IMPLEMENTATION AND DEPLOYMENT OF GENOMICALLY ENHANCED EPDS: CHALLENGES AND OPPORTUNITIES

Sally L. Northcutt

Angus Genetics Inc., American Angus Association

Genomic-enhanced Expected Progeny Differences (EPDs) are calculated on animals using the American Angus Association® (AAA) database along with the results from the IGENITY® Profile for Angus cattle to provide more thorough characterization of economically important traits and improved accuracy on young animals. Angus breeders have become accustomed to the rapid feedback of this new endeavor, and updated weekly carcass EPDs have become the norm, to provide timely selection tools beyond the classic interim EPD concept. Implementation by the Association has been rapid. Challenges seem unending since the technology continues to evolve, but opportunities for future genetic improvement likewise seem endless.

Implementation Overview

In October 2009, the AAA released National Cattle Evaluation (NCE) genomic-enhanced EPDs for carcass traits. Nearly two years of research collaboration between Angus Genetics Inc.® (AGI) and IGENITY has resulted in an IGENITY genomic profile, specific to Angus cattle. The AAA leadership, through AGI, has a vision to provide Angus breeders with the most advanced solutions to their genetic selection and management needs. AGI is a subsidiary of the AAA and is involved in the development and implementation of new technology for use by the beef industry.

The Association's weekly carcass EPDs are composed of the typical pieces one would expect in the NCE, but also include genomic results, or molecular breeding values, as available on animals. Molecular breeding values from IGENITY are derived from a High Density Whole Genome Scan with 50,000 markers (HD WGS). Every week, the full NCE for carcass traits is conducted for the most timely, up-to-date genetic predictions computed on nearly two million animals. Figure 1 illustrates how samples, animal identification, and genomic results move through channels to ultimately enter the American Angus Association NCE. Only the Angus-specific IGENITY profiles received through this data flow process are incorporated into the carcass EPDs.

Angus breeders submit the DNA sample directly to AGI, located within the parent company of the AAA in Saint Joseph, MO. The identity of the animal is recorded through the AGI system with a barcode. Through this process, the animal identity is known within the AAA records before the DNA sample is sent to IGENITY. An electronic file with this anonymous animal identification tracking and DNA samples are sent to IGENITY for genomic profiling. In three to four weeks, an electronic file of genomic results is returned to AGI for system upload and subsequent weekly carcass genetic evaluation.

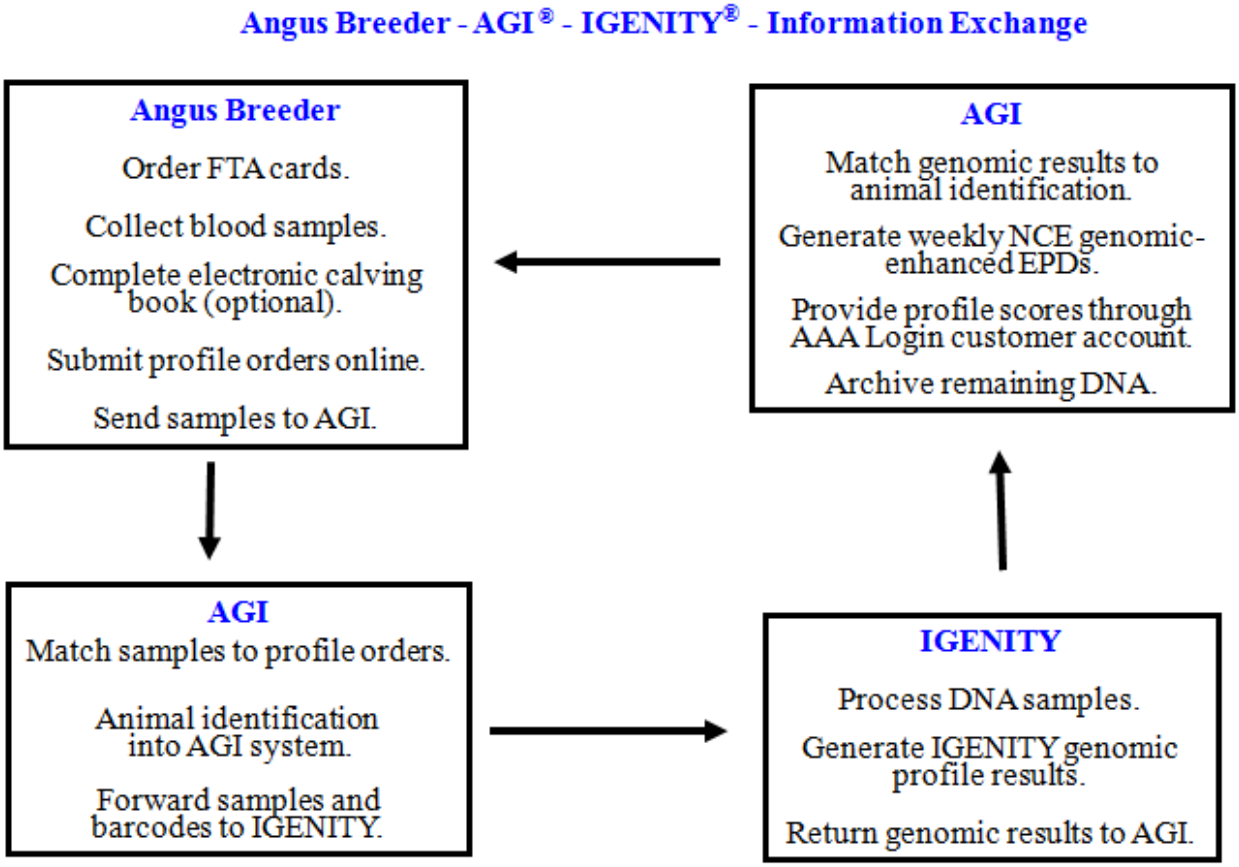

Figure 1. Information exchange between the breeder, AGI, and IGENITY

Carcass Evaluation Model

With the inclusion of genomic results, the carcass evaluation has an additional piece of information contributing to the genetic system. The weekly genetic predictions for carcass merit encompass carcass harvest records, ultrasound scans, and genomic results using methodology described in previous research (MacNeil and Northcutt, 2008; MacNeil et al., 2010a). The result of the integrated evaluation is a genomic-enhanced EPD for carcass weight, marbling score, ribeye area and fat thickness. The units of measure remain in carcass trait format, and ultrasound data and genomic results serve as indicator traits. Established genetic relationships between the indicator and carcass traits impact the EPDs and accuracy, with the genetic correlations between the molecular breeding values derived from HD WGS and the economically relevant carcass traits ranging from 0.50 to 0.65 (MacNeil et al., 2010b). In a weekly update, typically scheduled each Friday morning, the genomic-enhanced NCE EPDs are available at www.angus.org/Animal/EpdPedSearch.aspx.

Opportunities

Incorporation of genomic results into NCE procedures has opened the door to new opportunities in selection tools. By itself, the impact of weekly carcass evaluations has been sizable, providing breeders with rapid selection tool feedback beyond a traditional evaluation every six months. Key benefits of generating NCE genomic-enhanced carcass EPDs on a weekly basis include:

- NCE EPDs are the best genetic predictions for carcass traits, surpassing ratios, interim EPDs, and profile scores as selection tools.
- Pedigree-estimated interim EPDs for young nonparent animals are short-lived or bypassed to provide the more informative NCE EPDs each week.
- Carcass NCE EPDs are available on Angus cattle in a rapid timeframe.
- Ultrasound, carcass and genomic databases with a four-generation pedigree are used simultaneously each week.
- Carcass genomic profile results are incorporated into EPDs without a six-month wait for biannual evaluations.
- Ultrasound-scanned animals receive NCE EPDs within a week of the scan results being processed by the AAA, for a comprehensive prediction beyond what is available from interim EPDs.
- On calves with ultrasound or genomic profiles, dams that had no carcass EPDs in the past now receive weekly NCE EPDs without the time lag of a biannual evaluation.
- Calves with genomic profile results have calculated NCE EPDs using all data contributing to the comprehensive EPD system.
- The carcass bio-economic indexes are updated with the change of associated carcass trait EPDs.

A frequent question to a breed association is the 'equation' to calculate EPDs. Mixed model methodology to generate EPDs is not trivial, but can be referenced in the guidelines for the Beef Improvement Federation (Beef Improvement Federation, 2002). With efficient software routines and high-speed computers, the computational process to generate weekly carcass EPDs is straightforward. Weekly carcass evaluations with genomic results included in the analysis are part of the evolution to provide Angus breeders with rapid, accurate selection tools for genetic improvement.

Animal Accuracy Example

The beauty of using the genomic data as an indicator trait is that animals at a young age can have carcass trait EPDs prior to ultrasound scanning. As an example, for an Angus calf out of registered parents with no ultrasound scan record and no genomic profile, the EPDs are simply a parental average EPD, or interim EPD, with a default 0.05 accuracy level. If this calf of any age has a genomic result reported through AGI/AAA, the weekly carcass evaluation produces an

EPD with accuracies ranging from 0.28 to 0.38 depending on the carcass trait. Unlike the phenotypic data (carcass, ultrasound), the genomic result requires no contemporaries to enter the genetic evaluation. Thus, the genomic profile can be incorporated from animals of any age. If this calf is later scanned as a yearling and then accumulates progeny data later in life as a parent, each new piece of information is rolled into the weekly carcass evaluation.

For animals that already have an EPD in the carcass evaluation, the genomic results still have impact on the carcass traits. EPDs may move up, down, or stay the same, and the accuracies increase on animals in cases where there is not extensive data reported for the animal as a parent thus far. As another example, consider a dam with her own ultrasound scan record from a proper contemporary group and 11 scanned progeny. With the dam's own scan record and progeny information in the evaluation initially, the marbling EPD accuracy is 0.25. After her profile results are included in the weekly NCE carcass evaluation, her marbling EPD accuracy improves to 0.37.

Challenges

The opportunity to provide rapid, more accurate carcass EPDs to Angus breeders has been accompanied with some challenges. Each time the genomic panels are improved, the correlation between the molecular breeding value and the trait of interest must be re-estimated. With carcass traits this process has become more straightforward; however, time must still be allotted to implement any new improvements to the carcass evaluation model.

Also, animals may have existing molecular breeding values in the evaluation and then additional genomic profiles are subsequently purchased by other breeders. This results in the need for database storage and evaluation procedures to handle multiple molecular breeding values on a single animal.

Association databases must be flexible to receive varying amounts of genomic results on animals, track the source of such data pieces, and check for duplicate records as well. Breeder access to information relating to the timeframe for which samples are submitted, results received, and evaluation procedures conducted needs to be flexible. Much of this occurs through the breeder AAA Login website.

As the advances in characterizing Angus genetics with genomic technology continue to accelerate, Angus breeders are faced with sale catalog and print advertisement deadlines, and commercial bull buyer questions as to why EPDs change from one evaluation to the next. While the most current EPDs are available online and breeders are encouraged to use those tools for up-to-date information, the deadlines for printed material and the understanding of the new technology still generate demand for additional outreach from the AAA to its clientele.

Producer uptake and education is a critical challenge. Genomic values presented to breeders that are outside the realm of EPDs derived from NCE create confusion as to which selection tools are best for genetic improvement decisions. The Beef Improvement Federation commission on DNA markers released "Guidelines for Combining Molecular and Quantitative Approaches in Genetic Evaluation" in December 2008 (Tess, 2008) with the following statements regarding the reporting of DNA test results:

"It is important the DNA test results be reported to [the] beef industry in a consistent, understandable format. Further, the format should be compatible with NCE methods."

"BIF recommends that DNA test results be reported in the form of an EPD, in the units of the trait, on a continuous scale, and with a corresponding BIF accuracy."

"*Guiding Philosophy.* BIF believes that information from DNA tests only has value in selection when incorporated with all other available forms of performance information for economically important traits in NCE, and when communicated in the form of an EPD with a corresponding BIF accuracy. For some economically important traits, information other than DNA tests may not be available. Selection tools based on these tests should still be expressed as EPD within the normal parameters of NCE."

Associations will continue to be challenged to direct breeders to use NCE EPDs as the seamless route for genomic-enhanced selection. This will be particularly important as genomic results are available for traits in which phenotypes are more difficult to collect and quantify.

Literature Cited

Beef Improvement Federation. 2002. Guidelines for Uniform Beef Improvement Programs. (8th Ed.). Athens, GA.

MacNeil, M. D., and S. L. Northcutt. 2008. National cattle evaluation system for combined analysis of carcass characteristics and indicator traits recorded by using ultrasound in Angus cattle. J. Anim. Sci. 86:2518-2524.

MacNeil, M. D., J. D. Nkrumah, B. W. Woodward, and S. L. Northcutt. 2010a. Genetic evaluation of Angus cattle for carcass marbling using ultrasound and genomic indicators. J. Anim. Sci. 88: 517-522.

MacNeil, M. D., S. L. Northcutt, R. D. Schnabel, D. J. Garrick, B.W. Woodward and J. F. Taylor. 2010b. Genetic correlations between carcass traits and molecular breeding values in Angus cattle. Proc. 9th World Congr. Genet. Appl. Livest. Prod. (in press).

Tess, M. W. 2008. Guidelines for Combining Molecular and Quantitative Approaches in Genetic Evaluation. Proceedings of the 9th Genetic Prediction Workshop, Beef Improvement Federation. pp 76-82.