Historic EPD for Parasite Resistance Developed for Katahdins

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Editor's Note - A similar version of this article was published in the February, 2007 issue of "The Shepherd" Magazine.

The ability of sheep to resist parasites is highly heritable, and rapid improvement is now possible with a new EPD developed by scientists with the help of Katahdin breeders. The new Fecal Egg Count EPD will help participating Katahdin flocks enrolled in the National Sheep Improvement Program (NSIP) to select for more resistant sheep and to sell breeding stock—especially rams—that will pass on parasite resistance efficiently to other flocks.

From 2003-2005, the breeders submitted fecal samples for laboratory analysis of parasite egg counts from more than 850 lambs, which were sired by a total of 26 different rams. Differences among the Katahdin sires in breeding value for fecal egg count (FEC) were clearly expressed in their lambs. Rams with greater resistance to parasites passed along greater resistance to their offspring.

"This is another first for the Katahdin breed—and for the sheep industry," said Jim Morgan, data coordinator for the Katahdin NSIP flocks. "Parasites cause shepherds heavy losses and lowered production, especially among lambs. The new EPD will enable us to make rapid genetic progress in enhancing our breed's economic value and easy care status."

In addition, the study showed that heritability of FEC in Katahdins is at least equal to, and may be considerably larger, than that reported in other breeds. Katahdin sheep are superior already to most wool sheep in resistance to internal parasites such as the barberpole worm, *Haemonchus contortus*, and this resistance is one of the reasons for the increasing popularity of the breed.

Past research at Virginia Tech has shown that Katahdin lambs are superior to both Dorset and Dorper crossbred lambs but inferior to St. Croix x Barbados Blackbelly hair sheep lambs in parasite resistance, a result that is consistent with Katahdins' origin from crosses of U.S. wool and Caribbean hair types.

Selective breeding for parasite resistance in Merino sheep in Australia and Romney sheep in New Zealand has shown that resistance to internal parasites is under genetic control and led to development of highly resistant strains of these breeds.

However, Australian scientists estimate that a decade or more of selection in a susceptible breed is required before parasite resistance can be increased enough to allow a measurable reduction in frequency of deworming.

The initial high levels of parasite resistance in Katahdins, and the potential to further increase resistance, are thus significant assets for the breed. In particular, use of parasite-resistant Katahdin sheep in holistic parasite management programs involving FAMACHA scoring, strategic deworming, and novel anthelmintics such as copper filings and tannin-rich forages has potential to aid in control of internal parasites.

Fecal egg counts measure the numbers of worm eggs in fecal samples and provide an indication of the numbers of worms in the gut. Fecal egg counts are accepted worldwide as an indicator of parasite resistance, and the expanding participation of Katahdin flocks in the NSIP has provided opportunity to collect and process FEC data in an efficient manner.

Six NSIP Katahdin breeders began measuring fecal egg counts on lambs in 2003 in order to develop a FEC EPD. Participating flocks produced lambs from at least two sires in each year and were asked to monitor FEC on at least 10 lambs per sire. A few breeders also collected two fecal samples from each lamb in late summer, one week apart, to assess consistency in fecal egg counts from the same animal in the same infection cycle. By 2005, data were available on over 850 Katahdin lambs.

Fecal egg counts were measured at two different times:

- early in life, at approximately 8 weeks of age, before (or at the time of) first deworming. This measurement was designed to assess the extent of innate genetic differences in resistance.
- late in the grazing season, generally in late summer when lambs were at least 17 weeks of age and the risk of infection was often high. At this age, lambs have normally been exposed to parasites for several months and the immune system has had time to develop capacity to respond to infection.

Most previous studies of parasite resistance in sheep have used measurements taken at or after 17 weeks of age and have yielded unequivocal evidence for genetic differences in FEC. In the Katahdin study, deworming of lambs was required before the late-season measurement, in order to standardize parasite loads among lambs, with fecal samples collected four to six weeks after deworming. The average age at measurement was approximately 22 weeks.

Strong evidence for genetic control of FEC was obtained at both eight and 22 weeks, with large and significant sire effects observed at both times. Sire differences were generally consistent across years, flocks, and measurement times. For example, Figure 1 shows progeny mean [average] FEC at 22 weeks for a pair of rams compared to one another in two different flocks. Performance was quite

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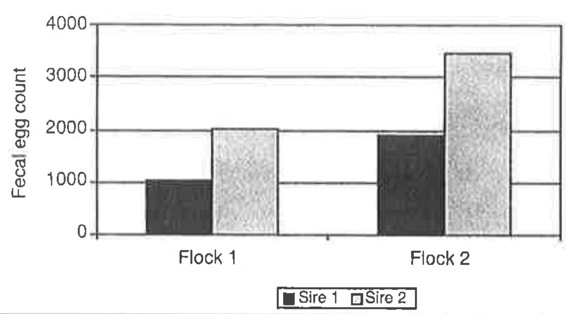
consistent, with higher progeny FEC for sire 2 in both flocks.

At 22 weeks of age, two measures of FEC, taken approximately one week apart, were available for 110 lambs from three flocks. The correlation between the two measures was 0.68, demonstrating good agreement between repeated measures of FEC taken at a similar age and in the same infection cycle. This association is important because it provides information about the number of measurements needed to accurately assess the "true" parasite resistance of an individual lamb.

Figure 1. Average progeny fecal egg counts at 22 weeks for two sires compared in two different flocks.



If the correlation is very high (for example, greater than 0.8), then repeated measures of FEC are expected to be relatively consistent, and there is limited value in taking more measurements. If the correlation is low (for example, less than 0.5), it means that a single measure of FEC is liable to random measurement error and that the accuracy of evaluation can be improved by taking more samples.

Most studies have shown that two or three FEC determinations on the same lamb would provide a very accurate assessment of resistance. Australia's program for on-farm recording of FEC requires only a single measurement.

Our results support the Australian model and indicate that a single measurement of FEC on each lamb is adequate for genetic evaluation, especially if records on related animals are included in the evaluation, as they are in NSIP. In such a situation, records on relatives, rather than additional measurements on the same animal, are used to improve the accuracy of evaluation.

Another important issue is the consistency of FECs taken at eight weeks, when animals may have had limited prior exposure to worms, and at 22 weeks, when the immune system has had more time to develop. In this study, 109 lambs from two flocks had FEC measurements at both ages. All lambs were dewormed and reinfected between the eight- and 22-week measurements. The correlation between FEC at these two ages was 0.43, lower than that between measurements taken in the same infection cycle, but still positive, substantial, and significant.

These results suggest that eight- and 22-week FECs provide generally consistent information and that selection to change one should result in corresponding changes in the other. Sire means for rams with progeny measured at both times were quite consistent (Figure 2).

Sire 1 in flock 1 had the highest FEC at both ages and in both years. In 2004, sire means for eight- and 22-week FEC in flock 1 were remarkably consistent; the four sires had exactly the same ranking at both ages. In flock 2, the two rams evaluated in 2003 were not particularly consistent across ages, but in 2004, Sire 7 consistently had the highest progeny mean FEC. These results suggest that, at the levels of infection observed in this study, eight-week FEC was a consistent predictor of

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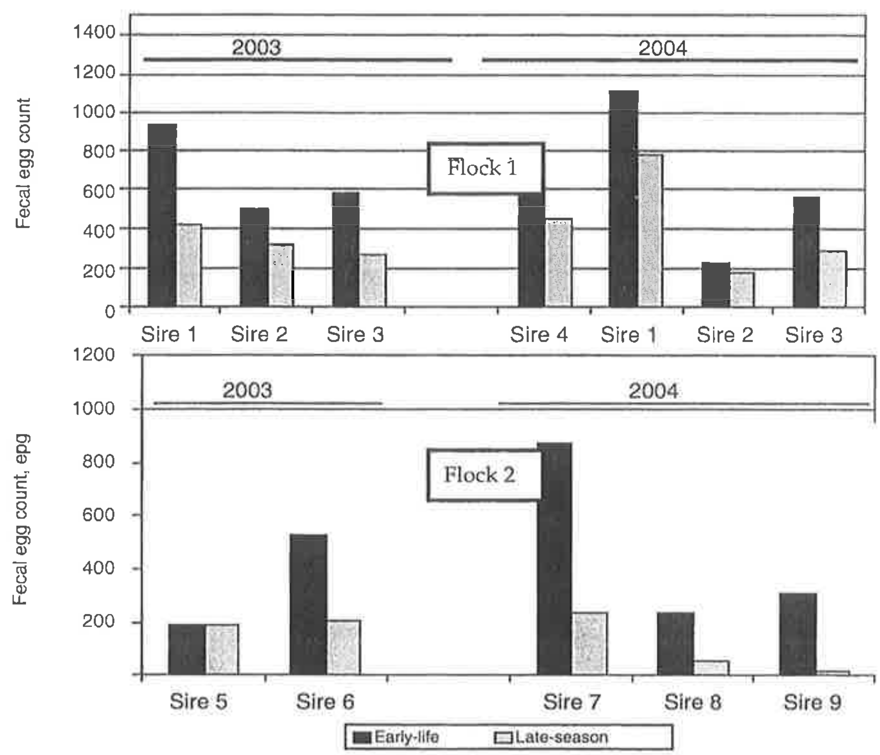
Figure 2. Comparisons of progeny fecal egg counts at 8weeks (early-life) and 22 weeks (late season) for sires evaluated in each year in flock 1 (upper panel) and flock 2 (lower panel).



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future resistance.

FEC EPDs at 22 weeks of age are shown in Figure 3 for the 26 sires evaluated in the study. Heritability estimates for FEC were 0.48 at 8 weeks at 0.54 at 22 weeks. These values were reduced to 0.45 at both times in the final analysis to be more consistent with previously reported values.

These heritabilities for FEC in Katahdin sheep were considerably higher than the common literature estimates of 0.2 to 0.3 in wool breeds and are nearly three times larger than the heritability of weaning weight. The genetic correlation between measurements of FEC taken at eight and 22 weeks was 0.50, indicating a positive genetic association between them. Thus rapid improvement in FEC appears possible.

Sire EPDs in Figure 3 are adjusted to a mean flock FEC of 2,000 eggs per gram (epg) and are ordered from left to right by increasing EPD. The range in 22-week FEC EPD is approximately 3,000 epg, suggesting that at a mean FEC of 2,000 epg, the best sire would have progeny with an average of approximately 500 epg (i.e., an FEC EPD of -1,500). The poorest sire would have progeny with an average FEC of approximately 3,500 epg (a FEC EPD of +1,500).

Even if the one ram in Figure 3 with a very high FEC EPD is removed, the remaining rams still have FEC EPDs that range over ±500 epg. At lower levels of infection and lower flock mean FEC, predicted progeny differences would be smaller, but relative differences among sire are expected to still be expressed.

Collecting more than one fecal sample per lamb would allow some improvement in accuracy, but a single FEC measurement is adequate to calculate EPDs, especially in a system like NSIP.

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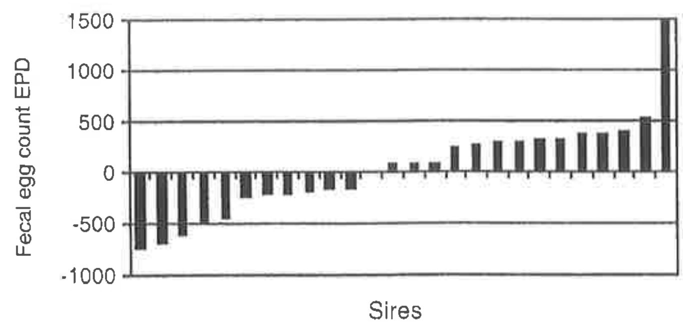
Figure 3. FEC EPDs for 26 Katahdin sires at 22 weeks of age. EPDs are ranked from lowest to highest.



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FEC were similar at eight and 22 weeks, they could be combined for use in selection. This result was not entirely expected and must be confirmed. In any case, at this time EPDs derived at either age appear useful for selection, at least at the relatively high mean FEC levels observed in this study.

In conclusion, the study clearly shows that genetic improvement in parasite resistance can be achieved in Katahdin sheep and that a single FEC determination at a point in time when lambs have relatively high mean FEC (≥ 1,000 eggs/gram by the McMaster test) can be used to derive EPDs for sires, dams, and lambs.

Development of a Katahdin FEC EPD is still a work in progress and will require some modification as more data accumulate, but results of this study provide strong evidence for the value of FEC EPDs.