Commercial Heifer Selection Using Genomics

Written by Alison Van Eenennaam, UC Davis

Alison Van Eenennaam, PhD
Cooperative Extension Specialist
University of California
Department of Animal Science
One Shields Avenue Ph:(530) 752-7942
Davis, CA 95616 Fax:(530) 752-0175
Email: alvaneenennaam@ucdavis.edu
Website: http://animalscience.ucdavis.edu/animalbiotech

Traits that are of the most economic value to self-replacing herds are reproductive traits including age at first calving, reproductive success and replacement rate.[1] These maternal traits are sex-limited, lowly heritable, and some are expressed quite late in life. This has precluded replacement heifer selection on these traits, and frustrated genetic progress. In fact, the antagonism between terminal and some maternal and calving traits may have led to negative progress, as positive selection on the terminal traits can result in negative selection on the maternal traits. It has been suggested that US cow-calf producers should have a relative economic emphasis of 47% on reproduction, 24% on growth, and 30% on carcass traits[2].

Given the economic importance of reproduction, cow-calf producers raising their own replacement heifers should focus some of their selection emphasis on maternal traits. However, many commercial producers have no EPD information upon which to base their replacement heifer selection decisions, and DNA testing offers an appealing approach to provide previously-absent selection criteria. Theoretically, DNA tests are ideally suited for traits where there is no other tool available for selection. Ironically, research shows that DNA tests for low heritability traits will be the most difficult to develop. That is because a very large number of "training" records will be required to obtain accurate DNA tests for low heritability traits. Additionally, such tests will also be the most difficult to validate as there is a shortage of cattle populations with sufficient phenotypic data to estimate the accuracy of new genetic tests for those traits.

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 (r) or % of genetic variation (r^2) explained by the test, and the selection intensity (i.e. proportion of available heifers are selected). The latter is dependent upon the calving and replacement rates. 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 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), and I otherwise used the assumptions outlined in Van Eenennaam et al. (2011)[3]. I used a multiple-trait selection index developed for a self-replacing herd targeting a high-value feedlot market. The relative economic values of traits in the breeding objective are shown in Figure 1.

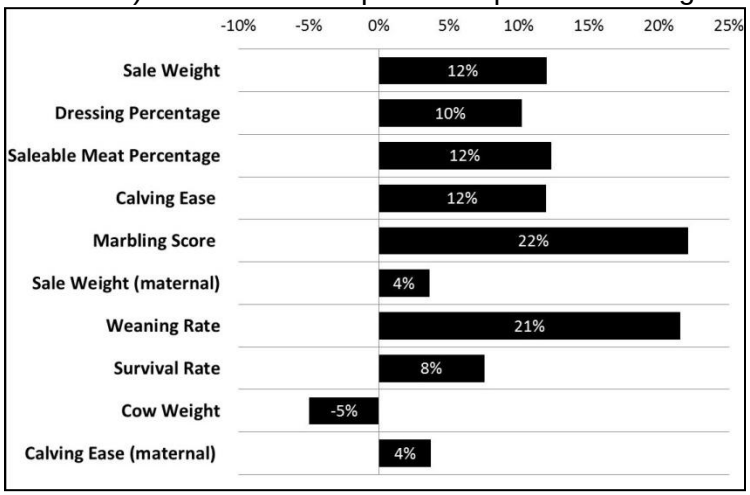

Figure 1. Relative importance (% relative economic value) of traits in the self-replacing herd breeding objective.

[1] Roughsedge, T., P. R. Amer, R. Thompson, and G. Simm. 2005. Development of a maternal breeding goal and tools to select for this goal in UK beef production. Animal Science 81: 221-232.

[2] Melton, B. E. 1995. Conception to consumption: The economics of genetic improvement. Proc. Beef Improvement Fed. 27th Ann. Mtg. p 40-87, Sheridan, WY.

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

The maternal trait with the highest relative economic value in that index was weaning rate (i.e. number of calves weaned). I then modeled hypothetical intermediate and high accuracy DNA tests trained on records from 1000 or 2500 animals, respectively. The breakeven cost of testing replacement heifers was $22.59 and $33.22 per test for the intermediate and high accuracy DNA test, respectively. Of this ~ 25% (< $10) of this value would be captured by the commercial producer, with the majority of the value being realized by the processing sector as a result of improvements in meat yield and quality. **The value of increasing the accuracy of commercial replacement heifer genetic evaluations is less than that for bulls since bulls produce more descendants from which to derive returns for accelerated genetic improvement.**

Several pieces of information are required to determine the value of using DNA tests to inform replacement heifer decisions. The first is the proportion of genetic variation explained (r^2) by the test for your selection criteria, and for the breed of cattle you are selecting. Independent estimates of this proportion are not available for all breeds and tests on the market. Some estimates are available for some traits in Angus cattle (Table 1).

Trait	h^2	IGENITY® Angus Profile		Pfizer HD 50K for Angus	
		Included	% Genetic variation (r^2)[4]	Included	% Genetic variation (r^2)[4,5]
Average Daily Gain	0.28	X		X	30[5]
Net/residual Feed Intake	0.50	X		X	12[5]
Dry matter intake	**0.40**	**X**	**20**	**X**	**42**
Tenderness	0.37	X		X	26[5]
Calving Ease (Direct)	**0.20**	**X**		**X**	**22[5]**
Birth weight	**0.42**	**X**	**32**	**X**	**26**
Weaning Weight	**0.20**	**X**	**20**	**X**	**27**
Yearling Weight	**0.20**	**X**	**12**	**X**	**41**
Yearling Height	0.45	X			
Calving ease (maternal)	0.12	X		X	40[5]
Milking Ability	**0.14**	**X**	**6**	**X**	**10**
Heifer Pregnancy	0.13	X			
Docility	**0.37**	**X**	**22**		
Mature Height	0.82	X			
Mature Weight	**0.55**	**X**			
Scrotal Circumference	**0.43**	♂			
Stayability	**0.10**	♀			
Carcass weight	**0.41**	**X**	**29**	**X**	**23**
Backfat thickness	**0.34**	**X**	**25**	**X**	**31**
Ribeye area	**0.33**	**X**	**34**	**X**	**36**
Marbling score	**0.45**	**X**	**42**	**X**	**32**
Percent choice	--	X			

Table 1. Percentage of genetic variation (r^2) associated with commercial DNA tests for targeted traits.
Bold traits are those that are currently being incorporated into the Angus genomic-enhanced EPDs.

To date, data suggest that tests trained and developed for use in one breed are unlikely to work well in a different breed, or in an admixed/crossbred population. Tests for maternal and reproductive traits will need to be developed for breeds other than Angus. 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. In the future it is envisioned that a single DNA test may be used for multiple purposes (e.g. parentage, identification of carriers of genetic defects, marker-assisted management) which may increase the overall value derived from DNA testing commercial heifers.

[4] Northcutt, S.L. (2011) Genomic Choices. American Angus Association®/Angus Genetics Inc. release. http://www.angus.org/AGI/GenomicChoice070811.pdf (posted July, 2011)

[5] Pfizer Animal Genetics. 2010. Technical Summary. https://animalhealth.pfizer.com/sites/pahweb/US/EN/PublishingImages/Genetics%20Assets/HD50K/50K%20Tech%20Summary%204-13-10.pdf. (posted April 2010)