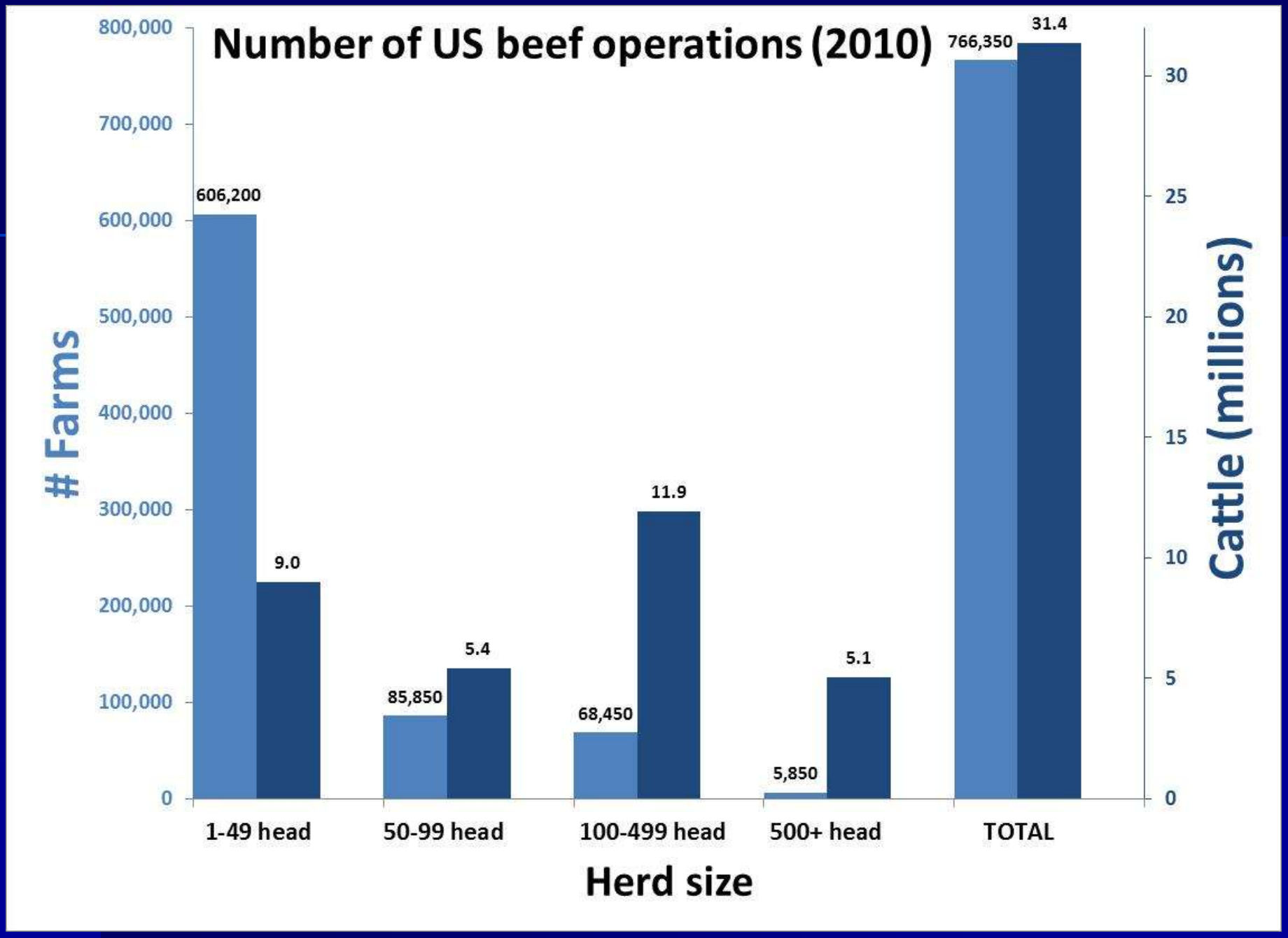
A new technology has now offered the beef industry a gene marker test using DNA analysis. The test results can predict the tenderness of the meat and the size of some of the beef cuts.

The Better Beef Scheme through Blade SW have teamed up with Genus and are using this technology to measure the quality of pure beef bulls available and from the results a continuous improvement programme is implemented to raise the score from each breed. This will in time offer us better eating quality bulls with the additional benefit of knowing that they are proven through an EBV system to have optimum growth rates in the production units.

Better Beef Scheme involving a partnership between Arla Foods Milk Partnership, Genus ABS, Southern Counties Fresh Foods, Blade Farming South West, Tesco and McDonald's.

"The Scheme involves integration of the supply chain from the development of gene marker technology by Genus through to breeders, wholesalers and retailers with the intention of giving farmers a guaranteed market for their calves at a set price providing the industry and consumers with better quality beef. This aims to use the Genus gene marker test to improve both the choice of animals for breeding and meat quality. In cases such as this, then, a process of developing integration between heterogeneous actors in food supply networks can be seen. ***This integration is increasingly being built on a greater understanding of the potential benefits that genetic techniques in livestock breeding can bring across the supply chain****."*

http://www.genusbreeding.co.uk/content.output/1/351/Beef/Beef%20for%20Dairy%20Farmers/Better%20Beef%20Scheme.mspx


Number of US beef operations (2010)
Farms
Cattle (millions)
Herd size
1-49 head
50-99 head
100-499 head
500+ head
TOTAL
606,200
9.0
85,850
5.4
68,450
11.9
5,850
5.1
766,350
31.4
800,000
700,000
600,000
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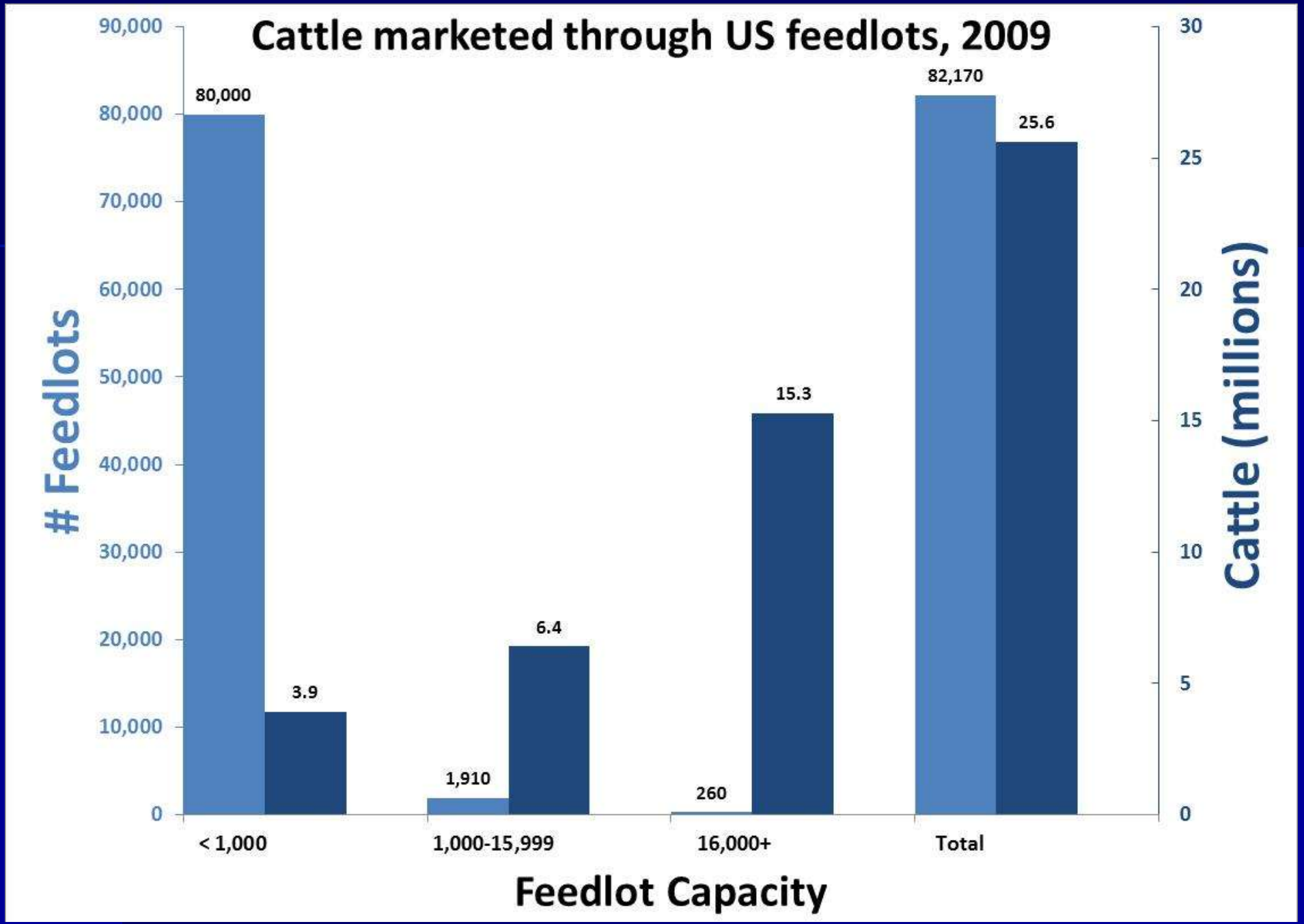
400,000
300,000
200,000
100,000
0
30
25
20
15
10
5
0

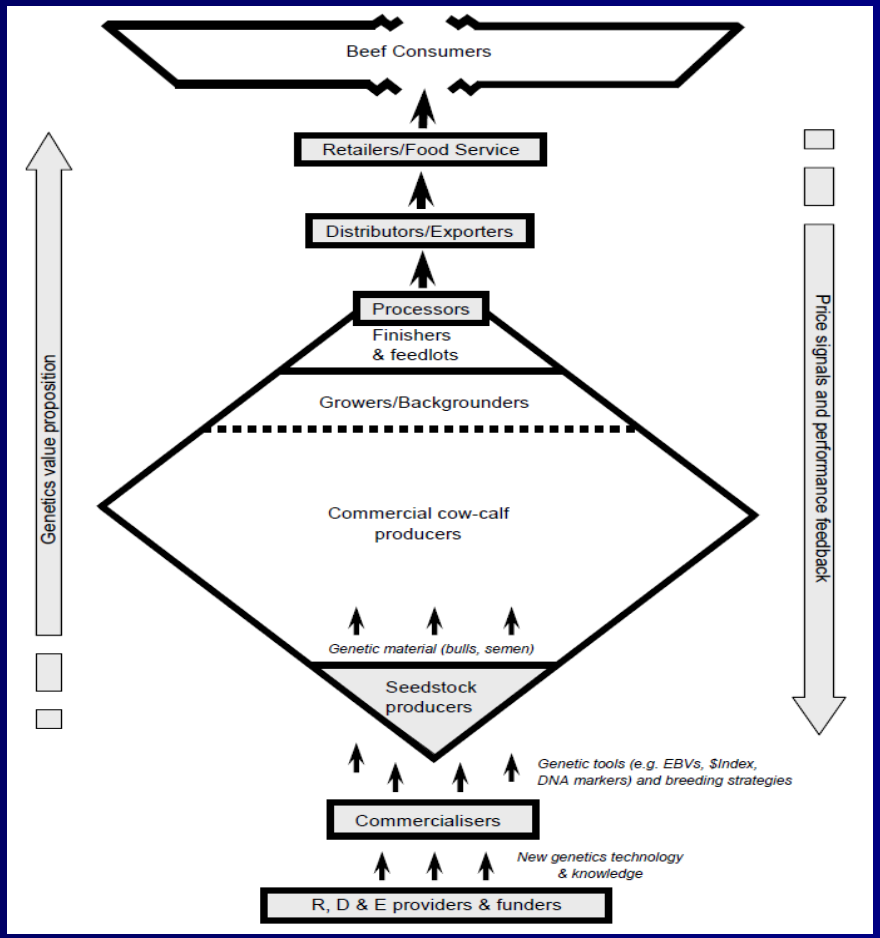

Cattle marketed through US feedlots, 2009
Feedlots
Cattle (millions)
Feedlot Capacity
< 1,000
1,000-15,999
16,000+
Total
80,000
3.9
1,910
6.4
260
15.3
82,170
25.6
90,000
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
30
25
20
15
10
5
0

Ninety percent of US cattle operations have fewer than 100 head, and most sell their cattle at auction prior to feedlot entry

Whole industry indexes are developed to maximize the profitability of the whole supply chain

- In reality most producers' financial returns are tied very closely to the number of calves, a function of reproduction, and less if at all to feedlot performance and carcass traits, and even less to bovine respiratory disease incidence and mortalities.
- To incentivize the inclusion of traits that provide value in downstream sectors in selection decisions, a mechanism to equitably share some of the value derived from improved feedlot performance and carcass quality is needed to compensate breeders and producers for including these traits into their breeding objectives and thereby reducing selection emphasis on economically-relevant traits of direct value to producers.

Industry structure may evolve to enable the exchange of information and value between the different sectors



For widespread technology adoption, breeders need to be adequately rewarded for making DNA investments and selection decisions for traits that benefit the different sectors of the beef industry.

Parnell, P.F. 2007. Effective value chain partnerships are essential for rapid adoption of beef genetics technology. Association for the Advancement of Animal Breeding and Genetics. 18. 167-174 .

Conclusions

- DNA information clearly has the potential to provide value to seedstock producers if it is meaningfully incorporated into national cattle evaluations
- It is difficult to make optimal selection decisions or even estimate the value of multi-trait DNA tests in the absence of information on their accuracy, and the incorporation of their target traits into breeding objectives and selection index calculations
- This will likely require the development of multi-trait selection indexes for whole-industry good breeding objectives of relevance to U.S. beef production systems
- For widespread technology adoption, breeders need to be adequately rewarded for making DNA investments and selection decisions for traits that benefit the different sectors of the beef industry.

National Colorado State University-Cornell University-University of Georgia

Beef Cattle Evaluation Consortium

This project 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?

Location of Te Mania

The herd now spans 1600 breeding cows, under the management of Tom Gubbins and brother-in-law, Hamish McFarlane, at Mortlake in Western Victoria.

What about the dog slides?






Which do you think is Tom's dog?