# final report

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# Improving cattle health and wellbeing at farm level using abattoir data feedback

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# Executive summary

Abattoirs in Australia collect large amounts of data on animals they process. These data include information on identification, breed, sex, age, meat parameters (such as colour, fat and bruising) as well as parasitological and pathological conditions identified in organ meat and body parts. This information is relatively underutilised for its value in animal health, but has potential as a useful tool to assist producers in identifying health and wellbeing issues within their herds. To be utilised within a feedback loop, the information must be provided to the producer in a comprehensible and timely manner.

In this project, data relating to bruising and condemned body parts (that is, organs which have disease or parasite damage) from OBE Organic slaughter lines were analysed. These data were used to identify prevalence (percentage of total consigned cattle) of bruising, some pathological (disease) and parasitological conditions that have the potential to reduce or negatively affect the productivity (and profitability) of cattle supplied for slaughter for that Property Identification Code (PIC).

A feedback report for individual properties was generated for 14 PICs in the supply chain. The report was designed to assist producers in identifying and managing conditions (diseases, parasites or well-being impacts) on their property that may be reducing productivity and profitability and/or potentially pose a risk to the well-being of the livestock. This report included of a set of guide notes and materials that producers could utilise to undertake more targeted biosecurity and welfare management within their enterprises.

More targeted sero-surveillance (blood testing) was undertaken to demonstrate the prevalence of certain production-limiting diseases such as Leptospirosis, Neosporosis and Pestivirus. The prevalence of these diseases was used to underpin economic modelling, to determine costs and benefits of a change of management for such diseases, such as the inclusion of vaccination, or an integrated control program.

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# 1 Background

## 1.1 Processing data as a resource

The purpose of this project was to assess if livestock slaughter data can be used to drive on-farm practice change that improved animal health and wellbeing, reduced waste, and increased farm and processing productivity.

Currently, slaughter data is under-utilised by producers as most are unaware exactly how much information in collected during processing. The information collected on parasitological and pathological conditions, and conditions that affect the well-being of livestock, could assist grass-roots producers in the implementation of more targeted health and productivity management plans. Whilst the characteristics and composition of carcases in slaughter lines is readily provided to producers, the health information gathered during processing historically has not been provided. In this project we focus on exploring if this information can add value to a niche organic grassfed beef supply chain.

Raw animal health data can be hard to understand. The datasets for a retrospective study are large with many data points per beast, and often provide vague 'faults' for condemned organs and body parts that cannot always be assigned to specific causative agents and health measures. Raw data still contains entry errors, duplications, and in some cases missing datapoints.

## 1.2 OBE Organic FLOURISH sustainability program

This project is a direct result of OBE Organic's FLOURISH sustainability program, which aims to help the company achieve long term goals by identifying and managing opportunities and risks.

Materiality assessments have shown animal wellbeing and waste are two priority areas for risks and opportunities to the OBE business – and are material to all other beef businesses as well. In a regular staff session to review the FLOURISH program and build internal sustainability capacity, staff identified a source of waste in the supply chain as being product lost due to disease and pathogens. Further enquiries revealed these data are being collected at slaughter, but not fed back to producers so they can make practice changes to prevent these losses, and to improve animal wellbeing outcomes.

# 2 Project objectives

## 2.1 Value adding to data collected during slaughter

### 2.1.1 Data collection and analysis

A list of faults that generate carcase wastage (such as trimming and organ condemns) during processing was developed. Retrospective analysis on bruising data and condemned offal data was used to identify which of these faults had a higher prevalence.

Organ condemnation data provided had been collected and entered by the On-Plant Veterinarian (OPV) during processing. The objective of this part of the project was to generate a cleansed data set that could be used for analysing patterns of organ condemnation.

### 2.1.2 Data mining to generate health and wellbeing hypotheses

A list of conditions resulting in organs being condemned was created. In some cases these were specific (for example – a hydatid cyst is a specific identifier of the condition), in other cases conditions were generalised and non-specific (for example abscesses and adhesions). Non-specific conditions such as these are often multi-causal and multi-factorial, and as such were not used to generate any hypothesis.

A number of ‘conditions’ identified had a high likelihood of being caused by, or provided a related infectious pathway to, a specific pathogen, and were utilised to direct the sero-surveillance in the next part of the project.

Data of bruising scores and bruising loss were analysed according to both yard-of-loading location and sex, in an attempt to determine the origin of the problem.

## 2.2 Providing feedback

### 2.2.1 Property report cards

The objective of the property report card was to identify conditions (diseases, parasites or well-being impacts) that may have been affecting profitability and where a change in management around animal health and biosecurity could improve productivity and profitability. This report card also included materials, tools and information to assist producers in implementing these changes.

### 2.2.2 Abattoir feedback sheets

In order to give producers a real time quantitative assessment of animal wellbeing, OBE Organic’s feedback sheets were revised to include the economic loss from bruising for each mob slaughtered, and to include an Animal Wellbeing summary table that rates each mob for bruising, meat colour and fat cover compared to the OBE Organic herd average. Each of these are potential indicators of animal wellbeing performance, and including this information helps producers to assess if they can improve and also highlights to producers the importance OBE places on animal wellbeing. In future, OBE Organic plans to monitor the weekly data provided by the feedback sheets on a quarterly basis to track changes in animal wellbeing outcomes.

### 2.2.2 Producer workshop and teleconference

A steering group consisting of four producers in the supply chain, participated in teleconferences during the development of materials included in the property report card. These producers were given opportunities to provide comment on the feedback sheets, property report card and the usability of the materials provided and likely uptake of recommendations.

OBE Organic hosted a Grazing Best Management Practices workshop at the Annual General Meeting in Thargomindah in October 2017. Included in the agenda was time for further discussion with producers on the project, and some brainstorming around management of identified conditions within an organic system and an opportunity to share existing knowledge and identify gaps that still existed.

## 2.3 Testing hypothesis through sero-surveillance

In addition to specific conditions such as hydatids that were identified in data analysis, four productivity-limiting diseases were identified as likely causes of or related to conditions that were being seen in condemned organs at slaughter. These were Leptospirosis (both *Leptospirosis hardjo – L hardjo* and *Leptospimosis Pomona – L pomona*), Neosporosis and Pestivirus.

Collection of blood samples at the point of slaughter during processing was undertaken with the objective of identifying the prevalence of these diseases in the cattle.

## 2.4 Economic analysis

A partial budget analysis was undertaken relating to implementation of preventative or control measures for certain diseases, to identify where investment could be made to improve productivity in a cost-effective manner.

# 3 Methodology

## 3.1 Data analysis

Data relating to organ and body part condemnation from OBE Organic slaughter lines between 14/01/2015 and 09/03/2017 were provided on the 14th March 2017. All together, there were 26,722 data lines relating to individual organs with a total of 427,552 data points. These data points relate to 6,828 individual identifiers (head) that were used in the study.

Additionally, data relating to bruising score, bruising discount and total cost of discount for bruising were provided for the OBE slaughter lines from the 01/07/2016 to 17/05/2017.

The steps in data cleansing were as follows:

1. Sort by eartag number list from smallest to largest (or Z to A) (this is equivalent to the RFID tag number)
2. Assign an identifier in lieu of an 'eartag' number
3. Assess 'tailtag' to assign correct PIC (use body codes and kill dates to assist)
4. Duplicate page (make a copy)
5. Highlight duplicates to make sure all the coding for 'eartags' are correct
6. Highlight 'eartags' and remove duplicates where applicable
7. Order 'tailtags' smallest to largest and copy and paste all those tags that have been added in (coded) for the missing to a new sheet
8. Review condemn coding – duplicate entries (especially kidneys) via fault code and reason (list by eartag and by condition filters)
9. Remove all line coded 'processing fault'
10. Run analytics - including pivot charts, countifs and sum
    a) Total cattle supplied in period of analysis
    b) count of organ condemnations per PIC
    c) count of conditions per PIC (and by organ)
    d) total bruising, average of bruising discounts per head.

## 3.2 Feedback loop report cards and producer teleconference

A number of conditions were considered in regard to wellbeing, including bruising or conditions that would render the animal unfit to load. Producer input helped guide the development of the wellbeing parameters.

Data from 14/01/15 to 09/03/17 were analysed to provide a more insightful report into animal well-being outcomes than the Animal Wellbeing summary of bruising, meat colour and fat depth. This report included a National Livestock Identification System (NLIS) report and a summary of pathological and parasitological conditions identified. The report also contained details of resources and planning tools, to support review of animal health and husbandry management plans, on-farm biosecurity plans, to address these issues.

A one-off property report card that provided a baseline of the animal health and wellbeing status on individual properties was provided to a test-group of four producers within the OBE Organic supply chain. A teleconference was held after the producers had reviewed their property report card and suggestions were incorporated before a property report card was sent to 14 of the largest suppliers.

An example of the data provided in the feedback report is contained in Appendix 9.1.

## 3.3 Sero-surveillance for proofing hypotheses

A number of hypotheses were generated during data analysis (see over page), and many of these could be tested through sero-surveillance. Blood was collected in 10ml clot tubes, and after clotting placed in a cooler box and transported to the nearest state laboratory for testing.

The number of samples required was calculated using Epitools© "Sample size to estimate a proportion or apparent prevalence". The laboratory processing the samples was unable to provide sensitivity and specificity for the tests used, so these were determined through a literature review and are estimated below with each hypothesis.

Using the results of prior sero-surveillance conducted on one of the local properties by the Department of Primary Industries and Regions, South Australia (PIRSA), we were able to gain a rough estimate of prior prevalence for use in the calculation of sample size.

Overall the number of samples required (as generated by Epitools© (within a large/finite population), with 0.95 confidence level and 0.1 precision) was 114. Other iterations for individual loads and properties were completed, and ultimately between 14-20 samples were taken from each property with the exception of one small consignment of cattle, when only 10 samples were taken. In total 136 samples were tested for Leptospirosis and Pestivirus and 108 samples tested for *Neospora.*

The first of the hypotheses related to the level of kidneys condemned due to nephritis. Some early research by Amatredjo, Campbell, & Trueman, (1976), indicated rates of condemnations due to nephritis were up to 3.8% in an average season but rising to 8% after a wet season. This study also found Leptospirosis to be the most predominant cause of the nephritis. With the rates of kidney condemnation in the data due to nephritis at 6% of total kill, sero-surveillance of cattle at slaughter for *L Pomona* and *L Hardjo* was undertaken.

For Leptospirosis testing, the Microscopic Agglutination Test (MAT) is known for high specificity (95-97%) and moderate - low sensitivity during acute phases of infection. However the sensitivity after the acute phase of infection is considered relatively high at 93-96% (Bajani, 2003, Niloofa et al, 2015, Musso and La Scola, 2013). In the calculation equation 95% was used for both sensitivity and specificity, given an assumption that there was a low likelihood of cattle with acute stages of infection having been well enough to make it through the muster, loading and transport.

The second hypothesis related to relatively high levels of condemned organs due to hydatosis. Given the spread pattern through wild dogs, it was postulated that other dog-spread diseases would also be present and possibly impacting productivity of the production system. Sero-surveillance for *Neospora* was undertaken.

The Enzyme Linked ImmunoSorbent Assay (ELISA) for *Neospora* has a specificity of between 93-100% and sensitivity of between 85-98% depending on the brand (Pare 1995, Alvarez-García 2013). With Epitools'© sample size for true prevalence with an imperfect test, the overall population test requirement was 126; with the 136 samples we had collected for Leptospirosis, we didn't require further samples for *Neospora* testing.

In addition to testing for the disease above, Pestivirus (Bovine Viral Diarrhoea - BVD) antibody tests were requested for the samples from each property and in a few cases where syndromic reports consistent with copper deficiency had been noted, liver samples were also taken.

Testing for BVD was completed using the BVD Agar Gel Immunidiffusion (AGID) method following Kirkland and MacKintosh (1993). The strength of the reaction (ranging from 0 – 3+), gives an indication of the time since infection (with 3 being most recent).

Only one property showed indications of a recent infection (within 6-9 months) demonstrated by a skew of the frequency of '3' reactors. The other properties within the sampling group showed majority '1' and '2' reactors, indicating a much longer time since exposure/infection. This testing protocol only demonstrated seroconversion following exposure and does not give an indication of persistently infected cattle.

## 3.4 Economic Analysis

Partial budget analysis was undertaken on some of the more prevalent diseases to determine if intervention would be cost effective.

A partial budget is used to measure the net profitability of a change in a system such as the implementation of vaccination in a herd, or a change in productivity associated with management changes. This type of analysis is primarily accountancy within a system and rarely considers indirect costs. The variables mostly relate to net outcomes of a change within the system, that affect the profitability of the enterprise or system being analysed.

If there is a positive output from a partial budget, this will help ascertain that a change is financially viable. This means the change should be considered for action as a net profitable change when the sum of the benefits outweighs the sum of the costs. This can also be considered as marginal benefits returned as a result of the change that is proposed. In this study we modelled the use of vaccination (for Leptospirosis and Pestivirus).

The losses associated with diseases spread by wild dogs, in this case *Neospora* and hydatids (without inclusion of physical injury through attacks and calf losses) are more complex in calculation, and an in-depth and all-encompassing analysis (including the impact of reduction of dog numbers and zoological factors) is beyond the capacity of a partial budget. In this case, rather than trying to measure a change within the system, it is more useful to make an estimate of primary losses.

By determining the costs associated with the disease, we can look at the bottom line of a return on investment (ROI) appraisal, giving an indication of what a feasible investment into dog control could be, for the level of current loss (i.e.) how much money could be invested into wild dog control, based on the current losses.

# 4 Results

## 4.1 Condemned organs and well-being parameters

### 4.1.1 General information on organs condemned

Of the 26,722 lines of data, 17,486 were removed as they related to condemnation due to controllable processes (i.e. operator error rendering the product unusable). This equates to just over 65% of the related data set but only relates to 2,429 head. Controllable processes do not affect the financial payment to the producers as offal is considered a by-product of beef processing. Processors can on-sell offal, and it can be a profitable resource for them. However, offal that is contaminated or damaged through controllable processes, may need to treated – such as rendering before use, or dumped as waste is unusable, which represents loss and additional costs for treatment or removal. Figure 1 demonstrates the breakdown of organ and body part condemns by reason, including controllable processes.

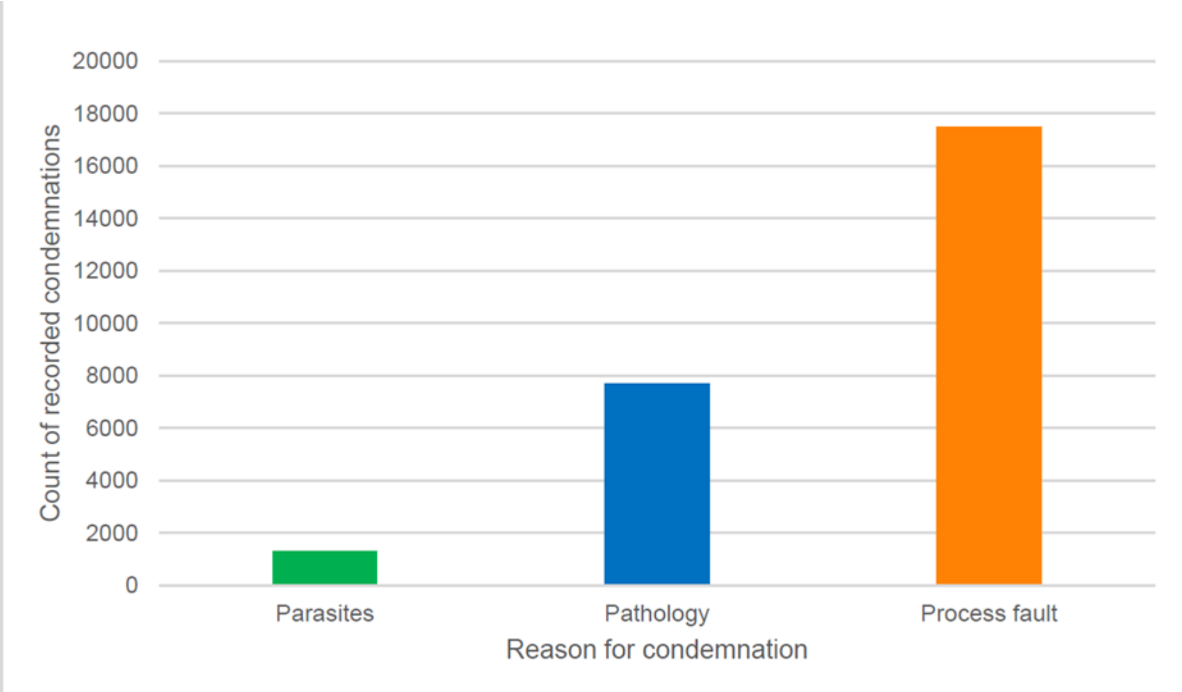


*Figure 1: Graph demonstrates the breakdown of organ and body part condemns according to the in-house recording labels for wastage 'parasitology, pathology and controllable processes'*

### 4.1.2 Well-being measurements

The AUS-MEAT Bruise Scoring System and the Australian Beef carcase evaluation system is utilised at this processing facility. The majority of bruising that did occur was graded at a bruising score of 1-3, which reflects bruising to a single location on the carcase.

For the purposes of this analysis, bruising scores were grouped into two categories – Bruising scores 1-4 (a single area of bruising) and bruising scores 5-8 (representing more than one area of bruising). Only six sides received a bruising score of 8 (from over 55,000 sides of beef processed in the period of analysis), equating to less than 0.01%. A bruising score of 8 indicates that there is bruising within three areas of that side of beef.

For the time period 01/07/15 to 17/05/16 only, producers were also provided with a financial loss statement as a result of bruising.

Carcase assessment sheets provided to us by the processing facilities also included a meat colour score. Dark cutting meat is considered to be a reflection of stress – relating to changes of pH within the meat causing darkening of the meat. While this can be due to a number of factors, those commonly cited include transport stress, handling, lairage, weather and time off feed and water. For the purposes of this study, a meat colour score of five or above was considered 'dark cutting'. Although pH is a better determinant than colour scoring, the original MSA grading for 'dark-cutting' was considered to be meat of a colour of 4 or greater (AMPC, 2016).

Producers are also provided with a financial loss statement as a result of dark cutting.

Prevalence of dark cutting beef in Australia is reported between 4.8 and 11% (Warner et al 2014) if a pH of greater than 5.7 is considered.

### 4.1.3 Disease and parasite parameters

Nephritis and hydatids were the most common reasons for organ condemns. In the report group, on a per head basis, nephritis was responsible for between 4.26 and 9.79% of kidney condemns, with a supply chain average of over 6%.

Nephritis has been linked to Leptospirosis and other pathogens such as *corynbacterium*, and this was followed up through sero-surveillance. The results of which are discussed in section 4.2

Hydatosis most commonly resulted in condemnation of lungs and liver, although other organs such as spleen and aorta were reported. There was also one case of generalised hydatosis. There was a great deal of variation between organs and properties, although one property demonstrated significantly higher condemnations in both liver and lung, and would be a target property for the implementation of control measures and monitoring changes in the level of condemnations as a result.

The project average for condemns of liver due to hydatids was 1.59% and in lungs 2.85%.

Lung disorders (including pneumonia, pleurisy and emphysema) were at a generally low prevalence across the supply chain (2.51%), although consistent in the reporting group, recording low variation in the number of condemnations (1.43% - 4.21%).

As lung conditions are often multi-causal and influenced by a number of factors, no primary determinant of these conditions was identified.

Liver fluke and lung worm were identified in the reporting group at a very low prevalence. Only two properties recorded lungworm, and for each of these properties only one case was identified at each. Liver fluke was found in condemned offal from 11 of the 14 properties in the reporting group, with the overall supply chain average only 0.2%.

### 4.1.4 Kidney condemns

A total of 2,305 head of cattle had one or more kidneys condemned due to pathological conditions. No parasitic conditions were recorded as fault codes within the kidney dataset. Nephritis was by far the greatest cause of condemnation, with retention cysts the next highest. Fig 2 shows the breakdown of fault codes relating to kidney condemnations.

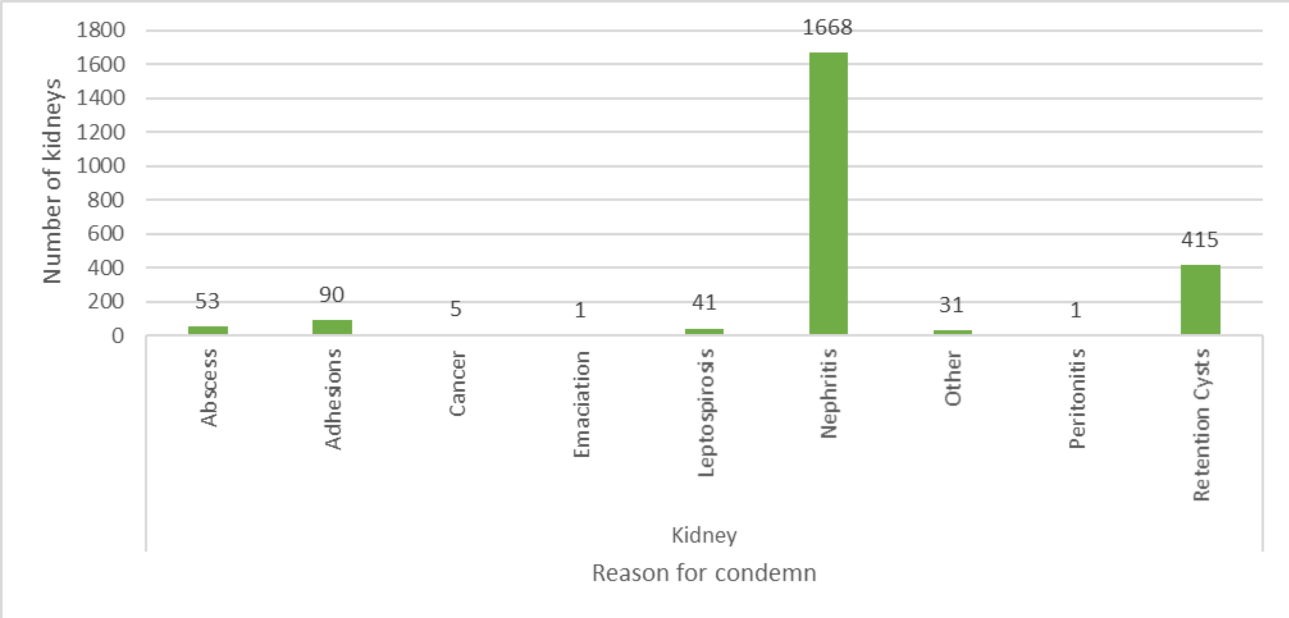


*Figure 2: Number of kidneys condemned broken down by fault code 14/01/15 to 09/03/17*

### 4.1.5 Liver condemns

A total of 2,004 livers were condemned from the 4,399 head of stock that were included in the preliminary analysis. The top three fault codes related to liver condemnations were adhesions, abscesses and hydatids. Fig 3 shows the breakdown of fault codes relating to liver.

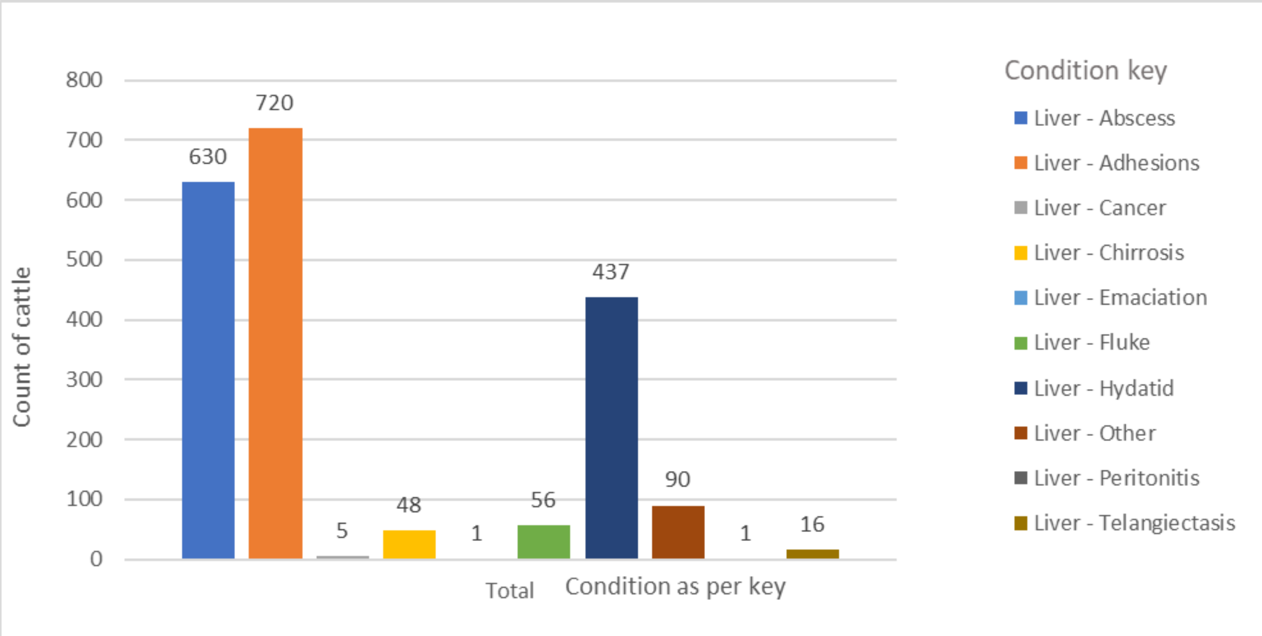


*Figure 3: Breakdown of live condemns by fault code 14/01/15 to 09/03/17*

### 4.1.6 Lung condemn

A total of 1,746 head of cattle from 4,399 cattle included in the preliminary analysis recorded lung condemnations. Hydatids were the highest cause of condemnation at 45% of total condemnation. Pleurisy was the next highest cause of condemnation and often has a multi-factorial aetiology. See Fig 4 below.

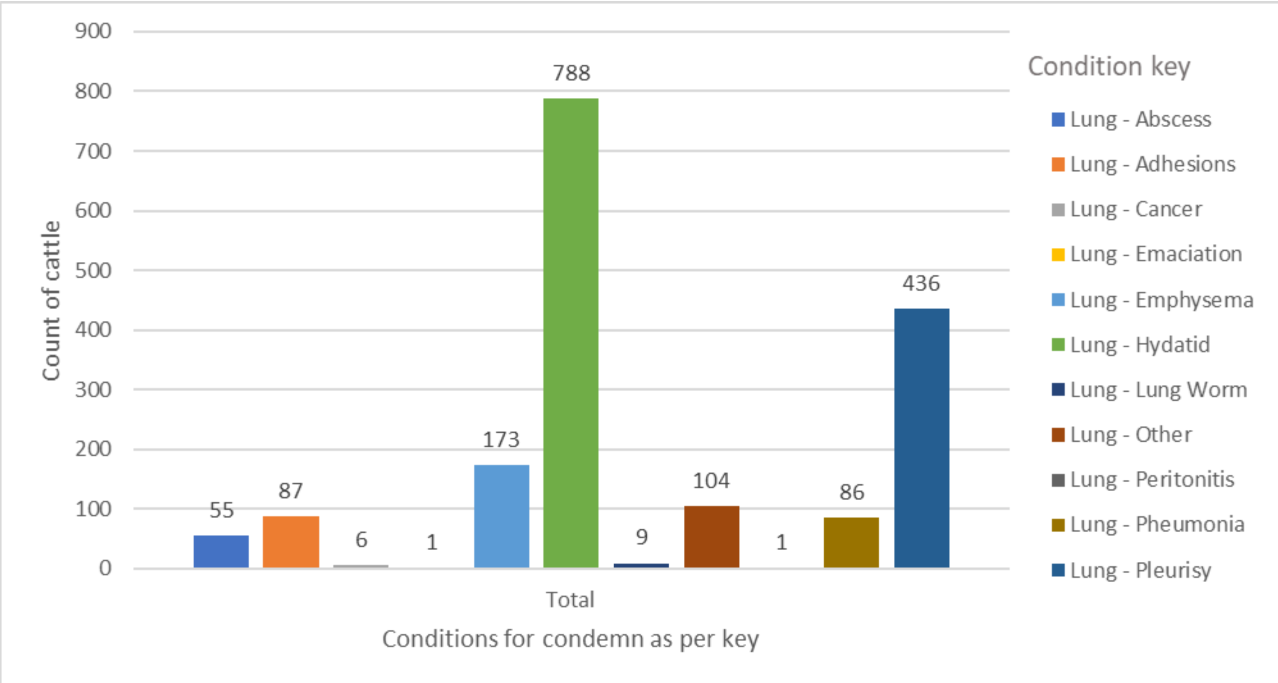


*Figure 4: Breakdown of lung condemns by fault code 14/01/15 to 09/03/17*

## 4.2 Sero-surveillance

### 4.2.1 Leptospirosis

The seroprevalence of *L hardjo* across the supply chain was 66.9% with all properties demonstrating at least some cattle with positive results. *L Pomona* seroprevalence was much lower at 20.6%, and not all properties had positive results. A positive result will be obtained from any animal that has been exposed to the bacteria and responded by developing antibodies as part of the body's immune response. This means that within the lifetime of these cattle, 66.9% had been exposed to *L hardjo*, not that 66.9% of the animals were diseased.

### 4.2.2 Neospora

As had been hypothesised, suro-surveillance demonstrated *Neospora caninum* to be present in all herds tested, with the supply chain prevalence sitting at 14.8%. This result indicates that this proportion of the herd had antibodies to this parasite, highlighting that wild dog control needs to be strengthened.

### 4.2.3 Pestivirus

The prevalence of pestivirus/BVD was 87.5%. Given there is uncontrolled mixing of cattle in different age and sex groups, and no vaccination for this disease utilised, a high prevalence was anticipated.

The strength of reactions as indicated by the AGID presented differently between the properties tested. In two cases, the cattle received for processing were younger in age, and stronger results were seen, indicating more recent exposure and a greater proportion of sero-negative animals. This can be seen in Fig 5 below.

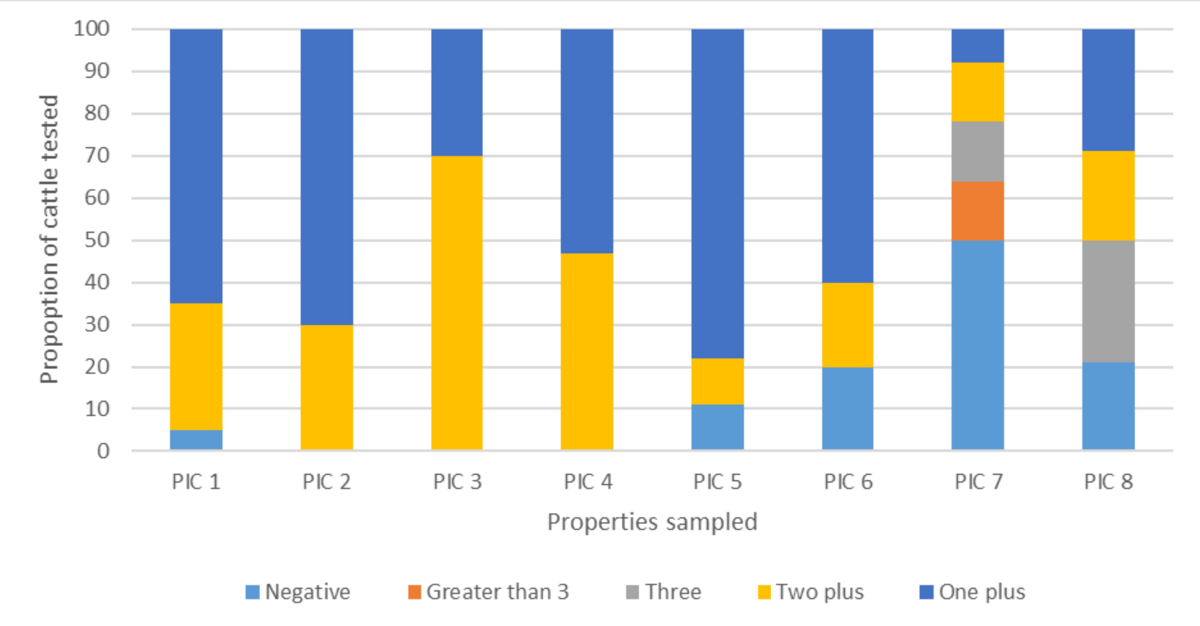


*Figure 4: The proportion of cattle showing different AGID reactions (Negative, Greater than 3, Three, Two plus and One plus) for BDV sero-surveillance by property (PIC)*

### 4.2.4 Copper

A number of livers were tested for copper levels, and all returned results within the normal range. The low number of samples, and single property tested, meant that little that can be concluded from these results.

## 4.3 Economic Analysis

### 4.3.1 Partial budgets for use of Leptospirosis vaccination

Positive and negative economic impacts were identified and calculated for a single change in the system for a one year period, relating to the implementation of a first-time vaccination protocol for *L pomona* and *L hardjo* in 1000 breeders.

Partial budget determines net value of a change in a system (e.g.) Net profit = (costs saved + new revenues) – (new costs + revenues forgone), in other words = (sum of all benefits) – (sum of all costs).

The impact of and outbreak of infection and the uptake of vaccination will have different results in an exposed herd vs. a naïve (unexposed) herd. Both possibilities were modelled in order to determine the benefits in each situation. Please refer to Table 1, 2 and 3 for the partial budget analysis for the naïve herd scenario.

Firstly consider the naïve herd – with no or low levels of herd immunity, infection could lead to an abortion storm, and high loss of calves and ongoing reduced fertility.

*Table 1: Increased returns expected through undertaking vaccination for leptospirosis in a niave (unexposed herd)*

| | amount ($) |
|---|---|
| Cows at risk | |
| 80% fertility in breeding cycle of 1000 = 800 | |
| Additional existing perinatal mortality 10% + 10% conditional handicap = 160 | |
| Remaining susceptible cows = **640** | |
| 50% cattle greater than 5 months pregnant = **320** | |
| Prevalence of *L hardjo* = 35% | |
| Abortions *L hardjo* = 35% * 320 = **112** | |
| Prevalence of *L pomona* abortion 10% of cows >5m pregnant | |
| Remaining susceptible cows (320-112) = **208** | |
| Abortion *L pomona* = 10% of 208 = 20.8 (**20**) | |
| Total abortions = 20+112 = **132** | |
| Weaning % = 132*0.72 = **95** | |
| Value of loss: 95*238*415 | 93,831.50 |
| subtotal for increased returns | $ 93,831.50 |

*Table 2: New costs + Revenues foregone for undertaking vaccination for leptospirosis in a naïve (unexposed) herd*

| | amount ($) |
|---|---|
| Vaccination @ $1.50 per cows (x 2 doses) x 1000 cows | 3,000.00 |
| Extra aerial mustering costs 6 hours @ $550 | 3,300.00 |
| Labour 3 staff for 16 hours each @ $19.88/hr | 954.24 |
| Cold chain set up cost for vaccination (once off) | 200.00 |
| Vaccinator gun ($49.29 wholesale - RRP $65) | 65.00 |
| Needles | 33.00 |
| Potential abortion loss due to muster – 13% of 320 @ 72%weaning = **29** head (Value = 29* 415c/kg*238 average kilograms (kgs) | 28,643.30 |
| subtotal new costs and revenues foregone | $ 36,195.54 |

*Table 3: Net impact of undertaking vaccination for leptospirosis in a naïve (unexposed) herd.*

| **Summary** | |
|---|---|
| Sum of benefits | $ 93,831.50 |
| Sum of costs | $ 36,195.54 |
| **Net impact** | **$ 57,635.96** |

If we consider a herd where an underlying level of infection is apparent, such as in our study group, where approximately 35% of cattle were tested as being sero-positive, and therefore it is likely that there is some level of herd immunity. Please refer to Table 4, 5 and 6 on partial budget analyses for a herd with some level of immunity and prior exposure.

*Table 4: Increased returns expected through undertaking vaccination for leptospirosis in a herd with some prior exposure*

| | amount ($) |
|---|---|
| **Cows at risk** | |
| 35% immune therefore 65% susceptible = **650** | |
| 80% fertility of remaining non-exposed cattle = **520** | |
| Additional existing perinatal mortality 10% + 10% conditional handicap = 160 | |
| Remaining susceptible cows = **416** | |
| 50% cattle greater than 5 months pregnant = **208** | |
| Prevalence of *L hardjo* = 35%, | |
| Abortions = 35% * 208 = 72.8 (**72**) | |
| Prevalence of *L pomona* abortion 10% of cows >5m pregnant | |
| Remaining susceptible cows (208-72) = **136** | |
| Abortion = 10% of 136= 13.6 (**13**) | |
| Total abortions = 72+13 = 85 | |
| Weaning % = 85*0.72 = 61.2 (61) | |
| Value of loss: 61cattle*238 kgs cwt*415c/kg cwt | 60,249.70 |
| Subtotal for increased returns | $ 60,249.70 |

*Table 5: New costs + Revenues foregone for undertaking vaccination for leptospirosis in a herd with some prior exposure*

| | amount ($) |
|---|---|
| Vaccination @ $1.50 per cows (x 2 doses) x 1000 cows | 3,000.00 |
| Extra aerial mustering costs 6 hours @ $550 | 3,300.00 |
| Labour 3 staff for 16 hours each @ $19.88/hr | 954.24 |
| Cold chain set up cost for vaccination (once off) | 200.00 |
| Vaccinator gun ($49.29 wholesale - RRP $65) | 65.00 |
| Needles | 33.00 |
| | |
| 13% loss for mustering 416*.13 = (54) | |
| Weaned 54*.72 = 38.9 (38) | |
| Total loss 38*415*238 | 18,766.3 |
| subtotal additional costs | $ 26,318.54 |

*Table 6: Net impact of undertaking vaccination for leptospirosis in a herd with some prior exposure*

**Summary**

| | |
|---|---|
| Sum of benefits | $ 60,249.70 |
| Sum of costs | $ 26,318.54 |
| **Net impact** | **$ $33,931.16** |

Assumptions for the calculations above are as follows:

- Calculation is per 1000 breeders over a one year cycle
- Cattle have not had previous exposure to Leptospirosis or herd immunity level is too low to be protective in Tables 3-5
- In Tables 6-8, it was assumed that 35% of cattle were immune to *L hardjo* and therefore only 65% of the population was at risk
- Vaccination is for the first year of protocol only - aka 2 doses, 4-6 weeks apart
- Vaccination is $1.50 per dose (based on purchase of dual cover *L hardjo* and *L Pomona* vaccination and transported to supply chain)
- One vaccination can be completed at a routine management muster - therefor only one set of extra muster costs
- Four hours of helicopter used for muster @ $550/hour plus additional labour costs
- Three extra staff employed for 2 days (16 hours each) @$19.88/hr (award pastoral wage for farm and stockhand level 5) (Australian Government, 2017)
- Assumed 80% cows in year-round breeding cycling in calf (MLA, 2006)
- 10% prenatal mortality assumed without including other reproductive diseases in this harvest system of beef management (low input), based on 5% in managed herds (Burns et al 2010) and 10% loss in Northern Downs areas (Fordyce 2014, McGowan et al 2014)
- Assumed proportion of Leptospirosis related abortions – *L hardjo* 35%, *L pomona* 10% (halved crude prevalence from study data)
- 50% of susceptible cows at 5 months pregnancy or above (MLA 2006, McGowan 2014)
- Weaning rate of 72% (McGowan et al 2014)
- Conditional handicap of 10% for low phosphorous and low growth tropical environment (McGowan 2014)
- Calculations for losses by *L hardjo* and *pomona* were run sequentially to avoid double counting.
- Average weight of carcase through abattoir - 119kg per side average HSCW (total per beast 238)
- Price per kg cwt 415c (average of indicator for the same time period as data anaysis) (MLA, 2018)
- Rounding cattle figures down where necessary to meet integer constraints
- 13% additional loss due to second mustering (McGowan et al 2014)

### 4.3.2 Investment into wild dog management for the control of *Neospora* and hydatids

In order to utilise the information we have available, we calculated the assumed loss associated with the dog-spread diseases (without calf mortalities or injury resulting from direct dog attacks) as an indicator of feasible investment into dog control. Table 7 below gives a summary of the losses associated with dog-spread diseases.

*Table 7: Showing summary of reduced returns (losses) as a result of hydatids and Neospora per 1000 breeders in an extensive beef production system*

| | amount ($) |
|---|---|
| **Hydatids** | |
| Lost carcase weight 16.8kg @ 415c/kg cwt = $69.72 | |
| Prevalence - 2.8% of 1000 cattle = 28 head | |
| Price per kg CWT 415 | |
| Hydatid losses | $ 1,952.16 |
| ***Neospora*** | |
| Abortion loss - 14% prevalence and 15% likelihood | |
| Cows at risk | |
| 80% of 1000 = 800 | |
| Additional existing perinatal mortality 10% + 10% conditional handicap = 160 | |
| Remaining susceptible cows = **640** | |
| 40% cattle within 4-7 months gestation = **384** | |
| Abortion loss in susceptible cows = **0.54 (1)** | |
| Weaning rate - 72% = 0.72 **(1)** | |
| Loss at processing = 1 head @ 238 kg paying 415c/kg | $978.70 |
| **TOTAL LOSS** | **$ 2939.86** |

Assumptions for the calculations above are as follows:

- Per 1000 breeders
- 1 year period
- Prevalence of *Neospora* in supply chain 14%
- Likelihood of abortion in infected cattle 1% (Range from unknown (Kirkland et al 2012) to 15% (Dubey et al 2007))
- Prevalence of hydatids in supply chain 2.8%
- Losses for hydatids - reduced body weight average 16.8kgs (Jenkins 2016)
- Assumed 80% cows in year-round breeding cycling in calf (MLA, 2006)
- Existing 10% prenatal mortality assumed without including other reproductive diseases in this harvest system of beef management (low input), based on 5% in managed herds (Burns et al 2010) and 10% loss in Northern Downs areas (Fordyce 2014, McGowan et al, 2014)
- Conditional handicap of 10% for low phosphorous and low growth tropical environment (McGowan 2014)
- Cattle from 4-7 months most susceptible ~ 40% (Landmann, 2010)
- 72% weaning rate (McGowan 2014)
- Conditional handicap of 10% for low phosphorous and low growth tropical environment (McGowan 2014)
- Average value of carcase through abattoir - 119kg per side average HSCW (total per beast 238kgs)
- Price per kg cwt 415c (MLA, 2018)
- Rounding cattle figures down where necessary to meet integer constraints (figures shown in brackets)

# 5 Discussions

## 5.1 Inconsistencies in data recording and the need for data cleansing

The data recorded on-the-chain during processing showed many inconsistencies. Duplication of entries was a recurring issue, as was inconsistency in the fault code recording. For example: In recording a kidney that had been condemned - the body part coding for kidneys could be recorded as "kidney", 'kidney x1" or "kidney 2". In some cases, individual identifiers (NLIS numbers) had up to 4 kidneys assigned to them. This anomaly meant that on average for the total head of cattle with renal condemnations, each NLIS number (cow) had an average of almost three kidneys.

As well as duplicated body parts, often double recording for an organ occurred – for example, a liver recorded twice for the same NLIS number, appeared twice, each with a different fault code assigned to the condemnation (for example, abscess and other). It is unclear what the purpose of the duplication is, but the recommendation would be to investigate how this duplication occurs within the chain (for example: are 2 different inspections occurring with repeated recording, where does the recording of different fault codes for the same condemned organ occur?).

The majority of organs with this fault code were likely due to processing activities causing ruptures in the gastro-intestinal tract and condemns are a method to maintain strict standards of hygiene for food safety in accordance with regulatory requirements. Some of these organs may also have contained specific disease-related conditions, but were not included in the analysis due to ineligibility.

Overall, processing errors would have low impact on producer outcomes, as producers are currently not paid directly for offal. However, this represents a loss to the processing sector and an increased cost of processing due to greater wastage.

## 5.2 Disease and parasite and animal well-being data analysis

Hydatid cysts and nephritis were the two main findings in the data set that led to a logical review of causative factors and epidemiology.

Current research into the prevalence of hydatids demonstrates that it is an issue in terms of wastage and reduced performance, albeit not recognised as a priority disease in cattle at this stage (Jenkins 2016, Lane 2015).

The percentage of livers condemned due to liver fluke was at a very low prevalence of 0.2%. However, given the majority of the animals in the supply chain are home-bred and taken direct to the abattoir and the arid geographical area these cattle are sourced from, the existence of liver fluke was an unexpected find. It seems unlikely the host (the *Lymnaid* snail) could survive at all in the environment and enable the perpetuation of the life cycle of liver flukes. It may be that this related to an inconsistency in determination of the cause of condemn when examined during processing, as the gross pathological signs of liver fluke are generally considered pathognomic for the parasite.

In the analysis, the category summarising 'lung disorders' included pleurisy, pneumonia and emphysema. The causation could not be determined from the data provided. Although in feedlot cows, respiratory disease plays a large role in lung disorders, in this case it was considered that due to the short timeframe between muster and slaughter, infectious processes were likely to be secondary to environmental and management factors such as dust, heat and stress during mustering and handling.

Abscesses and adhesions were relatively common across all PICs and all organs groups. The highest condemnation rates recorded were due to these conditions however, they can be multi-factorial in their causation and will often occur in more than one organ in the same beast. In some cases, they may be related to a specific disease condition, and not so in other cases. For example – if the liver of one beast has recorded fault codes of "hydatid" plus "abscess" and/or "adhesion, then the likely causal factor is hydatid. If a liver recorded a singular fault code of "abscess" without other fault codes, then aetiology is not determined.

## 5.3 Sero-surveillance

### 5.3.1 Leptospirosis

The sero-surveillance indicated the prevalence of Leptospirosis was much higher than originally suspected. Although no results for historical prevalence studies for this geographical area could be found, for other areas of Queensland (and areas debatably with higher rainfall), cited sero-prevalences are included in Table 8 below.

*Table 8: Historical Leptospirosis prevalence data for Queensland beef cattle for comparison*

| Area/herd | *L hardjo* prevalence | *L pomona* prevalence | Study by |
|---|---|---|---|
| Current study results – beef cattle supply chain | 66.9% | 20.6% | Wilson<br>MLA project |
| Central Queensland Beef cattle | 15.8% | 4% | Black et al (2001) |
| Central Queensland<br>Beef cattle herds<br>(low water holding soils) | 1.9-12.4% | 0.8-9.6% | Carroll and Campbell (1987) |
| Central Queensland<br>Beef cattle herds<br>(high water holding soils) | 9.4-33.3% | 1.7-8.1% | Carroll and Campbell (1987) |
| Queensland<br>Beef cattle | 36.23% | 18.32% | Elder and Ward (1978) |

There has been a significant period of time lapse since a broad geographical prevalence study for Leptospirosis in Queensland was last completed. Reduction in public funding for such large surveys is one of many reasons. Smaller regional surveys completed since 1987 in Central Queensland, which is a much higher rainfall area, show lower sero-prevalence of both *L hardjo* and *L pomona*.

This poses a risk for both animal productivity and human health. The inclusion of vaccination for Leptospirosis would be prudent to manage the risk of disease spread to humans and to improve productivity in the herd, however the low input harvest system of beef management does not accommodate the protocol for vaccination (i.e. two vaccinations, four weeks apart, then a yearly booster).

In discussions with the producers in the supply chain, very few already use vaccination for leptospirosis, and with the difficulties in administrating to deliver vaccination protocols effectively, it is unlikely that many more will include this in their herd health management protocol.

As a host-adapted serovar *L hardjo* can produce a carrier state in the cattle, which means the risk of spread to naive animals is much higher. It also means that infertility in these carrier cattle will be reducing the profitability of the enterprise.

As the maintenance host for *L pomona* includes pigs, it also lends to the debate on the control of such feral animals, and managing shared water sources whilst biosecurity planning, to reduce the risk of transmission of disease.

### 5.3.2 Neospora

We suspected that *Neospora* would be found through sero-surveillance, given the presence of wild dogs in the region, and the ongoing levels of hydatids found across the supply chain. Although it has been reported that there is cross reactivity from other parasites such as *Toxoplasma gondii,* in the tests used to identify *Neospora caninum* in cattle (Howe 2002, Gondim 2017), which could play a role (albeit likely to be insignificant), the presence of the definitive host in high numbers, leads us to believe the sero-surveillance is relatively accurate.

Studies of *N caninum* beef cattle across Australia have reported animal level sero-prevalences of 15-20% in Queensland and central Queensland respectively (Stoessel et al 2003, Fordyce et al 2013), and 11.3% in New South Wales (Molony et al 2017). Seroprevalence studies in dairy herds in Queensland have been reported levels up to 34% (Landmann et al 2011).

Determining the level of abortion due to this infection is difficult and beef cattle appear to be more resilient than dairy cattle. Estimates of abortion for calculation in the economic analysis were considered between an unknown (Kirkland et al 2012) and 15% (Dupey et al 2007). In the end 1% abortion rate was selected.

### 5.3.3 Pestivirus

Pestivirus (Bovine Viral Diarrhoea – BVD) is a common disease in extensively managed cattle in low input systems. It is estimated that up to 90% of Australian herds are infected. Seroprevalence increases with age, where in cattle at 10 years of age, you can expect seroprevalence of 75% in the age group (Taylor 2006). The cost of vaccination and the ability to successfully and conveniently implement the vaccination protocol, means little to no take-up of vaccination in this supply chain.

Natural exposure and sero-conversion gives life-long immunity, although this is not the case with immunity developed from vaccination. The testing on most properties indicated that seroconversion had not been recent. This means as time progresses and the number of naïve (unexposed) cattle increases, there may be abortion storms or an increase in syndromic calves (depending on the stage of pregnancy when infection occurred). As the bulls are in year round, no pregnancy diagnosis is undertaken, and no observation of the death of calves is recorded in most herds, it is likely to go unnoticed.

## 5.4 Disease management strategies

Management strategies for controlling or reducing the impact of disease had been part of biosecurity planning processes that the producers in the OBE supply chain had been participating in since 2015.

There are limitations to some methods of control and prevention within an organic system, which prohibits the use of chemicals or the use of chemically treated products. Human health and zoonotic disease is recognised within the biosecurity planning, as an issue that needs to be addressed within the system.

Reducing the risk of leptospirosis infection in humans is one such issue. The implementation of human health management strategies when working with cattle is something that many of the producers expressed interest in. Leptospirosis can be spread from cow-to-cow, pig-to-cow, and cow/pig-to-human. As a result it should be a priority disease to manage on farm to prevent human infection. Bacteria are spread most commonly in urine, meaning that contamination of non-reticulated water sources can be a primary source or spread. Staff should be aware of risk activities, and actively undertake measures to prevent infection. Such measures may include the cover up and wash up strategies recommended by human health departments, and infrastructure such as wash-up facilities to be provided in the cattle yards and handling facilities.

Wild dogs continue to have a significant presence in this area. They pose not only a risk to the animal in bite wounds and attacks killing young animals, but a risk for spreading parasites such as hydatids and *Neospora*. The use of broad-scale chemical baits, although a common conventional control method, is not allowed within the organic system. Given the estimates of cost associated with such diseases though, the implementation of other non-chemical methods of control may be considered as a good investment in this supply chain.

General biosecurity and managing the introduction of new livestock has been part of the OBE Organic program since 2015.

A copy of the recommended reading list and resources provided to producers relating to management strategies for the control and prevention of diseases and biosecurity risks is contained in Appendix 9.2.

## 5.5 Economic analysis

### 5.5.1 Partial budget analysis for the use of *Leptospirosis* vaccination on naïve and/or unexposed herds

Although the partial budget does show a significant net benefit for the inclusion of the vaccination protocol, as mentioned earlier, the difficulty incorporating this protocol into a low input system, has meant that most producers in this supply chain are not willing to take those steps as it is not a practical or easily implementable step.

Given that it is often assumed (and proven by sero-surveillance) that there is a level of herd immunity present, the cost-benefit to vaccination programs in exposed herds is questioned.

In the unexposed herd, the benefit of vaccination is shown to be just over $57 per head, assuming that abortion will occur in 35% of naïve dams exposed to *L hardjo* and 10% of dams exposed to *L pomona*, whereas in a previously exposed herd, with a level of herd immunity (in this case assumed to be 35% - consistent with the prevalence of sero-converted cattle), then the benefit is only $33 per head.

The benefits may have been slightly exaggerated in the analysis, owing to a number of unpredictable factors within the biological system and the inability to incorporate stochasticity into a partial budget. A full cost-benefit analysis would have enabled greater capacity to include fluctuations in variables including market prices, but would have been beyond the availability of data or resources available.

Some areas where estimations and assumptions around variables will influence the outcome of the economic analysis include:

- A rate of 72% weaning for the Northern Down country as described in (McGowan 2014) may reflect a better performance score than through much of the supply chain in this study, however it is difficult to ascertain, as year round breeding and little use of pregnancy diagnosis limits availability of data.
- Utilising the variable of 10% pre-natal mortality may under-estimate the impact as Fordyce et al (2014) states that up to 25% embryonic mortality may occur in extensively managed beef herds. It is difficult to separate the other causes of abortion and embryonic mortality, so the lesser figure was used.
- Assumptions that the herds are naïve (unexposed) to *L pomona* and *L hardo* and have no innate immunity is highly unlikely. However given that *L hardjo* can exist in a carrier state, and create issues with ongoing fertility, an overall impact of 35% of pregnant cattle (> 5 months in calf) was utilised.
- No information on herd structure and management other than year-round breeding was incorporated. Many factors could have an influence such as bull percentage, age and composition of breeding herd, climate and season and nutrition.
- We are also unable to discount the impact of other reproductive diseases in real life, although in this model we have assumed a discrete cause of Leptospirosis.

Although these factors will likely all impact the outcome of the economic analysis, the sensitivity of how big the impact is remains unknown. Of those factors with the greatest influence, prior exposure and immunity would likely have the greatest impact.

Despite the level of assumptions made and the unpredictability of some of the variables, the economic analysis supports that there is financial gain to be made through reducing the impact of *L pomona and L hardjo.* Consideration should also be given to the intangible benefits of undertaking vaccination, such as reducing the occupational risk of humans contracting the disease.

### 5.5.2 Investment into wild dog management for the control of *Neospora caninum* and hydatids

The comments made above related to reproductive/herd assumptions also apply in the investigation of the impact of *N caninum.* Additionally there are other limitations in our knowledge, which may impact the outcomes of the analysis.

Although we have an estimate of the prevalence of cattle that are sero-positive for *N caninum*, it is difficult to estimate how many of those cattle will abort. The relative risk of abortion associated with *N caninum* has been reported at around 3% (Landmann et al 2010, Wouda et al 1998) through to Australian studies where increased abortion risks in dairy cattle of 8-fold (Atkinson et al. 2000) and 13-fold (Hall et al. 2005) have been revealed. Abortion storms of up to 57% of all infected cattle have been reported (Schares et al, 2002, Dupey et al, 2007).

Kirkland et al (2012) found that although serological evidence of *N caninum* was not uncommon across Queensland beef herds, it was rare to see reduced reproductive performance as a result of this disease. Even if we assume one calf is lost as a result of Neosporosis per 1000 breeders, it still has a negative impact on profitability of the enterprise.

Vertical transmission (transplacental) of *N caninum* occurs with up to 95% of calves from infected dams being born infected (Dupey et al 2007), although these infected calves may be asymptomatic.

Hydatosis is an issue seen broadly across beef processing facilities in Australian, apart from South Australia where little disease is seen and Tasmania where an active eradication and control program is in place. Jenkins (2016) study from 2013 – 2016 in New South Wales, reported 5.5% of cattle infected with hydatids. In this study, hydatids were found in 1.59% of livers and in 2.85% of lungs in cattle processed, likely reflecting more extensive grazing patterns and lower grazing pressures.

Hydatid infestation results in downgrading of carcases, condemnation of offal and almost 17kg carcase weight loss attributable and 1.24 kg hide loss (Jenkins, 2016). Hide loss was not considered in the economic analysis in this study.

Hydatids can also affect humans and treatment of the problem in humans can be challenging.

Overall the economic analysis showed a benefit in investing in the prevention and control of diseases spread by wild dogs (specifically hydatids and *Neospora*). Even if the parameters in the modelling, specifically around *Neospora* infection and abortive losses show great variation, the benefit in preventing hydatosis is clear through improved weight gains and better productivity.

Investment into wild dog control is also a means to reduce losses from direct attacks and injuries sustained from wild dogs. Although sheep are considered to be more at risk, reports of $2.50 to $13 loss per cow have been reported anecdotally (Department of Natural Resources and Mines 2004).

Even at the lowest end of the estimation, that would add value to return on investment considered in implementing control measures.

# 6 Conclusions/recommendations

## 6.1 Usefulness of peri-mortem (abattoir) surveillance data

Data are collected from livestock during processing by On-Plant Veterinarians in all slaughterhouses in Australia. Much of these data remains un-utilised, when it can provide some insight into common conditions, diseases and parasites that may be impacting the profitability of an enterprise.

Although the data are uncleansed when released from the processor, and contain errors, duplications and anomalies that can bias the data in some form, it is a tool that should be utilised more as a cheap and accessible form of surveillance.

For some parameters (conditions and diseases), regular monitoring may give an early-warning as to an increase in a particular condition that can perhaps be remedied or mitigated before it causes increasing economic loss. Such conditions would include parasites such as liver fluke and lung worm, pneumonia (under certain conditions) and to some extent hydatids.

Whilst there may be seasonal fluctuations of some conditions, diseases and parasites (or their causal agent), that would perhaps go unnoticed in irregular monitoring, the more data that can be collected for comparison, the stronger associations may give an indication of the most effective times for the implementation of control of mitigation methods.

Further analytical breakdown of parameters such as sex, age and conditions score and the associated levels of disease or conditions, could also provide some insight into herd disease and well-being dynamics (see next section).

## 6.2 Future directions

### 6.2.1 Data collection and intuitive analysis for future feedback reporting

Raw data that are collected requires cleansing before analysis. Reducing recording errors for some conditions could be done (for example the duplication of kidney recording, by revising the in-house 'codes' for kidneys). However where there are duplication of code lines – such as for fault codes (duplication of a single organ, each listed with a different fault code), no error is flagged until a manual duplication check is run on the excel spreadsheet. Potentially analytic coding could be used to identify these errors for review.

For organs that are listed with more than one condition or fault code – for example 'hydatid' and 'abscess', it may be possible to code for intuitive removal of the duplications, to allow better data and easier analysis (less time in data cleansing and more accurate outcomes).

Further exploration of the data to make comparisons between different consignments from the same property or between similar classes of animal within the same system may also be possible. This would allow geographical and spatial patterns of disease or conditions to emerge.

### 6.2.2 Integrated analysis of organs and sero-surveillance

In order to ground-truth the future directions possible, a more intensive analysis integrating both individual beast slaughter data and sero-surveillance should be undertaken. The sero-surveillance undertaken in this study was conducted at the supply chain level, with no comparison of results for individual animals.

To assess the post-mortem conditions (condemned organs) in a more accurate process, blood collected from individual animals would be tested for diseases that were determined by the conditions that were seen in the carcases along the slaughter line. Logistically this poses a challenge when collecting blood samples during slaughter, as blood is taken prior to any exposure of most potential conditions within the carcase. However with each blood sample labelled with the unique identifier belonging to the beast, and with carcase and organ traceability as it is, then it would be possible.

Other blood testing, such as for cortisol levels to cross check with other indicators of stress such as dark cutting meat or bruising, could also provide some valuable information when analysed by breed, sex, age and body condition.

### 6.2.3 Extended economic modelling to include cost-benefit analysis

Economic modelling conducted in this study, was based on a partial budget – measuring only one change in the system or looking at the cost-expenditure of control methods. For a full analysis of an integrated system over a longer period of time, a property-level cost-benefit analysis would be required.

Although cost-benefit analysis is a comprehensive and flexible tool, a major limitation is the requirement for data, and the constant fluctuation of some of the data requirements (for example the changing present value of the price paid per kilogram of carcase weight).

To undertake a full cost-benefit analysis was beyond the scope of this project, both in terms of time and resources required, and the data available.

# 7 Key messages

## 7.1 Hydatids, neospora and wild dog control

As hydatids were the highest cause of lung and liver condemnation, and prevalent across the supply chain, the hypothesis that *Neospora caninum* would also be detected within the herds was proven. Although reproductive losses from *Neospor*a have not been demonstrated convincingly in northern beef cattle, such losses do lend weight to the value of an integrated control program for the definitive host of both these issues – dogs (and in particular wild dogs).

The cost effectiveness analysis supports implementing a greater level of integrated dog control using methods suitable for the organic system, which are likely to be trapping and shooting, given that baiting is not a practice suitable for the system.

## 7.2 Uptake of vaccination for controlling Leptospirosis

Sero-surveillance showed a higher than anticipated prevalence of both *L hardjo* and *L Pomona* based on prior studies. The spread of *L pomona* could be reduced through the implementation of biosecurity practices around shared water sources, and greater action in controlling feral pigs. *L hardjo* however is host adapted and will be spread by cattle in the system with a carrier state.

Use of vaccination was shown to have a positive cost-benefit in both exposed and naïve herds, understandable more so in naïve herd, where preventing an abortion storm could have large financial gains in subsequent years of productivity.

This poses a risk to human and animal health, and although the practical implementation of vaccination may be inconvenient and difficult to manage, the partial budget analysis shows a cost-benefit (insofar as improved returns). Vaccination of cattle is also a protective mechanism to reduce the risk of humans contracting the disease.

## 7.3 Rates of pregnancy and breeding herd

It is difficult to determine exact rates of pregnancy and therefor foetal and peri-natal loss in such an extensive and low input system. Dependant on the time of year, many cattle culled for slaughter were pregnant at various stages of development.

Whilst this affects the number of progeny of the ground for the future of production within the system, it also poses a potential well-being issue for late-pregnant cattle being transported or calving on trucks or on arrival at the processing plant or collection point.

Although it would be uneconomical to use a veterinarian for pregnancy diagnosis before trucking cattle (due to both activity and travel costs), there is great merit in training some of the staff/managers from the properties to undertake pregnancy diagnosis. Even if the accuracy is less than Veterinarians who are accredited in the Australian Cattle Veterinarians pregnancy diagnosis scheme, a relatively inexperienced lay preg-tester can often palpate the foetus of a heavily pregnant cow to exclude her from transport.

## 7.4 Organic production systems

Organic production systems for beef present challenges in the management of diseases and parasites due to the restriction on the use of chemical and medicines. However, vaccinations that are not live or genetically modified can be used within the system, and when necessary, vaccinations can be used under special veterinary permit to prevent an ongoing outbreak of disease without affecting organic status.

Organic systems in lush and highly productive pasture present more difficulties in managing disease and parasites than in dry, remote conditions, where to some degree weather and proximity are huge tools in the biosecurity cache.

Managing introductions of new livestock can assist in reducing the impact of diseases and parasites, and in home-bred production systems, this exposure to new livestock reduces the risk even further.

Some of the difficulties that are faced include the need to control feral animals and pests, which present as one of the most significant risks for the introduction of diseases. Control of these pest animals can be limited by legislation (in some states, especially wild dog control), limited by what products/chemicals can be used within the organic system and the huge expanse of territory that needs to be covered in such extensive and remote production systems.

To make the most of the natural environment and water supply, it is largely impractical in many parts of the remote extensive production system to have controlled or reticulated water supply, although this would potentially also be a measure that could help to reduce spread of some disease from pest animals (such as Leptospirosis from wild pigs) and to perhaps even provide areas that could be targeted for pest animal control (easier to trap/shoot wild animals using water points as a collection point).

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# 9 Appendix

## 9.1 Feedback Loop Report Card example (de-identified)

The following is an example of the report card to provide producers feedback.

### 9.1.1 Analysis 1: Your animal well-being summary for cattle supplied during the period 14/01/15 to 09/03/17

Our feedback sheets use bruising, meat colour and fat depth as indicators of animal wellbeing for each mob sent to OBE. The indicators of well-being used in this report include: (a) meat-related parameters: bruising and meat colour; (b) cattle parameters: number of cattle arriving in emaciated or unacceptable condition, offloaded as a downer/emergency slaughter, or arriving with any other condition that would render them **'unfit-to-load'**.

Table: For cattle supplied during the period 14/01/15 – 09/03/17

| | | | |
|---|---|---|---|
| Project Property Number | | xx | **NOTES** |
| Total cattle consigned | | xx | |
| Unslaughtered/unfit for transport | | xx | |
| Cattle fully condemned | | xx | |
| Total sides of beef processed[1] | | xx | |
| Sides of beef with bruising[2] | | xx | |
| Percentage of sides of beef with bruising[4] | | xx% | |
| Bruising scores[2] | Score 1-4 | xx | |
| | Score 5+ | xx | |
| % sides with dark cutting score 5 or above | | xx% | Average |

The graph below, following provides a breakdown of bruising score in consigned cattle between 14/01/15 and 09/03/17. For more detail on specific mobs, refer to your feedback sheets or ask us to re-send feedback sheets to you.

For cattle supplied in this period, xx sides of beef showed low levels of bruising from the xx cattle consigned and xx sides of beef processed. Bruising scores were generally on the lower end, however xx sides of beef had bruising score of 5 and above, which represents greater financial loss.

[1] Each beast is processed as 2 sides of beef, for which the parameters are reported
[2],[4] Bruising scores are on a 'per side of beef' basis

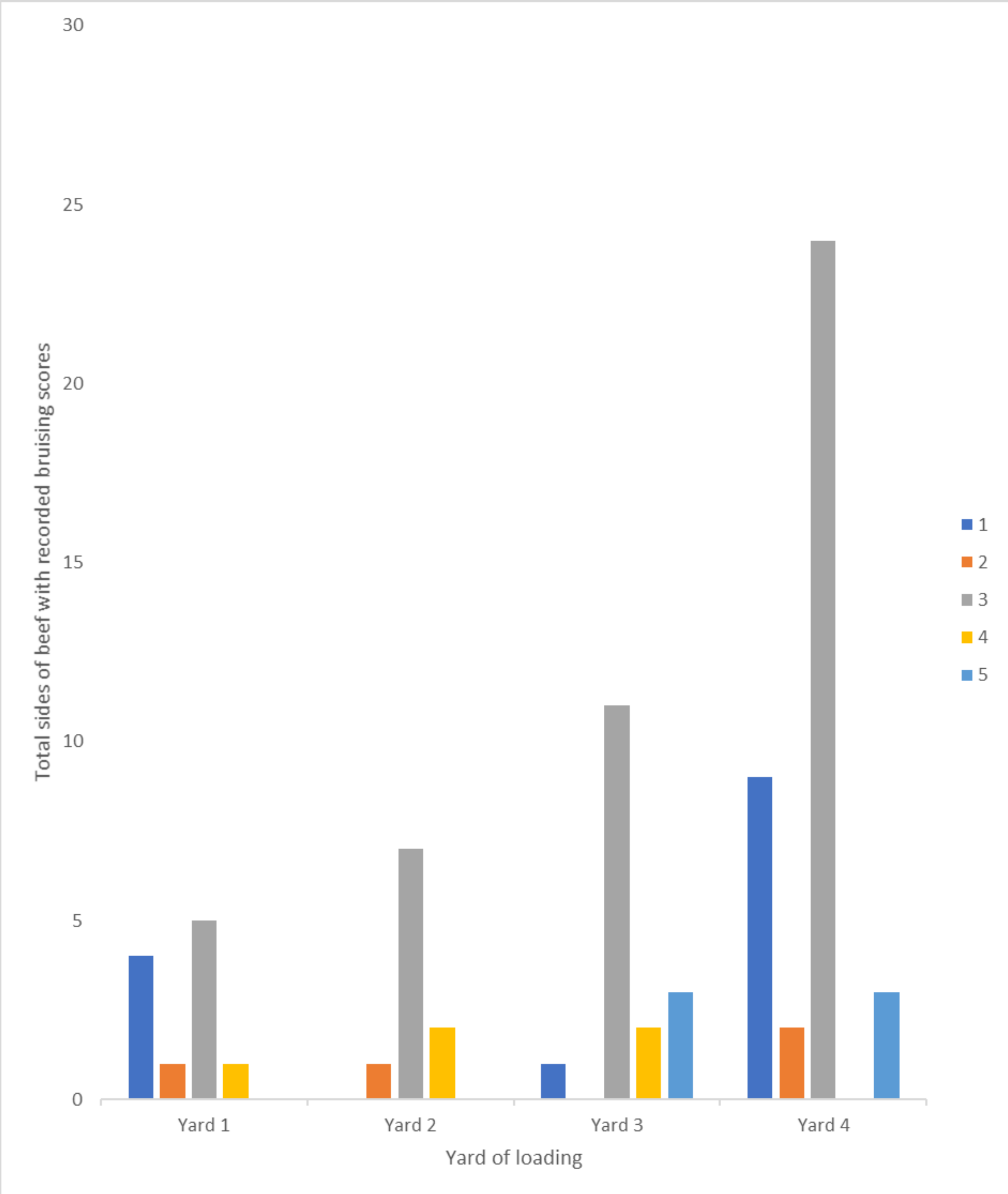


Figure: Bruising scores FY15-FY17, sorted by loading yards (example only)

### 9.1.2 Analysis 2: Bruising financial loss statement[3] for the period 01/07/2016 – 17/05/17

For the 2016-17 financial year, for data collected up to the time of analysis, we can give you an indication of losses for your consigned livestock which occurred as a result of bruising.

Total financial loss was -$xx with an average $xx per head **loss** consigned overall.

### 9.1.3 Analysis: disease and condition summary 14/01/2015 to 09/03/2017

As the cattle are processed, their carcases and organs are examined by meat inspectors. Any body part that shows abnormalities such as parasites, bruising, infection and inflammation or other conditions such as adhesions are condemned. Condemned body parts cannot be sold for human consumption.

By examining the body parts that are condemned, we are able to gain valuable insights into possible disorders that may be reducing the productivity of cattle on your property, and thereby reducing your profitability.

During the period from 14/01/15 to 09/03/17, xx head of cattle were consigned from your property number and were included in the analysis. A summary of conditions of interest identified through the analysis, relating to body parts condemned, is provided in the table below.

List of specified parasites or pathological conditions identified

| **Specific Conditions** | **Count or %** |
|---|---|
| Cattle with one of more organs condemned | xx |
| Percent of total cattle with one or more organs condemned | **xx%*** |
| Hydatids (count of total organ condemned) | xx |
| Hydatids % of total number of livers condemned | xx% |
| Hydatids - % total lungs condemned | xx% |
| Liver fluke - % of total livers condemned | xx% |
| Nephritis - % of total kidneys condemned | **xx%*** |
| Lung conditions (pleurisy, pneumonia, emphysema) % of total | **xx%*** |
| Lung worm – Count of total lungs condemned | xx |
| Abscesses (total count of organs condemned) | xx |
| Adhesions (total count of organs condemned) | xx |
| Cancer (count of head) | xx |

[3] Summary of financial losses for the financial year 16-17 up to the point of analysis (May 2017)

* Indicates conditions with an incidence of occurrence that has been identified as above project average.

Some indicators of disease - such as abscesses and adhesions - can have many causes, they are often secondary to a primary cause of disease. In some organs, such as the liver or lungs, a history of hydatids or liver fluke increase the likelihood of these organs ending up with abscesses or adhesions.

Nephritis is a condition relating to inflammation of the kidneys. There are many things that can cause this condition, including diseases and toxicities. In the later stages of this project, we will be undertaking further studies to help to identify some specific causes of the condition.

Pleurisy is the inflammation of the lining (pleura) of the chest cavity. It is a complex disease that can be caused by many different infectious agents, parasites, environmental conditions (particularly dry and dusty conditions) and poor immunity.

## 9.2 Recommendations and resources for management strategies

### 9.2.1 Recommendations: Disease management strategies for consideration

The management strategies listed here are considered best practice. We recognise some of these are impractical in extensive properties or are not compatible with organic systems.

1. For properties with hydatids reported
   a. Management plan for reducing hydatids through wild dog control.
      Under the Biosecurity Act (2014) in Queensland , The Dog Fence Act (1946) and The Natural Resources Management Act (2004) in South Australia, landholders have a legal responsibility to control wild dogs (including dingoes) on their land[4,5]. In the Northern Territory, wild dogs should be managed under a Wild Dog Management Program[6]. Effective wild dog control is best achieved through a cooperative 'nil tenure' approach with many stakeholders working across the landscape.
   b. As organic systems cannot use baiting as a control method, reliance on other management options is required. Wild dog control recommendations (other than baiting) can be found on the Pest Smart Website (http://www.pestsmart.org.au/tools-and-strategies-for-wild-dog-management/).
      Your shire council may also have some information to assist you on integrated planning.
2. For properties with liver fluke reported
   a. Liver fluke can have a significant impact on growth rates and ability to effectively convert feed.
   b. Chronically affected cattle may develop anaemia, bottlejaw and chronic diarrhoea. Secondary Black Disease can occur, and invariably results in death.

[4] https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/land-management/health-pests-weeds-diseases/pests/wild-dogs/law

[5] http://www.pir.sa.gov.au/biosecurity/weeds_and_pest_animals/animal_pests_in_south_australia/established_pest_animals/wild_dogs

[6] https://nt.gov.au/industry/agriculture/farm-management/controlling-pest-animals-wild-dogs-with-1080-poison

   c. Management of swampy and wet areas is paramount. Deny cattle access to grazing in such areas to reduce the chance of contracting liver fluke. Improve drainage to permanently wet areas.
   d. If you have a high incidence of liver fluke you may want to consider the use of a flukicide. This will mean your cattle are no longer able to be sold as 'organic', however it may be a means to breaking the liver fluke cycle.
3. For properties with pleurisy reported:
   a. Some management techniques may be implemented to improve conditions during weaning, yarding and mustering.
   b. Reducing dust through yard watering
   c. Reduce stress, particularly overcrowding and stress during mustering and handling.
   d. Avoid mustering and handling during periods of high temperatures.

4. For properties with high levels of kidney pathology (including Nephritis).
   a. In a previous scientific study performed on northern beef cattle[7], it was found that leptospirosis was the most predominant cause of the nephritis in kidney condemned through the processing facility. The levels of condemnation in this study averaged 3.8%, significantly lower than the average in this analysis. We will be doing further research to identify specific causes of nephritis.
   b. Leptospirosis can be spread from cow-to-cow, pig-to-cow, and cow/pig-to-human. As a result it should be a priority disease to manage on farm to prevent human infection. Bacteria are spread most commonly in urine, meaning that contamination of non-reticulated water sources can be a primary source or spread. Staff should be aware of risk activities, and actively undertake measures to prevent infection. More information on human prevention can be found at: http://www.wpro.who.int/mediacentre/factsheets/fs_13082012_leptospirosis/en/

### 9.2.2 Recommendations supported by industry to reduce bruising and improve the well-being of livestock

Yards and handling

- "Mustering should be carried out quietly and carefully to avoid undue stress to the animal.
- Cattle require time to settle after mustering, particularly after a difficult yard up or in adverse weather conditions.
- The Australian Model Code of Practice for the Welfare of Animals states that a rest period after mustering and handling of at least 12 hours is essential before transport"[8].
- Cattle must not be driven to the point of collapse.
- The use of shotgun pellets on cattle, as an aid to mustering (or for any other purpose), is not acceptable"[9].
- The use of dogs for mustering may cause unnecessary stress.

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[7] Amatredjo, Campbell, & Trueman, 1976

[8] Sourced directly from "Cattle and land management best practices in the Katherine Region" located at https://dpir.nt.gov.au/__data/assets/pdf_file/0010/227827/kbp_apr09_web_96dpi.pdf accessed 22/06/2017

[9] Sourced directly from "The grazing of cattle in the northern pastoral areas of western Australia" https://futurebeef.com.au/wp-content/uploads/2011/09/The_grazing_of_cattle_in_the_northern_pastoral_areas_of_West.pdf accessed 22/06/2017

- Procedures such as dehorning or branding should not occur as part of a muster-to-loading strategy.

Fit-to-load

An animal is not fit for the journey if it:

- is not strong enough to undertake the journey
- cannot walk normally, bearing weight on all legs
- is severely emaciated or visibly dehydrated
- is suffering from severe visible distress or injury
- is in a condition that could cause it increased pain or distress during transport
- is blind in both eyes
- is in late pregnancy

For more information please go to: Is it fit to load? A national guide to the selection of animals fit to transport (available to download at www.mla.com.au).

Transport

- 'Cattle require time to settle down after mustering. After handling in the yard they should also be rested prior to transport. Rushing cattle causes stress, which leads to tough or dark-coloured meat.
- Appropriate loading densities will depend on the size, shape and horn status of the cattle, as well as weather conditions and the distance to be travelled. Loading densities must be assessed for each pen in the stock crate to ensure the animals give each other mutual support'[10]. Assessed for each pen in the stock crate to ensure the animals give each other mutual support'[11].

### 9.2.3 The "person-in-charge"

The person in charge has responsibility for the livestock during transport, the transport standards and guidelines above describe this as:

'SA1.1 A person in charge must exercise a duty of care to ensure the welfare of livestock under their control and compliance with the livestock transport standards.

The responsibility for livestock welfare in the transport process is:

i) The **consignor** for the:

a) mustering and assembling of livestock; and

b) handling; and c) preparation, including inspection and selection as 'fit for the intended journey'; and

d) feed and water provision; and

e) holding periods before loading; and

ii) The **transporter** (except for rail and poultry) is responsible for:

a) the loading including final inspection during loading as 'fit for the intended journey'; and

b) the loading density; and

c) additional inspections of livestock; and

d) spelling periods during the journey; and

e) unloading

[10,14] Sourced directly from "Cattle Transport" located at: https://futurebeef.com.au/wp-content/uploads/2011/09/Loading_cattle_transport_BQ_factsheet.pdf accessed 22/06/2017

iii) The rail authority is responsible for the livestock during the rail journey…
vi) The **receiver** after unloading.

SA1.2 If a person in charge reasonably expects the journey time to exceed 24 hours, the transporter must possess a record which is accessible at the road side and that specifies:
i) the date and time that the livestock last had access to water; and
ii) the date and time of livestock inspections and any livestock welfare concerns and actions taken; and
iii) emergency contacts.'[12]

[12] Complete standards and guidelines found at http://www.animalwelfarestandards.net.au/files/2011/02/Land-transport-of-livestock-Standards-and-Guidelines-Version-1.-1-21-September-2012.pdf).