INTRODUCTION

The first step in developing a breed improvement program is to define the breeding objective. The subsequent steps include choice of selection criteria, organisation of performance recording, use of information in selection decisions and use of selected animals (Ponzoni, 1982). It is important to clearly distinguish between traits included in the breeding objective and traits used as selection criteria. James (1982, 1986) has stressed the need to include all traits that contribute to income and costs in the objective and has pointed out the importance of including feed consumption.

INDUSTRY STRUCTURE

The large majority of prime lambs for slaughter are produced in the south east of Australia from a tiered crossbreeding structure. Some Merino ewes, that are in primarily purebreeding flocks kept for apparel wool production, are crossed with Border Leicester rams. The F1 wether lamb progeny is slaughtered. The F1 ewes are grown out and sold to other breeders who use them as prime lamb dams by joining them to terminal sires of another breed, usually Poll Dorset. All the 'second cross' progeny are sold for slaughter at approximately 35kg liveweight. Prime lambs are also produced from general purpose pure breeds (e.g., Corridale and Coopworth) and new composite breeds are being developed for specialist lamb production, such as the Hyfer (Fogarty and Hall, 1982a).

The tiered crossbreeding structure provides advantages from the utilization of breeds, exploitation of heterosis and good utilization of land resources. However, Fogarty and Hall (1982b) have highlighted major limitations to genetic improvement of the prime lamb dam within this structure. These include lack of vertical integration, varying selection goals at different levels of the tiered structure, hierarchical structure within the purebreeds used and long lag time for the benefits of selection decisions to be passed on to prime lamb producers.
Some of the traits that contribute directly to income and costs for lamb production include:

- NLW: number of lambs weaned
- SW: sale weight of lambs
- CFD: carcase fat depth
- CFW: clean fleece weight
- FD: average fibre diameter
- EBW: mature ewe body weight (salvage).

When combined in a profit equation these traits contribute to income from prime lamb production in a pure breed (or synthetic) enterprise in the following way:

\[
\text{Income} = a_1G_{NLW} + a_2G_{SW} + a_3G_{CFD} + a_4G_{CFW} + a_5G_{FD} + a_6G_{EBW}
\]  

(1)

where \(a_i\) is the relative economic value and \(G\) the breeding value for the traits defined above. The comparable equation for specialised ewe sire breeds such as the Border Leicester is:

\[
\text{Income} = a_1G_{NLW} + a_2G_{SW} + a_3G_{CFD} + a_4G_{CFW} + a_5G_{FD} + a_6G_{EBW}
\]

(2)

The combination of economic values and breeding values for the Border Leicester in equation (2) may in reality give misleading weightings to each trait. Equation (2) makes the assumption that the other half of the prime lamb dam i.e., the Merino, is subject to the same breeding objective. In the industry this is clearly not the case. Considerably greater importance is placed on wool production and fibre diameter and less on reproductive rate in the breeding objective for the Merino industry. This should be reflected in the weightings for the traits in the objective for the Border Leicester.

Relative economic values were calculated for each trait in the objective (Table 1) for a prime lamb pure breed (synthetic) industry using the procedures of Ponzoni (1979). The relative magnitude of these economic values is similar to those presented by Stafford and Walkley (1979). Table 1 also presents the relative economic values for the various traits for a Border Leicester stud breeder who receives the majority of his income from the sale of rams. In this case the economic value for NLW is increased by 270% with only minor changes to the other traits in the objective. This illustrates the importance of defining the industry structure and the objectives of breeders at each level together with their sources of income and costs.

Other traits need to be considered in a comprehensive definition of the breeding objective. These include feed consumption (James 1982, 1986), longevity and disease resistance, length of breeding season (in some production/marketing systems) and easy care traits such as freedom from dystocia (Bradford and Meyer, 1986). However Ponzoni (1986) admits the paucity of reliable parameters and economic information has discouraged the inclusion of these traits in the formal derivation of breeding objectives.
TABLE 1: Economic values (\(a_i\)) and net prices used in their calculation for traits included in the breeding objective for pure breed prime lamb production and a Border Leicester stud.

<table>
<thead>
<tr>
<th>Trait</th>
<th>Pure Breed</th>
<th>Border Leicester Stud</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Price (a_i)</td>
<td>Price (a_i)</td>
</tr>
<tr>
<td>NLW $/hd</td>
<td>20.00</td>
<td>100(^2)/20(^3)</td>
</tr>
<tr>
<td>SW $/kg at sale</td>
<td>1.00</td>
<td>2(^2)/1(^3)</td>
</tr>
<tr>
<td>CFD $/mm GR fat</td>
<td>-0.50</td>
<td>0</td>
</tr>
<tr>
<td>CFW $/kg</td>
<td>1.80</td>
<td>1.80</td>
</tr>
<tr>
<td>FD $/um/kg</td>
<td>-0.05</td>
<td>-0.05</td>
</tr>
<tr>
<td>EBW $/kg livewt.</td>
<td>0.27</td>
<td>0.27</td>
</tr>
</tbody>
</table>

1Assumptions include, five age groups of ewes, 3% and 8% for ewe wastage and 120% and 80% for lamb weaning (sale) rate for purebreed and Border Leicester stud respectively and calculated as % return per ewe lifetime.

2Prices used for sale hogget rams

3Prices used for sale of surplus hogget ewes.

A further complication in determining breeding objectives for the Border Leicester is the importance of non-additive effects. The general argument is that additive genetic improvement in the parental breeds is passed on proportionately to the crossbred progeny. For example divergent selection for weaning weight in the Merino resulted in approximately half the divergence in BLxM progeny of the high and low weaning weight Merino lines (Yates and Pattie, 1970). The level of heterosis for weaning weight is small (6%) in crosses between the Border Leicester and Merino (McGuirk et al. 1978). There is a much higher level of maternal heterosis for reproduction and fitness traits in this cross (50% for NLW, McGuirk, 1967). Low fertility and survival in the Border Leicester, despite high fecundity, (Fogarty et al. 1974) contribute to the high level of heterosis found. This suggests there is a breed insufficiency which may be associated with a high level of inbreeding. In this situation selection effort to improve fertility and survival, which are components of NLW, will be of direct benefit to the Border Leicester stud, but these additive gains will be small and may be swamped by the non-additive effect in the BLxM F1 ewes.

PRACTICAL OBJECTIVE AND SELECTION CRITERIA: LAMBPLAN

Not withstanding the above comments the basis for a practical objective and appropriate selection criteria needs to be developed for implementation of national performance recording under the aegis of LAMBPLAN. Obviously this will be an ongoing process as additional information on parameters affecting the objective becomes available and LAMBPLAN is further developed. The traits of greatest importance in the objective for prime lamb dams are NLW, CFW and SW. The other traits included in Table 1 i.e., CFD, FD and EBW, are of lesser importance.
The minimum practical selection criteria that should be recorded to estimate breeding values for these traits are, number of lambs weaned (cumulated over the lifetime of the dam), greasy fleece weight and liveweight at some age between weaning and 15 months of age. Adjustments are required for known environmental effects on greasy fleece weight and liveweight. Other traits that could be measured include fat depth and average fibre diameter to estimate breeding values for CFD and FD respectively. These latter measurements are more expensive and of less importance to the breeding objective, but provision needs to be made for their inclusion to satisfy breeders who require a more sophisticated breeding program.

REFERENCES


