



Single-step Genetic Evaluation – Common Questions

Q: What is single step?

Single-step genetic evaluation is the method that will be implemented July 7, 2017, through AGI to calculate weekly Angus expected progeny differences (EPDs). Single-step methodology represents an evolution in the way AGI has calculated genomic-enhanced EPDs (GE-EPDs) since 2010, and offers the most advanced process available to generate genetic prediction tools. Single step will be capable of incorporating all genotype, pedigree, performance and progeny data simultaneously to derive GE-EPDs rather than requiring multiple steps, as in the current method.

The single-step process represents a more accurate, effective way to generate EPDs over time. It will provide breeders with the most current GE-EPDs with the most appropriate emphasis on all sources of information, each week. It's also the focus of an ongoing research effort that spans several years in collaboration with the professionals at the University of Georgia (UGA).

Q: How does single step differ from the current process of calculating EPDs?

In 2010, the American Angus Association and AGI began estimating GE-EPDs, selection tools that incorporated DNA-based information in addition to the performance, pedigree and progeny records already used in the evaluation. The genomic information has been incorporated using a two-step process that first involves using the genomic data to predict molecular breeding values, or MBVs. In the second step, MBVs are then incorporated as a correlated trait into the Association's genetic evaluation.

Calculating the MBV for the two-step process requires AGI and lab partners to conduct routine calibrations to train genomic equations using the population of genotyped animals available at a set point in time. The calibration step uses the genotyped animals as well as performance, pedigree and progeny information such as weights and carcass records to determine the MBV based on the genotype information. Since GE-EPDs were introduced, the Association has conducted five calibrations. The most recent occurred in April 2016 and included a population of more than 100,000 genotyped individuals.

In the single-step process, instead of using genotype information to calculate a preliminary MBV to be incorporated as a correlated trait into the Association's genetic evaluation, genomic data will be simultaneously inputted into the prediction equations with performance and pedigree information in one analysis. In other words, single step will leverage *all the information available* on an animal *each week*, thus eliminating periodic calibrations.

Q: What are the other benefits to single step?

A key difference between single-step genomic evaluation and two-step evaluation is how genetic relationships between animals are determined. With the traditional pedigree-based approach, the relationships between animals are determined by pedigree alone. Pedigree would dictate all full sibs, for example, would have a genetic relationship to one another of 0.50, and the relationship between grandparent and grandprogeny would be 0.25.

Understanding inheritance, however, we know variation exists in these relationships. For example, comparing the pedigree and genomic relationship between six flush-mates in the Association database, we see that the pedigree-based relationship between each of them is 0.59. We would expect the relationship to be 0.50, but it is slightly higher due to inbreeding in the extended Angus pedigree.

The pedigree relationship between each of these six animals is the same, but the genomic information identifies where there are differences that the pedigree alone cannot detect. The relationship amongst these six full-sibs varies from a low of 0.49 to a high of 0.65. Single step will allow AGI to utilize the genomic information to characterize the genetic relationships between animals and use this information to improve the accuracy of EPDs for both genotyped and non-genotyped animals.

Q: What changes will we see with the adoption of the single-step method?

With the move to single step, breeders will see some changes such as an initial re-ranking of sires and an eliminated need for recalibrations and training populations.

Initial movement: Single step is a new, more comprehensive way of incorporating data into the genetic evaluation. Because of this, an animal's EPDs have the potential to change after the initial incorporation of single step, similar to movement seen during the last five calibrations. Breeders can think of this as one last calibration that will affect animals across the entire population. After this, the genomic information will be used continuously, every week, to update GE-EPDs. Any change in these values will simply reflect the new information that has come into the evaluation. Keep in mind, this new method is an improvement over the current approach for predicting the effects genotypes have on performance.

Eliminating routine calibrations: Breeders will no longer have to anticipate routine calibrations because single step will incorporate genotypes continuously in the evaluation to better estimate relationships among individuals.

There will be no changes in the way DNA is collected, submitted or handled. This is simply a change in the way genomic results are incorporated into the evaluation.

Q: When will this take place?

The move to single step will take place July 7, 2017. The AGI and Association teams have collaborated closely with University of Georgia professionals, longtime partners in Association software and genetic evaluation platforms, to complete thorough development and testing prior to the release of EPDs using single-step methodology. As is the case for Angus genetic evaluation, the integrity of the data is a first and foremost consideration.

Q: Why now?

This has been an ongoing research effort for several years and was based on a thorough exploration of methodology and computational capabilities. Working alongside the research professionals at the University of Georgia, AGI and the American Angus Association are working to carry out Board direction to move to the single-step method.

This transition is the next evolutionary step in genetic evaluation, similar to the change witnessed by breeders when the Association moved from biannual genetic evaluations to weekly evaluations. Instead of waiting for the next biannual evaluation to incorporate data into the NCE, data were incorporated into the evaluation on a weekly basis. Therefore, EPDs moved in a more continuous manner each week; EPDs crept instead of jumped. Genomic results will now be incorporated continuously through single step rather than at key calibration periods, so a re-ranking of sires every time a calibration is released will no longer exist.

Q: How can AGI ensure single step is the preferred method for the Angus EPD base?

Extensive research has been done on single step by animal breeders and geneticists both nationally and internationally. This research supports a single-step method to incorporate genomic results into genetic evaluation as a more seamless approach with the potential to reduce biases unintentionally induced by training populations.

While changes will be experienced, much time and research has been utilized to move to single-step methodology. AGI, Association staff, board directors and third-party geneticists through UGA are confident that this transition offers the best approach for providing more-accurate, unbiased tools for measuring genetic merit. The two-step and single-step approach have been simultaneously conducted for several months as an internal measure to ensure the single-step methodology results in a more complete and current representation of GE-EPDs.

Q: How does this compare to genetic evaluations conducted for other breeds?

Most beef cattle institutions currently conduct a two-step approach. Smaller breed associations, including Brangus and Santa Gertrudis, have already moved to a single-step evaluation. Other meat animal industries, including pork and poultry, have already adopted single-step methodology to further genetic progress and maintain a foothold in the animal protein market. In addition, the dairy industry has moved toward single-step adoption.

Q: What will this mean for phenotypic data collected by breeders?

Phenotypic data will remain as important as ever. The basis of accurate cattle selection has always been based on accurate information. The development of genomic-enhanced selection tools has simply emphasized the need for accurate phenotypes. Just like the current two-step approach, the single-step method is also built off of accurate phenotypes.

Genomic technology will be updated weekly in our evaluation. If breeders are submitting phenotypic data on sires not closely related to the training population, this data will be leveraged with the genomic information weekly rather than having to wait on a routine calibration.

With the two-step approach, the calibration step determines a best “one size fits all” approach to predicting performance based on the genomic information. With single step the more closely related a breeder’s newly genotyped animals are to the database of genotypes and phenotypes, the more accurate the GE-EPDs will be. Those breeders who are doing the most phenotyping and genotyping will have the advantage of more accurate GE-EPDS for selection with single step. Breeders who rely solely on others to report phenotypic measures and utilize genomic testing to receive GE-EPDs will not see equal increases in accuracy.

Q: Where can I go for more information?

Additional information about single step will be available at www.angus.org or through Angus Media publications and programming. Breeders who would like to track changes are encouraged to create a custom report of the animals being tested to compare pre- and post-testing EPDs. They may also contact the Association at 816-383-5100.