SHEEP IQ

Increasing Your Lamb Crop Series

Genetic Selection and Prolificacy

National Sheep Improvement Program (NSIP) and Genetic Selection Tools in Sheep Production

WHAT IS NSIP?

The National Sheep Improvement Program (NSIP) is a performance-based genetic evaluation system used in the U.S. sheep industry. It provides estimated breeding values (EBVs) for various traits, including prolificacy (the number of lambs born per ewe lambing). These EBVs are calculated using performance and pedigree records of lambs, allowing producers to identify animals with superior genetic merit for traits important to flock productivity.

WHY USE GENETIC SELECTION TOOLS?

- **Increased Productivity:** Selecting for prolific genetics (i.e., animals that consistently produce more lambs) is one of the most effective strategies for improving reproductive efficiency and profitability in sheep production.
- **Objective Selection:** EBVs help separate genetic factors from environmental influences, making selection decisions more accurate than simply choosing animals based on observed performance (like picking only twins).
- **Cumulative Gains:** Even modest annual genetic improvements accumulate over time, resulting in substantial increases in flock productivity.

HOW ARE GENETIC SELECTION TOOLS USED?

- **EBVs (Estimated Breeding Values):** Producers use EBVs to select breeding stock (especially rams) with superior genetics for economically important traits. This can be done by purchasing animals from NSIP-participating flocks or by selecting within their own flock using NSIP data.
- **Pedigree and Performance Records:** Maintaining detailed records allows for more accurate separation of genetic and environmental effects, improving the reliability of selection decisions.
- **Genomic Selection:** Incorporating genomic data (GEBVs) further increases the accuracy of selection, especially for reproductive traits that are lowly heritable and expressed in only one sex (ewes). Genomic selection enables earlier and more reliable identification of superior breeding animals.

PRACTICAL CONSIDERATIONS

- **Ram Selection:** Most genetic improvement comes through ram selection, as rams sire many more offspring than ewes annually. However, since prolificacy is expressed in ewes, pedigree and performance records are essential for identifying superior rams.
- **Balancing Traits:** While increasing prolificacy, it's important to monitor other traits (like parasite resistance) that may be genetically antagonistic to high reproductive rates.
- **Optimizing, Not Maximizing:** There is an optimal level of prolificacy for each flock and production system. More is not always better—triplets, for example, may have lower survival rates. Accurate record keeping and use of EBVs help determine the optimal prolificacy rate.

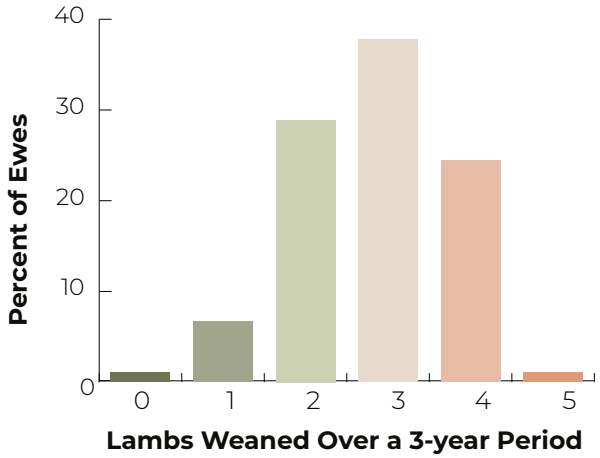
PROLIFICACY AND FLOCK GROWTH

Increasing prolificacy is one of the most effective strategies for improving reproductive efficiency and profitability. Prolificacy is the number of lambs born per ewe lambing. Spreading the ewe's cost across more lambs increases profit. Prolificacy is generally measured in percentages. A 140% lamb crop means that 100 ewes produced 140 lambs. However, in a selection program to increase prolificacy, it should be measured individually by counting the number of lambs born per ewe per lambing, also known as littler size.

There are ewes that can raise twins, even in challenging environments. Figure 1 shows the distribution of number of lambs weaned per ewe from ages 2 through 4 in a pasture lambing research flock with an average lamb crop of 140% born and 120% weaned. The most productive 25% of the ewes weaned 4 or more lambs over the 3-year period, while the least productive

37% weaned 2 or fewer lambs. Selection for greater prolificacy can lead to an increase in lamb production over the current average in a given environment. The aim of selection is to have a flock that has more ewes in the top end of the distribution. Therefore, to increase the flock average prolificacy, you should cull the least prolific ewes.

Figure 1. Distribution of number of lambs weaned per ewe from 3 lambings.



GENETICS AND ENVIRONMENT

Prolificacy is affected by genetics, and environment and the interaction genetics X environment. Effective selection for prolificacy is challenging because the number of lambs produced can only be observed in breeding-age ewes and is affected by a combination of genetic and non-genetic factors. Some of the non-genetic, or environmental, factors are nutrition, age, season of year and health. Effective selection must separate the genetic and environmental factors.

Breeders who want to improve prolificacy, but do not have comprehensive records, have practiced a selection method of choosing replacements born as twins. Because of the environmental factors that affect prolificacy, selecting twins is less accurate at identifying genetic merit than a method which takes environmental conditions into account. Therefore, progress from selecting only replacements born as twins is limited.

Fertility characteristics such as litter size and ovulation rate have low heritability (0.06-0.13), which indicates strong environmental influence. The application of molecular genetic markers in breeding programs is the basis for the future improvement in reproductive control in sheep and to enhance the prolificacy of ewes.

USING ESTIMATED BREEDING VALUES (EBV)

The U.S. lamb crop increased by only .04 % per year from 1966 to 2015 (USDA National Ag Statistics Service). In contrast, the genetic trend among Targhee flocks using National Sheep Improvement Program's (NSIP) estimated breeding values (EBVs) was .7% per year from 2006 to 2015. Even greater rates of progress are possible when more emphasis is placed on increasing prolificacy by selection. Even though .7% per year may seem small, when selection is practiced over several years, the gains accumulate. The cumulative increase can make a substantial difference in flock production. The use of EBVs gives flock owners the opportunity to identify genetic merit by using performance and pedigree records.

Selection for prolific genetics in a flock can be accomplished by obtaining breeding stock (such as rams) from flocks with superior genetic merit for prolificacy, or a producer can select from within his own flock. Ideally, producers will utilize both strategies to make significant improvement in a short period of time.

The use of a complete EBV profile for multiple production traits provides further benefit when it comes to genetic correlations. While increasing prolificacy, breeders should also pay attention to traits that may be genetically antagonistic to high reproductive rates, such as fecal egg count (parasite resistance).

PEDIGREE RECORDS

Most genetic improvement in a flock comes through ram selection, because a ram can produce several times as many offspring as a ewe will produce in her lifetime. However, prolificacy is only observed as a trait of the ewes. Therefore, pedigree records are essential to identify genetic superiority for prolificacy for potential breeding rams. If a management system does not maintain pedigree records, selection for increased prolificacy will be limited. Selection for prolificacy in this instance can be accomplished by obtaining breeding rams from breeders who use NSIP for calculating breeding values. Using rams that are genetically superior for prolificacy will increase the flock's prolificacy when their daughters make up a larger share of the flock.

If pedigree records are maintained for the flock, selecting for prolificacy from within this flock can be effective. Because there are several environmental factors that affect the number of lambs a ewe produces, estimating genetic merit for prolificacy involves a

process to separate genetic merit from environmental factors. Combining multiple years of lambing records and pedigree records allows for the separation of environmental effects from genetic effects. The genetic merit of young rams can be predicted from the performance of all his female relatives that have records. The complex calculations result in the best prediction of each animal's genetic merit. NSIP has a system in place to calculate genetic merit for prolificacy. Such calculations are better predictors of genetic merit than merely knowing if a ram was born as a twin or a single.

Genomics has been successfully incorporated in sheep breeding programs. Traits that are lowly heritable and expressed in one sex, such as prolificacy, can benefit most from genomic evaluation. Genomic enhanced estimated breeding values (GEBVs) are more accurate and allow younger animals to be selected more reliably. The GEBVs for sheep prolificacy have the potential to significantly improve sheep breeding programs, leading to faster genetic progress and increased flock productivity.

SELECTING OR PURCHASING STOCK

Determining whether to buy superior breeding stock, or select from within a home flock, depends on several factors, including:

- The ability to identify genetic superiority in young males
- The availability of genetically superior males with suitable genetic merit for economically important traits
- The potential for selling breeding stock

Producers may prefer to select breeding stock from within their own flocks when their sheep have desirable performance for other important traits and prolific genetics may not be available to purchase from other breeders. Selection within a flock leads to genetic improvements that accumulate and are passed on to the next generations.

Selection within a population does not produce an abrupt change. Therefore, management can evolve as the prolificacy increases. An abrupt change in prolificacy frequently requires an abrupt change in management.

Prolificacy can also be increased via crossbreeding and managing environmental factors, such as increased nutrition or treatment with hormones. Each of these factors requires continued inputs.

OPTIMIZING VS. MAXIMIZING

When increasing prolificacy through genetic selection, it is important to recognize that at some threshold, more is not always better. Especially in extensive or semi-extensive operations, triplet lambs have a lower survival rate and are generally lighter weight. Determining the optimal prolificacy rate can be accomplished by accurately measuring death loss and pounds-of-lambs weaned. When increasing number of lambs born does not further result in an increase in pounds of lamb weaned, then the optimal prolificacy rate for the flock has been exceeded. This is all best accomplished with accurate record keeping and the use of EBVs that separate out environmental factors.

KEY POINTS FOR INTERPRETING EBVS

- **Higher EBVs = Greater Genetic Merit:** For traits like prolificacy, animals with higher EBVs are genetically more likely to produce more lambs per lambing. Selecting rams and ewes with higher EBVs for prolificacy will increase the average lamb crop in your flock over time.
- **Multiple Traits:** EBVs are available for several traits. When selecting breeding stock, consider the full EBV profile. For example, while increasing prolificacy, also pay attention to EBVs for parasite resistance or growth rate, as some traits may be genetically antagonistic.
- **Obtain EBV Data:** Use NSIP reports or flock records to access EBVs for your animals.
- **Identify Top Animals:** Select rams and ewes with the highest EBVs for the traits you wish to improve (e.g., prolificacy).
- **Balance Traits:** Avoid selecting solely for one trait; consider the overall EBV profile to maintain health and productivity.
- **Track Progress:** Monitor flock performance over time to ensure that genetic gains are translating into improved productivity.

SUMMARY

EBVs are powerful tools for genetic selection in sheep. By understanding and applying EBVs, producers can make objective, data-driven decisions that lead to sustained improvements in flock productivity and profitability. For more information visit https://nsip.org/nsip-resources-2/estimated-breeding-values/

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