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

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## Introduction

The use of genomic technology is revolutionizing beef cattle evaluation and selection. High density genotyping and integration into national cattle evaluations are further bending the genetic improvement curve. While up until now these advancements in technology have been primarily used in the seedstock industry, opportunities now exist for use in commercial beef herds. A fundamental decision facing commercial producers is selection of replacement females and as the U.S. beef herd rebuilds, it is important to select heifers with the highest genetic potential as brood cows.

Utilizing available genomic testing and the multiple-trait, economic based indexes that accompany these tests offer producers an opportunity to select heifers for optimum lifetime improvement at a very young age and affordable price. This approach may be used in conjunction with, or as a replacement for traditional selection methods based on visual appraisal, first born, heaviest at weaning or dams performance. As a result it allows for a more balanced and desired response across traits instead of the potential consequences of selection based predominantly on visual appraisal. It follows that understanding anticipated multi-trait response to selection and associated sources of value return are important for adoption of this technology by commercial cow-calf producers.

## Development of GeneMax Advantage

In 2014 in collaboration with Angus Genetics Inc. and Certified Angus Beef, Zoetis released GeneMax Advantage to the beef industry. Advantage is a genomic test that is applicable to beef females that are ≥ 75% Black Angus composition. Advantage was originally developed using over 39,000 Angus seedstock animals tested with HD50K molecular breeding values (MBV) that were a part of National Cattle Evaluation for registered Angus cattle conducted by the American Angus Association. This platform was used as the foundation for Advantage because it contains the most reliable genomic predictions for maternal, growth and carcass traits available for Angus cattle.

Table 1 shows the most recently estimated correlations between MBV and the respective phenotypic data from the latest Angus validation (American Angus Association and Angus Genetics Inc, 2016). These correlations range from .37 to .80, with the higher correlation indicating a stronger relationship between the molecular predictions and the phenotypic data. Explained variation, the proportion of additive genetic variability explained by the molecular predictions and calculated as the square of the correlation, ranges from .14 to .64 with an average of .44 across all evaluated traits. Approximate progeny equivalents (not shown) from these correlations range from 6 for carcass weight up to 23 for yearling weight.

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

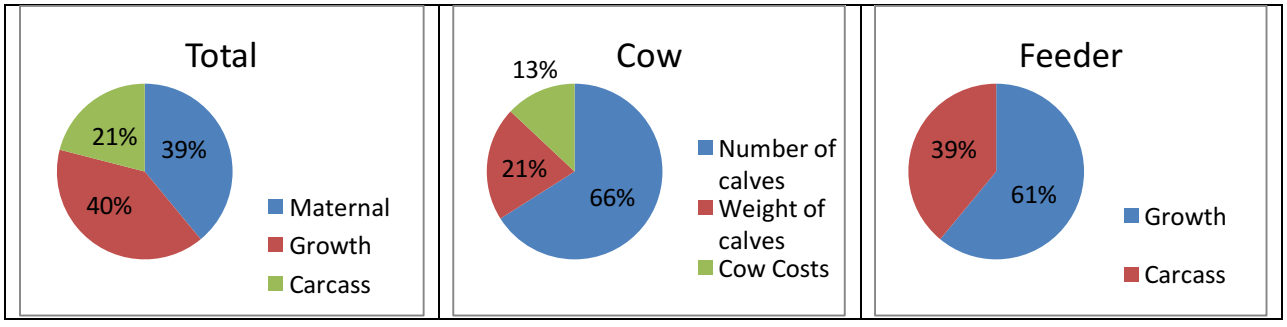
| Trait | Correlation | | Trait | Correlation | | Trait | Correlation |
|---|---|---|---|---|---|---|---|
| CED | .67 | | SC | .80 | | CWT | .60 |
| BW | .69 | | DOC | .68 | | MARB | .65 |
| WWT | .56 | | HP | .62 | | REA | .68 |
| YWT | .68 | | MILK | .37 | | FAT | .65 |
| DMI | .73 | | MWT | .74 |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

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

The foundation of Advantage are MBV for commercial heifers based upon a strategically developed assay and imputation to the Zoetis custom HD Illumina platform used for the registered Angus population. These MBV are predicted for thirteen traits and then consolidated into three bio-economic indexes that can be used for heifer selection, mating and marketing decisions. Advantage indexes were derived using simple selection index methodology and economic assumptions used by AGI in the economic ($) indexes available to both breeders and commercial cow-calf users of Angus genetics. Relative economic values for each trait were modeled by considering both costs and returns for each stage of production using deterministic modeling and all inputs in the economic modeling (costs and returns) are based on three-year rolling averages (American Angus Association, 2016; Beal, 1998; Beal, 1998b; CattleFax, 2014; Fox et al., 1988; McCorkle and Bevers, 2009; NRC, 2000).

The indexes offered with Advantage are Total - encompassing traits from conception to carcass, Cow - which includes traits associated with maternal and reproductive performance, and Feeder - which includes traits associated with post-weaning gain, efficiency and carcass attributes valued on a quality grade based grid. In addition to the three indexes, outlier reporting is also provided for four traits: marbling, tenderness, docility and cow cost. Relative trait weightings for the trait groupings are shown in Figure 1. Maternal traits included in the Total index include heifer pregnancy rate, calving ease maternal and mature size. Growth and intake traits include weaning and yearling weight and dry matter intake. Carcass related traits include carcass weight, ribeye area, fat, and marbling. As shown in Figure 1, the Total index is reasonably balanced across trait areas, whereas the Cow Advantage index places emphasis on maternal traits that impact number of calves, weaned calf weight and costs associated with milk and cow size. The Feeder Advantage index places roughly 60% emphasis on growth and feed intake and 40% on carcass traits.

**Figure 1. Relative contribution of trait categories for Advantage Total, Cow and Feeder indexes.**

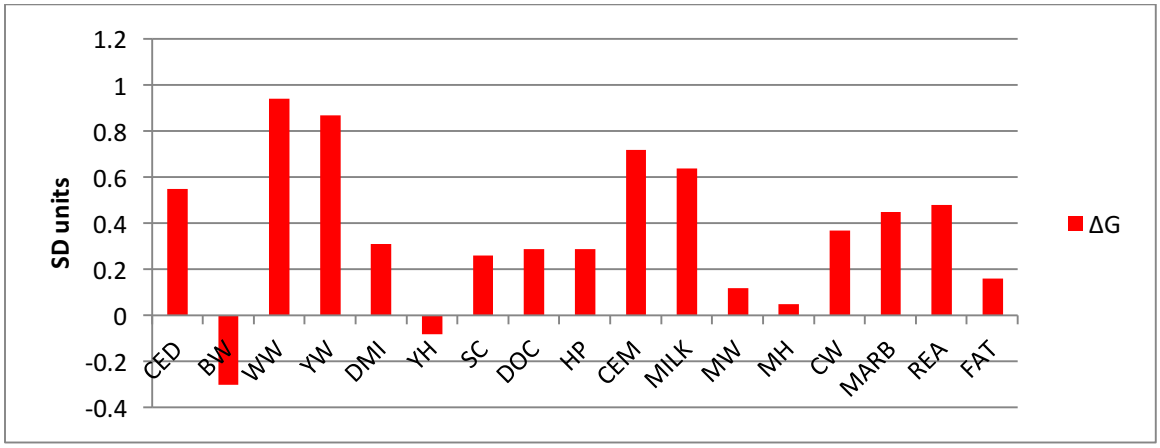


Annually, relative economic weights are re-estimated using updated economic costs and returns. Now that sufficient genotypes are available on commercial heifers, MBV are used from this population in the model to estimate relative economic values. These values are more indicative of the commercial population in which results will be utilized and tend to show less genetic variability than parameters from the registered genotyped animals. Once final index values are calculated on their underlying economic scale, they are transformed to a normally distributed 1 to 100 point score with 50 representing the mean of the tested commercial Angus heifer population.

**Potential Genetic Improvement**

Using genetic parameters estimated from 37,519 animals with genotypes prior to March, 2016, potential genetic improvement has been estimated for individual traits and overall economic value. Assumptions are that two-thirds of heifers of a given heifer-calf crop are genomically tested, that 45% of tested heifers are then selected as replacements based on the Total Advantage index, and for the purpose of estimating potential genetic improvement, that males (service sires) are HD-50K tested and selected using the same index and represent bulls from the top 25% of the seedstock population. Using these assumptions annual economic improvement of $7.26 is theoretically possible. Figure 2 shows potential genetic improvement from continual selection for Total Advantage index over a 5 year period. Using an index that is weighted according to economic value of the respective traits results in a small but balanced response in generally the desired direction for all traits considered.

**Figure 2. Potential standardized cumulative genetic change over a five year period of continual selection based on Total Advantage index.**



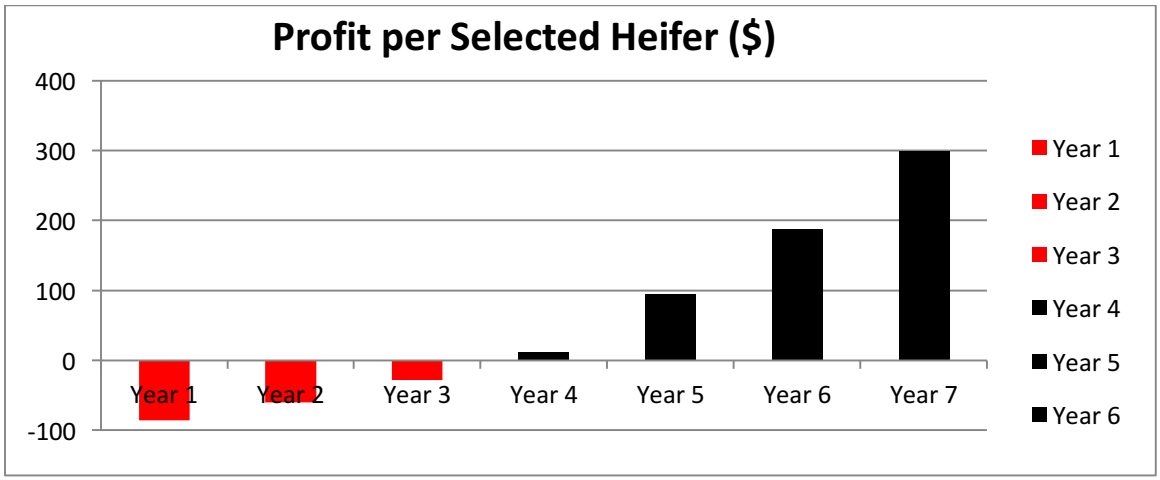

**Value of Genomic Testing**

As with any investment in a new practice or technology, producers have to consider the potential return on their investment. Cost has to be weighed against potential returns to assess whether or not to utilize the new technology. Major considerations for a cow-calf producer include deciding whether a genetic investment will impact the number of live calves per exposed female, increase the number and weight of weaned calves or reduce replacement rates by decreasing involuntary culling of cows. If improvements in output can be attained while either maintaining or reducing feed requirements, the net result should be beneficial.

Using similar assumptions to predicting possible rate of genetic gain, the value return to commercial cow-calf users of GeneMax Advantage technology for replacement heifer selection was estimated. Along with testing and selection rates described above, it was assumed that selected heifers produce 6 calves lifetime and testing cost is $39/head. Revenue is generated from selected females and their descendants (retained daughters' and their marketed progeny, as well as marketed steer and heifer progeny) and is discounted at a rate of 6% back to year one in which testing costs were incurred. The inclusion of descendants is important because a key component of genetic improvement is the transmission of favorable genes to an animal's offspring. Selection intensity in each generation of descendants was assumed to be equivalent to that of the original selected heifers.

In the first year, only testing costs are incurred from both selected and culled heifers and no revenue is generated. Beginning in year 2 and continuing through year 7, revenue is generated through the selected heifers' offspring (6), grand-offspring from daughters (up to 10) and great-grand-offspring from grand-daughters (up to 3). Figure 3 depicts annual cumulative returns to the original investment of genomically tested candidate heifers.

**Figure 3. Discounted lifetime returns generated from the initial genomic testing investment.**




In the scenario considered, break even occurs between years 3 and 4 in the original tested heifer's lifetime. Revenues increase considerably from years 4 through 7, where descendants also significantly contribute to total value and demonstrate the added value of this technology to future generations. Under assumptions considered here, there is a potential of approximately $300 additional lifetime profit per female from a more informed heifer selection decision.

To put this into perspective, a $39 test cost is approximately $15 more than what would be spent on a typical vaccination and deworming program on a replacement heifer up until her first calving and represents about 43% of what would be spent on her health protocol through six calving crops. Preventative health management is an integral part of minimizing risk and optimizing cow lifetime productivity and genomic testing provides an additional tool to identify replacement heifers with the highest potential lifetime productivity.

**Other Potential Uses of the Genomic Results**

Another practical feature of this technology is Sire Match where registered HD-50K and i50K tested bull batteries are specifically matched to daughters that originated from multi-sire pastures and or AI sires. This can then also be used to either manage inbreeding and associated

impacts on reproductive, fitness and survival traits as well as for corrective mating to optimally match the heifers and potential breeding sires' strengths and weaknesses.

In addition to using results to select and mate replacement heifers, there are other potential uses of genomic testing of commercial heifers. For example, where more heifers are tested than needed, excess heifers can be marketed to other producers as value added replacements. In the case of custom heifer growers, genomic tests and their accompanying index rankings may be used to price heifers accordingly. The Show Me Select program in Missouri is an example of where genomic information is being used to market replacement heifers at a premium compared to non-tested heifers (Decker, 2016).

Likewise when combined with bull battery GE-EPD information, the steer/herd mates and or progeny of tested and selected heifers and cows now possess more documented genetic merit for post-weaning feedlot gain, feed efficiency and carcass performance, and increasingly may be sold as value added feeder calves through programs such as Reputation Feeder Cattle and Top Dollar Angus (http://reputationfeedercattle.com; http://www.topdollarangus.com). These programs are conduits through which commercial cow-calf adopters of genomic technology can derive greater immediate returns from their investment in testing and begin to change traditional paradigms associated with feeder cattle price discovery.

**Summary**

Genomic testing is now becoming more widely available to the commercial beef industry to help make more informed decisions associated with the replacement heifer enterprise. While tests are available to more accurately identify heifers with highest genetic merit for maternal, feedlot performance and carcass characteristics at a very young age, it is important to understand the amount of genetic variation explained in the tested population and the sources of value return from the investment in testing. These sources of return include more informed selection and culling decisions, lifetime complimentary mating decisions (and associated bull/semen buying), as well as the more immediate impact of feeder cattle price discovery.

The technology presented here offers producers valuable information based on arguably the most accurate genomic predictions available to the beef industry for the target population of seventy-five percent and higher Black Angus replacement heifer candidates. Depending upon the producers' goals, different economic selection indexes more correctly identify replacement heifers to fit their production system and generate higher lifetime net returns. If these indexes are used on an ongoing basis along with intense sire selection, significant genetic improvement and expressed productivity can be achieved. Genetic improvement is a long-term investment and utilization of tools such as genomic selection can help mitigate risks and increase the opportunity for better performance and financial returns to commercial beef producers.

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