Strategies
to
Eliminate Inherited Pigmentation
in
Australian Merino Sheep.

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Declaration

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

Signature

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Baa, baa, Merino, have you any spots?
Yes sir, yes sir, rather a lot:
One gene from my sire and one from my dame,
And incomplete penetrance — oh, what a shame.

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Abstract

The viability of eliminating inherited pigmentation from the Australian Merino flock by DNA technology was investigated as a means of reducing dark fibre contamination of white wool.

Two genetically distinct forms of inherited pigmentation are known. Symmetrical patterns follow simple recessive inheritance. Meanwhile the inheritance of piebald spots is uncertain. Inheritance models for piebald were assessed against new and prior field records to resolve this point, but a clear-cut conclusion was not possible at this time — further field experimentation is required.

Gene discovery for Mendelian characters by homozygosity mapping was reviewed and applied in simulation to livestock situations. The method was found to be efficient, powerful, robust, and readily adaptable to a wide range of gene discovery problems. In particular, modifications to the design of HM to suit livestock had a relatively small effect on experimental power in many cases.

For a ram-breeding flock, paternal culling in addition to phenotypic culling was found to be a highly effective strategy to reduce the frequency of undesirable pigmentation alleles as well as being cost-effective through reduction in the incidence of pigmented phenotypes. Taking steps to minimise allele frequency prior to the commencement of DNA gene testing also gave large benefits.

When DNA gene testing becomes available, early adoption and rapid elimination of pigmentation alleles were found to be preferable in most situations for ram breeding flocks. The costs of eliminating pigmentation alleles and the concomitant loss of selection intensity were found to be inversely proportional to the initial allele frequency. Across a spectrum of inheritance models (excluding simple dominance) the particular inheritance model had little additional effect. An efficient testing strategy could significantly reduce costs.

Economic analysis at the industry level has revealed the key costs and sources of revenue which would be affected by eliminating inherited pigmentation. While many factors were difficult to specify, the cost of DNA testing emerged as the most critical factor.

This study has demonstrated the technical potential of DNA technology to reveal many of the missing pieces of the puzzle of inherited pigmentation and its elimination from Merino flocks. DNA technology is vital to both gene discovery and gene testing for the presence of undesirable pigmentation alleles, and no practical alternatives exist.

The economic viability of widespread DNA gene testing is subject to many uncertainties at this time. However many industry players are keen to adopt gene testing even at quite a high test cost and the trend for the cost of a new technology to decline over time would improve the financial outcome. Meanwhile, indirect benefits through enhancing the reputation of Australian apparel wool could be substantial. While the uncertainty over the eventual returns from investments in research should prompt some caution, continuation of research in this field is encouraged.