Select on One Trait or Multiple Traits?

NSIP Fact Sheet
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Should you concentrate on one major trait or on a combination of two or more traits? This is not a simple question. This fact sheet discusses both strategies.

Background B Heritability and Crossbreeding:

AHeritability@ is the percentage of variability for a measured trait that is due to genetic differences (or more precisely, due to Aadditive genetic effects@). For example, a 20% heritability for weaning weight means that 20% of the observed variability is due to genetic differences (and conversely, 80% is due to non-genetic differences). 20% is a medium-heritability trait. Wool traits and postweaning growth traits have relatively high heritabilities (30 to 50%), while maternal traits and preweaning growth traits have medium to low heritabilities (10 to 20%). Although a reference table of general heritability values can be found in the *SID Sheep Production Handbook* (Breeding Chapter), NSIP actually calculates specific heritabilities from the individual breed datasets when the breed has enough records to make this possible. This procedure insures that the heritability values used in the evaluation of across-flock EPDs are the most appropriate for the specific data being evaluated.

Pros and Cons of Multiple Trait Selection:

Profit is not a single trait creature. Your ability to make a profit from a sheep flock depends on many traits.

Genetic progress in one trait is most efficient when you select only for that one trait and ignore all others. Therefore, you only want to select for the most important traits.

Ignoring traits, however, can sometimes lead to unexpected and disappointing results because of underlying relationships between traits. These correlations between traits are discussed next...

Correlated Traits:

In the real world, one trait often affects other traits because genes that affect one trait may also affect other traits. This is called AGenetic Correlation.@

A correlation can be described two ways: (1) by direction, and (2) by economic consequence. These aren=t the same, and the terminology can be confusing:

(1) By Direction

This is a clear-cut numeric relationship. Traits can have a *positive* numeric correlation **C** which means that both traits tend to move in the same direction (eg. as one increases, so does the other). Traits can have a *negative* correlation **C** which means that two traits tend to move in opposite directions (as one increases, the other trait decreases). Or traits can have *no* correlation **C** which means that the movement of one trait will not affect the other.

Slowing Progress

Selecting for multiple traits will slow genetic progress for each trait. In fact, this phenomenon can be described by the formula:

Genetic Progress = 1/ / n, where n = number of independent, non-related traits of equal heritabilities.

This means, for example, that if you actively select for four independent traits (n = 4), then your expected genetic progress for any one of these traits would only be 50% (= 1/ / 4 = 1/2) of the progress compared to selecting for only one trait.

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(2) By Economic Consequence

This is an economic relationship that depends on the market values of the specific traits. If a genetic correlation gives profitable responses in both traits, the correlation is *beneficial*. If a genetic correlation causes an unprofitable response in one trait, the correlation is *antagonistic*.

In selection, we always try to avoid correlations that are economically antagonistic.

The only well-documented antagonistic relationship in sheep is the correlation between fleece weight and fiber diameter. Selecting for higher fleece weight will concurrently tend to result in larger fiber diameter. Coarser wools are usually worth less in the market. (Terminology can be confusing here: This is a positive numeric correlation because both traits move in the same direction, but this correlation is *economically antagonistic* because it reduces the economic value of one trait.)

Current data indicate that all NSIP growth traits are positively correlated and beneficial. Growth and maternal traits are generally not correlated at all, although a small antagonistic relationship may exist in some breeds. This means that selection for any single growth trait or maternal trait will either have beneficial effects on the other traits or at least do no harm.

Important Note: Correlations only represent statistical *tendencies*, not direct cause-and-effect relationships! Correlation means that, *on the average*, the movement of one trait will result in the correlated response of another trait. However, you will occasionally find individual animals that show EPDs in the *opposite* directions of a correlation. These are the outstanding animals that you look for when you are selecting for two traits that are antagonistically correlated. (For example, sheep that show positive EPDs for fleece weight and negative EPDs for fiber diameter).

Heritability

AHeritability@ translates as Ahow easy is it to improve a trait genetically?@ Traits with higher heritabilities, such as wool traits, respond more quickly to selection than low-heritability traits, such as % lamb crop.

Correlated Traits

Current data indicate that the following traits are correlated:

All body weight traits are positively correlated. For example, selecting for higher weaning weight will also tend to increase postweaning weight. This correlation is particularly high when lambs are reared under intensive conditions.

Body weights and fleece weights are positively correlated. Selecting for larger body weight will also tend to increase fleece weight.

Fleece weight and fiber diameter are positively correlated, but this has a *negative* economic consequence. See text.

A General Selection Strategy:

1. First, define breeding objectives for your operation. Are you striving for growth? Wool quality or quantity? Maximum lambing percentage? You can=t change all these traits quickly at the same time. Decide on realistic long-term and short-term goals and stick with them **C** genetic improvement is long-term and cumulative. In your operation, *your* bottom line should be *the* bottom line.
2. Secondly, choose *one main trait* that you can improve through selection to achieve these goals. Examine your flock=s management and financial records to help you analyze your flock=s high and low production characteristics.
3. Select primarily on this main trait. If your EPD results are in a spreadsheet, sort all the data by this trait, ranking the animals from highest to lowest. Make your initial selections based on this trait=s EPD values.
4. Thirdly, refine your initial selections by looking at the EPDs of other NSIP traits. For example, you can set minimum levels for each other NSIP trait of interest below which animals will not be selected. This strategy protects you from poor quality in any trait while it allows you to concentrate on your main trait. This strategy is also known as the A**Independent Culling Level Method.@**

5. Concentrate only on the traits that are economically most important to you. Extraneous traits (for your operation) distract your selections from your true objectives and reduce your flock=s genetic progress.
6. Finally, go out into the pens and make your final selections by combining these Akitchen table@ choices with visual appraisals of the animals.

Hint: Always give serious consideration to genetic correlations, even if you only select for one trait. Correlated traits will also move because of your selections. Wool producers take special note: if you only pay attention to one antagonistic trait, then the other trait will probably move in an undesirable direction. See below.

Especially for Wool Producers...

Producers of fine wool must deal with a difficult genetic situation: your two main traits are genetically antagonistic. Selecting for larger fleece weight will also tend to increase fiber diameter. This means that you should always be aware of both traits during your selection process.

Average animals tend to show this correlation. Therefore, you should look for the rare animals that break the rule: i.e., animals who have high positive EPDs for fleece weight and low negative EPDs for fiber diameter. These are the exceptional animals you want.

If you cannot locate such exceptional animals, then you should at least try to minimize the effects of this economic antagonism:

1. If you are primarily interested in fleece weight, look for an animal with a high fleece weight EPD who also has a fiber diameter EPD less than zero, or as close to zero as possible.
2. If you are primarily interested in fiber diameter, look for an animal with a negative fiber diameter EPD (i.e., less than zero) who also has a fleece weight EPD above zero, or as close to zero as possible.

Be wary, however, of very extreme animals. These animals can increase the variability of your wool clip, which would reduce its economic value.

Background Note: One traditional selection method called A**Tandem Selection**@ is a sequential procedure in which you select exclusively for one trait for a while and then switch and select for a different trait, etc. Tandem Selection is not normally efficient for wool producers **C** because while you select for your first trait, the correlated trait will probably move in an undesirable direction. Then, after you switch to the second trait, you must make up for lost ground. A more efficient strategy is to select for one trait aggressively while deliberately holding the second trait constant (EPD = 0), rather than simply ignoring it.

Fiber Diameter EPDs

Remember that EPDs are expressed in the normal units of a trait. *Fiber diameter is the only NSIP trait for which a negative EPD is better.* For example, a ram with a fiber diameter EPD of -0.5 will sire progeny that, on the average, will grow wool 0.5 microns (F) finer than the average of that flock.

(Translation: this ram has the genetic value for *reducing* the diameter of the fiber, which generally makes wool more valuable).

For Further Information:

SID Sheep Production Handbook, Breeding Chapter.

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