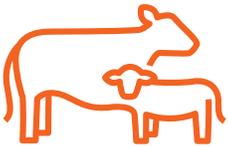


TECHNICAL BULLETIN

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PREDICGEN TECHNICAL SUMMARY

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KEY POINTS

- PredicGEN™ is a *Bos taurus* genomic heifer selection tool that provides accurate predictions of genetic merit for key carcass traits – marbling score, USDA yield grade and tenderness, as well as an index that predicts carcass grid value
- PredicGEN can be used to prioritize selection of replacements as well as differentiate the value of feeder calves on the basis of key outcomes defining carcass value
- PredicGEN can be used to support sire verification in progeny from qualifying PredicGEN and HD 50K-tested or PredicGEN and i50K™-tested bulls
- PredicGEN has been validated for use in a broad range of British and Continental breeds and their crosses
- PredicGEN, when used to select replacement heifers and breed them to superior, proven Angus sires resulted in carcass grid premiums above \$113/head, depending on market conditions¹

INTRODUCTION

Carcass quality and consumer satisfaction continue to drive the value of beef. The increase in grid marketing of fed cattle,² where value of a given animal is based in part upon the assigned USDA quality grade (QG) and yield grade (YG), clearly illustrates both the sensitivity of the market to these drivers as well as the willingness of the market to reward premium product. In addition, the number of USDA Certified Beef Programs that specify aspects of carcass quality and/or yield as criteria for enrollment also incentivizes and influences carcass outcomes.³

Given the economic incentives to produce higher quality and yielding beef carcasses, cattle producers stand to benefit from implementing genetic improvement strategies

that prioritize traits that drive QG and YG, and therefore carcass value—including marbling, ribeye area and backfat. Unfortunately, these traits can be difficult to select for in large part because they cannot be evaluated directly in live animals. Also, the time and cost associated with collecting progeny data delays the opportunity to exploit superior genetics. As an alternative, genomic technologies provide a mechanism by which genetic merit for these traits can be accurately estimated early in life.

Zoetis has developed a new genomic tool—PredicGEN™—designed to aid in the selection, mating and marketing of beef cattle for traits driving QG, YG, carcass value, as well as tenderness. PredicGEN is validated for use in British and Continental breeds and their crosses. This provides a great opportunity for producers leveraging crossbreeding programs to utilize a single tool to inform management decisions.

PREDICGEN DEVELOPMENT

PredicGEN was developed from a proprietary resource population of more than 10,000 animals with recorded carcass outcomes and Illumina® BovineSNP50 genotypes. All major British and Continental beef breeds were represented within the reference population. *Bos indicus*, Japanese and dairy breeds were not included in the reference population. The targeted phenotypes include:

- Marbling score
- Calculated YG as derived from hot carcass weight, ribeye area, percent kidney-pelvic-heart fat and backfat measurements

- Tenderness as determined by Warner-Bratzler shear force testing. Genomic predictions were derived from estimated marker effects using established methods. The available dataset was split into calibration (two thirds) and validation (one third) subsets. An optimized subset of markers from the Illumina BovineSNP50 was selected using the compound covariate predictor feature selection algorithm to identify those SNP markers associated with the strongest, independent effects on the targeted traits. Resulting marker effects for selected SNPs were estimated using Bayes C in GenSel.⁴

Internal validation demonstrated strong correlations with underlying phenotypes for all three traits; 0.45, 0.34 and 0.31 for marbling, YG and tenderness, respectively. Assuming a similar heritability for all three traits of approximately 35%, these correlations equate to explaining between one third and one half of the genetic variation.

EXTERNAL VALIDATION

PredicGEN has been subjected to more comprehensive external validation against production phenotypes than any other genomic product exclusively developed by Zoetis. It has been evaluated across a range of conditions in commercial feedyards to determine the accuracy of the genomic predictions and the stability of those predictions across environments.

FIGURE 1: MARBLING PREDICTIONS AND EXPRESSED PROBABILITY OF QUALITY GRADE*

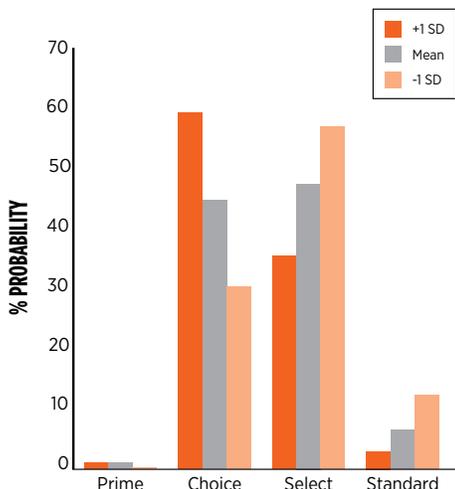
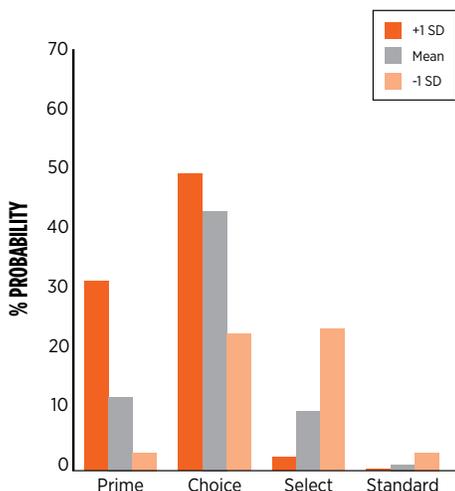


FIGURE 2: YIELD GRADE PREDICTIONS AND EXPRESSED PROBABILITY OF PERFORMANCE*



*Data for each graph derived from marginal probabilities from conditional logistics regression models evaluating the association between genomic predictions for (Figure 1) marbling score and observed USDA quality grade and (Figure 2) yield grade and observed USDA yield grade. Presented relative to mean MVP +/-1 standard deviation.

Commercial Validation of Predictions

The first trial was comprised of 2,500 crossbred steers in a commercial feedyard sampled at a terminal sort approximately 75 days prior to harvest.¹ The cattle were primarily calf feds (97%) on feed for 198 days, on average. Cattle were sourced from throughout the U.S. and included 51% black hides, 25% red, 12% gray, 6% white and 6% other. All cattle received a beta-agonist⁵ and were

implanted as per feedyard protocols. Carcass data was collected at harvest including marbling score, USDA QG and USDA YG.

The correlations between PredicGEN values and observed phenotypes were 0.39 and 0.43 for marbling score and YG, respectively. Using generalized linear effects models to account for clustering by pen, PredicGEN values were significant at the $P < 0.0001$ level in predicting marbling score, USDA QG and USDA YG. Cattle that possessed PredicGEN values for marbling one standard deviation above the mean were two times more likely to grade Choice or better than those one standard deviation below the mean. Cattle one standard deviation above the mean for YG had a 25% probability of being discounted as YG 4s and 5s, compared to a 9% and 2% probability on average (for YG 4s and 5s respectively) for cattle one standard deviation below the mean for yield grade.

Collectively, these results demonstrate that PredicGEN accurately estimates genetic potential for key carcass traits in a commercial setting.

The high correlations and strong associations illustrate how robust these predictions are, even in a very diverse group of calves.

Influence of Performance Technologies

An important consideration when managing for optimum carcass quality outcomes are the impacts associated with use of performance technologies. Specifically, the use of beta-agonists and growth promotion implants has been associated with decreased marbling score and USDA yield grade.^{6,7,8}

Therefore, it is important to understand the extent to which genomic predictors of carcass outcomes, and specifically the accuracy thereof, may be affected by the use of various combinations of performance technologies.

In this experiment, 1,100 crossbred steers were tested with PredicGEN™ and allocated to one of 5 groups based on predicted genetic merit for marbling and yield grade: 1) high marbling and high yield grade; 2) average marbling and average yield grade; 3) low marbling and low yield grade; 4) high marbling and low yield grade; and 5) low marbling and high yield grade.¹ Within each group, steers were randomly assigned to treatment groups in a 2x2 factorial design. Treatment 1 included ractopamine hydrochloride⁹ fed over the last 28 days of the feeding period vs. zilpaterol hydrochloride¹⁰ fed over the last 20 days of the feeding period with a 4-day withdrawal. Treatment 2 compared Synovex® Choice implant at allocation vs. Synovex Plus implant at allocation. Steers were fed between 97 and 123 days prior to harvest.

Data were analyzed using generalized linear mixed effects models to account for fixed effects of treatment, first-order interactions and clustering by assigned group. PredicGEN values were significantly associated ($P < 0.001$) with observed carcass outcomes, confirming the accuracy of these predictions. Importantly, significant interactions were not observed between PredicGEN values and either beta-agonist or implant treatments. This indicates that cattle with varying genetic merit for marbling and yield grade respond similarly to available performance technologies.

Practical Application

PredicGEN results are reported as easily interpreted scores from 0 to 100 where 50 is average. Higher scores are desirable for all traits. The grid merit index results are reported on the same scale and represent underlying economic index values for combined marbling and yield grade.

The implementation of PredicGEN in a commercial setting was demonstrated in a study conducted by Zoetis in collaboration with Gardiner Angus Ranch, Triangle H Grain and Cattle, and Tom Brink.¹

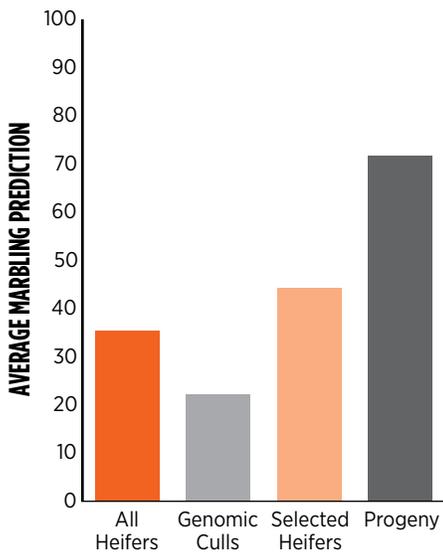
One hundred commercial heifers of primarily Continental breed composition were purchased from a single ranch in Texas. These heifers were tested with PredicGEN and evaluated based on their predicted genetic merit for marbling. Relative to the reference population and other commercial populations tested with PredicGEN, these heifers were considerably below average with respect to marbling potential.

PredicGEN marbling values were used to select the top two thirds of available females for breeding; the remainder of the cohort was fed and harvested. Those heifers selected for breeding were A.I. bred to two registered Angus bulls that ranked in the top 6% of the breed for calving ease and the top 1% of the breed for \$B. The resulting progeny were tested with PredicGEN and fed to harvest.

Figure 3 on the following page illustrates the increase in average PredicGEN value achieved by using the information to inform selection decisions, combined with the use of superior sire genetics for marbling. The PredicGEN score for the entire heifer cohort averaged 36

or approximately half of a standard deviation below the mean of the reference population for marbling. The heifers in the bottom one third averaged 22 or nearly 1.5 standard deviations below the mean, and those selected for breeding scored 44, approaching the average of the reference population. The resulting progeny averaged 72 or 1.3 standard deviations above the mean.

FIGURE 3: AVERAGE DNA MARBLING BY GROUP



The progeny expressed performance also matched the PredicGEN values. The cattle graded 95% Choice or better, including 6% Prime carcasses, and brought a grid premium of \$113.10 per head. This clearly illustrates that the use of genomic data, in combination with appropriate sire selection strategies, has the potential to create considerable value for cattle producers.

INTERPRETATION

PredicGEN values are designed for easy interpretation and use by commercial cattlemen. Genomic predictions are reported for marbling, YG and tenderness on a normally distributed 0 to 100 scale,

with an average of 50 and a standard deviation of 20. A value of 50 represents the average of the reference population with higher numbers most desirable for all traits. In addition, an index value is reported on a similar scale, representing the combined genetic score for marbling and yield assuming typical carcass premiums and a Choice-Select spread of \$8.00/cwt. PredicGEN results can thus be used to easily benchmark carcass trait genetic merit and expected relative grid value as compared to the extensive Zoetis crossbred reference population.

PredicGEN values can be used to support a variety of selection, breeding and management decisions. Application of results can be very straightforward. For example, when selecting replacement females, consider the following strategy:

1. Test eligible replacement candidates with PredicGEN 45 to 60 days prior to the anticipated time of selection.
2. Rank heifers based on the PredicGEN index to identify those with the highest predicted grid merit.
3. Generally select the heifers with the highest grid merit index values, choosing the correct number based on expected herd replacement rate. Special consideration should be given to heifers with extremely low values for any individual trait with respect to keep/cull decisions and corrective mating opportunities.
4. Assign matings to high marbling bulls for heifers that are weaker in marbling, and to high REA and/or low FAT bulls for heifers with weaker yield grade values.

PredicGEN is a heifer selection tool that enables producers to make more informed selection, mating, management and marketing decisions that improve carcass merit.

PredicGEN™ can also be used to inform sire assignment in the progeny of bulls tested with 50K or i50K™ through Zoetis.¹¹ The markers in PredicGEN are a subset of markers in both the HD 50K and i50K panels. The resulting markers provide sufficient exclusion power to be employed in either sire verification of recorded parentage, or sire assignment from defined multi-sire breeding schemes. This provides an added feature that can help producers effectively manage mating decisions (i.e., avoidance of inbreeding, selection of heifers from sires that are superior in maternal traits), assess bull performance and evaluate the number of progeny produced.

A final valuable element of implementing PredicGEN is use of the results to inform price discovery in feeder cattle. Cattle buyers recognize the differences in profitability associated with cattle that possess the potential to produce high value carcasses and those that do not. However, in most cases they do not have sufficient information to accurately identify those different types of cattle. PredicGEN can provide the insight that

buyers need when predicting break-even values and establishing feeder cattle prices. In addition, PredicGEN results may be used as part of existing branded feeder calf certification and marketing programs.

CONCLUSIONS

Carcass quality, yield and tenderness are extremely important in beef production. They help drive consumer satisfaction with beef and strongly influence profitability throughout the supply chain. PredicGEN provides valuable insight into key carcass attributes associated with carcass premiums, and enables better genetic management of antagonisms between marbling and yield grade in crossbred animals. This insight makes PredicGEN a powerful heifer selection tool, enabling producers to make informed selection, mating, management and marketing decisions to ensure that improved carcass merit remains a priority, and that those animals possessing superior genetics for these traits are valued accordingly.

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10. Zilmax, Merck, Kansas City, MO
11. Note that this does not apply to bulls tested with HD 50K or i50K™ through Angus Genetics, Inc.