MODELING JD ON SHEEP FARMS:
A TOOL TO ESTIMATE COST-BENEFIT OF CONTROL STRATEGIES

(Nelly MARQUETOUX, Rebecca Mitchell, Anne RIDLER, Mark STEVENSON, Peter WILSON, Cord HEUER)
Background

- **Sheep farming in NZ:**
  - Pastoral farming
  - Strong *seasonality*

- **Mycobacterium avium paratb.**
  - Complex infection dynamics
    - (MAP infection ↔ Johne’s)
  - JD: *production limiting* factor

- Emphasis on control of JD on-farm

- Modeling: a tool to gain understanding and help decision making
Modeling production

• Not “a typical” sheep farm in New Zealand!

• Model:
  ✓ Traditional NZ breeding flock (end = meat production)
  ✓ Self-replacement
  ✓ Farm type: North island Hill country
Modeling production

Weaning

Drafting for meat production (prime lamb)

Time in months

Number of animals

- Lambs
- Weaners
## Model validation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Published data NZ</th>
<th>Value model</th>
</tr>
</thead>
<tbody>
<tr>
<td># lambs tailed/# lambing ewes</td>
<td>132 %</td>
<td>131 %</td>
</tr>
<tr>
<td>% of lamb crop slaughtered by Dec.</td>
<td>21%</td>
<td>20%</td>
</tr>
<tr>
<td># lambs slaughtered/# lambing ewes</td>
<td>101%</td>
<td>92%</td>
</tr>
</tbody>
</table>

*Source: Beef+Lamb NZ, statistics New Zealand*
Dynamics of infection with MAP

- Mild lesions in gut
  - Low shedding of MAP

  → progression to JD
  OR
  → Recovery

- Severe lesions in gut
  - High shedding of MAP

  → progression to JD
Modeling MAP infection dynamics

- Mild lesions Low shed.
- Severe High shed.

- Progressor track
- Non-progressor track

- Environment

- Variables and parameters:
  - $S$, $Lt$, $R$
  - $\lambda$, $\mu$, $\tau$, $\delta$, $\mu_c$
  - $\sigma_p$, $\sigma_m$
  - $\chi$, $\alpha$

- Mathematical model equations and parameters are not fully visible in the image provided.
PTB in sheep in NZ

- Average NZ flock clinical incidence = 0.16% (Verdugo 2012)
- **Problem farms**, high mortalities due to JD

Results: clinical incidence of JD = 1%
## Model validation

<table>
<thead>
<tr>
<th>Outcome (MA ewes)</th>
<th>Published data</th>
<th>Value model</th>
</tr>
</thead>
<tbody>
<tr>
<td>prev. of “ever infected”</td>
<td>?</td>
<td>70-80%</td>
</tr>
<tr>
<td>prev. of shedding</td>
<td>2-26%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>6-7%</td>
</tr>
<tr>
<td>annual OJD mortality (all ages)</td>
<td>2.9%&lt;sup&gt;a&lt;/sup&gt;</td>
<td>2.9%</td>
</tr>
<tr>
<td>annual OJD mortality (ewes only)</td>
<td>1%&lt;sup&gt;b&lt;/sup&gt;</td>
<td>1.8%</td>
</tr>
</tbody>
</table>

<sup>a</sup> Reddacliff, L., J. Eppleston, et al. (2006)

<sup>b</sup> Morris, C. A., S. M. Hickey, et al. (2006)
Model outcomes: cost of Johne’s

Prices 2012 (/head):
Prime lamb: $113.5
Mutton: $93

Source: Beef+Lamb Economic service

Annual cost of JD (2012)
NZD 3.2 / ewe

Estimate for 2013:
NZD 2.64

Mortality 93.5% of OJD cost

- Lower LWT 0.5%
- Sub-fertility 6%
- Lamb meat 11.5%
- Mutton meat 82%
Cost effectiveness of vaccination

Annual cost of JD: $3.20
Vaccine per head: $3
Vaccination replacement: 0.37 * 3 = $1.11

Vaccine efficacy: 90% drop in shedders and JD mortality (Reddacliff 2006)
Cost effectiveness of vaccination

JD mortality 1.8%

JD mortality 0.75%
Conclusion

• Vaccination:
  - cost–effective in some scenarios (extra OJD mortality >1%)
  - Long term process

• Cost effectiveness: not the only incentive for control:
  - Perception (stigma)
  - Food safety
  - Welfare

• This model:
  - Sensible prediction (disease/production)
  - Tool to help decision making on farm

• Lack of robust data on true impact of JD on farm
Thank you for your attention
Lambs (0-3 months)
- Seasonal lambing (late winter)
- Weaning at 3 months old

Weaners (3-12 months)
- Drafted regularly for meat
- Keep replacement to maintain flock size

Replacement (12-24 months)
- First mating season as 2-tooth
- Replace culled ewes at following lambing

Ewes (> 2 years)
- Seasonal mating in autumn
- Annual culling (replacement rate 25%)
Situation of PTB in sheep in New Zealand (Verdugo 2012)

Herd level true prevalence: 79%

% of infected herds reporting cases: 54%

Annual clinical incidence (95% CI): 0.16% (0.09 - 0.24%)