

Sheep GEMS News Brief 3 – July 2024
Genomic selection: a new era in U.S. sheep breeding

Genomic information has been used in many livestock breeding programs for four primary applications: 1) parentage identification, 2) identification of carriers of genetic conditions, 3) evaluation of individual and populational genetic diversity, and 4) prediction of the genetic merit of selection candidates to be used for breeding. These applications show that genomic information has multiple uses key to implementing sustainable breeding programs. The U.S. sheep industry has recognized the added value of genomics and is moving to incorporate it into its genetic evaluations through the National Sheep Improvement Program (NSIP). In this first article on the topic of genomic selection, we will discuss the use of genomic information for the prediction of genomic breeding values.

The success of a breeding program relies on the timely and accurate identification of the breeding animals with the optimal genetic merit for the traits of interest. The selection of animals based on genomic information, i.e., genomic selection, requires the prediction of Genomic Enhanced Breeding Values (also known as GEBV). The prediction of GEBV corresponds to the use of thousands of genomic markers spread across the genome to calculate the genetic merit of individual animals for traits of interest, which can then be used for ranking animals and making selection and culling decisions. The most common genetic markers are known as SNP (Single Nucleotide Polymorphisms), which are variations at a single position in a DNA sequence among individuals. They are especially useful to evaluate traits measured later in the life of an animal (e.g., longevity), sex-limited (e.g., litter size), or difficult to assess (e.g., feed efficiency, meat quality). By having access to more accurate GEBV, sheep breeders can accelerate genetic progress for traits of interest by increasing selection intensity and accuracy of breeding values. Genomic selection is the process in which GEBV are used for selection of individuals to become the parents of the next generation.

The first step for the prediction of GEBV is the development of a reference population, which is a set of individuals that are genotyped and have pedigree and phenotypic records for the traits of interest. Typically, GEBV are more accurate than pedigree-based Estimated Breeding Values (EBV) with reference populations larger than 3,000 individuals. The next step is the calculation of GEBV for selection candidates based on the relationships between genotypes and phenotypes developed within the reference populations. More accurate GEBV are obtained for animals that are more related to those in the reference populations, for traits with higher heritability, and traits with larger number of records. The advantages of genomic predictions increase as the number of phenotypic records and genomic data increase (i.e., both data types are needed). Continuous collection of phenotypic and genomic data in flocks and animals that represent the whole breed will maximize the benefits of genomic selection over time. In addition to enabling faster genetic progress,

genomic information can also be used for more accurate assessment of inbreeding levels and relatedness among animals, which is also important for mating decisions aiming to reduce inbreeding rate and maintaining genetic diversity in U.S. sheep populations.

Key challenges for the implementation of genomic selection include the limited availability of phenotypic records for various important traits of interest, especially those indicative of disease resistance, longevity, climatic resilience, meat quality, and feed efficiency. Secondly, the cost of genotyping is still a constraint. However, genotyping prices are decreasing over time, and initiatives such as the Sheep GEMS project contribute to the development of reference populations for the main U.S. sheep breeds. In summary, the use of GEBV has been very successful in many livestock industries around the world. The U.S. sheep industry is also making progress in the same direction, including the recent availability of GEBV for Katahdin sheep, which will be highlighted in the second part of this article.

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