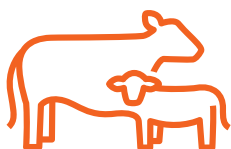


TECHNICAL BULLETIN

August 2016



GENEMAX[®] ADVANTAGE[™] IS DESIGNED FOR COMMERCIAL BEEF HERDS

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KEY POINTS

- GeneMax Advantage is a genomic test for commercial Angus replacement females that are 75% or greater Black Angus breed composition
- GeneMax Advantage delivers three economic index scores, genomic predictions for ten individual traits, customizable outlier reporting for three traits and Sire Match to HD 50K and i50K[™] tested Angus sires
- GeneMax Advantage was built, and is periodically updated from the foundation of Zoetis HD 50K and i50K used in Angus seedstock, and along with GE-EPDs for Angus bull buying is intended to provide commercial users of Angus with the most advanced genetic tools possible for making selection, breeding and marketing decisions
- Accumulative value return from selection based on Total Advantage Score has been estimated to be upwards of \$300 per retained female⁹.

INTRODUCTION

Selection of replacement females is one of the most challenging aspects of commercial cow-calf production, and replacement costs (heifers and bulls) typically rival annual feed costs as the two highest ranking categories of expense. Producers must decide whether a given heifer can be a productive and profitable cow before she has had an opportunity to express productivity associated with profitability, including fertility, calving ease, milking ability, growth and mature size. As if that were not difficult enough, the significance of this decision ultimately spans all phases of the beef production supply chain. In most situations, the average commercial cow has produced and weaned more than four calves before returning a profit. This makes it critical for producers to select and develop the right replacement heifers – and consistently mate them to complementary sires - to optimize revenues versus costs for enhanced profitability.

GeneMax Advantage extends the simplicity of the GeneMax brand to a more comprehensive suite of traits and features

GeneMax Advantage results complement other sources of information that may be used in commercial heifer selection, such as phenotypic evaluation, age, pedigree information and dam productivity. Genomic predictions included in GeneMax Advantage provide valuable insight into the genetic potential of young animals, particularly for traits that are otherwise difficult, time consuming or expensive to measure using traditional methods. Sources of value return from testing go beyond more profitable selection decisions, to also include more complementary lifetime A.I. and natural service breeding (semen and bull buying), as well as more informed price discovery for steer mates and future progeny.

PRODUCT DESCRIPTION

Zoetis, through collaborative partnerships with Angus Genetics Inc. (AGI) and Certified Angus Beef® (CAB), now offers GeneMax Advantage as the premier Angus heifer selection tool for commercial cattlemen. Designed for

use in high-percentage commercial Angus replacement females, GeneMax Advantage extends the simplicity of the GeneMax brand to a more comprehensive suite of traits and features.

GeneMax Advantage was developed from HD 50K and i50K for Angus Version 5 and more than 108,000 genotyped animals integrated into the American Angus Association® (AAA) National Cattle Evaluation (NCE) for registered Angus seedstock. This NCE is the standard for genomic enhanced expected progeny differences (GE-EPDs) and breeding information and provides high-accuracy predictions for maternal, growth and carcass traits, as well as economic indexes.

The efficacy of the HD 50K and i50K platform and calibration of marker effects from which GeneMax Advantage is derived can be characterized based on the correlations between genomic predictions and observed performance recorded in the AAA herd book (Table

TABLE 1: GE-EPDS POWERED BY HD 50K FOR ANGUS—EXPLAINED VARIATION AND APPROXIMATE PROGENY EQUIVALENTS¹

Trait	Correlation for GE-EPDs	Explained Variation (%)	Approximate Progeny Equivalents ^a
Calving Ease Direct	0.67	45	24
Birth Weight	0.69	48	13
Weaning Weight	0.56	31	19
Yearling Weight	0.68	46	24
Dry Matter Intake	0.73	53	17
Yearling Height	0.75	56	12
Scrotal Circumference	0.80	64	16
Docility	0.68	46	11
Heifer Pregnancy	0.62	38	22
Milk	0.37	14	14
Mature Weight	0.74	55	16
Carcass Weight	0.60	36	7
Marbling	0.65	42	8
Ribeye Area	0.68	46	11
Fat	0.65	42	12

^aApproximate progeny equivalents associated with accuracy of GE-EPDs powered by HD 50K and i50K based on verified pedigree and HD 50K and i50K information. Progeny equivalents for carcass traits are actual progeny carcass records—equates to ultrasound scans from approximately 30 progeny.

1). Higher correlations indicate more informative genomic predictions of future performance of tested animals. The percent of genetic variation explained by the underlying genomic prediction can be calculated by squaring the correlation. For example, the 0.67 correlation between genomic predictions for calving ease direct and observed calving ease scores indicates that about 45% of additive genetic variation is explained by the genomic predictions. It follows that for this trait, conventional genetic evaluation would require approximately 24 progeny with calving ease scores to achieve equivalent accuracy to that of GE-EPDs based on HD 50K and i50K predictions and verified pedigree information.

GENEMAX ADVANTAGE ECONOMIC INDEX SCORES

Selection indexes are a common and effective way to make selection decisions based on information for many traits, ensuring a balanced genetic improvement strategy. GeneMax Advantage translates the multi-trait genetic merit of tested heifers into three predictors of profit potential across production phases. Using

these indexes, producers are able to gain valuable information genetic merit for maternal, growth, efficiency and carcass traits.

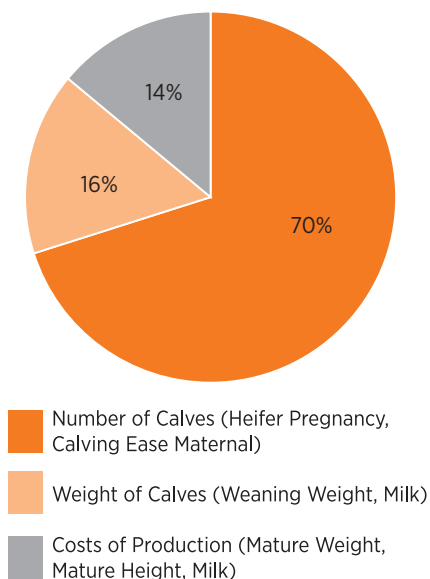
These economic scores were derived using classic selection index methodology.

The economic assumptions (i.e., input costs, output prices/value) were derived from various industry sources, are consistent with the assumptions used by AAA for dollar-value indexes, and generally represent the most recent three-year averages, where appropriate.²⁻⁸ The weights applied to trait predictions were calculated based on these economic inputs, and adjusted for their respective variances and genetic correlations. The resulting index values are transformed to a normally distributed 1 to 100 scale for easy ranking, interpretation and use in selection. Higher values represent more desirable merit and mean values are generally equal to a score of 50 as compared against a reference population of 37,519 commercial Angus females.

The three GeneMax Advantage economic indexes include the following:

GeneMax Advantage translates the multi-trait genetic merit of tested heifers into three predictors of profit potential

COW ADVANTAGE INDEX



- **Cow Advantage Index** – This index describes maternal genetic merit that contributes to differences in profitability from heifer development through the sale of weaned progeny. It includes reproductive traits related to heifer pregnancy and calving ease total maternal (includes birth weight), direct and maternal (milk) weaning weight, associated costs of production ascribed to mature cow size and milk production, as well as cull cow value.

- **Feeder Advantage Index** – This index describes genetics from dams that contribute to differences in performance of feeder calf progeny from weaning to CAB carcass. These values are driven by post-weaning growth, carcass weight and grade (USDA Quality and Yield Grades), and cost of production attributed to genetic differences in dry matter intake. Notably, this serves as a complement

Figure 1. Relative contributions of trait groupings to Cow Advantage index values

FEEDER ADVANTAGE INDEX

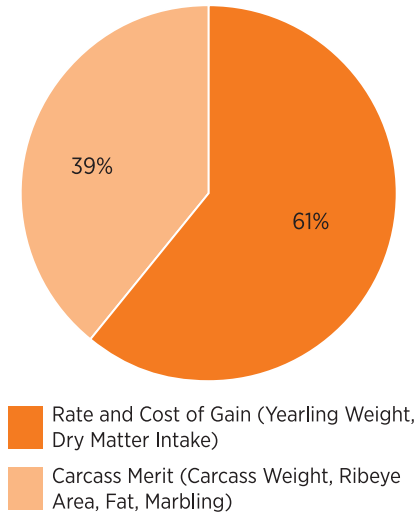


Figure 2. Relative contributions of trait groupings to Feeder Advantage index values

TOTAL ADVANTAGE INDEX

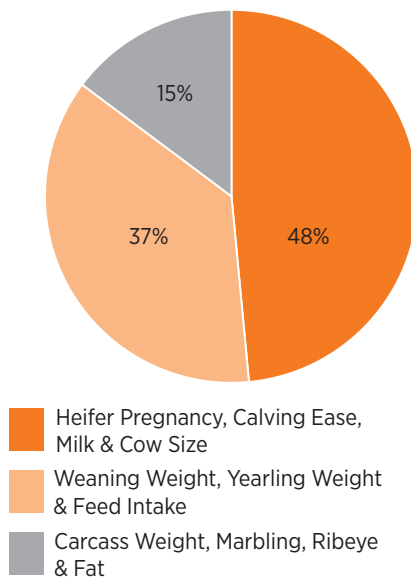


Figure 3. Relative contributions of trait groupings to Total Advantage Index values

to historic or parallel selection in herd mates using GeneMax® Focus™ which similarly emphasizes post-weaning gain and USDA Quality Grade (marbling).

- **Total Advantage Index** – This index describes differences in profitability from genetic merit of commercial females and merit transmitted to progeny across all economically relevant traits captured in the two component indexes.

The relative contributions of different trait groupings to each index are illustrated in Figures 1, 2 and 3.

ASSOCIATIONS BETWEEN GENEMAX ADVANTAGE INDEX SCORES, EXPECTED NET RETURNS AND IMPROVEMENTS IN INDIVIDUAL TRAITS

Females with higher Cow Advantage Scores are anticipated to produce more calves and financial return at weaning due to more desirable genetic merit, expressed through heifer pregnancy and calving ease, as well as growth, milk and cow size. Females with higher Feeder Advantage Scores are expected to produce feeder calves with greater post-weaning profit potential attributed to superior feedlot rate and cost of gain, increased carcass weight, and higher carcass Quality and Yield Grade premiums. Females with greater Total Advantage scores are expected to be more profitable over their lifetimes due to all evaluated facets of maternal, feedlot and carcass production efficiency.

Cow, Feeder and Total Advantage scores are driven by differences in underlying genetic merit expressed in net dollars for combinations of traits mentioned above, weighted according to economic impact. Ten (10) points of difference in Cow, Feeder and Total Advantage Score represent roughly \$10.90, \$7.70 and \$16.50 respective predicted difference in net return per calf for typical cow-calf operations. These economic benefits

GeneMax Advantage scores are driven by underlying genetic merit for combinations of traits, weighted according to economic impact

TABLE 2: CORRELATIONS BETWEEN GENEMAX ADVANTAGE INDEX SCORES AND MOLECULAR VALUE PREDICTIONS AS EVALUATED IN THE REFERENCE POPULATION OF COMMERCIAL ANGUS FEMALES (N=37,519)⁹

Trait	Total Advantage	Cow Advantage	Feeder Advantage
Calving Ease Direct, %	.42	.44	.26
Birth Weight, lb	-.23	-.33	-.04
Weaning Weight, lb	.74	.40	.83
Yearling Weight, lb	.68	.39	.91
Dry Matter Intake, %	.26	.20	.29
Yearling Height, in	-.02	-.10	.08
Scrotal Circumference, cm	.23	.18	.19
Docility, %	.24	.16	.26
Heifer Pregnancy, %	.48	.73	.04
Calving Ease Maternal, %	.56	.60	.33
Milk, lb	.54	.32	.48
Mature Weight, lb	.07	-.09	.28
Mature Height, in	.03	-.08	.19
Carcass Weight, lb	.34	.25	.41
Marbling, units	.34	.16	.44
Ribeye Area, sq in	.40	.34	.45
Fat, in	.12	.13	.06

from selection are largely applicable to each annual calf crop, and accumulate throughout the productive lives of selected females. The notable exceptions are economic values assigned to genetic merit for heifer pregnancy and maternal calving ease which have greater impact in the first calf crop. However, benefits in these traits and others are also realized from any future heifer calves retained out of genetically superior dams, and their respective progeny. Accumulative value return from selection based on Total Advantage Score has been estimated to be upwards to \$300 per retained female¹⁰. Additional sources of value return include more informed mating decisions (and associated bull buying), as well as from feeder cattle marketing programs that incorporate genetic information for price discovery.

When using indexes to simplify selection, it is useful to understand relationships between index values and predictions for individual traits. Correlations between GeneMax Advantage indexes and

underlying Molecular Value Predictions (MVP – genomic breeding values) are provided in table 2, and help breeders gauge the direction and magnitude of selection pressure and response in individual traits that is expected from selection using the corresponding index. For example, correlations between MVP for growth traits are high with Feeder Advantage Score, notably lower with Cow Advantage Score where heifer pregnancy and calving ease maternal are more important drivers, and intermediate with Total Advantage Score where simultaneous improvement across more traits is the objective. These correlations can also help to inform breeders where more or less selection and mating attention may need to be exercised using individual trait predictions.

GENEMAX ADVANTAGE INDIVIDUAL TRAIT SCORES

Genomic predictions for ten individual traits that are drivers of the Cow, Feeder and Total Advantage indexes are also

Females with higher Cow Advantage values are anticipated to produce more calves and financial return due to more desirable genetic merit

TABLE 3: GENEMAX ADVANTAGE TRAIT SCORES, INTERPRETATION AND UNDERLYING MVP PER TEN SCORE UNITS

Trait Score	Score Interpretation	MVP / 10 Trait Score Units
Calving Ease Maternal	Higher Score- Easier Calving	1.9% probability
Weaning Weight	Higher Score - Heavier	6 lbs.
Heifer Pregnancy	Higher Score - Higher Probability	1.4% probability
Milk	Higher Score - More Milk	3 lbs.
Mature Weight	Higher Score - Heavier	14 lbs.
Cow Advantage Score	Higher Score - More Profit	\$10.90
Gain	Higher Score - Higher Gain	5 lbs.
Carcass Weight	Higher Score - Heavier	5 lbs.
Marbling	Higher Score - More Marbling	.19 score units
Ribeye Area	Higher Score - Larger Ribeye	.13 in ²
Fat Thickness	Higher Score - Less Fat	-.01 in
Feeder Advantage Score	Higher Score - More Profit	\$7.70
Total Advantage Score	Higher Score - More Profit	\$16.60

reported as transformed normally distributed scores ranging from 1 to 100, where 50 represents average genetic merit as benchmarked against the reference population (n=37,519). Individual trait scores help explain specific sources of index value, and are intended for use along with indexes to help refine selection, mating and marketing decisions. Generally, higher scores mean more favorable underlying MVPs. Exceptions include scores for milk and mature weight, where intermediate scores likely represent more optimum levels of genetic merit and associated feed requirements for many operations. A guide to interpreting trait/index scores and the magnitude of MVP/\$ for every 10 score units is provided in table 3. As an example, if selected heifers have Total Advantage Scores that average 30 units higher than non-selected heifers, their predicted advantage in net return would be nearly \$50 per calf (3 X \$16.60 = \$49.80).

OUTLIERS IDENTIFIED IN SMART REPORTING

While GeneMax Advantage indexes quantify differences in profitability due to predicted multi-trait genetic merit,

additional traits may warrant special consideration and impact returns. This includes traits that are difficult to define as to their economic impact, and traits that may augment selection and mating for specific situations. To help producers readily identify potential outliers, customizable thresholds and reporting are available through secured AAA customer login. Customers may set the desired limits of ranking as benchmarked against the current reference population (n=37,519), and then view as well as generate PDF or Excel reports where animals with genetic merit that exceed thresholds are flagged for the following traits:

- **Cow Cost** – High cow maintenance and production feed costs associated with genetics for combined mature cow size and milk (default is most expensive 5%).
- **Docility** – Females with less desirable docility/temperament (default is most undesirable 5%).
- **Tenderness** – Least desirable for tenderness as determined by genomic predictions for Warner-Bratzler shear force (default is least desirable 5%).

AVAILABLE SIRE MATCH ENABLED WITH HD 50K AND 150K

GeneMax Advantage also matches registered, transferred Angus sires to

tested heifer progeny. This important feature allows producers with HD 50K and i50K-tested Angus bulls to proactively manage inbreeding when mating tested heifers, while still providing the flexibility of multi-sire breeding systems, and combined use of artificial insemination and natural service breeding. Inbreeding has generally been documented to adversely affect reproductive, survival and fitness traits. Ideally, customers are advised to designate candidate sires with their AAA registration numbers at time of order submission. Otherwise, in cases where candidate sires have not yet been HD 50K/ i50K tested, or if ownership has not yet been transferred at the time heifers are tested, Sire Match may be requested following initial delivery of GeneMax Advantage results.

USE OF GENEMAX ADVANTAGE IN BREEDING DECISIONS

GeneMax Advantage provides notable flexibility in replacement heifer selection and a wealth of information for mating and marketing decisions. While Total Advantage provides the most comprehensive assessment of an individual heifer's future contribution to supply chain profitability, there are specific instances where the other Advantage indexes and/or individual trait predictions may be more applicable. For example, in instances where environmental constraints or prolonged drought put a premium on

cow adaptability, use of Cow Advantage Scores coupled with heifer pregnancy and close attention to Cow Cost outliers will limit cow size and milk while emphasizing reproduction and the resulting number of calves produced for sale at weaning. Alternatively, for producers with less severe input constraints and the opportunity to benefit directly from feedlot and carcass performance or from special feeder cattle marketing programs, emphasis on Feeder Advantage will help optimize these traits for enhanced profitability.

GENEMAX ADVANTAGE IS DESIGNED FOR COMMERCIAL HERDS

GeneMax Advantage is a collaborative effort between Zoetis, AGI and CAB designed for use in high-percentage Angus commercial replacement females. As a general rule, this means progeny of HD 50K and i50K-tested, registered Angus bulls mated to half-blood or greater Angus cows (i.e., heifers that are 75% or greater Angus genetics). It is not intended for use in registered Angus females or bulls. The predictions obtained with GeneMax Advantage are not incorporated into the AAA NCE and will not influence the GE-EPDs of registered animals.

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