Breeding practices in the Merino industry

Andrew Swan
Animal Genetics and Breeding Unit
University of New England
Introduction

- The production and ram breeding sectors of the Merino industry
- Breeding objectives
- Genetic evaluation
- Breeding programs
Trends in commercial Merino production

- 85% of sheep are Merinos
- Income from wool has historically dominated meat
- Meat prices are now high relative to wool:
  - Dual purpose focus in many commercial enterprises
  - Widespread use of terminal sires over Merino ewes
- Specialised wool flocks more likely to be fine wool
Future challenges

° Drought and reduced sheep numbers
° Low wool prices
° Phase out of mulesing by 2010
## Comparison of enterprises

<table>
<thead>
<tr>
<th>Enterprise</th>
<th>Gross Margin ($/DSE) 5 year average prices</th>
<th>Gross Margin ($/DSE) July 2003 prices</th>
</tr>
</thead>
<tbody>
<tr>
<td>Merino wethers (17 µ)</td>
<td>27.50</td>
<td>41</td>
</tr>
<tr>
<td>Merino wethers (19 µ)</td>
<td>22</td>
<td>19</td>
</tr>
<tr>
<td>Merino wethers (21 µ)</td>
<td>12</td>
<td>21</td>
</tr>
<tr>
<td>Merino ewes (17 µ)</td>
<td>31</td>
<td>48</td>
</tr>
<tr>
<td>Merino ewes (19 µ)</td>
<td>28</td>
<td>34</td>
</tr>
<tr>
<td>Merino ewes (21 µ)</td>
<td>22</td>
<td>36</td>
</tr>
<tr>
<td>First cross lambs</td>
<td>17</td>
<td>38</td>
</tr>
<tr>
<td>Second cross lambs</td>
<td>13</td>
<td>36</td>
</tr>
</tbody>
</table>

Source: Rogan (2003), Sheep CRC
Structure of the ram breeding sector

- Around 1000 studs across Australia
- Traditionally a hierarchical structure
Structure of the ram breeding sector

Group breeding schemes appeared in the 1970’s:

- Open nucleus schemes (see Turner and Jackson)

Australian Merino Society (AMS)

Structure of the ram breeding sector

- Development of across flock evaluation in the 1990’s:
  - Use of performance data and AI led to breakdown of parent – daughter stud relationships
Breeding objectives

- **Economically important traits:**
  - Wool production (fleece weight)
  - Wool quality (fibre diameter, staple strength, style)
  - Reproduction
  - Disease
  - Growth and carcass
  - Feed intake
  - Easy care and welfare related traits (e.g. mules free sheep)
Wool price between 1974 and 2000

Prices from Wool International Market Report

Year

Wool price (cents/kg clean)
Fibre diameter and staple strength are the major determinants of wool price

Source: Wool cheque micron price schedule 2002 - 2004
(www.woolcheque.com.au)
### Heritabilities of wool traits:

(From Safari et al 2005, LPS 92:271)

<table>
<thead>
<tr>
<th></th>
<th>Dir effects</th>
<th>Mat effects</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$h^2$</td>
<td>$h^2$</td>
</tr>
<tr>
<td>GFW</td>
<td>0.37</td>
<td>0.25</td>
</tr>
<tr>
<td>Yield</td>
<td>0.56</td>
<td>-</td>
</tr>
<tr>
<td>CFW</td>
<td>0.36</td>
<td>0.28</td>
</tr>
<tr>
<td>MFD</td>
<td>0.59</td>
<td>-</td>
</tr>
<tr>
<td>FDCV</td>
<td>0.52</td>
<td>-</td>
</tr>
<tr>
<td>SS</td>
<td>0.31</td>
<td>-</td>
</tr>
<tr>
<td>SL</td>
<td>0.46</td>
<td>-</td>
</tr>
</tbody>
</table>
Important genetic correlations for wool traits

Antagonistic:
- Fleece weight and fibre diameter ($\approx 0.3$)
- Fibre diameter and staple strength (0.37)

Favourable:
- Clean and greasy fleece weight (0.86)
- CV of fibre diameter and staple strength (-0.52)

(From Safari et al 2005, LPS 92:271)
Combining wool traits in breeding objectives

- Fleece weight – fibre diameter relationship is critical

- Wool quality traits included in objectives using *price premiums*:
  - 1 micron reduction in FD gives a 10% increase in price → **10% Micron Premium**
  - The price premium approach can be used for any wool quality trait (eg. staple strength, style)
What micron premiums exist?

Micron premiums between 2002 and 2004 (staple strength >= 21 Nkt)

Source: Wool cheque micron price schedule 2002 - 2004
(www.woolcheque.com.au)
Fleece weight – fibre diameter response under different micron premiums

- **Equal FW & FD**
- **Option A - 3% MP**
- **Option B - 6% MP**
- **Option C - 12% MP**

**Start**

**Maximise FW Maintain FD**

**Maintain FW Maximise FD**

**Higher Fleece Weight.**

**Lower Fibre Diameter.**
Reproduction is lowly heritable, but highly variable

<table>
<thead>
<tr>
<th>Trait</th>
<th>Heritability</th>
<th>CV (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lambs weaned</td>
<td>0.07</td>
<td>63</td>
</tr>
<tr>
<td>Fertility</td>
<td>0.08</td>
<td>51</td>
</tr>
<tr>
<td>Litter size</td>
<td>0.10</td>
<td>38</td>
</tr>
<tr>
<td>Survival</td>
<td>0.03</td>
<td>47</td>
</tr>
<tr>
<td>Body weight</td>
<td>0.41</td>
<td>12</td>
</tr>
</tbody>
</table>

(From Safari et al 2005, LPS 92:271)
Reproduction genetic correlations

<table>
<thead>
<tr>
<th></th>
<th>Lambs weaned</th>
<th>Fertility</th>
<th>Body weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertility</td>
<td>0.73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Body weight</td>
<td>0.33</td>
<td>0.40</td>
<td></td>
</tr>
<tr>
<td>Scrotal size</td>
<td>0.20</td>
<td>0.20</td>
<td>0.60</td>
</tr>
</tbody>
</table>

(From Safari et al 2005, LPS 92:271)
Breeding for disease resistance

- Major diseases of sheep:
  - Gastrointestinal roundworms (WEC)
  - Fleece rot and fly strike
  - Foot rot
  - Johne’s disease

- Breeding for parasite resistance has been demonstrated in research flocks:
  - CSIRO and WA Agriculture selection lines
Disease resistance is difficult to include in breeding programs

- Hard to measure production losses
- Breeders reluctant to expose animals to disease
- Difficult to analyse parasite resistance data:
  - Trait distributions not normal
  - Different species of parasite across flocks
  - Different challenge history
- Value of correlated traits and gene markers
Using desired gains indexes for worm resistance

- Selection on a production index (INDEX) and on worm resistance (FEC EBV) can be made independently
- Alternatively, an index including worm resistance can be calculated with moderate (WORM50) or high (WORM70) emphasis on resistance
The development of breeding objectives

- Woolplan in the 1980’s attempted to provide objectives to industry:
  - Too prescriptive, poor adoption

- Rampower in the 1990’s:
  - Industry standard objectives (3, 6, 12 MP)
  - Emphasis on indexes customised for individual breeders

- Sheep Object software to develop customised indexes:
  - To be delivered through SGA
Genetic evaluation

Across flock comparisons:

- Wether trials
- Central test sire evaluation (CTSE)
- On-farm progeny testing, across-flock BLUP, Sheep Genetics Australia (SGA)
Wether trials

Large differences between flocks:
- Production traits → profitability

An aid to commercial growers:
- Compare current and potential ram sources

A valuable resource:
- Comparing up to 200 ram breeding flocks
Wether trial bloodline comparison data

Source: Advanced Breeding Services
Wether trial bloodline comparison data

Source: Advanced Breeding Services
Limitations of wether trials

- Commercial flocks representing studs:
  - Time lag (10-20 years?)
- No information on breeding goals and genetic trends
Central test sire evaluation (CTSE)

- Independent progeny testing of industry sires
- Linked sites across Australia testing around 100 sires annually
- Measure progeny for a range of measured and visual traits
- Merino Superior Sires report
Top performing sires are used widely.

http://mss.csiro.au
Pro’s and con’s of CTSE

♦ Pro’s:
  - Independent comparison run under strict guidelines
  - Run by breeders
  - Data structure useful in combining on-farm data

♦ Con’s:
  - Limited number of sires compared
  - Progeny testing time lag
On-farm across-flock evaluation

- The future of genetic evaluation for Merinos
- Began with Merino Benchmark
- Merino Genetic Services (MGS)
- Now replaced by Sheep Genetics Australia
Sheep Genetics Australia
(http://www.sheepgenetics.org.au)

- Launched October 2005
- Merging of several databases, including on-farm and CTSE data
- Merino analysis is MERINOSELECT:
  - Currently including around 1 million animals
MERINOSELECT

- Data integrity underpinned by QA guidelines
- Data analyses run fortnightly:
  - Testing of flock linkage
  - BLUP analysis using OVIS
- Reporting using a common language:
  - Australian Sheep Breeding Values (ASBV) or Flock Breeding Values (FBV)
  - Standardised trait definition
# MERINOSELECT Breeding Values

<table>
<thead>
<tr>
<th>Age</th>
<th>Carcase</th>
<th>Wool</th>
<th>Health</th>
<th>Reproduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Weight</td>
<td>Weight</td>
<td>Quality</td>
<td>WEC</td>
</tr>
<tr>
<td>Birth</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weaning</td>
<td>✓</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post Weaning</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>Yearling</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>Hogget</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
</tr>
<tr>
<td>Adult</td>
<td>✓</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
<td>✓ ✓</td>
</tr>
</tbody>
</table>
ASBV versus FBV

EBV meets ACCURACY threshold?

Trait meets linkage requirement?

Not Reported

FBV

MERINOSELECT ASBV

LAMBPLAN ASBV
Genetic groups are a feature of the MERINOSELECT analysis

Flock – time period genetic groups:

- Flock groupings to account for the wide range in merit within the Merino breed for many traits
- Time period groupings within flocks to help estimate genetic trends where pedigree is sparse (often sire only)
Time pedigree groups improve estimation of trends in a flock with sire only pedigree
Breeding programs

- Breeding goals based on improved productivity are generally accepted.
- There are diverse views on how to attain these goals:
  - Traditional visual assessment
  - Measurement based programs
  - Skin based programs
The SARDI Merino Selection Demonstration Flocks (SDF)

Five selection flocks:
- Control (CON)
- Measured performance (MPR)
- Visual assessment by sheep classers (PCA)
- Elite wool / SRS (EWF)
- Meat Merino (FM+)

Selection by industry participants (breeders, classers etc), to a common breeding goal
CFW response in SDF selection lines

MFD response in SDF selection lines

Fibre Diameter at 16 Months Genetic Trends

## Hogget fleece value ($ / head) in the 2002 drop SDF progeny (3yr prices)

<table>
<thead>
<tr>
<th>Flock</th>
<th>Rams</th>
<th>Ewes</th>
</tr>
</thead>
<tbody>
<tr>
<td>CON</td>
<td>40.15</td>
<td>37.01</td>
</tr>
<tr>
<td>MPR</td>
<td>58.38</td>
<td>51.05</td>
</tr>
<tr>
<td>PCA</td>
<td>55.14</td>
<td>45.79</td>
</tr>
<tr>
<td>EWF</td>
<td>50.73</td>
<td>45.34</td>
</tr>
<tr>
<td>FM+</td>
<td>58.99</td>
<td>48.67</td>
</tr>
</tbody>
</table>

Key messages - 1

Traits of importance for Merinos:
- Fleece weight – fibre diameter relationship
- Price premium approach to including wool quality traits
- Reproduction traits lowly heritable but highly variable
- Breeding for disease resistance is possible
- Desired gains approach to combine resistance with production traits
- Growing importance of growth and carcass traits
Key messages - 2

- **Large variation between ram breeding flocks for production traits:**
  - Usefulness of wether trial data, particularly for commercial growers

- **Development of across flock evaluation leading to MERINOSELECT**

- **Alternative breeding philosophies:**
  - Common goals, different approaches to animal selection
Thank you!