THE BIOLOGICAL AND FINANCIAL IMPACT OF OVINE JOHNE’S DISEASE IN AUSTRALIA

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Declaration

Apart from the assistance stated in the acknowledgements and where reference is made in the text, this thesis represents the original work of the author. I certify the work presented in this thesis has not been submitted for any other degree or qualification at any other university.

Russell David Bush
B.Sc.Agr (Hons.I)
November 2005
Dedication

This thesis is dedicated to my wife, Susan, for her inspiration and encouragement to commence a tertiary degree after an extended absence from formal study and her continual support throughout my undergraduate and postgraduate endeavours.
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This thesis would not have been possible without the assistance of many people and organisations. In particular, I would like to acknowledge my supervisor Dr Jenny-Ann Toribio and co-supervisor Associate Professor Peter Windsor for their encouragement, guidance, support and attention to detail throughout this study. I would also like to acknowledge Mr Stewart Webster (NSW DPI Orange), my other co-supervisor, for his guidance and intellectual contribution during the development of the gross margin model.

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Summary

This study was conducted to provide accurate information about the impact of OJD on sheep mortality and financial status on infected farms in Australia. Industry considered this research to be important because little credible information was available regarding the magnitude of the OJD problem and the responses required to control and manage OJD in southern Australia.

This 3-year study, conducted on 12 OJD-infected farms in southern NSW, commenced with a 12-month observational study in 2002. During this year OJD mortality estimates were derived from farm records (livestock inventories) and quarterly farm visits (necropsy inspections). Questionnaires, climatic records and pasture samples enabled a detailed description of each farm to be made and a single collection of blood and faecal samples provided OJD prevalence information for specific age cohorts of sheep in each flock. The financial impact of OJD was established using two approaches, a gross margin analysis and the provision of a financial value on the mortalities inspected during the necropsy inspection periods.

For a further 2 years, inventory and management information was collected from each of the twelve farms to provide 2003 and 2004 estimates for OJD mortality and financial loss due to OJD based on gross margin analyses. A more detailed gross margin model was developed that has the capacity to compare three disease status scenarios (uninfected, infected and vaccinated) for a number of different sheep production enterprises. These enterprises include fine, medium and strong wool Merino ewes and wethers as well as 1st and 2nd cross lamb production.

From the four 5-day necropsy inspections conducted in 2002, a most likely cause of death was determined for 362 necropsied sheep on the basis of findings related to the environment, clinical signs, gross pathology and histopathology. Of these, OJD was most likely to have contributed to the death of 250 sheep, OJD was unlikely to have contributed to the death of 1 sheep and OJD did not contribute to death of 111 sheep. During 2002, across the 12 farms, there were a total of 52,718 wethers and 47,374 ewes at-risk of becoming infected with OJD. The distribution of mortalities in each
sex group translates to an OJD mortality rate of 4.3% among wethers and 4.9% among ewes. Distribution across inspection periods showed a trend among OJD-related necropsies and total necropsies with the majority occurring in winter (31%) and spring (35%) and fewer in autumn (18%) and summer (16%).

Across the 12 farms, the annual OJD mortality rate ranged from 1.8% to 17.5% during the 3-year study with mean annual figures of 6.2% in 2002, 7.8% in 2003 and 6.4% in 2004. Of concern is the fact that these mean OJD mortality figures were all above the accepted annual mortality rate from all causes for adult sheep of 4-6% (McGregor et al., 2003) for Australian flocks.

Gross margins were calculated for each of the 12 farms assuming each farm was free of OJD and then these were compared with the actual farm gross margin. The mean percentage decrease in gross margin due to a farm being infected with OJD was 6.4% in 2002, 8.5% in 2003 and 7.4% in 2004. This equates to a mean reduction in annual income of $15,000 per farm in 2002, $12,154 in 2003 and $13,991 in 2004.

Using the necropsy inspection information the mean estimated cost of OJD losses on the 12 farms over 2002 was $60,500 (range $10,978 to $150,836). The estimated cost of OJD losses accounted on average for 69.4% (range 19.4% to 100%) of the estimated total loss related to sheep deaths over the 12-month period.

The OJD prevalence in 2-year old sheep in 2002 based on pooled faecal culture (PFC) ranged from 0.7% to > 23% on the 12 farms and was found to be associated with OJD mortality rate (P = 0.02). In contrast, no significant relationship was found between faecal excretion rate of MAP in two-year old sheep based on PFC and OJD mortality rate, or between age-related OJD seroprevalence and OJD mortality rate.

The association between various environment, management and disease factors and quarterly OJD mortality rate was analysed and several factors (including flock size, stocking rate, area of improved pasture and weaning age) were identified as being important for further investigation. Definite conclusions based on statistical analysis could not be made due to the small number of farms and use of whole flock data. However, the results provide strong support for an additional study, involving a large
number of farms and focusing on a specific sheep cohort, to identify the major risk factors for OJD.

The necropsy study in 2002 established 31% of deaths were due to causes other than OJD and could have been prevented in most cases. More than half (63%) of the non-OJD deaths were attributed to malnutrition, with 57% of these deaths occurring on one farm where pregnancy toxaemia resulted from sheep receiving inadequate nutrition in late pregnancy. Many of these deaths could have been prevented with earlier feeding. The occurrence of grain poisoning on some farms reinforces the need for improved strategies when supplementary feeding. Under more favourable seasonal conditions these nutritional syndromes are unlikely to occur.

Sporadic drought conditions throughout the 3-year study period, for each of the four study regions, were likely to have a minimal effect on measuring the impact of OJD on the 12 farms. At the end of 2002, following the realisation the drought would likely persist into 2003, the 12 farms on average selectively reduced flock numbers by 25%. However, this reduction is unlikely to have had an adverse effect on establishing the proportion of OJD mortalities as stock reductions occurred mainly towards the end of 2002 and the sheep most likely to be sampled at each necropsy inspection period were unlikely to be sold, as they displayed low body condition score and showed signs of weakness.

A gross margin model was developed to provide an estimate of the on-farm cost of OJD. Non-infected, infected (status quo) and infected (vaccination) disease scenario examples were run for 1000 head Merino ewe and wether enterprises as well as first and second cross prime lamb enterprises. The total cost of OJD (relative to an uninfected status) and an avoidable cost of OJD (using Gudair™ vaccination) were reported at four investment horizons to illustrate the cost of an OJD infection on a flock as well as the potential cost saving if a control strategy involving vaccination is implemented. Although vaccination reduces OJD mortalities, there is still an unavoidable cost incurred by the producer when compared to an uninfected flock. Results are presented as cumulative gross margin per dry sheep equivalent expressed in net present value terms (GM (NPV)/DSE) at 5, 10, 15 and 20-year intervals to enable a comparison between enterprises.
The model suggests a vaccination breakeven point is achieved in two to three years for breeding enterprises if the level of OJD is high. If the level of OJD is low a vaccination breakeven point is achieved in three years for either a 1st cross or 2nd cross enterprise and seven years for a Merino ewe enterprise. The Merino ewe enterprises take the longest time to reach a vaccination breakeven point as more young sheep are retained annually for breeding in addition to the cost involved with vaccinating lambs, which is borne by all three breeding enterprises. The returns to vaccination are greatest for the 1st and 2nd cross lamb enterprises due to the value and number of lambs sold annually. With Merino wethers a vaccination breakeven point is reached in year one for all disease categories due to vaccinated replacement hoggets being introduced to provide an immediate response in reducing OJD mortalities, however as no breeding occurs the ability to increase income is limited. In the absence of OJD mortalities with the at-risk disease category, a vaccination breakeven point is not reached within the model’s 20-year time frame for any of the enterprises.

This study provided the first objective data on the true impact of OJD on 12 farms, and the findings are generally applicable to sheep flocks in southern Australia. Industry groups claiming that OJD does not present a threat on-farm can now be provided with accurate figures on direct losses attributable to OJD within the endemic area of NSW. There was a wide range of impacts, with some very high mortality rates. The data can be used to justify vaccination programs, other control options and the general concept of disease control and prevention.

The challenge now for industry is the design and implementation of an education and extension package that can incorporate these findings and the gross margin model along with other recent research findings to address issues of misinformation about OJD and inform producer decisions regarding on-farm disease control.
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**Glossary**

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<th>Description</th>
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<td>AAGIS</td>
<td>Australian Agricultural and Grazing Industries Survey</td>
</tr>
<tr>
<td>ABC</td>
<td>Assurance Based Credit</td>
</tr>
<tr>
<td>ABARE</td>
<td>Australian Bureau of Agricultural and Resource Economics</td>
</tr>
<tr>
<td>ADF</td>
<td>Acid Detergent Fibre</td>
</tr>
<tr>
<td>AFB</td>
<td>Acid-fast Bacilli</td>
</tr>
<tr>
<td>AGID</td>
<td>Agar-gel Immunodiffusion (gel test)</td>
</tr>
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<td>AAHC</td>
<td>Australian Animal Health Council</td>
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<tr>
<td>BJD</td>
<td>Bovine Johne’s Disease</td>
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<tr>
<td>CD</td>
<td>Crohn’s disease</td>
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<tr>
<td>CFA</td>
<td>Cast For Age</td>
</tr>
<tr>
<td>CFU</td>
<td>Colony Forming Units</td>
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<tr>
<td>CMI</td>
<td>Cell Mediated Immunity</td>
</tr>
<tr>
<td>DDM</td>
<td>Digestible Dry Matter</td>
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<tr>
<td>DM</td>
<td>Dry Matter</td>
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<tr>
<td>DSE</td>
<td>Dry Sheep Equivalent</td>
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<tr>
<td>DV</td>
<td>District Veterinarian</td>
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<tr>
<td>ELISA</td>
<td>Enzyme-linked Immunosorbent Assay</td>
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<tr>
<td>EA</td>
<td>Exclusion Area</td>
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<td>GM</td>
<td>Gross Margin</td>
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<td>Growth Index</td>
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<td>Ha</td>
<td>Hectare</td>
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<tr>
<td>H &amp; E</td>
<td>Haematoxylin and Eosin</td>
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<tr>
<td>JD</td>
<td>Johne’s Disease</td>
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<tr>
<td>MAP</td>
<td><em>Mycobacterium avium</em> subspecies <em>paratuberculosis</em></td>
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<tr>
<td>ME</td>
<td>Metabolisable Energy</td>
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<td>MLA</td>
<td>Meat and Livestock Australia</td>
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<tr>
<td>NJDILC</td>
<td>National Johne’s Disease Industry Liaison Committee</td>
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<td>NOJDP</td>
<td>National Ovine Johne’s Disease Control and Evaluation Program</td>
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<tr>
<td>NPV</td>
<td>Net Present Value</td>
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<tr>
<td>OD</td>
<td>Optical Density</td>
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<tr>
<td>OJD</td>
<td>Ovine Johne’s Disease</td>
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<tr>
<td>PBS</td>
<td>Phosphate-buffered Saline</td>
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<td>PCR</td>
<td>Polymerase Chain Reaction</td>
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<td>Property Disease Eradication Plan</td>
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<td>PDMP</td>
<td>Property Disease Management Programs</td>
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<td>Restriction Endonuclease Analysis</td>
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<td>RLPB</td>
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<td>SDR</td>
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<td>Se</td>
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<td>SheepMAP</td>
<td>Australian Sheep Johne’s Disease Market Assurance Program</td>
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<td>Sp</td>
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