Using Genomic Tools in Commercial Beef Cattle: Taking Heifer Selection to the Next Level

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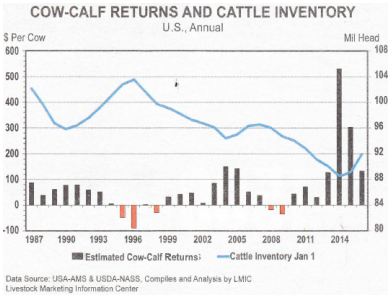
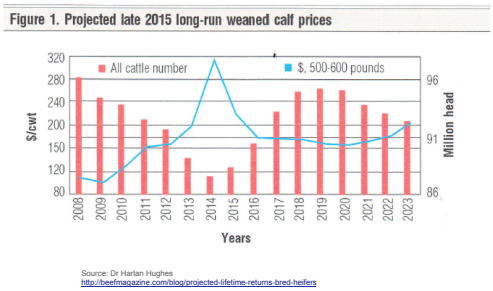
Can genetic information obtained from a simple DNA sample allow us to predict with reasonable accuracy the potential lifetime productivity of these replacement heifers?

With technology available to producers today, the answer is

YES!





"Herd expansion is in full swing….

"Given the current information, it is possible the 2016 January 1 Cattle Inventory report will show heifers for beef cow replacement nationally up 6 to 7 percent from a year ago. (Some of these heifers are fairly low quality heifers to be placing in the breeding herd)."

Dr Andrew Griffith, Univ of TN Ag Economist
Tennessee Cattle Business, Dec. 2015

*Taken these two factors into consideration (**lower prices** and **excess heifers**), there may never be a better time for producers to use tools to help them identify heifers with highest genetic potential!*

Using genomic tools in the commercial segment

- Several options exist for producers to improve performance and profitability
  - *Tests and rankings that emphasize growth/carcass*
  - *Tests and rankings that emphasize maternal performance (ie, pregnancy rates, calving ease)*
  - *Combinations of the two*

So which one should I use?

Development of GeneMax Advantage

- Initial collaboration with Angus Genetics, Inc and Certified Angus Beef, GeneMax Advantage was released to the industry in 2014
- Applicable to beef females that are ≥ 75% Black Angus
- Based on HD50K platform using ~39K Angus seedstock animals
- This platform provided the most reliable genomic predictions for maternal, growth and carcass traits available for Angus cattle

Table 1. Correlations between molecular breeding values and phenotypic data in the most recent Angus validation[1].

Trait	Correlation	Trait	Correlation	Trait	Correlation
CED	.67	SC	.80	CWT	.60
BW	.69	DOC	.68	MARB	.65
WWT	.56	HP	.62	REA	.68
YWT	.68	MILK	.37	FAT	.65
DMI	.73	MWT	.74		
YHT	.75	MHT	.71		

[1]Based on validations including >108,000 head.
Source: American Angus Association and Angus Genetics Inc. 2016.

Development of GeneMax Advantage

- MBV are generated for 13 traits and consolidated into 3 bio-economic indexes

  Cow Advantage, Feeder Advantage, Total Advantage

- Advantage indexes derived using simple selection index methodology and economic assumptions (revenues/costs) consistent with those used by the American Angus Association in their economic ($) indexes; 3-year rolling averages
- These indexes can then be used for heifer selection, mating and marketing decisions

GeneMax Advantage Index Scores

Represented on a 1 to 100 scale - higher score means more $ profit

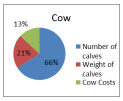
Cow Advantage Score
Conception to Weaning

Feeder Advantage Score
Weaning to CAB carcass

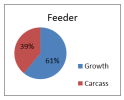
Total Advantage Score
Conception to Carcass

Traits included in the GeneMax Advantage indexes

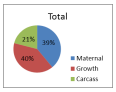
- **Cow Advantage**
  Heifer Pregnancy, Calving Ease, Weaning Weight, Milk, Cow Size (cow costs)



- **Feeder Advantage**
  Feedlot Gain, Dry Matter Intake, Carcass Weight, Yield Grade, Quality Grade (marbling)



- **Total Advantage** (conception to CAB carcass)



Why present the information as an index?

- *The primary reason and benefit for using an index in beef cattle selection is to simplify improvement for many traits with different underlying genetic control (heritability) and economic value into a simple to use single number*
- *Maximum genetic (economic) improvement is then made by selecting and mating males and females with highest indexes*
- *Dr Bob Weaber reviewed many currently available*

http://articles.extension.org:80/pages/73372/beef-cattle-economic-selection-indices

Index Selection for Commercial Heifer Selection

- Identify candidates for selection
  - *Remove visual culls for temperament or phenotype*
- Rank based on Index value (such as Total Advantage)
  - *Consider outliers where relevant (cow cost, marbling, docility, etc)*
- Select the top as replacements
  - *The percent you keep is based on replacement rate in your cow herd*
  - *Heifers selected based on the index value will have a higher average index and therefore higher expected profit per calf*

Example report

Tag	Birth Date	Cow Cost Outlier	Doc Outlier	Marb Outlier	Tend Outlier	Cow	Feeder	Total
9A	02/13/2013				[-]	80	92	96
25A	02/18/2013					69	93	92
22A	02/16/2013	[-]		[+]		49	93	92
3A	02/10/2013			[-]		76	90	90
18A	02/16/2013	[-]		[+]		59	90	90
34A	02/23/2013	[-]		[+]		57	90	89
17A	02/16/2013			[-]		59	83	86
20A	02/16/2013			[+]		56	82	86
101A	03/06/2013			[+]		70	78	86
31A	02/20/2013					65	69	86
13A	02/15/2013					55	84	85
15A	02/16/2013			[+]		28	89	82
5A	02/12/2013					68	69	82
38A	02/28/2013			[+]		38	65	59
125A	03/08/2013					40	72	58
115A	03/07/2013			[+]		49	57	58
68A	03/04/2013			[-]		26	78	51
53A	03/20/2013					48	45	51
145A	03/10/2013			[+]		35	52	49
100A	03/06/2013			[+]		37	56	46
184A	03/24/2013			[+]		39	67	45
67A	03/04/2013					46	58	41
86A	03/05/2013			[+]		41	33	41

Value of the technology – show me the money!

1)From a genetic improvement standpoint

2)From an economic standpoint, ie, return on investment

3)Other benefits

The model

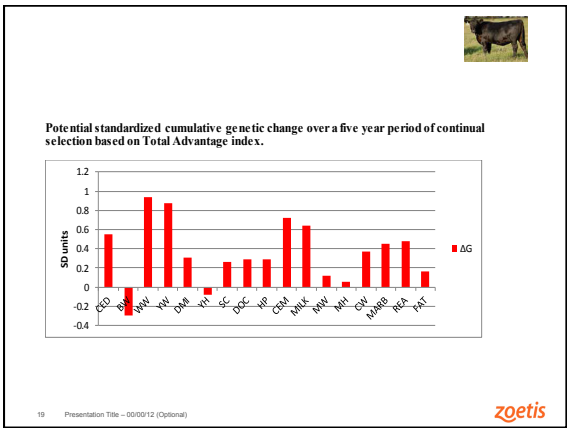
GeneMax Advantage Genetic Trend Calculator

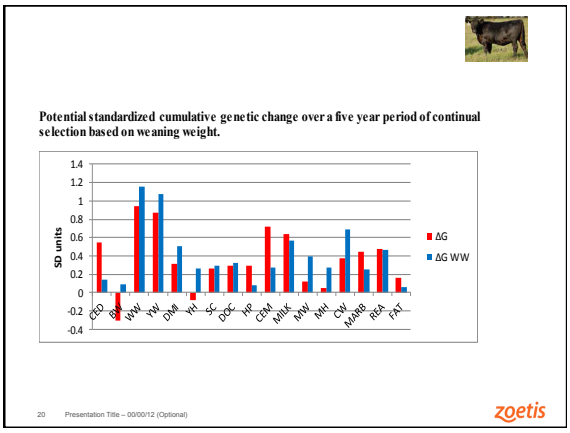
<=Inputs that can be changed <=Calculated Values

Inputs			
Index for Selection of Replacements ([T-Total,C-Cow, F-Feeder]	Total	Total Advantage Index	
Herd Size (# cows)	100	Expected Cumulative Genetic Change over next 5 Years	
Number Heifers Born Annually	50		
Percent of heifers tested	66%	Direct CE (% unassist)	2.79
Number Cows Culled Annually	15	Birth Weight (lbs)	-0.79
Number Replacement Heifers Retained Annually	15	Weaning Weight (lbs)	9.47
Heifer Proportion Selected	0.45	Yearling Weight (lbs)	16.16
Bulls HD 50K tested (Y or N)	Y	Mature Weight (lbs)	0.15
Bull Proportion Selected	0.25	Heifer Pregnancy Rate (%)	0.68
		Milk (lbs)	5.36
Heifer Selection Intensity	0.87	Docility (score)	4.79
Bull Selection Intensity	1.28	Carcass Weight (lbs)	3.16
Average Selection Intensity	1.07	Marbling (score)	0.15

Assumptions in Genetic Improvement Calculations

1. *Two-thirds of heifers produced are genomically tested and ranked on Total Advantage*
2. *Top forty-five percent of tested heifers are retained as replacement females (ie, 15 per year in a 100 cow herd)*
3. *Males (service sires) are HD-50K tested, are selected on the same index and come from the top 25% of the seedstock population*





Assumptions in Value Calculations

1. *Two-thirds of heifers produced are genomically tested and selected on Total Advantage*
2. *Top forty-five percent of tested heifers are retained as replacement females (ie, 15 per year in a 100 cow herd)*
3. *Males (service sires) are HD-50K tested, are selected on the same index and come from the top 25% of the seedstock population*
4. *Selected heifers produce 6 calves lifetime (1 per year)*
5. *Each offspring/grand-offspring, etc has a 50% chance of being female*
6. *Future generations also considered*
7. *Test cost is $39*

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Compounding Benefits

The genetic advantage we build into her through selection is also passed on to her progeny giving them a genetic advantage as well. The model accounts for both over their respective lifetimes, discounted to present dollars.

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Gene Flow Schematically

Year	1	2	3	4	5	6	7
	Test	Offsp1	Offsp2	Offsp3	Offsp4	Offsp5	Offsp6
				GrOff11	GrOff12	GrOff13	GrOff14
					GrOff21	GrOff22	GrOff23
						GrOff31	GrOff32
							GrOff41
						GGrOff111	GGrOff112
							GGrOff211
Contribution	1	0.50	0.5	.5+.25	.5+2*.25	.5+3*.25+.125	.5+4*.25+2*.125
Accumulative	1	0.5	0.5	0.75	1	1.375	1.75

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Value of testing

- *In year 1, only testing costs are incurred, no revenue generated*
- *In years 2 through 7, value is generated through the selected heifers own performance and that of their offspring (6), grand-offspring (up to 10), and great-grand-offspring (up to 3)*
- *Revenue in years 2 through 7 is discounted to year 1 to put on same time as when the investment is made (6% discount rate)*
- *Although not considered in the value calculations, in years 8 through 10 up to potentially16 grand-offspring descendants and 12 great-grand-offspring descendants are influenced by the original selected heifers' genes*

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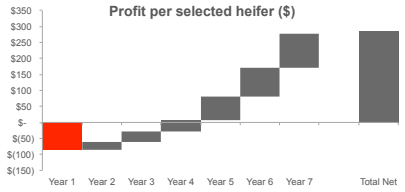
Value of testing

Discounted Lifetime Returns Generated from the Initial Genomic Testing Investment



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Value of testing

- *Break-even occurs between years 3 and 4*
- *Value created by future generations is about 1.5X that of tested females (demonstrates the value of this technology in subsequent generations)*
- *Enhanced production (beyond 6 calves lifetime) will further increase the value of tested heifers*
- *Under assumptions considered here, there is a potential of an additional ~$300 lifetime profit from selected females*
- *Genetic improvement is a long term investment!*

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Value of testing

- *Tested 500+ heifers in western US herd*
- *Advantage index ranged from 14 to 96, averaged 69 pts*
- *Top 20% average 87 pts, bottom 20% average 46 pts*
  - *39 pt difference @ $1.55/pt = $60 difference in potential per calf, $360 lifetime*
- *Top 20% average 87 pts, every other heifer average 68 pts*
  - *19 pt difference @ $1.55/pt = $29 difference in potential per calf, $174 lifetime*

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Value of testing

- *Tested 146 heifers in SD herd*
- *Top 100 based on visual appraisal average 56 pts*
- *Top 100 based on Advantage index average 65 pts*
  - *9 pt difference = $14 difference in potential per calf, $84 lifetime*

*** 68 heifers in common between the two groups, however 32 high index heifers omitted by visual selection and many heifers were included that were near the very bottom in terms of index!*

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Value of testing

- *Case Study from the University of Missouri, Dr. Jared Decker (http://www.cattlenetwork.com/advice-and-tips/genomics-case-study)*
- *Tested 80 U of M heifers in 2014*
- *Selected top 60% of heifers as replacements*
- *Dr. Decker estimates that one year of selection has added $12.56 more profit per heifer calf or $63 more profit lifetime*
- *Only assumed 5 calves lifetime and only considered own performance*
- ***At 6 calves lifetime this equates to $75, which is more than the $61 we estimate based on own performance only – doesn't consider any contribution from future generations***

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Value of testing

- *Relative to other herd investments*
  - *A $39 test cost is approximately $15 more than a recommended health protocol incurred for a heifer up to first calving, or 43% of a preventative health protocol through 6 calvings*
  - *Compared to genetic costs from natural service bulls (purchase price only)*
    - *$40 per calf for a $4000 bull*
    - *$70 per calf for a $7000 bull*

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Other value considerations

1) Sire match component – if sires have been HD-50K or i50K tested, sires can be matched to daughters from multi-sire pastures; manage inbreeding

2) Corrective mating – based on strengths/weaknesses of tested heifers, mating sires can be matched to improve areas needed; manage bull battery

3) Value added marketing programs – steer mates
   - Reputation Feeder cattle (http://reputationfeedercattle.com)
   - Top Dollar Angus (http://www.topdollarangus.com)

4) Value added marketing of heifers
   - Show-Me-Plus, Missouri (http://blog.steakgenomics.org/2016/02/genomic-roi-early-returns-suggest.html)

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Commercial Tests Available

Provider	Test	Target Population	Cost
Zoetis	GeneMax Advantage	≥ 75% Black Angus	$39
	GeneMax Focus	≥ 75% Black Angus	$17
	PredicGEN	Crossbred	$17
GeneSeek/ Igenity	Gold Profile	Crossbred/ straight-bred	$40
	Silver Profile	Crossbred/ straight-bred	$25
	Angus Gold Profile	≥ 75% Black Angus	$40
	Angus Sliver Profile	≥ 75% Black Angus	$25
	Maternal Edge Female Profile	Gelbvieh influenced females	$26
	Herd Navigator	≥ 75% Red Angus	$25
Method Genetics	Commercial	Crossbred/ Purebreds	$22
	Choice	Crossbred/ Purebreds	$32

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Summary

- *Affordable and cost-effective genomic tools are now available for commercial cattle producers*
- *These tools offer the opportunity to improve performance and profitability of selected females over and beyond traditional selection methods*
  - *Repro technologies, Dr Allan*
- *This technology also offers other advantages such as*
  - *managing inbreeding, corrective mating*
  - *value added marketing of tested heifers, steer mates and progeny of tested females*
- *Value to commercial producers is unique due to lack of routine genetic evaluations and EPDs*

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Thanks to

Dr Darrh Bullock
Dr Kent Andersen

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Thank You!

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