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**Pneumonia and pleurisy in sheep:
Studies of prevalence, risk factors,
vaccine efficacy and economic impact**

A thesis presented in partial fulfilment
of the requirements for the degree of Doctor of Philosophy
at Massey University, Palmerston North
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Abstract

The objectives of this thesis were to investigate patterns of lamb pneumonia prevalence of a large sample of New Zealand flocks including an investigation of spatial patterns, to evaluate farm-level risk factors for lamb pneumonia, to determine the efficacy of a commercially available vaccine for the disease and to estimate the likely cost of lamb pneumonia and pleurisy for New Zealand sheep farmers.

Data were collected by ASURE NZ Ltd. meat inspectors at processing plants in Canterbury, Manawatu and Gisborne between December 2000 and September 2001. All lambs processed at these plants were scored for pneumonia (scores: 0, <10% or \geq 10% lung surface area affected) involving 1,899,556 lambs from 1,719 farms. Pneumonia prevalence was evaluated for spatial patterns at farm level and for hierarchical patterns at lamb, mob and farm levels (Chapter 3). The average pneumonia prevalence in Canterbury, Feilding and Gisborne was 34.2%, 19.1% and 21.4% respectively. Odds ratios of lambs slaughtered between March and May were vastly higher than those slaughtered in other months indicating longer growth periods due to pneumonia. Since pneumonia scores were more variable between mobs within a flock than between flocks, it was concluded that pneumonia scores were poor indicators for the flock pneumonia level due to their lack of repeatability. There was no statistically significant spatial autocorrelation in pneumonia prevalence for any region, hence lamb pneumonia appeared to be largely independent of topographical and geo-climatic factors.

A questionnaire-based case-control study was conducted investigating farm-level factors from a sample of farms with either high (case) or zero (control) pneumonia prevalence at slaughter (Chapter 4). Significant risk factors for case farms were: (1) shearing lambs on the day of weaning, (2) breeding ewe replacements on-farm (3) number of lambs sold (an indicator of flock size) and (4) increased percentage of lambs sold late in the season (March to May). Significant protective factors included: (1) set stocking lambs after weaning, (2) injecting lambs with Vitamin B12 at the time of tailing, (3) injecting lambs

with Vitamin B12 at weaning. In Canterbury, flocks with Romney ewes and other ewes had a higher risk of pneumonia than those with fine wool type ewes (Merinos, Corriedales or Halfbreds).

In a clinical trial, 8,364 lambs from seven commercial sheep farms with a history of lamb pneumonia were vaccinated with Ovipast Plus® or placebo by systematic random allocation within mob and farm. An assessment of the extent of pneumonic lesions was conducted at slaughter and lamb growth rate was monitored through the growth period (Chapter 5). The vaccination trial showed no statistically significant effect of Ovipast® vaccination on the extent of lung lesions at slaughter or ADG of lambs from the first treatment until slaughter. No significant differences were found between isolation rates of *Pasteurella* spp and patho-histological classifications from pneumonic lung samples of placebo and vaccinated lambs.

A spreadsheet-based stochastic model was constructed to estimate the cost of lamb pneumonia and pleurisy to New Zealand farmers. The estimate was based on data of the effect of pneumonia on lamb growth rate, distributions of pneumonia severity, prevalence of moderate to severe pneumonia ($\geq 10\%$ lung surface area) and pleurisy prevalence (Chapter 6). The simulated annual average cost of pneumonia was NZ \$28.1 million and that of pleurisy NZ \$25.1 million. The combined cost of pneumonia and pleurisy to New Zealand farmers had an average of NZ \$53.2 million (95% stochastic interval = \$32.4–\$78.9 million), or US \$31.9 million per annum. This would equate to NZ \$2.32 per lamb. In comparison, animal health, shearing expenses and feed expenses cost NZ \$2.37, \$2.62 and \$1.85 per lamb, respectively.

This research has demonstrated sub-clinical pneumonia to be a widespread disease in the New Zealand sheep farming population while previous research has focussed on case studies of affected farms. The estimated costs of pneumonia and pleurisy to New Zealand farmers (\$53.2 million) highlight the financial effects of these diseases and the need for further research. We also found that the commercially available vaccine could neither prevent sub-clinical effects (lamb growth rate) nor clinical manifestations (pneumonic lung lesions) of lamb pneumonia. The case-control study has revealed farm-level factors which, in the absence of effective vaccines, indicated management practices that farmers might perceive as opportunities to control lamb pneumonia. However, it is advisable to evaluate the efficiency of such management changes.

Pneumonia is aetiologically complex disease involving the interplay of many environmental, host and pathogen factors. It is also a difficult disease to study in the absence of diagnostic tests in live animals. However, further research should focus on the development of management changes until effective vaccines are available. A starting point for this research would be to evaluate the impact of such management changes in reducing the incidence of lamb pneumonia. More specifically, the roles of stress during crowding of lambs for extended periods warrants further investigation. The development of efficient vaccines requires an analysis of pathogens, especially *Pasteurella (Mannheimia) haemolytica* and *Mycoplasma* species, the sources of infection, their strain diversity and transmission dynamics.

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