WHERE IN THE BEEF CATTLE SUPPLY CHAIN MIGHT DNA TESTS GENERATE VALUE?

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DON'T BE *SUCH* A SCIENTIST

TALKING SUBSTANCE IN AN AGE OF STYLE

RANDY OLSON

WRITER/DIRECTOR OF *FLOCK OF DODOS: THE EVOLUTION-INTELLIGENT DESIGN CIRCUS* AND *SIZZLE: A GLOBAL WARMING COMEDY*

How Academic versus General audiences respond to various aspects of communication

Communication aspect	Academic	General
Main information channel	Audio and visual	Visual
Structure	Information is fine	Need a story
Mode of response	Cerebral	Visceral
Need humour?	Not necessarily	Pretty much
Like sincerity?	Suspicious of it	Always
Sex appeal?	Potential disaster	The ultimate
Prearoused?	Yes	No
Effective elements	Information	Humour, sincerity, sex
Effective organs	Head	Heart, gut, gonads
Preferred voice	Robotic	Human

Olson, R. 2009. **Don't be such a scientist. Talking substance in an age of style**. Island Press.


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Overview

- US versus Australian beef industry
- Industry sectors
  - Seedstock
    - ❖Nucleus
    - ❖Multiplier
  - Commercial
  - Feedlot
  - Processor
- Value Proposition for each sector


United States (x 10⁶)
Australia (x 10⁶)
1.1
.39
Seedstock Cows
35.7
12.5
Commercial Cows + replacements
.8 (on feed)
13.6
(on feed)
43.2
10.6
Other Beef Animals (calves, steers, heifers and bulls)

US versus Australian Beef Industry

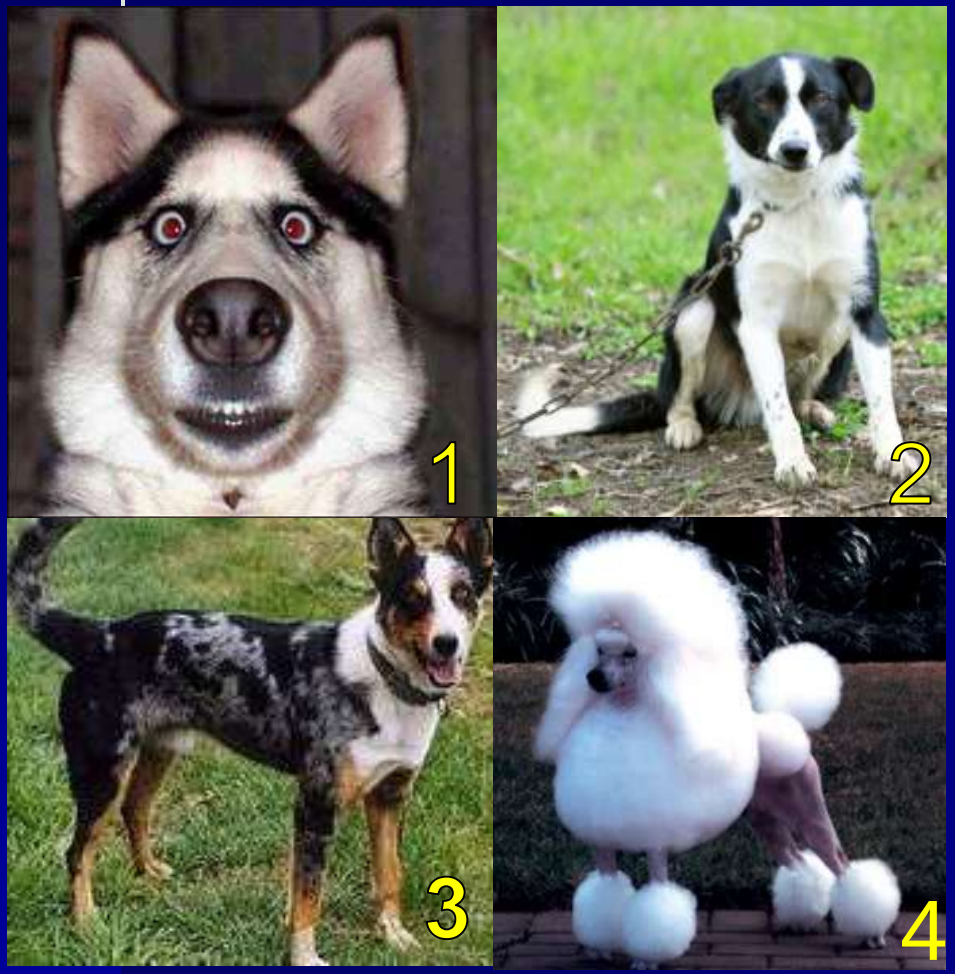
	US	Australia
# Beef operations	766,350	40,188
Million Cows	31.4	12.9
Average herd size	122	605
<u>Herds < 100 head</u>		
# Producers (%)	692,050 (90%)	12,017 (30%)
million cows (%)	14.4 (49%)	0.4 (3%)
<u>Herds > 500 head</u>		
# Producers (%)	5,850 (0.8%)	11,042 (27%)
million cows (%)	5.1 (16%)	10.3 (80%)
# Feedlots	82,170	712
Million Fed (2009)	26.0	2.3

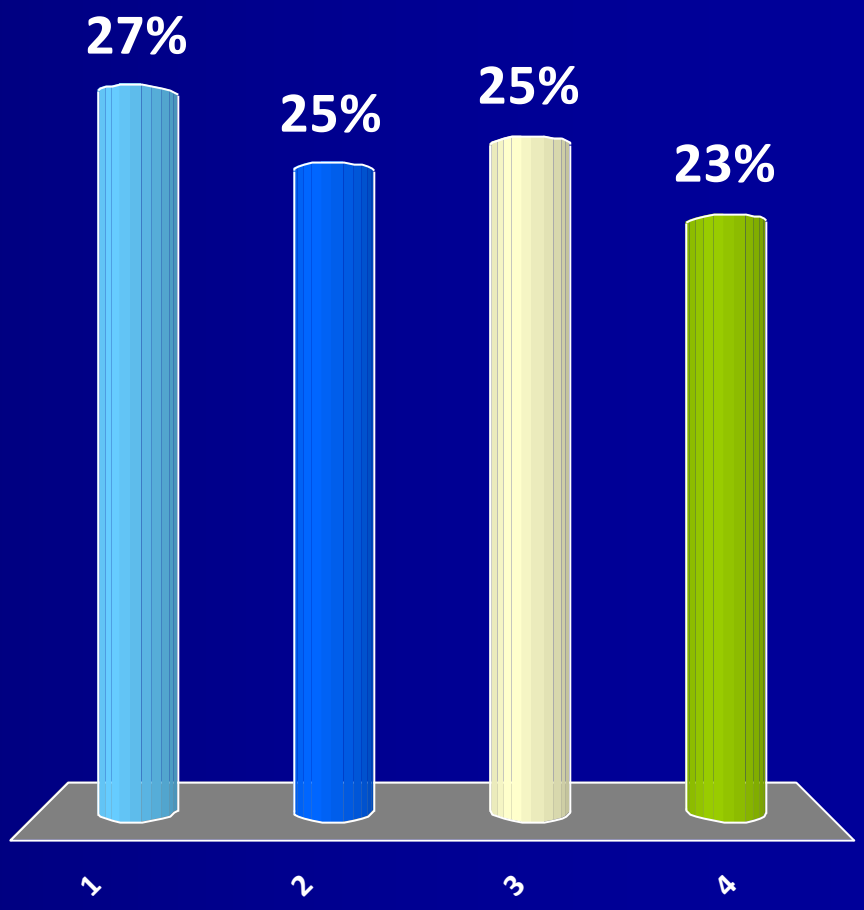
Given this information……





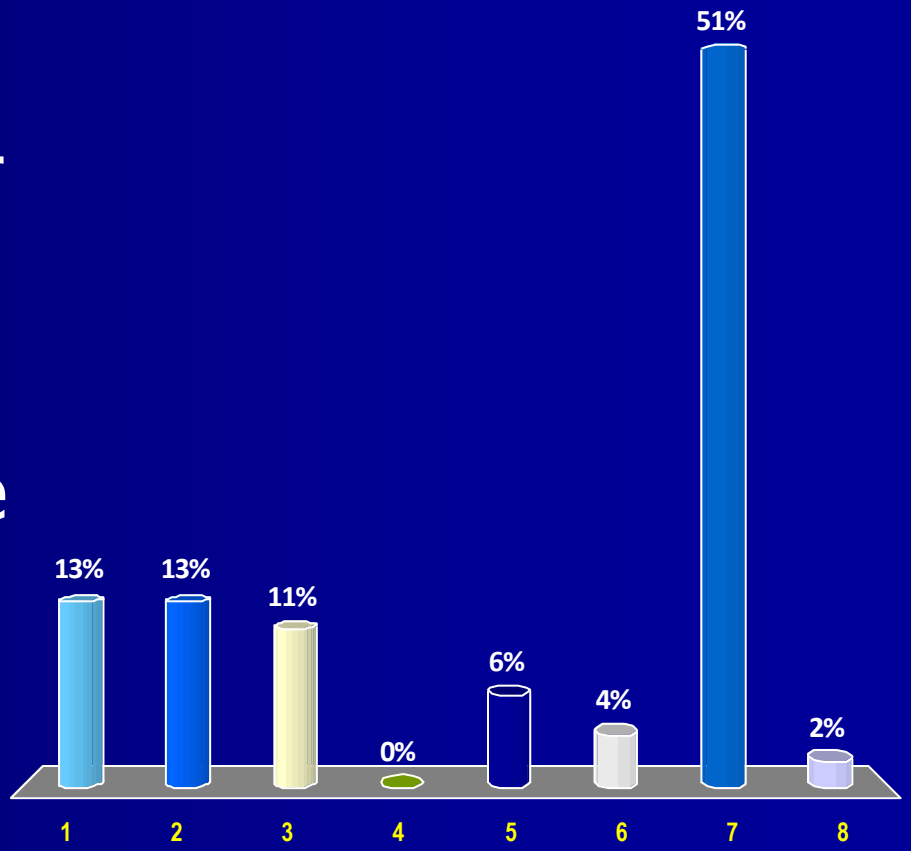

Which do you think is Wayne Upton's dog?





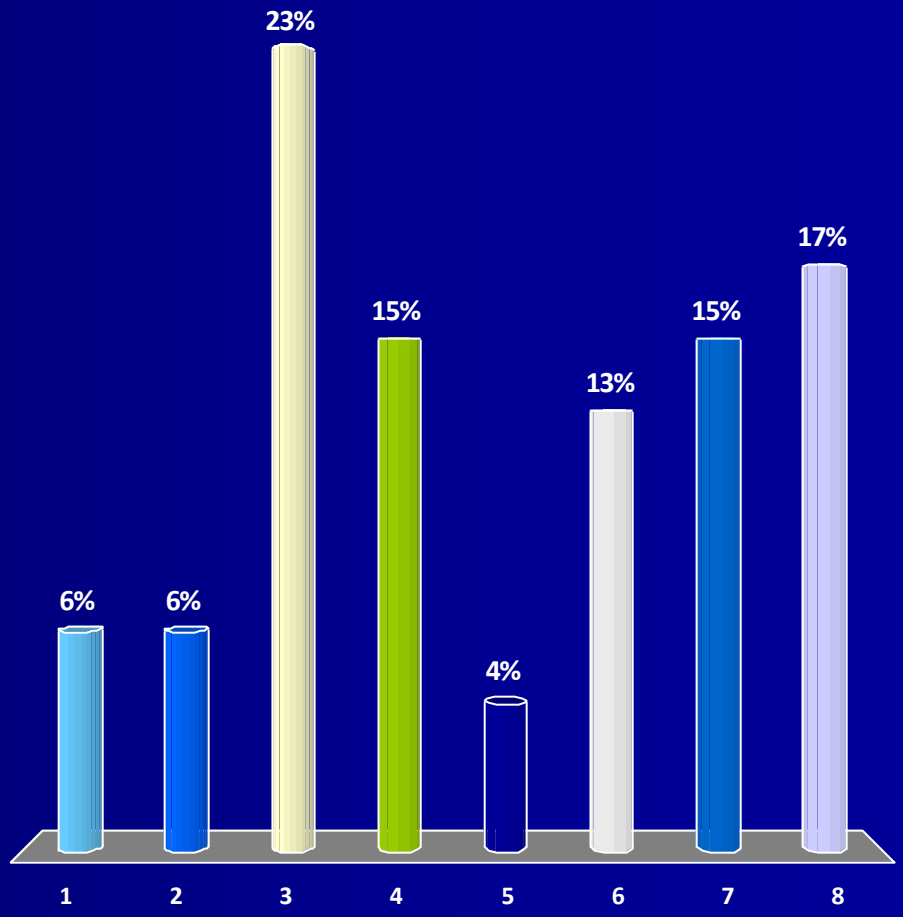
Who am I talking to?

1. Seedstock - sheep
2. Seedstock - beef
3. Commercial producer
4. Feedlot owner
5. Genomics company
6. Breed Representative
7. Research/educator
8. My relative



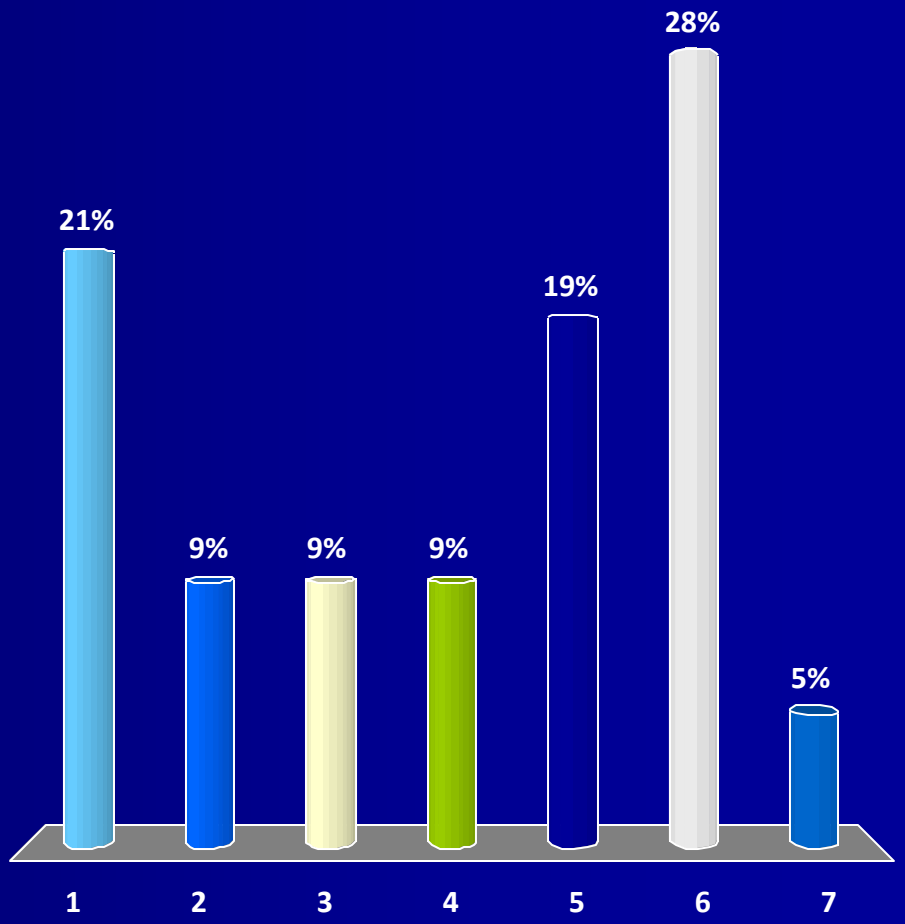
How many females do you run?

1. 0
2. <50
3. 51-200
4. 200-500
5. 500-800
6. 800-1500
7. >1,500
8. >5,000



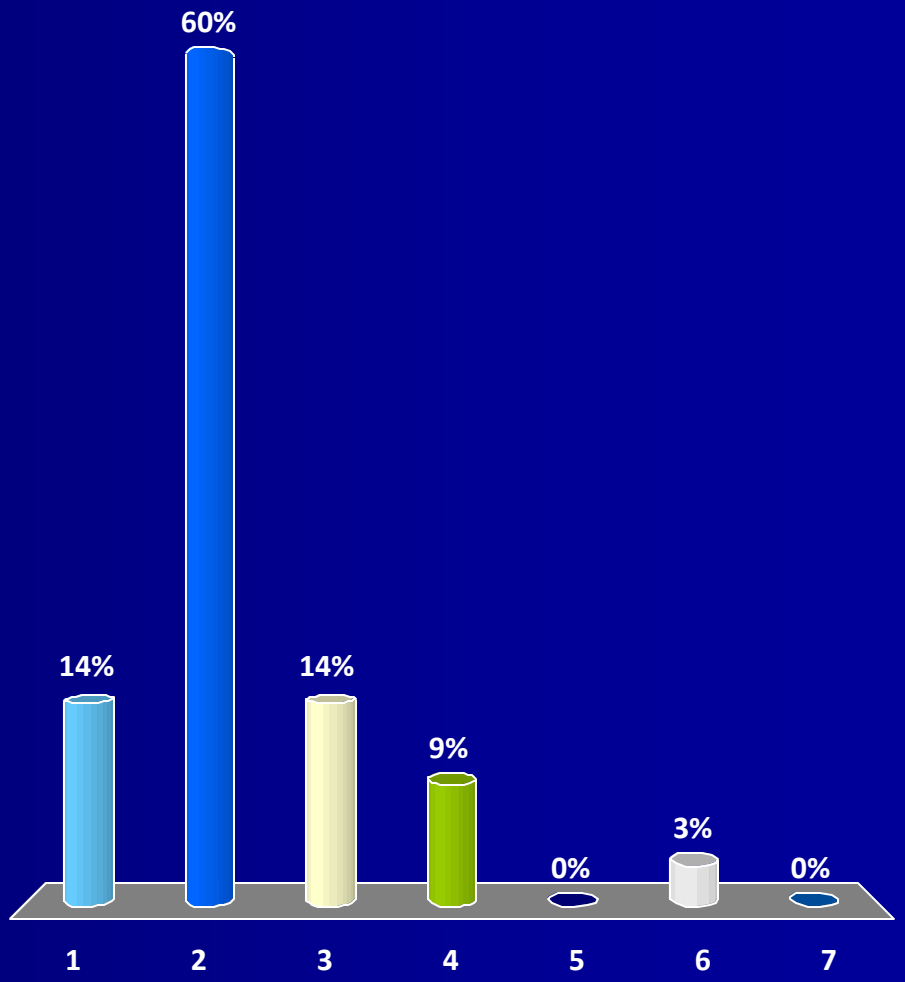
How many sires do you plan to sell this year?

1. 0
2. 1-5
3. 5-10
4. >10
5. >50
6. >100
7. >500



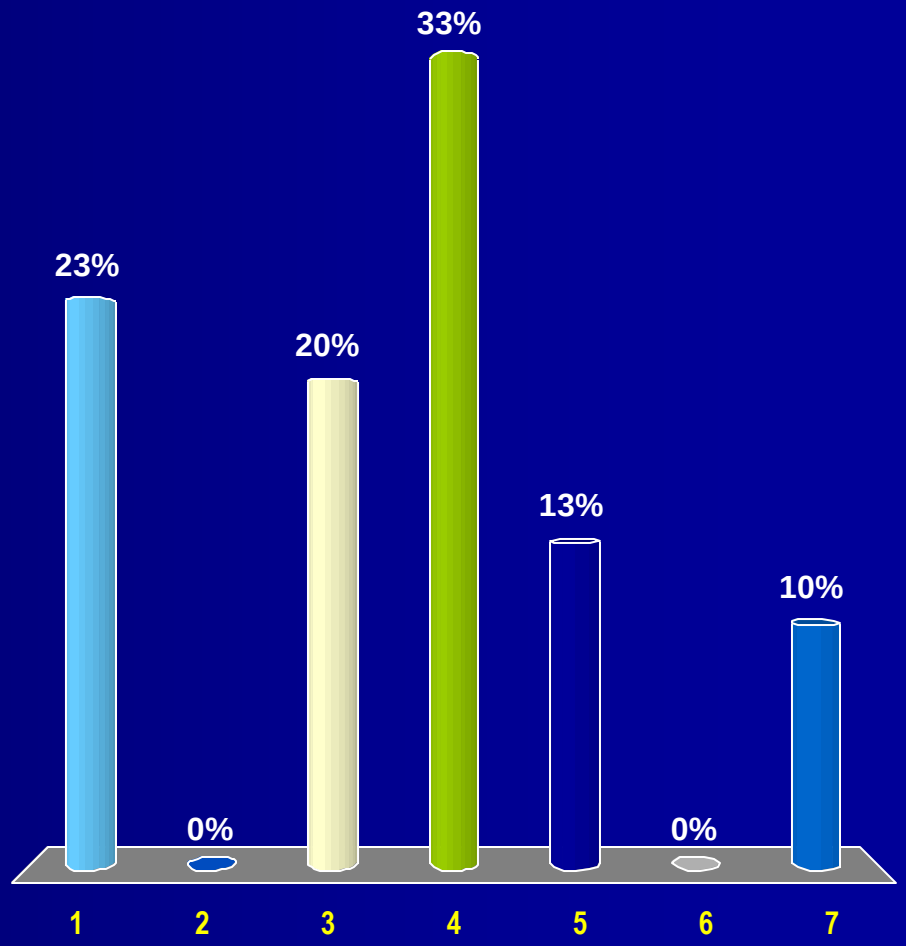
How many sires do you plan to purchase this year?

1. 0
2. 1-5
3. 5-10
4. >10
5. >50
6. >100
7. >500



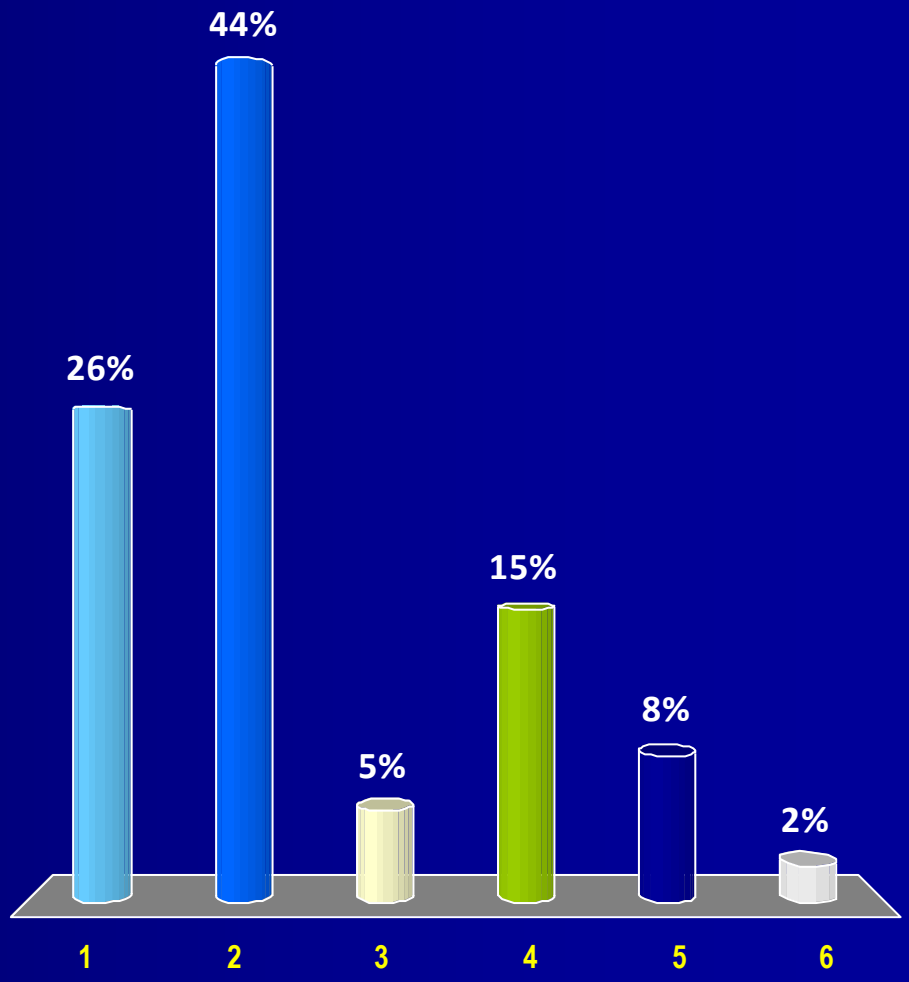
How much do you currently spend (per animal) on peformance recording?

1. $0
2. $1-5
3. $5-10
4. $10-50
5. $ 50-100
6. $100-200
7. >$200



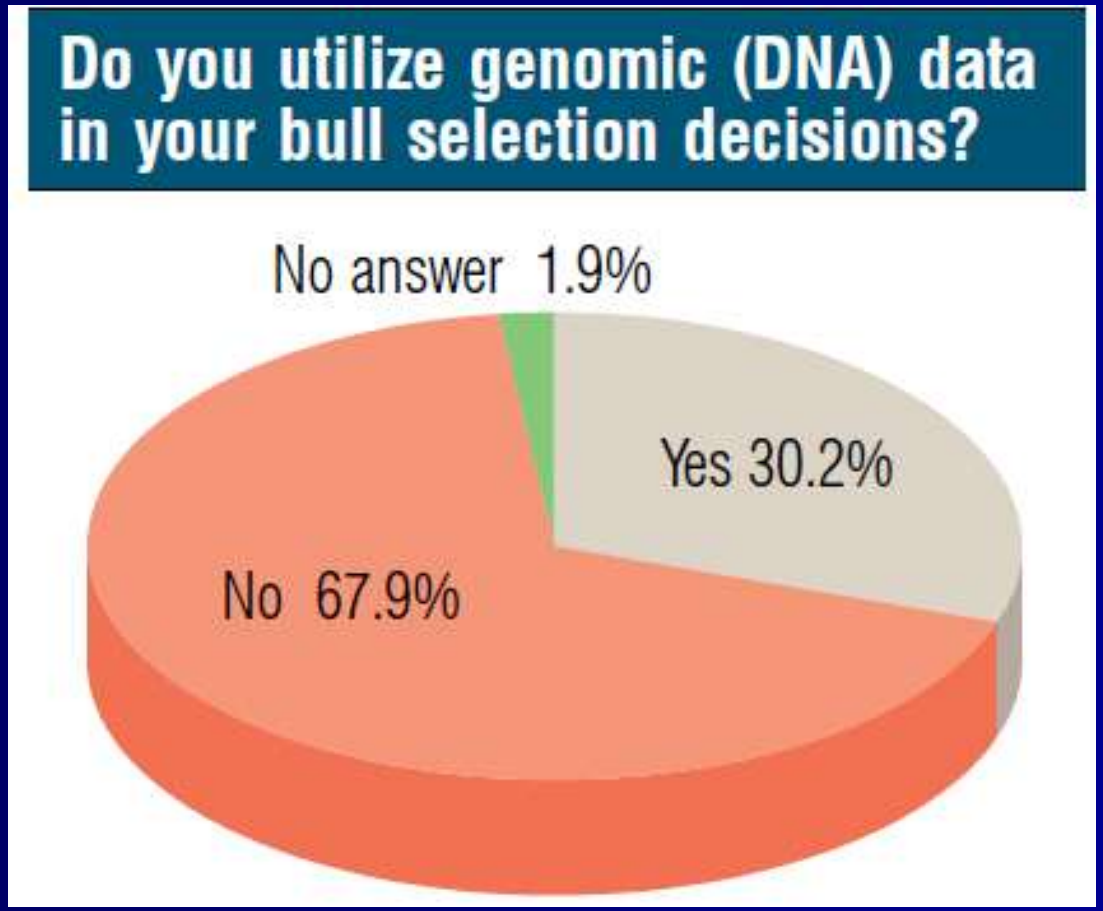
Which sector do you think stands to benefit the most from genomics?

1. Seedstock
2. Commercial
3. Feedlot
4. Processors
5. No idea
6. None



March 1, 2010 Beef Magazine Survey

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



Base = 635 (All Cow-Calf Operations)

Potential uses of genomic information for beef sectors

Use	Seedstock	Commercial	Feedlot	Processor
DNA-assisted selection	X	X		
Parentage	X	X		
Recessive allele testing	X	X		
Control of Inbreeding	X	X		
Mate selection	X	X		
DNA-assisted management	X	X	X	
Product differentiation				X
Traceability				X

Potential Value of DNA information to the seedstock sector

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.

High (h^2) and **intermediate** (½ h^2) accuracy DNA tests explaining genetic variation in all of selection criteria and traits in the breeding objective were used to test all male progeny from one calf crop

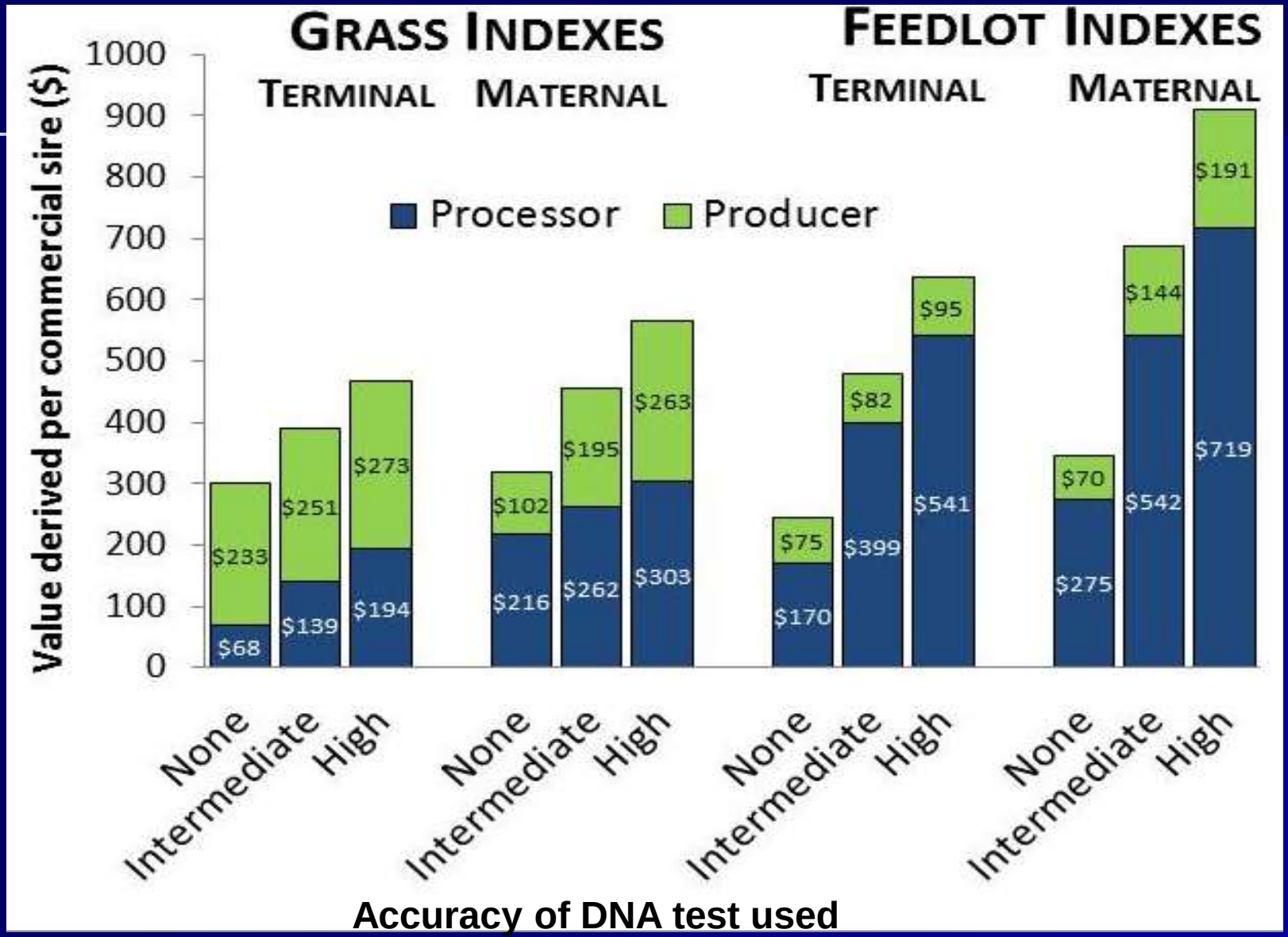
Objective Trait	h^2
Sale liveweight – direct	0.31
Sale liveweight – maternal	0.04
Cow weaning rate	0.05
Cow survival rate	0.03
Cow weight	0.41
Calving ease – direct	0.10
Calving ease – maternal	0.10
Dressing Percentage	0.33
Saleable meat Percentage	0.56
Fat depth (rump)	0.41
Marbling score	0.38

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

Value of improved selection response for beef seedstock sector due to DNA-test increase in index accuracy

Variable	Unit	Accuracy of DNA test used	Grass/Domestic		Feedlot/Export	
			Terminal	Self-replacing	Terminal	Self-replacing
Improvement in selection response	**%**	**Intermediate**	**29**	**46**	**94**	**95**
		High	**54**	**81**	**157**	**158**
Increased value derived from ΔG in commercial sires	$/ DNA test	Intermediate	45	69	118	170
		High	83	124	196	282
Increased value derived from ΔG in stud sires	$/ DNA test	Intermediate	160	203	421	506
		High	297	366	701	836
Total value per test to seedstock operator	**$/ DNA test**	**Intermediate**	**$ 204**	**$ 272**	**$ 539**	**$ 676**
		High	**$ 380**	**$ 490**	**$ 897**	**$1119**

Industry breakdown of ΔG value derived from increased accuracy from genomic selection



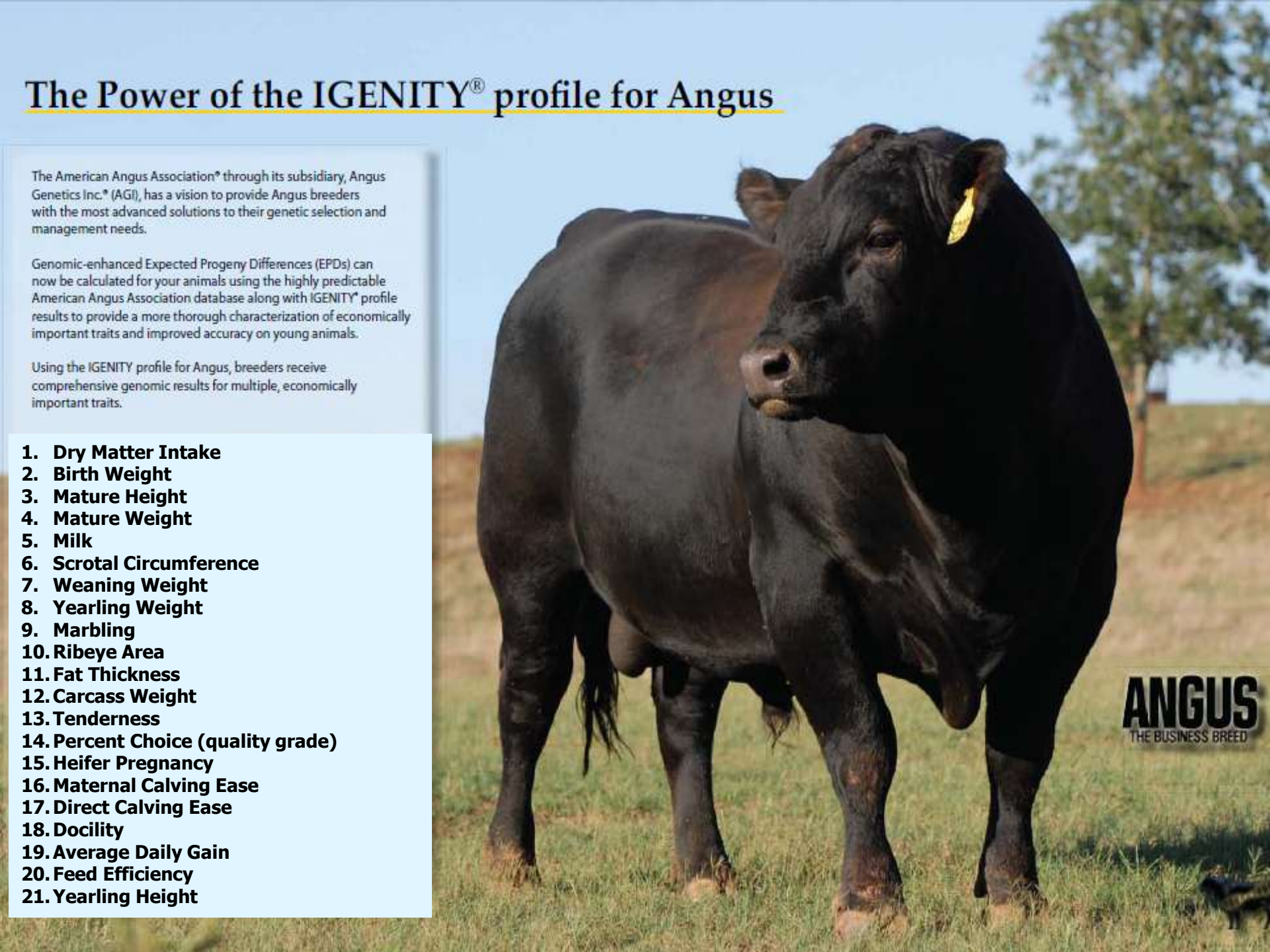
The Power of the IGENITY® profile for Angus

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**



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

Genetic correlations for National Cattle Evaluation traits by company

384 SNP 50K SNP

	Igenity	Pfizer
Carcass Marbling	.65	.57
Carcass Rib	.58	.60
Carcass Fat	.50	.56
Carcass Weight	.54	.48
Birth Weight	.57	.51
Weaning Weight	.45	.52
Yearling Weight	.34	.64
Milk	.24	.32
Dry Matter Intake (component of RADG)	.45	.65
Docility	.47	n/a

http://www.angus.org/AGI/GenomicChoiceApril2011.pdf

American Angus Association performs weekly evaluations with genomic data

	Igenity	Pfizer
Calving ease (CED CEM)		
Growth (BW WW YW Milk)	✓	✓
Residual Average Daily Gain (RADG)	✓	✓
Docility (DOC)	✓	
Carcass (CWT MARB RIB FAT)	✓	✓

http://www.angus.org/AGI/GenomicChoiceApril2011.pdf

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Do you consider genomics (DNA marker data) when buying herd bulls?

- Yes, it is the main consideration: 16%
- Yes, but EPDs are still more important: 39%
- No, I don't consider genomics data. I only look at EPDs.: 32%
- No, I don't consider any genetic information (EPDs, genomics data, ultrasound): 11%

Actual Email correspondence from a US producer

"Good morning.

Tuesday, February 08, 2011

Is there a reason why we wouldn't do the Ingenity DNA test on each of our 62 yearling bulls at $40 per head to get information on birth weight, carcass weight, yield grade, back fat, ribeye area, etc.? I realize our bulls aren't purebreds, but isn't a cow a cow when it comes to DNA testing?"

Value of genomic information for recessive genetic defects

- From a scientific standpoint, Arthrogryposis multiplex (AM) is the complete deletion of a segment of DNA that encompasses two different genes
- One of these genes is expressed at a crucial time in the development of nerve and muscle tissue. The mutation results in no protein being produced from this gene and therefore it is unable to carry out its normal function so homozygotes show phenotype

From September 8 – November 3, 2008 identified genetic problem, developed test, and released carrier status of 736 bulls!

- In the 11 months following the release of the test, the AAA posted the results of tests for AM on about 96,247 cattle.
- **This amounts to $2.4 million in testing costs**
- Of these, 20% (19,529) were carriers of AM. **That leaves 23,638 bulls and more than 53,000 heifers which tested as free of AM.**
- **At $4K/bull and $2K/heifer ~$200 million**

Based on calculations in Buchanan, D.S. 2009. Genetic Defects in Cattle. http://www.ag.ndsu.edu/williamscountyextension/livestock/genetic-defects-in-cattle

Potential Value of genomic information for commercial sector

Look Who's Using IGENITY

IGENITY® - Just What This Commercial Producer Has Been Waiting For

Wayne Cockrell, manager, Carter Ranch, Oakwood, Texas, says IGENITY® helps him manage the ranch's 1,500-head cow herd in a way that until now has been next to impossible.

"We raise our own replacement heifers and we have always been able to evaluate those heifers phenotypically, but that is it. We really didn't know what we had in our cow herd," Cockrell says. "Based on carcass data from our calf crop, I knew that we had a product that was about 60 percent choice. But, we had no way of knowing where the other 40 percent of the animals came from."

The breakeven cost of testing all of the potential replacement heifers in a commercial herd with a replacement rate of 20% and 45 potential replacement heifers born per 100 cows per year was **< $5** ($3.16 and $3.75 for domestic and export self-replacing indexes, respectively) assuming no performance recording

Potential Value of genomic information for feedlot sorting

Capacity of large cattle feeding operations in the U.S. – 2009 (Source: web sites of the companies listed and personal communication)

Rank	Company	One-time capacity
1.	JBS Five Rivers Cattle Feeding LLC, Greeley, CO	839,000
2.	Cactus Feeders, Inc., Amarillo, TX	520,000
3.	Cargill Cattle Feeders LLC, Wichita, KS	335,000
4.	Friona Industries LP, Amarillo, TX	275,000
5.	AzTx Cattle Co., Hereford, TX	265,000
6.	J. R. Simplot Co., Grand View, ID	230,000
7.	Irisk and Doll, Cimarron, KS	200,000
8.	Four States Feedyards, Lamar, CO	195,000[1]
9.	Agri Beef Co., Boise, ID	175,000
10.	Pinal Feeding Company, Maricopa, AZ	150,000[2]

[1]Value for 2006 obtained from: http://agr.wa.gov/fof/docs/feedlot.pdf.

[2]Reported as "capacity for over 150,000 head of cattle" on the company web site.

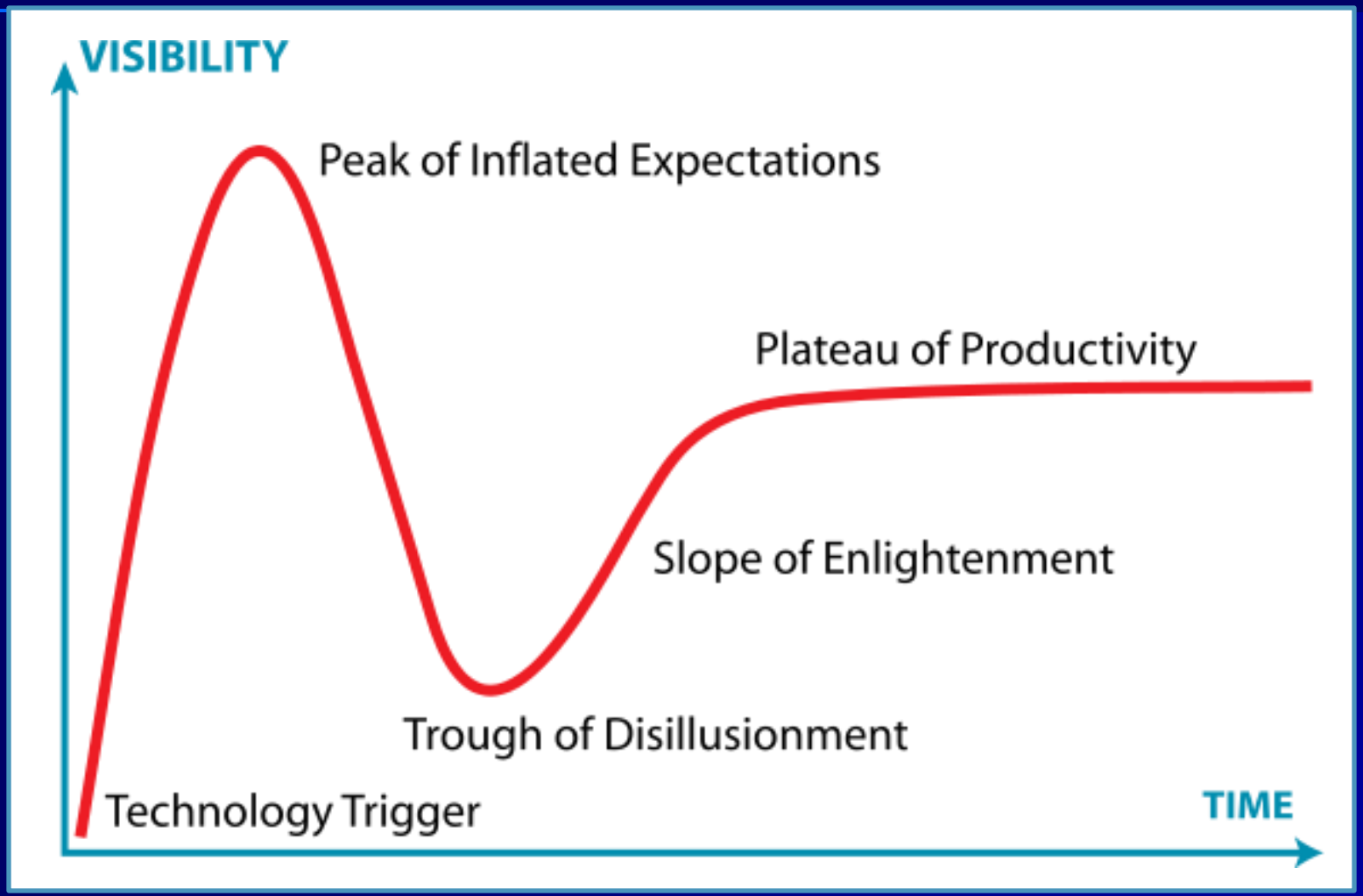
http://ag.arizona.edu/ANS/swnmc/Proceedings/2010/06_Galyean_2010.pdf

Potential Value of DNA information for beef sectors

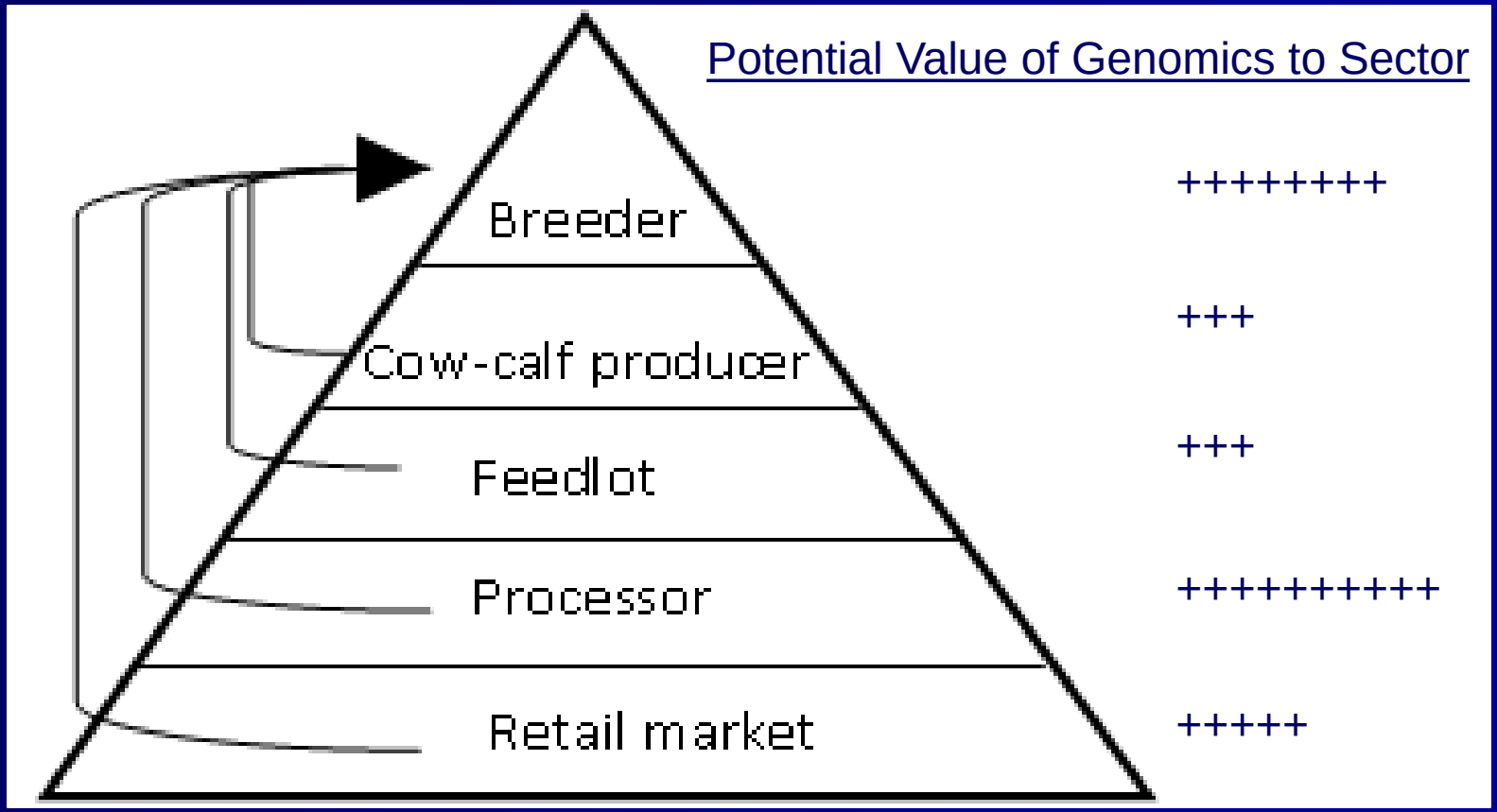
Use	Seedstock	Commercial	Feedlot	Processor
DNA-assisted selection	XXXX	X	X	XXXX
Parentage	XX	X		
Recessive allele testing	XX	X		
Control of Inbreeding	XX	X		
Mate selection	XX	X		
DNA-assisted management		X	XX	
Product differentiation				XX
Traceability				XX


The Future
NEXT EXIT

Hype cycle: the over-enthusiasm or "hype" and subsequent disappointment that typically happens with the introduction of new technologies



Ideally cattle would be genotyped once early in life and genotypes shared among production sectors to derive the maximum value from the fixed DNA collection and extraction costs



McEwan, J. C. 2007 Current status and future of genomic selection. Proceedings of the New Zealand Society of Animal Production 67: 147-152.

Parting thought….

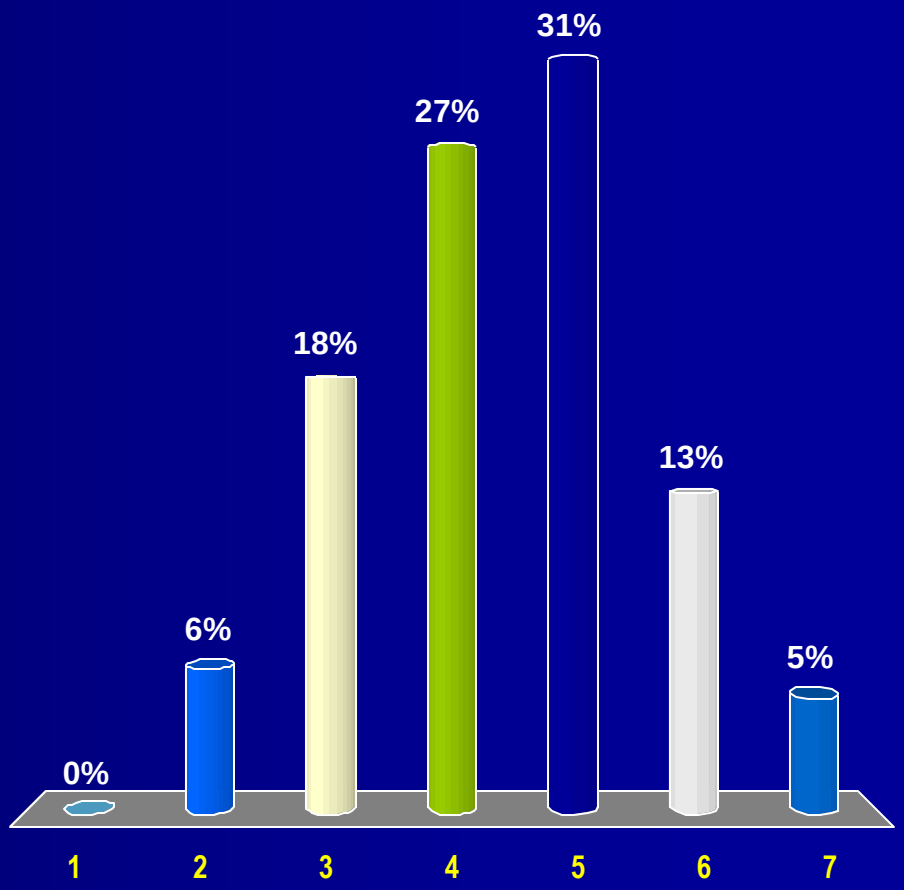
Breeds/groups that can organize themselves to take advantage of the rapidly-declining cost of genotyping and capture the cumulative supply chain value derived from using genomic information for multiple purposes (selection, parentage, genetic defects, marker-assisted management, product differentiation, traceability) will be ideally positioned to fully realize the nascent potential of genomic information.

Thanks for inviting me!

The DNA value determination 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 Animal Genome Program to AVE.

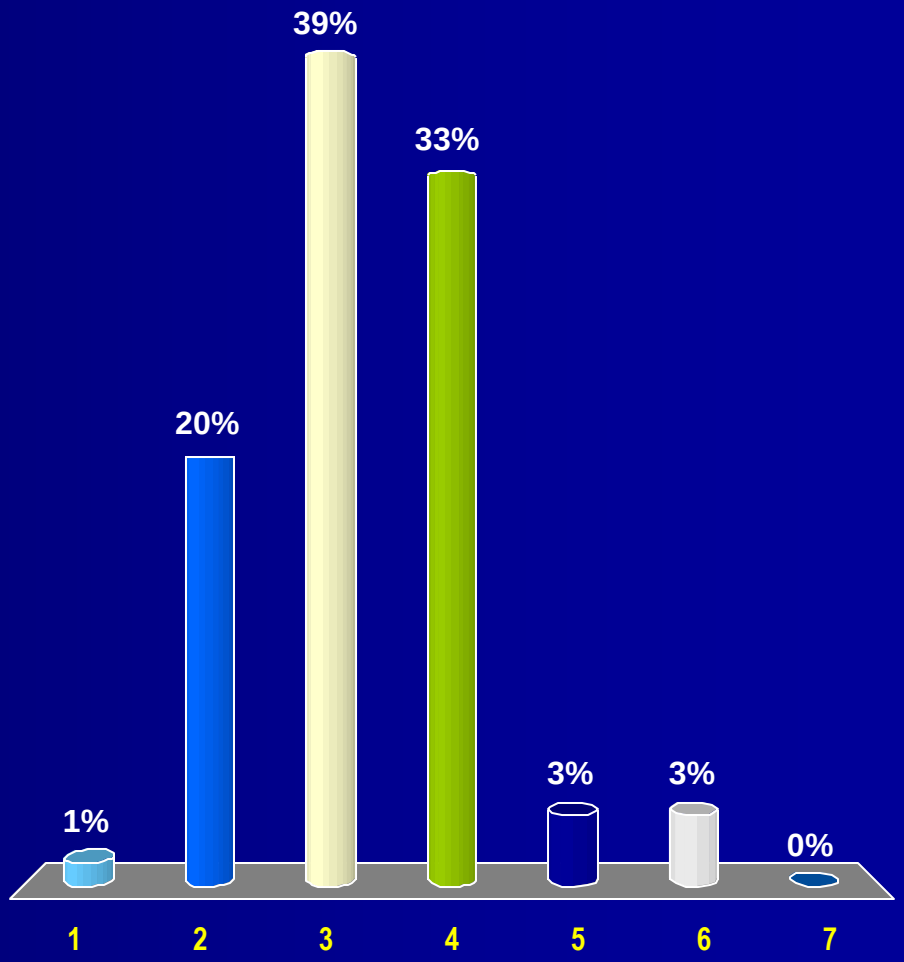
What do you feel is the breakeven cost of DNA testing in the seedstock sector?

1. $ 0
2. $ 1-5
3. $ 5-10
4. $10-50
5. $ 50-100
6. $100-200
7. >$200



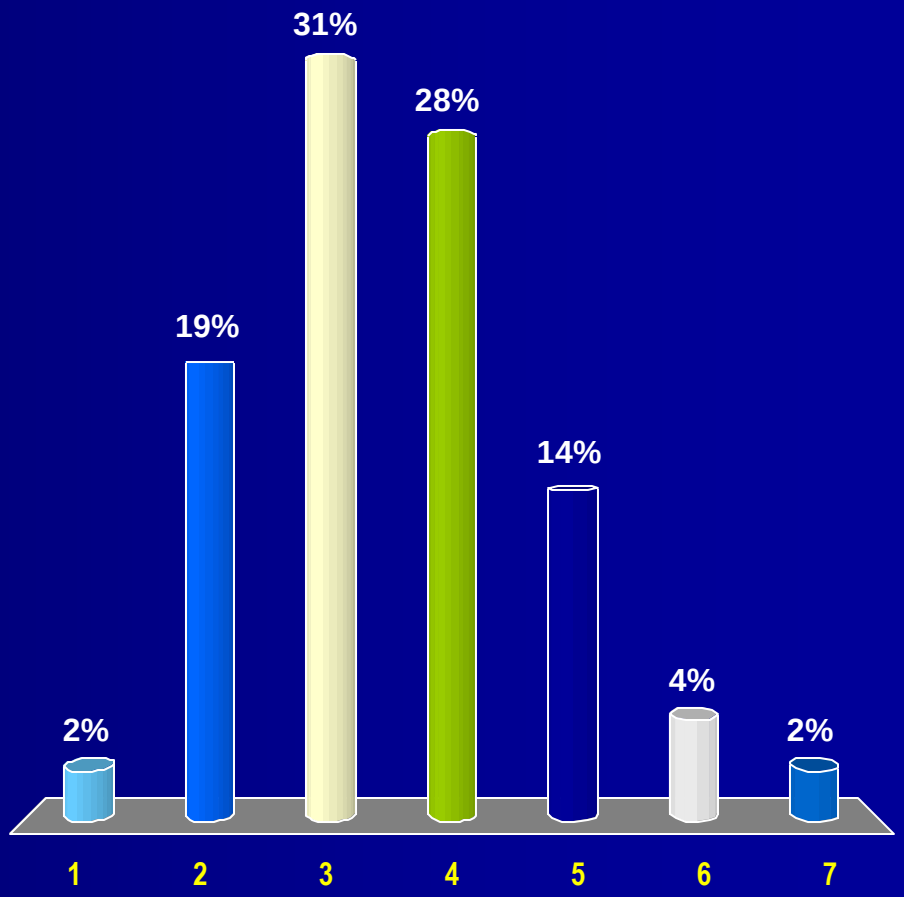
What is the breakeven cost of DNA testing in the commercial sector?

1. $0
2. $1-5
3. $5-10
4. $10-50
5. $ 50-100
6. $100-200
7. >$200



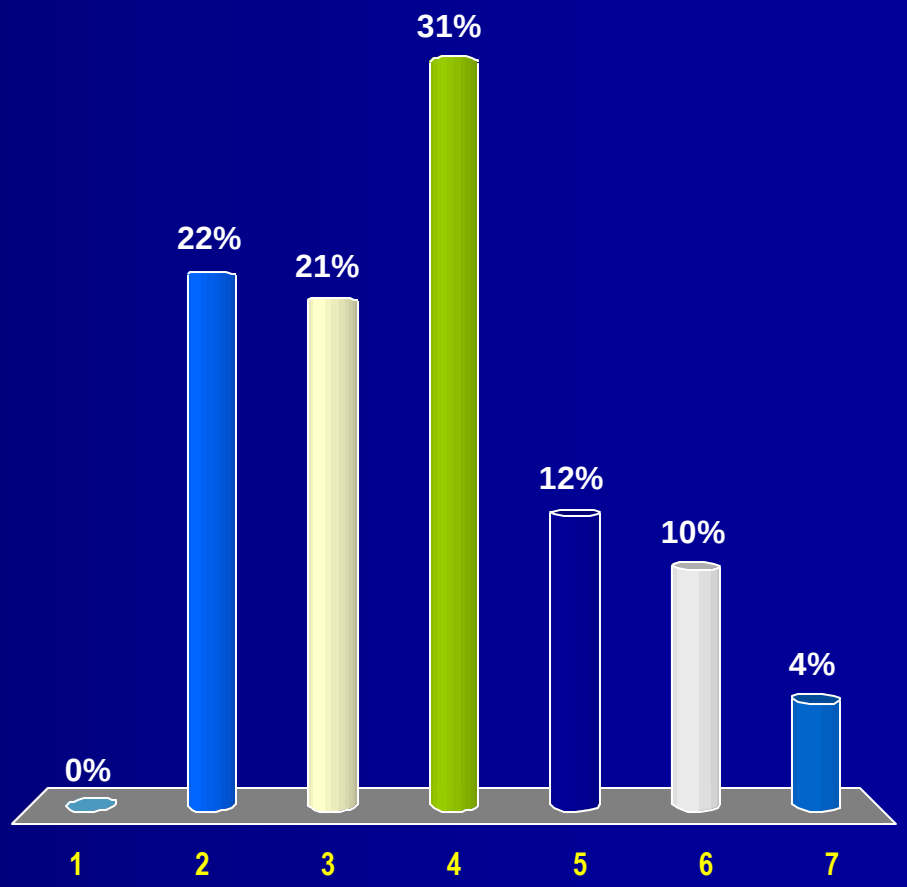
What is the breakeven cost of DNA testing in the feedlot sector?

1. $0
2. $1-5
3. $5-10
4. $10-50
5. $ 50-100
6. $100-200
7. >$200



What is the breakeven cost of DNA testing in the processing sector?

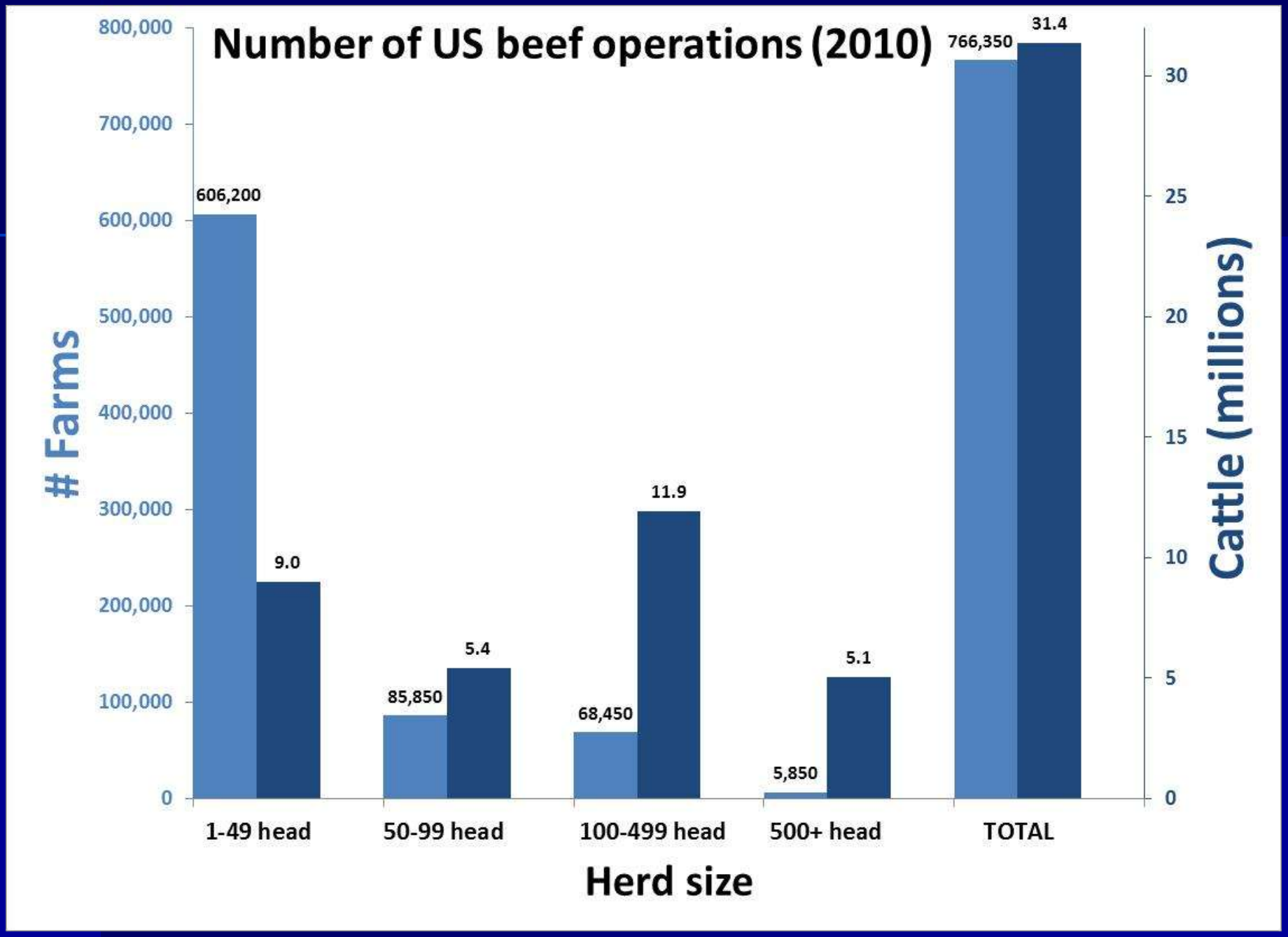
1. $0
2. $1-5
3. $5-10
4. $10-50
5. $ 50-100
6. $100-200
7. >$200

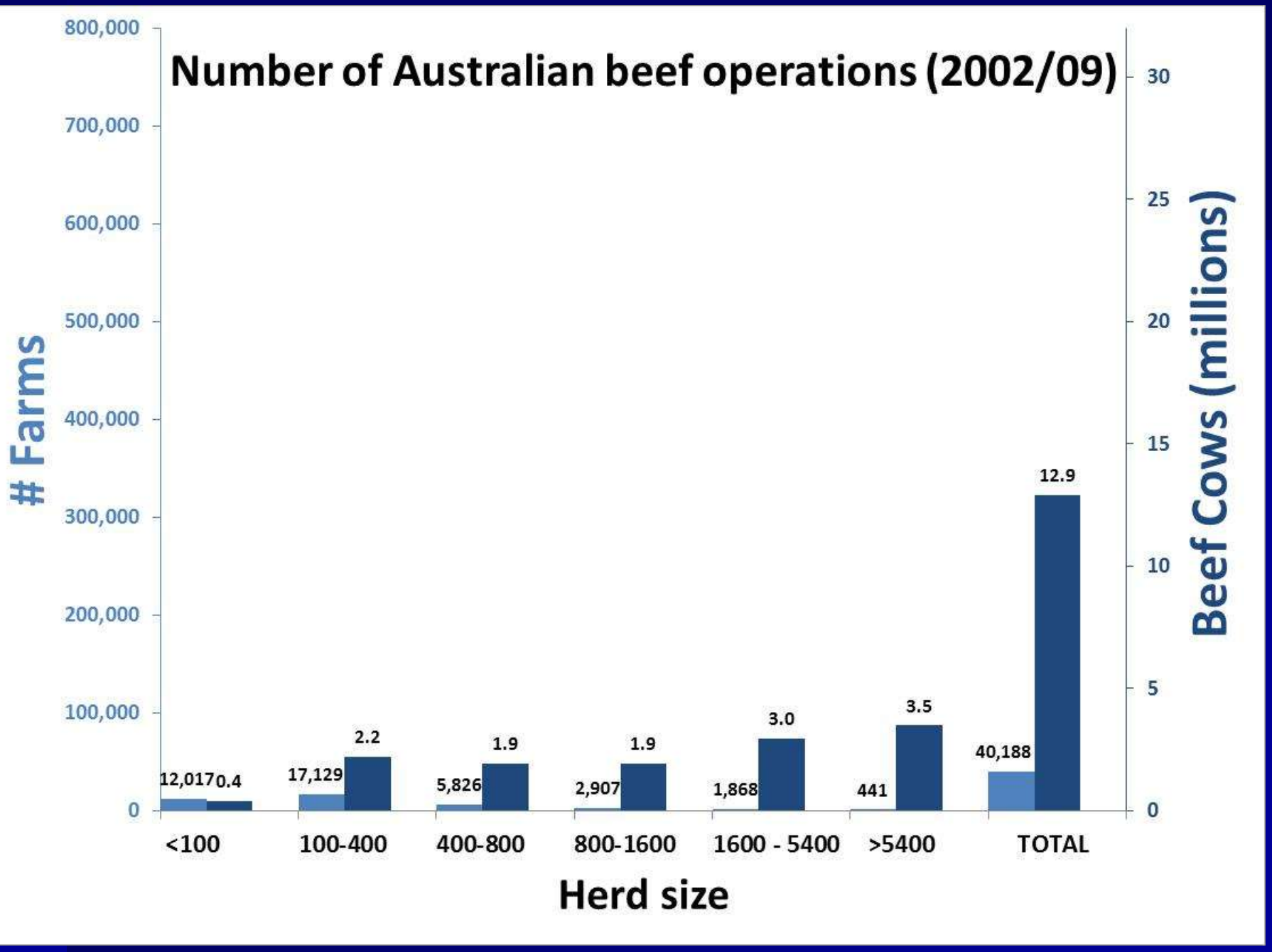


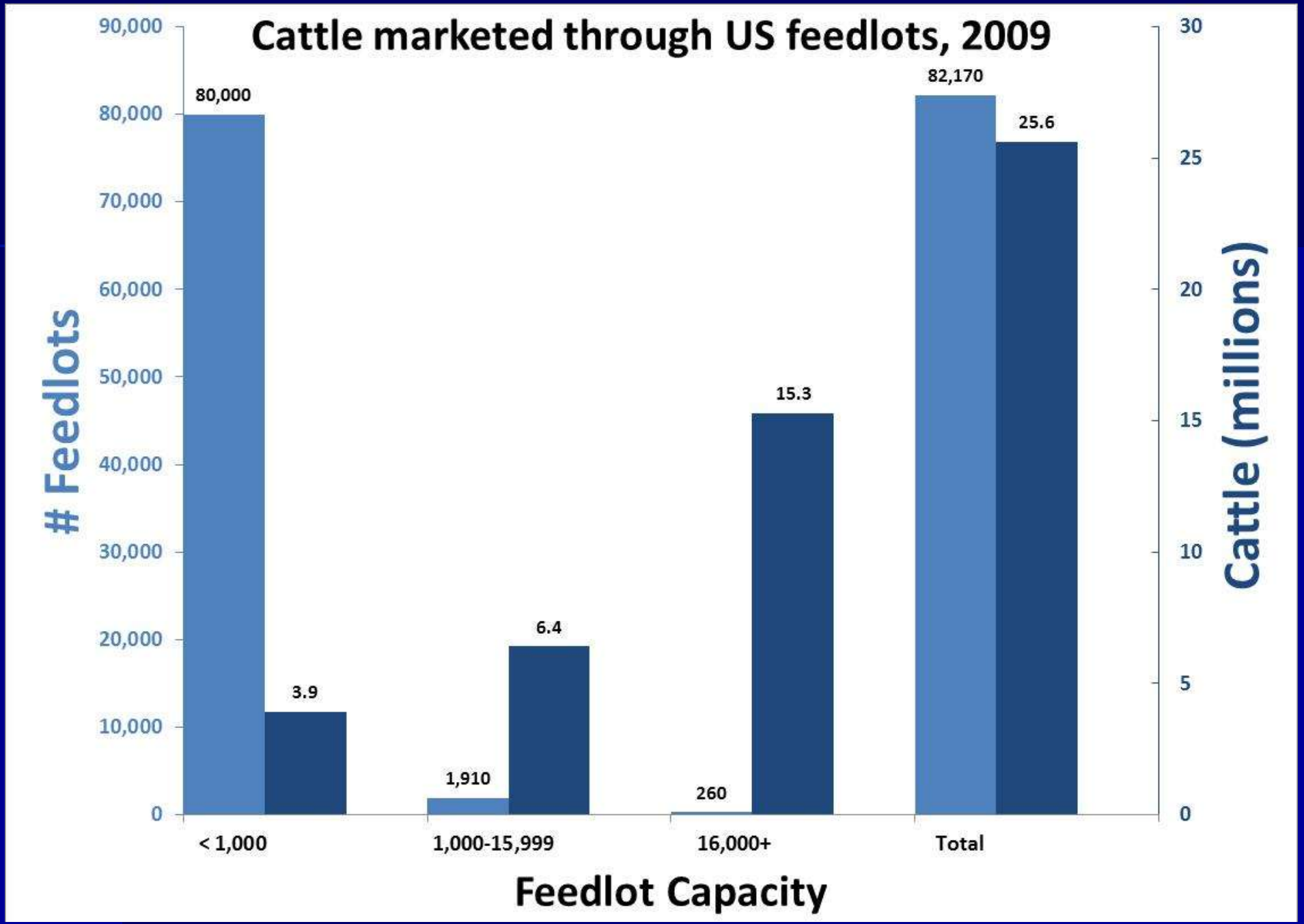
Cost of commercially-available DNA tests for livestock (as of 1/2011)

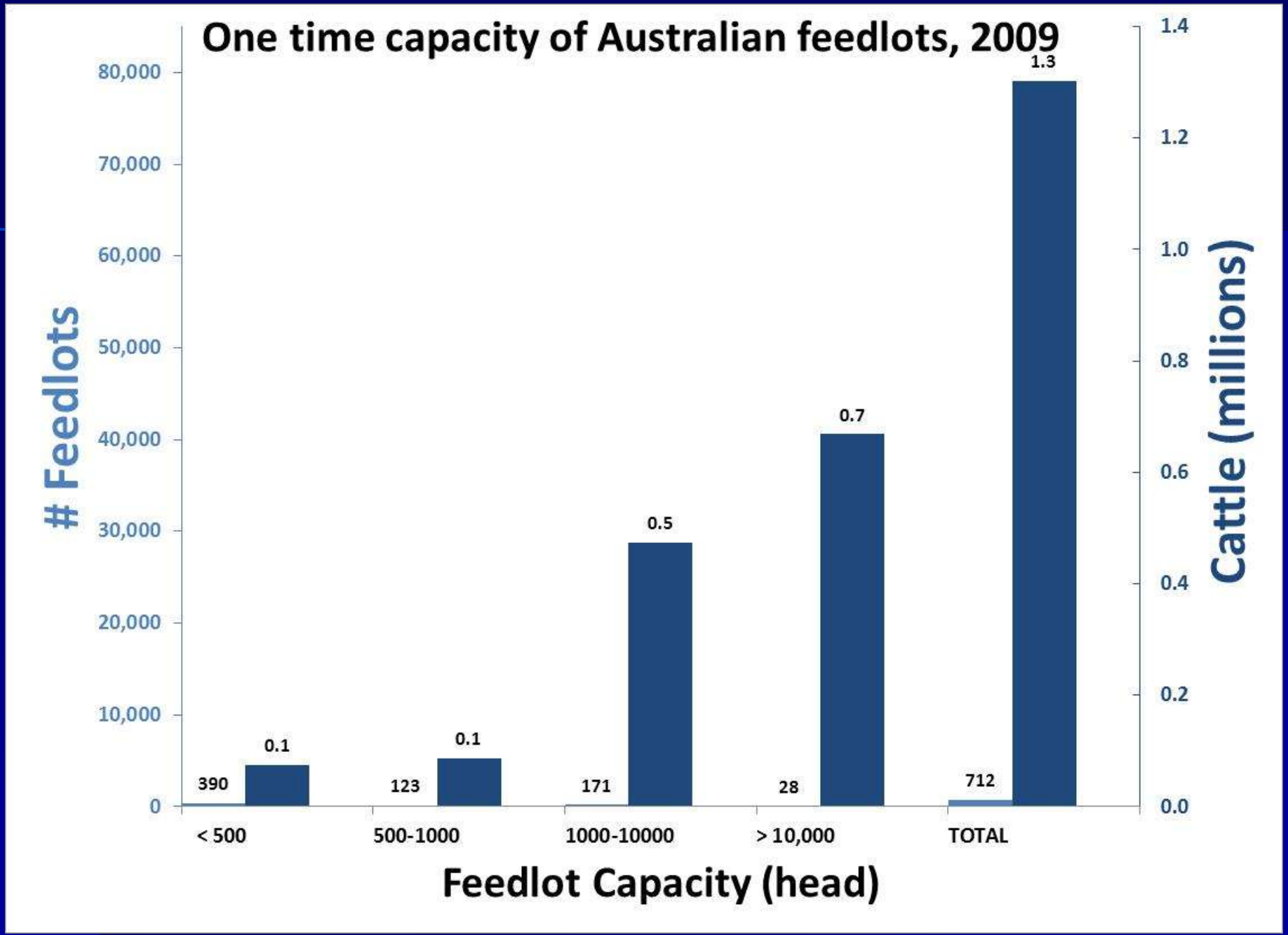
Type/Purpose of DNA Test	Species	Cost ($US)
Microsatellite or SNP-based parentage test	Cattle	$ 15-25
Genetic Defects/Single gene tests	Cattle	$ 15-100
Illumina Bovine 3K (just genotypes - no prediction equation)/Research	Cattle	$ 38
Illumina Bovine 50K (just genotypes)/Research	Cattle	$100
Affymetrix Bovine 650K (just genotypes)/Research	Cattle	$200
Illumina Bovine 770K (HD) SNP Test (just genotypes)/Research	Cattle	$210
384 SNP Angus Profile (Igenity US/AGI)/Selection	Beef Cattle	$ 65
Illumina Bovine 3K (Pfizer Animal Genetics US)/Selection	Dairy Cattle	$ 45
Illumina Bovine 50K (Pfizer Animal Genetics US/AGI)/Selection	Beef Cattle	$139
Illumina Bovine 50K (Holstein Ass.)/Selection	Dairy Cattle	$150
Illumina Bovine 770K (HD) SNP Test (Holstein Ass.)/Selection	Dairy Cattle	$365
Illumina Bovine 50K (Pfizer Animal Genetics NZ)/Selection	Sheep	$756 (NZ$990)

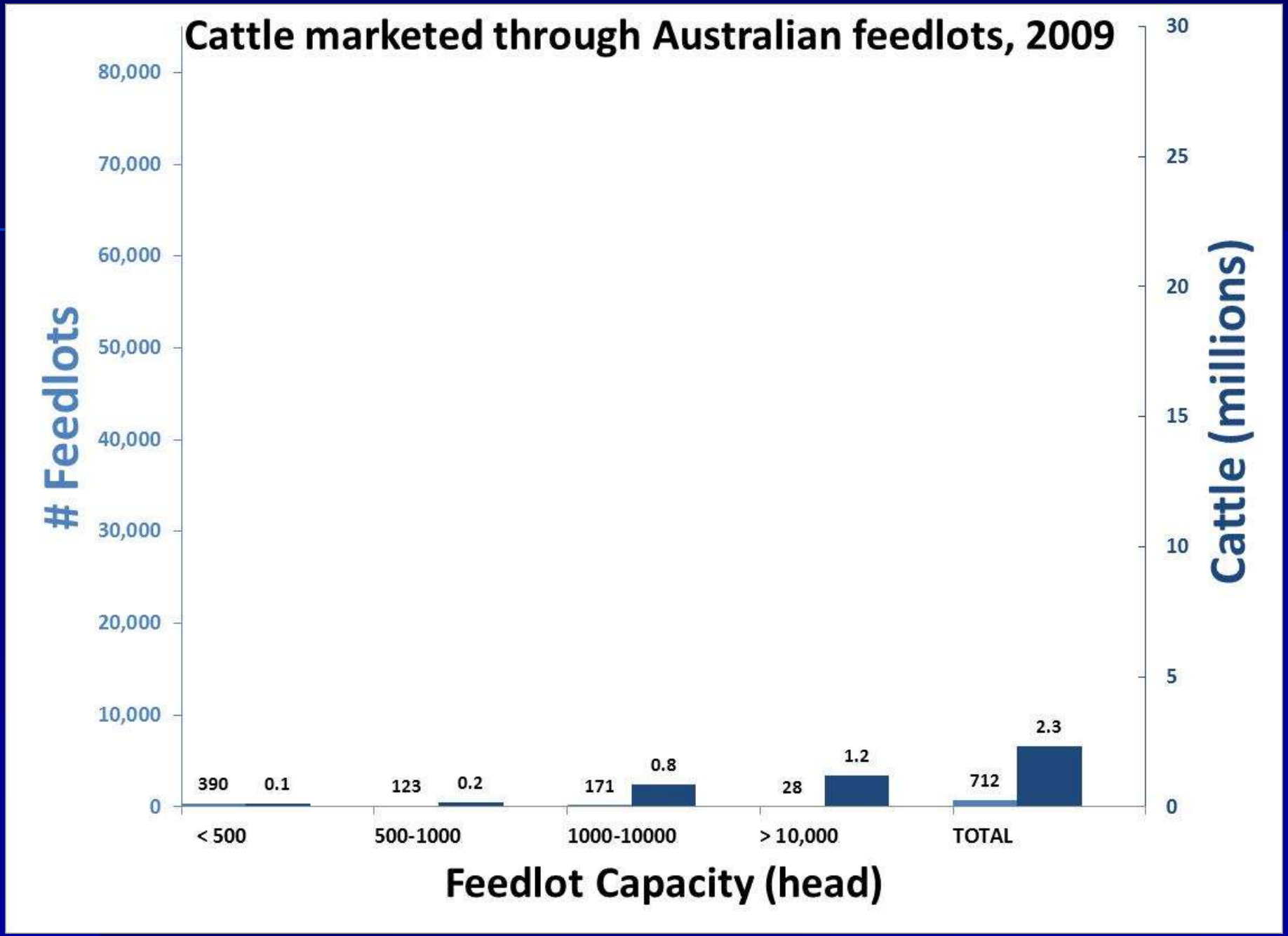
		384 SNP panel		50,000 SNP CHIP		
Trait	**h^2**	**Igenity Angus Profile**		**Pfizer HD 50K for Angus**		
		Included	% Genetic variation, (US)	Included	% Genetic variation, (US)	% Genetic variation (AU)
Average Daily Gain	0.28	X		X	30	1-10
Net/residual Feed Intake	0.39	X		X	12	0
Dry matter Intake	0.39		20	X	42	4-5
Tenderness	0.37	X		X	26	na
Calving Ease (Direct)	0.10			X	22	6
Birth Weight	0.31		32	X	26	12-16
Weaning Weight	0.25		20	X	27	12-19
Yearling Weight	0.60	X	12		41	
Calving Ease (maternal)	0.10	X		X	40	4
Milking Ability	0.25		6	X	10	10-14
Heifer Pregnancy	0.20	X				
Stayability	0.10	X				
Docility	0.37	X	22			
Yield Grade	0.64	X				
Carcass Weight	0.39	X	29	X	23	6-13
Backfat Thickness	0.36	X	25	X	31	14-19
Ribeye Area	0.40	X	34	X	36	10-20
Marbling Score	0.37	X	42	X	32	4-11
Percent Choice		X				


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
500,000
400,000
300,000
200,000
100,000
0
30
25
20
15
10
5
0


Number of Australian beef operations (2002/09)
Farms
Beef Cows (millions)
800,000
700,000
600,000
500,000
400,000
300,000
200,000
100,000
0
30
25
20
15
10
5
0
12,017
0.4
17,129
2.2
5,826
1.9
2,907
1.9
1,868
3.0
441
3.5
40,188
12.9
<100
100-400
400-800
800-1600
1600 - 5400
>5400
TOTAL
Herd size


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


One time capacity of Australian feedlots, 2009
Feedlots
Cattle (millions)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
390
0.1
123
0.1
171
0.5
28
0.7
712
1.3
< 500
500-1000
1000-10000
> 10,000
TOTAL
Feedlot Capacity (head)


Cattle marketed through Australian feedlots, 2009
Feedlots
Cattle (millions)
80,000
70,000
60,000
50,000
40,000
30,000
20,000
10,000
0
30
25
20
15
10
5
0
390
0.1
123
0.2
171
0.8
28
1.2
712
2.3
< 500
500-1000
1000-10000
> 10,000
TOTAL
Feedlot Capacity (head)