"Commercial Heifer Selection Using Genomics"

Australian seedstock breeders take their business very seriously!

"Commercial Heifer Selection Using Genomics"

- What traits are of importance for heifer replacement selection?
- What selection criteria are currently available?
- What traits are genomic predictions available for?
- What is the value of genetic improvement in commercial females?

What traits are of importance for heifer replacement selection?

- Has to be big enough to breed as a yearling
- Has to be phenotypically/structurally sound

THEN IF THERE ARE ANY LEFT – CAN CONSIDER SELECTION

- Reproductive traits are sex-limited, lowly heritable, and some are expressed quite late in life.
  - age at first calving
  - reproductive success
  - replacement rate

i.e. type of traits benefit most from genomics!

What selection criteria are currently available?

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 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

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

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

Trait	AGI h^2	IGENITY® Angus Profile		Pfizer HD 50K for Angus	
		Included	% Genetic variation (r^2)	Included	% Genetic variation (r^2)
Average Daily Gain		X		X	30[2]
Net/residual Feed Intake				X	12[2]
Dry matter intake		**X**	**20[1]**	**X**	**42[1]**
Feed Efficiency		X		X	
Tenderness		X		X	26[2]
Calving Ease (Direct)		X		X	22[2]
Birth weight	**0.42**	**X**	**32[1]**	**X**	**26[1]**
Weaning Weight	**0.20**	**X**	**20[1]**	**X**	**27[1]**
Yearling Weight	**0.20**	**X**	**12[1]**	**X**	**41[1]**
Yearling Height		X			
Calving ease (maternal)		X		X	40[2]
Milking Ability	**0.14**	**X**	**6[1]**	**X**	**10[1]**
Heifer Pregnancy		X			
Docility		**X**	**22[1]**		
Mature Height		X			
Mature Weight		X			
Scrotal Circumference		X			
Carcass weight	**0.31**	**X**	**29[1]**	**X**	**23[1]**
Backfat thickness	**0.26**	**X**	**25[1]**	**X**	**31[1]**
Ribeye area	**0.32**	**X**	**34[1]**	**X**	**36[1]**
Marbling score	**0.26**	**X**	**42[1]**	**X**	**32[1]**
Percent choice		X			

[1] Northcutt, S.L. (2011) Genomic Choices. American Angus Association®/Angus Angus Genetics Inc. release. http://www.angus.org/AGI/GenomicChoiceApril2011.pdf (Released 6 April 2011)

[2] Pfizer Animal Genetics. 2010. Technical Summary. http://www.pfizeranimalgenetics.com/sites/PAG/Documents/50K%20Tech%20Summary.pdf

What is the value of genetic improvement in commercial females?

Need to know the following……

1. Selection objective being targeted
2. Heritability of the analyzed trait (h^2)
3. Accuracy of genetic estimates already available to inform selection decisions
4. Genetic correlation between MVP and the trait (r_g)
5. Genetic variances and covariances for selection index calculations
6. Regression coefficient of phenotype on MBV (b)
7. Biological attributes and structure of stud and commercial herds
8. Selection intensity of replacement stud sires and bulls for sale (and females)
9. Number of calves per exposure
10. Type of herd (terminal, maternal)
11. Value derived from accelerated genetic progress
12. Sector where value is derived and how that is value is shared
13. Cost of test, and which animals are being tested
14. Planning horizon etc., etc., etc.

Potential Value of DNA information to the commercial sector

Estimate the value of using DNA test information to increase the accuracy of bull and replacement selection in a commercial herd

The expected returns from using DNA testing to improve the accuracy of selection for

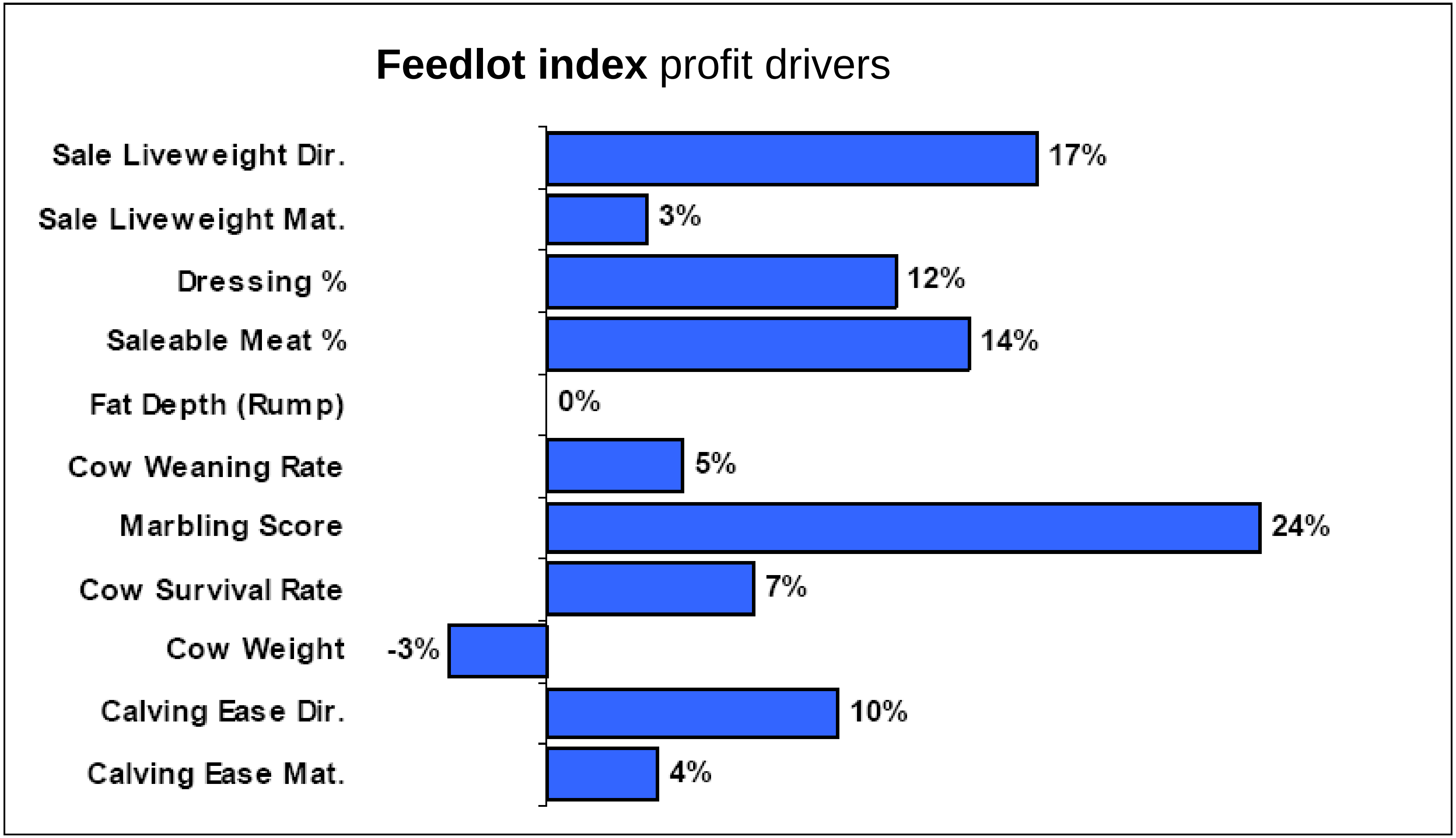
- commercial sires sourced from a seedstock herd
- replacement commercial females

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.

The following commercial operation was modeled

Parameters	Value
Number of cows	100
Number of heifer calves available for selection	45 (all get tested with DNA test)
Number of replacement heifers selected each year	20 (~50%; i = 0.8)
Maximum age of commercial sire	5 (4 breeding seasons)
Commercial cow:bull ratio	25
Planning horizon	20 years
Discount rate for returns	7%
Number of live calves available per exposure	0.9
Cull for age threshold of cow	10
Age structure of breeding cow herd	0.2, 0.18, 0.17,0.15, 0.12, 0.09, 0.05, 0.03, 0.01
Age structure of bulls in commercial herd	0.34, 0.27, 0.22, 0.17

Used an index to weight relative economic importance of different traits



High (h^2) and **intermediate** (½ h^2) accuracy DNA tests explaining genetic variation in all of the economically-relevant traits in the breeding objective and selection criteria

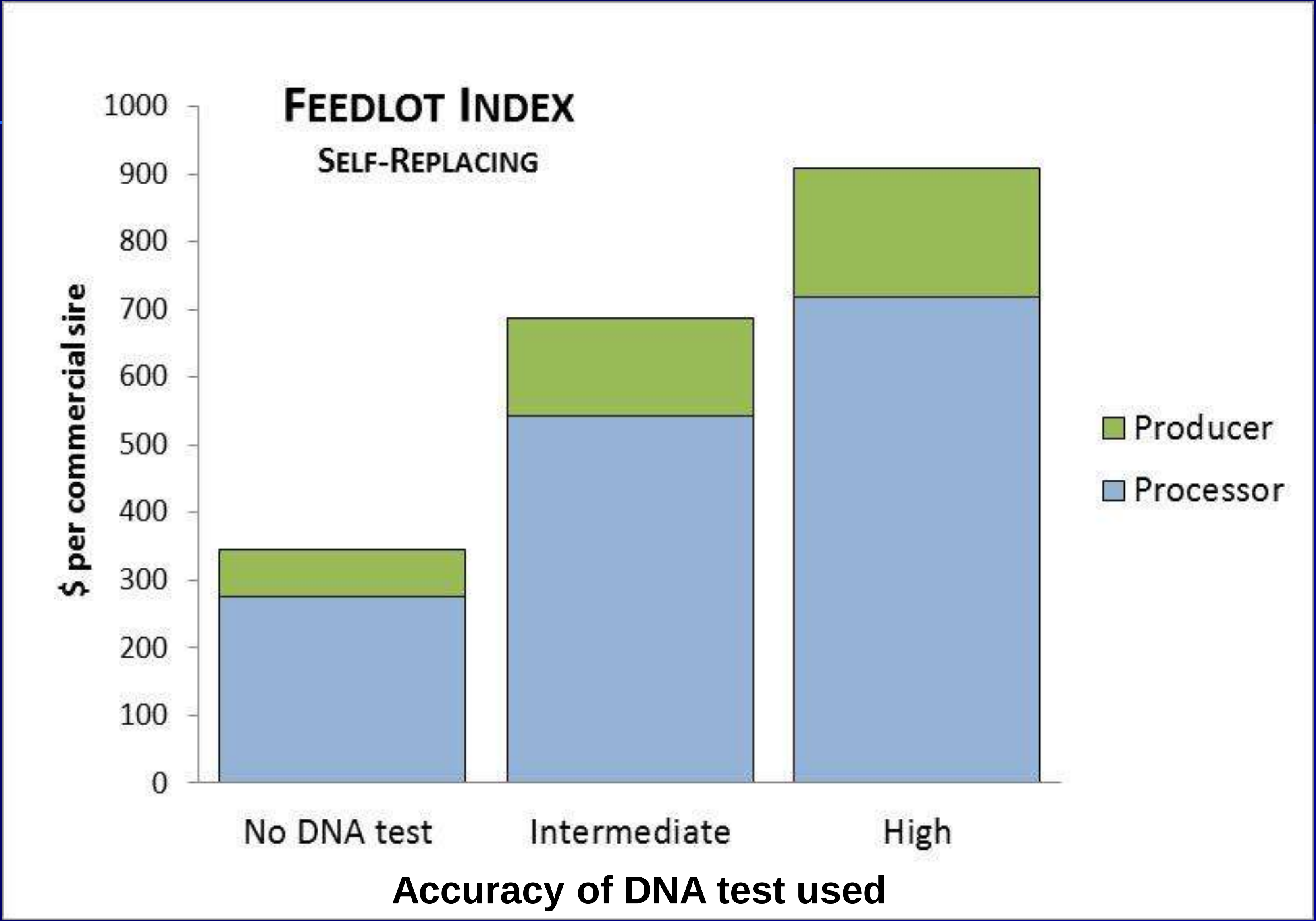
Economically-relevant Trait	h^2
Sale liveweight – direct	0.31
Sale liveweight – maternal	0.04
Cow weaning rate	0.05
Cow survival rate	0.03
Cow weight	0.41
Calving ease – direct	0.10
Calving ease – maternal	0.10
Dressing Percentage	0.33
Saleable meat Percentage	0.56
Fat depth (rump)	0.41
Marbling score	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 commercial bulls due to DNA-test increase in index accuracy (i=0.8)

Variable	Unit	Accuracy of DNA test used	Feedlot
Increased value derived from ΔG in commercial sires	$/ DNA test	Intermediate	170
		High	282

Where are returns from genetic gain (ΔG) realized?



Assumptions: Value of testing for heifer selection

The value of using DNA information in making replacement heifer selection decisions will depend upon

- the information available at the time of selection,
- the accuracy of the test with regard to the selection objective, and
- the selection intensity (i.e. what proportion of available heifers are selected).

- I modeled the breakeven cost of testing 45 potential replacement heifers born per 100 cows per year in a commercial herd with a replacement rate of 20% (i.e. 20 replacement heifers were selected/100 cows each year).
- I assumed that the commercial producer was not performance recording (i.e. had no other data upon which to base heifer replacement decisions)

What is the value of genetic improvement in commercial females?

- The breakeven cost of testing replacement heifers was **$3.63** and **$6.53** per test for the intermediate and high accuracy DNA tests, respectively.
- These values are unique to the hypothetical DNA tests modeled in this study, and are not representative of commercial products.
- **The value of increasing the accuracy of commercial replacement heifer genetic evaluations is less (ten-fold in this case) than that for bulls because bulls produce more descendants from which to derive returns for accelerated genetic improvement.**

Potential Value of DNA information for beef sectors

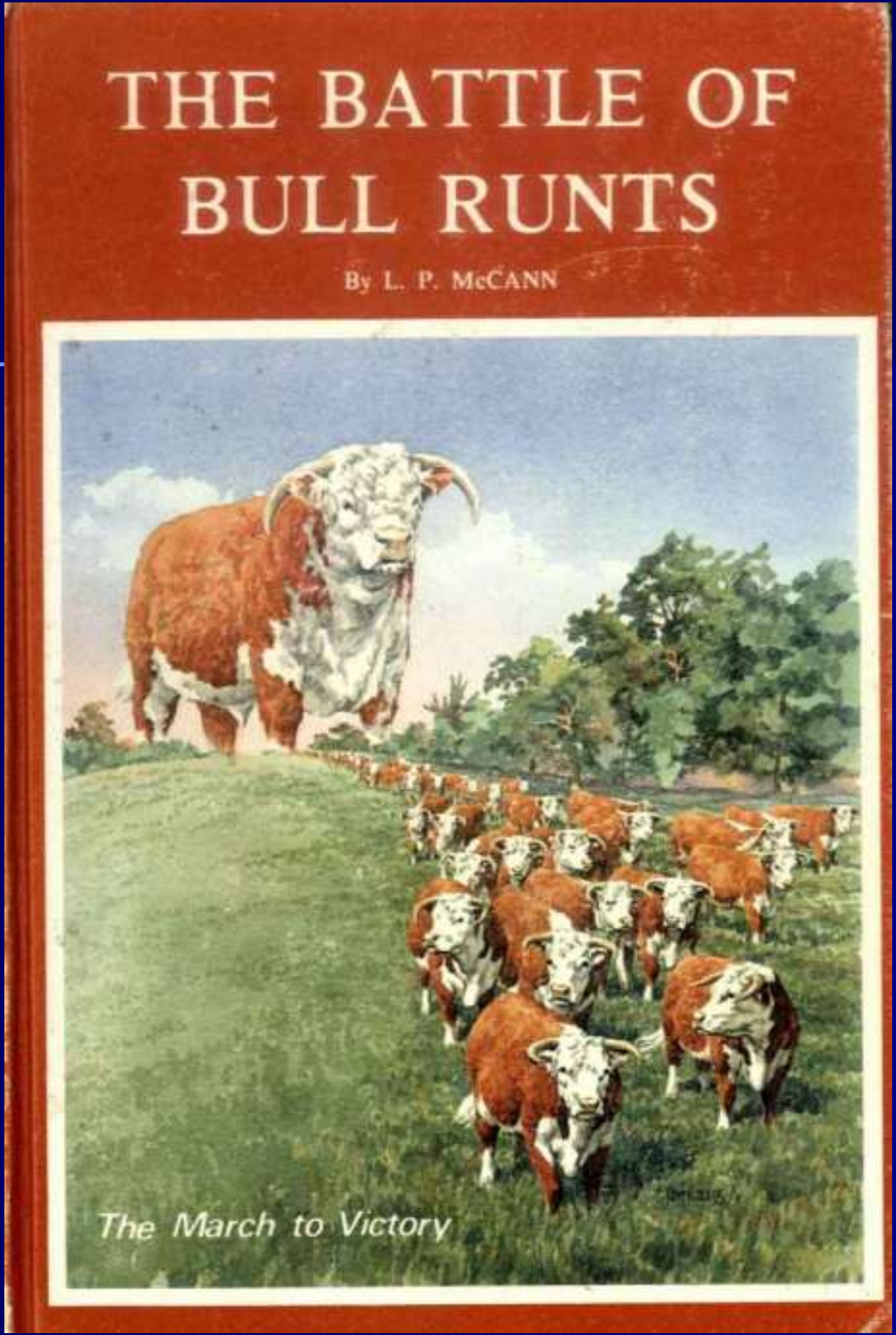
Use	Seedstock	Commercial	Feedlot	Processor
DNA-assisted selection	XXXX	X	X	XXXX
Parentage	XX	X		
Recessive allele testing	XX	X		
Control of Inbreeding	XX	X		
Mate selection	XX	X		
DNA-assisted management		X	XX	
Product differentiation				XX
Traceability				XX

Compare 20th century response to dwarfism to 21st century response

An early '50's advertisement that superimposed a measuring stick in the picture of this bull who was nick-named "Short Snorter."

Based upon his height and age, he was less than a frame score 1.

Image from https://www.msu.edu/~ritchieh/historical/shortsnorter.jpg



A 1956 survey of Hereford breeders in the USA identified 50,000 dwarf-producing animals in 47 states.

Through detailed pedigree analysis and test crosses, the American Hereford Association, in concert with breeders and scientists, virtually eliminated the problem from the breed. Because carrier status was difficult to prove and required expensive progeny testing, some entire breeding lines were eliminated.

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

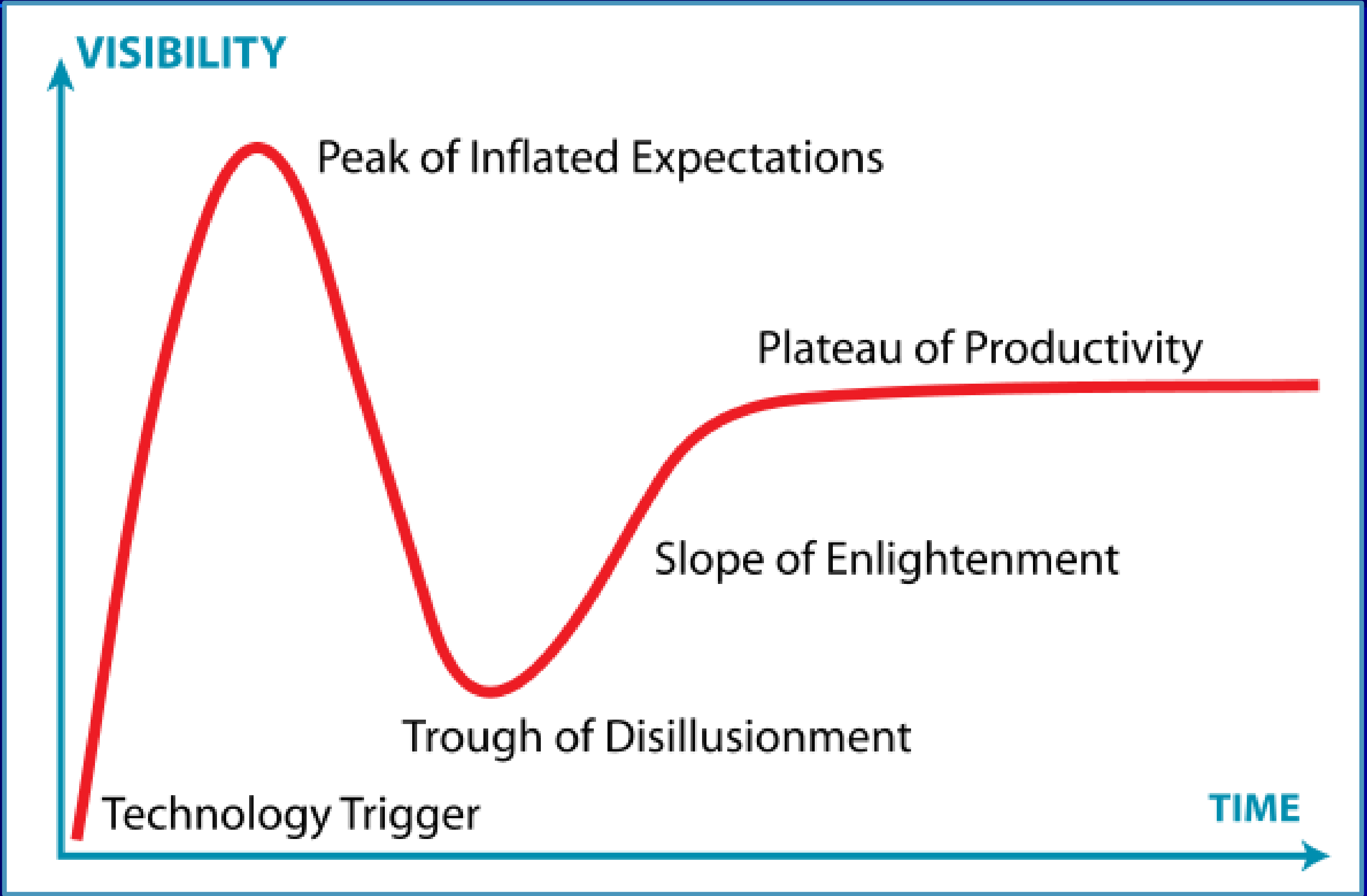
- Of these, 20% (19,529) were carriers of AM. **That leaves 23,638 bulls and more than 53,000 heifers which tested as free of AM.**

At $4K/bull and $2K/heifer ~$200 million

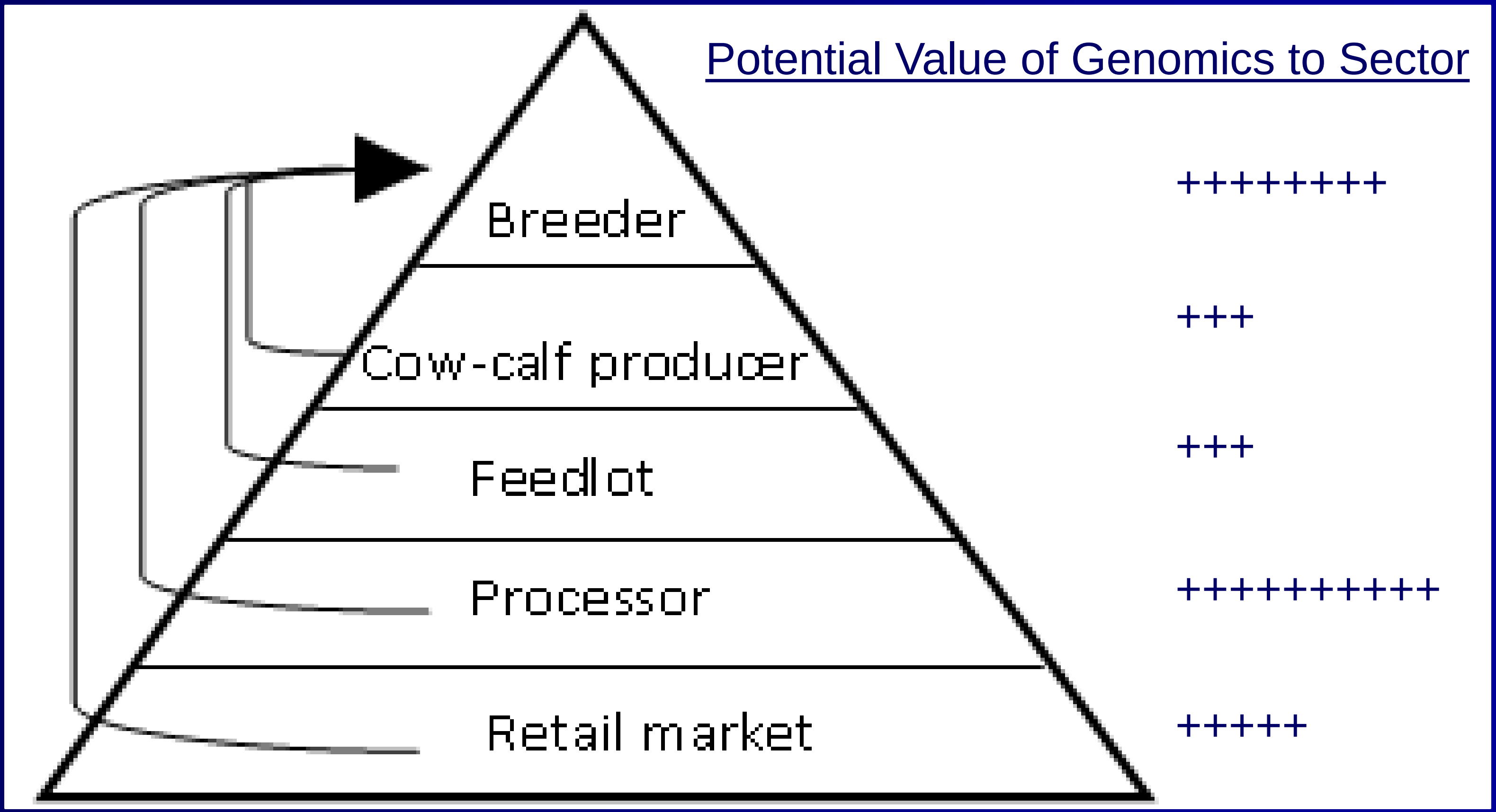
Based on calculations in Buchanan, D.S. 2009. Genetic Defects in Cattle. http://www.ag.ndsu.edu/williamscountyextension/livestock/genetic-defects-in-cattle


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.

Summary

- Reproductive traits are a major profit driver of self-replacing herds and DNA tests have the potential to provide previously-absent selection criteria for commercial replacement heifer selection.
- Such tests will need to be accurate for maternal traits and inexpensive because the genetic gain in commercial animals is passed onto fewer descendants from which to recoup testing costs.
- Need to capture the cumulative supply chain value derived from using genomics for multiple purposes (selection, parentage, genetic defects, marker-assisted management, product differentiation, traceability)

Thanks for inviting me!

National Beef Cattle Evaluation Consortium
Colorado State University-Cornell University-University of Georgia

USDA
United States Department of Agriculture
National Institute of Food and Agriculture

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