Summary

This first interim report gives an account of the study material and shows trends in expected outputs to date related to ovine Johne’s disease (OJD). Twenty farms were enrolled between August 2012 and July 2013 of which 18 have delivered data. Because this is a multicentre study, an online database (IRIS) was developed with entries from 644 ewes sampled at post mortem or from live animals in poor body condition. The proportion of sampled animals that all had low body condition scores (BCS 1-2 of 5) and that were also diagnosed with clinical OJD was 57%. This percentage varied from 20% to 100% among farms; Merino (62%) appeared to be more prone to OJD than other breeds (44%) among culled ewes. The majority (89%) of 140 clinically affected ewes were ELISA positive whereas a minority (15%) of 58 ewes without overt clinical, pathological or histological signs of OJD were ELISA positive.

An attempt was made to provide a first estimate of OJD related loss at farm and population level. This required a number of assumptions, detailed in the results, which need to be corroborated by further data collection. From available data, the age at culling was 6 months lower in ewes diagnosed with clinical OJD than in non-OJD ewes. Based on this difference, farms with a relatively high incidence of OJD associated ewe mortality such as the study farms (2.85%), lost $1.1 per ewe due to OJD. This estimate was similar to outputs from modelling presented at the NZVA conference in July 2013. Extrapolated to population level, the annual loss due to OJD in the New Zealand sheep may be around $9 million. The estimate may be conservative as it was assumed that 26% of MAP infected sheep farms were latently infected without any OJD mortality, 58% had low OJD mortality incidences and only 6% had high OJD incidences as observed in the study farms. Caution should taken when communicating these preliminary estimates.

A selected sample of tissues (97) has been forwarded to AgResearch for culture and strain typing and another set is in preparation to be sent by end of February. No results are available as yet, but are expected to be available by end of April, and presented at the International Colloquium for Paratuberculosis in June, 2014 (abstract submitted on 7 Feb 2014).
Aims and Scope

Expected outputs from the project are:

- An estimate of the rate of total ewe loss on farm known to be affected by Johne’s disease
- An estimate of the proportion of ewe loss on farm attributable to OJD in sheep flocks known to be affected by Johne’s disease;
- An estimate of the cost-benefit of known interventions for the control of OJD in sheep (e.g. vaccination or test & cull)

Here we report about progress of implementation, a description of farms and of results from post mortem and suspect sampling and testing, and an initial estimate of presumed ewe loss attributable to OJD specific mortality.

Implementation

Schedule: Farm enrolment commenced in July 2012 and farm monitoring from September 2012 onwards as planned; some background survey data were available from each farm at enrolment, detailed farm tallies from a limited number. The first interim report was planned to be available by April 2013, but this deadline was postponed due to additional funding by the Merino Breeders Association and subsequent enrolment of Merino farms (Figure 1).

Enrolment: The project commenced in July 2012 by contacting and enrolling 20 commercial sheep breeding farms. Six Merino farms and 4 with other breeds were enrolled until December 2012. After additional funding was committed by the Merino Breeder Association, additional 6 Merino farms were included and 4 farms with mixed breeds were added including 2 North Island farms between March and July 2013 (Figure 1). Farms with ‘other’ breeds were Composite (2 farms), Corriedale (1), Halfbred (1), and Romney (3).
Material and data received: Post mortem reports were received from 18 farms, samples from live, OJD suspect ewes from 13 farms, and initially survey data (e.g. stock numbers) from 17 farms until reporting date (Feb. 2014). Stock numbers ranged from 750 to 8,200 on 15/17 farms; two large South Island stations grazed 20,100 (Te Pa) and 36,245 ewes (Bog Roy Station); 12/17 also grazed beef cattle and none of the properties with available stock reports farmed deer.

Database: A database was developed online (IRIS) to allow data entry at multiple sites (Massey, Blenheim, NZVP) and data inspection and download (Massey, JDRC Wellington, Blenheim). Several thousand items from post mortem and live animal sampling were entered and are currently validated. Most basic survey data about farms were entered, too. However, dynamic data such as tallies of lambs, deaths etc. still need to be collected from farms.

Testing and Analysis: The project is still in the process of collecting data and samples. Ongoing testing of samples include the pathology-scoring of histological tissue sections for stages of OJD progression and ELISA of blood serum. This will be associated with breed, age, farm size, season, vaccination history, lamb offtake per ewe, and other variables. A comparison of age at culling of ewes with/-out OJD will quantify the difference in productive lifetime due to OJD. Together with assumptions about culling rates and the proportion ewes in poor body condition at culling, this will lead to an estimate of production effects attributable to OJD-specific mortality.

Strain typing: tissues of various stages of OJD progression or severity, indicated by histology scores, are currently subjected to culture at AgResearch Wallaceville (c/o Geoff De Lisle) and molecular strain typing by VNTR/SSR methods (c/o Marian Price-Carter and Des Collins). An association between OJD tissue lesion severity and strain types (ST) would suggest virulence differences that might become instrumental for OJD control. So far, 97 samples were cultured and ST results are expected by May 2014.
Interim Results

It is too early for results or conclusions as data entries need to be validated. However, some descriptive analyses are shown below. Post mortem inspections of 297 culled ewes revealed strong farm differences in the proportion of ewes diagnosed as OJD (Figure 3) whereas there were no clear seasonal trends (Figure 4). Corriedale, composite breeds and merino appeared to have more OJD in culled ewes than Halfbreed and Romney (Figure 5, left). However, breed was partially confounded by farm (or ‘management’) as only merino is well represented by 12 farms, other breeds by only 1-2 farms. Body condition of the studied ewes was low, mostly 1 or 2 of 5; there was a trend of more OJD among BCS=1 ewes than higher BCS (Figure 5, right).

![Figure 3: Percentage OJD diagnosed on each farm by post mortem inspection among 297 ewes culled at BCS 1 or 2/5](image)

![Figure 4: Percentage OJD among culled ewes by season](image)
There was a clear association between OJD affected and unaffected ewes in poor body condition at culling and ELISA titres. Almost all ewes without sign of OJD at post mortem inspection or histological examination were below the ELISA cutoff (S/P=50), and most OJD affected ewes were above the threshold (Figure 6). There was however no ELISA trend among the affected ones. This suggests that the extent of tissue lesions or acid fast organisms seen in histology sections was not associated with the humoral immune response. Still only 6 samples were available from ewes where few tissue lesions were observed (score 2). If anything, there was a downward trend from lesion types 2 to 3c, but the trend was not significant.
Age at culling: Ewes that were provisionally diagnosed as having clinical OJD at post mortem were about 6 months younger ($p = 0.0071$) than ewes that were culled for reasons than OJD, such as poor molars, parasite infestation, lameness or lung disease (Table 1). The difference was independent of breed, hence merino ewes were not culled at a different age due to OJD as were other breeds. The difference was also the same when the potentially confounding effect of farm was considered.

Table 1: Age at culling of OJD and non-OJD ewes.

<table>
<thead>
<tr>
<th>Provisional diagnosis at PM</th>
<th>n</th>
<th>Mean</th>
<th>95% Confidence Interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Other conditions</td>
<td>218</td>
<td>5.06</td>
<td>4.83 5.29</td>
</tr>
<tr>
<td>OJD</td>
<td>216</td>
<td>4.55</td>
<td>4.34 4.76</td>
</tr>
<tr>
<td>Difference</td>
<td>0.51</td>
<td>0.20</td>
<td>0.82</td>
</tr>
</tbody>
</table>

**Estimated production loss at farm level due to OJD:** an initial attempt is made here to estimate the farm-level and economic loss attributable to OJD based on the data currently available. A number of assumptions had to be made which may have to be revised as more data a becoming available. Data from this project informing the estimate are from the comparison of age at culling shown in Table 1. A half year difference in productive lifetime of a ewe translates to 19% annual culling of non-OJD ewes and 22% in OJD affected ewes. On high incidence farms such as most of the farms in this study, this difference in productive lifetime would mean that approximately $1 was per ewe and year due to OJD mortality if it was assumed that 20% of ewes to be culled were in low body condition of 1-2 on a scale of 5. The data showed that 57% of ewes in poor body condition had clinical OJD, hence presumably died prematurely due to OJD. Appreciating that mortality accounts for 93.5% of total OJD related loss, the annual cost of OJD on high incidence farms increases to $1.1 per ewe.

**Estimated production loss at farm level due to OJD:** Accepting that 78% sheep farms were MAP infected (2008-10 survey), and assuming further that 28% farms with MAP infection would not have any OJD related loss, that 45% would have low OJD related mortality of 0.1-2% and 5% farms have high OJD mortality >2% (using current study farm data: 2.85%), the total loss for the New Zealand sheep population of 30 million adult sheep would be NZ$8.5 million. Adjusting the estimate to additional 6.5% loss from reduced reproductive performance and lamb growth rates, the total annual loss increases to $9 million for the entire industry.