Final report

Analysis and extension to support beef producers in improving animal health performance

Project code: P.PIP.0753

Prepared by: Food & Veterinary Services Pty Ltd

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Meat & Livestock Australia Limited
PO Box 1961
NORTH SYDNEY NSW 2059

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Abstract

The previous animal health data project (P.PIP.0464) demonstrated that reliable collection of inspection data, with an improvement in the specificity of the data collected was possible. This project (P.PIP.0753) was designed to provide a detailed analysis of the diseases and parasites which would be essential so that producers can understand what these conditions cost them and the broader industry in terms of lean meat and co-products yield.

The hypothesis prior to this analysis was that diseases and defects affect the livestock weight and average daily weight gain. Very basic analysis just assessing average paid weight proved this to be the case for most diseases however, with more detailed analysis using pricing grids, did not allow the hypothesis to be proven nor disproven during this project.

Findings and recommendations following completion of this project include:

- In practice post-mortem verification needs to be a combination of desktop data analysis and on-site or remote verification of the collection of the data to provide the level of accuracy required for cost benefit analysis. The complexity of the supply chain in combination with disease progression and the complexity in pricing grids means that every effort needs to be made to ensure the data is as clean and therefore as reliable as possible for the producers making (potentially costly) decisions on it.
- It is recommended that further analysis is conducted to assess pricing considering all the different feed types. Analysis in this project used over 180,000 records. Due to the complexity of the supply chain and pricing grids very large data sets of verified accurate data are required.
- Additional data should also be considered in the analysis (background variables such as treatment) to enable true cost benefit analysis.
- Further investigations into co-presentation of disease and the regional prevalence of disease within Australia are also warranted to provide the true cost of disease and defects on the Australian beef industry.
- Benchmarking of data should be shared with caution to ensure it is not misunderstood or misinterpreted due to the supply chain complexities.

Executive summary

Background

The previous animal health data project (P.PIP.0464 - Collection and reporting of inspection data for continuous improvement and productivity throughout the beef supply chain) demonstrated that reliable collection of inspection data, with an improvement in the specificity of the data collected was possible. This project (P.PIP.0753) was designed to provide a detailed analysis of the diseases and parasites which would be essential so that producers can understand what these conditions cost them and the broader industry in terms of lean meat and co-products yield.

Objectives

The objectives of the project were successfully met and were:

- A cost impact of various disease conditions including parasites on producers and processors.
- Improved Teys Australia extension material for producers highlighting costs of disease/parasites.
- Specialist veterinary support to Teys Australia and interested producers.
- Ongoing validation of inspection data collection to ensure it is accurate and correct.

Methodology

Data verification activities included desktop review of data and on-site verification of data and were conducted to confirm the completeness and accuracy of data input prior to data analysis. Data analysis looked at cost of offal condemnations due to animal health and processing defects at post-mortem inspection and carcase costs due to animal health and processing defects at post-mortem.

Results/key findings

The hypothesis prior to this analysis was that diseases and defects affect the livestock weight and average daily weight gain. Very basic analysis just assessing average paid weight proved this to be the case for all diseases except for cases of Grade 2 Liver Abscesses, Viable Liver Fluke, Lung Granulomas, Lung Neoplasia and Grade 1 Pleurisy. However, with more detailed analysis using pricing grids, did not allow the hypothesis to be proven nor disproven during this project. There were no uniform trends in the price variations; some price categories in groups showed an increase in carcase price and some showed a decrease and there was no correlation in these across the groups, or between feed types. The majority of MSA qualifying carcases are greater in price however, which is to be expected with the MSA premium.

Despite the both the basic and complex forms of data analysis being completed on over 180,000 records the analysis showed that further data analysis is required with a much larger accurate data set to conclusively prove or disprove the hypothesis that diseases and defects affect the livestock weight and average daily weight gain.

The observations at on-site verification demonstrate that desktop data verification alone is not sufficient to ensure accuracy of the data. Given the combination of the complexity of the grid pricing and the supply chain mean that the accuracy of the data is paramount to this further analysis and to provide producers with the confidence to make (potentially costly) changes to their husbandry practices knowing that these will provide financial benefits to their business.

In addition, this project has demonstrated that to allow producers to make these decisions support is required in the form of additional extension material and networks. Extension material on the information begin provided, what it means and how it can be used along with disease and associated husbandry information. The opportunity of a network that allows for discussion and understanding of benchmarked information is also important to ensure understanding of the producers supply chain and the variations any benchmarked data.

Benefits to industry

This project is a significant step forward in demonstrating that diseases and defects which are detected at post-mortem inspection are impacting on commercial outcomes for Australian beef producers. Through the duration of the project, it became evident that interpretation of diseases and defects data is a specialised veterinary field (veterinary public health) and includes concepts that are difficult to convey to livestock buyers, plant operations staff and producers.

Future research and recommendations

- Although data analysis through big data in theory can allow for verification of the data collected and cost benefit analysis in practice post-mortem verification needs to be a combination of desktop data analysis and on-site or remote verification of the collection of the data to provide the level of accuracy required for cost benefit analysis. The complexity of the supply chain in combination with disease progression and the complexity in pricing grids means that every effort needs to be made to ensure the data is as clean and therefore as reliable as possible for the producers making (potentially costly) decisions on it.
- Due to the complexity of the supply chain very large data sets of data are required for further analysis.
- Post-mortem findings are only a part of the animal health picture. Future analysis should also consider background variables such as treatment to enable true cost benefit analysis.
- It is recommended that further analysis is conducted to assess pricing considering all the different feed types. Additionally, the price per kilogram is based on complex combinations of animal and carcase traits (sex, dentition, carcase weight, fat depth, muscle score) which is understandably set to meet consumer and quality requirements. The price variation of 149c/kg of MSA carcases in the MLA Market information Over the Hook Indicator – cattle (MLA Pricing) used in this analysis, not to mention the market fluctuation, can have a significant impact on the comparison prices across groups, feed types and MSA qualification.
- Further investigations into the prevalence of disease with the throughput and weight categories, the prevalence and implications of co-presentation of disease and the regional prevalence of disease within Australia are also warranted to provide the true cost of disease and defects on the Australian beef industry.
- Benchmarking of data should be shared with caution to ensure it is not mis-understood or mis-interpreted due to the supply chain complexities.

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1. Background

On average, 8.5 million cattle are slaughtered in Australia annually. Each of these animals is subject to ante and post-mortem inspection. Total condemnations are recorded with minimal information about what the cause of the condemnation was. Partial condemnation data is not collected.

There is some research showing that apart from losing offal due to parasites such as hydatids and liver fluke, and conditions such as liver abscesses, the growth rate of the cattle is also adversely affected due to sub-clinical disease. Some of this work is from 1982, well before the current grid or MSA grading systems were implemented (Roberts 1982, Jenkins 2016, Boray 1982). More recent trial work conducted by a drug company and an MLA-funded project (B.AHE.0041) in Tasmania showed that when collected post-mortem data is fed back to producers, who implement preventative treatments, there is a significant net return for both producers and processors.

An impediment to data collection has been the lack of specificity of inspection (Uzal et al 2002). Feeding the incorrect information back to producers would lead to those producers making incorrect decisions on farm. Another impediment to data collection has been the lack of a data recording standard.

The change in government policy around who can conduct post-mortem inspection has allowed the engagement of inspectors via third party providers, where the quality (i.e. specificity) of the collected data form part of the requirements of the inspection service.

The previous project (P.PIP. 0464 - Collection and reporting of inspection data for continuous improvement and productivity throughout the beef supply chain) demonstrated that reliable collection of inspection data, with an improvement in the specificity of the data collected was possible. However, the project did suffer a number of delays caused by the absolute necessity of recording data accurately, reliable and consistently.

This project (P.PIP.0753) was designed to provide a detailed analysis of the diseases and parasites which would be essential so that producers can understand what these conditions cost them and the broader industry in terms of lean meat and co-products yield. There needs to be a clear benefit to producers if they are to change their on-farm practices to address any of these conditions. At the time of the project's commencement, there was no current information about the financial effect of these conditions.

2. Objectives

The objectives of the project were successfully met and were:

- A cost impact of various disease conditions including parasites on producers and processors.
- Improved Teys Australia extension material for producers highlighting costs of disease/parasites.
- Specialist veterinary support to Teys Australia and interested producers.
- Ongoing validation of inspection data collection to ensure it is accurate and correct.

3. Methodology

3.1 Internal steering committee

An internal steering committee was formed at the outset of the project. The committee was comprised of representatives from Teys Australia and Food & Veterinary Services Pty Ltd. Steering committee meetings provided a forum for project updates as well as discussion on areas for improvement. Meetings were conducted throughout the duration of the project.

3.2 Data collection

Data was collected by third party meat inspectors and input at terminals at carcase, viscera and head stations across Teys Australia's six processing sites. Due to varying staffing configuration the input of data at the carcase stations varied from complete data entry to entry by exception. The previous project (P.PIP. 0464 - Collection and reporting of inspection data for continuous improvement and productivity throughout the beef supply chain) demonstrated that reliable collection of inspection data, with an improvement in the specificity of the data collected was possible. This was confirmed prior to commencement of verification activities and also repeated on the data used for data analysis. Appendix 1 demonstrates that for the analysis period (October 2019 – March 2020), data collection was consistently greater than 95%.

3.3 Data verification

The purpose of the verification process was to confirm that:

1. 100% of data is being collected,
2. Data that is being entered is accurate, and
3. Data is provided timely to allow for reporting.

Data verification activities included desktop review of data and on-site verification of data.
Onsite verification allowed observation of the post-mortem inspection process and data entry. From this, we could confirm that:

- Meat Inspectors are identifying defects
- When a defect is identified, it is identified correctly
- The correct defect is being entered at the data terminal
- Data is entered against the correct body number (i.e. correlation is maintained)
- Data is entered for all head/carcase/viscera sets

Onsite verification data also enabled verification of the data reporting system i.e. if a meat inspector was observed to have identified a liver abscess and entered this data at the terminal for body number one, then 'liver abscess' should be recorded against body number one throughout the data system and ultimately be listed against body one on the animal health summary.

Desktop review of the data allowed:

- Confirmation of the volume of data collection
- In combination with on-site verifications, confirmation of data being correctly reported throughout the data system and on producer and processor reports.

3.4 Data analysis on the cost impact of post-mortem inspection defects

Following data verification to allow a high level of confidence in the accuracy of the data collected, data analysis was conducted on animal health data collected at one of Teys Australia's six processing plants. Analysis was conducted on data collected over a six-month period (October 2019 – March 2020). Data has been extracted out of the Teys Australia Tableau system for this analysis.

Data extracted included baseline data (i.e. total throughput and a breakdown of throughput against feed type) as well as animal health defect data and, animal and carcase traits. Data analysis looked at cost of offal condemnations due to animal health and processing defects at post-mortem inspection and carcase costs due to animal health and processing defects at post-mortem.

Full data analysis reports outlining the methodology, results, discussion, and conclusion were developed. Given the commercial nature of the information held within these reports they have not been published. Data analysis for cost of offal condemnations due to animal health and processing defects at post-mortem inspection considered:

- Prevalence of animal health conditions in viscera
- Defect origin i.e. whether the condition identified was of producer origin (e.g. liver fluke), processor origin (e.g. contamination) or could be attributed to either producer or processor, but origin cannot be confirmed (e.g. bruising).
- Impact of feed type on animal health condition prevalence
- Condemnation costs
- Hot Standard Carcase Weight and animal health conditions

Data analysis for carcase costs due to animal health and processing defects at post-mortem considered:

- Estimated prices of carcases with liver and lung defects recorded according to the MLA Market information Over the Hook Indicator – cattle (MLA Pricing) carcase groups of:
    - Cows,
    - Non-MSA and MSA steers and heifers, and
    - Non-MSA and MSA steers and heifers grain fed 70 days;
- Impact of liver/lung defects on carcase weights across groups;
- Comparative analysis of carcase prices between carcases with liver/lung defects and carcases with no viscera defects recorded; and
- Impact of feed type on prices of carcases with liver/lung defects recorded.

4. Results

4.1 Data verification

Verification activities are designed and were applied during this project to ensure that:

1. 100% of data is being collected,
2. Data that is being entered is accurate, and
3. Data provision is timely to allow for reporting.

1. 100% of data is being collected

Confirming that all data is being collected requires both desk-based assessment and on-site verification. This activity looked at:

- Is data being recorded for every item that is being inspected?
- Is every observation for every item being recorded?

Ensuring that data is complete for each animal is vital to providing useful feedback to producers and allowing correct interpretation of the feedback.

2. Data that is being entered is accurate

Confirming that data is being entered accurately requires both desk-based and on-site verification. This activity looked at:

- Did inspection staff correctly identify the defect?
- Was this defect correctly entered into the system?
- Was this entry into the system correctly represented in the database and feedback reports?

This element of data verification considers not only the expertise and actions of the inspection staff but also the importance of having IT systems and infrastructure integration.

3. Data provision is timely to allow for reporting

Confirming that data is received in a timely manner requires desk-based verification. Animal disease and defect data may need to be provided by specific deadlines to allow generation of reports. This verification process considers the various deadlines and needs of potential feedback users to ensure that animal health feedback reports can be generated in a timely manner.

4.1.1 On-site verification

During the project, on-plant verification took place at five of the six Teys Australia sites. From February 2018 to March 2020, the project team conducted twelve verification visits. During that time, verification was put on hold for six months due to the transition to a new IT system for data collection. Verification resumed following the install of the new system and training of meat inspectors. In March 2020, on-plant verification stopped due to the understandable implementation of COVID-19 restrictions.

The consolidated findings from on-plant verification activities are as follows.

- Early visits identified that data entry was not established in the meat inspector's routine to ensure regular data entry. This affects the quality of the data collected. There were also instances of block data entry (i.e. the meat inspector entering data for a large volume of bodies in one instance rather than data entering after each body). This improved as the project progressed, with data entry embedded into the routine of meat inspectors. However, this was

observed to fall out of the routine of meat inspectors at some sites during change over of task or when training of new staff occurred.

- IT systems and hardware at terminals also have the potential to affect data quality. Prior to the transition of IT systems midway through the project, meat inspectors were observed to have difficulties with terminal hardware (i.e. touch screens were not responding to all efforts to enter data resulting in multiple efforts to data enter. Pooling of water and drips on the screen were registering as 'touches' on the screen, incorrectly assigning conditions that had not been identified was also observed). Configuration of the screens also required navigation through multiple pages/multiple touches to enter data. This prolonged the amount of time required for data entry.
- Meat inspectors are required to enter data for every carcase/head/viscera inspected. At one site, where meat inspectors are responsible for the inspection and data entry for carcases, data was being entered by exception (i.e. for those carcases with a condition identified) on the carcase stand.
- Meat inspectors are required to enter data for all defects identified. This includes defects resulting in downgrades. At one site, defects resulting in downgrades were observed to occur in the kidneys however this data was not being recorded.
- Meat inspectors are required to enter data based on the defect identified and the guidance provided in the work instruction. During data verification, inconsistency in the recording of 'contamination' defects – i.e. when to record defects was identified. Inconsistency in the use of some conditions was also identified. Additional clarification on when to use these conditions on the screens was provided.

On-site data verification findings were also compared to the Animal Health Summary reports that were generated based on the data. This identified additional issues including defects that were observed to be detected by the meat inspectors and entered at the terminal on-site were not appearing on the Animal Health Summary reports. The defects were recorded in the raw data but had not translated to the Animal Health Summary reports.

All issues identified were rectified following identification through:

- Transition to a new IT system and input of new terminals to rectify system and hardware issues
- Re-training of all meat inspectors following the introduction of the new system and on-going on-site verification to confirm data entry was being conducted in-line with the work instructions for data entry
- Feedback to meat inspection providers following verification activities

However, the above on-site verification findings demonstrate the importance of continuing routine verification activities to identify issues as they arise and to determine why they have arisen. Animal health data collection is complex, with the potential for issues to occur at multiple points in the data collection and reporting process. On-site data verification activities are required to confirm that data capture is complete and correct and to underpin the accuracy of the data pool as a whole.

Due to travel restrictions in response to COVID-19 and the decision by Teys Australia to expedite the completion of the project, verification activities were transitioned to Teys Australia. To assist QA staff in undertaking verification, Food & Veterinary Services Pty Ltd developed a data verification template and training presentation that explained why on-site verification is conducted and how to conduct on-site verification using the data verification template.

4.2 Data analysis on the cost impact of post-mortem inspection defects

Full data analysis reports outlining the methodology, results, discussion, and conclusion were developed. Given the commercial nature of the information held within these reports they have not been published. A summary report on the carcase cost variations due to liver and lung defects which have been calculated as the differences in carcase prices and weights of the carcases with defects from the carcases with no defects recorded in the viscera was also produced. The cost comparisons are presented in Appendix 2 as:

- Difference in overall weighted average prices of carcases with a defect and carcases with no defects in the viscera.
    - The weighted average prices of carcases (see below) were calculated using the average carcase price from each price category and the volumes of carcases within those price categories. This value indicates the difference in prices of all carcases with the defect and those with no defect recorded in the viscera.
    - Price categories were determined using the MLA Market information Over the Hook Indicator – cattle (MLA Pricing) and were: 220-240 kgs, 240-260kgs, 260-280kgs, 280-300kgs and 300-320kgs for the Steer and Heifer carcase groups and 180-200kg, 200-220kg, 220-240kg, 240-260kg, 260-280kg, 280-300kg and 300-400kg for the Cow group.
- The range of these differences in average carcase weight and price for each price category of carcases with no defects in the viscera verses each of the liver and lung defects, were also presented.
- The weighted average of the differences in each price category between carcases prices of carcases with each defect and carcases with no defects in the viscera using the defect carcase volumes as weighting were presented. This value indicates the average difference of prices comparing carcases from the same weight categories.

The key findings from the analysis of the cost of carcases due to animal health defects and processing defects at post-mortem inspection are:

- The most prevalent liver defects were abscesses, cysts, adhesions and liver fluke
- The most prevalent lung defects were cysts, contamination, pneumonia, pleurisy and abscesses
- MSA carcases received higher prices overall due to higher c/kg cwt price and higher average carcase weight
- In this detailed analysis there were no uniform trends in the price variations; some price categories show an increase in carcase price and some show a decrease and there is no correlation in these across the groups (heifer, steer, cow), or between feed types.

Given the complexity of the carcase costing analysis addition simpler analysis was conducted under the expense funds at the request of Teys Australia. This analysis looks at the impact of key diseases and defects for liver and lung. These reports were compiled using extractions from the Teys Australia Tableau system.

These reports provide information on the following animal, carcase and defect parameters:

- Disease or defect prevalence by month
- Breed distribution and variation
- Sex distribution and variation
- Age (based on Dentition) distribution and variation
- Carcase Paid Weight distribution and variation

- MSA distribution and variation
    - pH distribution and variation
    - eye muscle area
    - fat colour
    - marbling score distribution and variation
    - meat colour
    - ossification marbling score distribution and variation
    - rib fat distribution and variation
    - tropical breed (hump height) content

All of these parameters affect the price of a carcase on a commercial grid, which is designed to meet customer and commercial requirements. As this is a simpler analysis that can be understood more easily it is this information that that will be provided on the Teys Australia Producer Portal rather than price information within the Producer Handbook.

This very basic analysis across the entire data set demonstrated that diseases affect the average paid carcase weight in the case of all diseases except for Grade 2 Liver Abscesses, Viable Liver Fluke, Lung Granulomas, Lung Neoplasia and Grade 1 Pleurisy. In the case of Lung Granulomas and Lung Neoplasia the recorded case numbers are too low for this to be significant.

Despite the both the basic and complex forms of data analysis being completed on over 180,000 records the analysis showed that further data analysis is required with a much larger accurate data set to conclusively prove or disprove the hypothesis that diseases and defects affect the livestock weight and average daily weight gain.

Given that the data used in these reports were generated based on 6 months of data from one Teys Australia processing plant, the framework for generating them is saved within the Teys Australia Tableau system to allow future use including expansion to a greater time period or other plants once there is confidence in the quality of data to update the impact that animal health disease and defect data has on the animal and carcases traits.

4.3 Communication and extension

4.3.1 Producer workshops

During P.PIP.0753, Food & Veterinary Services Pty Ltd attended a number of producer workshops and events to present on the animal health project. These events included:

- Teys Australia Guyra Producer Day on the 12 April 2018 (31 attendees)
- Beef 2018 (Food and Veterinary Services Pty Ltd sessions on the animal health project Tuesday 8 May – Thursday 10 May) 2018 as part of Teys Australia's Beef 2018 program).
- Teys Australia Naracoorte Producer Day 16 August 2018 (100 attendees)

Producers at these sessions ranged from producer who had no previous knowledge of the project through to producers who had previously engaged with the project through the phase 1 projects (P.PIP.0464). Questions and feedback from producers was encouraged at all events and feedback received was used to guide the development of the animal health summary reports and extension resources for the roll out of the Animal Health Summaries. Additional one-on-one meetings were held with Teys feedlot managers and a larger producer to support the development of benching marking tools within the Teys Australia system.

4.3.2 Generation of producer reports and extension resources for producers

At the beginning of the project a gap analysis was conducted to determine what data and extension material is currently available to producers on individual diseases and animal health conditions. The list of conditions and diseases for the gap analysis was compiled from the conditions and diseases that are currently covered on State Government Agricultural Departments websites. Industry bodies, Research and Development Organisations, Pharmaceutical Companies, International Animal Health Organisations and also a general internet search for each of the conditions was also conducted to determine the availability of information on animal health conditions and diseases. The gap analysis identified that while information is available to producers on numerous conditions, there is no one site or information source that can provide them with general information on all conditions from a local and national perspective. The scope and level of the information provided on diseases also varied considerably. For example, some sites provided full fact sheets on conditions while other sites only referenced the condition. Some sites also only offered information on the occurrence of the disease in other species (e.g. liver fluke in sheep or hydatids in dogs) despite these also being conditions that can affect cattle. This analysis is available in Appendix 3.

A producer handbook was developed to align with the data collected through P.PIP.0753 and provide the following information to producers:

- Introduction to the animal health project
- How the animal health data is collected
- How to interpret the Animal Health Summary
- Definitions and information on each of the animal health assessments
- Factsheets and further information on key conditions
- Frequently asked questions
- Links to additional industry and government resources

Livestock buyers and staff have been identified as the first point of contact for any producer queries on their Animal Health Summaries. Training was provided by Food & Veterinary Services Pty Ltd and addressed:

- What is expected of livestock staff and buyers when responding to an Animal Health Summary enquiry
- *How to interpret your Animal Health Summary* – this document was prepared as a standalone factsheet and included in the producer handbook. A short presentation was also prepared and has been recorded as a webinar for producers. The training ran through the presentation and factsheet, how to use these resources, where they will be available and how to support producers using these resources.
- Frequently asked questions – a livestock buyer and staff version of this document has been prepared. This document provided additional prompts and support for livestock buyers and staff when addressing Animal Health Summary enquiries. A producer version of the FAQs was also developed and is available to producers as a standalone factsheet and as a part of the producer handbook.
- Producer enquiry dashboard – a dashboard of reports has been produced for use by the livestock buyers and staff when responding to Animal Health Summary report enquiries. The training covered what reports are available on the dashboard and how to use these reports when responding to Animal Health Summary report enquiries especially on benchmarking.
- Producer portal – information was provided on the producer portal and what resources will be available to support producers through this platform. This included the producer handbook, factsheets and short webinars on how to interpret the animal health summary report and how the data is collected.

Direct access was not provided to producers to the dashboard of reports that allow benchmarking or individual benchmarking reports as many considerations need to be made when reading these and they can very easily be misread. For example comparison of prevalence to the local area,

- if there is a feedlot in the local area, this will significantly change the disease prevalence profile,
- if the producer is a trader of stock verses a breeder/finisher or finisher this means that the data may not have any relevance to the local area at all, or
- if the mob is a cull group rather than a true profile of the herd the levels of disease in this mob would be expected to be higher and not correlation to the local area as a whole.

This is why livestock buyers and staff were trained in the interpretation of these reports and how to use the dashboards in order to have a conversation with the producers and provide appropriate and more accurate advise to them directly.

It was anticipated at the commencement of this project that four champion producers would be identified to work with to allow quantification of the benefits. However due to travel restrictions in response to COVID-19 and the decision by Teys Australia to expedite the project, this was not possible. Potential cost benefits were considered as a part of the data analysis on cost of offal condemnations due to animal health and processing defects at post-mortem inspection and carcase costs due to animal health and processing defects at post-mortem. However, as identified through this analysis, there are a considerable number of variables that have the potential to impact cost benefit analysis for each producer.

As at the final milestone of this project, Teys Australia are providing Animal Health Summary Reports to all producers of direct consignments of cattle.

4.4 Lessons Learnt

A lessons learnt register was maintained for the duration of this project. This register highlights the key learnings and feedback provided through out the project, their impact and recommendations on how these may be addressed. The lessons learnt register is provided as Appendix 4.

5. Conclusion

The previous animal health data project (P.PIP.0464 - Collection and reporting of inspection data for continuous improvement and productivity throughout the beef supply chain) demonstrated that reliable collection of inspection data, with an improvement in the specificity of the data collected was possible. This project (P.PIP.0753) was designed to provide a detailed analysis of the diseases and parasites which would be essential so that producers can understand what these conditions cost them and the broader industry in terms of lean meat and co-products yield.

The hypothesis prior to this analysis was that diseases and defects affect the livestock weight and average daily weight gain. Very basic analysis just assessing average paid weight proved this to be the case for all diseases except for cases of Grade 2 Liver Abscesses, Viable Liver Fluke, Lung Granulomas, Lung Neoplasia and Grade 1 Pleurisy. However, with more detailed analysis using pricing grids, did not allow the hypothesis to be proven nor disproven during this project. There were no uniform trends in the price variations; some price categories in groups showed an increase in carcase price and some showed a decrease and there was no correlation in these across the groups, or between feed types. The majority of MSA qualifying carcases are greater in price however, which is to be expected with the MSA premium.

Despite the both the basic and complex forms of data analysis being completed on over 180,000 records the analysis showed that further data analysis is required with a much larger accurate data set to conclusively prove or disprove the hypothesis that diseases and defects affect the livestock weight and average daily weight gain.

The observations at on-site verification demonstrate that desktop data verification alone is not sufficient to ensure accuracy of the data. Given the combination of the complexity of the grid pricing and the supply chain mean that the accuracy of the data is paramount to this further analysis and to provide producers with the confidence to make (potentially costly) changes to their husbandry practices knowing that these will provide financial benefits to their business.

In addition, this project has demonstrated that to allow producers to make these decisions support is required in the form of additional extension material and networks. Extension material on the information being provided, what it means and how it can be used along with disease and associated husbandry information. The opportunity of a network that allows for discussion and understanding of benchmarked information is also important to ensure understanding of the producers supply chain and the variations any benchmarked data.

5.1 Key findings

- Although data analysis through big data in theory can allow for verification of the data collected and cost benefit analysis in practice post-mortem verification needs to be a combination of desktop data analysis and on-site or remote verification of the collection of the data to provide the level of accuracy required for cost benefit analysis. The complexity of the supply chain in combination with disease progression and the complexity in pricing grids means that every effort needs to be made to ensure the data is as clean and therefore as reliable as possible for the producers making (potentially costly) decisions on it.
- Due to the complexity of the supply chain very large data sets are required for further analysis to ensure that each of the combinations of supply chain are covered.
- Post-mortem findings are only a part of the animal health picture. Future analysis should also consider background variables such as treatment to enable true cost benefit analysis.
- It is recommended that further analysis is conducted to assess pricing considering all the different feed types. Additionally, the price per kilogram is based on complex combinations of animal and carcase traits (sex, dentition, carcase weight, fat depth, muscle score) which is understandably set to meet consumer and quality requirements. The price variation of 149c/kg of MSA carcases in the MLA Pricing used in this analysis, not to mention the market fluctuation, can have a significant impact on the comparison prices across groups, feed types and MSA qualification.
- Further investigations into the prevalence of disease with the throughput and weight categories, the prevalence and implications of co-presentation of disease and the regional prevalence of disease within Australia are also warranted to provide the true cost of disease and defects on the Australian beef industry.
- Benchmarking of data should be shared with caution to ensure it is not mis-understood or mis-interpreted due to the supply chain complexities.

5.2 Benefits to industry

This project is a significant step forward in demonstrating that diseases and defects which are detected at post-mortem inspection are impacting on commercial outcomes for Australian beef producers.

The complexities in the supply chain and associated payment systems mean a significantly larger data set, than what was possible in this project, will be required to provide the statistical proof. The preliminary results provided in this project warrants this work being undertaken.

Although meat inspection undertaken in Australian abattoirs is undertaken by qualified persons following accredited systems, on-going and multi-layered verification is required to ensure that the data collected can be used by producers to make production decisions. This is because of the constantly changing nature of the inspection duty performed and staffing to meet the production pressures in modern abattoirs. The project conclusively shows that collection systems on their own are not enough to provide accurate data to allow high quality decisions to be made.

Through the duration of the project, it became evident that interpretation of diseases and defects data is a specialised veterinary field (veterinary public health) and includes concepts that are difficult to convey to livestock buyers, plant operations staff and producers. While extension material produced during this project will greatly assist in this understanding, there is no substitute for proper veterinary advice. For example, there are multiple pathways which can lead to the presentation of a disease and defect including animal health, meat processing and regulatory requirements and specialist training and experience is required to explain these.

6. Future research and recommendations

- Although data analysis through big data in theory can allow for verification of the data collected and cost benefit analysis in practice post-mortem verification needs to be a combination of desktop data analysis and on-site or remote verification of the collection of the data to provide the level of accuracy required for cost benefit analysis. The complexity of the supply chain in combination with disease progression and the complexity in pricing grids means that every effort needs to be made to ensure the data is as clean and therefore as reliable as possible for the producers making (potentially costly) decisions on it.
- Due to the complexity of the supply chain very large data sets of data are required for further analysis.
- Post-mortem findings are only a part of the animal health picture. Future analysis should also consider background variables such as treatment to enable true cost benefit analysis.
- It is recommended that further analysis is conducted to assess pricing considering all the different feed types. Additionally, the price per kilogram is based on complex combinations of animal and carcase traits (sex, dentition, carcase weight, fat depth, muscle score) which is understandably set to meet consumer and quality requirements. The price variation of 149c/kg of MSA carcases in the MLA Pricing used in this analysis, not to mention the market fluctuation, can have a significant impact on the comparison prices across groups, feed types and MSA qualification.
- Further investigations into the prevalence of disease with the throughput and weight categories, the prevalence and implications of co-presentation of disease and the regional prevalence of disease within Australia are also warranted to provide the true cost of disease and defects on the Australian beef industry.
- Benchmarking of data should be shared with caution to ensure it is not mis-understood or mis-interpreted due to the supply chain complexities.

7. References

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8. Appendix

8.1 Appendix 1 – Percentage data collected by inspection station

Percentage Data Collected by Inspection Station

	Kill Site / Inspection Station		
Date - Process Level	Head	Retain Rail	Viscera
1/10/2019	98.63	1.92	99.93
2/10/2019	99.93	4.21	100.00
3/10/2019	99.86	1.93	100.00
4/10/2019	99.72	1.03	99.38
8/10/2019	99.23	1.34	99.37
9/10/2019	99.59	2.44	99.66
10/10/2019	99.72	4.96	100.00
11/10/2019	97.86	2.41	99.31
12/10/2019	99.78	5.22	100.00
14/10/2019	99.38	4.06	100.00
15/10/2019	98.62	6.28	100.00
16/10/2019	99.24	0.97	99.93
17/10/2019	68.38	1.16	68.02
18/10/2019	99.20	1.07	100.00
21/10/2019	99.39	0.54	100.00
22/10/2019	99.45	0.69	99.93
23/10/2019	98.48	1.24	99.93
24/10/2019	99.59	0.41	100.00
25/10/2019	98.62	0.34	100.00
28/10/2019	99.08	5.11	100.00
29/10/2019	99.87	6.50	99.93
30/10/2019	99.24	1.86	100.00
31/10/2019	99.10	1.86	100.00
1/11/2019	98.14	2.54	80.34
4/11/2019	98.97	1.65	99.79
5/11/2019	98.69	0.62	99.86
6/11/2019	99.24	1.65	99.93
7/11/2019	99.45	3.38	99.52
8/11/2019	99.04	2.48	99.72
9/11/2019	99.58	1.13	99.86
11/11/2019	97.59	2.41	99.38
12/11/2019	99.10	4.96	99.93
13/11/2019	99.59	4.00	100.00
14/11/2019	98.25	0.63	99.93
15/11/2019	99.39	0.88	100.00
16/11/2019	99.33	0.44	99.89
18/11/2019	98.71	2.14	100.00
19/11/2019	99.00	0.87	99.93
20/11/2019	99.31	4.42	100.00
21/11/2019	99.59	0.76	99.93
22/11/2019	98.35	0.41	99.24
25/11/2019	99.71	0.94	100.00
26/11/2019	99.86	1.20	99.86
27/11/2019	99.87	1.20	100.00

Kill Site / Inspection Station

Date - Process Level	Head	Retain Rail	Viscera
28/11/2019	99.80	2.80	99.20
29/11/2019	99.45		99.86
2/12/2019	99.45	1.31	100.00
3/12/2019	99.66	1.36	100.00
4/12/2019	99.73	1.47	100.00
5/12/2019	99.67	0.73	99.93
6/12/2019	99.79	1.24	100.00
7/12/2019	98.44	4.44	99.78
9/12/2019	99.12	0.07	100.00
10/12/2019	99.26	6.09	99.93
11/12/2019	99.52	1.16	100.00
12/12/2019	99.59	2.24	99.86
13/12/2019	99.66	1.52	99.79
16/12/2019	99.86	3.17	100.00
17/12/2019	99.80	2.80	100.00
18/12/2019	99.53	6.67	100.00
19/12/2019	99.66	5.57	100.00
20/12/2019	97.45	1.98	100.00
21/12/2019	99.77	16.51	100.00
23/12/2019	99.59	0.96	100.00
24/12/2019	100.00	1.34	99.87
27/12/2019	99.46	0.81	100.00
30/12/2019	100.00	0.55	100.00
31/12/2019	98.90	1.38	100.00
2/01/2020	98.76	1.52	100.00
3/01/2020	99.05	0.41	100.00
6/01/2020	99.77	2.14	100.00
7/01/2020	99.92	2.17	100.00
8/01/2020	99.92	3.98	100.00
9/01/2020	98.93	2.30	100.00
10/01/2020	99.85	2.23	99.92
11/01/2020	100.00	4.56	100.00
14/01/2020	97.93	1.64	100.00
15/01/2020	99.38	3.67	99.86
16/01/2020	99.52	2.75	99.52
17/01/2020	99.66	1.72	99.79
18/01/2020	99.78	3.00	100.00
20/01/2020	99.93	5.51	99.93
21/01/2020	99.33	5.66	99.87
22/01/2020	99.93	3.53	99.67
23/01/2020	99.53	3.86	99.67
24/01/2020	99.67	4.80	100.00
27/01/2020	99.92	5.28	98.90
28/01/2020	99.80	3.84	99.60

Kill Site / Inspection Station

Date - Process Level	Head	Retain Rail	Viscera
29/01/2020	99.93	1.40	99.13
30/01/2020	97.73	1.00	99.27
31/01/2020	98.67	0.67	99.27
3/02/2020	99.87	1.53	99.40
4/02/2020	99.73	0.80	100.00
5/02/2020	99.52	0.54	99.59
6/02/2020	92.13	0.20	92.39
7/02/2020	99.67	1.40	99.20
10/02/2020	99.67	2.66	98.93
11/02/2020	99.10	2.83	99.10
12/02/2020	99.31	0.83	99.79
13/02/2020	97.45	0.69	100.00
14/02/2020	99.24	3.31	99.79
17/02/2020	98.46	6.18	98.81
18/02/2020	99.13	3.36	99.73
19/02/2020	99.66	0.62	100.00
20/02/2020	98.35	1.51	98.97
21/02/2020	99.45	2.00	99.79
24/02/2020	99.04	1.93	99.52
25/02/2020	99.72	0.62	100.00
26/02/2020	99.57	0.22	100.00
27/02/2020	99.52	2.35	99.93
28/02/2020	99.53	4.07	100.00
2/03/2020	99.31	1.10	100.00
3/03/2020	99.59	1.24	99.86
4/03/2020	99.52	1.65	100.00
5/03/2020	99.38	0.76	99.93
6/03/2020	99.56	0.15	99.93
9/03/2020	99.45	1.30	99.73
10/03/2020	99.85	1.24	99.78
11/03/2020	99.38	1.79	97.93
12/03/2020	99.21	0.50	99.57
13/03/2020	99.73	1.62	99.93
17/03/2020	99.31	3.19	99.72
18/03/2020	99.50	0.71	99.93
19/03/2020	99.46	0.07	99.25
20/03/2020	99.00	0.40	99.93
21/03/2020	99.67		98.01
23/03/2020	99.80	0.20	99.39
24/03/2020	99.39	0.07	98.10
25/03/2020	99.73	0.47	99.73
26/03/2020	98.74	0.33	99.87
27/03/2020	99.45	0.55	99.66
28/03/2020	99.88	0.36	98.56

30/03/2020	99.20	0.33	99.93
31/03/2020	99.28		100.00

8.2 Appendix 2 – Summary of carcase cost variations due to liver and lung defects

Summary of carcase cost variations due to liver and lung defects

Data was grouped according to carcase weights for each of the price categories given in the *MSA Market Information – Over the Hooks Indicator – Cattle (MLA Pricing).* The price categories based on the MLA Pricing were 220-240 kgs, 240-260kgs, 260-280kgs, 280-300kgs and 300-320kgs for the Steer and Heifer carcase groups and 180-200kg, 200-220kg, 220-240kg, 240-260kg, 260-280kg, 280-300kg and 300-400kg for the Cow group. The average carcase weight was calculated then multiplied by the corresponding price from the MLA Pricing to obtain the average carcase price of a carcase with each liver or lung defect or no defects in the viscera for each of the price categories.

The volume of carcases with each defect in each price category was used to calculate the overall weighted average prices. The weighted average price of carcases with no defects in the viscera was subtracted from the weighted average price of carcases with each of the liver or lung defects. This difference is given in each table below in the column titled '**Difference in overall weighted average prices ($)**'. These values show the difference between the average carcase prices for those with a defect and those with no defects in the viscera.

The average carcase weight and price from each price category of carcases with no defects in the viscera was subtracted from the corresponding average carcase weight and price in each price category for each of the liver and lung defects. The range of these differences is presented in each of the tables below under the column headings '**Range of weight variation within price categories (kg)**' and '**Range of average price variation within price categories ($)**'.

The weighted average of the price differences within each price category between carcases with a defect recorded and carcases with no defects in the viscera was calculated. This was calculated using the volume of carcases with the defect recorded in each of the price categories to weight the figures. These figures are given in each of the tables below under the column heading '**Weighted average of price differences within price categories ($)**'. These figures show the average differences between carcases with a defect and those with no defects in the viscera, with carcase comparisons focused on comparing within price categories.

The following tables present the data performed in the carcase cost analysis where data presented here is grouped according to defect rather than carcase groupings. The carcase groupings are from the MLA Pricing. These groups included Steer, Heifer, Steers grain fed 70 days (GF70), Heifers GF70 and Cows. The tables below present the carcase cost comparisons for the most prevalent liver and lung defects in the data analysed.

Table 1: Comparison of price and weight differences of Non-MSA carcases with **liver fluke** recorded from each of the carcase groups.

Group	Difference in overall weighted average prices ($)	Range of weight variation within price categories (kg)		Range of average price variation within price categories ($)		Weighted average of price differences within price categories ($)
		Min	Max	Min	Max	
Steer	-145.74	-4.38	2.09	-25.01	12.25	6.10
Steer GF70	-73.24	-3.24	4.38	-18.63	25.62	-3.88
Heifer	-36.02	0.42	3.52	2.44	20.10	13.93
Heifer GF70	-	-	-	-	-	-
Cow	-13.14	-6.30	7.20	-29.23	34.85	-0.42

Table 2: Comparison of price and weight differences of Non-MSA carcases with **liver or lung cysts** recorded from each of the carcase groups.

Group	Cyst location	Difference in overall weighted average prices ($)	Range of weight variation within price categories (kg)		Range of average price variation within price categories ($)		Weighted average of price differences within price categories ($)
			Min	Max	Min	Max	
Steer	**Liver**	44.94	-2.51	1.14	-14.71	6.62	-5.84
	Lung	-7.29	-3.68	2.30	-21.01	13.59	-3.02
Steer GF70	**Liver**	-20.64	-1.64	5.20	-9.43	30.68	6.26
	Lung	-34.82	-4.04	5.20	-23.23	30.68	-7.68
Heifer	**Liver**	36.64	-0.97	2.21	-5.68	12.62	3.43
	Lung	36.56	-1.49	0.38	-8.73	2.17	-1.35
Heifer GF70	**Liver**	-	-	-	-	-	-
	Lung	-	-	-	-	-	-
Cow	**Liver**	24.54	-6.20	3.90	-30.01	18.68	0.48
	Lung	23.10	-6.20	3.90	-30.01	18.68	0.17

Table 3: Comparison of price and weight differences of Non-MSA carcases with **liver abscesses** recorded from each of the carcase groups.

Group	Abscess grade	Difference in overall weighted average prices ($)	Range of weight variation within price categories (kg)		Range of average price variation within price categories ($)		Weighted average of price differences within price categories ($)
			Min	Max	Min	Max	
Steer	**1**	6.45	-3.86	2.96	-22.43	17.35	-3.21
	2	-13.18	-2.71	2.30	-15.61	13.13	-2.02
Steer GF70	**1**	9.65	-1.42	0.52	-8.31	3.02	-0.76
	2	-56.10	-2.92	-0.82	-16.94	-4.80	-12.87
Heifer	**1**	24.35	-2.67	6.88	-15.25	40.32	2.91
	2	-21.58	-0.95	5.68	-5.38	33.28	5.32
Heifer GF70	**1**	-	-	-	-	-	-
	2	-	-	-	-	-	-
Cow	**1**	-0.28	-10.20	8.10	-49.37	39.20	1.03
	2	9.62	-7.30	3.30	-33.29	16.30	0.57

Table 4: Comparison of price and weight differences of Non-MSA carcases with **pleurisy or pneumonia** recorded from each of the carcase groups.

Group	Lung defect	Difference in overall weighted average prices ($)	Range of weight variation within price categories (kg)		Range of average price variation within price categories ($)		Weighted average of price differences within price categories ($)
			Min	Max	Min	Max	
Steer	Grade 1 Pleurisy	89.42	-0.39	7.49	-2.27	43.89	6.89
	Grade 2 Pleurisy	-20.62	0.84	0.84	4.88	4.88	4.88
	Grade 3 Pleurisy	-	-	-	-	-	-
	Pneumonia	-15.69	-3.92	6.36	-23.17	37.27	1.11
Steer GF70	Grade 1 Pleurisy	95.59	1.58	1.58	9.24	9.24	9.24
	Grade 2 Pleurisy	71.02	-2.62	-2.62	-15.33	-15.33	-15.33
	Grade 3 Pleurisy	-1474.55	-	-	-	-	0.00
	Pneumonia	-116.13	-3.75	-2.34	-21.75	-13.45	-16.77
Heifer	Grade 1 Pleurisy	-35.12	-3.12	9.72	-18.28	56.47	-1.67
	Grade 2 Pleurisy	-46.33	-1.63	3.08	-9.23	17.59	10.88
	Grade 3 Pleurisy	130.44	6.97	6.97	40.15	40.15	40.15
	Pneumonia	-91.76	-2.79	0.63	-15.79	3.60	-8.07
Heifer GF70	Grade 1 Pleurisy	-	-	-	-	-	-
	Grade 2 Pleurisy	-	-	-	-	-	-
	Grade 3 Pleurisy	-	-	-	-	-	-
	Pneumonia	-	-	-	-	-	-
Cow	Grade 1 Pleurisy	307.49	-7.40	9.30	-36.56	45.94	0.73
	Grade 2 Pleurisy	9.53	-2.70	3.10	-13.47	15.31	2.02
	Grade 3 Pleurisy	21.49	-7.80	8.30	-38.53	38.51	-0.31
	Pneumonia	28.16	-10.20	10.00	-49.37	46.90	-0.15

Table 5: Comparison of price and weight differences of MSA carcases with **liver fluke** recorded from each of the carcase groups.

Group	Difference in overall weighted average prices ($)	Range of weight variation within price categories (kg)		Range of average price variation within price categories ($)		Weighted average of price differences within price categories ($)
		Min	Max	Min	Max	
Steer	6.26	-0.07	0.90	-0.41	5.35	-0.39
Steer GF70	-5.81	-1.15	3.68	-6.95	22.26	0.15
Heifer	-3.29	-0.38	0.34	-2.26	2.01	1.13
Heifer GF70	42.75	-2.23	-0.04	-13.00	-0.24	-9.81

Table 6: Comparison of price and weight differences of MSA carcases with **liver of lung cysts** recorded from each of the carcase groups.

Group	Cyst location	Difference in overall weighted average prices ($)	Range of weight variation within price categories (kg)		Range of average price variation within price categories ($)		Weighted average of price differences within price categories ($)
			Min	Max	Min	Max	
Steer	Liver	-26.88	-0.70	0.22	-4.08	1.32	-0.82
	Lung	5.83	-0.83	0.21	-4.84	1.25	-0.63
Steer GF70	Liver	-7.59	-0.64	1.12	-3.81	6.78	-1.22
	Lung	-3.41	-0.88	1.50	-5.24	9.06	-1.39
Heifer	Liver	17.45	-0.08	0.38	-0.47	2.26	0.52
	Lung	12.85	-0.03	0.38	-0.17	2.20	0.54
Heifer GF70	Liver	6.88	-3.35	-3.35	-19.36	47.98	1.01
	Lung	78.38	-5.35	-5.35	-30.92	47.98	10.91

Table 7: Comparison of price and weight differences of MSA carcases with **liver abscesses** recorded from each of the carcase groups.

Group	Abscess grade	Difference in overall weighted average prices ($)	Range of weight variation within price categories (kg)		Range of average price variation within price categories ($)		Weighted average of price differences within price categories ($)
			Min	Max	Min	Max	
Steer	1	6.52	0.11	0.41	0.64	2.43	-0.21
	2	-18.48	-0.60	0.14	-3.50	0.84	1.90
Steer GF70	1	-0.77	-0.49	1.93	-2.92	11.68	2.80
	2	7.68	-0.24	0.91	-1.44	5.50	0.16
Heifer	1	-5.07	-0.34	2.11	-1.97	12.55	0.91
	2	0.72	-0.67	0.61	-3.95	3.63	0.93
Heifer GF70	1	-39.65	1.35	1.35	7.80	17.32	10.97
	2	55.86	0.12	0.12	0.69	21.81	10.31

Table 8: Comparison of price and weight differences of MSA carcases with **pleurisy or pneumonia** recorded from each of the carcase groups

Group	Lung defect	Difference in overall weighted average prices ($)	Range of weight variation within price categories (kg)		Range of average price variation within price categories ($)		Weighted average of price differences within price categories ($)
			Min	Max	Min	Max	
Steer	Grade 1 Pleurisy	14.94	-0.69	0.84	-4.02	5.04	1.73
	Grade 2 Pleurisy	6.46	0.41	1.95	2.44	11.47	4.46
	Grade 3 Pleurisy	-22.72	-2.42	1.86	-14.11	10.94	1.50
	Pneumonia	1.83	-0.34	0.72	-2.02	4.32	1.45
Steer GF70	Grade 1 Pleurisy	8.12	-0.94	1.11	-5.59	6.66	2.19
	Grade 2 Pleurisy	-24.33	-2.56	1.01	-15.46	6.11	-2.12
	Grade 3 Pleurisy	-33.24	-2.86	1.79	-17.02	10.81	-1.76
	Pneumonia	0.96	-0.37	2.95	-2.22	17.85	1.55
Heifer	Grade 1 Pleurisy	-3.60	-0.51	1.11	-2.97	6.55	0.68
	Grade 2 Pleurisy	16.10	-0.43	2.41	-2.51	14.34	2.85
	Grade 3 Pleurisy	0.21	-3.02	2.32	-17.76	13.80	-0.07
	Pneumonia	7.27	-0.74	3.20	-4.37	19.04	0.69
Heifer GF70	Grade 1 Pleurisy	-60.00	-2.63	-2.63	-15.33	5.61	0.37
	Grade 2 Pleurisy	-	-	-	-	-	-
	Grade 3 Pleurisy	-	-	-	-	-	-
	Pneumonia	108.01	-8.85	-8.85	-51.15	12.35	65.44

8.3 Appendix 3 – Gap Analysis and Animal Health Extension Material

	NSW DPI	QLD DPI	VIC DPI	PIRSA (SA)	NT DPI	WA	TAS	Future Beef	MLA	Veterinary Handbook	Livestock Biosecurity Network	Animal Health Australia	Merck Vet Manual	Google Search	FAO/OIE	DAWR	Cattle Council Australia	AMPC	National Farmers Federation	Victorian Farmers Federation	Breed Organisations	Target 100	RSPCA	AVA	Elanco	Coopers	Zoetis	Virbac Australia	Boehringer- Ingelheim	Jurox
Bacterial Disease																														
Actinobaillosis (wooden tongue)	✓	✓	✓	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Actinomycosis (lumpy jaw)	✓	✓	✓	✗	✗	✗	✗	✓	✗	✓	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Anthrax	✓	✓	✗	✗	✗	✓	✗	✓	✗	✗	✗	✗	✓	✓	✓	✓	✗	✗	✗	✓	✗	✗	✗	✓	✗	✗	✓	✓	✗	✗
Botulism	✓	✓	✗		✓	✓	✓	✓	✗	✗	✓	✗	✓	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗
Bovine Johne's Disease	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✓	✗	✗	✗	✓	✗	✗	✓	✗	✗	✗
Clostridial Diseases - Black Disease	✓	✓	✓		✗	✗	✗	✓	✓	✗	✓	✗	✗	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✗	✓	✗	✗
Clostridial Diseases - Black Leg	✓	✓	✓		✗	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗
Clostridial Diseases - Enterotoxaemia (pulpy kidney)	✓	✓	✓				✗	✓	✓	✓	✓	✗	✗	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗
Clostridial Diseases - Malignant Oedema	✓	✓	✓		✗	✗	✗	✓	✓	✓	✓	✗	✗	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗
Clostridial Diseases - Tetanus	✓	✓	✓		✓	✗	✗	✓	✓	✗	✓	✗	✓	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗
Leptospirosis	✓	✓	✓		✗	✗	✗	✓	✓	✗	✓	✗	✓	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✓	✗	✓	✓	✓	✗	✗
Listeriosis	✗	✓	✗		✗	✗	✗	✗	✗	✓	✗	✗	✓	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗
Melioidosis	✓	✓	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Pink Eye	✓	✗	✓		✓	✓	✗	✓	✓	✓	✓	✗	✗	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗
Q Fever	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓	✓	✓	✗	✓	✗	✓	✗	✓	✗	✓	✗	✗	✗	✗	✗	✗
Salmonellosis	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Septic Abortion	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Vibriosis	✓	✓	✓		✓	✗	✗	✓	✓	✗	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗
Viral																														
Akabane, Aino and Palyam viruses (arboviruses)	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Bluetongue	✗	✓	✗		✗	✓	✗	✗	✓	✓	✓	✗	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗		✗	✗	✗	✗	✗	✗
Bovine Ephemeral Fever	✓	✓	✗	✓	✓	✗	✗	✓	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗
Enzootic Bovine Leucosis	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗
Papilloma Virus (warts)	✗	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Pestivirus/Bovine Viral Diarrhoea	✓	✓	✓	✓	✗	✓	✓	✓	✓	✓	✓	✗	✗	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✓	✗	✗	✓	✗	✗	✗
General																														
Arthritis	✗	✗	✗		✗		✗	✗	✓	✓		✗	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗
Bloat	✓	✓	✓	✗	✗	✗	✗	✗	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Bovine Respiratory Disease	✓	✗	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✓	✗	✗
Bruising	✗	✗	✗		✗	✗	✗	✗	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Calf Scours	✓	✗	✗	✗	✗	✓	✗	✓	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗
Cancer Eye	✓	✗	✓	✗	✗	✗	✗	✓	✗	✓	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Foot abscess/footrot	✓	✗	✗		✗	✗	✗	✗	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✓	✗		✗		✗	✗	✗	✗	✗	✗
Grain Poisoning/Acidosis	✓	✗	✗		✗	✓	✗	✓	✓	✗	✗	✗	✗	✓		✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Heat Stress	✓	✗	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✓	✗	✓	✗	✗	✗	✗	✗	✗

Jaundice	✗	✗	✗		✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Lameness	✗	✗	✓	✗	✗	✗	✗	✗	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗		✗	✗	✗	✗	✗	✗	✗
Livestock Cancers	✗	✗	✓		✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Nephritis	✗	✗	✗		✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Photosensitisation	✓	✗	✓		✗	✓	✓	✗	✗	✓	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Pleurisy/Pneumonia	✗	✗	✗		✗	✗	✗	✗	✗	✓	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Polioencephalomalacia (PEM)	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Pregnancy Toxaemia	✓	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✓		✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Rib Fractures	✗	✗	✗		✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Urinary Calculi (Bladder Stones)	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Vacinnation Abscess/Innoculation Abscess	✗	✗			✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Parasitic & Protozoal																													
Buffalo Fly	✓	✓	✗	✗	✗	✗	✗	✓	✗	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗
Cattle Lice	✓	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓
Cestodes (Tapeworms)	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Coccidia	✓	✗	✗		✓	✗	✗	✗	✓	✓	✗	✓	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗
Cysticerus bovis (Beef Measles)	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Hydatid Disease	✓	✓	✓		✗			✗	✗	✗		✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗
Liver Fluke	✓	✗	✓		✗	✓	✓	✓	✓	✗	✓	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✓	✗	✓
Lungworm	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✗	✓
Neospora caninum	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗
Round Worms (Nemotodes)																													
E.g. Ostertagia	✓	✗	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗
Stomach Fluke	✓	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓
Theileria	✓	✗	✓	✓	✗	✓	✓	✗	✓	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗
Tick Fever	✗	✓	✗	✗	✓	✗	✗	✗	✓	✓	✗	✗	✓	✓	✓	✓	✗	✗	✗	✗	✗	✓	✗	✗	✓	✗	✓	✗	✗
Ticks	✓	✓	✗	✗	✓	✗	✗	✗	✓	✗	✓	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✓	✓	✓	✗	✗
Trichomoniasis	✓	✗	✗	✗	✓	✗	✗	✓	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Fungal																													
Cryptococcosus	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Ring Worm	✗	✓	✗	✗	✗	✗	✗	✓	✗	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Toxicities																													
Aflatoxin poisoning	✗	✓	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Blue Green Algae Toxicity	✗	✗	✓	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Bracken Fern Poisoning	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Ergot Poisoning	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Heliotrope Toxicity	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Ionophore Poisoning	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Lead Poisoning	✓	✗	✗	✗	✓	✗	✗	✓	✗	✗	✓	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Oestrogens in Pasture Hay & Silage	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Pimelea Poisoning	✗	✓	✗	✗	✗	✗	✗	✓	✓	✗	✓	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Rye Grass Staggers	✗	✗	✓		✗	✓	✓	✗	✗	✗	✓	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Sarcostemma (pencil caustic) poisoning	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Swainsona Poisoining	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Urea Poisoing	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Zamia (cycad) poisoning	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗

Deficiencies																												
Cobalt deficiency	✗	✗	✗	✗	✗	✓	✗	✓	✓	✗	✓	✗	✓	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✓	✓	✗	✓
Copper Deficiency	✗	✓	✗		✗	✗	✗	✓	✓	✓	✗	✗	✓	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✗	✓	✗	✗
Grass Tetany	✓	✗	✓		✗	✓	✓	✓	✓	✗	✗	✗	✗	✓	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Selenium Deficiency	✗	✗	✗	✗	✗	✓	✗	✓	✓	✓	✓	✗	✗	✓	✓	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✓	✓	✗	✗	✓
Transit Tetany	✗	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗
Vit A Deficiency	✓	✗	✗	✗	✗	✗	✗	✓	✓	✗	✗	✗	✓	✓	✓	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗
Vit E Deficiency	✓	✗	✗	✗	✗	✗	✗	✓	✓	✓	✗	✗	✓	✓	✓	✗	✗	✓	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗
Congenital																													
Congenital contractural arachnodactyly ('fawn calf syndrome') in Angus cattle	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✓	✗	✗	✗	✗	✗	✗	✗	✗	✗

8.4 Appendix 4 – Lessons learnt register

Appendix 4 - P.PIP.0753 – Lessons Learnt Register

Number	Issue Name	Problem/Success	Impact	Recommendation
1	Change Management	Meat inspectors at some sites did not understand their role in the project and why they were required to collect the level of data requested.	This affected buy in by meat inspectors as well as having the potential to affect accuracy, completeness and timeliness of data.	Ensure inspectors at all sites understand the importance of the project and their role in the project to increase buy in. This should be routinely followed up.
2	IT system integration	Integration of multiple IT systems.	Integration of multiple systems has affected the accuracy, completeness and timeliness of data collected at some sites during this project.	Ensure any future schedules or project plans allow additional time for potential issues caused by IT system integration.
3	Training	During verification a variation in how conditions were recorded was identified.	Possible inconsistency in data feedback with an increase in use of 'other'.	Training to be provided to the meat inspectors on what condition to record each thing under and a contact number if high level of other recorded in the mob.
4	NLIS fields on producer reports	Some producers have indicated that NLIS ID would be a more useful ID for them than RFID.	This could potentially affect the useability of producer feedback.	Investigate whether inclusion of 'NLIS ID' on the producer feedback sheet is feasible. Review producer feedback based on this advice.
5	Producer confidence in data	Lack of confidence in the data provided (on this occasion internal observations passed on) could be due to lack of understanding, expectations or external advice.	Could lead to in-action on the data provided.	Increased communication with pilot producer and processing staff. Provide on-going support in the area.
6	Correct Diagnosis of Conditions	Meat inspectors are able to detect 'abnormal' or an observable difference, however the allocation of a condition may not always be correct when followed through to gross and histopathological testing.	This could lead to a lack of confidence in the data.	Data verification checks on data are required continuously to ensure that if the level of a condition reported does not appear to correlate with current understanding of a disease or condition, further investigation is warranted to ensure the data is as accurate as possible.
7	On-site verification	Current verification practices require on-site verification to confirm identification of defects and input of data by meat inspectors.	On-site verification can be costly due to time commitments and travel requirements. It also requires access to the site. This limits the level of verification that can be conducted. On-site verification is not currently feasible due domestic travel and other restrictions due to COVID-19.	Investigate whether there are viable alternatives to on-site verification. E.g. are there devices such as wearable cameras or smart glasses that could be utilised to allow remote verification?
8	Producer workshops	The original plan for extension for this project included quarterly attendance at producer workshops.	Attendance at producer workshops is not currently feasible due to domestic travel requirements and other restrictions to COVID-19. While workshops are a valuable extension tool, they do only allow access to those producers who are able to attend.	A series of recorded webinars will be developed and housed on the Teys Australia Producer Portal. These will allow producers to access information that would usually be provided at a workshop at a time that is convenient to them, as well as providing access for producers who may not ordinarily be able to attend producer workshops.
9	Data entry of animal health assessments	Meat inspectors at one site identified to be incorrectly applying the 'ES' assessment.	It was identified at one plant that meat inspectors were entering the 'ES' assessment against carcases that were not identified as emergency slaughter and had not come from an emergency kill. This results in inconsistent and incorrect data/assessments being applied.	This specific instance was rectified by removing the 'ES' assessment from the post-mortem terminals, as this data is already collected by Teys Australia through another terminal. On-site verification needs to be on-going to ensure the accuracy of the data being provided in feedback and also to identify and rectify issues, such as the one discussed here, as they arise.
10	Changes in data source	Data used for reports produced for use by Teys Australia can have multiple sources. Changes in data mapping can affect accuracy of existing reports.	Bruising data is collected at two points. Meat inspectors enter 'bruise' as animal health data when identified at postmortem inspection. Teys Australia staff enter a bruise score when grading. Changes in data mapping and data source of bruising has the potential to affect the accuracy of retain rail reports measuring data capture rates.	Teys Australia to consider how any changes in data mapping may affect any existing reports that are generated prior to implementing changes in data mapping or data source.
11	Incomplete data entry	Due to system breakdowns or processing issues, the meat inspectors may miss data entry during periods.	Data entry will not be complete.	Communication and feedback between meat inspectors and the sites is vital to ensure that reasons for drops in data capture are noted and rectified as soon as possible.
12	Data sets and data analysis	Data for analysis comes from multiple sources/through multiple IT systems	Data captured and the platforms used to house and extract the data can limit what data can be extracted	Ideally from a pure research perspective, data captured on animal health defects for data analysis would be conducted with the end analysis in mind and on a discrete data set designed for the purpose. However, as the data captured for

			and as such, the analysis that can be conducted.	animal health data analysis is housed in multiple systems, and may have multiple business functions (e.g. HSCW is captured and used by multiple parties within the business for multiple purposes), integration of data and interrogation and extraction of the data sets for analysis are often not simple or straightforward. Data analysis methodologies need to be developed with this in mind.
13	Benchmarking data	Feedback from producers indicated that benchmarking data would be beneficial.	Depending on the benchmarks selected, benchmarking data would allow producers to compare their performance.	Benchmarking could be investigated, however in selecting potential benchmarks, Teys Australia will need to consider: 1. Privacy considerations if looking to provide benchmarking data against other producers/regions etc 2. Suitability of benchmarks (e.g. benchmarking the liver cyst data of producers from a northern region with a high incidence of hydatids against southern region with a low incidence of hydatids does not provide meaningful performance benchmarking data for producers, sourcing and the supply chain must be considered) 3. Extension and training to support interpretation of any additional benchmarking or analysis provided to producers 4. If selecting benchmarking 'targets', the rationale for selection of targets also needs to be identified and carefully considered.