Further Thoughts on Selecting Parasite Resistant Sheep

By James Morgan

Editor's note. An earlier version of this article was published in the February 2007 issue of The Shepherd magazine. For more information about the FEC-EPD, check out the article in the Winter 2007 Katahdin Hairald.

Recently, I received a call from a sheep breeder wanting to know where to find parasite resistant sheep. The shepherd asked for flocks which required no deworming and were in the eastern USA. Is that a good strategy to find resistant sheep? If not, what are better strategies?

In the parts of the USA where gastrointestinal nematodes are a significant issue, the important species is the barber pole worm, *Haemonchus contortus*. Four common approaches have been used by shepherds to select for sheep resistant to the barber pole worm and these are presented in Table 1. Recently, a fifth technique that has been used is the FEC-EPD (Fecal Egg Count Expected Progeny Difference). Each has strengths and weaknesses.

Author's note - The principles and discussion about selecting sheep resistant to parasites apply to any trait (e.g. growth, prolificacy, milk production, maternal behavior). To make genetic progress, shepherds need a trait that: i) has a genetic component (heritable), ii) is variable within the population of sheep/lambs and iii) can be accurately measured.

Before going into detail, it is important to discuss genetic selection. Common traits important for livestock production such as weaning weight, milking, fertility, prolificacy or parasite resistance exhibit a range of phenotypes in the flock/herd. The phenotype is a combination of the genetics of the animal and its interaction with the environment (nature and nurture). The rate of selection progress for a trait is affected by a combination of a) heritability of the trait, b) the variation observed, c) accuracy of measurement and d) generation time. The more of the observed difference between two animals that is heritable and the greater the variation in the population, the faster breeders can make progress at improving that trait.

Figure 1 (shown on page 4) is a model population of lambs with their fecal egg counts. For the 45 lambs, there is a range of fecal egg counts from low to high. Note that the population expresses the common finding by parasitologists that 20% of the animals are contributing 80% of the worm eggs on pasture. Progress for resistant animals can be made by selecting the top animals, culling the bottom or doing both. The greater the ability to identify those in the top 25% of the flock from the bottom 25%, the faster livestock producers can improve genetics.

So is selecting animals that do not require drenching a good approach? Also, a similar question, should a shepherd select animals from a flock that does not require drenching? On the surface, selecting sheep that do not need drenching has great appeal. That is what many shepherds want- sheep that do not need deworming, so that death losses are reduced and performance is maintained. While there are differences between the top and bottom animals in Figure 1, most veterinarians suggest that none of these animals actually need

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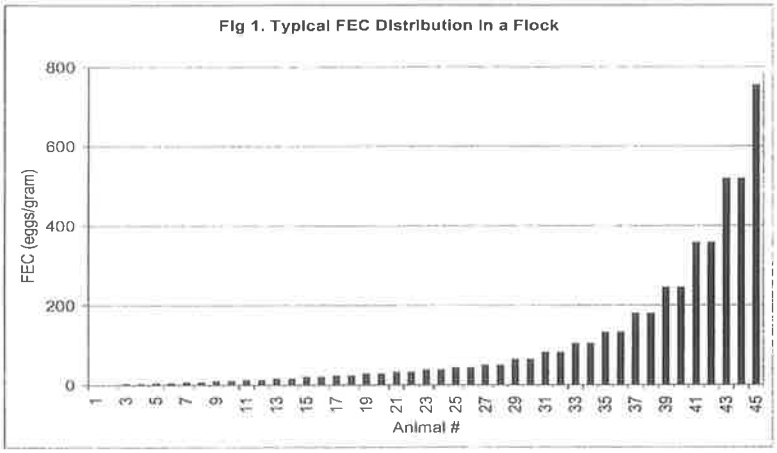
Table 1. Looking at the numbers: Different types of Selection for Improving Genetics for Parasite Tolerance/Resistance

Selection Factor	Range/ Variation	Notes about the Selection Factor
Culling animals that require deworming	Yes/No	Little differentiation between top and bottom of lamb crop
FAMACHA© scoring	1-5	Selects for resilience[1]. Scoring can be subjective. Small range.
Packed Cell Volume (PCV)	8%-36%	Selects for resilience[1]. Moderate range.
Fecal Egg Count (FEC) (McMaster's Method)	0 <25,000 eggs per gram	Selects for resistance*. Potentially, a very large range = fastest improvement
FEC-EPD (fecal egg count – expected progeny difference)	0-2000	Selects for resistance*. The statistical and genetic calculations use by the EPD increase accuracy of the FEC and allows shepherds to compare resistant animals in different flocks.

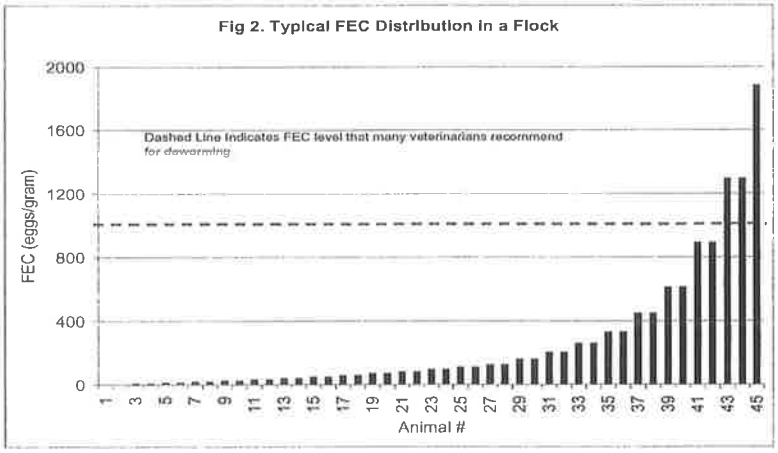
* - Resistance = sheep that prevents the establishment of worms in the gut.

[1]- Resilience = sheep that tolerate worm infestation without much or any negative effect.

deworming because FECs are below 1000 eggs/gram (epg). If a flock does not require drenching and no other measure of parasite resistance is measured, shepherds can be selecting animal number 1 with 0 epg or animal number 45 from the bottom of the flock with almost 800 epg and not know the difference (Figure 1).



If a few animals in the flock require drenching (see Fig 2), then selection accuracy is slightly better, but not much. Besides accuracy of selection, it is important to note that lack of drenching of a flock is often due to excellent management (managing forage height to minimize worm larvae ingestion) or just keeping sheep at low densities. Lack of drenching often has little to do with any genetics for parasite resistance. The following statement could be considered extreme, but it has been used before: Selecting sheep based on deworming or not deworming from either i) a flock that does not deworm or ii) from a flock that only deworms a few animals is similar to putting on a blind fold and throwing a dart at the target. It relies a lot on luck to select a resistant animal, since there is little ability to tell which animals are resistant and which are not. There is little ability to tell which animals are in the top 5-10% of the flock.



If drenching versus not drenching an animal is not effective at identifying parasite resistant animals, what about the other approaches in Table 1? Fecal egg count (FEC) easily has the largest potential variation in measurement. The difference between the five approaches is not just a factor of one or two, but several orders of magnitude. Many important performance traits have a factor of two in variation. For example 60 day weights in many flocks can range from 35 lbs to 70 pounds.

There may be no other trait in livestock genetics that has this ability for such rapid genetic improvement if selection occurs when FECs have a range of 0-10,000 epg or greater. Selection based on FEC is significantly more powerful than using FAMACHA© or PCV just because of the potential variation.

With that said, it is important that there be variation in the FEC amongst the lambs to be able to select on it. Most parasitologists suggest that a minimum range of 1000 eggs/gram is needed. Selecting animals based on differences of a few hundred eggs/gram is very inaccurate. While a high fecal egg count range (e.g. 0-10,000 epg) is excellent for identifying lambs that are superior for parasite resistance, it does create a nightmarish management situation and probable lamb mortality. With lower, more manageable FEC ranges (e.g. 0-2,000 epg), accuracy of selection can be improved by measuring FEC several times during the summer. In this situation, one can select ram and ewe lambs that consistently have lower fecal egg counts. I want to strongly emphasize the following key point: to make progress on identifying resistant lambs, there needs to be a sufficient worm load to accurately differentiate between resistant and non-resistant animals.

Resilience versus resistance. There is another significant difference between the traits listed in Table 1. FECs identify animals that are more *resistant* to nematodes while FAMACHA© and PCVs may only identify *resilient* sheep. In this discussion, a resistant sheep is one that can prevent larval and adult worms from inhabiting their gut while a resilient sheep tolerates infestation without much negative effect. In terms of the barber pole worm, resilience is demonstrated by a sheep that has a higher fecal egg count/high worm load, but does not become anemic.

Vigorous discussions about whether shepherds should select for resistance or resilient sheep have occurred for years among the experts. Some of the points made are similar to classic discussion: which came first: the chicken or the egg. With resistant sheep, few worms are present and there is less need for resilience. On the other side, if the sheep are very resilient, it doesn't matter if there are worms in the pasture. Those favoring resilience say "I want a sheep that can tolerate parasite loads. There can always be

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environmental and/or management situations that will overwhelm even the most resistant sheep". The resistance camp counters with a couple of points: a) resilient ewes (passing lots of worm eggs) can create contaminated pastures. There can be considerable mortality and decreased lamb performance before lambs develop significant resilience and b) shepherds can make greater progress selecting for resistance using FECs than selecting for resilience using FAMACHA© or PCVs. The "best sheep" would be one that is both resilient and resistant. But this would require a significantly more complicated and slower selection process.

The best methods of selection incorporate the mathematics and statistics used to calculate EPDs (expected progeny differences) with FECs. New Zealand, Australia and the USA all have programs that calculate FEC-EPDs. EPDs have further merit in they also provide the ability to compare resistance in a) different flocks and b) and amongst lambs born in different years. Progress with across flock EPDs is also significantly faster since the pool of lambs to select superior sires and dams can be a 1000 or greater when multiple flocks are involved. The one out of a thousand is typically better than the one out of a hundred lambs.

In the absence of an EPD, shepherds can still make progress identifying resistant animals using fecal egg counts. Flocks with very high FECs (e.g. > 10,000 epg), should have significant accuracy. Also, accuracy can be increased by doing multiple FECs on each lamb during the parasite season. Superior lambs are those with consistently low fecal egg counts when the majority of lambs in the flock experience high fecal egg counts.

In summary, selecting for parasite resistant sheep requires a) a significant worm load so that resistant animals can be distinguished from the non-resistant ones, b) a method of measuring resistance that has a significant numerical range to increase accuracy of selecting superior and culling inferior animals.