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Financial impact of Ovine Johne's Disease on the processing sector

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Abstract

The aim of this pilot study was to estimate the financial loss due to ovine Johne's disease (OJD) to producers and processors in Tasmania, using consignment and individual carcase information on presence of OJD and OJD vaccination lesions. The information was collected from the Tasmanian Quality Meats (TQM) abattoir. A case study investigated producer attitudes towards abattoir disease feedback and OJD management practices. Data from 358 consignments and 31,858 individual carcases were collected. Six mutton consignments were OJD positive, with a median apparent within consignment prevalence of 4.6% (5-95%, 3.5% - 16.1%). Forty-seven consignments had OJD vaccination lesions, with a 3.0% (0.40% – 17.6%) median proportion of carcases with lesions. The mean carcase weight, value, fat class, slaughtering time and skin price per consignment were not associated with the presence of OJD, OJD vaccination lesions and the proportion of lesions within consignment. The individual carcase weight was associated with the presence of OJD vaccination lesions ($p = 0.008$). The median proportion of total consignment weight trimmed due to OJD vaccination lesions was 0.03% (0 – 0.73). The data collected in this study were not appropriate to examine the impacts of the presence of OJD on processing, due to the limited number of OJD positive consignments. The framework for the economic analysis considered direct and indirect costs at slaughter. The direct costs are due to the meat, viscera and skin loss and the waste disposal costs; while, the indirect costs are due to an increase in labour costs. The distribution of these costs between the abattoir and the farmer will depend on the nature of the consignment and the contractual arrangement between the abattoir and the farmer. Most producers (19 out of 20) participating in the case study believed the disease feedback received from TQM was useful. This feedback prompted changes in producers' attitudes towards these conditions and management practices in most producers, who indicated that costs due to reduced payment from the abattoir was the most important motivator for practice change. This pilot study has provided an insight into the potential impacts of OJD and OJD vaccination lesions during processing as well as the producers' attitudes and behaviours towards abattoir disease feedback.

Executive summary

Paratuberculosis or Johne's disease (JD), a chronic enteric disease of ruminants caused by *Mycobacterium avium* subsp. paratuberculosis (MAP), causes considerable economic losses to the livestock industries. However, the financial impact of OJD in sheep at slaughter has not been previously investigated and as such, there is a need to quantify the magnitude of this loss, identify the direct and indirect costs of OJD and investigate the relationship between the OJD on-farm status with the carcase quality and economic cost caused by this condition. This project, which was considered a pilot study, provides a conceptual framework for estimating the costs of OJD incurred during animal processing and identifying the different components of these costs. The aim of the project was to estimate the financial loss due to OJD to producers and processors in Tasmania in sheep (>=2 years old) identified during the slaughter process and to investigate potential associations between the severity of the carcase lesions with estimated OJD on-farm status, carcase quality and economic cost of the disease.

Data on different disease conditions, including OJD and OJD vaccination lesions, were collected during two periods of time; the first one from the 14th of May to the 18th of June 2012 and the second from 16th of November 2012 to 27th of March 2013. In addition, a component of this research project included a telephone survey on producer attitudes and management practices in relation to OJD. This social research component aimed to broaden understanding of the role of the abattoir in promoting awareness and changes to sheep management to reduce the impact of disease for the producer and the processor.

Data from 358 consignments and 31,858 individual carcases were collected. Six mutton consignments were OJD positive, with a median apparent within consignment prevalence of 4.6% (5-95%, 3.5% - 16.1%). Forty-seven consignments had OJD vaccination lesions, with a 3.0% (0.40% – 17.6%) median proportion of carcases with lesions. The mean carcase weight, value, fat class, slaughtering time and skin price per consignment were not associated with the presence of OJD, OJD vaccination lesions and the proportion of lesions within consignment. The individual carcase weight was associated with the presence of OJD vaccination lesions ($p = 0.008$). The median proportion of total consignment weight trimmed due to OJD vaccination lesions was 0.03% (0 – 0.73) with a mean of 0.18%. Interpretation of results obtained is difficult due to the lack of available data on OJD positive consignments. The potential reasons for this reduction in OJD presence among mutton consignments in comparison with previous years could be due to various factors. Results from the retrospective data contrast with results obtained with data from the current study, and suggest that there is a potential economic impact of OJD presence on the processing sector and returns to farmers. More detailed analysis of retrospective data from this abattoir and others could provide more evidence of this potential impact.

Results from the qualitative study indicate that receiving feedback directly from the abattoir on a range of animal health conditions was valued by the producers interviewed for this project. In addition, how the feedback was provided was suitable for most producers, although TQM could consider some modifications to aspects of the information and the use of alternative communication technologies. In most cases, farmers responded that feedback did result in changes in management practices related to OJD control.

The data collected in this study were not appropriate to examine the impacts of the presence of OJD on processing, due to the limited number of OJD positive

consignments. In order to accurately estimate the direct and indirect costs of OJD at processing level, more comprehensive data from a larger number of OJD positive consignments, which would allow representative comparisons. Data from multiple abattoirs within a region would be more appropriate to estimate these costs. In addition, data should incorporate detail in relation to skin price and intestine condition in relation to the presence of OJD. Examination of change in farmer decisions in relation to disease control and culling protocols and in response to market feedback, is required to better understand the impact of OJD on animals presented for slaughter. The current study suggests that abattoir feedback might result in management changes. However, further investigation is required to validate this result and identify adequate strategies.

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1 Introduction

Paratuberculosis or Johne's disease (JD), a chronic enteric disease of ruminants caused by *Mycobacterium avium* subsp. paratuberculosis (MAP), causes considerable economic losses to the livestock industries. Several previous studies have estimated a significant financial impact of OJD in Australia at on-farm and industry level (Webster and Hall, 2000; Sergeant, 2003; Bush et al., 2006; Bush et al., 2008). However, the financial impact of OJD in sheep at slaughter has not been previously investigated.

Monitoring under the National Sheep Health Monitoring Program for ovine Johne's disease (OJD) at Tasmanian Quality Meats (Cressy, Tasmania) in 2011 confirmed an escalating prevalence of infected flocks in Tasmania with many consignments demonstrating >10% lesions. The financial loss to producers and processors in Tasmania due to OJD in mutton sheep at slaughter is estimated to be substantial including direct (such as loss of runners, reduced meat yield, reduced value of meat and skin and loss for condemnation) and indirect costs (additional abattoir costs such as increased time and labour required for inspection). Similar financial impacts are expected in those states with similar OJD prevalence. Figure 1 summarises the financial costs due to OJD identified during slaughter of sheep.

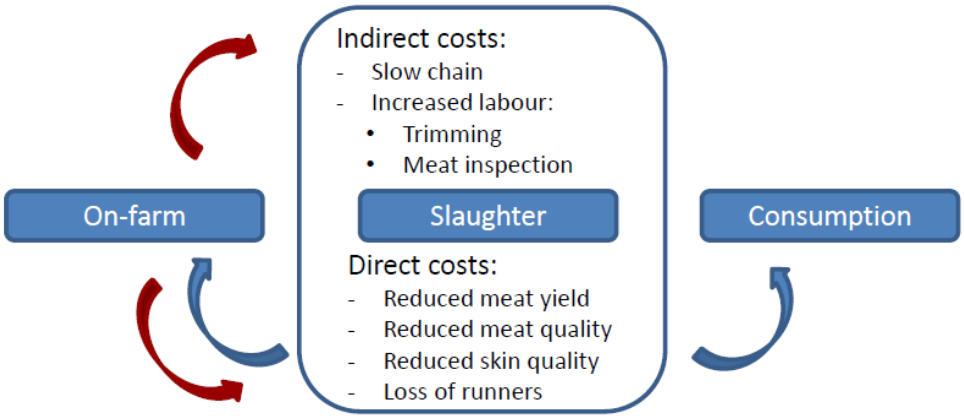


Figure 1. Summary of the financial costs due to Ovine Johne's Disease identified during slaughter of sheep (Red arrow = influence on; blue arrow = impact to).

There is a need to quantify the magnitude of this loss, identify the direct and indirect costs of OJD and investigate the relationship between the OJD on-farm status with the carcase quality and economic cost of OJD.

The Tasmanian Quality Meats abattoir in Cressy (Tasmania) provided preliminary data demonstrating the variation in carcase quality and the estimated economic cost of OJD in a heavily infected flock. Furthermore, the abattoir manager estimated an additional cost between AU$0.20 and 0.50/kg of meat produced due to increased labour and time required to process infected sheep. The increased labour relates to additional casual trimmers and extra time needed for carcase inspection (C. Cocker, personal communication).

The Tasmanian Quality Meats abattoir indicated a willingness to support a research project aimed at defining the costs of OJD to the processing sector. As such, the aim of the proposed project was to investigate the financial loss of OJD to producers and processors in Tasmania in sheep at slaughter, using data collected at Tasmanian Quality Meats in 2012 and 2013. In addition, the project also aimed to evaluate the level of adoption of recommendations from the abattoir regarding management of OJD on-farm, and identify potential barriers to adoption of these recommendations.

This project, which was considered a pilot study, could provide a conceptual framework for estimating the costs of OJD incurred during animal processing and identifying the different components of thee costs. This conceptual framework could be further developed for its application on a national scale, considering the differences on OJD prevalence among states and regions of Australia and the different practices applied at abattoirs.

2 Project objectives

General objective: To estimate the financial loss due to OJD to producers and processors in Tasmania in sheep (>=2 years old) identified during the slaughter process and to investigate potential associations between the severity of the carcase lesions with estimated OJD on-farm status, carcase quality and economic cost of the disease.

Specific objectives:

1. Estimate the incidence of carcases with signs of OJD infection in animals presented at slaughter at Tasmanian Quality Meats (TQM) Cressy abattoir over a 3-month period

2. Determine and categorize the severity of OJD lesions in individual carcases

3. Conduct a risk factor analysis to determine association of the severity of OJD lesions with the estimated on-farm status and category of sheep (breed, sex, age) and the carcase category (weight, fat and skin class)

4. Estimate the financial loss due to OJD infection according to:

a. Direct costs:
    - Loss of runners (due to condemnation and inability to use them for processing)
    - Poor condition score (CS) of infected animals:
        - Reduced meat yield (and value of meat/kg to producer) due to poor condition score (CS)
        - Reduced skin value
        - Condemnation of animals due to emaciation
        - Costs of disposal of nil value skins etc

b. Indirect costs:
    - Increased time and labour during processing

5. Estimate the level of adoption of abattoir recommendations to reduce the severity of impact of OJD infection and the financial costs of the disease to producers.

3 Material and methods

3.1 Data collection at the abattoir

3.1.1 Recording sheet for data collection

A recording sheet to gather information on the incidence of OJD lesions in the sheep intestines, the severity of these lesions and the incidence of OJD vaccination abscesses was developed at the start of the project (Appendix A). The recording sheet also allowed for the recording of other conditions significant to the region (Caseous lymphadenitis, liver fluke, measles, false hydatids, sarcocystis, pleurisy, arthritis, grass-seed and dog bites). The amount of carcase trim due to each condition, for individual carcases as well as for the whole consignment was also recorded.

The recording sheet incorporated information allowing for the investigation of the potential economic impact of the different conditions, such as, the chain speed and the number of extra staff and overtime required due to trimming. Other information included in the recording sheet was the use of the vaccination ear tag (V-tag) and the estimated proportion of animals affected with footrot.

3.1.2 Data collection process

Data was collected during two periods of time; the first one from the 14th of May to the 18th of June 2012 and the second from 16th of November 2012 to 27th of March 2013. Periods of data collection have been dependent on the number of mutton sheep being sent to slaughter at the abattoir. A decision to cease collection of data in June 2013 was made, due to low numbers of appropriate sheep being processed. Although the mutton season was expected to start in November as in previous years, due to unforseen changes in market conditions, the start of the 2012-2013 mutton season was delayed and the number of mutton consignments sent to the abattoir significantly reduced from the previous year.

Data collection was conducted by the on-plant meat inspector under the supervision of the quality assurance manager, Mr Chris Cocker. The following data for each monitored lot was forwarded to the research team on a weekly basis for data entry:

- Scanned copy of the recording sheet
- Lot feedback summary: Information on weight and fat category of the animals and corresponding price per kg and for each skin.
- Daily lot report: General information on all lots in the kill list for the day
- Lot condemnation report: Information on animals condemned, their weight and the reason for being condemned
- Lot feedback report: Individual information of each animal in the lot (time of slaughter, lot, carcase number, origin, destination, fat, weight, animal category)

3.2 Retrospective data

To obtain retrospective information on OJD monitoring in consignments sent to Tasmanian Quality Meats abattoir, the historical National Sheep health Monitoring Program (NSHMP) from mid 2007 to December 2012 was used. Among all consignments monitored at this abattoir for OJD (and other conditions, including OJD vaccination abscesses), consignments with more than 49 sheep (only mutton) were selected. Subsequently, the abattoir was contacted to obtain available production data for consignments monitored during 2011 and 2012. Production data from previous years was not available. The abattoir administrative team contributed in-kind to this process, and provided all information available for the period of time specified.

A total of 353 consignments which had contributed to the NSHMP monitoring during 2011 and 2012 were identified (A single consignment reported through the NSHMP could include multiple lines killed at this abattoir often on a number of days), with information from a total of 51,013 individual mutton carcases available from the abattoir. Information on OJD and OJD vaccination lesions presence as well as of other conditions is only available at consignment level.

3.3 Data management

A purpose built Microsoft Excel database was initially used to enter the abattoir data, but subsequently exported to a Microsoft Access database to improve data entry and automatic data linkage between all the fields. The database contains information for each individual animal for all monitored consignments. Data was subsequently manipulated to create the final database for analysis. This manipulation included the creation of variables to describe:

- Individual, mean and total carcase weight per consignment: The mean carcase weight was calculated including and excluding condemned carcases. In addition, the weight for each individual carcase was corrected considering the required trim for every condition monitored, to allow for a more accurate estimation of the carcase weight if only the condition of interest (OJD or OJD vaccination lesions) were present. For example, the corrected weight for OJD vaccination lesions was calculated adding the overall trim due to all conditions to the net carcase weight, except the trim caused by OJD vaccination lesions.

- Individual, mean and total carcase net value: The net value for each carcase was calculated according to the net carcase weight and the price per kg of carcase paid over the hooks the week of the 20th of January 2013. A corrected carcase net value was also calculated for each condition.

- Mean slaughtering time per carcase per consignment: The total slaughtering time per consignment was obtained from the abattoir. This time included the time from weighting the first carcase to the last carcase, with the time of the two long breaks (morning tea, lunch) being subtracted. However, this time included any other stoppages of unknown cause. Each individual slaughtering time was reviewed and those carcases with killing times of less than 7 seconds and more than 60 seconds were removed from the analysis.

Regarding the retrospective data, consignment and individual carcase information was obtained from the abattoir and the same production variables than for the information gathered in the current project were created. In addition, consignment information was linked with information obtained from the NSHMP, being able to link

a total of 353 consignments. The main information included in the database with linked information from the two sources was:

- *Abattoir production data*: slaughtering date, origin (property identification code), animal category (lamb, hogget, mutton), total and mean consignment weight (and corrected weight for each condition monitored), mean fat class per carcase, total number of animals, number of condemns, breed (National Vendor Declaration information for some of the consignment), mean price per carcase and total carcase value for each consignment, mean carcase and total skin price and mean slaughtering time per carcase.

- *NSHMP*: number of animals killed per consignment, age of the animals, breed (for some consignments), number of animals inspected, number of lesions identified in the consignment, number of samples sent, number of negative, suggested and positive samples and OJD line result.

Individual production data was available for 51,013 individual mutton carcases; however, individual carcase information is not available through the NSHMP.

3.4 Epidemiological data analysis

3.4.1 Data collected during the study period

Descriptive statistics and further statistical analyses were conducted using GenStat software (©2000-2012 VSN International Ltd, Hemel Hempstead, UK). Data was analysed by consignments and by individual animals. Linear and logistic regression analysis were conducted to investigate the association of the presence of OJD and OJD vaccination lesions with a series of animal and carcase characteristics. For these analyses, univariable analyses were first conducted and those variables associated with the outcome of interest with a p-value > 0.20 were considered for further multivariable analysis. Multivariable models were built using a backward selection procedure and only those variables with a p-value < 0.05 were kept in the final model. Potential confounders were investigated adding them to the final model, and those causing a change on the parameter estimates of the fixed effects of 20% or more were kept in the model. Clustering within property of origin was considered incorporating the property as a random effect in the models, as in some instances the same property had more than one consignment monitored. Model assumptions (normality, linearity, homoscedasticy) were tested and transformation of the data conducted if required. Specific analyses conducted are described below:

- *Presence of OJD and OJD vaccination lesions:* Associations of the presence of OJD and OJD vaccination lesions (and the proportion of lesions within consignment) in consignments with the breed (Merino, Crossbreed, Mixed or unknown) and animal category (mutton, lamb and hogget) were investigated using logistic regression analysis.

- *Mean carcase weight, mean fat class, mean carcase net value:* For mutton consignments, the effect of the presence of OJD and OJD vaccination lesions on the consignment mean carcase weight, mean fat class and mean carcase net value was investigated through linear logistic regressions. The potential effect of the proportion of OJD vaccination lesions within consignment with the mean carcase weight and carcase net value was also investigated.

- *Mean carcase slaughtering time:* For mutton consignments only, the associations of the mean carcase slaughtering time with the presence of

OJD, OJD vaccination lesions and the proportion of OJD vaccination lesions within consignment were investigated.

- *Skin price:* Association of the mean skin price for each consignment with the presence of OJD and OJD vaccination lesions was also investigated using linear regression analyses.

- *Individual carcase weight:* Among OJD infected consignments, the association of the individual carcase weight with the presence of OJD in the individual animal was investigated through linear regression. Similarly, among consignments with OJD vaccination lesions, the association of the individual carcase weight with the presence of vaccination lesions in the animal was investigated using linear regression analysis. In addition, in consignments with OJD vaccination lesions, the effect of the amount of trim required due to these lesions on the individual carcase weight was also investigated.

- *Amount of trim:* The amount of trim (including condemns) due to every condition monitored at the abattoir was described and the difference on the proportion of this trim over the total consignment weight among these conditions was estimated using linear regression analyses.

3.4.2 Retrospective data

The association of the presence of OJD in a consignment and the proportion of OJD lesions within a consignment with the following parameters was evaluated: *mean carcase weight, carcase net value, carcase slaughtering time and skin price.*

3.5 Economic analysis

Initially we focussed on the processing sector and the impacts OJD might have on the way in which it operated in a physical sense before evaluating the impact from a commercial perspective. However, the data available from the study were not sufficient for that analysis. Important in those data was the large reduction in the number of animals with advanced OJD presented for slaughter at the abattoir in comparison to reports from previous years. As such, the results section presents a framework for investigating the relationships between the mutton production and farmer behaviour, and how this can be influenced by the presence of OJD in the farm. In addition, a general framework to estimate disease economic impacts, considering direct and indirect costs, is presented.

3.6 Case-study on the attitudes of producers towards abattoir feedback

A component of this research project included a telephone survey on producer attitudes and management practices in relation to OJD. The focus of the questions related to information sent to the producers about animal health conditions found in sheep consigned for slaughter during the study period. This social research component would broaden understanding of the role of the abattoir in promoting awareness and changes to sheep management to reduce the impact of disease for the producer and the processor. The specific objectives of this qualitative part of the research project were to gain an understanding of:

- producer attitudes following receipt of feedback from the abattoir on animal health conditions

- likelihood that abattoir feedback will result in practice change on farm
- strategies for improving abattoir feedback

This study was approved by the Human Ethics Committee of the School of Animal and Veterinary Science, Charles Sturt University (Approval number 416/2012/13).

3.6.1 Questionnaire design

A questionnaire, to be administered through a phone interview, was designed to investigate producers' attitudes to abattoir feedback. The final version of the telephone script and the questionnaire used in this study is attached in Appendix B. The questionnaire included general questions on the size of the sheep flock, the relative significance of this business to the farm income and the selling strategies for mutton and specific questions regarding the abattoir feedback on OJD and OJD vaccination lesions and actions taken on the basis of the feedback and information provided by the abattoir.

3.6.2 Development of OJD factsheets

As part of the project, factsheets about OJD and OJD vaccination abscesses were developed (Appendix C). The factsheets included information on the aetiology, economic consequences, infection, diagnosis, treatment and prevention of the disease, as well as the Tasmanian Department of Primary Industries Parks Water and Environment (DPIPWE) contact details. Factsheets in relation to the other conditions were also developed by the DPIPWE and were also distributed in conjunction with the OJD and OJD vaccination factsheets as part of the abattoir feedback among producers participating in this study.

3.6.3 Qualitative data collection

Animal health recording sheets from all sheep slaughtered at Tasmanian Quality Meats during the study period were analysed for evidence of either OJD or OJD vaccination abscess. Producers with consignments identified with OJD or OJD vaccination lesions or abscesses were the target population for this qualitative study. Some of these consignments also had other animal health conditions. There were a total of six consignments identified as OJD infected, and 49 consignments identified as having OJD vaccination lesions. Among consignments with OJD vaccination lesions only those with a proportion of lesions within consignment of 2% or higher (n = 32 consignments from 21 properties) were included in the target population. The six OJD infected consignments originated from six different properties.

A copy of the explanatory letter (co-signed by the manager of Tasmanian Quality Meats and DPIPWE), the project recording sheet from the abattoir and relevant factsheets (OJD, OJD vaccination abscesses, other conditions present) was sent to the 27 Tasmanian producers during May and June 2013. Among these, twenty producers were randomly selected for the telephone survey. A phone call to each of these producers was made a week later and telephone interview times were established. Telephone surveys were all conducted by one researcher (Rowena Bell) and recording of responses occurred directly on the question sheet. All producers contacted were willing to participate in the interview. Interview length was approximately 15 minutes.

4 Results and discussion

4.1 Epidemiological data analysis

4.1.1 Data collected during the study period

A total of 364 consignments have been monitored, including 32,000 carcases. For the purpose of the analysis, records of 31,858 individual carcases and 358 consignments were used. Mixed ram and mutton consignments (n = 6; 136 rams and 7 mutton carcases) were excluded from the analysis due to the low number of consignments of this animal category.

A summary of the total number of consignments monitored during the period of study, including sheep class, OJD positive consignments and OJD vaccination lesions is shown in Table 1. Information on individual carcases is presented in Table 2.

Table 1. Summary of total number of consignments monitored for OJD and OJD vaccination lesions at Tasmanian Quality Meats.

Animal category	Inspected (% of total)	OJD positive (%)	Apparent within consignment OJD prevalence (median,5-95%)	OJD Vaccination lesions (%)	Within consignment OJD vaccination lesion prevalence (median, 5-95%)
Lambs	203 (56.7)	0	0	6 (3.0)	0.007 (0.003 – 0.175)
Hoggets	17 (4.7)	0	0	2 (11.8)	0.196 *(mean)*
Mutton	138 (38.5)	6 (4.3)	0.046 (0.035 – 0.161)	39 (28.3)	0.031 (0.005 – 0.112)
Total	358	6 (1.7)	-	47 (13.1)	0.030 (0.004 – 0.176)

Table 2. Summary of total number of individual carcases monitored for OJD and OJD vaccination lesions at Tasmanian Quality Meats.

Animal category	Inspected	Apparent OJD positive individuals (%)	OJD Vaccination lesions (%)
Lambs	10,792	0	47 (0.46)
Hoggets	261	0	12 (4.36)
Mutton	20,805	52 (0.25)	271 (1.30)
Total	31,858	52 (0.16)	331 (1.04)

Of the total consignments, 6 mutton consignments were detected with gross lesions suggestive of OJD on visual inspection with all confirmed OJD positive on histopathology (originating from 6 PICs), and 47 consignments (originating from 27 identified PICs, and 2 saleyard mixed consignments) had OJD vaccination lesions [2 hoggets (11.8%), 6 lambs (3.0%), 40 mutton (28.3%)]. Within OJD positive consignments, the median (5-95%) apparent within consignment prevalence was 4.6% (5-95%, 3.5% - 16.1%). Within consignments affected with OJD vaccination lesions, the median proportion of carcases with lesions was 3.0% (0.40% – 17.6%).

Information of sheep breed was only available from 231 consignments, of which 107 were Merino, 114 were crossbred and 10 were consignments with mixed breeds. Most lamb consignments were crossbred (101 out of 106, 95.3%) and most mutton

consignments were Merino (99 out of 121, 81.8%). The six consignments affected with OJD were Merino.

OJD vaccination lesions

The regression models identified a significant random effect of the property of origin on the presence of OJD vaccination lesions, suggesting presence of vaccination lesions was clustered within properties. Among the 27 identified properties sending consignments to the abattoir with OJD vaccination lesions, 18 sent only one consignment with OJD vaccination lesions, while the rest of properties sent more than one consignment identified with these lesions (four properties sent two consignments each, three properties sent three consignments each, one property sent four consignments and another property sent five consignments with vaccination lesions).

Table 3 shows results of the univariable logistic regression for the presence of OJD vaccination lesions by breed and animal category. Presence of OJD vaccination in the consignment was significantly ($P < 0.001$) associated with breed (excluding those consignments with unknown breed) in the univariable regression analysis, with a higher proportion of Merino consignments (33.6%) with vaccination lesions than mixed (10.0%) and crossbreed (2.6%) consignments. However, these results should be interpreted with caution as most crossbreed consignments were lambs, and most lambs sent to the abattoir are not vaccinated for OJD. The proportion of OJD vaccination lesions within affected consignment did not differ by breed or animal category.

Table 3. Univariable logistic regression analyses to investigate the association of the presence of OJD vaccination lesions and consignment breed and type of animal.

	n (%)	OR (95%CI)	*P-value*
Sheep breed*			< 0.001
Merino	36 (33.6)	-	
Mixed	1 (10.0)	0.15 (0.01 – 3.17)	
Crossbreed	3 (2.6)	0.005 (0.001 – 0.03)	
Animal category†			
Mutton	39 (28.3)	-	< 0.001
Hogget	2 (11.8)	0.35 (0.08 – 1.60)	
Lamb	6 (3.0)	0.08 (0.03 – 0.19)	

*Only consignments with known breed were included in the analysis

†It can be assumed that Crossbred lambs destined for slaughter at less than 2 years of age are not vaccinated for OJD.

Mean carcase weight, mean fat class, mean carcase net value

For mutton consignments, the mean carcase weight (corrected for all conditions except for OJD vaccination lesions) was not affected by the presence of OJD, OJD vaccination abscesses or the proportion of OJD vaccination abscesses within the consignment. However, a random effect of property of origin was also seen for the mean carcase weight. For investigating the potential association of the proportion of OJD vaccination lesions within consignment with the mean carcase weight, categorization of this proportion was required as the required assumptions for a linear regression analysis (linearity and homoscedasticity) were not fulfilled. Categories were based on quartiles of the distribution. Figure 2 shows a box-plot of the mean carcase weight according to the presence of these conditions. Although this dataset did not show a significant difference between the mean carcase weight

and the proportion of OJD vaccination lesions, there is a trend to increasing variability in mean carcase weight with increasing proportion of lesions within consignment. Figure 3 shows the distribution of the mean carcase weight according to the presence of OJD vaccination lesions and the proportion of lesions within consignment.

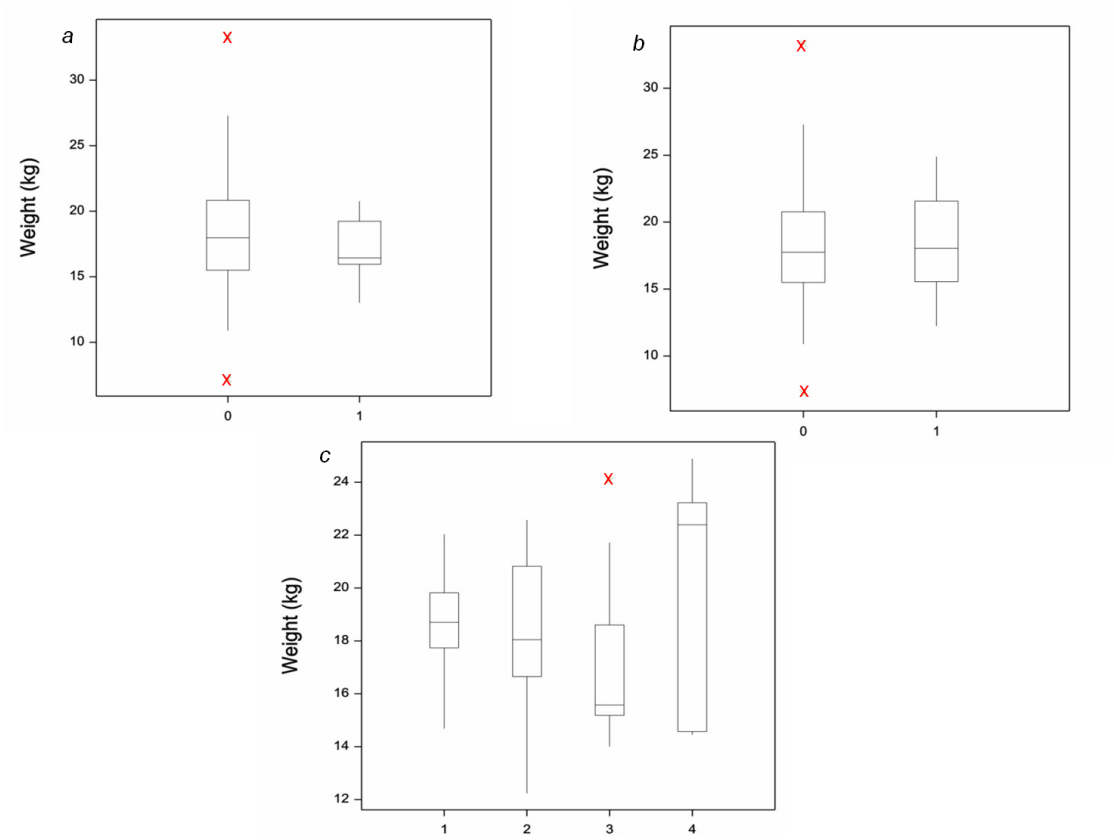
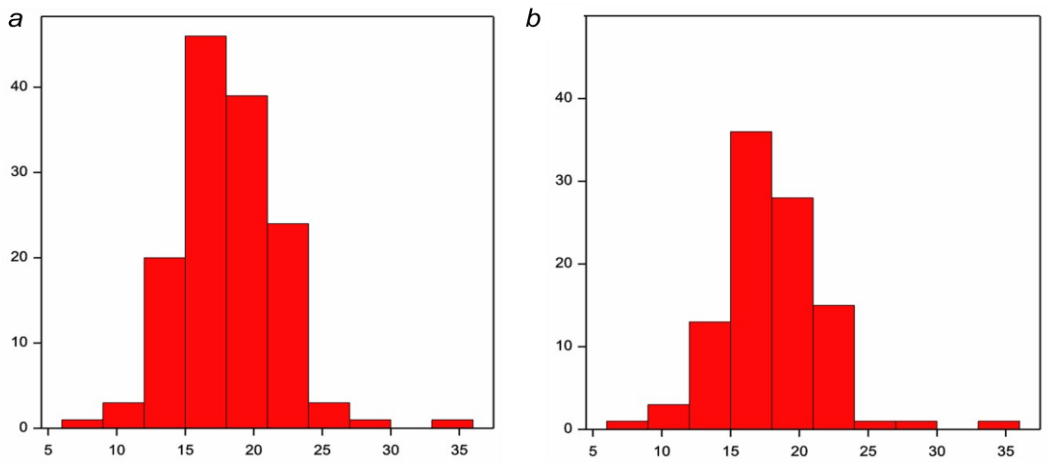


Figure 2. Box-plots representing the distribution of the mean carcase weight (kg) among mutton consignments according to OJD presence (a) *(0 = absence; 1 = presence)*; presence of OJD vaccination lesions (b) *(0 = absence; 1 = presence);* and, the proportion of OJD vaccination lesions among consignment with this condition (c) *(1 ≤ 1.27%; 2 = 1.28 to 3.00%; 3 = 3.10 to 7.10%; 4 > 7.10%)*



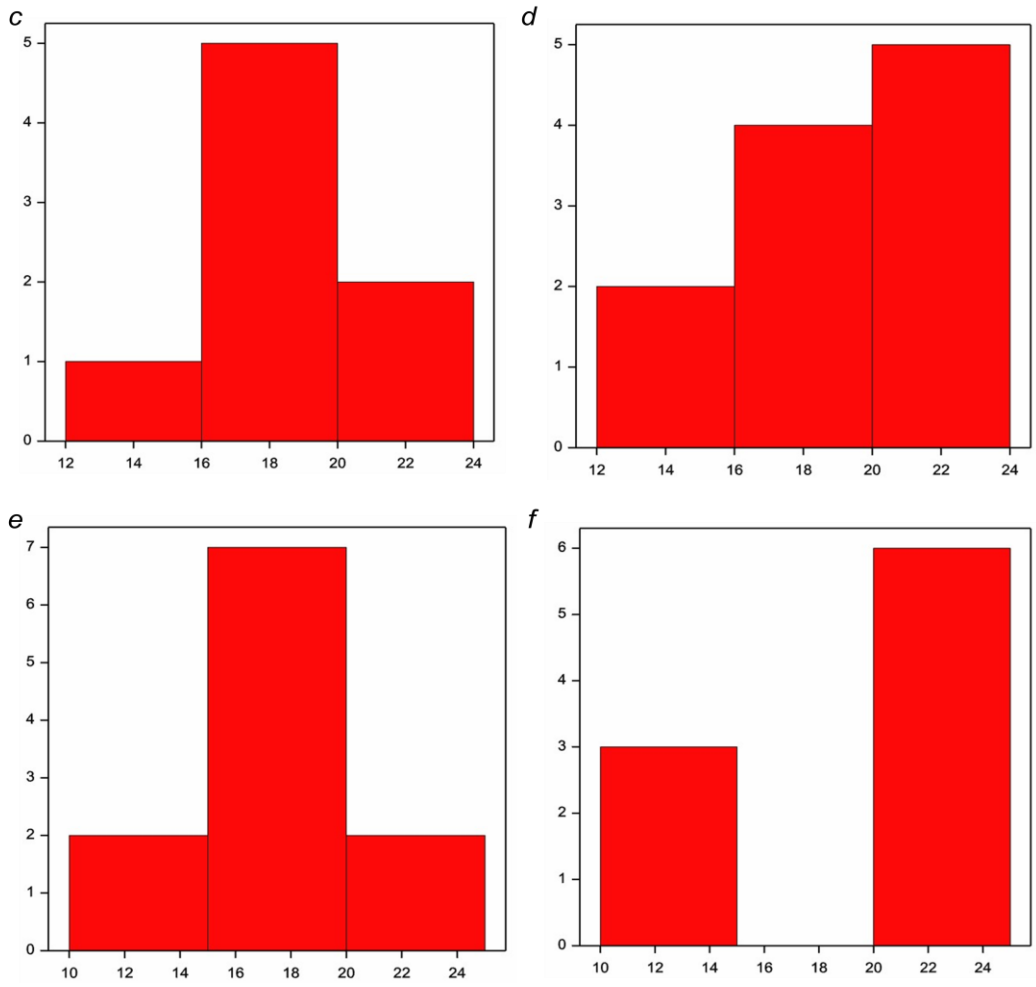


Figure 3. Distribution of the mean carcase weight (kg) (x-axis) for all mutton consignments (a); mutton consignments without OJD vaccination lesions (b); and mutton consignments with a proportion of vaccination lesions within consignment of ≤1.27% (c), between 1.28 to 3.00% (d), between 3.10 to 7.10% (e), and of >7.10% (f).

Similarly, the mean carcase value (corresponding to the carcase corrected weight and the price per kg of carcase paid over the hooks the week of the 20th of January 2013), was not dependent on the presence of OJD and OJD vaccination lesions in the consignment, nor the proportion of OJD vaccination lesions within consignments with this condition. A significant random effect of the property of origin was identified. Figure 4 shows a box-plot of the mean carcase value according to the presence of these conditions. The mean fat class per consignment was not significantly associated with any of these conditions.

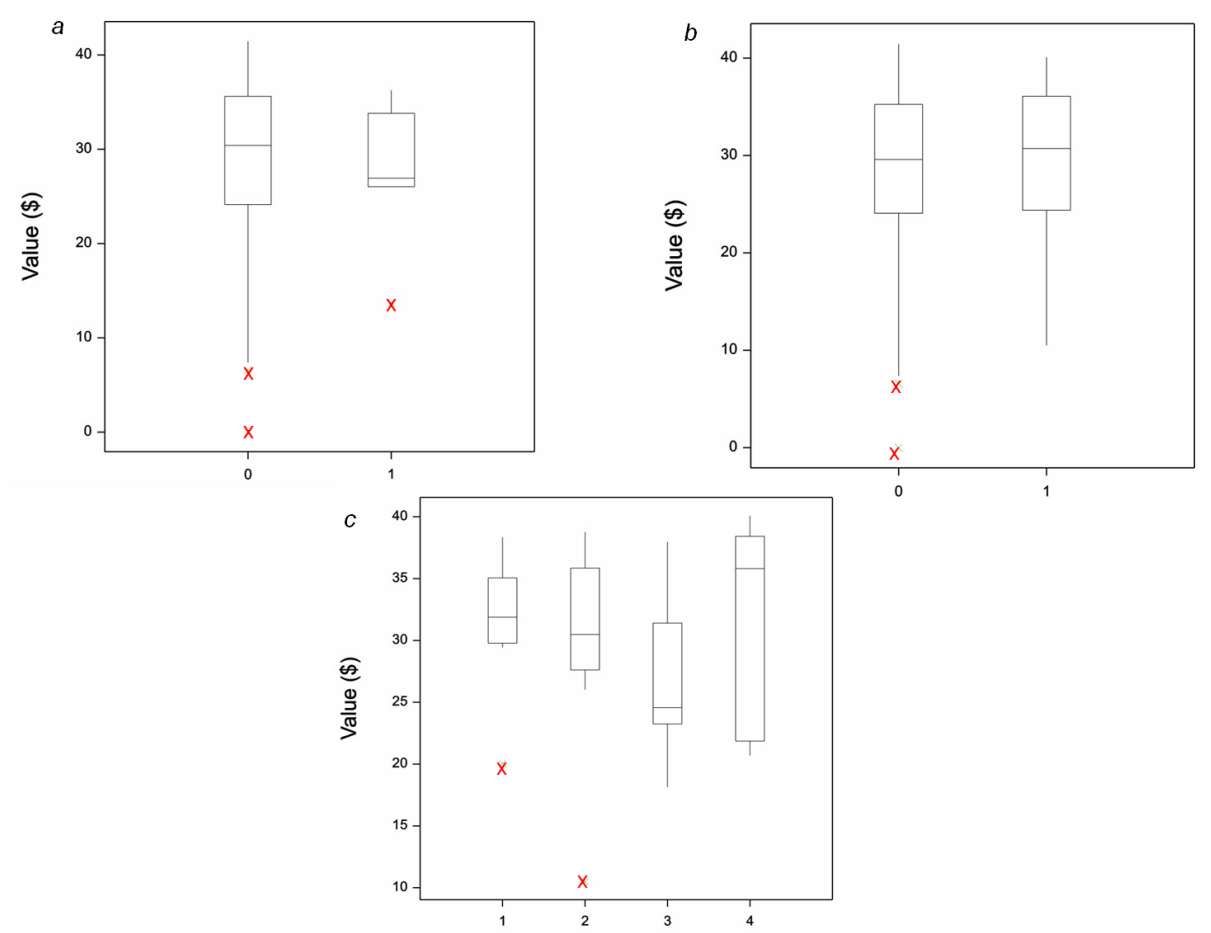


Figure 4. Box-plots representing the distribution of the mean carcase value ($) among mutton consignments according to OJD presence (a) *(0 = absence; 1 = presence)*; presence of OJD vaccination lesions (b) *(0 = absence; 1 = presence);* and, the proportion of OJD vaccination lesions among consignment with this condition (c) *(1 ≤ 1.27%; 2 = 1.28 to 3.00%; 3 = 3.10 to 7.10%; 4 > 7.10%)*

Mean carcase slaughtering time

During the study period different chain speeds were used at the abattoir, which made difficult to estimate the mean carcase slaughtering time and the potential association with presence of OJD and OJD vaccination lesions. Mutton consignment data was split into two subsets (chain speed = 220 animals/h or 265-300 animals/h), with 51 and 87 mutton consignments slaughtered at 220 animals/h and at 265-300 animals/h, respectively. Among consignments slaughtered at 220 animals/h only one consignment was positive for OJD, thus analyses were not conducted. Twenty-two of these consignments had OJD vaccination lesions; however, the mean carcase slaughtering speed did not differ according to the presence of this condition (p = 0.661). Among consignments slaughtered at 265-300 animals/h, 5 were positive for OJD and 17 had OJD vaccination lesions. When investigating the differences on mean carcase slaughtering time among consignments slaughtered at the faster speed according to the presence of OJD (p = 0.972) and OJD vaccination lesions (p = 0.565), no association was observed.

Skin price

The mean skin price per mutton consignment was not associated with the presence of OJD (p = 0.077) and neither was the presence of OJD vaccination lesions (p = 0.17). In addition, the distribution of the mean skin price for mutton consignments monitored, had a median of $15.2 (5 – 95%, 1.5 – 25.6) for OJD positive consignments compared to $7.3 (0 – 16.9) for non-OJD affected consignments. As such, further investigation on the skin price and the presence of diseases is required to fully understand the potential impact of these diseases on the carcase skin price.

Individual carcase weight

The individual carcase weight (corrected for all conditions except for OJD) was not significantly associated with the individual OJD status (within consignments affected by OJD). In contrast, when investigating the association of the individual carcase weight (corrected for all condition except for OJD vaccination lesions) with the presence of OJD vaccination lesions in the consignment, a significant difference on weight was seen between consignment with and without OJD vaccination lesions (p = 0.008) (

Table 4). According to the model, the individual carcase weight was estimated to decrease 0.593kg among animals with OJD vaccination lesions compared to those without these lesions. The random effect of the property of origin on the individual carcase weight was significant. The median individual carcase weight in animals with OJD vaccination lesions was 17.6kg (5-95%, 12.2 – 28.2) compared to 18.0kg (12.4 – 26.8) among animals without OJD vaccination lesions. Figure 5 shows a box-plot of the individual carcase weight according to the presence of OJD and OJD vaccination lesions.

Table 4. Univariable linear mixed regression analysis to investigate the association of the individual carcase weight and the presence of OJD vaccination lesions in the individual. (Property of origin included as random effect)

	Parameter estimate	s.e.	Wald-test	P-value
Presence of OJD vaccination lesions				
Constant	*18.51*	*0.653*		
Presence of OJD vaccination lesion *(ref No)*				
Yes	-0.593	0.225	6.93	0.008

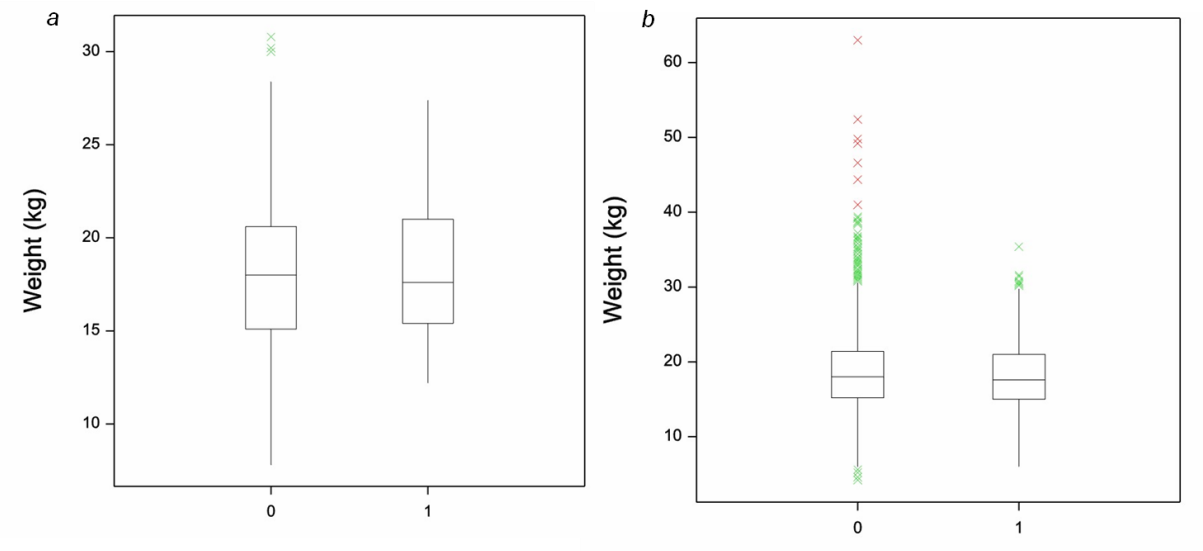


Figure 5. Box-plots representing the distribution of the individual carcase weight (kg) according to OJD presence (a) *(0 = absence; 1 = presence)*; and, presence of OJD vaccination lesions (b) *(0 = absence; 1 = presence),* among consignments affected with OJD and OJD vaccination lesions, respectively.

As expected, the individual carcase weight was also associated with the amount of trim due to vaccination lesions ($p < 0.001$), with those carcases requiring trim for OJD vaccination lesions having a lower individual carcase weight. For every kg increase on the trim due to OJD vaccination lesions, the estimated individual carcase weight decreased 0.66kg.

Amount of trim

Table 5 shows a summary of the proportion of the total consignment weight due to trim according to the different conditions recorded in this study. This trim also includes condemns due to each condition. The proportion of the total consignment weight due to trim differed depending on the condition ($p < 0.001$). The median proportion of total consignment weight trimmed due to OJD vaccination lesions was 0.03% (5-95%, 0 – 0.73). Sarcocystosis is the condition requiring the highest ($p < 0.001$) proportion of the carcase being trimmed compared to the other conditions, with a median of 0.82% (0 – 7.65) in an affected consignment. Regarding the amount of trim required in each affected individual carcase, sarcocystosis and arthritis are the two conditions requiring the highest amount of trim per affected carcase ($p < 0.001$). The required median trim in carcases affected with OJD vaccination lesions was 0.50 (0 – 3.00) kg. Figure 6 shows a box-plot of these trim variables according to the different conditions.

Table 5. Descriptive statistics of the carcase trim required for different conditions identified in sheep at the abattoir.

Condition	Consignments affected, n (%)	Mean proportion (Median, 5 - 95%) of total consignment weight* due to trim	Individuals affected, n (%)	Mean individual trim (kg) (Median, 5 – 95%) per affected carcase
Arthritis	32 (8.9)	0.46 (0.13, 0.03 – 2.70)	43 (0.13)	4.89 (3.00, 1.65 – 16.27)
Caseous Lymphadenitis	32 (8.9)	0.33 (0.11, 0.01 – 2.03)	83 (0.26)	2.43 (1.00, 0.33 – 15.71)
Dog Bite	28 (7.8)	0.13 (0.08, 0.02 – 0.37)	34 (0.11)	1.53 (1.00, 1.00 – 3.00)
Grass Seed	13 (3.6)	0.79 (0.11, 0.02 – 3.90)	474 (1.49)	0.55 (0.50, 0.50 – 0.65)
Measles (Taenia Ovis)	120 (33.5)	0.07 (0, 0 – 0.37)	383 (1.20)	0.43 (0, 0 – 0)
OJD vaccination lesions	47 (13.1)	0.18 (0.03, 0 – 0.73)	330 (1.04)	0.74 (0.50, 0 – 3.00)
Pleurisy	53 (14.8)	0.09 (0.04, 0 – 0.36)	107 (0.34)	1.10 (0, 0 – 4.00)
Sarcocystosis	66 (18.4)	1.87 (0.82, 0 – 7.65)	871 (2.73)	5.60 (2.32, 0 – 20.19)

*corrected consignment weight for all conditions except the condition of interest

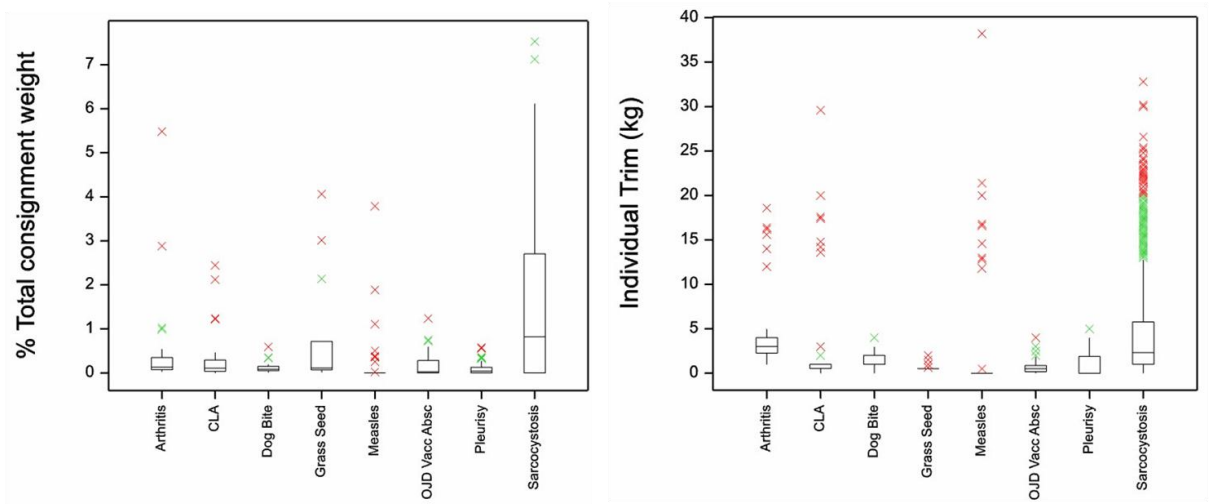


Figure 6. Box-plots representing the distribution of the proportion (%) of the total consignment weight due to trim *(bounded at 8%)* and the individual carcase trim (kg) according to the different conditions *(CLA = Caseous Lymphadenitis; OJD Vacc Absc = OJD vaccination abscesses)*.

Interpretation of presented results is difficult due to the lack of available data from OJD positive consignments. The potential reasons for this reduction in OJD presence among mutton consignments in comparison with previous years could be due to various factors. One of the reasons is further explored in section 4.2, which relates to market system feedback and changes in farmers' behaviour. In addition, there could have been a shift in demand between different processing facilities in Tasmania at the time of the study. Another potential cause could be a reduction of the prevalence of OJD in Tasmania flocks; however, this needs further investigation.

Among animals monitored in this study, sarcocystosis was detected in 18.4% of consignments, and the median trim due to this condition represented almost 2% of the total consignment weight, suggesting this condition might cause significant economic impact for the farmer as well as at processing. To fully understand the prevalence of this condition and its significance further research with a wider target population is required.

4.1.2 Retrospective data

All property identification codes identified as OJD positive during the current project (n = 6) were previously monitored during the period of 2007 to 2012. Four of the six properties had previously sent OJD positive consignments to the abattoir. Table 6 shows a summary of the historical monitoring information on consignments sent by the 6 property detected as OJD positive in the current project.

Table 6. Historical information on OJD monitoring among properties identified as OJD positive in the current project.

PIC	Historical monitoring (2007 – 2012)		
	Negative	Positive	Total
1	1	0	1
2	3	1	4
3	2	1	3
4	0	12	12
5	9	2	11
6	5	0	5
Total	20	16	36

Among properties with consignments with OJD vaccination lesions (n = 27), 22 were previously monitored (81.5%), and 9 were found to be OJD positive (40.9%).

Among the 353 consignments contributing to the NSHMP monitoring during 2011 and 2012, most were mutton (n = 336), with only 9 and 8 lamb and hoggets consignments respectively. Among mutton consignments, information on breed was available from 233 consignments, of which 77.3% were Merino and 22.7% were Cross-bred. Only mutton consignments were included in the analyses.

OJD presence

The presence of OJD in the consignment was not associated with the consignment breed (p = 0.192; OR 1.66, 95%CI 0.89 – 2.42), with 15.0% of Merino and 22.6% of Cross-bred consignments being laboratory confirmed as positive for OJD.

The mean carcase weight (corrected for all conditions except OJD) was found to be significantly associated (p = 0.044) with the presence of OJD in the consignment. The linear regression model indicated that the mean carcase weight in consignments with OJD is estimated to be 1.01kg lower than among non-affected consignments. The distribution of the mean carcase weight according to OJD presence in the consignment is shown in Table 7.

Table 7. Descriptive statistics of the distribution of the mean carcase weight among mutton consignments monitored during 2011 and 2012 at Tasmanian Quality Meats abattoir, according to the OJD status of the consignment.

OJD status	Number of consignments, n (%)	Mean of the mean carcase weight (5-95%) (kg)	Median of the mean carcase weight (Min – Max) (kg)
Positive	63 (18.7)	18.1 (14.1 – 25.7)[a]	17.3 (12.2 – 29.0)
Negative	273 (81.3)	19.1 (14.1 – 25.7)[b]	18.8 (9.0 – 37.5)

[a,b] Different superscripts differ significantly (p < 0.05)

Among mutton OJD positive consignments, the proportion of OJD positive animals within consignments was not significantly associated with the mean carcase weight of the consignment (p = 0.814) (Figure 7).

The mean carcase value, according to the corrected weight for OJD and the price per kg of carcase paid over the hooks the week of the 20th of January 2013, was also found to be significantly associated with the presence of OJD in the consignment (p = 0.007). The median of the mean carcase value was $32.3 (5-95%, $18.2 – $40.7) and $28.8 ($16.9 – $40.5) for OJD negative and positive consignments, respectively. The proportion of affected animals within OJD positive mutton consignments was not associated with the consignment mean carcase value. Figure 8 represents the distribution of the mean carcase value according to the consignment OJD status.

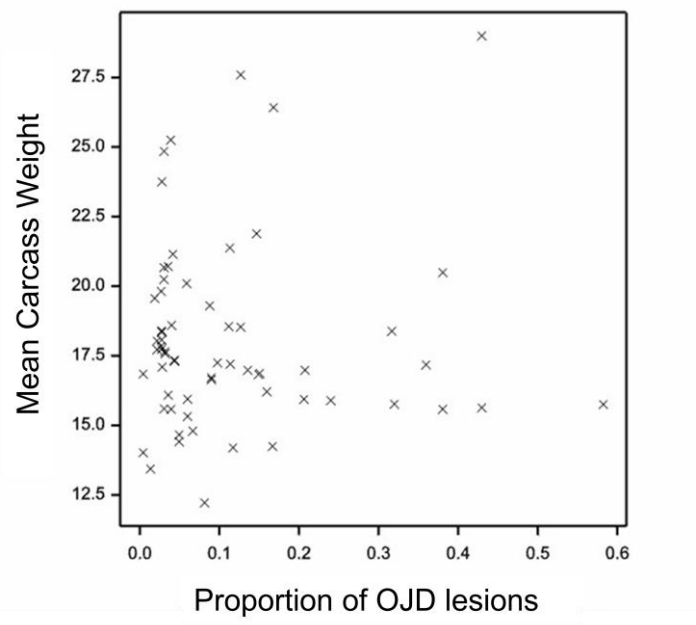


Figure 7. Scatter plot of the mean carcase weight (kg) and the proportion of OJD lesions among 63 mutton consignments with OJD monitored at Tasmanian Quality Meats abattoir during 2011 and 2012.

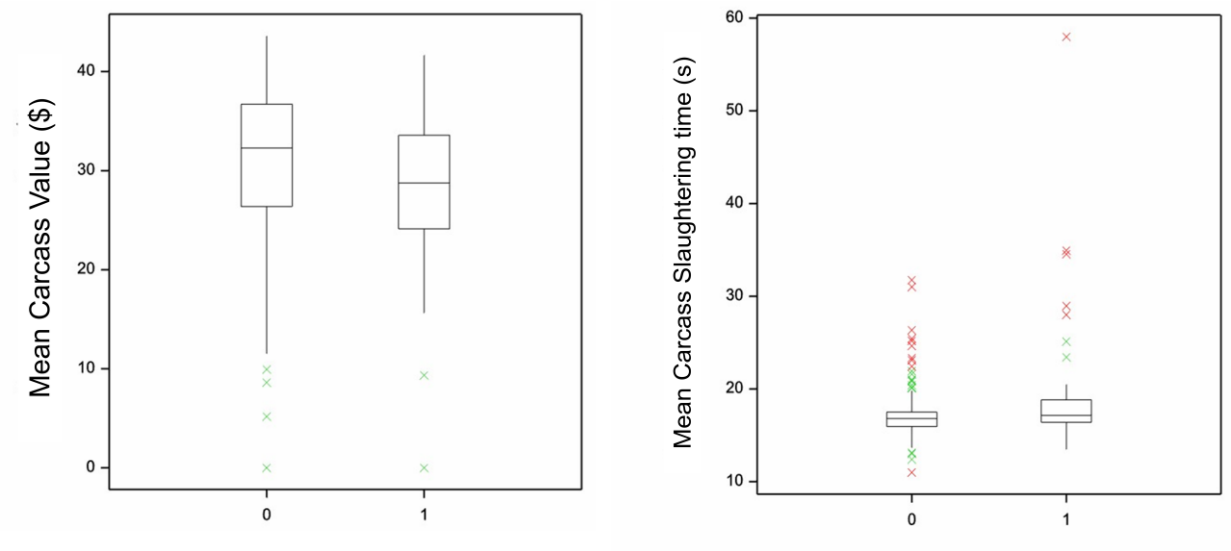


Figure 8. Box-plots representing the distribution of the mean carcase value ($) and the mean carcase slaughtering time (s) among mutton consignments monitored at Tasmanian Quality Meats abattoir during 2011 and 2012, according to OJD presence (a) *(0 = absence; 1 = presence).*

Among mutton consignments, the mean carcase slaughtering time was higher ($p < 0.001$) among OJD positive consignments compared to non-affected consignments. The median of the distribution of the mean carcase slaughtering time among OJD positive consignments was 17.2 seconds (5-95%, 15.4 – 31.2) compared to 16.8 seconds (14.4 – 20.9) for non-affected consignments (Figure 8). The mean consignment skin price was not influenced by the OJD status of the consignment ($p = 0.086$).

Results from the retrospective data contrast with results obtained with data from the current study, and suggest that there is a potential economic impact of OJD presence on the processing sector and on returns to farmers. More detail analysis of retrospective data from this abattoir and others could provide more evidence of this potential impact.

4.2 Economic analysis

4.2.1 Mutton production and farmer behaviour

While changes in farmer behaviour in relation to mutton production were not explored in this study it appears that changes in practice may have been impacting on the prevalence of OJD detected in mutton at the abattoir. One possibility is that farmers were electing to not send severely affected animals to slaughter to this abattoir. Alternatively, or in addition, it is possible that the abattoir was not purchasing animals likely to be affected by OJD.

These observations support the supposition that mutton production is a dynamic system responding to changes in the commercial environment with OJD operating as one factor within that system.

An alternative approach to understanding the interactions between the various participants in the system is through the use of value chains, where value chains explore the linkages between the various players in the mutton supply system and

the influences of OJD on that system. This section introduces some of the ideas in that approach.

The value chain is largely controlled by demand for the product and there are price and other signals that indicate the desirability of various forms of product. A diagrammatic representation of a mutton value chain is provided in Figure 9.

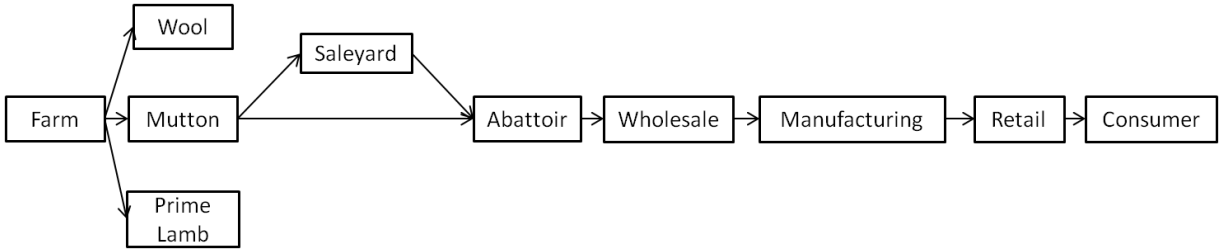


Figure 9. Representation of a mutton value chain

As illustrated in Figure 9 mutton sheep are supplied by farmers (the supply side) to abattoirs and their customers (the demand side). On the supply side mutton is often a by-product of a wool or prime lamb production system with mutton producing animals being culls from the other enterprises.

On the demand side there is feedback from the market, including the abattoir, to be considered in relation to the desirability of various classes of mutton producing animals. Abattoirs are commercial operations (as are farms) and therefore the interactions (through price and other signals) provided by abattoirs to farmers would be expected to change the behaviour of the farmers in relation to the animals they present to the abattoir for slaughter.

Understanding the interactions between activities to control or manage OJD (including selection of animals to be culled) and mutton supply forms an important part of the mutton supply system. Culling animals is an important part of stock management and some options available to farmers in relation to cull animals are presented in Figure 10. This subsequently will impact on the potential costs of OJD during the slaughter process.

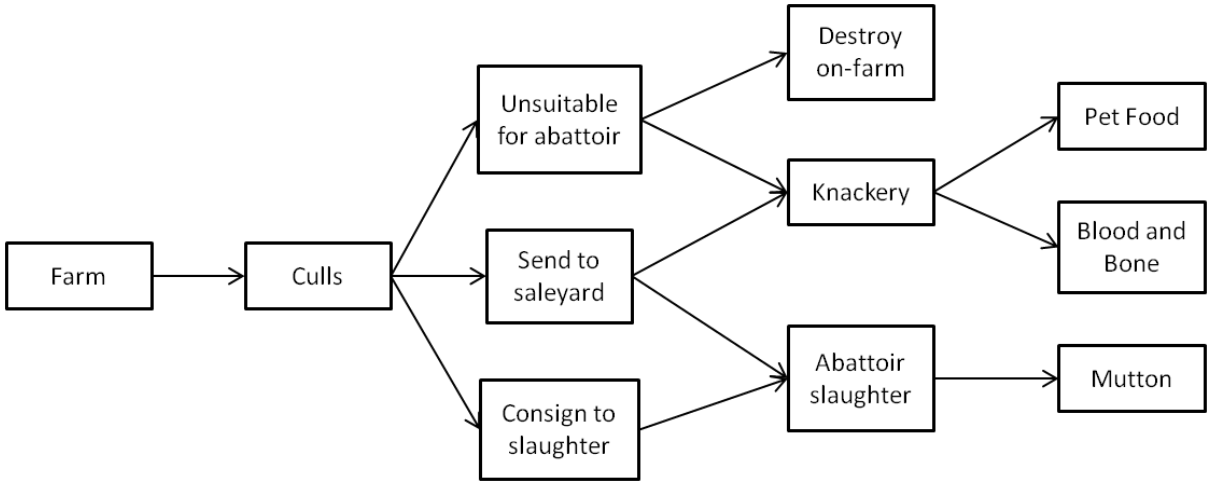


Figure 10. Example of options available to the farmer in relation of disposal of cull animals

The decision a farmer makes to manage OJD on his property can take several forms, for example the farmer can:

- Introduce vaccination to control OJD which would be expected to increase the age at which animals would be culled due to low body weight.
- Cull low weight animals when detected (usually at shearing) so they are not carrying unproductive animals.

The decision as to what constitutes low weight will also impact on the subsequent decision on how to dispose of culled animals. The decision on whether to sell cull animals (and the way in which they will be sold) or to destroy them on-farm has several influencing factors including the financial viability of the approach to be taken, as shown in

Figure 11.

For example, a farmer bears a cost to consign an animal to slaughter and if the price received is low the cost of selling and processing can exceed the price received. It would be expected that this would constitute a feedback to farmers and may result in them changing their behaviour. This could have been one of the reasons why in the current study there was a reduction on the number of mutton sent to TQM abattoir as well as on the number of OJD positive consignments. A wool producer on an OJD affected farm has several choices in relation to the management of the flock, most of which impact on mutton production but most are unlikely to be driven by mutton production itself.

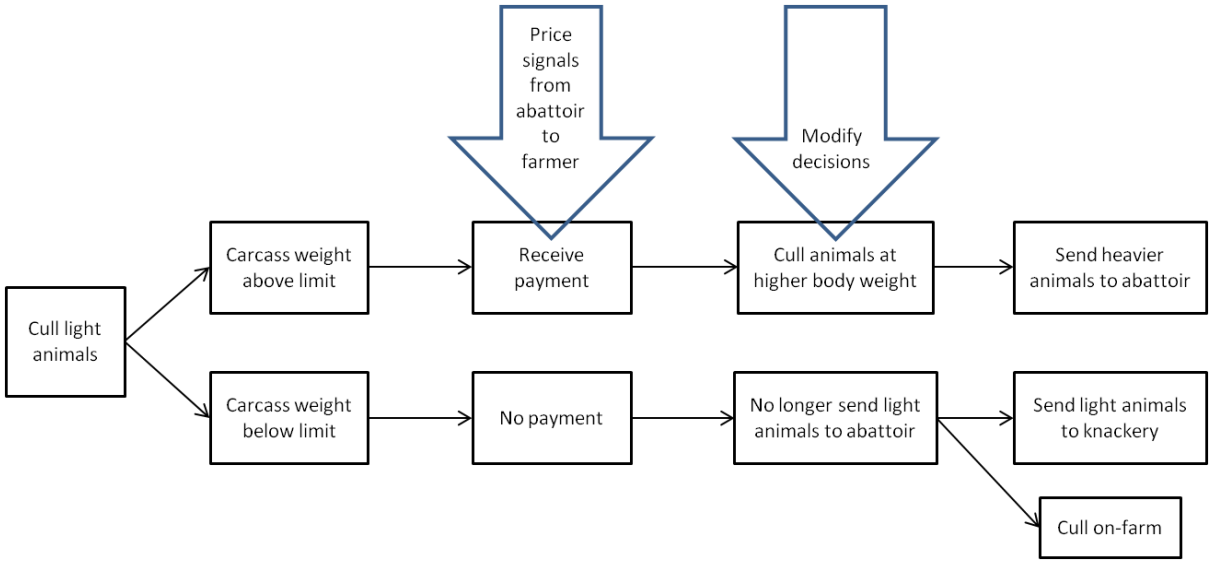


Figure 11. A representation of the change in decision making as a response to price signal from the abattoir.

Any of these decisions will impact on mutton production and at the same time the costs due to OJD during the slaughtering process. As such, a better understanding of the farmer decision process and the interactions between different players in the

value chain (supply and demand sites) is crucial to be able to accurately estimate the costs of disease, as these will depend on specific market circumstances.

The data collected in this study were not appropriate to examine the impacts of the presence of OJD on processing, due to the limited OJD positive consignments. However, we have developed an approach to carrying out that analysis.

4.2.2 Framework for the economic analysis

A framework for the economic analysis is based on direct and indirect costs at the slaughter:

Direct costs at slaughter

Direct costs (or losses) can be obtained by comparing an affected animal with unaffected animals from the same group. Direct costs due to OJD and OJD vaccination lesions (and potentially other conditions) identified can be defined as costs due to:

- Reduced meat yield *(lower carcase weight)*
- Reduced meat quality
- Reduced skin quality, and
- Intestines (runners) that are not suitable for consumption

Reduced meat yield can be due to weight loss before slaughter or the result of carcase trimming required after slaughter. The loss may be the difference between the weight of the animal in comparison to unaffected animals in the consignment or can be the total loss of the carcase where the carcase weight falls below the threshold of 12kg or where the carcase is condemned due to emaciation. Similarly, reduced meat quality, may result in a reduction in the price paid per kilogram for the carcase although usually this is reflected by reduced carcase weight causing the animal to drop into a less valuable section of the grid. Sheep sold over the hooks are paid for their meat value based on weight in a weekly price grid for each of the following categories: crossbred lamb, merino lamb, hogget, mutton. Fat score appears not to be a factor in the price grid unless the animals are emaciated (condemned). Rams are paid a set price per head. The weight grid is categorised as follows: < 12.1kg (zero value), 12.1 – 16.0kg (moderate value), 16.1-26.0kg (high value), 26.1 – 30.0kg (moderate value) and >30.0kg (low value). Other abattoirs might have another grid system that might factor fat score.

Associations of the presence of OJD and OJD vaccination lesions with consignment mean carcase weight and individual mean carcase weight within affected consignments was investigated with the data available from this study (see section 4.1.1). Data available did not show a significant difference between mean carcase weight between affected and non-affected consignments (OJD and OJD vaccination lesions). However, the mean individual carcase weight did differ between animals with and without OJD vaccination lesions, suggesting that affected individuals will have a reduction of meat yield and subsequently, bearing a cost due to this condition.

In contrast to results from the current study, analyses of retrospective data suggest that the mean carcase weight, value and slaughtering time was significantly associated with the presence of OJD in the consignment. OJD positive consignments were found to have a lower mean carcase weight and value and higher carcase slaughtering time than non-affected consignments (see section 4.1.2).

The quality of the skin, and as such the price of the skin, might also be affected by OJD infection and other conditions. It became apparent in the present study that the value of skins is not generally well understood by the producer or others not directly involved in the skin trade. This is particularly important as in some consignments the skin value could approach the meat value of the animals slaughtered, while in numbers of consignments the skin values were very low or nil value. Factors affecting skin value included grass seed and vegetable matter presence/damage, length of wool, feel, lustre, tip, micron, strength, break, breed etc. In the absence of an objective grading system we were only able to determine net value as nominated by the buyer/skin valuer at the abattoir (ranging from 0 to over $20/skin). The skin value is the same for all animals within a consignment, calculated as the average price for the consignment. When investigating the skin price according to the presence or absence of OJD (see section 4.1.1), no association was observed, however, the low number of OJD positive consignments does not allow drawing conclusions from these results. In addition, skins of condemns are not paid and these nil value skins also incur a disposal cost (approximately $0.50/skin). Further investigation on the skin price is required to better understand the significance of the skin price on the overall value of the animal as well as the potential impact of different conditions on the skin price.

Under current regulation, only intestines grossly affected by OJD are to be condemned and not sent to the food chain. However, anecdotal evidence suggests that intestinal walls from OJD infected animals, in those consignments with high proportion of animals affected, are fragile and break during processing. The price paid for intestines by TQM abattoir at 20th of January 2013, was $5.50 and $4.50 for lambs and hoggets/mutton, respectively. Considering the mean estimated carcase value for mutton consignments monitored in the current study was approximately $30, the value of intestines could represent a significant proportion (e.g 15%) of the overall carcase value. Data from the current study did not allow estimation of the costs incurred due to non-usable intestines; however, among affected OJD consignments, a median of 4.6% of animals within consignment were affected with OJD, with a maximum of 18.0%. If intestines of these consignments (or a proportion of those) would need to be condemned for food safety reasons or would be non-usable for processing, the costs could be significant. Further investigation on the association of the presence of OJD in the animal and the severity of the OJD lesions with the intestine condition is required to better understand and estimate the corresponding potential costs.

Indirect costs at slaughter:

The presence of animals with Johne's disease or vaccination abscesses in a consignment can have various impacts, which could be considered indirect costs, on the operations of the abattoir. The impacts include reducing the speed at which the slaughter chain is operating due to the need to for example, examine animals more closely and trim the carcases (common with vaccine abscesses but rarely required with OJD infection as all intestines in all mutton consignments are routinely inspected). Additional labour may also be needed during and after slaughter to enable the trimming to be carried out and additional meat inspection staff may also be required. These indirect costs could be defined as:

- Reduced chain speed
- Increased labour due to:
    - Trimming
    - Meat inspection

It is important to note that the abattoir also bears a cost in slaughtering smaller animals because a small animal will cost the same as a larger animal to process (assuming the same chain speed and number of workers employed on the chain), therefore increasing the cost of slaughter per kilogram of meat processed. It is likely that the lower grid prices for low weight animals, accounts for this slaughtering inefficiency. Operators of the abattoirs would be expected to pass these costs onto the various users of the abattoir.

Data from the current pilot study did not allow investigation of the indirect costs in detail. Only one of the consignments with OJD vaccination lesions (and none of the OJD positive consignments) required the slaughter line chain speed to be reduced from 220 to 180 animals/h, due to all animals being affected with vaccination lesions, and an additional two extra staff-hours to process the consignment. In addition, chain speed was increased from 220 to 300 animals/h during the study period, which made it more difficult to compare mean carcase time per consignments (see section 4.1.1). Data available suggest that there were no differences in mean carcase weight among consignments with and without OJD or OJD vaccination lesions, when considering the different chain speeds used at the abattoir.

Calculating the loss:

In order to calculate the overall potential loss due to a specific disease condition, direct and indirect costs should be considered as follows:

Direct loss = Meat loss + viscera loss + skin loss + waste disposal costs

The direct costs are due to the meat, viscera and skin loss and the waste disposal costs. The meat loss can be calculated considering the difference between the individual animal price for those affected animals and the average price for non-affected animals *(Meat loss = Σ (Average Price for non-affected animals - Individual animal's price of affected animals).* The viscera loss, in the case of OJD, would be the intestines costs, will depend on the average price paid for the intestines at a specific time and the number of intestines being rejected (condemned or non-usable) *(Viscera loss = Average price × Number rejected).* Similarly, the skin loss will depend on the average price and the number of skins required to be rejected *(Skin loss = Average price X Number rejected).* In addition, the direct cost also incorporate the costs to dispose any waste due to condemned carcases and/or skins due to the specific condition investigated *(Waste disposal = Condemned carcase disposal + skin disposal).*

Indirect loss = Increase in labour costs

The indirect costs are due to an increase in labour costs, which incorporate an increase in labour hours due to additional meat inspection required, additional trimming required during routine processing and slowing of the chain speed. As such increasing labour costs are defined as:

Increase in labour costs = (a + b + c) × Hourly rate

where, *a* is the increase in labour hours due to additional meat inspection required; *b* is the increase in labour hours due to additional trimming required during routine processing (In severely affected consignments further trimming is conducted on the trim rail after the normal slaughtering process to minimise the impact on chain speed); and *c* is the increase in labour hours due to slowing of chain.

Distribution of impacts

Distribution of the impacts between the abattoir and the farmer (or trader) from direct losses will vary depending on the nature of the consignment and the contractual arrangement between the abattoir and the seller of the animals including the time at which the price to be paid for the animals is determined. Adult sheep may be sold in the paddock, at auction or over the hooks at the abattoir. For example, if the animals are purchased by the abattoir before slaughter the abattoir will bear the costs. If the animals are purchased based on their weight and grading after slaughter then the farmer will bear the costs associated with the presence of OJD (due to reduced weight but not necessarily the loss of runners) or vaccine abscesses. In some situations the offal including intestines are owned by the abattoir irrespective of the time at which the rest of the animal changes hands; a similar situation may apply to skins.

4.3 Case-study on the attitudes of producers towards abattoir feedback

4.3.1 General information

The 20 producers contacted were willing to participate in the interview. Among these producers, there was a good representation of producers from across the main sheep breeding areas of Tasmania including Northern and Southern Midlands, Flinders Island and the East Coast. The number of sheep property ranged from 1,200 (including ewes/wethers/rams, hoggets and prime lambs) to 50,000, with a mean of 9,938 and median of 7,500 sheep (5-95%, 1,485 – 24,350) per property (prime lambs are generally about 10% of total sheep numbers on these properties).

4.3.2 Financial information

Regarding farm income, sheep production (including wool/sale of prime lambs/sale of stores) represented between 30% and 70% of farm income for 14 properties. In five properties, sheep production represented over 70% of farm income and one property indicated that sheep production represented less than 30% of total farm income.

The majority (n = 14) of producers used a mix of systems to sell their mutton sheep for slaughter. These include 'over the hooks' plus skin value, by computer description on Computer Assisted Livestock Marketing or sold direct to the processor at dollar/kg liveweight. The remaining 6 producers sold sheep by one method only ('over the hooks' plus skin value) or a combination of 2 selling methods.

4.3.3 Attitudes of producers towards abattoir feedback

The majority of participants (n = 17) reported having read the information sent to them regarding the sheep consignment processed at TQM. Interestingly, most (n = 16) were not aware of the presence of OJD vaccination lesions (or any of the other conditions) in their sheep before TQM contacted them. Four producers indicated that they had had previous notification of presence of OJD in sheep sent to TQM.

Usefulness of information:

Nearly all participants indicated that the information from TQM was useful. Fifteen producers said that they found the information very useful, with four finding the information moderately useful. Interestingly, one of the producers who indicated that the information provided was moderately useful indicated that information was useful for all conditions except OJD, as this could jeopardize market access. In addition, one indicated that the information was not useful as he already knew of presence of condition and indicated that the information would have been useful if more

interpretation of the findings were provided, such as the level of acceptability for each condition.

Change in management practices following abattoir communication:

Information received regarding OJD and OJD vaccination lesions from TQM did prompt changes in producers' attitudes towards these conditions and related management practices in most producers interviewed.

Among producers who were not aware about the fact that they had problems with vaccination lesions or were diagnosed with OJD, the main changes identified were:

- Review the vaccination protocol and improve the vaccination technique
- Contact with private vet to discuss findings and find ways of reducing the problem
- Discussion with stockmen about findings with the focus of improving vaccination practice
- Contact with property owner to let him know about findings
- Looking at bringing stockmen to TQM to do plant tour to better understand the findings
- Start vaccinating for OJD
- Start whole-flock vaccination for OJD

Five producers indicated that no action was required at present as the problem was considered not significant or because lack of knowledge of how to improve the vaccination technique (one producer).

Producers who consigned sheep to TQM where other conditions were identified also reported some changes to minimize the impact of these conditions. These included:

- Put muzzle on offending sheep dog (Dog bite condition)
- Better/strategic use of fluke drench (Liver fluke condition)
- More regular worming of farm dogs (Sheep measles condition)

Motivation to change practices following abattoir communication:

Producers were asked to ranked three options as the most likely to prompt them to take action to manage a condition present in their animals: 1. Animal Health and Welfare; 2. Costs to them from lost production on-farm; 3. Cost to them from reduced payment from the abattoir. Ten producers ranked the three options equally as motivators to change management practices.

Among the rest of producers (n = 10), seven indicated that reduced payment from the abattoir was the most important motivator, and ranked animal health and welfare as the least likely motivator to practice change. Two producers ranked the cost of production on-farm as the most important motivator and only one producers ranked animal health and welfare as more important than costs.

Suggestions on how to improve feedback from abattoir:

Ten producers had no further suggestions to improve the feedback received from the abattoir. Among the rest of producers (n = 10), the main suggestions on how communication could be improved included:

- Receiving feedback directly (not via agents) using email instead of fax
- Prompt feedback as soon after the slaughter as possible
- Receiving a picture of the condition as part of report
- Provide more information on the severity rating for each condition
- Provide information on total cost to producer from finding (eg total kg's lost from trimming)
- Provide some more information on the significance of the findings, especially with regard to OJD vaccine abscess, in order to know if the abattoir considers line prevalence higher than normal.

Interest in receiving feedback from abattoir in the future:

All producers were willing to continue receiving information on animal health conditions from TQM. Several expressed a wish to see the other major sheep processors adopting similar reporting systems.

Additional comments:

Additional comments provided by participant producers included:

- Very supportive of the work TQM doing in this area and would like to it continue
- Value is in seeing data on animal health over long time frame to understand trends
- TQM initiative to provide feedback to producers could be used as a marketing tool for Tasmanian sheep meat (eg. monitoring for health conditions)
- TQM feedback is a good indicator on how on-farm staff are performing (eg vaccination technique)
- TQM is seen as very progressive in this area
- Would like to see more extension on effective vaccination technique

Results from this qualitative study indicate that receiving feedback directly from the abattoir on a range of animal health conditions was valued by the producers interviewed for this project. In addition, the method how the feedback was provided was suitable for most producers, although TQM could consider some modifications to aspects of the information and the use of alternative communication technologies. In most cases, feedback did result in changes in management practices related to OJD control.

5 Conclusions and recommendations

- In order to accurately estimate the direct and indirect costs of OJD at processing level, more comprehensive data from a larger number of OJD positive consignments, which would allow representative comparisons, are required. Data from multiple abattoirs within a region would be more appropriate to estimate these costs. In addition, data should incorporate detail in relation to skin price and intestine condition in relation to the presence of OJD.

- Retrospective data used in the current study provided an indication that OJD might have a financial impact during processing. More detail analysis of retrospective data from this abattoir and others could provide more evidence of this potential impact.

- Any further investigation into financial impacts of disease in the processing sector should incorporate evaluation of other conditions in conjunction with OJD. The current study suggests that other conditions were more prevalent than OJD and OJD vaccination lesions, and as such the potential economic impact might be more significant.

- Examination of changes in farmer decisions in relation to disease control and culling protocols and the relationship of those changes to market feedback, is required to better understand the impact of OJD on animals presented for slaughter. The current study suggests that abattoir feedback might result in management changes. Further investigation is required to validate this result and identify adequate strategies.

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8 Appendix

Appendix A - Data recording sheet

RECORDING SHEET - Processing losses project							Date:			Lot number:		
Chain speed:			Extra staff:				Footrot %:		V -tag:			
Re-work:	number of staff:			Hours:			PIC:			Breed		
Overtime:	number of staff:			Hours:			Additional pay per hour:					
Body No.	OJD 1-3	CLA 1-3	Fluke 1-3	Measles 1-3	False hydatids 1-3	Sarco 1-3	Pleurisy 1-3	Arthritis 1-3	Grass-seed	Dog Bite	OJD Vaccination abscess 1-3	Comments

Appendix B – Interview script and questionnaire used for the qualitative case study

Telephone Interview Form

Name:…….

Contact Nos:……

Condition/s……

Date……

Time:…….

I would like to ask you some questions about the feedback from TQM following processing of your sheep at TQM. I am doing this as part of an MLA funded project through CSU. The purpose of this research is to find out how best to communicate with producers about diseases or conditions found in sheep at abattoirs.

You will not be identified in any way following this interview. The Chief Investigator from CSU or the funding body (MLA) will not be told of interviewee identity. The PIC number of your property will be the only identifier.

Are you happy to proceed? ……(*yes/no)*

General questions:

1. Approximately how many sheep do you manage on your property?
Include nos of adult sheep (ewes, hoggets, wethers, rams) and nos of prime lambs turned off/year
……

2. How important are sheep as part of your farm income?

- Less than 30%
- Between 30 and 70%
- Greater than 70% of farm income

……

3. On what basis do you sell your **mutton**?
   a) Over the scales plus skin value
   b) Processor purchases at $ per head in the paddock
   c) By description on computer (CALM)

……

Specific Questions:

1. Have you had a chance to read the information sent to you about (*name of condition*) from sheep processed on *(…….date*) at TQM?
   Yes or
   No……

2. Were you aware of the presence of *(name of condition)* in your sheep?
   - If yes, do you currently have a control program – describe.
     ……
   - If aware, but not taken any action, why?
     ……

     If not aware, continue with interview

3. Did you read the information about the disease/condition that was found in your sheep?
   (Yes/No)……

4. Did you find the feedback and information sent to you useful?
   - Was it a) very useful b) moderately useful c) not useful
   - If useful, what was useful?
     ……

5. What actions have you decided to take on the basis of feedback and information provided by the processor in this instance?
   ……
   ……
   Example of options: (prompt only if they are having trouble remembering)
   - *Talk to advisor/vet/rural merchandiser*

- *Talk to DPIPWE vet*
- *Talk to abattoir*
- *Purchase vaccine*
- *Start vaccinating*

6. If you have decided not to take any action, what are the reasons for this?

   ……

7. Of the following, which one is most likely to prompt to you take action to manage the condition?

   (ask them to rank 1 (most impt) to 3 (least important)

   a) Animal Health and Welfare……..
   b) Costs to you from lost production eg reduced wool, increased deaths, reduced lambing % …….
   c) Cost to you from reduced payment from abattoir……

8. How could the information sent to you be improved to assist you make decisions about animal health conditions?

   ……

9. Would you be interested in receiving feedback from the abattoir on any animal health conditions found in your sheep at slaughter?

   Give examples eg sarco, grass seeds, dog bites, footrot, hydatids, sheep measles, CLA, bladder worm, arthritis, pneumonia

   ……

10. Do you have any other comments about feedback on animal health conditions from TQM?

    ……