THE BOOROOLA GENE AND ITS USE IN THE LAMB INDUSTRY

J.E. Stafford
S.A. Department of Agriculture,
Struan Research Centre

1. Where did the Booroola gene come from?

The Booroola gene was first recognised in a Merino flock which had originally been run at Cooma by the Seears Brothers on their property "Booroola". Stock were bought from this property by C.S.I.R.O. in 1958 but it wasn't until later that it was suspected that the high reproduction rate was caused by a single gene. Dr. H.N. Turner examined the origins of the Seears sheep and concluded that the gene could have either arisen as a mutation in the Seears flock or have survived as a remnant of Cape or Bengal sheep which arrived in Australia in 1788 and 1792. Investigations revealed that these sheep may well have been in the ancestry of the Booroola sheep.

So, even though we know the Booroola gene as a Merino gene today, it probably wasn't when it first came to Australia. Now C.S.I.R.O. scientists have mated Border Leicesters to Merinos which carry the Booroola gene, and the offspring of these have been mated back to Border leicesters until they had a flock of 7/8 Border Leicesters which carry the Booroola gene.

2. What is the Booroola Border Leicester?

The Booroola Border leicester is a normal Border Leicester which carries the Booroola (F) gene. When mated to Merino ewes they will produce first cross ewes which also carry the Booroola gene. We calculate that these will lamb at about 212 lambs born/ewe joined and wean 162%. This is about 40% more lambs sold than their non-Booroola counterparts. In all other respects the sheep are the same, the Booroola gene only affects reproduction rate.

The distribution of birth types of Booroolas is not ideal. The following is our estimate of the likely distribution of birth types of 100 Booroola ewes.

<table>
<thead>
<tr>
<th>Litter size</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution</td>
<td>3</td>
<td>19</td>
<td>46</td>
<td>24</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>Lambs born</td>
<td></td>
<td>0</td>
<td>19</td>
<td>92</td>
<td>72</td>
<td>24</td>
</tr>
<tr>
<td>Survival</td>
<td></td>
<td>0.95</td>
<td>0.85</td>
<td>0.70</td>
<td>0.60</td>
<td>0.20</td>
</tr>
<tr>
<td>Lambs Marked</td>
<td>18</td>
<td>78</td>
<td>50</td>
<td>14</td>
<td>2</td>
<td>162%</td>
</tr>
</tbody>
</table>

Ideally, we would like more twins and less singles, quads and quintuplets. One possible way is to reduce feed supply at mating. Experiments with Booroola Merino ewes have shown that this does result in less triplets and quads but did not result in a higher overall number of lambs.

If we were to achieve the survival rates shown on this table there would be little problem in having triplets and quads. These projections can be achieved as will be shown by Colin in the next session.
3. How do we produce these sheep?

(a) Lamb industry.

Traditional lamb dams

\[ \text{BL ram} \times \text{M ewe} \rightarrow \text{BLXM} \times \text{Dorset etc ram} \rightarrow \text{Lamb} \]

We are looking at using the F gene in this system.

(b) Basic genetics – What do we need for our dam.

Genes in each individual are paired. Most characters are controlled by a large number of gene pairs. Some are controlled by one gene pair. These are called single gene characters. The Booroola is a single gene character. This gene is called the F (Fertility) gene. Ewes with a pair of Booroola genes are highly fertile. Ewes with one Booroola gene are just as fertile i.e. the Booroola gene is dominant.

Thus we need BLXM type dams which carry at least 1 Booroola gene.

How do we produce these dams.

Genes are passed from parent to offspring. One gene of the offspring's pair comes from the sire, one from its dam.

Merino ewes from which the BLXM ewes are produced will usually have no Booroola genes. Thus the source of Booroola genes will be the Border Leicester sire.

If the Border Leicester sire has 2 Booroola genes all his offspring will carry one Booroola gene.

\[ \text{BL ram} \times \text{M ewe} \rightarrow \text{BLXM ewe} \times \text{Dorset etc ram} \rightarrow \text{Lamb} \]

This ewe has high reproduction rate.
This is what we are aiming for.

However, it is not easy to recognise which rams carry two Booroola genes. To prove that they do is expensive.

If the Border Leicester ram has only one Booroola gene then half of the offspring will get the Booroola gene but half will get the non-Booroola gene.

\[
\begin{array}{c}
\text{BL ram} \\
\text{F+} \\
\end{array}
\begin{array}{c}
\times \\
\text{ewe} \\
\text{M} \\
\text{++} \\
\end{array}
\Rightarrow
\begin{array}{c}
\text{BLXM ewe} \\
\text{X} \\
\text{Dorset etc. ram} \\
\end{array}
\begin{array}{c}
1/2 \text{ F+} \\
1/2 \text{ ++} \\
\text{Lamb} \\
\end{array}
\]

This half of ewes have \( \rightarrow \) high reproduction rate.

This half don't \( \rightarrow \)

Where a ewe breeder mates his ewes to a group of rams that includes FF, F+ and ++ types the more FF types and the less of the other two the better. The higher the proportion of F genes the better.

**How will the lamb producer obtain his ewes?**

From a ewe breeder who uses Booroola Border Leicester rams. The proportion of high fertility ewes is the same as the proportion of F genes in the group of rams used.

**How will the dam breeder obtain his rams?**

From us or other ram breeders who have worked to increase the proportion of F genes in our/their flock. We should be able to estimate the proportion of F genes from the flock history.

**How will the ram breeder obtain his rams?**

Rams used to breed rams must be tested FF. Using an FF ram increases the proportion of F genes. Using an F+ and ++ rams will reduce the proportion of F genes. Ram breeders may buy their tested rams from us or breed and test their own. We will ensure that the facilities and expertise for testing rams is available to breeders.

Thus, our role in this system is to ensure a supply of proven FF rams for ram breeding. To do this we have to test and breed them. This we are doing in conjunction with C.S.I.R.O. Armidale, who have already bred 7/8 Border Leicester sheep, some of which carry one copy of the gene. We test rams from that flock to identify the carriers. In the first instance only F+ rams will be identified but as these are mated back into the flocks we will find FF rams. These rams are then mated in both the Armidale flock and our own. Initially, tested FF rams will only come from our flock or the Armidale flock.
4. What has been our progress in developing the supply of these rams?

We are aiming to develop two lines of Booroola Border Leicester sheep. One will be greater than 7/8 (87%) Border leicester blood. This line, when mated to Merino ewes should produce ewes which, apart from their higher reproduction rate, have similar characteristics to the Border Leicester Merino ewes currently used in the industry. The other line will have about 65% Border Leicester blood, the rest being Merino. We expect that this will produce ewes with a higher fleece value than the Border Leicester Merino ewes, but do not know how their mothering ability and growth potential will compare.

To produce the 87% line we are mating pure Border Leicester ewes with rams from Armidale which are shown to carry the gene. To produce the 65% we are mating Border Leicester – Merino ewes which are known to carry the gene to the Armidale rams. Thus we are more advanced with the development of the 65% line than the 87% line.

We are testing 25 rams this year, the results of these tests should be known for this years mating. We expect to find both FF and F+ rams in both the 65% and 87% lines.

If we identify FF rams from either line this year we should be able to supply their semen to ram breeders.

We do not intend to sell rams for ewe production until we estimate that the proportion of F genes is at least 75%. We expect a small number of BL65s to be available in 1991 and this will increase in later years. A supply of BL87 rams for ewe production should become available 2 years after we identify our first FF ram.

FF rams will become available for sale after we satisfy our own requirement for these rams.

5. Testing rams for the F gene

There is no easy way of testing rams for the F gene. Each ram to be tested has to be mated to 50 Merino ewes which do not carry the gene. The female lambs from this mating are grown to 5–6 months of age when they are stimulated to ovulate. The number of eggs shed (ovulation rate) is then determined using an endoscope. With this instrument we look at the ewe’s ovaries to determine how many eggs have been shed. This is the ovulation rate. Because of the number of ewes and lambs involved, the number of rams that can be tested is limited. It follows that while it is necessary to test rams before they are used for further ram production, it is too expensive to test rams for ewe production. Thus we provide groups of rams with a high proportion of F genes for ewe production.