

SHEEP GENETICS AND SELECTION



BASICS

OVERVIEW

- There are genetic correlations between many of the production characters in sheep.
- Genetic correlations occur when selecting for a particular character in a ram or ewe results in changes in other characteristics in the progeny.
- Genetic correlations may be positive or negative.
- Correlations may produce desirable or undesirable changes, so they must be considered in any selection program.
- Heritability estimates how much of the superiority of the parents is, on average, passed on to their progeny.
- Genetic gain depends on how high the heritability is for a character.
- Many production characters in sheep have medium to high heritability and will respond to selection.

SHEEP BREEDS

- There are at least 47 recognized breeds of sheep in the U.S., and many more than that worldwide.
- Each breed has strengths and weaknesses, and the producer's choice of breed or breed combination should be matched to the goals of the sheep enterprise (e.g., meat/carcass quality, fine wool, milk production, reproductive efficiency, show lambs, colored fleece, etc.).
- Breeds should also be chosen based on their adaptability to the environment of the operation, their mature size, and the availability of quality breeding stock in the region.

BREEDING CONCEPTS

- Selection is the process that increases the frequency of desirable genes, which leads to genetic improvement within a flock.
- General-purpose breeds have a balance of meat, wool, and/or adaptability traits.
- The producer must decide which trait(s) are important to the specific sheep enterprise, and have some method to measure the trait(s). They can then compare the sheep in their flock and select those that are superior in terms of the desired trait(s) to be the parents of the next generation.
- Measuring traits and comparing animals requires an identification and record keeping system.
- The most common method of individual sheep identification is ear tags. Pre-numbered tags are commercially available, or blank tags can be purchased for the producer to apply their own numbering system. The producer should develop a system that works for their flock, which can range from simple to complex.

- Numbering systems commonly include a code for the order in which the lamb was born, and the year in which the lamb was born (e.g., 1601, or 16-1, might signify the first lamb born in the flock in the year 2016).
- Breed associations can assign registration numbers to individual sheep within purebred, registered flocks. Many breed associations will also help provide genetic evaluation information on your sheep.
- Ear tattoos are a permanent method of sheep identification but may not be as convenient to read as ear tags. Paint brands are commonly used for short-term identification until an ear tag or tattoo can be applied.
- It is necessary to develop a record keeping system to make accurate selection decisions. Production records can be used in combination with visual evaluation to make selection decisions.
- Record keeping systems commonly start with the birth of the lamb. Lamb ID, birth date, birth type (single, twin, triplet), sire, and dam are recorded along with other information critical to the sheep enterprise (other items that may be found in production records include birth weight, weaning weight, postweaning weight, average daily gain, medication records, fleece traits, information on difficult births, comments about the dam's disposition or mothering ability, comments about the lamb's physical appearance, and more).
- The National Sheep Improvement Program (NSIP) offers producers a genetic evaluation tool to provide Estimated Breeding Values (EBVs) for growth, carcass, fleece and other traits.

SELECTION AND HERITABILITY

- To understand selection, some basic genetic concepts that need to be understood. The phenotype (physical appearance) of a sheep is the result of the interaction of two factors, genotype (genetics) and environment (climate, health, feeding, and management system).
- Sires and dams cannot pass "environment" on to their offspring, but they do pass on their genes. To make improvements, effects of genotype must be separated from effects of environment, to select those individuals that are genetically superior.
- Performance records help to compare the traits of lambs of similar breed, age, sex, birth type, and management system.
- NSIP measures the genetic value of individual sheep in flocks.

Table 1 Traits of various sheep breeds

Breed	Known for	Wool type	Hardiness ^a	Mature size ^b	Growth rate ^a	Prolificacy ^a	Breeding season ^c	Availability ^d
Border Leicester	Long wool	Long	M	L	M	M	S	U
Cheviot	Meat	Medium	M	S	L	M	S	U
Columbia	General purpose	Medium	M	L	H	M	M	C
Coopworth	General purpose	Long	M	M	M	M	S	U
Corriedale	General purpose	Medium	M	M	M	M	M	U
Dorper	Meat	Hair	H	M	H	M	L	R
Dorset	Out of season breeding	Medium	M	M	M	M	L	C
East Friesian	Dairy	Medium	L	L	H	H	S	R
Finnsheep	Litter size	Medium	L	S	L	H	L	U
Hampshire	Meat	Medium	M	L	H	M	M	C

Katahdin	Hair	Hair	M	M	M	M	L	R
Montadale	General purpose	Medium	M	L	M	M	M	U
Oxford	Meat	Medium	M	L	H	M	S	U
Polypay	Litter Size	Medium	M	M	M	H	L	U
Rambouillet	Wool Quality	Fine	H	L	M	M	L	C
Rideau Arcott	Dairy	Medium	M	M	M	H	L	R
Romanov	Litter size	Colored	H	S	L	H	L	R
Romney	Long wool	Long	M	M	M	L	S	U
Shropshire	Meat	Medium	M	L	M	M	M	U
Southdown	Meat	Medium	M	M	L	M	M	C
Suffolk	Meat/growth	Medium	L	L	H	M	M	C
Targhee	Wool quality	Medium/fine	M	L	M	M	L	U
Texel	Meat	Medium	M	M	M	M	M	R

Note: Information in this table adapted from the SID Sheep Production Handbook.

^a Hardiness, growth rate, and prolificacy (litter size) are rated: high, medium, and low.

^b Mature size is rated: small, medium, and large.

^c Breeding season is rated: short, medium, and long.

^d Availability is rated: common, uncommon, and rare.

- Heritability is defined as the portion of variation due to genetics.
- Growth, carcass, and fleece traits tend to be moderately or highly heritable, so significant progress through selection is possible.
- Most reproductive traits are low in heritability, which means it is much more difficult to make genetic progress by selecting for these traits. Traits that are low in heritability can be improved more by changing the management system (i.e., reproductive traits can be improved more by altering feeding and health programs than through genetic selection).
- Steps for developing a successful selection program
 1. Determine the goals for the sheep enterprise.
 2. Select a breed or breeds that are suited for these goals.
 3. Determine which traits are most important for meeting the defined goals.
 4. Identify and keep records on all sheep.
 5. Evaluate the ewe flock based on the important traits to determine where improvement is needed.
 6. Choose rams that are superior in the traits in which the ewe flock needs improvement.
 7. Select replacement ewes that are above the flock average for the important traits.

TRAIT SELECTION

- The fewer traits selected for, the more rapid the progress that can be made. Because rams have a much greater influence on the genetics of each lamb crop, it is critical to place the heaviest selection emphasis on rams.
- The rams and ewes in a flock each contribute 50% of the genetics of the next generation; however, since there are often many more ewes in a flock than rams, the genetic influence of each individual ram is far greater than that of each individual ewe.
- Growth, carcass, and fleece traits tend to be moderately or highly heritable, so significant progress through selection is possible.

MATING SYSTEMS

- Purebreeding is the mating of rams of a particular breed to ewes of the same breed.
- Breeders of registered sheep must use a purebreeding system. Sheep producers who sell breeding stock (especially rams) to other producers generally use a purebreeding system. Some commercial producers use a purebreeding system in cases where a particular breed is best suited to their management system and environment.
- There are two basic types of purebreeding systems: outbreeding (the mating of individuals less closely related than the average of the breed) and inbreeding (the mating of individuals more closely related than the average of the breed).
- Most purebred producers utilize outbreeding; however, inbreeding can be a useful tool to detect the presence of genetic recessive defects in certain bloodlines. The elite seedstock producers also use inbreeding because they may not be able to find unrelated rams that are superior to their own rams.
- Crossbreeding is the mating of rams of one breed to ewes of a different breed. Crossbreeding is a common practice for commercial sheep producers because it allows the producer to take advantage of the desirable traits of more than one breed. For example, many large commercial producers maintain a fine-wool flock of ewes (to take advantage of the wool quality and hardiness of those breeds), and mate them to a meat-type ram (to take advantage of the growth and carcass quality of those breeds).
- Some breeds may be included in a crossbreeding system to improve prolificacy or out-of-season breeding.
- Systematic crossbreeding involves the mating of rams and ewes of specific breed types to produce offspring of a specified type. Many of these systems rely on purebred flocks to supply replacement rams, and in some cases replacement ewes.
- The two advantages to systematic crossbreeding are to take advantage of complimentary breeds and heterosis (hybrid vigor).
- Heterosis is defined as the superiority of the crossbred individual relative to the average of the purebreds used in the cross.
- In general, crossbreds tend to be more vigorous, more fertile, and faster growing than the average of the purebreds used in the cross.
- The effects of heterosis tend to be large for traits that are low in heritability (such as reproductive traits), and small for traits that are higher in heritability.
- In general, unless selling breeding stock, producers may benefit by taking advantage of a crossbreeding system.
- A crossbreeding system is not just mating rams and ewes of several different breeds. Rather, a crossbreeding system specifically targets two or three breeds that compliment each other's strengths and weaknesses to best fit the production goals.



MISCELLANEOUS

ABBREVIATIONS

- ID = identification

SUGGESTED READING

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