Update on breeding for resistance to footrot

Main messages

- Susceptibility to footrot in sheep is in part, determined by genetic make-up
- Breeding values (EBVs) for footrot can be estimated after routine hoof scoring of flocks using a simple 5-point scale
- The use of breeding as part of a control strategy will be more effective in flocks where it is a major problem
- The current gene test for footrot that was developed at Lincoln University, NZ cannot be recommended for use in Texel or Blackface sheep in the UK.

The control of footrot through management practices is usually an effective way to keep on top of the disease. The use of foot bathing, quarantine of affected animals, vaccinations and other methods such as the use of a 'snacker' feeder to avoid a high concentration of sheep in one area are often used in a combination of ways that best suits the farm. However, with ever higher labour costs associated with controlling the disease, coupled with an increased pressure to reduce farm costs and to avoid environmental contamination, there is a need for a sustainable and long-term solution such as building up a genetic resistance to footrot.

A project was conducted by a team of scientists led by SAC to investigate strategies to breed for footrot-resistance in UK sheep. Two approaches, including traditional selection and molecular genetic testing methods were investigated. In this way we could tease out to what degree footrot is due to genetic make-up and how much of an effect other factors such as management have. As a prerequisite for this research it was necessary to develop a reliable method to differentiate hoof footrot conditions on a graded scale of severity. The Figures below show five images from a clean hoof (score 0, Figure 1), to scald (score 1, Figure 2) (which, if left as untreated can lead to footrot), then inter-digital necrosis (score 2, Figure 3), under-running of the hoof (score 3, Figure 4) to complete under-running of the hoof (score 4, Figure 5). Figure 6 shows scores 3 and 4 diagramatically. These different stages represent the progression to classical footrot if hooves are left untreated. This scoring method was found to be a good way to separate different hoof states, which was then used to screen a large number of sheep (13,867 sheep with a total of 55,468 individual hoof records!) from Blackface, Texel and Mule sheep from 27 commercial and experimental flocks that had pedigree information. Most of the flocks were part of the Signet Sheepbreeder recording scheme and so had additional information on their flock's performance. This comprehensive data set of footrot scores was used as a basis to answer most of the genetic questions. In addition, we took blood samples from each animal and a subset of these were used for molecular genetic analyses.

Figure 1- score 0

Clean hoof – no signs of footrot

Figure 2 – Score 1

Mild interdigital dermatitis (scald).

Figure 3 – Score 2

More extensive interdigital dermatitis

Figure 4 – Score 3

Severe interdigital dermatitis and under-running of the horn of the heel and sole

Figure 5 – Score 4

Severe interdigital dermatitis and under-running of the horn of the heel and sole.

Figure 6 – Score 5

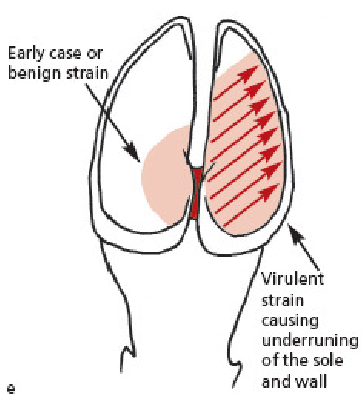

Illustration of scores 3 and 4 (Courtesy of Agnes Winter

Results

The average percent prevalence of scores 1-4 for the three breeds ranged from 17% to 57% over the three year scoring period, 2005-2007. Large differences between average prevalence levels for individual farms were also seen, with less than 1% for a few farms, to nearly 60% for another farm.

From the large quantity of data generated, we found that the major factors that affect footrot prevalence in ewes include the farm and management group, age of ewe (with older ewes having more footrot), and the number of lambs reared (with ewes rearing twins being at higher risk than barren or single-rearing ewes). For lambs, male lambs had twice as severe footrot scores compared to those for females, and no differences were detected between lambs reared as a single or twin.

Genetic aspects

The heritability of a trait (such as footrot) quantifies how much of the variation between animals is due to genetic factors, and is expressed on a scale of 0 to 1 (or 0 to 100%). The higher the heritability, the easier it is to change a particular trait through breeding methods. The average estimate for heritability of footrot in ewes was 0.2, which means it has a low to moderate heritability and conventional breeding approaches can be used to improve resistance and assist in footrot control. We also found that for flocks with high levels of footrot, the impact of using breeding methods to help control footrot will be greater and seen sooner, than for flocks with low footrot levels. It is also beneficial to score ewes more than once, as this gives more accurate assessments, with ewes ideally being scored at the same time each year. The ewe, and her relatives (including offspring), can then be given breeding values based on these repeated measures. This is good news for tup breeders; rams will still get EBVs for footrot from information generated from his relatives, without any need for the tup himself to be exposed to the disease.

What happens to other breeding goals if greater resistance to footrot is selected for?

In breeding programmes it is important to understand what will happen to other traits if selection for footrot resistance is undertaken. This can be looked at by estimating genetic correlations, which measure the degree of association at the genetic level between two traits on a scale of -1 to +1. We found that footrot resistance usually was either favourably correlated with performance traits, or uncorrelated. For example, we found in Texel lambs that footrot was not related with either live weight or muscle depth, but it was moderately positively genetically correlated (0.27) with fat depth. This means that lambs that grow faster are **not** more genetically susceptible to footrot, and that current breeding goals to reduce fatness in sheep are compatible with improving improve lambs' resistance to footrot. When we studied maternal performance data from Blackface ewes, we found small, favourable genetic correlations for footrot with ewe longevity, number of lambs reared and lamb survival. So in general, selection to improve footrot in sheep is likely to bring both economic and animal welfare benefits.

Reduced pasture contamination

We estimated that the prevalence of the disease can be reduced by between 0.25 and 0.5% per year (e.g. from 10% to 9.5%, and so on), by selection for increased footrot resistance alone. However using modelling techniques that also take into account the benefits of having less contaminated pasture, we estimated that double the rate of progress is possible to reduce footrot prevalence in the medium term (e.g. 2-5 generations) compared to predictions using the genetic models alone. This means that the use of breeding to control footrot is likely to be an effective and sustainable solution, complementing other control strategies to reduce pasture contamination by the bacteria that cause footrot.

Molecular genetic testing

To validate existing genetic tests in different sheep populations it is necessary to have foot scores on many different sheep with diverse genetic backgrounds as well as a sample of their DNA. The existing genetic marker test currently available in New Zealand and developed at Lincoln University is based on a gene that is known to be involved with immunity in sheep. We looked at different ways to associate the test with the footrot score described above (on the 0 to 4 scale), whether or not sheep had any footrot at all, how many feet were affected, if they just had under-running footrot etc., amongst others. We saw that the Texel and Blackface had very different variants of the gene that reflects the diversity between these breeds. Unfortunately, our data did not show any consistent associations of footrot and the gene marker test in either breed. This means that using the test is unlikely to detect genetic differences for footrot resistance in the populations tested, and its widespread use in a breeding programme in this country can not be recommended in either the UK Texel or Scottish Blackface breed.

Recently a new technology, ‘single nucleotide polymorphism (SNP) chips’, has been made available for sheep that will give us the opportunity to screen the whole sheep genome for associations with resistance to footrot and other diseases in a single test in a cost-effective manner, and give us a more comprehensive insight into disease resistance. This technology is being widely used to detect gene associations for humans for a range of diseases including diabetes, stroke and Alzheimer's disease, and may prove invaluable in the fight against footrot in the future.

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