Lincoln University Gene-Marker Laboratory

Cold Tolerance

Gene-Marker Test

LINCOLN UNIVERSITY
TE WHARE WĀNAKA O AORAKI

Background

Lamb mortality within the first few days of birth results in economic losses to the sheep industry. It also poses a welfare concern. While some lamb deaths can be attributed to specific causes such as birthing difficulties (dystocia), poor mothering, lamb misadventure and disease, approximately a third of them are associated with cold exposure and starvation.

While, completely eliminating lamb deaths is impossible, studies have demonstrated genetic variation in cold survival through the establishment of lines of sheep with high and low cold resistance. Thus, gains in lamb survival are possible by including cold tolerance as a selection criterion in breeding programmes. Unfortunately, in order to do this each sheep has to be subjected to a cold challenge in order to ascertain its level of tolerance, a practice not easily achieved on-farm. An alternative approach is to identify a gene-marker associated with differing levels of cold tolerance.

Research at Lincoln University has focused on the β3-adrenergic receptor (ADRB3) gene, a key gene in the pathway that leads to heat generation in response to cold stress. We have linked variation in this gene to the ability of newborn lambs to survive cold weather. That is, different forms (alleles) of the gene are associated with lambs having a

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greater or lesser risk of dying from cold exposure. This research has become the basis of a gene-marker test that enables sheep breeders to identify animals that will produce lambs that are more or less likely to die from cold exposure.

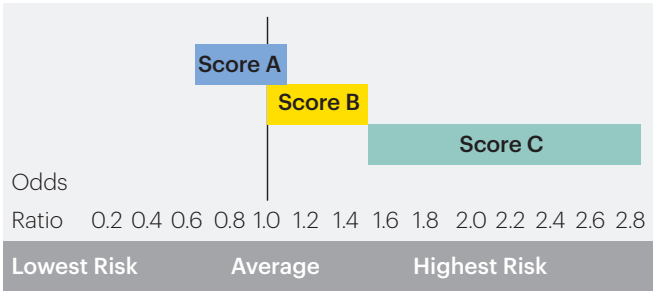
Given that the weight of meat and wool produced each year is more dependent upon the total number of lambs that survive to weaning, than upon the individual performance of the lambs, it could be argued that lamb survival is an important selection criterion that should be included in all breeding programmes.

The test

Blood samples collected from sheep can be typed to reveal which alleles of the ADRB3 gene they possess. Each animal will have two alleles, one allele inherited from each parent. The two alleles can be the same or different and either one of them can be passed on to the animal's progeny in approximately a 1:1 ratio. The inheritance of a particular allele can, therefore, be traced through extended pedigrees.

In order to simplify the gene information for breeding purposes, the alleles have been codified according to their associated risk of cold-related mortality.

Those alleles that are associated with an average or below average (decreased) risk of cold-related mortality are designated as A, while those alleles that tend towards an above average risk of cold-related mortality are designated with a B, whereas those alleles associated with a marked increased risk of cold-related mortality are designated C. This coding system has been designed to promote a conservative approach to selecting for cold tolerance and one in which the focus is placed on removing sheep with bad alleles as opposed to selecting for sheep with good alleles. This will maintain genetic diversity, potentially increasing the ability to make genetic gains in other traits.



The graph above shows the 95% confidence intervals for the risk of cold-related mortality (expressed as an odds ratio) for each of the three scores A, B and C.

The test allows for easy identification of sheep that will pass on good cold-tolerance genetics to their progeny. All other things being equal, lambs that inherit those A score alleles have an increased likelihood of surviving a cold challenge compared to those lambs inheriting C score alleles.

Breeding for cold tolerant lambs

The Cold Tolerance Gene-Marker Test results can be used to aid in the selection of sheep that are more likely to have cold tolerant progeny. It should be noted that the effectiveness of the test in defining the percentage of lambs that will die from cold exposure from a single sire will vary depending on numerous factors, including the severity of the cold challenge and the genetics of the ewes that any given tested ram is mated to.

In breeding, the test will improve both the accuracy of selecting sheep that are considered less likely to have progeny that will die from cold exposure and the speed of genetic gain, as sheep can be DNA typed from birth and, therefore, preferentially selected at an earlier age.

A number of breeding strategies can be employed, but we recommend that:

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Lincoln University Gene-Marker Laboratory Tests

A1/A2 Cattle Genetics
Booroola
Cold Tolerance
Dermatosparaxis
Footrot
Gaucher Disease
GDF9 Fertility
Inverdale
Microphthalmia
Scrapie
T+ Muscling

- The test is used predominantly on existing and potential sires (i.e. rams) as these have greater genetic influence on flocks than ewes.
- Sires that have poor progeny survival rates are removed from breeding programmes at the first practical opportunity regardless of their Cold Tolerance Gene-Marker results. There are some animals that may have good Cold Tolerance Gene-Marker results, but still produce lambs with poor cold tolerance because of other inherent faults (e.g. insufficient birth coat).
- Breeders should use discretion when selecting replacement ewes and ideally ewes that have been sired by rams with good cold tolerance *ADRB3* alleles should be used to increase the rate at which genetic gain is made within flocks.

In breeding for increased cold tolerance in lambs, the following must also be remembered:

1) It doesn't matter how good a lamb's genetics are regarding cold tolerance, if it is not in good condition, then it will not have the fat reserves required to convert into heat. Thus, ewe nutrition and health is very important in ensuring that a lamb is born with adequate fat reserves and that the lamb has plentiful milk to drink.
2) This gene-marker test is based upon the analysis of populations of sheep and the cold tolerance scores reflect variation from the average in a population. In any given population there are always individuals who do not reflect that population as a whole. These individuals fall outside the 95% confidence intervals and are called outliers. These sheep may produce progeny which are cold intolerant despite having good gene-marker results. There is no absolute guarantee of the extent of the flock response to the recommendations made based on this gene-marker test, other than that on average, sheep with A score alleles are considered more likely to have cold tolerant lambs than those with B and C score alleles.

Getting your sheep tested

Contact the Lincoln University Gene-Marker Laboratory at the numbers listed. We will send out special cards for collecting small blood samples, along with instructions on how to safely and easily collect blood from sheep. Only when your samples are received by the Laboratory can typing be undertaken. If you are outside of New Zealand, an import certificate will be supplied. Multiple tests can be done from the same blood sample, so please have sufficient blood on the card.

Testing costs

A schedule of prices is available on request. Discounts are avaialable for large volumes or multiple tests. For overseas clients we price test and invoice in your currency.

Find out more at research.lincoln.ac.nz/testing-analytical-services/gene-marker-lab

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