final report

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Prepared by: Nigel Perkins
AusVet Animal Health Services

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Meat and Livestock Australia Limited
Locked Bag 991
NORTH SYDNEY NSW 2059

Respiratory disease of export cattle

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Abstract

A literature review on bovine respiratory disease (BRD) in feedlot and export cattle has been completed.

Two meetings have been conducted. The first (Perth on 12 June 2008) involved technical input into design options and feasibility and resulted in a major change in the proposed methodology for the project. A draft project design was developed as a result of the discussions held at this meeting. The design involved a shift away from specific, time-limited studies involving deployment of project personnel and clinical studies looking at vaccine efficacy to a broader design that involved development of a sustainable system for collection of valid and credible data on mortalities by on-board veterinarians and stockmen.

The draft project design was then presented to industry stakeholders at a second meeting (Perth, 17 October 2008) and received broad support.

Feedback from the second meeting has been incorporated into a final project proposal which is described in this report.

The proposal describes a research project lasting 3 years with a go/no-go point after one year. The project will describe causes of mortality in export cattle. It will also result in the development of training material and other resources (veterinary handbook) as well as systems for ongoing collection of valid and credible data to describe mortality in export cattle. The intention is to develop and refine a robust and sustainable method for ongoing monitoring of mortality in export cattle that can provide information for regulatory reporting requirements and provide value to the industry for quality assurance purposes and to allow industry to better manage the export process for optimal animal health and welfare.

Executive summary

This project was implemented in response to a small number of voyages to the Middle East that were associated with elevated mortalities attributed to respiratory disease in some consignments of cattle. These voyages led to discussion over the possible value of a decision to mandate vaccination against respiratory disease agents in all cattle destined for live export from Australia. The lack of information on which to assess such a decision led to this project.

This project involved completion of a literature review of bovine respiratory disease in feedlot cattle, assessment of available data describing causes of mortality in long-haul export cattle and industry consultation on options for design of observational and experimental studies in long-haul export cattle to describe causes of morbidity/mortality and in particular to assess the importance of respiratory disease.

The major findings of this process are summarised below:

1. BRD is a major cause of morbidity and mortality in feedlot cattle. There is very little data derived from rigorous, credible scientific studies describing major causes of death in live export cattle. A single study on four voyages to the Middle East has identified BRD as an important cause of death in live export cattle.
2. Findings from post mortem examinations of cattle dying from BRD on four long-haul export voyages indicate that pathology is essentially the same as is observed in feedlot BRD cases. Infectious agents and non-infectious risk factors influencing BRD in live export are considered to be the same as in feedlot cattle with additional factors likely to be operating in export vessels in association with pen design on-board ship, ventilation and local (pen, deck and ship level) conditions during the voyage
3. Published studies on efficacy of vaccines against BRD in feedlot cattle do not provide clear and unequivocal support for routine vaccination to prevent or minimise the risk of BRD. In some cases vaccination may result in adverse impacts on health and performance outcomes.
4. There is insufficient information currently available on which to determine with confidence that BRD risk is sufficiently high across all cattle that are exported to warrant mandatory vaccination in all exported cattle, or to identify a particular vaccine that should be used, or to expect that vaccination with a particular product would be likely to reduce BRD risk.
5. Clinical trials designed to investigate efficacy of BRD vaccines in live export cattle are likely to be very expensive, very difficult to implement, likely to result in collection of biased data, and return equivocal results that are unlikely to offer value in determining whether to vaccinate live export cattle.
6. There is a need to collect credible information describing causes of death in live export cattle. This means using objective, scientific methods that are carefully designed to ensure high levels of validity and reliability .
7. The low mortality rates in export cattle mean that care must be exercised in designing any project aiming to describe causes of death because of the large number of voyages that must be studied to describe causes of death with confidence. A project that is limited to collection of data only from voyages that are accompanied by project personnel is likely to be inefficient, expensive and produce results of little value.

The findings outlined above have resulted in a major shift in the proposed approach to move to a broader project intended to produce valid and credible descriptions of the causes of death in cattle exported over long distances from Australia. A critical part of this shift is a move to the development of systems designed for industry to collect valid and credible mortality data in a sustainable manner beyond the completion of this project. The shift has meant that the proposed project has had to develop new objectives and methods.

The outcomes will include better training and task definition for veterinarians and stock persons, improvement in the validity and coverage of mortality (and morbidity) data from export vessels, improvement in quality assurance and reporting, and continual feedback for veterinarians and stock persons with improved morale and interest in their responsibilities.

Detailed objectives are described in this report for a project to deliver the outcomes described in general terms above and information concerning methods that may be implemented to achieve the objectives.

Contents

1 Background

In recent years there have been a small number of voyages involving shipments of cattle to the Middle East where consignment mortalities have exceeded 1% and where deaths have been attributed to respiratory disease. These events have raised concerns over the importance of respiratory disease in long-haul export cattle and whether vaccination of animals may be warranted to protect against agents responsible for respiratory disease.

Initial discussions indicated a general scarcity of objective, scientific information concerning respiratory disease in export cattle and expected efficacy of available vaccines in reducing risk of respiratory disease.

This project has involved completion of a literature review of bovine respiratory disease in feedlot cattle, assessment of available data describing causes of mortality in long-haul export cattle and options for design of observational and experimental studies in long-haul export cattle to describe causes of morbidity/mortality and in particular to assess the importance of respiratory disease.

2 Project objectives

1. Complete a literature review and consultation process to gather information about feedlot BRD and RDEC:
    a. Review scientific literature on feedlot BRD and information on mortalities in cattle undergoing live export from Australia. The review will include available data and reports from LiveCorp, MLA, AQIS and on-board veterinarians where available.
    b. Consult with people experienced in the cattle export industry on issues related to mortalities in exported cattle and issues associated with performing research into causes of mortalities on-board export vessels.
2. Develop a proposal and budget for a longitudinal study to investigate morbidity and mortality in cattle undergoing live export from Fremantle to the Middle East. Proposal to include consideration of:
    a. Development of protocols for examination of sick animals and for post-mortem of any dead animals during assembly and on-board ship during voyage. Protocols to include collection of post-mortem samples for laboratory investigation in Australia.
    b. Advantages and disadvantages of collecting samples from apparently healthy animals in the assembly feedlot period as a potential measure of health or to provide an indication of prevalence of selected diseases such as BVD. This part of the proposal will assess cost and possible value of this approach.
    c. Assessment of cattle in assembly feedlot
    d. Assessment of cattle on-board ship during voyage
    e. The use of NLIS to identify cattle throughout the export chain.
    f. Advantages and disadvantages of nested studies involving preventive treatment (vaccination) of a subset of cattle on one or more voyages as a way of assessing value of treatments for reducing risk of disease and death during voyage, including cost / benefit analysis.
    g. Feasibility of collecting data on animal health and in particular mortalities during the period after discharge in the country of destination.
    h. Detailed budget for completing the proposed study.

3. Contribute to organisation of a meeting in Perth (or an alternative venue) with industry stakeholders to discuss the report and agree on whether to proceed with the proposed study and on the methodology.
4. Finalise the detailed design and budget for the proposed study (provided the study is supported by industry).

3 Methodology

A literature review has been submitted. The bulk of the literature review focuses on bovine respiratory disease (BRD) in feedlot cattle. There is very little information on respiratory disease in live export cattle though there is a body of work on heat stress and management of boats and animals to reduce the risk and severity of heat stress. There is insufficient information derived from rigorous scientific studies on bovine respiratory disease in export cattle to make validated conclusions about BRD and risk factors that may be operating in the export environment. However, it is reasonable to assume that the infectious agents are the same as for feedlot BRD and that the causal factors operating in feedlot BRD will also be operating in export BRD with the additional influence of ship-related factors and heat stress.

A meeting was held at Murdoch University, Perth on 12 June 2008 that involved a number of people with experience in the live cattle export industry to discuss the issues and various approaches to longitudinal study design. The timing was arranged to coincide with a sheep live export meeting held in Perth the previous day since many of the attendees were the same people.

The following people attended the 12 June 2008 meeting:
Dr Nigel Perkins (chair)
Dr Anne Barnes
Dr David Beatty
Dr John Creeper
Dr Barry Richards
Dr Mike McCarthy
Dr John House

Discussions at the June meeting in Perth resulted in important modifications to the proposed project, described in the milestone 2 report.

A second meeting was held in Perth on 17 October 2008, attended by Dr Richard Norris, Dr Tony Higgs, Dr David Jarvie, Dr Wayne Hall, Mr Justin Morrisey, Mr John Edwards, Mr Chris Reeves and Ms Cherie Sam.

The draft proposal outlined in the Milestone 2 report was presented and discussed at this meeting. The proposal outlined in this final report incorporates feedback from the participants at this meeting.

4 Results and discussion

4.1 Introduction

A literature review has been completed of bovine respiratory disease (BRD). The review focused mainly on cattle managed in feedlots with consideration of information on BRD in live export cattle as well.

BRD in feedlot cattle has been well documented in the scientific literature over a number of years. The condition has a complex and multi-factorial aetiology with different combinations of infectious and non-infectious factors influencing occurrence and severity of BRD in different situations. Although clinical symptoms of BRD are due to viral/bacterial infection, non-infectious factors have an important stress-mediated role in predisposing animals to infection, and increasing susceptibility and exposure risk.

Most of the infectious agents associated with BRD are ubiquitous in cattle populations, meaning that it is not feasible to attempt to eliminate exposure risk as a means of reducing occurrence or severity of BRD.

Strategies to reduce risk of BRD In feedlot cattle are therefore heavily dependent on management to reduce risk of exposure, optimise health of animals and minimise stress. Vaccination is commonly used in many feedlots in an attempt to increase animal and mob immunity to circulating agents. There are a variety of vaccines available overseas and vaccines against three agents (BHV-1, BVD and *Mannheimia haemolytica*) are available in Australia. There are many different vaccination strategies including live vs killed vaccines, single vs multiple administration, varying timing of administration (on-farm, at induction and after induction) and varying combinations of specific vaccine antigens. However, the expanding number of published papers describing efficacy trials do not offer clear findings to support the efficacy of vaccines in preventing BRD in feedlot cattle. Published scientific studies describe a range of findings including some trials where vaccinated animals have higher mortalities and poorer weight-gains than unvaccinated animals, many trials where vaccination has relatively little impact, and some trials where vaccination resulted in statistically significant improvements in weight gain, morbidity or mortality. Equivocal findings probably reflect the complexity of causal factors that may influence BRD in any given combination of space and time. An important conclusion is that vaccination of animals should not be seen as a panacea for BRD and that in some circumstances it may result in an adverse effect, particularly in the period immediately after vaccination.

There are few studies that have investigated causes of morbidity and mortality in export cattle in a rigorous manner. In fact the only such study identified was the work by Norris and others that involved a review of records and placement of veterinarians on board ship for four voyages to the Middle East with post mortem examinations performed on all mortalities. The work identified respiratory disease as an important cause of morbidity and mortality in cattle being exported to the Middle East. Post mortem examination of animals dying from respiratory disease revealed pathology that was grossly and histologically typical of *Mannheimia haemolytica* or *Pasteurella multocida* infection. There was support for the hypothesis that the infectious agents and many of the risk factors influencing feedlot BRD will also be contributing to BRD risk in live export cattle. In addition BRD in export cattle may be influenced by factors that are unique to the export situation particularly

those factors associated with the ship (pen design, ventilation, air quality, stocking density, heat stress, boat movement and local climatic conditions).

4.2 Industry discussion of related issues

4.2.1 Voyage reports

Reports are generated on cattle mortalities for each voyage (daily mortality report, accredited veterinarian end of voyage report, stockman end of voyage report, report by the master of the vessel). These reports describe numbers of deaths and may also include observations on causes of death. There were three consignments over the period 2006-2007 with reportable mortality levels where respiratory disease was identified in official AQIS reports as a contributing factor.

While the various voyage reports offer a valuable source of information on numbers of mortalities, they do not offer valid or verifiable information on causes of disease and death in live export cattle. There appears to be little standardisation for disease diagnosis and recording of disease events on board ship and different people (veterinarians and stockmen) may classify disease occurrence and severity using varying criteria. There is little training for veterinarians on disease diagnosis, classification, treatment and prevention and no manual describing standardised approaches to these issues to improve consistency and reliability. These issues mean that there is a real risk of misclassification of disease status (non-detection of diseased animals, assignment of incorrect diagnosis in truly diseased animals, assignment of a disease status to non-diseased animals etc) and a risk of variability between observers. The major impact of these issues is that voyage reports do not offer a source of valid data on which conclusions may be drawn concerning the importance of specific causes of death such as BRD. There may be genuine risks to industry from reports that contain subjective and unverified observations that are made with the best of intentions but that may be misleading.

4.2.2 Vaccination against BRD

Given the state of knowledge concerning infectious agents and factors contributing to BRD in feedlot cattle and the likely relevance of this information to cattle being prepared for live export, there was discussion over whether there was a reasonable case for vaccination against BRD agents for some or all cattle being prepared for live export. Modifying factors included variation in BRD risk amongst different types of cattle that are being exported such that vaccination could be applied in some animals deemed to be at higher risk and not applied to animals deemed to be at lower risk. In the feedlot situation younger, lighter animals that have been comingled from multiple sources and weaned immediately prior to shipment tend to be associated with the highest risk of BRD. It is not clear whether the risk profile in export cattle is the same as for feedlot cattle and the types of cattle being prepared for export are different to those entering feedlots. Anecdotal observations from people with direct experience in the Australian cattle export industry indicate that *Bos taurus* cattle may be more likely to be observed with BRD compared to *Bos indicus* cattle. In addition, BRD is more likely to be observed in long-haul cattle shipments and is relatively less common on short-haul voyages.

It is understood that destination country requirements may also vary with different destinations either requiring vaccination to occur prior to export, allowing vaccination or prohibiting vaccination. It is understood that cattle destined for Saudi Arabia are currently vaccinated with an imported, killed

vaccine containing BHV-1, BVD, PI-3, BRSV and *Haemophilus somnus* (Triangle 4+HS, Fort Dodge), in compliance with requirements from the importer and a special limited licence allowing use of a product not registered in Australia. In addition, it is understood that one WA exporter is currently administering a *Mannheimia haemolytica* vaccine (Bovilis) to cattle destined for long-haul voyages.

There is little or no data on which to make a valid assessment of the efficacy of these vaccine practices.

4.2.3 Clinical trials to assess efficacy of vaccination against BRD

There is uncertainty over the feasibility and value of clinical trials to assess efficacy of vaccination as a measure to prevent BRD in cattle. Clinical trials are relatively common in the land-based feedlot situation to assess efficacy of various health procedures including vaccination for BRD. Animals may be randomly assigned to treatment groups (vaccinated and non-vaccinated) and then monitored prospectively through the feedlot period for evidence of disease and for performance. Animals are typically subjected to physical examinations and collection of various samples (blood, nasal swabs for example). Sick and dying animals are then subjected to more detailed examinations and post-mortems are performed on all deaths. Even under carefully controlled conditions in feedlots, it is very difficult to manage a clinical trial and to achieve a successful outcome (unequivocal demonstration of efficacy or lack of efficacy). Many of the published papers that have assessed vaccine efficacy in feedlot trials have produced equivocal results particularly when comparisons are based on health outcomes such as mortality and morbidity.

One of the major difficulties in implementing clinical trials for BRD in feedlot cattle is the variable level of exposure of animals to disease agents and associated variation in levels of disease in control or untreated animals. When background exposure and disease rates are low, it is very difficult to measure any improvement in outcomes (morbidity/mortality/weight gain) in treated animals compared to untreated animals. Data from annual National Livestock Export Industry Shipboard Performance Reports indicate that average mortality per shipment over the last several years has been less than 1% and a number of voyages have reported zero mortalities. The range of observed mortalities by consignment are more variable but are still relatively low, particularly from a trial design perspective where treatment efficacy is dependent on statistical detection of an improvement in a measurable health outcome in treated animals vs untreated animals. The sample size requirements for a trial in export cattle to achieve reasonable statistical power for detection of a beneficial treatment effect are large enough (several hundred pens of animals in each treatment group) to make clinical trials prohibitively expensive and logistically difficult.

There are considerable practical and logistical difficulties that make clinical trials very difficult in export voyages. Physical examination of clinically ill animals to assist in diagnosing specific diseases is often based on visual inspection only. It is very difficult to subject individual animals on-board ship to a detailed clinical examination for diagnosis of specific conditions and even measurement of rectal temperature may be difficult or impossible to collect. A decision to treat animals with antibiotic or other medications may be based on visual detection of abnormal signs in animals and on some level of assessment of risk of disease. Early treatment is considered likely to increase the probability of successful resolution of illness and is therefore an important management approach. Since early signs of illness (depression, inappetence) may be non-specific, it also means that this practice is not conducive to accurate diagnosis of specific disease conditions.

There was a strong view amongst technical experts and industry representatives that clinical trials aiming to assess efficacy of vaccination for BRD in live export cattle would be very difficult to implement effectively and were not likely to result in valid and reliable information that could inform decisions on preventive strategies for BRD such as vaccination.

There is some rationale for assessing efficacy for BRD vaccines in controlled pen trials which guarantee exposure and then making a decision on their use in the field based on data concerning prevalence of pathogens rather than efficacy of specific vaccines in large-scale field trials.

4.2.4 Longitudinal studies to asses causes of mortality including BRD

Technical experts and industry representatives have provided input into the feasibility and possible value of a prospective longitudinal study on causes of morbidity and mortality in live export cattle as a means of informing industry on the major causes of morbidity and mortality and contributing to future recommendations aimed at continuing to improve health and welfare. These comments relate to a study where the primary source of data is through observations and activities of project personnel who accompany voyages, perform examinations and necropsies and collect samples. This means data are only collected from those voyages where project personnel are present.

In addition the author of this report has been involved in a prospective study on morbidity and mortality that has been conducted over the past few years in the live sheep export industry with particular emphasis on the assembly feedlot and voyage components of the export process. The study has involved research personnel attending the assembly depot during assembly periods and travelling on board ship to collect data on morbidity and mortality including performing post mortem examinations on animals that died during both assembly and voyage. One of the major concerns with this approach is that when the morbidity and in particular the mortality rate is very low the value of a longitudinal study is limited. An important benefit of the sheep live export project has been the development of standardised processes for collecting information, including denominator data on the number of animals at risk and data on morbidities and mortalities.

A longitudinal study approach with project personnel collecting intensive data was not supported as an effective means of collecting information on morbidity and particularly on mortality. There were three broad reasons for this decision. The first was that the low levels of background mortality meant that project personnel would need to be present during a large number of shipments (at assembly and during the voyage) to collect data, presenting major challenges in terms of resourcing the study. Low background mortality with occasional mortality events mean that even if a large number of shipments were followed, the results may not be very informative in terms of explaining the risks that may influence high mortality events, simply because there may be few such events and different causal factors operating in each event. Thirdly, practical logistic issues mean that it is very difficult to collect good data on morbidity on board ship because it is difficult to examine individual animals and difficult to collect samples. The major form of examination remains post-mortem of dead animals.

An effective alternative approach was identified that involved a combination of project personnel and industry personnel (AQIS-accredited on-board veterinarians and stockmen) collecting standardised data on mortalities. Project personnel were identified as being critical to the development of objective, valid and reliable methods, training of industry personnel, and in assisting in development of systems for management of data, analysis of data and generation of reports. Industry involvement was identified as critical in the broader application of methods across larger numbers of voyages and in sustainable ongoing monitoring of mortalities beyond the project lifespan.

4.3 Major findings from literature review and industry meetings

1. BRD is a major cause of morbidity and mortality in feedlot cattle. There is very little data derived from rigorous, credible scientific studies describing major causes of death in live export cattle. A single study on four voyages to the Middle East has identified BRD as an important cause of death in live export cattle.
2. Findings from post mortem examinations of cattle dying from BRD on four long-haul export voyages indicate that pathology is essentially the same as is observed in feedlot BRD cases. Infectious agents and non-infectious risk factors influencing BRD in live export are considered to be the same as in feedlot cattle with additional factors likely to be operating in export vessels in association with pen design on-board ship, ventilation and local (pen, deck and ship level) conditions during the voyage
3. Published studies on efficacy of vaccines against BRD in feedlot cattle do not provide clear and unequivocal support for routine vaccination to prevent or minimise the risk of BRD. In some cases vaccination may result in adverse impacts on health and performance outcomes.
4. There is insufficient information currently available on which to determine with confidence that BRD risk is sufficiently high across all cattle that are exported to warrant mandatory vaccination in all exported cattle, or to identify a particular vaccine that should be used, or to expect that vaccination with a particular product would be likely to reduce BRD risk.
5. Clinical trials designed to investigate efficacy of BRD vaccines in live export cattle are likely to be very expensive, very difficult to implement, likely to result in collection of biased data, and return equivocal results that are unlikely to offer value in determining whether to vaccinate live export cattle.
6. There is a need to collect credible[1] information describing causes of death in live export cattle. This means using objective, scientific methods that are carefully designed to ensure high levels of validity[2] and reliability[3].
7. The low mortality rates in export cattle mean that care must be exercised in designing any project aiming to describe causes of death because of the large number of voyages that must be studied to describe causes of death with confidence. A project that is limited to collection of data only from voyages that are accompanied by project personnel is likely to be inefficient, expensive and produce results of little value.

The findings outlined above have resulted in a major shift in the proposed approach to further investigation of respiratory disease in live export cattle. A critical part of this shift is a move to the development of systems designed for industry to collect valid and credible mortality data in a sustainable manner beyond the completion of this project. The shift has meant that the proposed project has had to develop new objectives and methods.

The outcomes will include better training and task definition for veterinarians and stock persons, improvement in the validity and coverage of mortality (and morbidity) data from export vessels, improvement in quality assurance and reporting, and continual feedback for veterinarians and stock persons with improved morale and interest in their responsibilities.

[1] credible: results of research are believable
[2] validity: findings reflect the underlying truth
[3] reliability: findings are similar when repeated across different voyages and using different observers.

4.4 Revised Project Objectives

4.4.1 Stage 1: Development of methods

1. Develop a veterinary handbook or vade mecum that contains descriptions for common diseases that occur in live export cattle including diagnosis, management, treatment and prevention. In addition the handbook will describe procedures for performing post-mortem examination of animals that die during a voyage.
    a. An important part of the handbook will be development of standardised terminology for describing clinical signs and their severity and a clearly defined standardised approach to performing a post-mortem examination including recommendations for samples (blood, tissue etc) to be collected for subsequent examination by a veterinary pathologist to establish the cause of death.
    b. Activities have already begun under a separate MLA project to develop a veterinary handbook. Any additional activities under Objective 1 in this project will need to be integrated with existing work being directed at development of a veterinary handbook.
2. Define data requirements necessary to be able to describe mortalities that occur during the live export process and particularly during the voyage (for long-haul voyages). This will include data to describe the vessel, voyage (load date, climatic and sailing conditions, destination, load plan, etc), denominator or line of cattle, data collected from observations of animals that die (such as: animal identification, date of death, age, sex, breed, condition, clinical signs, any treatments, location within vessel, findings from post-mortem examination).
    a. NLIS: It is anticipated that a variable proportion of cattle exported from Australia will have NLIS tags and these offer additional potential as a unique animal identity code for use in tracking all data collected during the project, and potentially leverage of additional benefit by extracting further data from the NLIS database. There are privacy constraints that may limit or prevent extraction of individual animal information or information concerning a specific property. NLIS may offer the ability to describe some factors relating to property of origin and characteristics of the journey from the property to the export assembly depot. These issues will need to be explored and clarified before a determination can be made of the value of NLIS data.
3. Develop systems for collection of:
    a. data concerning mortalities on board export vessels;
    b. tissue samples in formalin collected from post-mortem examination of animals that die during a voyage and their subsequent importation into Australia on return of the export vessel to Australia.
    c. fresh or frozen samples (not in formalin) for importation into Australia for specific diagnostic procedures such as microbial culture.
4. Review, clarify and define the responsibilities of accredited on-board veterinarians and stockmen in consultation with exporters and industry stakeholders to ensure the positions are complementary and to incorporate responsibilities associated with objectives 1, 2 and 3.
5. Review training material and training activities for accredited veterinarians and stockmen to ensure that relevant information from Objectives 1 to 4 are covered.
6. Develop systems for movement of samples collected during necropsies performed during a voyage to a veterinary pathologist in Australia on return of the vessel to Australia and for examination of samples to establish the cause of mortality. Systems to consider options such as:
    a. examination of all samples from all voyages.

   b. examination of samples only from voyages or lines where the mortality rate exceeds a defined threshold. Other samples to be stored or discarded.
   c. incorporation of nested studies that may involve collection of additional samples from some animals or voyages such as fresh or frozen samples for microbial culture.
7. Review existing systems for collection, management, analysis and reporting of data concerning mortality in export cattle to stakeholders and develop a project information management system to collect and manage data.

4.4.2 Stage 2: Pilot study

8. Apply systems and methods from Objectives 1 to 7 on a limited number of voyages as a pilot study to test their application and functionality. The pilot study will incorporate input from individuals across all parts of the system (veterinarians, stockmen, pathologists etc) and from exporters to identify any problems or areas that require further modification. This will be followed by development of version 1 of a robust, sustainable system for monitoring of health in export animals, termed the cattle export health monitoring system.

4.4.3 Stage 3: Collection of data on 24 months of voyages

9. Apply version 1 of the cattle export health monitoring system to two years of voyages.

4.5 Methodology

The proposed approach involves implementation of an initial three year project to develop and implement a practical system of collecting valid data on causes of livestock mortalities. An important part of the project will be the development of effective and sustainable systems for monitoring mortalities that can be continued by industry. The term sustainability is used to describe outcomes that continue to be implemented beyond the lifespan of the project ie that are adopted by industry as ongoing activities.

It is important to note that this project is intended to investigate mortalities in long-haul export journeys. The veterinary handbook, training initiatives and methods may be equally applicable to short-haul export journeys. It is proposed that the project be developed and applied to long-haul journeys only in the first instance and then a decision can be made at the end of the project about the value and possible application of these methods to short haul export voyages.

Project objectives will be completed in three stages. The activities that will be completed in each stage are outlined below.

4.5.1 Stage 1: Development of methods

1. Finalisation of project team including:
   a. project leader: responsible for coordination of project and reporting.
   b. veterinary pathologist(s): responsible for analysis of post-mortem samples collected during the project (and other samples if collected).
   c. PhD student responsible for data collection in conjunction with on-board veterinarians and stockmen.

   d. project reference group to provide strategic input and oversight into the project design and monitor progress.
   e. additional technical input may be sourced as required for example to contribute to development of handbook and training material.
2. Consultation with stakeholders:
   a. project reference group meeting
   b. exporters
   c. on-board veterinarians and stock-men
   d. AQIS
   e. Sate department and MLA concerning access to and value of NLIS data
3. Completion of Stage 1 Objectives. This is likely to include one or more project team members travelling on an export voyage to observe procedures and opportunities/constraints for data collection in the development of the draft project design.
4. Stage 1 is anticipated to last 6 to 9 months and will conclude with a report delivering against each of the Stage 1 Objectives identified above.

4.5.2 Stage 2: Pilot study

5. Systems developed in Stage 1 will be applied to a small number of voyages involving cattle being exported to the Middle East. It is anticipated that up to two voyages will involve the PhD student accompanying the ship and additional voyages will be selected for the pilot study where AQIS-accredited veterinarians will collect data.
6. Stage 2 is anticipated to last about 3 months and will conclude with delivery of a report describing:
   a. assessment of implementation and functionality of systems for data collection, handling, analysis and reporting.
   b. assessment of systems for collection of post-mortem samples during a voyage and their subsequent importation into Australia and examination by a veterinary pathologist.
   c. refinement of information management systems and project design into version 1 of the cattle export health monitoring system.
   d. preliminary findings on causes of mortality.
7. Delivery of the Stage 2 report will be followed by a meeting with industry stakeholders to discuss findings and is identified as a go/no-go point for the remainder of the project.

4.5.3 Stage 3: Collection of data on 24 months of voyages

8. Roll-out of version 1 of the cattle export health monitoring system across all cattle export voyages (dependent on support of exporters) for a 24-month period.
9. It is anticipated that the project will involve different levels of activities:
   a. routine collection of mortality data by AQIS-accredited veterinarians using version 1 of the cattle export health monitoring system.
   b. additional nested studies involving collection of additional data or samples on selected voyages accompanied by the PhD student as well as the regular AQIS-accredited veterinarian. It is anticipated that these voyages may involve collection of additional samples such as fresh samples from post-mortem for microbial culture or environmental data.

4.6 Reporting

Milestone reports will be delivered at the end of each of the three stages.

In addition it is anticipated that brief interim reports would be delivered at quarterly or 6-monthly intervals during Stage 3 of the project.

4.7 Consideration of specific issues in Objective 2

A number of specific issues have been presented under Objective 2 (see Section 2: Objectives) that relate to design of the project. Comments are provided against each of these issues here.

4.7.1 Protocols for examination of sick animals and for post-mortem.

This has been addressed in Objectives 1, 2 and 3 of the modified project design presented in this report.

4.7.2 Collecting samples from apparently healthy animals.

The modified proposal described in this report does not incorporate sampling from apparently healthy animals. The approach has been changed to focus on a broad method aiming to describe causes of death in feedlot cattle. There is potential for nested studies to be incorporated within the larger study that may include more detailed sampling or sampling from apparently healthy animals.

4.7.3 Assessment of cattle in assembly feedlot

Mortality data during assembly will be collected as part of the proposed project using the same methods as are described for the voyage.

4.7.4 Assessment of cattle on-board ship during voyage

This is described in the Objectives and Methods in Section 4 of this report.

4.7.5 The use of NLIS to identify cattle during export.

NLIS tags will be used where possible to trace animals during the study. If NLIS tags are not available then alternative methods will be used including property tags.

It is noted that there may be additional potential for leveraging of further data from the NLIS database using numbers recorded from animals during export voyages. This may allow description of geographic location of property-of-origin and possibly facilitate access to additional on-farm factors. It is anticipated that there will be privacy constraints limiting access to data from the NLIS database and access may be limited to aggregated data. This will be clarified during consultation.

4.7.6 Advantages and disadvantages of nested studies.

Clinical trials have been assessed and are not proposed as suitable for producing credible and valid results that could guide management decisions such as whether to vaccinate against respiratory disease or not. Nested studies involving additional or different data/samples being collected are included in the project design.

4.7.7 Feasibility of collecting data after discharge.

It is proposed that the project focus on development of methods that can be implemented by industry from assembly feedlot to destination port. Findings from this project should then be assessed for suitability and application to the post-discharge phase for Australian cattle exported to other destinations. Systems for training of animal health providers and collection of mortality data should be applicable in the post-discharge environment and would provide additional data of value to the industry.

4.7.8 Detailed budget for completing the proposed study.

Not relevant to this report. This report describes a set of Objectives and Methods for a revised project. These items can then be used for development of a detailed study plan and budget to implement the project.

5 Success in achieving objectives

All objectives are considered to have been completed.

6 Impact on meat and livestock industry – now and in five years time

This report describes a project that will develop and implement systems for collection of objective, valid and reliable data describing causes of death in cattle exported from Australia to Middle Eastern destinations. The project will also contribute to the further development of industry resources (veterinary handbook, standardised methods for diagnosing and managing disease and investigating deaths and training of accredited veterinarians and stockmen). Provision of improved training and resource material for animal health and welfare will ensure that health and welfare outcomes are both monitored and maintained during export. Standardised procedures for collection of data on mortalities will ensure credible and valid information on mortalities is collected and reported. The project will describe causes of death in cattle undergoing long-haul cattle and will contribute to ongoing industry assessment and improvement of animal health and welfare during export. Valid, credible data on causes of death in export cattle and factors contributing to deaths will feed back into decisions concerning effective management of cattle for optimal health and welfare. The same data will allow more detailed and valid reporting of mortalities and contribute to improvements in quality assurance for the industry.

A critical outcome of the project is the involvement of industry and in particular export accredited veterinarians and stockmen in the project. The project aims to deliver systems that are sustainable beyond the lifespan of the project meaning that the major benefits of the project will be systems that will be implemented into the future for the benefit of the industry.

7 Conclusions and recommendations

This report describes the background and findings from information gathering processes (literature review and industry consultation) concerning value and design attributes of a project to investigate causes of death in cattle subjected to long haul export from Australia. In addition the report details Objectives for a project and Methods that may be implemented to achieve the Objectives.

It is recommended that this report be used to develop a Terms of Reference for a project to investigate causes of death in cattle being exported from Australia to the Middle East and other long-haul destinations.