Breeding for Breech Strike Resistance
Re-cap

- Selective breeding is a good alternative because it is minimal intervention
- The trouble with disease traits:
  - We need indirect selection criteria
- Previously reported on subsets of data, this is ‘final iteration’ with all data included
Objectives

1. Evaluate potential indirect selection criteria for breech flystrike

2. Develop industry best practice guidelines for including breech strike resistance in Merino breeding programs

3. Make preliminary estimates of heritability and correlations between breech and production traits – the tools to estimate genetic gain
How long will it take?

Response to selection is dependent upon...

- Which traits we use
- Amount of existing variation
- Heritability
- Correlations among traits
- How many traits in the breeding objective
- Relative ‘weighting’ on those traits
- Selection intensity
- Generation interval
- Use (or not) of outside genetics

Trial Outcomes

Differs between breeders

A national breech strike R&D technical update 12th July 2016
CSIRO, Armidale  fine wool sheep, summer rainfall environment
DAFWA, Mt Barker  medium wool sheep, Mediterranean environment

Phase I

Industry flocks (one-off purchase of ewe lambs in 2005, total n ~600)

1  2  3... 10  11 (CSIRO)

Control (unselected, n=200)
- mulesed
- unmulesed

Commercial (selected sires, unselected dams, n=200)
- mulesed
- unmulesed

Intense (selected sires and dams, n=200)
- mulesed
- unmulesed

X

sires from industry
2006-2008
mainly within-flock sires
2009
replacement ewes
replacement sires (from 2009 onward)
culls

2010 no mating, change of flock structure, sheep type and selection criteria
Design changed for Phase 2

2011-2015 inclusive
Target to fine/superfine type and selection on breech flystrike

2010 no mating, change of flock structure, sheep type and selection criteria

Susceptible n=200
all unmulesed

Resistant n=200
all unmulesed

mainly within-flock sires,
few industry link sires

replacement ewes
replacement sires
culls

Phase I
Phase II
Annual calendar

- Wean
- Crutch
- Mate
- Shear ewes
- Shear yearlings
- Mark lambs

LTA rainfall (mm)

- Flystrike season

Month:
- Jan
- Feb
- Mar
- Apr
- May
- Jun
- Jul
- Aug
- Sep
- Oct
- Nov
- Dec

Rainfall:
- 0
- 20
- 40
- 60
- 80
- 100
- 120
What got recorded

600 ewes and their followers

Breech strike resistance indicators
(measured and assessed at birth, marking, post-weaning, yearling and adult)

Reproduction, lambing & pedigree

Disease traits
(flystrike, fleece rot, worms)

Environment
(fly population, weather)

Fleece traits
(yearling & adult)

Bodyweight
(at birth, post-weaning, yearling & adult)
Flystrike recording

- No ‘whole flock’ preventative treatment (except at marking)
- Sheep checked at least 3 times per week
- Fly season is governed by frost incidence (Oct-Apr inclusive)
- Body strikes recorded separately
- All classes of sheep for as long as they remained in flock
  - Weaners, hogget ewes and rams, breeding ewes, sires
Results
Breech cover and breech wrinkle

Distribution in unselected, unmulesed population

Sheep had high wrinkle and high cover
Flystrike

- Rates vary with year (climate), overall ~20% weaner breech strikes
- Weaners most susceptible
- Females more likely to be struck than males
- Body strikes up to 5-6% in Phase I (due to use of sires not suited for high summer rainfall but had good breech traits)
- Body and Breech strike not correlated

<table>
<thead>
<tr>
<th>Across years</th>
<th>Weaners</th>
<th>Yearling ewes</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave BRSTR</td>
<td>18.6%</td>
<td>9.9%</td>
<td>10.9%</td>
</tr>
<tr>
<td>Range BRSTR</td>
<td>11.4 – 25.8%</td>
<td>2.1 – 25.1%</td>
<td>1.8 – 23.3%</td>
</tr>
</tbody>
</table>
Sire group differences in breech flystrike

A national breech flystrike R&D technical update 12th July 2016

Average weaner breech strike rate

Rainfall during flystrike season (mm)

LTA annual rainfall ~800mm, LTA for flystrike season rainfall 540 (~70%)
Flystrike risk with indicator traits

Gold columns where flystrike rate similar to mulesed animals
In some years unmulesed resistant sheep had similar strike rates to mulesed controls.

Mulesed resistant sheep very low strike rates
Individual sires had large impact on trends in some years
Low strike years harder to get accurate assessments

**Phenotypic trend**

<table>
<thead>
<tr>
<th>Year</th>
<th>Control/Susceptible (%)</th>
<th>Commercial (%)</th>
<th>Intense/Resistant (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>0.00</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>2006</td>
<td>0.00</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>2007</td>
<td>0.00</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>2008</td>
<td>0.00</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>2009</td>
<td>0.00</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>2010</td>
<td>0.00</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>2011</td>
<td>0.00</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>2012</td>
<td>0.00</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>2013</td>
<td>0.00</td>
<td>0.05</td>
<td>0.10</td>
</tr>
<tr>
<td>2014</td>
<td>0.00</td>
<td>0.05</td>
<td>0.10</td>
</tr>
</tbody>
</table>

- **Phase I**: 2010 no mating
- **Phase II**: 2010 no mating

**Genetic trend**

<table>
<thead>
<tr>
<th>Year</th>
<th>Control/Susceptible EBV</th>
<th>Intense/Resistant EBV</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>+0.2</td>
<td>+0.8</td>
</tr>
<tr>
<td>2006</td>
<td>-0.2</td>
<td>-0.4</td>
</tr>
<tr>
<td>2007</td>
<td>+0.8</td>
<td>+0.4</td>
</tr>
<tr>
<td>2008</td>
<td>+0.8</td>
<td>+0.4</td>
</tr>
<tr>
<td>2009</td>
<td>+0.8</td>
<td>+0.4</td>
</tr>
<tr>
<td>2010</td>
<td>+0.8</td>
<td>+0.4</td>
</tr>
<tr>
<td>2011</td>
<td>-0.2</td>
<td>-0.4</td>
</tr>
<tr>
<td>2012</td>
<td>+0.2</td>
<td>+0.4</td>
</tr>
<tr>
<td>2013</td>
<td>+0.2</td>
<td>+0.4</td>
</tr>
<tr>
<td>2014</td>
<td>+0.2</td>
<td>+0.4</td>
</tr>
</tbody>
</table>

**Raw mean breech flystrike (%)**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Mulesed</th>
<th>Unmulesed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I (Control &amp; Intense)</td>
<td>6%</td>
<td>31%</td>
</tr>
<tr>
<td>Phase I (mulesed &amp; unmulesed)</td>
<td>Intense/Resistant</td>
<td>Control/Susceptible</td>
</tr>
<tr>
<td>Phase II (all unmulesed)</td>
<td>10%</td>
<td>33%</td>
</tr>
<tr>
<td>Phase II (all unmulesed)</td>
<td>8%</td>
<td>30%</td>
</tr>
</tbody>
</table>

There was no 2010 drop
**Breech wrinkle**

For phase 2 classed out sheep not suited to high summer rainfall, impacted on phenotype.

**Phenotypic trend**

**Genetic trend**

<table>
<thead>
<tr>
<th>Year</th>
<th>EBRWR ASBV</th>
<th>Control/Susceptible</th>
<th>Intense/Resistant</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>+0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2006</td>
<td>-0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2007</td>
<td>-0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>+0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>+0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2010</td>
<td>0.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2011</td>
<td>-0.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012</td>
<td>-0.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>+0.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>-0.3</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Raw mean breech wrinkle score**

<table>
<thead>
<tr>
<th></th>
<th>Mulesed</th>
<th>Unmulesed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I (Control &amp; Intense)</td>
<td>1.9</td>
<td>2.6</td>
</tr>
<tr>
<td>Phase I (mulesed &amp; unmulesed)</td>
<td>Intense/Resistant</td>
<td>Control/Susceptible</td>
</tr>
<tr>
<td>Phase II (all unmulesed)</td>
<td>2.4</td>
<td>3.3</td>
</tr>
</tbody>
</table>
Breech wrinkle and breech strike

Sire eBRWR ASBVs and wBRSTR EBVs

\[ y = 1.0x + 0.02 \]
\[ r^2 = 0.24 \]
**Breech cover**

### Phenotypic trend

![Phenotypic trend graph](image)

### Genetic trend

![Genetic trend graph](image)

### Raw mean breech cover score

<table>
<thead>
<tr>
<th></th>
<th>Mulesed</th>
<th>Unmulesed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I (Control &amp; Intense)</td>
<td>3.9</td>
<td>4.3</td>
</tr>
<tr>
<td>Phase I (mulesed &amp; unmulesed)</td>
<td>3.8</td>
<td>4.3</td>
</tr>
<tr>
<td>Phase II (all unmulesed)</td>
<td>3.8</td>
<td>4.3</td>
</tr>
</tbody>
</table>
Armidale is a low dag environment

Phenotypic trend

Raw mean dag score

<table>
<thead>
<tr>
<th></th>
<th>Mulesed</th>
<th>Unmulesed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase I (Control &amp; Intense)</td>
<td>1.5</td>
<td>1.7</td>
</tr>
<tr>
<td>Phase I (mulesed &amp; unmulesed)</td>
<td>1.6</td>
<td>1.8</td>
</tr>
<tr>
<td>Phase II (all unmulesed)</td>
<td>1.2</td>
<td>1.3</td>
</tr>
</tbody>
</table>

Genetic trend
### Key candidate traits

<table>
<thead>
<tr>
<th>Trait</th>
<th>Variable</th>
<th>Heritable</th>
<th>Correlated with breech strike</th>
</tr>
</thead>
<tbody>
<tr>
<td>Breech wrinkle</td>
<td>✓✓✓</td>
<td>✓✓</td>
<td>✓✓</td>
</tr>
<tr>
<td></td>
<td>0.66</td>
<td>0.36</td>
<td>0.47</td>
</tr>
<tr>
<td>Breech cover</td>
<td>✓✓</td>
<td>✓✓</td>
<td>✓✓</td>
</tr>
<tr>
<td></td>
<td>0.37</td>
<td>0.24</td>
<td>0.35</td>
</tr>
<tr>
<td>Crutch cover</td>
<td>✓✓</td>
<td>✓✓✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>0.38</td>
<td>0.37</td>
<td>0.28</td>
</tr>
<tr>
<td>Dag</td>
<td>✓✓</td>
<td>✓</td>
<td>✓✓✓</td>
</tr>
<tr>
<td></td>
<td>0.37</td>
<td>0.16</td>
<td>0.81</td>
</tr>
<tr>
<td>Urine</td>
<td>✓✓</td>
<td>✓✓</td>
<td>✓</td>
</tr>
<tr>
<td></td>
<td>0.39</td>
<td>0.22</td>
<td>0.06</td>
</tr>
</tbody>
</table>

Based on the genetic parameters estimated for the Armidale flock the genetic gain in breech strike would be greater if the selection criterion was either BRWR and or DAG rather than BRSTR itself (in general agreement with the WA data).
Fixed effects on wrinkle

Effects of birth-rearing type and age-of-dam

Singles ~ ½ score more wrinkly than twins
Adult dam ~ ¼ score more wrinkly than maiden
## Breech flystrike genetic parameters

<table>
<thead>
<tr>
<th>Trait</th>
<th>$V_p$</th>
<th>Weaner</th>
<th>Yearling</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weaner</td>
<td>0.21</td>
<td><strong>0.18 (0.03)</strong></td>
<td>0.29</td>
<td>0.22</td>
</tr>
<tr>
<td>Yearling</td>
<td>0.09</td>
<td>0.92</td>
<td><strong>0.16 (0.03)</strong></td>
<td>0.33</td>
</tr>
<tr>
<td>Adult</td>
<td>0.61</td>
<td>0.40</td>
<td>0.26</td>
<td><strong>0.26 (0.05)</strong></td>
</tr>
</tbody>
</table>

Heritability bolded

Combine trait all ages $V_p = 0.13$ and Heritability $0.20 (0.03)$
<table>
<thead>
<tr>
<th></th>
<th>Breech wrinkle</th>
<th>Breech cover</th>
<th>Dag</th>
<th>Breech strike</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Body weight</strong></td>
<td>✓ (-0.25)</td>
<td>✓ (-0.42)</td>
<td>✓ (-0.23)</td>
<td>~</td>
</tr>
<tr>
<td><strong>Greasy fleece weight</strong></td>
<td>✗ (0.36)</td>
<td>✓ (0.11)</td>
<td>✓ (-0.21)</td>
<td>~</td>
</tr>
<tr>
<td><strong>Clean fleece weight</strong></td>
<td>✗ (0.27)</td>
<td>✓ (0.11)</td>
<td>✓ (-0.20)</td>
<td>~</td>
</tr>
<tr>
<td><strong>Yield</strong></td>
<td>✓ (-0.18)</td>
<td>~</td>
<td>~</td>
<td>✓ (-0.12)</td>
</tr>
<tr>
<td><strong>Fibre diameter</strong></td>
<td>~</td>
<td>✗ (-0.14)</td>
<td>✗ (-0.22)</td>
<td>✗ (-0.25)</td>
</tr>
<tr>
<td><strong>CV fibre diameter</strong></td>
<td>✓ (0.37)</td>
<td>~</td>
<td>✓ (0.30)</td>
<td>✓ (0.31)</td>
</tr>
<tr>
<td><strong>Fibre curvature</strong></td>
<td>~</td>
<td>~</td>
<td>~</td>
<td>~</td>
</tr>
<tr>
<td><strong>Staple length</strong></td>
<td>✓ * (-0.36)</td>
<td>✗ (0.17)</td>
<td>~</td>
<td>✓ (-0.16)</td>
</tr>
<tr>
<td><strong>Staple strength</strong></td>
<td>~</td>
<td>~</td>
<td>✓ (-0.22)</td>
<td>✓ (-0.17)</td>
</tr>
</tbody>
</table>

✓ = favourable, ~ = neutral, ✗ = unfavourable

Correl’n between Wrinkle & Fleece Weight similar to correl’n between Fleece Weight & FD
Implications and implementation in industry

- Industry standards for assessing wrinkle, wool cover, dags, urine stain etc.
- Added to, and modified with considerable input from these projects
- ASBV’s for breech wrinkle, breech cover and dag in 2009.
- Those ASBV’s remain relevant, possible further traits as ASBV’s?
How industry uses breech traits

Stud
(2% of sheep)

- Record breech traits on ewes and rams for ASBVs
- Include breech traits in selection decisions (within-flock selection)
- Purchase sires/semen with ASBVs (across flock selection)
- Multi-trait index incorporating breech traits (yet to come)

Performance recorded

Commercial
(98% of sheep)

- Cull flock ewes on visual assessment of indirect indicators
- Cull sheep that get flystruck
- (Can purchase semen or rams with ASBVs for breech traits)

‘Traditional’

A national breech strike R&D technical update 12th July 2016
Where we’re at

• Changing wrinkle and cover by 1-1.5 units gives effect similar to mulesing

• In 10yrs demonstrated gains in breech flystrike resistance almost as good as mulesing (low dag environment)
  But, we used everything at our disposal
    a) initial buy in of selected dams
    b) across flock selection of sires esp. in early years
    c) within flock selection predominantly on breech traits

• Industry can not change so quickly as there are many more traits in the breeding objective

• Industry has to deal with
  a) unfavourable relationships between breech traits and production traits
  b) no real price premium for unmulesed wool
1. This works, but no single simple ‘recipe’ for every grower
2. Rate of response will be different in every flock
3. Choice of indirect selection criteria will vary with sheep/wool type, production system and environment (climate)
4. Like any selective breeding, gains are cumulative and permanent
5. Selective breeding is a useful tool in the IPM tool-kit

(and whether its at the top or bottom of the tool-kit, is up to the individual)
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