AUSTRALIAN GENETIC RESOURCES FOR MEATSHEEP PRODUCTION

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SUMMARY

Several sheep breeds encompass the genetic resources of the Australian lamb industry. The results of genetic analysis of industry and research flocks for seven of these breeds are presented. The estimates of heritability for the major economic traits show that genetic variation exists in Australian meatsheep breeds, and that the potential response to selection in the medium term is substantial. Moreover, there is a range of breeds available to meet specific product requirements and production environments. Sound breeding programs are required to fully exploit these genetic available resources.

INTRODUCTION

The profit function for a meatsheep production enterprise is complex. For prime slaughter lamb, the critical traits include growth rate, carcass value (particularly fat depth and eye muscle area) and skin value. For the prime lamb dam, emphasis is given to wool production (quantity and quality) and reproductive rate, as well as growth and carcass traits. The central quest in lamb production is to produce lambs which will meet market specifications from dams that maximise productivity and profitability from the sale of meat, wool and surplus animals. The genetic merit of the dams and sires and their lamb progeny is important in this quest. The main strategies for maximising genetic merit are selection for additive genetic improvement and crossbreeding to capitalize on heterosis. Combining both selection and crossbreeding strategies will lead to more efficient use of available genetic resources. LAMBPLAN is a powerful tool to assist breeders in exploiting the genetic resources available in Australia.

PRODUCTION SYSTEMS

Lamb production systems have evolved over many years and include several categories: two-breed cross; three-breed cross; and self-replacing or purebred. Within the crossbreeding systems, producers commonly specialize at one tier of the structure. The self-replacing breeds include medium, strong and carpet wool types, with varying emphasis between meat and wool production. This gives a breed-type classification which includes terminal sire breeds, maternal breeds and self-replacing breeds (strong wool, medium wool or carpet wool). Several special-purpose breeds now exist, such as the Hyfer (Fogarty 1992a), recently developed to allow intensive year-round production of high quality lamb. In addition, new breeds to

Australia such as the US Suffolk, Finn and Texel, are being imported to add to the meatsheep genetic resources. This diversity of breeds and industry structure means that industry-wide genetic improvement of meatsheep breeds and provision of breeding services is difficult.

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The most common crossbreeding structure in south-eastern Australia involves three breeds. Border Leicester x Merino ewes are mated to Poll Dorset rams to yield prime slaughter lambs, making maximum use of maternal and individual heterosis. Such a structure also allows the breeding objectives for the breeds contributing to the crossbred dam to be specifically tailored to maternal requirements and those for terminal sires tailored to growth and carcase requirements. Few producers run an entire two-tier crossbreeding system as well as breeding their own seedstock, due to the complexity of management. Under this structure the opportunities for additive genetic improvement of lamb production are largely in the hands of Poll Dorset and Border Leicester stud breeders. These breeders may be remote from the market values and signals which directly affect commercial lamb prices. The large effects of heterosis have also led to less emphasis on selection for production traits in these breeds despite selection gains being passed on to crossbred progeny (Yates and Pattie 1970). This situation has been ameliorated by the widespread adoption of LAMBPLAN by terminal sire seedstock producers to improve growth rate and leanness, but little progress has been made on the dam side.

The self-replacing breeding systems of the Coopworth, Corriedale and Gromark breeds are much simpler. Many producers run their own stud flock, giving much more control over selection decisions and with direct incentives to make additive genetic improvement. Some breed society rules ensure attention is given to objectively measured performance. Heterosis is generally not utilized. Although these breeds are crossed in some situations, selection decisions are based on breeding objectives for purebreeding.

WITHIN-BREED VARIATION

Genetic analysis of a number of large industry and research data sets undertaken by the sheep genetics unit of NSW Agriculture at Orange has produced for the first time an extensive range of genetic parameters for traits of Australian meat sheep breeds. The heritability estimates obtained for important lamb production traits among various breeds are summarised in Table 1. The estimates for some breeds are averages of estimates at different ages. The standard errors for the estimates of heritability were generally between 0.03 and 0.10. The heritability estimates vary between the breeds but are in the moderate to high range for liveweight, fat depth and wool production. The Gromark estimates for liveweight and fat depth are low, as discussed by Brash et al. (1992). The estimates presented are generally consistent with the few other estimates that are available for these breeds and for the Merino. There is considerable scope for selection to improve each of these traits.

The reproductive performance was measured as total lambs born divided by lambing opportunities; Hyfer data was restricted to three opportunities in two years. The heritability estimates are low for the Border Leicester and Corriedale, but quite high for the Dorset and Hyfer. Estimates of heritability for one record of ewe performance were considerably lower, hence the importance of having as much information as possible when estimating breeding values for reproduction. The presence of the Boorooloo F gene at an estimated frequency of 0.10 would have contributed to the high heritability for the Hyfer breed.
Table 1. Heritability estimates for liveweight, fat depth (adjusted for liveweight), wool (greasy fleece) weight and average ewe reproduction (lambs born per ewe joined) for seven meat sheep breeds in Australia

<table>
<thead>
<tr>
<th>Breed</th>
<th>Liveweight</th>
<th>Fat depth</th>
<th>Wool weight</th>
<th>Lambs born</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poll Dorset</td>
<td>0.25^A</td>
<td>0.29^A</td>
<td>-</td>
<td>0.17^C</td>
</tr>
<tr>
<td>Border Leicester</td>
<td>0.18^B</td>
<td>0.25^B</td>
<td>0.16^C</td>
<td>0.03^C</td>
</tr>
<tr>
<td>Corriedale</td>
<td>0.25^B</td>
<td>0.37^B</td>
<td>0.32^C</td>
<td>0.06^C</td>
</tr>
<tr>
<td>Coopworth</td>
<td>0.40^B</td>
<td>0.21^B</td>
<td>0.28^C</td>
<td>-</td>
</tr>
<tr>
<td>Hyfer</td>
<td>0.45^D</td>
<td>0.29^D</td>
<td>0.38^D</td>
<td>0.18^D</td>
</tr>
<tr>
<td>Suffolk</td>
<td>0.28^B</td>
<td>0.27^B</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Gromark</td>
<td>0.09^B</td>
<td>0.12^B</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

^A Atkins et al. 1991.  
^C L.D. Brash et al., unpublished data.  
^D Fogarty et al. 1992a.

**PREDICTED RESPONSE TO SELECTION**

As an example, consider a Corriedale stud flock of 500 ewes in five adult age groups with 3% annual mortality and a weaning rate of 100%, where 6 new rams are selected each year and used for up to 3 years. The available selection intensity averaged over the sexes is 1.62, and the generation interval is around 3.5 years. Using the appropriate parameters from Table 1 and phenotypic standard deviations for the four traits of 6.1kg, 0.81mm, 0.50kg and 0.27 lambs respectively, gain from 10 years of single trait selection (for lambing rate, lifetime records on ewes only) is predicted to be:

a) 7.1kg higher liveweight at 10-14 months (11% of the initial mean);  
b) 1.4mm less fat depth at the C site at 10-14 months (37%);  
c) 0.74kg higher greasy fleece at hogget shearing (22%); or  
d) 0.04 more lambs born per ewe joined (3%).

In practice, selection will be based on a combination of these and other traits, so that the response in each trait will be reduced. However a shorter generation interval, lower ram percentage or higher reproductive rate would increase the predicted rate of response. The predicted response for lambs born would clearly be higher for some other breeds.

Predicted responses from 10 years of selection using 3 LAMBPLAN indexes in a 300 ewe Poll Dorset flock are as follows (Anon.):

a) High growth index: 10kg higher liveweight and no change in fat depth;  
b) High lean index: 1kg higher liveweight and 4mm less GR fat;  
c) Lean growth index: 7.5kg higher liveweight and 3mm less GR fat.

The lean growth option represents a 12.5% improvement in liveweight and a 33% reduction in fat depth relative to initial mean values. These predictions illustrate the dramatic changes that are possible from an
effective breeding program. In conjunction with on-going improvements in management and nutrition, medium-term breeding programs could produce spectacular improvement in lamb production and quality of product to consumers.

DISCUSSION

The extent of the genetic variation found for the range of important lamb production traits demonstrates the enormous scope for genetic improvement among Australian meat sheep breeds. LAMBPLAN (Banks 1990), which has recently been expanded to cater for maternal and dual-purpose breeds (Fogarty et al. 1992b), provides breeders with a simple tool to assist implementation of breeding programs to realise this potential. Estimated breeding values (EBVs) are calculated using breed-specific parameters for traits such as liveweight, fat depth, fleece weight, reproduction, fibre diameter and eye muscle depth, depending on the measurements recorded. These EBVs are combined in indexes appropriate to each breed type with the breeder having a choice of breeding objectives and selection criteria.

Optimal use of genetic resources in the lamb industry combines sustained selection and crossbreeding. Constraints due to the physical environment, other farm enterprises, economy of size and the complexity of management mean that most producers operate within a segment of the industry and do not have complete control over the use of genetic resources, i.e. selection decisions in stud flocks and mating of animals in commercial flocks. The constraints largely determine the breed-type and production system used in a given situation. For example, a producer with expertise in breeding and wanting complete genetic control will use a self-replacing breed, while one constrained by a seasonal rainfall and cropping commitments may choose to breed first-cross ewes from introduced Merino ewes and Border Leicester rams.

Selection of a breed, within a breed-type (e.g. terminal sire), is largely a matter of preference of the breeder as differences between the breeds are generally small compared to differences between animals and the potential response to selection. The sourcing of superior genotype rams and/or ewes for breeding is of great importance for producers at all tiers of a crossbreeding structure. Hall et al. (1992) provides clear evidence that purchasing rams on the basis of LAMBPLAN EBVs directly and appreciably affects carcass weight and fat depth of lamb progeny. Lamb is evolving from a low-value, undifferentiated commodity to a range of higher-valued product to meet specific markets. The Elite Lamb program being supported by the MRC has already given an advantage to specialist lamb producers who can effectively combine genetics and management to contribute to a year-round supply of large lean carcasses, and lower returns can be expected for those who cannot.

REFERENCES

ANON. "LAMBPLAN Breeding Objectives: Terminal Sires". LAMBPLAN.