final report

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Priority list of endemic diseases for the red meat industries

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Abstract

This report provides a systematic review of the most economically damaging endemic diseases and conditions for the Australian red meat industry (cattle, sheep and goats). A number of diseases for cattle, sheep and goats have been identified and were prioritised according to their prevalence, distribution, risk factors and mitigation. The economic cost of each disease as a result of production losses, preventive costs and treatment costs is estimated at the herd and flock level, then extrapolated to a national basis using herd/flock demographics from the 2010-11 Agricultural Census by the Australian Bureau of Statistics. Information shortfalls and recommendations for further research are also specified.

A total of 17 cattle, 23 sheep and nine goat diseases were prioritised based on feedback received from producer, government and industry surveys, followed by discussions between the consultants and MLA. Assumptions of disease distribution, in-herd/flock prevalence, impacts on mortality/production and costs for prevention and treatment were obtained from the literature where available. Where these data were not available, the consultants used their own expertise to estimate the relevant measures for each disease. Levels of confidence in the assumptions for each disease were estimated, and gaps in knowledge identified.

The assumptions were analysed using a specialised Excel model that estimated the per animal, herd/flock and national costs of each important disease. The report was peer reviewed and workshopped by the consultants and experts selected by MLA before being finalised. Consequently, this report is an important resource that will guide and prioritise future research, development and extension activities by a variety of stakeholders in the red meat industry. This report completes Phase I and Phase II of an overall four-Phase project initiative by MLA, with identified data gaps in this report potentially being addressed within the later phases.

Modelling the economic costs using a consistent approach for each disease ensures that the derived estimates are transparent and can be refined if improved data on prevalence becomes available. This means that the report will be an enduring resource for developing policies and strategies for the management of endemic diseases within the Australian red meat industry.

Executive summary

This report provides the results for Phase I (survey and shortlisting a priority list of endemic disease) and Phase II (review and assessment of diseases) of a four-phase survey of livestock diseases of interest to the Australian red meat industry. The results provide a comprehensive economic assessment of the most significant endemic diseases which currently affect the cattle, sheep and goat red meat industries.

Since 2006, Meat & Livestock Australia Limited (MLA) and wider industry have relied on a report from project B.AHW.087 by Sackett *et al.* (2006), with its estimates of the economic cost of some common endemic cattle and sheep diseases, to guide research, development and extension (RD&E) activities. Aside from a number of shortcomings to this report such as the omission of goats, there has been an increasing need to provide a more up-to-date estimate of the economic impact of endemic diseases within the Australian red-meat industry. This is required so that MLA, livestock producers and their advisors can access a comprehensive and relevant document that more accurately informs and guides their understanding of the economic consequences of common or emerging diseases, hence decisions on RD&E activity.

The priority list of diseases was developed from a variety of surveys conducted across key stakeholders affected by livestock diseases within the red meat industries. Surveys were specifically developed, for livestock producers, veterinarians, processors, animal health companies and Chief Veterinary Officers, to identify the most economically important diseases. Stakeholders were surveyed with a variety of methods, ranging from computer assisted telephone interviews to more detailed and structured face to face interviews.

The results of the surveys were assessed by the project team, in a series of workshops, with the aim of establishing an agreed list of priority diseases. Prioritisation commenced with the list obtained from the producer survey (see Appendix) with the priority order modified and some additional diseases included based on information from the other surveys and the consultants' opinions.

The final list included 17 cattle, 23 sheep and nine goat diseases that were assessed as having the greatest economic impact. The identified diseases are listed in the tables below.

Cattle	
Cattle tick	Grass tetany
Pestivirus (Bovine viral diarrhoea)	Calf scours complex
Buffalo fly	Vibriosis
Dystocia	Theileriosis
Neonatal mortalities	Pinkeye
Internal parasites	Clostridial infection
Bloat	Tick fever
Bovine ephemeral fever	Johne's disease
Botulism	

Sheep	
Neonatal mortalities	Liver fluke
Internal parasites	Pneumonia
Dystocia	Caseous lymphadenitis ('Cheesy gland')
Weaner ill-thrift	Pregnancy toxaemia
Flystrike - body & breech	Hypocalcaemia
Perennial ryegrass staggers	Foot abscess
Lice	Bacterial enteritis
Mastitis	Pyrrolizidine alkaloid poisoning
Footrot	Sheep measles
Arthritis	Campylobacter abortion
Ovine Johne's disease (OJD)	Sarcocystis
Clostridial disease	

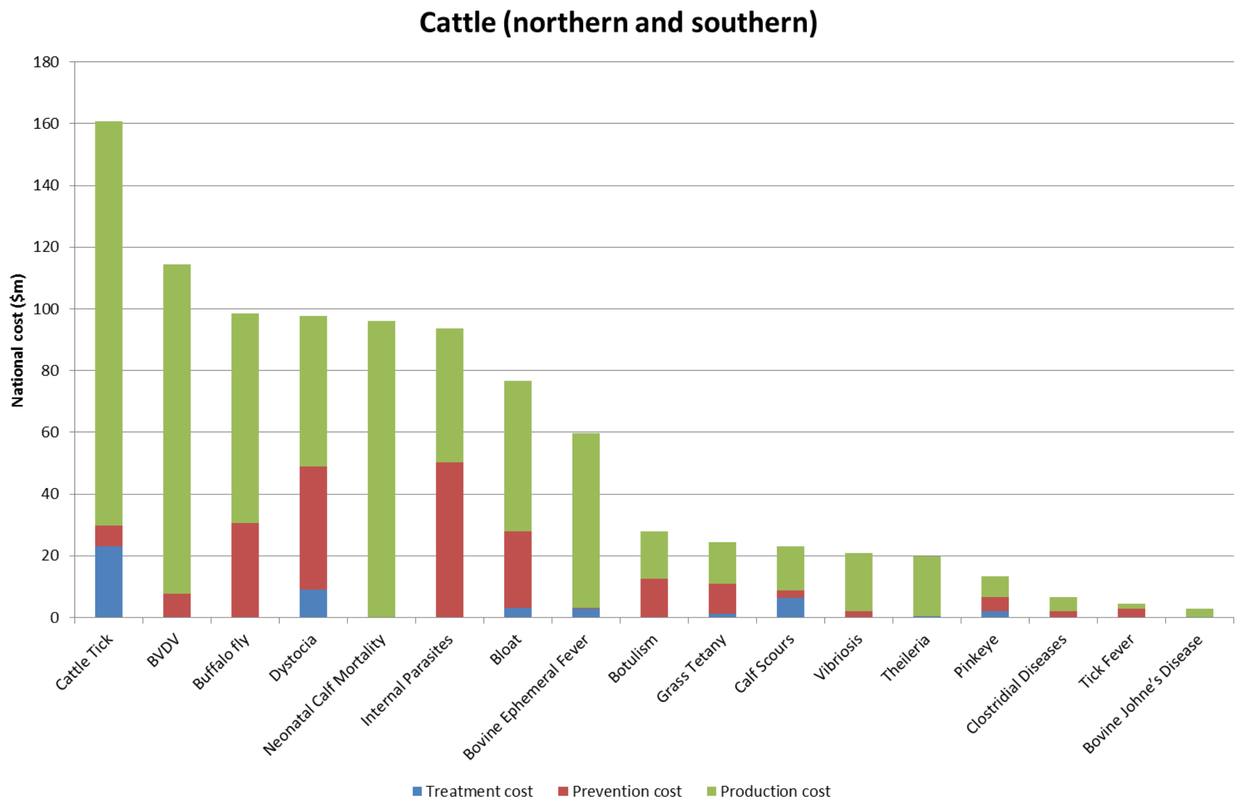
Goats	
Internal parasites	Liver fluke
Enterotoxaemia	Footrot
Lice	Johne's disease
Pregnancy toxaemia	Caprine arthritis-encephalitis (CAE)
Caseous lymphadenitis ('Cheesy gland')	

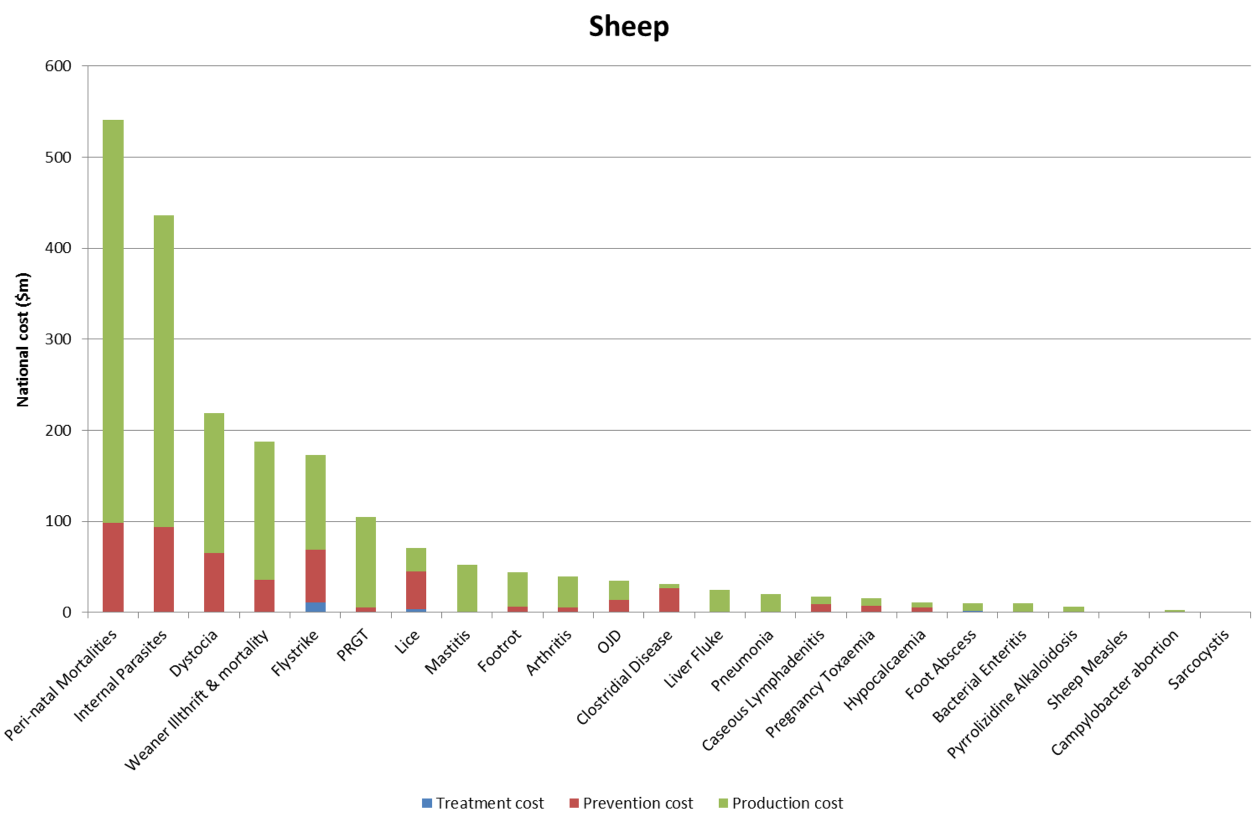
Assumptions for disease distribution, in-herd/flock prevalence, impacts on mortality/production and costs for prevention and control were obtained from the literature where available. In the absence of appropriate data, the consultants used pooled industry knowledge to estimate the various measures. A level of confidence in each assumption was provided.

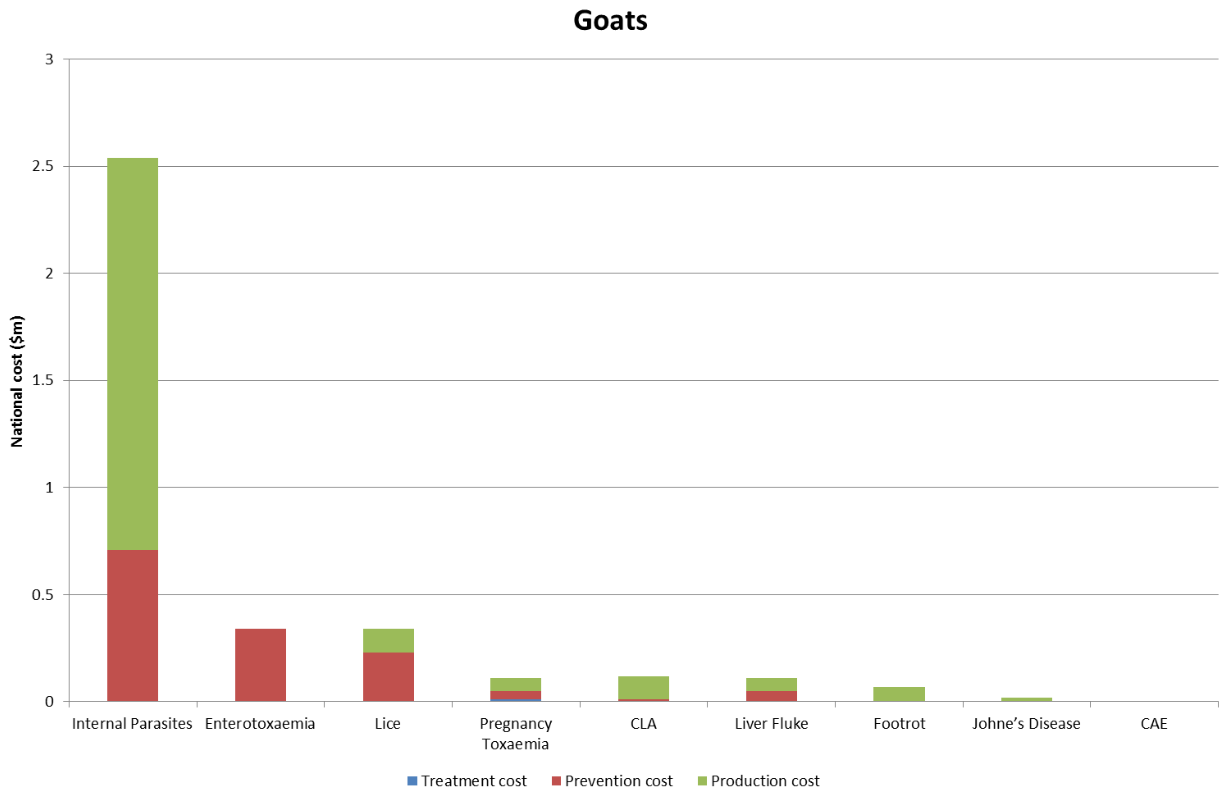
A specifically designed Excel model, encompassing the Australian beef cattle, sheep and goat industries, was developed to incorporate these measures to calculate the costs of each disease to each industry. Importantly, each model for cattle, sheep and goats was built on a 'typical' herd/flock structure assumption for each species by production region; north and south for cattle, high rainfall zone, sheep/wheat zone and pastoral zone for sheep, and type of production for both sheep (wool, prime lambs, dual purpose) and goats (rangeland and farmed).

The model provides an estimate of the cost per herd/flock at the farm level for each disease. Costs were calculated for treatment, prevention and production losses. These results have been extrapolated across the regions in which each disease occurs, in line with adopted herd and flock demographics from Australian Bureau of Statistics Agricultural Commodities Statistics for 2010-11 in order to provide a national total cost estimate. Prioritisation commenced with the list obtained from the producer survey (see Appendix) with the priority order modified and some additional diseases included based on information from the other surveys and the consultants' opinions.

The results of the estimated annual economic cost of the priority diseases for cattle, sheep and goats are shown in the following three graphs:




Sheep
600
500
400
300
200
100
0
National cost ($m)
Peri-natal Mortalities
Internal Parasites
Dystocia
Weaner Illthrift & mortality
Flystrike
PRGT
Lice
Mastitis
Footrot
Arthritis
OJD
Clostridial Disease
Liver Fluke
Pneumonia
Caseous Lymphadenitis
Pregnancy Toxaemia
Hypocalcaemia
Foot Abscess
Bacterial Enteritis
Pyrrolizidine Alkaloidosis
Sheep Measles
Campylobacter abortion
Sarcocystis
Treatment cost
Prevention cost
Production cost


Goats
3
2.5
2
1.5
1
0.5
0
National cost ($m)
Internal Parasites
Enterotoxaemia
Lice
Pregnancy Toxaemia
CLA
Liver Fluke
Footrot
Johne's Disease
CAE
Treatment cost
Prevention cost
Production cost

These results highlight a significant variation in the estimated economic costs of the priority diseases. Whilst the results in this report are not directly comparable with those in Sackett *et al.* (2006), nor are they striving to be, they provide a timely and up-to-date assessment of the most economically important endemic diseases for the cattle, sheep and goat industries. The estimated costs are based on assumptions of disease distributions and impacts for which information is sometimes lacking. Every attempt has been made to source data from existing research and surveillance reports of disease prevalence and impacts but such data are often incomplete. Expert opinion was used where possible to fill knowledge gaps.

The report highlights the gaps in current knowledge and reviews the availability or effectiveness of preventive and treatment strategies currently available for each disease. Where information is lacking, further investigations as envisaged in Phase III and Phase IV of the wider livestock disease survey may be warranted to increase the confidence in and/or accuracy of the cost estimates.

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Abbreviation	Description
BVDV	Bovine viral diarrhoea virus
BCS	Body condition score
BEF	Bovine ephemeral fever
BJD	Bovine Johne's Disease
BW	Bodyweight
CAE	Caprine arthritis encephalitis
CFW	Clean fleece weight
CW	Carcass weight
FD	Fibre diameter
FEC	Faecal egg count
FECRT	Faecal egg count reduction test
HRZ	High rainfall zone
IGR	Insect growth regulator
kg	Kilogram
LW	Live weight
M	Millions
N/kTex	Newtons per kilotex
NSHMP	National sheep health monitoring project
PA	Pyrrolizidine alkaloidosis
PCR	Polymerase chain reaction
PI	Persistent infection
PRG	Perennial rye grass
PRGT	Perennial rye grass toxicosis
WEC	Worm egg count
YO	Years old (refers to age of the animal)

1 Background

Since 2006, MLA has used the final report of project B.AHW.087 by Sackett *et al.* (2006) with its estimates of the economic cost of endemic cattle and sheep diseases in Australia to guide research, development and extension (RD&E) investments. However, it is recognised that this report has a number of shortcomings, namely that it:

- Was a desk-top study which relied on expert opinions and published literature.
- Excluded goats.
- Was unable to address problems perceived to be relatively localised in their impact.
- Was completed before newly emerged bovine theileriosis became a problem in NSW and Victoria.

The B.AHW.087 final report is now over eight years old and there is a need for an up-to-date, objective assessment of the most common endemic diseases for the red meat industries. In preparing this report, GHD referred to outputs from the Sackett *et al.* (2006) report, however the authors did not directly compare the cost outcomes or justify any differences that arose because of the differences in the methodology. These differences included the use of different economic modelling techniques, changes in livestock populations (including for sheep a shift in production from wool to prime lambs for meat) and changes in the geographic distribution of the livestock. As well, since 2006 there have been changes in the availability of products for prevention and treatment of diseases and the costs of these.

In order to better define the parameters for a new livestock disease survey, MLA funded a scoping study (B.AHE.0226), which recommended that the survey be multi-phased with a number of steps grouped together to be delivered over four phases:

- Phase I – Steps 1-3: survey of producers, veterinarians, processors and others; and review available data for compilation of a priority disease list.
- Phase II – Step 4: review the available information on the diseases in the list and identify knowledge gaps with regard to prevalence, risk factors, mitigation steps and economic impact.
- Phase III – Steps 5-6: conduct targeted field and abattoir surveys of diseases where knowledge is considered to be incomplete.
- Phase IV – Steps 7-9: determine on-farm and abattoir costs for priority diseases and report on the results.

This project encompasses Phase I and Phase II of the broader livestock disease survey for Australian red meat production (cattle, sheep and goats). The report considers diseases and conditions predominantly impacting on the grazing industries. A 2013 report prepared by Nigel Perkins (P.PSH.0547) provided up-to-date information on animal health of the Australian Feedlot Industry and a survey of the live export sector is the responsibility of LiveCorp rather than MLA.

2 Objectives

The objectives of this report are to provide:

1. A valid list of 20 to 40 of the most economically damaging endemic diseases of cattle, sheep and goats.
2. A documented systematic review of each disease on the priority list with special emphasis on prevalence and distribution, risk factors, mitigation steps and economic impacts.
3. For each disease, recommendations on further research requirements to define the nature, extent and importance of the disease.

3 Methodology

The project was completed by GHD Pty Ltd is association with the following sub-consultant veterinarians: Dr Tristan Jubb, Dr Richard Shephard, Dr Geoffry Fordyce and Dr John Webb-Ware (including other members of the Mackinnon Project).

The project team completed the following activities to prioritise diseases and estimate their economic impacts.

3.1 Surveys

GHD conducted a range of surveys similar to those described in the *B.AHE.0226 Endemic diseases scoping study Step 1*. Surveys were designed and implemented at a number of different levels and using different methods appropriate to each survey. The surveys were used to gauge the level of diseases across different geographic regions and were designed to gain an understanding of the perceptions of different stakeholders about the extent of diseases. The surveys employed are described below. Appendix 1 and Appendix 2 (separate document) include copies of surveys and results.

a) Livestock producers

A phone survey of cattle, sheep and goat producers was completed using the Computer-assisted telephone interviewing (CATI) services of a commercial research company contracted by GHD. The consultants designed a "producer friendly" questionnaire designed to explore producer perceptions of important livestock diseases in their locations (cost and effort for prevention and treatment, impacts on production and profit, ranking degree of importance). The survey was administered to a stratified random sample of cattle, sheep and goat producers compiled from the MLA producer member database. The sample frame captured producers of all species (cattle, sheep, goats), enterprise types (breeding, fattening, wool, lamb) and regions (north, southwest and southeast) in all states and territories. A total of 300 producer surveys were completed with Figure 1 providing a breakdown of survey results by state. Of the 300 producer surveys completed, 110 were with southern cattle producers, 70 with northern cattle producers, 90 with sheep producers and 30 with goat producers. These numbers broadly reflect the relative "grazing pressure" of the different livestock types within Australia.

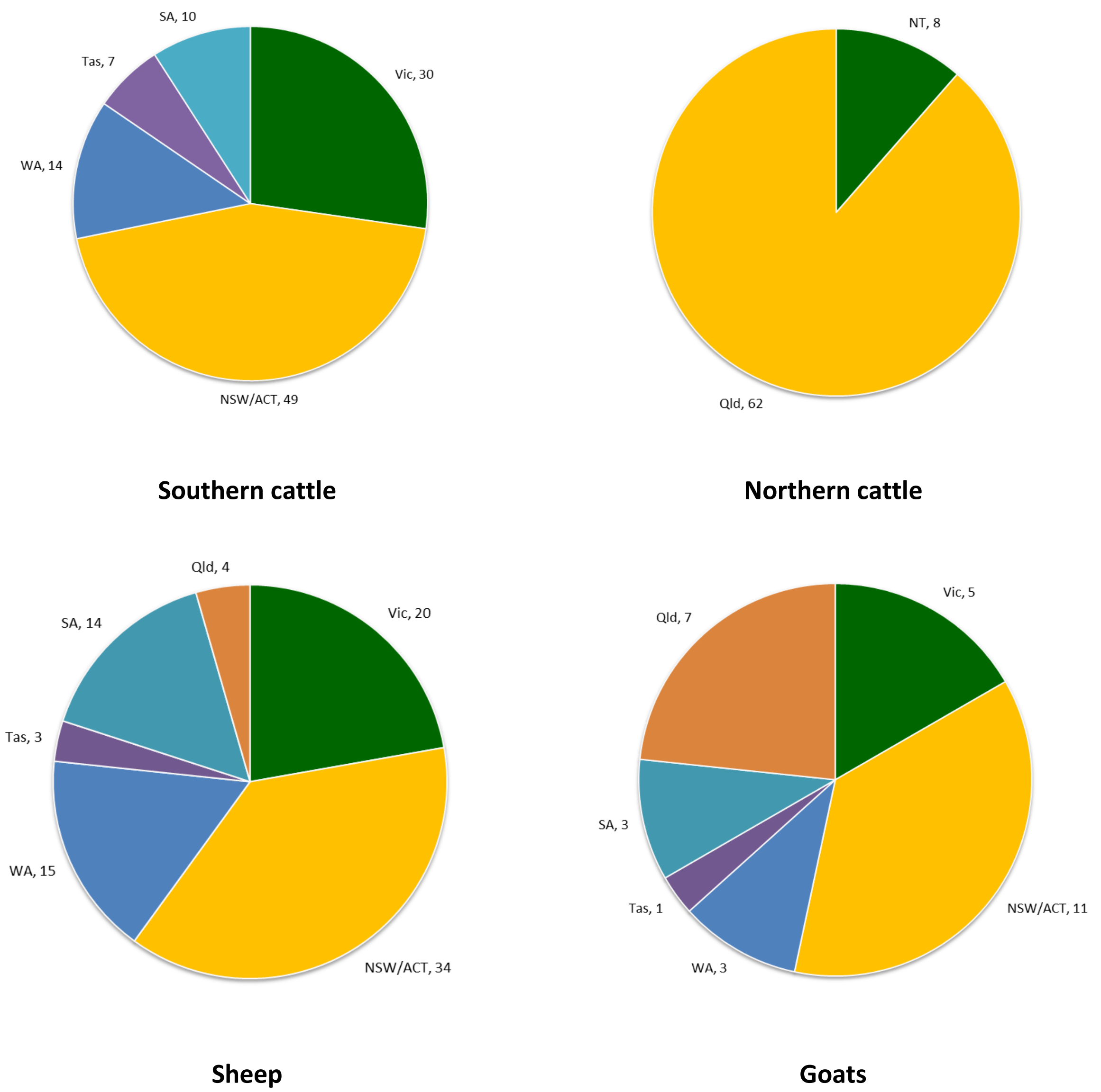
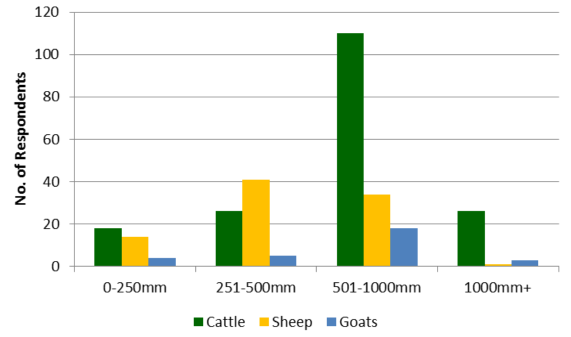
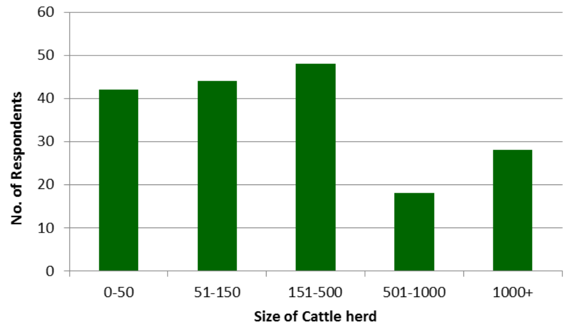


Figure 1 State breakdown of producer surveys by species

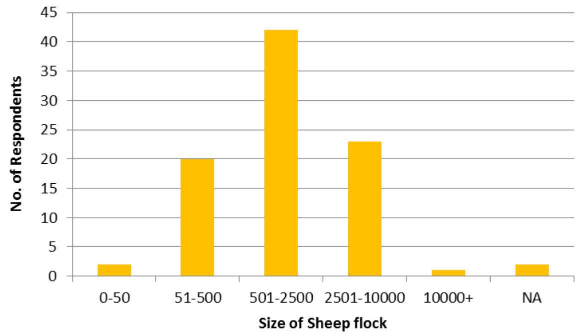
Figure 2 below outlines the survey results by rainfall zone and the herd / flock size by survey respondents.



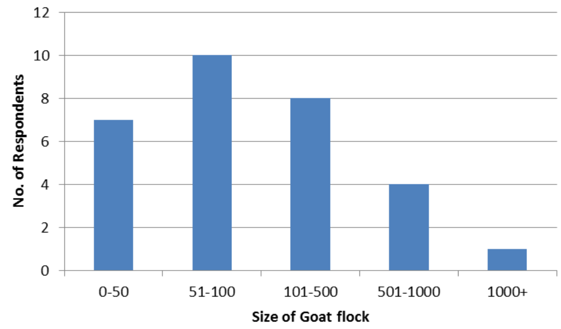
Respondents by rainfall zone



Respondents by size of cattle herd



Respondents by size of sheep flock



Respondents by size of goat flock

Figure 2 Number of survey respondents broken down by rainfall and herd/flock size

b) State Departments of Primary Industries

The Chief Veterinary Officer (CVO) in each state and territory were contacted by MLA and requested to complete a survey of endemic diseases of importance within their jurisdictions with the following information requested:

- The economic importance of each disease (high, medium or low) from the list provided for each species.
- The extent to which more extension (awareness) of currently available treatment and prevention options could reduce economic impact.
- The extent to which more research is required to identify better treatment and control options to reduce economic impact.
- Any comments about the disease/condition/syndrome especially if it relates to any emerging trends that will require attention in the near future.

In addition, CVOs were requested to provide summary data on diagnoses of diseases from specimens submitted to their animal health laboratories.

c) Livestock veterinarians

Livestock veterinarians were requested to complete a survey similar to that prepared for the CVOs as outlined above. The request was emailed to members of the Australian Cattle Veterinarians (ACV) and Australian Sheep Veterinarians (ASV). This email directed participants to a dedicated website which provided background on the project and links to download and complete the survey. Once completed the survey could either be returned via email or post.

d) Processors

A meeting was held in Sydney with a representative of the Australian Meat Industry Council (AMIC) which represents livestock processors to gain information on endemic diseases that impact on carcase and co-product yields and downgrades. In addition, AMIC completed a similar survey which identified those livestock conditions or diseases of medium or high economic importance to processors. Of particular importance to the processors are those diseases or conditions that lower the processing 'value' (by intrinsically lowering the value of the animal and/or increasing processing costs) of the animal product (e.g. increased dark cutters, increased meat inspection / trimming).

e) Department of Agriculture and Animal Health Australia

The Australian Department of Agriculture provided data on cattle, sheep and goat carcase condemnations that occurred at the processing stage from its Export Production and Condemnation Statistics (EPACS) database.

Animal Health Australia (AHA) provided information from three of its livestock surveillance programs:

- National Significant Disease Investigation Program.
- Sheep Health Monitoring Program Abattoir surveillance.
- National TSE Surveillance Program.

Data from these were further analysed by GHD to assist in disease prioritisation.

f) Animal health companies

Key representatives from Animal health companies were also surveyed to assist in developing a list of priority diseases or conditions. This survey asked similar questions to that of livestock veterinarians and CVOs with additional questions as follows:

- For the diseases and conditions listed, please state what product(s) your company has available for use in Australia.
- For the products you provided above, what is the standard price per animal of the recommended dose or application rate?

3.2 Project workshops and discussions

The project team completed a number of teleconferences and two project team workshops to initially finalise the survey questionnaires and then, based on the results of those surveys, finalised the list of priority diseases for further analysis. One major workshop was attended by MLA with the following outcomes:

- Review of the disease or condition lists compiled from the above surveys.
- Valid final list of livestock disease for cattle, sheep and goats agreed; and
- Establish and agree on the framework for economic analysis and presentation of each disease.

Attendees at the major workshop analysed the results of all the surveys and the outputs of the data provided by relevant agencies to prepare a condensed list of the main diseases for cattle, sheep and goats. The producer survey outcomes formed the initial priority list which was modified using the information from the other surveys and the consultants' own experience in disease investigation. The final list of 17 cattle, 23 sheep and nine goat diseases was agreed in consultation with MLA.

Team members sourced information on the prevalence and impacts of each disease from published literature and where necessary this was supplemented by informal approaches to colleagues known to be experts for particular diseases. Despite this level of investigation, knowledge gaps were identified and such gaps may require further investigation in the later phases of the broader disease project. Assumptions on disease prevalence and impacts were assembled for each disease and then adopted within an Excel spreadsheet to estimate economic impact (see below).

For many variables that comprise economic impact there is a degree of uncertainty surrounding the assumptions adopted. This is represented in the reports for each disease by a rating scale that provides the degree of confidence for each assumption. The transparent list of assumptions adopted enables estimates to be easily refined in the future when more accurate data become available.

3.3 Review and modelling

An Excel spreadsheet model was constructed to quantify the economic impacts of each disease. The spreadsheet was based on defining a "typical" herd/flock structure for each species by region (north and south for cattle; high rainfall zone, sheep/wheat zone and pastoral zone for sheep) and type of production for sheep (wool, prime lambs, dual purpose) and goats (rangeland and farmed).

The model included a range of variables associated with the economic cost of diseases (prevalence, mortality, reproductive loss, weight loss, product quality, costs for prevention and treatment). The final output is a cost per herd/flock for each disease which is then extrapolated across the regions of disease occurrence to provide a national economic total. The model also includes a calculation of the net gain from moving susceptible herds and flocks from the current prevalence level to the lowest level of disease. It should be noted that model inputs do not reflect all potential situations; e.g. though a disease may very occasionally be associated with mortality, the assumption of zero impact may be entered as this is very close to the overall effect for a region. This process captures the realisable gains from better disease management understanding that total elimination of disease is usually impossible or impractical.

The Excel spreadsheet for each disease was provided to MLA to enable the ready updating of the costs of disease if more accurate data become available. The spreadsheet represents a standardised template for future assessments – allowing the capture of relative change in disease impacts to be followed over time – and could also be used as a valuable tool in scenario planning of the potential outcomes of future RD&E proposals. Example screen shots of model inputs and outputs are provided in Appendix 3.

It should be noted that the cost models were constructed with the aim of comparing each disease to enable the prioritisation process. It is envisaged that models could be further refined in Phases III and IV of this project and that such refinement would improve the accuracy of the economic costs of each disease.

Herd and Flock Demographics

The spreadsheets model adopted herd and flock demographics based on data from the Australian Bureau of Statistics (ABS) Agricultural Commodities (2012) data for 2010-11. These data were analysed at the Natural Resource Management (NRM) regions level which is also consistent with livestock numbers reported by MLA. Data on livestock numbers and average herd/flock sizes are shown in Table 3-1, Table 3-2, Table 3-3 and Table 3-4.

The analysis examined the total livestock numbers and the total number of livestock enterprises which was then used to work out average herd and flock sizes. Cattle were split into northern and southern regions while sheep were split across pastoral, sheep/wheat and high rainfall zones.

Table 3-1 Cattle and sheep numbers

Cattle	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Total
Northern			12,449,623		1,059,821		2,197,359	-	15,706,803
Southern	5,383,931	2,365,851	-	1,109,640	894,561	466,583	-	8,807	10,229,373
Total	5,383,931	2,365,851	12,449,623	1,109,640	1,954,382	466,583	2,197,359	8,807	**25,936,176**

Sheep	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Total
Pastoral	3,251,045	493,416	3,653,238	1,128,932	364,994	-	1,855	-	8,893,480
Sheep/ Wheat	21,070,130	6,957,062	-	3,381,602	6,018,036	-	-	54,092	37,480,922
High rainfall	2,503,522	7,761,539	-	6,498,008	7,616,824	2,344,469	-	-	26,724,362
Total	26,824,697	15,212,017	3,653,238	11,008,542	13,999,854	2,344,469	1,855	54,092	**73,098,764**

Table 3-2 Number of cattle and sheep businesses

Cattle	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Total
Northern	-	-	19,226	-	263	-	254	-	19,743
Southern	27,164	16,020	-	4,628	4,265	2,602	-	51	54,730
Total	27,164	16,020	19,226	4,628	4,528	2,602	254	51	**74,473**

Sheep	NSW	Vic	Qld	SA	WA	Tas	NT	ACT	Total
Pastoral	743	565	1,818	103	98	-	3	-	3,330
Sheep/ Wheat	13,356	5,714	-	2,370	2,795	-	-	32	24,267
High rainfall	2,319	4,691	-	4,339	3,330	1,552	-	-	16,231
Total	16,418	10,970	1,818	6,812	6,223	1,552	3	32	**43,828**

Table 3-3 Cattle and sheep average herd sizes

Cattle	Average Herd Size
Northern	796
Southern	187

Sheep	Average Herd Size
Pastoral	2671
Sheep/Wheat	1545
High rainfall	1647

The current demographics of Australian goats were extrapolated from the Australian Bureau of Statistics (ABS) Agricultural Commodities (2012) data for 2010-11 and a consultant's report prepared for MLA (BCS Agribusiness 2011).

A final figure of 4 million rangeland and 250,000 farmed meat goats and 150,000 farmed fibre goats (99% mohair) was decided with the 400,000 farmed goats split 10%, 20% and 70% into the high rainfall, sheep-wheat and pastoral zones respectively.

It is estimated that there are possibly 25,000 dairy goats in Australia. In 2009 there were approximately 65 commercial dairy goat farms, carrying close to 12,000 goats (BCS Agribusiness 2011) and there are many small herds with less than 10 animals (GICA 2014). Dairy goats have not been considered in this study.

Table 3-4 Goat numbers

Goats	Total
Rangeland	4,000,000
Meat	250,000
Fibre	150,000
Total	**4,400,000**

3.4 Priority diseases for modelling

The priority lists of diseases for cattle, sheep and goats adopted by the consultants are shown below. The lists were derived from an analysis of the survey results (see Appendix 2 for these results) and were initially primarily ranked according to the opinions of the livestock producers surveyed. Final lists were derived at a workshop with the consultants at which an MLA representative attended and assented to the list. Those diseases that were considered but were not included in the priority list are provided in section 0.

Cattle

Cattle tick	Grass tetany
Pestivirus (Bovine viral diarrhoea)	Calf scours complex
Buffalo fly	Vibriosis
Dystocia	Theileria
Neonatal mortalities	Pinkeye
Internal parasites	Clostridial infection
Bloat	Tick fever
Bovine ephemeral fever	Johne's disease
Botulism	

Sheep

Neonatal mortalities	Liver fluke
Internal parasites	Pneumonia
Dystocia	Caseous lymphadenitis
Weaner ill-thrift	Pregnancy toxaemia
Flystrike - body & breech	Hypocalcaemia
Perennial ryegrass staggers	Foot abscess
Lice	Bacterial enteritis
Mastitis	Pyrrolizidine alkaloidosis
Footrot	Sheep measles
Arthritis	Campylobacter abortion
Ovine Johne's disease (OJD)	Sarcocystis
Clostridial disease	

Goats

Internal parasites	Liver fluke
Enterotoxaemia	Footrot
Lice	Johne's disease
Pregnancy toxaemia	Caprine arthritis-encephalitis (CAE)
Caseous lymphadenitis	

3.5 Other diseases considered

The following diseases were also nominated from the range of surveys as being of importance to the livestock industries. However, the consultants did not include these in a priority list for further systematic review for the following reasons (note that no additional goat diseases were provided from the survey results):

- Covered in the priority list (e.g. blackleg included in clostridial diseases)
- More relevant to other livestock sectors (e.g. dairy, feedlots, live exports)
- Considered to be episodic with well-known aetiology, prevention and treatment options (e.g. anthrax)
- While some diseases were important in certain regions, the analysis was conducted at the industry level
- Considered to be of lower priority within a time and budget constrained project setting.

Cattle diseases not included in priority list

Blackleg	Abortion
Leptospirosis	Acaracide resistance
Liver fluke (fascioliasis)	Lantana poisoning
Enterotoxaemia	Perennial ryegrass toxicosis
Footrot	Micro-nutrients
Tetanus	Anthrax
Mastitis	Neospora
Milk fever (Hypocalcaemia)	Annual ryegrass toxicity
Plant poisoning	Pregnancy toxaemia (fatty liver disease)

<u>Sheep diseases not included in priority list</u>

Brucella ovis (Brucellosis)	Prolapse
Scabby mouth	Acidosis
Cancer	Clover disease
Copper deficiency	Dermatophilosis
Mastitis	Fleece rot
Pinkeye	Lupinosis
Annual ryegrass toxicity	Pizzle rot
Selenium + Vitamin E deficiency	Phalaris staggers
Cobalt deficiency	Phalaris sudden death
Iodine deficiency	Mycoplasma ovis
Toxoplasmosis	
Campylobacter abortion	

Sections 0, 5 and 6 provide a description of each of the diseases, the assumptions adopted including for distribution, prevalence and production impacts, and the estimated the economic impacts calculated by using the spreadsheet model. The economic impacts are calculated at a herd/flock and national level. A draft of the report with the economic impacts was peer reviewed by veterinary consultants selected by MLA. In addition, these reviewers, the project team members and MLA staff conducted a workshop to review model input assumptions prior to finalising the economic costs presented in this report.

3.6 Presentation of results

The diseases for cattle, sheep and goats are presented in order of the estimated cost of the disease. For each disease, a brief introduction on its aetiology is provided, followed by a description (with evidence) of its prevention, treatment, distribution and prevalence. For each of these attributes, the consultants provide a summary of the current level of knowledge using a 10-point scale (e.g. for prevention, the scale ranges from “low efficacy/ unproven treatments available” through to “effective treatments available”).

The economic impact of each disease is then informed by assumptions that are summarised in a table of relevant variables. The value adopted for each variable includes a confidence rating (from “*” = low confidence, to “***” = high confidence). To limit the space required, the assumptions tables include abbreviations for the respective variables. A description of the abbreviations is provided in the table on page 12.

Finally, for each disease a summary table of the costs for treatment, prevention, production losses and the total for these is provided at an animal, herd/flock and national level based on outputs from the economic model. Note that total costs for each disease are not necessarily mutually exclusive. For example, the costs of neonatal mortalities in sheep include production losses associated with dystocia and mastitis which are also separately reported. An explanation is provided in these cases.

Section 7 includes summaries of the diseases in priority order based on estimated costs to the industry. Included in the summaries is an analysis of the gaps in knowledge in relation to aetiology, distribution and prevalence of each disease, and commentary on the availability of products and/or management opportunities to effectively prevent or treat the disease. An overall score that combines current knowledge (aetiology, distribution and prevalence) and the ability to manage the disease (availability of effective preventive and treatment agents) is also calculated to provide guidance on those aspects of the diseases that will most benefit from future research, development and/or extension.

It should be noted that the calculated overall score is largely based on subjective assessments by the consultants – it is more a qualitative ranking than an absolute measure – and should be used as such to assist in guiding decision making and to enable MLA to consider the most appropriate research, development or extension strategy to assist the livestock industries to better manage diseases. Care is needed if this score is to be used, recognising its limitations as a definitive metric for decision making.

4 Results – Cattle diseases

4.1 Cattle tick

The disease

The cattle tick, *Rhipicephalus microplus*, causes anaemia by virtue of blood sucking. As well, it is the vector for three tick fever organisms in Australia. Ticks favour warm moist conditions in their non-parasitic stage which is between when the engorged female leaves its host to lay eggs, and when larval ticks reattach for their 21-day feeding period. The non-parasitic stage can be as long as 7 months. Increasing *Bos indicus* content is associated with higher resistance to tick attachment, but within level of (0-100%) *Bos indicus* there is substantial variation in resistance; the heritability is 34% (Mackinnon *et al.* 1991). Cattle ticks can also parasitise a wide range of other animal species, including horses. Holroyd *et al.* (1988) reported that in years with highest tick burdens, Droughtmaster cattle in a dry topical environment were up to 25kg heavier through a reproductive cycle, had conceptions rates up to 30% higher and weaned calves up to 24 kg heavier when tick infestation was fully controlled. Johnston *et al.* (1981) had previously found average annual live weight effects of <10 kg and no effect on conception rates. Tick control increases annual growth of Brahman cross heifers from weaning to the end of mating at 2.5 years of age by >10 kg without affecting maiden pregnancy rates (Holroyd and Dunster 1978; Johnston *et al.* 1981). Heifer pregnancies were unaffected by tick control in either study.

Unknown aetiology — *Known aetiology*

								X	

Prevention

In addition to breed and within breed selection, acaracides are the most frequently used control method. There is a long history of ticks developing resistance to these chemicals, which has led to research for an effective tick vaccine. An efficacious first-generation vaccine was available for a short period in the 1990s, but no new vaccine has become commercially available (Willadsen 2008). White *et al.* (2003) estimated that the effect of ticks on live weight production could be reduced by 60% in Australia by genetic changes alone. The shift away from high percentage Brahman cattle is increasing the need for efficacious preventative measures such as vaccine and genetic change. Sackett *et al.* (2006) stated the annual quarantine cost to NSW and Queensland to be $2-7M and <$2M, respectively.

Low efficacy/ unproven preventives available — *Effective preventives available*

							X		

Treatment

O'Rourke *et al.* (1992) reported that 78% of cattle in high-rainfall regions were treated for ticks, and ~48% of cattle in the balance of the tick zone of northern Australia were treated, with approximately 5% across both regions not treated. Playford (2005) reported that $16.8M was spent on acaracides in 2003. Some labour is associated with all treatments. Hide values, currently ~$30, can be reduced by 25% with an average of 20% affected (Playford 2005). While treatment is an option it is not considered to be cost effective.

Low efficacy/ unproven treatments available *Effective treatments available*

						X			

Distribution

Dry and cool climate areas combined with tick-free zones restricts the tick and thus the disease to eastern and northern areas of Queensland, Northern Territory and Western Australia.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Approximately 45% of Queensland's cattle are within the regulated tick-free zone, no regulated zone exists in either the NT or WA. There is a low prevalence of ticks in Queensland's endemic tick zones beyond 200 km from the coast following droughts in the 1990's, 2000's and current, where approximately 40% of cattle are reared. There has been limited resurgence of ticks during wetter years where dry seasonal conditions have eliminated them.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Cattle tick (southern)

As tick is restricted to northern Australia, the annual cost of tick in southern Australia is limited to the assumed cost of quarantine of $5M.

Assumptions: Cattle tick (northern)

Table 4-1 Assumptions: cattle tick (northern)

Variable	Value adopted	Confidence
Regional Extent	15%, 15%, 35% and 35% of herds with a high, medium, low and nil incidence	***
% herds infected	Infestations of clinical significance occur every year, 2 in 3 years, and in one year in three in high, medium and low incidence regions.	**
Mortalities	The model assumes no mortalities are caused by the tick. Note that tick fever causes loss, and most producers institute treatment to minimise tick impacts.	**
Weight loss	Annual weight deficit due to ticks in untreated clinically-affected cattle averages 15 kg.	*
Fertility	Conception rates are reduced by 10% in clinically-affected cattle.	*
Market avoidance	Clearing of ticks for market access is covered under treatment. 25% of hides have values reduced by 25%.	**
Movement restrictions	Quarantine zones are in place and cost $1.7M annually to manage in Queensland	**
Treatment	75%, 50% and 50% of clinically-affected cattle are treated in high, medium and low incidence regions, respectively.	**
Prevention	No specific cost as use of tropically-adapted breeds is primarily based on production potential rather than tick resistance specifically. Some costs associated with strategic prevention are included as treatment costs.	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of cattle tick in northern Australia at $156.0M (Table 4-2).

Table 4-2 Economic cost of cattle tick – northern

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$5.03	$2.22	$1.11	$0.17	$0.17	$0.17	$21.34	$15.90	$7.95	**$26.54**	**$18.28**	**$9.22**
Per Herd	$3,998	$1,759	$879	$133	$133	$133	$16,941	$12,621	$6,311	**$21,072**	**$14,513**	**$7,323**
Total	**$23.1M**			**$1.7M**			**$131.2M**			**$156.0M**		

Total cost of disease

The total cost for cattle across Australia at the current prevalence of disease is estimated at $161.0M per annum. The net gain from moving all herds experiencing tick infestation to the lowest level of disease is estimated at $62.0M.

4.2 Bovine viral diarrhoea virus (BVDV or pestivirus)

The disease

Various strains of Type 1 BVDV (a pestivirus) in Australia impact on reproduction and mortality in grazing beef cattle. The virus is mainly spread by direct contact with persistently-infected (PI) animals. The major problems are conception failure, early-pregnancy abortion, and mortality of PI calves of which approximately 50% die by weaning age, and approximately 50% of surviving calves die annually thereafter (McGowan *et al.* 1993a; McGowan *et al*. 1993b; Kirkland *et al*. 1990). The virus also has a predilection for the immune system, and this may increase the incidence of other diseases when animals are experiencing transient infection. McGowan *et al.* (2014) reported that the average percent cattle pregnant within 4 months of calving was 57%, 43% and 34% in north Australian herds with <20%, 20-80% and >80% of cows sero-positive to BVDV, respectively. Prevalence of >30% of recent BVDV infection in early-mid pregnant cows was associated with almost 10% higher foetal and calf loss than in herds with <10% prevalence of recent infection, also reported by Kirkland *et al.* (2012) and Morton *et al.* (2013). Modelling that uses an understanding of BVDV epidemiology in Australia and the known incidence of PI animals suggests that, depending on the relative prevalence of BVDV strains with varying abortigenic effect, weaning rate is conservatively estimated to be lower by between 1% and 4.5% as a result of between 3% and 7% of cows being infected in early pregnancy each year. Some live export market protocols require freedom from BVDV and/or no evidence of this disease being recently transmitted within the source herd.

Unknown aetiology *Known aetiology*

									X

Prevention

A range of strategies is used to control infection and impacts. These include control and eradication through identifying immune animals and PIs using the large range of diagnostic tests available, biosecurity to prevent movement of PIs and or to identify movement of unborn PIs, and strategic use of a killed vaccine with efficacy of ~80% which is registered for use in Australia (Bergman and Reichel 2014). The vaccine, which can increase pregnancy rates by 15% in endemically-infected herds (Bergman and Reichel 2014), has a retail cost of $4-5/dose, requires two initial injections, and may be recommended for annual use in some herds. An average of ~0.5M and ~1M doses of vaccine were sold annually in northern and southern Australia in 2012-13 (Zoetis, pers comm).

Low efficacy/ unproven preventives available *Effective preventives available*

Treatment

No specific treatment exists for BVDV.

Low efficacy/ unproven treatments available *Effective treatments available*

Distribution

Recent data from >37,000 cattle that were mostly 1-2 years of age and destined for live export showed there is very little variation in >1% prevalence of cattle being BVDV antigen positive across Australia (Dr Peter Kirkland, Elizabeth McArthur Agricultural Institute, NSW, personal communication). Extensive testing of steers of a similar average age at feedlot entry in Australia has found that ~0.5% are PI cattle (MR McGowan, UQ, personal communication).

Distribution contracting *Distribution stable* *Distribution increasing*

Prevalence

McGowan *et al.* (2014) reported that 15-21%, 39-50% and 35-40% of north Australian cow herds had prevalence of cows sero-positive to BVDV of <20%, 20-80% and >80%, respectively; recent infection was found in 4-16% of cow herds. St George *et al.* (1967) had previously reported that 61% of Australian cattle were seropositive and 79% of herds infected, indicating little change in prevalence in 45 years. Both Kirkland *et al.* (2012) and Morton *et al.* (2013) also reported a low proportion of cattle herds having recent BVDV infection. Both groups reported that half the herds they studied had 0-30% sero-positive animals, indicating high susceptibility to the virus.

Prevalence decreasing *Prevalence increasing*

					X				

Economics

Assumptions: Bovine viral diarrhoea virus – southern

Table 4-3 Assumptions: Bovine viral diarrhoea virus – southern

Variable	Value adopted	Confidence
Regional Extent	10%, 25%, 45% and 20% of herds with a high, medium, low and nil incidence rate	**
% herds infected	An average of 20% of cows are transiently infected in high-incidence herds in a year with 7% of calves born as PIs, contributing to a national prevalence of 0.5% PIs as yearlings. Rates are set at 50% and 5% of this in moderately- and lowly-affected herds.	**
Mortalities	50% mortality of PIs as weaners and then annually	***
Weight loss	No temporary weight loss	***
Fertility	Half of the cows infected in the first trimester abort. As many infected cows are culled because they are non-pregnant, the reduction in pregnancy rate is set at 2% in high-incidence herds.	***
Market avoidance	No PIs exported for breeding	***
Movement restrictions	Nil	***
Treatment	No treatment available	***
Prevention	Vaccination of all cattle in 20% of low-incidence herds where 30% of heifers are vaccinated. As many infected cows are culled because they are non-pregnant, the reduction in pregnancy rate is set at 2% in high-incidence herds.	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of BVDV in cattle in southern Australia at $63.5M (Table 4-4).

Table 4-4 Economic cost of bovine viral diarrhoea virus – southern

	Treatment			**Prevention**			**Production**			**Total**		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0	$0	$0	$1.08	$19.14	$9.61	$2.99	**$19.23**	**$9.69**	**$4.13**
Per Herd	$0	$0	$0	$0	$0	$201	$3,578	$1,797	$560	**$3,596**	**$1,812**	**$772**
Total	**$0M**			**$5.0M**			**$58.5M**			**$63.5M**		

The net gain from moving all southern herds experiencing BVDV to the lowest level of disease is estimated at $29.7M.

Assumptions: Bovine viral diarrhoea virus – northern

Table 4-5 Assumptions: bovine viral diarrhoea virus – northern (cattle)

Variable	Value adopted	Confidence
Regional Extent	10%, 30%, 40% and 20% of herds with a high, medium, low and nil prevalence rate	**
% herds infected	An average of 20% of cows are infected in high-incidence herds in a year with 7% of calves born as PIs, resulting in national prevalence of 0.5% PIs as yearlings. Rates are set at 50% and 5% of this in moderately- and lowly-affected herds.	**
Mortalities	50% mortality of PIs as weaners and then annually	***
Weight loss	No temporary weight loss	***
Fertility	Half of the cows infected in the first trimester abort. As many infected cows are culled because they are non-pregnant, the reduction in pregnancy rate is set at 2% in high-incidence herds.	***
Market avoidance	No PIs exported for breeding	***
Movement restrictions	Nil	***
Treatment	No treatment available	***
Prevention	Vaccination of all cattle in 5% of low-incidence herds with 30% of heifers only in these herds. vaccinated in 15% of herds. All rates are reduced for the proportion of cows vaccinated with 80% vaccination efficacy.	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of BVDV in cattle in northern Australia at $50.9M (Table 4-6).

Table 4-6 Economic cost of bovine viral diarrhoea virus – northern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0	$0.00	$0.00	$0.44	$11.54	$5.87	$0.44	**$11.57**	**$5.89**	**$0.89**
Per Herd	$0	$0	$0	$0	$0	$343	$9,073	$4,614	$343	**$9,069**	**$4,631**	**$701**
Total	**$0M**			**$2.7M**			**$48.2M**			**$50.9M**		

The net gain from moving all northern herds experiencing BVDV to the lowest level of disease is estimated at $39.9M.

Total cost of disease

The total cost of BVDV in cattle across Australia at the current prevalence of disease is estimated at $114.4M per annum, which is higher than the estimate of $49.1M by Lanyon *et al.* (2011). The net gain from moving all herds experiencing BVDV to the lowest level of disease is estimated at $98.5M. Note that the estimated costs are averaged across all herds and as such do not recognise the episodic fashion in which BVDV impacts on individual herds; very few herds experience this 'average' loss in any given year.

This estimate of BVDV impact substantially exceeds the perceptions of many beef producers and veterinarians. Much of this perception is derived from the apparent low visibility of the PI mortality rate and impacts on pregnancy rates that have been reported in domestic and international studies. BVD is a complex and insidious disease. There are limited data that provide a national perspective, and because of this, some inputs may have been incorrectly assigned in modelling the impacts of BVDV impact. Further impacts research is indicated.

4.3 Buffalo fly

The disease

Haematobia irritans exigua is a blood sucking fly that can only survive by 10-40 daily feeds (Meat & Livestock Australia 2005). It reproduces in cattle dung and populations may therefore be impacted by the presence or absence of dung beetles. Populations are highest during warm wet conditions and can average 1,000 per animal (Holroyd *et al*. 1984). Growth advantages from efficacious fly control have been reported by several authors (Meat & Livestock Australia 2005) and may average about 10%. Some cattle are sensitive to flies or to the skin-residing parasite they transmit, *Stephanofilaria sp.*, resulting in intense irritation causing skin lesions that may affect hide values and suitability for live export. This sensitivity is lowly heritable. Flies are a welfare issue as cattle seek treatments they have learned to be associated with relief from infestation.

Unknown aetiology *Known aetiology*

							X		

Prevention

Any treatment is expected to have welfare benefits. A well-controlled study showed that live weight impacts can only be achieved through sustained, highly-efficacious chemical fly control (Holroyd *et al.* 1984). Occasional treatment is unlikely to have a long-term live weight impact despite obvious effects on welfare on the animals. Fly control also eliminates skin lesions (Holroyd *et al*. 1984).

Low efficacy/ unproven preventives available *Effective preventives available*

			X						

Treatment

O'Rourke *et al.* (1991) reported that 67% of north Australian producers applied buffalo fly prevention, and a further 5% whose cattle experienced infestation applied no treatment. A range of insecticide treatments are available with an estimated $4-6M spent annually on chemical control (Meat & Livestock Australia 2005). Other treatments such as fly traps are very expensive and few are in use.

Low efficacy/ unproven treatments available *Effective treatments available*

							X		

Distribution

The fly is mainly distributed in eastern Queensland, the northern areas of the NT and WA, and the NE corner of NSW (Meat & Livestock Australia 2005). However the fly has also been recorded in Victoria and in Alice Springs.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Prevalence is affected by seasonal conditions. Particularly under early wet season conditions, high fly populations can occur very quickly as the life cycle can be less than 2 weeks (Meat & Livestock Australia 2005). Populations are highest in near-coastal regions of northern Australia where humidity is highest. Populations become very low under dry or cool conditions. Where flies are persistent, populations sufficient to affect live weight production may persist for 2-6 months annually.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Buffalo fly – southern

Table 4-7 Assumptions: buffalo fly – southern (cattle)

Variable	Value adopted	Confidence
Regional Extent	0%, 5% and 10% of herds with high, medium and low incidence	**
% herds infected	Entire herds are infested, but an average of 33% and 10% of the year in medium and low incidence herds, respectively	**
Mortalities	No mortalities caused	***
Weight loss	Where prevention is applied during infestation, in 25% of these situations there is effective prevention of permanent weight loss, which is 10% over the infestation period	*
Fertility	Nil effect	*
Market avoidance	Skin lesions cause 5% and 2% of cattle in medium and low incidence herds, respectively, to have net market value reduced by $0.10/kg	*
Movement restrictions	Nil	***
Treatment	As for prevention	**
Prevention	70% of cattle in affected areas have some form of control applied. An average of $1/animal/month is required for full control. Partial control costs half this.	**

Based on the adopted prevalence and impacts of buffalo fly on the classes of animals affected, GHD has calculated the annual cost of buffalo fly in cattle in southern Australia at $4.1M (Table 4-8).

Table 4-8 Economic cost of buffalo fly – southern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0	$0.03	$2.04	$0.44	$0	$4.27	$0.41	**$0.03**	**$6.31**	**$0.85**
Per Herd	$0	$0	$0	$5	$384	$83	$0	$802	$77	**$5**	**$1,186**	**$160**
Total	**$0M**			**$1.5M**			**$2.6M**			**$4.1M**		

The net gain from moving all southern herds experiencing buffalo fly to the lowest level of disease is estimated at $2.8M.

Assumptions: Buffalo fly – northern

Table 4-9 Assumptions: buffalo fly – northern (cattle)

Variable	Value adopted	Confidence
Regional Extent	10%, 50% and 30% of herds with high, medium and low incidence	**
% herds infected	Entire herds are infested, but an average of 80%, 33% and 10% of the year in high, medium and low incidence herds, respectively	**
Mortalities	No mortalities caused	***
Weight loss	Where prevention is applied during infestation, in 25% of these situations there is effective prevention of permanent weight loss, which is 10% over the infestation period	*
Fertility	Nil effect	*
Market avoidance	Skin lesions cause 10%, 5% and 2% of cattle in high, medium and low incidence herds, respectively, to have net market value reduced by $0.20/kg	*
Movement restrictions	Nil	***
Treatment	As for prevention	**
Prevention	70% of cattle have some form of control applied. An average of $1/animal/month is required for full control. Partial control costs half this.	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of buffalo fly in cattle in northern Australia at $94.6M (Table 4-10).

Table 4-10 Economic cost of buffalo fly – northern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0	$7.59	$1.95	$0.42	$26.34	$2.91	$0.28	**$33.93**	**$4.86**	**$0.7**
Per Herd	$0	$0	$0	$6,026	$1,547	$335	$20,915	$2,311	$223	**$26,941**	**$3,858**	**$558**
Total	**$0M**			**$29.1M**			**$65.4M**			**$94.6M**		

The net gain from moving all northern herds experiencing buffalo fly to the lowest level of infestation is estimated at $84.9M.

Total cost of disease

The total cost of buffalo fly in cattle across Australia at current prevalence is estimated at $98.7M per annum. The net gain from moving all herds to the lowest level of infestation is estimated at $87.7M.

4.4 Dystocia

The disease

Dystocia is most commonly due to foetal-maternal incompatibility – foetus is relatively or absolutely too large to fit through the maternal pelvis – but may also occur due to malpresentation of the foetus. Less commonly dystocia can occur secondary to other disease such as milk fever and malformation of the calf. Foetal-maternal incompatibility is the most important cause of dystocia in Australia occurring predominately in primiparous heifers and arising due to mismating (heifer too small, poor bull selection), overlong gestations and/or (most commonly) inadequate nutrition in growing pregnant heifers.

A 2000 survey of dystocia in Angus heifers reported an incidence of around 5.0% in heifers enrolled in controlled (growth-rate selective) breeding programs and an incidence of approximately 10.0% in uncontrolled matings. The incidence of dystocia in mature cows is low – an estimated maximum of 2% is assumed. The survival of calves to weaning following a difficult calving has been estimated to be 12% less than calves born normally.

For northern Australia we have assumed a lower incidence of dystocia – averaging at 2.0% of heifers and 0.3% of cows. We have assumed fewer inspections of calving cows in the northern industry and subsequently all dystocic calves and around 25% of dams die following unaided dystocia.

The cause of the disease and predisposing risk factors are well known. Viral and other causes of arthrogryposis can result in malpresentation vary in incidence and distribution from year to year but are generally minor causes. Nutrition of the dam – especially yearlings and heifers – and during late gestation strongly influences maternal-foetal mismatch. Under-nutrition is the major predisposing factor for dystocia in northern animals.

Unknown aetiology *Known aetiology*

								X	

<u>Prevention</u>

Prevention of the majority of dystocia due to foetal-maternal mismatch is well known. Mating well-grown heifers to low birthweight bulls combined with adequate supervised nutrition throughout pregnancy and at calving is essential. Foetal-maternal mismatch provides significant animal welfare challenges. The cost of preventing dystocia through selective genetics and better nutrition has not been assigned as the benefits from these practices extend beyond just dystocia prevention. Dystocia due to foetal-maternal mismatch can be controlled by good management. Access and ability to effectively monitor calving stock is markedly different between the southern more intensive and the northern more extensive industries. This is reflected in different labour costs and survival rates for dystocic cows and their calves between the two industries.

Low efficacy/ unproven preventives available *Effective preventives available*

								X	

<u>Treatment</u>

Regular inspection of calving cattle combined with judicious assistance is an essential component of good animal husbandry. Veterinary assistance is occasionally required. A daily inspection cost at calving has been assigned to prevention. Assistance should be administered early enough to ensure a live calf can be delivered. This needs to be balanced against not intervening too early, especially in heifers.

Low efficacy/ unproven treatments available *Effective treatments available*

							X		

<u>Distribution</u>

All beef cattle are at risk of dystocia. Intensification of production systems is leading to more disease.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

The average prevalence of dystocia is assumed at 5% for heifers and <1% for cows. Of these assistance is required in one in ten cases. Mortality of calves born to difficult calving is assumed to be 12% greater than background mortalities. Mortality in the dam is assumed at 0.5% of cases.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Dystocia – southern

Table 4-11 Assumptions: dystocia – southern (cattle)

Variable	Value adopted	Confidence
Regional Extent	All beef herds are at risk of dystocia – malpresentation can occur in any animal	***
% herds infected	5% of southern herds experience large-scale dystocia problems: up to 25% of heifers and 2% of mature cows experiencing dystocia 10% of southern herds experience moderate problems: up to 10% of heifers and 1% of mature cows experiencing dystocia 85% of southern herds experience minor problems: up to 5% of heifers and 0.5% of mature cows experiencing dystocia	**
Mortalities	A 1% cow mortality rate is assumed. The mortality rate of calves born to dystocic births is 12% higher than for non-dystocic births.	**
Weight loss	A 10kg and 5kg average temporary weight loss is assumed in dystocic heifers and cows respectively. There is an additional 5 kg weight loss assumed for dystocic heifers.	*
Fertility	No further impacts beyond direct mortalities listed above	*
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Treatment is by manual assistance to calve by the farmer (pull – costed at $50) with a 10% of cases being serviced by veterinarians (costed at $350). This provides an average cost of $80 per assisted dystocia with 90% of southern cattle experiencing dystocia being detected and assisted.	**
Prevention	Daily inspections costs have been assigned to prevention. Twice daily inspection at calving is assumed for herds with severe problems and once daily for others.	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of dystocia in cattle in southern Australia at $59.6M (Table4-12)

Table 4-12 Economic cost of dystocia – southern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$3.24	$1.35	$0.67	$8.76	$4.38	$3.41	$4.21	$1.73	$0.86	**$16.22**	**$7.46**	**$4.95**
Per Herd	$613	$255	$127	$1,656	$828	$644	$796	$327	$163	**$3,065**	**$1,410**	**$935**
Total	**$9.0M**			**$39.0M**			**$11.6M**			**$59.6M**		

The net gain from moving all southern herds to the lowest dystocia prevalence band is estimated at $8.4M per annum.

Assumptions: Dystocia – northern

Table 4-13 Assumptions: dystocia – northern (cattle)

Variable	Value adopted	Confidence
Regional Extent	All beef herds are at risk of dystocia – malpresentation can occur in any animal	***
% herds infected	5% of northern herds experience large-scale dystocia problems: up to 20% of heifers and 2% of mature cows experiencing dystocia 15% of northern herds experience moderate problems: up to 10% of heifers and 1% of mature cows experiencing dystocia 85% of northern herds experience minor problems: up to 5% of heifers and 0.5% of mature cows experiencing dystocia	*
Mortalities	A 25% heifer and 10% cow mortality rates are assumed. The mortality rate of calves born to dystocic births is assumed twice that of southern herds due to the lower assistance rate in the north (24% higher than for non-dystocic births).	*
Weight loss	An average of 5kg temporary and 5kg permanent weight loss is assumed in dystocic heifers that survive. No weight loss is assumed for dystocic cows that survive.	*
Fertility	No further impacts beyond direct calf mortalities listed above	*
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Treatment is by manual assistance by the farmer or veterinarian. An average cost of $50 per dystocia is assumed (non-veterinary 'pulls' only) but only 5% (severe), 2% (moderate) and 1% (low) of dystocia cases are detected and/or assisted in each of the three herd prevalence levels in the north.	*
Prevention	Daily inspections costs have been assigned to prevention. Twice daily inspection at calving is assumed for herds with severe problems and once daily for others. However, only 10% (severe), 3% (moderate) and 1% (low) affected herds use once daily inspections.	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of dystocia in cattle in northern Australia at $38.2M (Table 4-14).

Table 4-14 Economic cost of dystocia – northern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0.11	$0.02	$0.00	$0.51	$0.15	$0.03	$9.42	$3.88	$1.94	**$10.04**	**$4.05**	**$1.97**
Per Herd	$79	$13	$2	$382	$115	$19	$7,066	$2910	$1,455	**$7,528**	**$3,037**	**$1,476**
Total	**$0.1M**			**$0.9M**			**$37.1M**			**$38.2M**		

The net gain from moving all northern herds to the lowest dystocia prevalence band is estimated at $9.1M; although this may not be practically achieved due to difficulties of inspection and handling of the majority of dystocic animals in the northern environment.

Total cost of disease

The total cost of dystocia in cattle across Australia at the current prevalence of disease is estimated at $97.8M per annum. The net gain from moving all herds (northern and southern) to the lowest dystocia prevalence band is estimated at $17.8M.

4.5 Neonatal calf mortality of unknown cause

<u>The disease</u>

Recent Beef CRC data confirmed that in northern Australia, about 2/3rd of reproductive loss occurs as calf loss within the neonatal period up to a week after birth (Bunter *et al.* 2014), but 1/3rd in southern Australia (Copping *et al.*: In press). The aetiology of several percentage units is known and some are discussed elsewhere in this report. It includes: reproductive diseases such as vibriosis and BVDV (Fordyce *et al.* 2014) across Australia, and Neosporosis in southern Australia (Atkinson *et al.* 2000); animal factors such as udder conformation (Bunter *et al.* 2014) and dystocia, especially in heifers; losses associated with cow mortality which is primarily associated with available nutrition and the physiological state of the cow as reflected in body condition and stage of the reproductive cycle (Fordyce *et al.* 2014). The aetiology of neonatal loss in excess of ~5-10% has remained largely unknown in northern Australia, though recent research has shown the major risk factors to be behavioural, nutritional, managerial and environmental (Fordyce *et al.* 2014). Insufficient milk production and delivery and inadequate calf suckling are hypothesised to be how these risk factors mediate their effect.

Unknown aetiology *Known aetiology*

	X								

Prevention

Prevention of high neonatal calf mortality rates with unknown cause may be achieved through managing nutritional and environmental factors, but this has not been demonstrated.

Low efficacy/ unproven preventives available *Effective preventives available*

	X								

Treatment

A small percentage of these calves are rescued and are hand-reared.

Low efficacy/ unproven treatments available *Effective treatments available*

				X					

Distribution

Calf loss of unknown cause is probably widespread, matching the prevalence of the risk factors, but has rarely been measured as it was in the Beef CRC and Cash Cow projects.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

In addition to losses due to cow mortality, median reproductive wastage between confirmed early pregnancy and weaning (two thirds of which occurs in the neonatal period) in northern Australia varies from 5-16% depending on region and cow age (Fordyce *et al.* 2014). These authors demonstrated that loss is regularly as high as 15% in regions of high soil fertility but as high as 30% in areas with low soil fertility. Data from southern Australia (Copping *et al.*: In press) suggests that calf loss levels and variation may not be dissimilar to that in Queensland's southern forest.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Neonatal calf mortality of unknown cause - southern

Table 4-15 Assumptions: neonatal calf mortality of unknown cause – southern (cattle)

Variable	Value adopted	Confidence
Regional Extent	100% of herds with a low prevalence rate	**
% herds infected	An average of 2% of pregnancies are affected annually	*
Mortalities	Calf mortality is associated with each incident	***
Weight loss	No temporary weight loss	***
Fertility	Affected cows have usual re-conception rates	***
Market avoidance	No market impact	***
Movement restrictions	Nil	***
Treatment	Treatment rarely used	***
Prevention	No controls have been developed	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of neonatal calf mortality of unknown cause in cattle in southern Australia at $21.1M (Table 4-16).

Table 4-16 Economic cost of neonatal calf mortality of unknown cause – southern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0	$0	$0	$0	$0	$0	$4.11	**$0**	**$0**	**$4.11**
Per Herd	$0	$0	$0	$0	$0	$0	$0	$0	$772	**$0**	**$0**	**$772**
Total	**$0M**			**$0M**			**$42.2M**			**$42.2M**		

There is no predicted net gain from moving all southern herds experiencing neonatal calf mortality of unknown cause to the lowest level of disease.

Assumptions: Neonatal calf mortality of unknown cause – northern

Table 4-17 Assumptions: neonatal calf mortality of unknown cause – northern (cattle)

Variable	Value adopted	Confidence
Regional Extent	30%, 20% and 50% of herds with a high, medium and low prevalence rate	***
% herds infected	An average of 4.2%, 3.3%, and 2.4% of pregnancies are affected annually in high, medium and low incidence herds, respectively	***
Mortalities	Calf mortality is associated with each incident	***
Weight loss	No temporary weight loss	***
Fertility	90% of affected cows reconceive, which is often higher than usual rates	***
Market avoidance	No market impact	***
Movement restrictions	Nil	***
Treatment	Treatment rarely used	***
Prevention	No controls have been developed	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of neonatal calf mortality of unknown cause in cattle in northern Australia at $53.9M (Table 4-18).

Table 4-18 Economic cost of neonatal calf mortality of unknown cause – northern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0	$0	$0	$0	$4.74	$3.72	$2.71	**$4.74**	**$3.72**	**$2.71**
Per Herd	$0	$0	$0	$0	$0	$0	$3,677	$2,889	$2,101	**$3,677**	**$2,889**	**$2,101**
Total	**$0M**			**$0M**			**$53.9M**			**$53.9M**		

The net gain from moving all northern herds experiencing neonatal calf mortality of unknown cause to the lowest level of disease is estimated at $12.4M.

Total cost of disease

The total cost of calf mortality of unknown cause in cattle across Australia at the current prevalence is estimated at $96.2M per annum. The net gain from moving all northern herds to the lowest level of disease is estimated at $12.4M. Note that the economic loss is in addition to the costs of other reproductive losses considered elsewhere in this report, including dystocia, BVDV, vibriosis and calf scours.

4.6 Internal parasites

<u>The disease</u>

Internal parasites in cattle are primarily a problem up to the age of 2 years, from which time acquired immunity generally suppresses clinical disease. There has been little published work on production responses following the internal parasite controlled study of Smeal (1981) that was discussed in the Sackett report. They reported an average (but variable) 20-30 kg greater liveweight in 16-20 month animals after a suppressive parasite treatment program (since weaning) when compared to untreated controls. This value is likely to be representative of the maximum gain from effective internal parasite control in high rainfall southern regions compared to no control.

We estimate that 60% of southern beef cattle are in higher rainfall areas (and therefore under similar parasite challenge to the Smeal study) with 10% in the pastoral zone (and therefore under very low parasite challenge). The equivalent figures for northern Australia are 3% (wet tropics) and 12% in moderate rainfall (parasite non conducive) regions. The remaining cattle in each region are in low rainfall areas and are typically subject to moderate challenge by internal parasites in most years.

Since the work of Smeal and colleagues in the 1980s there has been increased use and reliance on mectin-based drenches. This has provided greater efficacy in general but may have also hastened the emergence of resistance to this chemical group. Rendell (2010) recently reported resistance in at least one strongyle species to benzimadazoles, levamisole and ivermectin on 54%, 100% and 62% of investigated properties in south west Victoria. *Ostertagia* species demonstrated the greatest resistance across the chemical groups. The emergence of chemical resistance may reduce the efficacy of drenching programs.

Approximately $50-60 million of drench product for cattle is sold each year. Whilst most product is used effectively, a proportion appears to be used inappropriately – either in the wrong class of stock or when a drench is not required. There is also an increasing level of drench resistance reducing drench efficacy and promoting increased drenching frequency.

While aetiology of the disease is quite well known, the methods (and importance) of managing refugia in internal parasite control programs and the emergence and spread of drench resistance are developing.

Unknown aetiology *Known aetiology*

							X		

Prevention

Eliminating worms and preventing re-introduction is not feasible in most high rainfall regions. The parasite challenge is reasonably predictable within regions although preventing the introduction of drench resistance is an emerging challenge for cattle producers. This can be achieved by careful selection of introductions, quarantine and treatment (with effective products) on entry. Strategic worm control programs have been developed and continue to be refined for regions and production systems. While benefits of anthelmintics are clear from weaning age and 6-8 months beyond, less evidence is available on the need and effectiveness for control in older animals. Monitoring worm burdens using faecal egg counts is a practical way to assist disease management, however faecal egg count testing in cattle is not considered to be a reliable tool. Resistance/drench failure (partial or complete) is becoming a more important problem.

Low efficacy/ unproven preventives available — *Effective preventives available*

						X			

Treatment

There is a range of anthelmintic products however no new chemical group has been identified for cattle in the past few decades. Resistance is an emerging problem – primarily of intensification – and combination drenches and/or effective drench rotation systems are required on many properties. There is greater need for monitoring systems to support calendar-based drenching programs.

Low efficacy/ unproven treatments available — *Effective treatments available*

						X			

Distribution

Most internal parasite problems occur in higher rainfall areas and under more intensive stocking rates. The year-on-year distribution of worms tends to be constant although *Haemonchus* can extend or shrink in distribution each year depending on seasonal temperature and rainfall. While the distribution of parasites is constant, resistant strains may be emerging and expanding. There is a lack of information of the boundaries where diseases is problematic (e.g. between wet and dry tropics in the north, and between eastern and western areas in south-eastern Australia).

Distribution contracting — *Distribution stable* — *Distribution increasing*

					X				

Prevalence

The within-herd challenge by internal parasites is a function of region, climate and rainfall, production enterprise, stocking rate and efficacy (including resistance) of drenching program system(s) used. This challenge is stable and predictable on the majority of properties.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Internal parasites – southern

Table 4-19 Assumptions: internal parasites – southern (cattle)

Variable	Value adopted	Confidence
Regional Extent	60% of southern cattle are on properties in higher rainfall regions (> 600 mm per annum) with 10% in the pastoral zone (no requirement for worm control in most years)	***
% herds infected	10% of properties experience high levels of disease and production impacts 60% of properties experience moderate levels of disease and production impacts 30% of properties experience low levels of disease and production impacts	**
Mortalities	1% in clinical young stock	**
Weight loss	Highly affected: up to 20 kg weight loss in young stock – 10 kg permanent; and 10 kg weight loss in yearlings – 5 kg permanent Moderately affected: up to 10 kg weight loss in young stock – 5 kg permanent; no weight loss in yearlings or older Lowly affected: up to 4 kg weight loss in young stock – 2 kg permanent; no weight loss in yearlings or older	*
Fertility	No impact	**
Market avoidance	Nil	***
Movement restrictions	Nil	***

Variable	Value adopted	Confidence
Treatment	Individual animal treatment not generally practised with control via seasonal prevention programs (see below)	**
Prevention	Effective control programs require 2 to 3 drenches from weaning to adulthood. Adults do not require drenching. 95% of highly affected properties average 4 drenches per year in young stock 75% of moderately affected properties average 4 drenches per year in young stock 30% of lowly affected properties average 1-2 drenches per year in young stock	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of internal parasites in cattle in southern Australia at $82.0M (Table 4-20).

Table 4-20 **Economic cost of internal parasites – southern (cattle)**

	Treatment[1]			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0	$6.84	$5.40	$0.66	$5.10	$3.88	$3.37	**$11.94**	**$9.28**	**$4.03**
Per Herd	$0	$0	$0	$1,286	$1,016	$124	$959	$729	$634	**$2,245**	**$1,744**	**$758**
Total	**$0M**			**$42.4M**			**$39.6M**			**$82.0M**		

The net gain from moving all southern herds to the lowest level of disease is estimated at $40.5M.

[1] All costs have been assigned to prevention

Assumptions: Internal parasites - northern

Table 4-21 Assumptions: internal parasites – northern (cattle)

Variable	Value adopted	Confidence
Regional Extent	15% of northern cattle are on properties in higher rainfall regions (> 600 mm per annum) with 85% in the low-rainfall zone (no requirement for worm control in most years)	***
% herds infected	3% of properties experience high levels of disease and production impacts 12% of properties experience moderate levels of disease and production impacts 85% of properties experience low levels of disease and no significant production impacts	**
Mortalities	0.5% in clinically-affected young stock	**
Weight loss	Highly affected: up to 20 kg weight loss in young stock – 10 kg permanent; and 10 kg weight loss in yearlings – 5 kg permanent Moderately affected: up to 10 kg weight loss in young stock – 5 kg permanent; no weight loss in yearlings or older Lowly affected: no effect	*
Fertility	No impact	**
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Individual animal treatment not generally practised with control via seasonal prevention programs (see below)	**
Prevention	Effective control programs require 4 to 6 drenches from weaning to adulthood. Adults do not require drenching. 80% of highly affected properties average 4 drenches per year in young stock 65% of moderately affected properties average 4 drenches per year in young stock 50% of lowly affected properties average 1-2 drenches per year in young stock – despite no scientific evidence that they are required	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of internal parasites in cattle in northern Australia at $11.6M (Table 4-22).

Table 4-22 Economic cost of internal parasites – northern (cattle)

	Treatment[2]			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0	$1.39	$1.01	$0.39	$2.20	$1.09	$0.05	**$3.59**	**$2.11**	**$0.44**
Per Herd	$0	$0	$0	$1,104	$806	$310	$1,755	$870	$42	**$2,859**	**$1,676**	**$352**
Total	**$0M**			**$7.8M**			**$3.8M**			**$11.6M**		

The net gain from moving all northern herds to the lowest level of disease is estimated at $6.3M.

Total cost of disease

The total cost of internal parasites in cattle across Australia at the current prevalence of disease is estimated at $93.6M per annum. The net gain from moving all Australian herds to the lowest level of disease is estimated at $46.8M with most of this potential gain in southern Australia.

It should be noted that over-treatment of stock (resulting in financial losses from excess drench costs) appears likely. The total cost of disease to the industry is only slightly more than the total spent on drench by producers. The amount spent on drench is also in excess of the achievable gains from better parasite control; much expenditure on anthelmintics appears unnecessary.

4.7 Bloat (southern)

<u>The Disease</u>

Bloat is the excessive accumulation of gases of fermentation in the rumen. This, if unable to be eructated, can lead to abdominal distension and development of clinical signs of pain, respiratory and circulatory distress, collapse and in severe cases death. The most common cause of bloat in pastured cattle is due to formation of a stable froth in the rumen following rapid digestion of lush legumes with high digestible protein and low fibre (frothy bloat). Bloat is a disease of intensification – improved clover-based pastures and leguminous crops such as lucerne are risk factors.

High rainfall regions are most prone to bloat. Approximately half of southern cattle are held in regions that can produce pasture bloat under the right circumstances. A survey of a high risk region found an annual prevalence of 3%.

Unknown aetiology *Known aetiology*

[2] All costs have been assigned to prevention

Prevention

Controlling access to at-risk pastures (strip grazing, hay supplementation etc.), use of bloat capsules (when available in the market) and vigilance all contribute to control. However outbreaks can occur suddenly and losses can be heavy. Furthermore, bloat capsules have not been available in the Australian market for the past two years.

Low efficacy/ unproven preventives available *Effective preventives available*

						X			

Treatment

Treatment requires release of rumen gases – by natural means, stomach tube or rumen incision. Mild cases may be treated by gently walking to safe pastures. However, treatment is generally not possible as most severe cases are found dead. Treatment is also costly and time consuming.

Low efficacy/ unproven treatments available *Effective treatments available*

	X								

Distribution

High rainfall areas with leguminous and productive pastures are high risk. Approximately 50% of southern cattle are in high rainfall regions.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Prevalence is generally constant – but is influenced by season (and availability of bloat capsules).

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Bloat – southern

Table 4-23 Assumptions: bloat – southern

Variable	Value adopted	Confidence
Regional Extent	50% of southern beef herds are within the high rainfall area affected by bloat	**
% herds infected	5% of southern herds experience large-scale outbreaks: up to 15% of ruminants affected (not unweaned calves). 10% of southern herds experience moderate outbreaks: up to 5% of ruminants affected (not unweaned calves). 35% of southern herds experience minor outbreaks: up to 3% of ruminants affected (not unweaned calves). 50% of southern herds experience no disease	**
Mortalities	A 25% mortality rate has been assumed for clinical bloat	**
Weight loss	No weight loss, fertility or other production effects are assumed; all production losses are due to deaths.	*
Fertility	Nil	***
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Treatment is by movement of moderately affected animals to safe pasture, stomach tubing/stabbing of severe cases; veterinary assistance is required for some stabbed cases. Only 50%, 25% and 10% of cases on severe, moderate and lowly affected herds are found and treated before death or self-resolution. An average cost of $50 per treated case has been assumed.	***
Prevention	Prevention is by hay feeding and grazing management. Bloat capsules (when available) are used in a proportion of herds. An annual prevention cost of $25/ dose is assumed with 75%, 50% and 25% of highly, moderately and lowly affected herds applying active prevention. We have not costed losses from forced avoidance of high-risk pastures/crops. These are too difficult to estimate with accuracy and lead to questions of suitability of the farming system.	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of bloat in cattle in Australia at $76.8M (Table 4-24).

Table 4-24 Economic cost of bloat – southern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$3.75	$0.63	$0.15	$18.75	$6.25	$2.50	$30.96	$10.35	$6.24	$53.46	$17.24	$8.89
Per Herd	$701	$118	$29	$3,506	$1,169	$468	$5,789	$1,936	$1,166	$9,996	$3,223	$1,662
Total	**$3.1M**			**$24.9M**			**$48.8M**			**$76.8M**		

The net gain from moving all southern herds experiencing bloat to the lowest level of disease is estimated at $31.3M.

4.8 Bovine ephemeral fever (three-day sickness)

The disease

Bovine ephemeral fever (BEF), or three-day sickness as it is more commonly known, is caused by a virus that is spread between cattle by biting insects. The primary clinical signs are ephemeral high fever and lameness. Because of its high prevalence, clinical infection mostly occurs in cattle up to 2 years of age, except following successive dry years when insect vector populations are insufficient to achieve high sero-conversion rates in young cattle (Uren 1989). An average of approximately one third of cattle in a group will be affected in a typical outbreak and mortality rate in affected cattle may be ~0.5% (McGown *et al.* 2010). Permanent weight loss in affected animals is thought to average 10 kg (Walker and Cybinski 1989). Fordyce *et al*. (2009) reported pregnancy rates per cycle to halve in an outbreak in 2-year-old heifers during their maiden mating. The high fever associated with BEF can cause temporary sub-fertility in bulls and abortion. No published data is available on the effect on calf output, which is debatable, as: temporary bull sub-fertility is usually only likely to affect single-sire matings (not usual practice); and, though abortion due to high fever is a possible outcome, the evidence for significant loss due to fever associated with BEF is lacking.

Unknown aetiology *Known aetiology*

							X		

Prevention

A vaccine given as two initial injections with annual boosters is available and can achieve a six-fold reduction in the incidence of clinical effects. A large north Australian trial with male and female cattle failed to show any significant benefits from vaccinating (McGown *et al.* 2010). The disease was noted to occur during the study, but the period (2003-2009) was noted as of generally low-incidence. In a subsequent larger study with female cattle aged 2 years and older conducted during generally wetter years, BEF prevalence had no effect on fertility (McGowan *et al.* 2014). In this study, a quarter of northern beef producers vaccinated bulls, and virtually none vaccinated female cattle.

Low efficacy/ unproven preventives available — *Effective preventives available*

			X						

Treatment

Injectable analgesics and anti-pyretic drugs prescribed and or administered by veterinarians are used in treating acutely-affected cattle. Such animals are usually heavy, well-conditioned and older than 2 years. O'Rourke *et al.* (1991) reported that 14% of north Australian producers treated or vaccinated animals with BEF, with a further 12% were aware that BEF caused disease that they did not treat.

Low efficacy/ unproven treatments available — *Effective treatments available*

							X		

Distribution

The disease mainly occurs in northern Australia, but has progressed down eastern Australia as far as Victoria in some years.

Distribution contracting — *Distribution stable* — *Distribution increasing*

				X					

Prevalence

Across northern Australia McGowan *et al.* (2014) found that ~8% of all heifer (aged 2-3 years) and cow groups and >10% of cattle tested had experienced recent infection. At least 70% of herds had high sero-prevalence, and ~90% of cattle were sero-positive. No herd had <20% sero-positive animals.

Prevalence decreasing — *Prevalence increasing*

				X					

Economics

Assumptions: Bovine ephemeral fever (three-day sickness) – southern

Table 4-25 Assumptions: bovine ephemeral fever (three-day sickness) – southern

Variable	Value adopted	Confidence
Regional Extent	Infection usually only occurs under moist hot conditions every few years	***
% herds infected	5% of the cattle in this region are exposed every 5 years	**
Mortalities	0.5% mortality in affected cattle	*
Weight loss	Temporary weight loss of 10 kg in affected cattle	**
Fertility	50% chance of outbreak occurring during mating with pregnancy rates down by 20%	*
Market avoidance	10% of affected steers have market value reduced by $0.20/kg	*
Movement restrictions	Nil	***
Treatment	10% of affected animals may be treated	*
Prevention	No significant vaccination occurs	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of BEF in cattle in southern Australia at $0.1M (Table 4-26).

Table 4-26 Economic cost of bovine ephemeral fever (three-day sickness) – southern

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0.02	$0	$0	$0	$0	$0	$0.21	**$0**	**$0**	**$0.23**
Per Herd	$0	$0	$4	$0	$0	$0	$0	$0	$39	**$0**	**$0**	**$43**
Total	**$0M**			**$0M**			**$0.1M**			**$0.1M**		

No net gain is expected from moving all southern herds experiencing BEF to the lowest level of disease.

Assumptions: Bovine ephemeral fever (three-day sickness) – northern

Table 4-27 Assumptions: bovine ephemeral fever (three-day sickness) – northern (cattle)

Variable	Value adopted	Confidence
Regional Extent	Occurs across north Australia	***
% herds infected	40% of the cattle in this region are exposed every year; 50% of cattle are affected every 3 years, and 10% of cattle every 5 years	*
Mortalities	0.5% mortality in affected cattle	*
Weight loss	Temporary weight loss of 10 kg in affected cattle	**
Fertility	50% chance of outbreak occurring during mating in moderate- and low-incidence regions with pregnancy rates down by 20%	*
Market avoidance	Nil	*
Movement restrictions	Nil	*
Treatment	5% of affected animals may be treated	*
Prevention	25% of bulls vaccinated, with little vaccination of other cattle classes	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of BEF in cattle in northern Australia at $59.7M (Table 4-28).

Table 4-28 Economic cost of bovine ephemeral fever (three-day sickness) – northern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0.32	$0.23	$0	$0	$0	$2.59	$4.46	$3.45	**$2.60**	**$4.79**	**$3.68**
Per Herd	$0	$256	$184	$8	$8	$8	$2,060	$3,542	$2,738	**$2,063**	**$3,800**	**$2,925**
Total	**$2.9M**			**$0.1M**			**$56.6M**			**$59.7M**		

The net gain from moving all northern herds experiencing BEF to the lowest level of disease is estimated at $1.8M.

Total cost of disease

The total cost of BEF in cattle across Australia at the current prevalence of disease is estimated at $59.8M per annum. The net gain from moving only northern herds experiencing BEF to the lowest level of disease is estimated at $1.8M. The costs reflect what occurs on average but do not take into account that this is a “spiking” disease with catastrophic consequences to individual at-risk herds when challenged by the required combination of predisposing causes.

4.9 Botulism

<u>The disease</u>

Botulism is caused by a clostridial bacterium that produces an extremely powerful toxin under low-oxygen conditions. Both C and D types are widely distributed. Cattle of all ages and gender are most susceptible when they eat carcasses or residues when attempting to overcome nutrient deficiencies, especially of protein and phosphorus, or when rotting carcasses are accidentally included in food or water. Deficient appetites are common in north Australia where vast areas have low soil and pasture phosphorus (McCosker and Winks 1994). Most clinically-affected cattle die from flaccid paralysis, though sub-clinical toxin challenge appears regular.

There is no evidence that non-lethal botulism has significant impacts of annual live weight gain. Henderson *et al.* (2013) reported that herds not vaccinated against botulism had about 5% higher (not significant) female cattle annual mortality rates in a study of 36 northern herds, of which only two did not vaccinate.

Severe outbreaks in which 40% of cattle in a herd die have been reported (Trueman *et al.* 1992). Reproductive losses occur in association with cow mortality. In addition, suckling calves are susceptible between when immunity is provided in colostrum of vaccinated cows and when the calves are vaccinated, usually at branding or weaning. Losses of such calves usually only occurs in extremely poor seasons and rates are very low. There is no evidence that incidence of botulism has any impact on market access or values. The cattle disease is not a zoonosis and poses no food safety issues.

Unknown aetiology *Known aetiology*

<u>Prevention</u>

O’Rourke *et al.* (1992) reported that 19% of north Australian beef producers in 1990 vaccinated cattle against botulism, with 42-74% vaccinating in most northern forest regions of Queensland; 1% of producers were aware of botulism presence but did not vaccinate. Bortolussi *et al.* (2005) reported that 60-84% of cattle were being vaccinated against botulism in tropical Australia in 1996-

97, with 5-33% of properties vaccinating in central Queensland. A more recent estimate for vaccine use suggests an average of 44% across northern Australia (Levantis and Hooper 2009). Suggested levels (moderate confidence) are 80% in the northern forest, 50% on northern downs, 10% in sub-tropical regions, and 1% in southern Australia. Most vaccination outside tropical regions is in response to diagnosed outbreaks, or when susceptibility increases in line with poor seasonal conditions. A range of highly efficacious vaccines is available, with average cost/animal/year of protection at about $1.50, including some labour.

Low efficacy/ unproven preventives available *Effective preventives available*

									X

Treatment

No specific treatment exists for botulism. Rare sub-lethal clinical cases can be nursed back to full health over approximately one month.

Low efficacy/ unproven treatments available *Effective treatments available*

X									

Distribution

In the absence of verifying data, professional opinion (high confidence) is that botulism spores are prevalent throughout Australia, and especially in north Australia (Sackett *et al.* 2006). The movement of cattle across the country in the past 50 years may have ensured both C and D types are equally prevalent.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

From reports commencing in the mid-1960s when botulism was recognised and vaccination was unavailable or not used, it is suggested (moderate confidence) that within the northern forest of north Australia, lethal dose challenge may occur on average in 0.3% of cattle yearly, and in 3% every 5yrs, with full protection usually afforded by vaccination; in the absence of published data, assumed rates in northern downs are 0.15% and 1.5%, in sub-tropical north Australia are 0.03% and 0.3% and in southern Australia are 0.01% and 0.1%, respectively.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Botulism – southern

Table 4-29 Assumptions: botulism – southern (cattle)

Variable	Value adopted	Confidence
Regional Extent	All cattle have the potential to be exposed to botulism	***
% herds infected	All cattle in a low-challenge environment in which an average of 0.03% of cattle are challenged annually	*
Mortalities	100% of unvaccinated challenged cattle	**
Weight loss	No temporary weight loss	**
Fertility	No impact	***
Market avoidance	No impact	***
Movement restrictions	Nil	***
Treatment	No treatment available	***
Prevention	Almost no routine vaccination used	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of botulism in cattle in southern Australia at $6.0M (Table 4-30).

Table 4-30 Economic cost of botulism – southern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0	$0	$0	$0	$0	$0	$0.29	**$0**	**$0**	**$0.29**
Per Herd	$0	$0	$0	$0	$0	$0	$0	$0	$110	**$0**	**$0**	**$110**
Total	**$0M**			**$0M**			**$6.0M**			**$6.0M**		

There is no expected net gain from changing current practice for southern herds.

Assumptions: Botulism – northern

Table 4-31 Assumptions: botulism – northern (cattle)

Variable	Value adopted	Confidence
Regional Extent	All cattle have the potential to be exposed to botulism	***
% herds infected	52% of cattle in a moderate-high challenge probability region where 0.2% of stock challenged annually 48% of cattle in a low-challenge probability region where 0.1% of stock challenged annually	*
Mortalities	100% of unvaccinated challenged cattle	**
Weight loss	No temporary weight loss	**
Fertility	No impact	***
Market avoidance	No impact	***
Movement restrictions	Nil	***
Treatment	No treatment available	***
Prevention	Within the high-, medium- and low-challenge regions, 80%, 50% and 10% of cattle are vaccinated annually	*

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of botulism in cattle in northern Australia at $22.0M (Table 4-32).

Table 4-32 Economic cost of botulism – northern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0	$1.61	$1.01	$0.18	$0.32	$0.79	$0.71	**$1.93**	**$1.80**	**$0.89**
Per Herd	$0	$0	$0	$1,282	$801	$140	$253	$629	$566	**$1,534**	**$1,430**	**$706**
Total	**$0M**			**$12.5M**			**$9.5M**			**$22.0M**		

The net gain from moving all northern herds experiencing botulism to the lowest level of disease is estimated at $8.0M.

Total cost of disease

The total cost of botulism in cattle across Australia at the current prevalence of disease is estimated at $28.0M per annum. The net gain from moving only northern herds experiencing botulism to the lowest level of disease is estimated at $8.0M. The impact of botulism would be much higher if widespread use of efficacious vaccine was not already being practised.

4.10 Grass tetany (hypomagnesaemia)

The disease

Grass tetany is seen in beef herds grazing improved pastures on solodic and solodised soils in the higher rainfall regions of south-eastern Australia (disease is essentially absent outside of this region). These soils are dense clays with high salt contents and strongly adsorbed sodium and magnesium ions. Magnesium is essential for proper functioning of muscle and nerve tissue and is involved in complex relationships with other ions – especially calcium and potassium - in moderating cell function. Absorption of magnesium by grazing cattle may be insufficient if there is insufficient magnesium, calcium and/or phosphorous or if there are high levels of inhibitory substances such as potassium and nitrogen in the soil or pasture. These conditions are most common on improved grass-dominant pasture or cereal crops that have received potash fertilisers. Magnesium demand is greatest in lactating cows and therefore grass tetany is most commonly seen in late winter and autumn in freshly lactating (winter-spring calving) cows.

Unknown aetiology *Known aetiology*

								X	

Prevention

Grass tetany may be effectively managed by moving to spring calving. The supplementation of cattle with magnesium (Causmag®, magnesium block, magnesium rumen boluses), controlling potassium intake (fertiliser programs), managing fibre intake (hay feeding) and minimising stress in grazing stock are ways that grass tetany risk and occurrence can be managed.

Low efficacy/ unproven preventives available *Effective preventives available*

							X		

Treatment

Most clinical cases are found dead before treatment. Intravenous calcium and magnesium supplementation can save clinical cases. Prevention is more important than treatment.

Low efficacy/ unproven treatments available *Effective treatments available*

					X				

Distribution

Approximately 60% of southern beef cattle are in high rainfall regions predominated by solodic and solodised soils. Up to 40% of herds can experience disease with up to 5% clinical incidence in mature cows in severe outbreaks.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

The within-herd incidence of disease is typically very low. Outbreaks can occur when a risk factor – such as high potash pasture, bad weather – occur in at risk cattle. Most cattle producers are aware of grass tetany and understand most requirements for managing disease in their herds. The feeding of hay and supplementation of cows with Causmag® are the main preventives. System-level controls such as modified fertilizer programs, pasture renovation, timing of calving and stocking density adjustments were not considered.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Grass tetany – southern

Table 4-33 Assumptions: grass tetany – southern (cattle)

Variable	Value adopted	Confidence
Regional Extent	60% of southern cattle are on properties in higher rainfall regions (> 600 mm per annum) with 10% in the pastoral zone (no requirement for control in most years)	***
% herds infected	5% of properties experience high levels of disease: 2.5% incidence in younger cows and 5.0% incidence in older cows. 15% of properties experience moderate levels: 1.0% incidence in younger cows and 2.0% incidence in older cows. 40% of properties experience moderate levels: 0.0% incidence in younger cows and 0.5% incidence in older cows. 40% of properties do not have grass tetany	**
Mortalities	50% mortality in younger cows and 80% mortality in older clinical cases are assumed	**

Variable	Value adopted	Confidence
Weight loss	No weight loss or fertility impacts are assumed. Calves of affected dams are assumed to survive.	***
Fertility	Nil	***
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Treatment is applied in only 50% of cases as most cases die or are found dead. Intravenous calcium and magnesium is applied. Some require veterinary attention. An average cost of $100 per case is assumed.	**
Prevention	Effective control relies on use of hay and Causmag®. A total cost of $10 per adult cow is assumed for control - 100% of highly affected properties use Causmag® and hay - 66% of moderately affected properties use Causmag® and hay - 33% of lowly affected properties use Causmag® and hay	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of grass tetany in cattle in southern Australia at $24.3M (Table 4-34).

Table 4-34 Economic cost of grass tetany – southern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0.67	$0.27	$0.10	$3.33	$2.20	$1.10	$7.29	$2.91	$1.25	**$11.29**	**$5.38**	**$2.45**
Per Herd	$126	$51	$19	$630	$416	$208	$1,377	$551	$236	**$2,133**	**$1,017**	**$463**
Total	**$1.2M**			**$9.7M**			**$13.4M**			**$24.3M**		

The net gain from moving all southern herds to the lowest level of disease is estimated at $9.1M.

4.11 Calf scours (southern)

<u>The disease</u>

Calf scours due to cryptosporidia, rotavirus, coronavirus, salmonella and/or *E.coli* is an emerging problem of the southern beef cattle industry. Surveys[3] suggest that 80% of southern producers have at least one case of white scours each year. The majority (70%) of producers experiencing outbreaks have fewer than 5% of calves affected but 20% can have up to 15% of calves affected and 10% with up to 30% of calves affected. The case fatality rate can be 10%. Whilst the major pathogens are generally known, the frequency of outbreaks and the size of outbreaks may be trending upwards. Intensification and concurrent disease are risk factors for outbreaks.

Unknown aetiology *Known aetiology*

						X			

<u>Prevention</u>

Vaccination has a role in some outbreaks. Mixed pathogen involvement is common. Vaccination of the pregnant cow is required for some pathogens (e.g. E. coli K99).

Low efficacy/ unproven preventives available *Effective preventives available*

					X				

<u>Treatment</u>

Treatment is symptomatic – replacement of lost fluids and parenteral antibiotic support. Dehydration, malnutrition (whilst withheld from milk) and secondary infection are the main causes of mortality. Electrolytes and antibiotics are effective in most cases but application is labour intensive.

Low efficacy/ unproven treatments available *Effective treatments available*

						X			

[3] Incidence and prevalence surveys were not random – a selection or self-reporting bias is likely to be present

Distribution

Distribution appears to be expanding (along with severity and size of outbreaks). Surveys indicate that intensification of production is associated with increased disease.

Distribution contracting *Distribution stable* *Distribution increasing*

							X		

Prevalence

The size of outbreaks is increasing on affected farms. Reports of up to 50% of calves affected have been received. Multiple pathogen involvement may be contributing. Furthermore, multiple pathogens and associated disease (trace element deficiency, parasites) may result in larger outbreaks on affected farms.

Prevalence decreasing *Prevalence increasing*

						X			

Economics

Assumptions: Calf scours (southern)

Table 4-35 Assumptions: calf scours – southern (cattle)

Variable	Value adopted	Confidence
Regional Extent	80% of southern beef herds have at least one case of calf scours per year.	***
% herds infected	5% of southern herds experience large-scale outbreaks: up to 30% of calves affected 15% of southern herds experience moderate outbreaks: up to 15% of calves affected 60% of southern herds experience minor outbreaks: up to 5% of calves affected 20% of southern herds experience no disease	**
Mortalities	10% mortality rate is assumed	**
Weight loss	No weight loss or other production effects are assumed; all production losses are due to calf deaths.	**
Fertility	Nil	***
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Treatment is by electrolytes, antibiotics and support. A cost of $25 per case has been assumed. However only 5% of cases are found alive and treated.	**
Prevention	Prevention is by vaccination. A dose is estimated to cost $1.00 (vaccine plus labour) and 50%, 70% and 90% of highly, moderately and lowly affected herds are assumed to vaccinate.	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of calf scours in cattle in Australia at $23M per year (Table 4-36).

Table 4-36 Economic cost of calf scours – southern (cattle)

	Treatment			**Prevention**			**Production**			**Total**		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$516	$258	$86	$221	$74	$37	$1,158	$579	$193	$1,895	$911	$316
Per Herd	$2.76	$1.38	$0.46	$1.18	$0.39	$0.20	$6.19	$3.10	$1.03	$10.13	$4.87	$1.69
Total	**$6.4M**			**$2.4M**			**$14.3M**			**$23.0M**		

The net gain from moving all southern herds experiencing disease to the lowest level of calf scours disease is estimated at $9.2M per annum.

4.12 Vibriosis

The disease

Campylobacteriosis (vibriosis) is caused by a bacterium that is sexually transmitted between cattle. It has primarily been associated with embryo loss (Clark 1971), which usually occurs prior to the typical time for foetal ageing in commercial beef herds; abortions are also regularly caused by vibriosis. However, in a large north Australian study, high prevalence of vaginal mucus samples positive for antibodies to *C.fetus sp.veneralis* had no association with percent pregnant within 4 months of calving, but was associated with 7% higher foetal and calf loss than in herds where >30% of cows had vaginal mucus antibodies than where antibody prevalence was low to moderate (McGowan *et al.* 2014). The epidemiology of the disease is not fully understood as sensitive and specific tests for both the bacterium and evidence of infection are unavailable (Lew *et al.* 2006).

Unknown aetiology *Known aetiology*

			X						

Prevention

One vaccine is available, and is primarily used in bulls at approximately $12.50/year including labour to administer. The efficacy of the vaccine is not clear, though research published at the time it was developed suggested it was high (Clark 1971). Schatz (2011) showed an 11% increase in early-mating conceptions in vaccinated compared to unvaccinated heifers. O'Rourke *et al.* (1992) reported that 19% of north Australian beef producers in 1990 vaccinated. Bortolussi *et al.* (2005a, 2005b) reported that 29-71% of bulls were being vaccinated against vibriosis in northern Australia in 1996-97, with 3% of properties vaccinating in northern WA. McGowan *et al.* (2014) reported that 68% of north Australian beef business vaccinated bulls against vibriosis. An average of ~0.5M doses of vaccine was sold in 2012-13 (Zoetis, pers comm). Biosecurity management is very difficult as diagnosis is difficult, primarily because the bacterium is a strict anaerobe, and cohabits the reproductive tract with a large number of other bacteria. Infection seems to be ephemeral in some studies (Lew *et al.* 2006), which may create false perception during diagnosis. PCR tests (e.g. McMillen *et al.* 2006) generally have insufficient specificity.

Low efficacy/ unproven preventives available — *Effective preventives available*

			X						

Treatment

The bacterium can be cleared with antibiotic therapies, but this is rarely done because of the difficulty of diagnosis.

Low efficacy/ unproven treatments available — *Effective treatments available*

						X			

Distribution

The bacterium is relatively ubiquitous.

Distribution contracting — *Distribution stable* — *Distribution increasing*

				X					

Prevalence

McGowan *et al*. (2014) reported that 4-14% of north Australian herds had a high prevalence of vaginal mucus antibody in breeding cows. In over 4,000 samples assayed, 9.4% were positive with little evidence of year or age differences. There was some evidence for lower prevalence of antibody-positive animals in regions where bull vaccination was more prevalent. While vibriosis has historically been considered to have low prevalence in the south, anecdotal evidence suggests it may not be as low as perceived. As no published data are available for prevalence in southern herds, the same prevalence as in northern Australia is presumed.

Prevalence decreasing — *Prevalence increasing*

				X					

Economics

Assumptions: Vibriosis – southern

Table 4-37 Assumptions: vibriosis – southern (cattle)

Variable	Value adopted	Confidence
Regional Extent	10%, 10%, 10% and 70% of herds with a high, medium, low and nil prevalence rate	*
% herds infected	An average of 40%, 20%, and 10% of cows are infected annually in high, medium and low incidence herds, respectively	*
Mortalities	No mortalities caused	***
Weight loss	No temporary weight loss	***
Fertility	5% fewer of infected cows fail to calf	**
Market avoidance	No market impact	***
Movement restrictions	Nil	***
Treatment	Treatment rarely used	***
Prevention	Vaccination of bull in 40% of herds, and heifers only vaccinated in 1% of high-prevalence herds	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of vibriosis in cattle in southern Australia at $8.3M (Table 4-38).

Table 4-38 Economic cost of vibriosis – southern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0	$0.16	$0.13	$0.13	$4.34	$2.17	$1.09	**$4.51**	**$2.31**	**$2.31**
Per Herd	$0	$0	$0	$30	$25	$25	$817	$408	$204	**$847**	**$433**	**$229**
Total	**$0M**			**$0.4M**			**$7.8M**			**$8.3M**		

The net gain from moving all southern herds experiencing vibriosis to the lowest level of disease is estimated at $4.5M.

Assumptions: Vibriosis – northern

Table 4-39 Assumptions: vibriosis – northern (cattle)

Variable	Value adopted	Confidence
Regional Extent	10%, 40%, 10% and 40% of herds with a high, medium, low and nil prevalence rate	**
% herds infected	An average of 40%, 20%, and 10% of cows are infected annually in high, medium, low and nil incidence herds, respectively	*
Mortalities	No mortalities caused	***
Weight loss	No temporary weight loss	***
Fertility	5% fewer of infected cows fail to calf	**
Market avoidance	No market impact	***
Movement restrictions	Nil	***
Treatment	Treatment rarely used	***
Prevention	Vaccination of bulls in 60% of herds, and 15% of heifers vaccinated in high-prevalence herds	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of vibriosis in cattle in northern Australia at $12.7M (Table 4-40).

Table 4-40 Economic cost of vibriosis – northern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0	$0.41	$0.11	$0.11	$2.20	$1.10	$0.55	**$2.61**	**$1.21**	**$0.66**
Per Herd	$0	$0	$0	$323	$90	$90	$1,746	$873	$437	**$2,069**	**$963**	**$527**
Total	**$0M**			**$1.5M**			**$11.2M**			**$12.7M**		

The net gain from moving all northern herds experiencing vibriosis to the lowest level of disease is estimated at $6.5M.

Total cost of disease

The total cost of vibriosis in cattle across Australia at the current prevalence of disease is estimated at $21.0M per annum. The net gain from moving all herds to the lowest level of disease is estimated at $11.0M. It is acknowledged that these estimates are based on unsubstantiated opinion for southern Australia where prevalence has not been systematically investigated.

4.13 Theileria

The disease

Theileria is a tick-borne infection of cattle produced (in Australia) by the *Theileria orientalis* group of haemoprotozoan parasites. *T. orientalis* (*buffeli)* has been present in Australia since the early 1900s and was traditionally associated with asymptomatic infections. Since 2006 an increasing number of clinical infections due to pathogenic strains of the parasite – especially *Ikeda*, and *Chitose* – have been reported along the eastern seaboard and recently in Western Australia. The majority of clinical disease has been reported in the southern industry (however a 'hot spot' in the far north of Queensland has been identified). The range of disease is believed by many to follow the distribution of the bush tick (*Haemaphysalis longicornis*). The emerging disease has been named bovine anaemia caused by *Theileria orientalis* to separate the disease syndrome from infection with the endemic and typically non-pathogenic *Buffeli* serotype and called Benign Bovine Theileriosis.

There is a spectrum of disease ranging from non-pathogenic infection (mainly *Buffeli* serotype) through to severe anaemia, abortion, recumbency and death. Clinically affected animals lose weight. Mortalities of 10% in young stock (<2YO) and up to 3% of adults can occur in severe outbreaks. This is typically associated with recent introduction of pathogenic strains into naïve herds. A recent New Zealand study found clinical anaemia to be the major driver of clinical signs and production loss (not parasitaemia *per se*). Anaemia was strongly associated with reduced milk production and reduced reproductive performance in dairy cattle. Significant recovery times after severe anaemia can occur. Weight loss can be dramatic and abortion and reproductive failure are common sequelae.

The disease agents are known but the reasons behind the emergence of pathogenicity (mutation or introduction) is not clear. The local intermediate host(s) range and distribution have not been confirmed, but are the subject of ongoing research.

Unknown aetiology *Known aetiology*

					X				

Prevention

There are no effective preventive methods. Whilst tick control can assist control, only a small number of ticks are required to spread the parasite. There is currently no vaccine. A vaccine will likely be essential to prevent disease due to the persistence in intermediate hosts (ticks) especially along the length of the eastern and northern seaboards.

Low efficacy/ unproven preventives available *Effective preventives available*

		X							

Treatment

There are no registered effective treatments for the parasite. Buparvaquone has been shown to be effective at controlling the infection but there is no registered product available in Australia. Symptomatic treatment of the anaemia (nursing) can reduce mortalities. Treatment is time consuming and expensive. Recovery is slow as the animal needs to replace red cells lost due to the anaemia.

Low efficacy/ unproven treatments available *Effective treatments available*

		X							

Distribution

Small scale typing studies found the prevalence of infected herds to be high in Queensland (85%) and Victoria (80%) with slightly lower prevalence in NSW (45%). Ikeda was more prevalent in NSW and Victorian isolates than in Queensland. Mixed infection (Ikeda and Chitose) were common. The distribution of disease-causing strains is increasing along the eastern seaboard.

Distribution contracting *Distribution stable* *Distribution increasing*

							X		

Prevalence

Approximately 55% of sampled Queensland cattle were seropositive. The NSW cow-level sample seroprevalence was approximately 25% and in Victoria it was 34%. However not all positive animals showed disease signs. Large outbreaks are increasingly common in previously naïve herds.

Prevalence decreasing *Prevalence increasing*

							X		

Economics

Assumptions: Theileria (southern)

Table 4-41 Assumptions: theileria – southern (cattle)

Variable	Value adopted	Confidence
Regional Extent	50% of southern cattle population in exposed region (excludes the arid inland regions).	**
% herds infected	1% of herds newly infected and previously naive highly affected: 25% of herd (all ages) infected 10% of herds moderately affected: 15% of young stock, 5% of older stock infected 34% of herds lowly affected: 10% of young stock and 1% of older infected	**
Mortalities	10% in young stock, 5% in older.	**
Weight loss	Significant weight loss in affected (20 kg in young stock, 10 kg in older stock).	**
Fertility	Clinical cases have reduced fertility (45% pregnancy rate versus 90% pregnancy rate). Clinical course of disease is 3 months therefore average reduction in pregnancies for clinical cases is 11%.	*
Market avoidance	Nil	**
Movement restrictions	Nil	**
Treatment	Not available	***
Prevention	Not available	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of theileria infection in cattle in southern Australia at $18.0M per year (Table 4.42).

Table 4-42 Economic cost of theileria – southern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	H	M	L
Per Cattle	$0.33	$0.05	$0	$0	$0	$0	$18.64	$6.02	$2.81	$18.97	$6.07	$2.81
Per Herd	$615	$9	$0.02	$0	$0	$0	$3,486	$1,126	$526	$3,547	$1,135	$526
Total	**$0.1M**			**$0M**			**$17.9M**			**$18.0M**		

The net gain from moving all southern herds experiencing theileria to the lowest level of disease is estimated at $5.0M.

Assumptions: Theileria (northern)

Table 4-43 Assumptions: theileria – northern (cattle)

Variable	Value adopted	Confidence
Regional Extent	50% of northern cattle population in exposed region (coastal)	**
% herds infected	Disease incidence is half that of southern industry 0.5% of herds newly infected and previously naïve, highly affected: 12.5% of herd (all ages) infected 5% of herds moderately affected: 5% of young stock, 2% of older stock infected 17% of herds lowly affected: 0.5% of young stock and 0% of older infected	**
Mortalities	10% in young stock, 5% in older.	**
Weight loss	Significant weight loss in affected (20kg in young stock, 10kg in older stock)	**
Fertility	Clinical cases have reduced fertility (45% pregnancy rate versus 90% pregnancy rate), Clinical course of disease 3 months therefore average reduction in pregnancies for clinical cases is 11%	*
Market avoidance	Nil	**
Movement restrictions	Nil	**
Treatment	Not available	***
Prevention	Not available	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of theileria in cattle in northern Australia at $1.6M (Table 4-44).

Table 4-44 Economic cost of theileria – northern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0.45	$0.20	$0.02	$0	$0	$0	$2.78	$1.12	$0.12	**$3.23**	**$1.31**	**$0.15**
Per Herd	$337	$146	$18	$0	$0	$0	$2,075	$833	$92	**$2,412**	**$980**	**$110**
Total	**$0.2M**			**$0M**			**$1.3M**			**$1.6M**		

The net gain from moving all northern herds experiencing theileria to the lowest level of disease is estimated at $1.1M.

Total cost of disease

The total cost of theileria in cattle across Australia at the current prevalence of disease is estimated at $19.6M per annum. The net gain from moving all herds experiencing theileria to the lowest level of disease for their regions is estimated at $6.1M.

4.14 Pinkeye

<u>The disease</u>

Infectious bovine keratoconjunctivitis (Pinkeye) is an infection of the eye caused by the bacterium *Moraxella bovis* and it occurs in all cattle producing regions of Australia. Disease is more common in naïve animals and in general outbreaks are more common in young stock in spring and summer in the southern industry but may occur in any age group. Affected cattle may lose weight and there are significant welfare concerns with clinical disease – especially if both eyes are affected concurrently.

The risk factors for disease are well understood. *M. bo*vis must adhere to the cornea to produce disease. Adherence is facilitated by damage to the cornea such as may follow dusty conditions, fly irritation, direct sunlight and/or physical scratching of the corneal surface (e.g. hay). *Bos taurus* are more susceptible than *Bos indicus*. Increased herd size and grouping of young stock into larger numbers may predispose to outbreaks.

Unknown aetiology *Known aetiology*

						X			

<u>Prevention</u>

Vaccination is available. Piligard has three strains only; not all outbreaks are due to the strains in the vaccine. Managing dust, flies and eye trauma reduces the risk of outbreaks. A recent Australian sero-survey found (only) 64% of isolates were homologous with vaccine strains. Other infectious agents may also produce ocular disease. Many 'unnecessary' treatments are also used e.g. Vit ADE in the belief they have an effect.

Low efficacy/ unproven preventives available *Effective preventives available*

							X		

Treatment

Topical antibiotics may be used to treat disease. These need to be applied daily to ensure corneal levels remain at therapeutic levels. Veterinarians may inject a depot of antibiotics into the cornea that can last several days. Eye patches and isolation further reduce spread. Treatment is time consuming – repeat yarding needed. There are also significant animal welfare aspects that must be considered.

Low efficacy/ unproven treatments available *Effective treatments available*

							X		

Distribution

Disease is more common in the southern beef industry due primarily to the predominance of *B. indicus* cattle in northern Australia.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Slatter *et al.* (1982) found a high prevalence of farms experiencing disease in southern Australia (80%) and reported a within-herd incidence range of 1% (Tasmania) to 8% (NSW). Unfortunately the age cohort specific incidences were not reported. GHD has therefore assumed 80% of southern herds have at least one case per year and 80% of northern herds avoid pinkeye resulting in an annual incidence estimate of around 2.5% of cattle in southern Australia and 0.6% in northern Australia. Whilst the underlying prevalence research is now thirty years old there is no evidence that disease has changed over the ensuing period. The high quality of the original survey work provides a robust estimate of pinkeye in the southern herd. The prevalence of pink eye has been assumed to be stable in the southern industry. Larger herds may however be prone to bigger outbreaks due to aggregation effects.

Outbreak prevalence decreasing *Outbreak prevalence increasing*

					X				

Economics

Assumptions: Pinkeye – southern

Table 4-45 Assumptions: pinkeye – southern (cattle)

Variable	Value adopted	Confidence
Regional Extent	80% of southern cattle properties experience at least once case per year. 80-90% of herds are *Bos taurus*.	**
% herds infected	5% of herds highly infected and previously naive (50% of calves and 1% of adults affected) 10% of herds moderately affected (20% of calves and 0.5% of older stock infected) 70% of herds lowly affected (5% of calves and 0% of older stock infected)	**
Mortalities	1% in young stock	*
Weight loss	10 kilograms in young stock (5 kg permanent, 5 kg temporary) 5 kg in older stock (temporary)	**
Fertility	No impact	***
Market avoidance	10% of clinical disease in young stock develop severe corneal scarring precluding them from sale into some markets (e.g. feedlots)	***
Movement restrictions	Nil	***
Treatment	Treatment applied to 75%, 50% and 25% of clinical cases in highly, moderately and lowly affected herds. Treatment costs assumed at $10.00 head to $12.50 head across the course of disease (multiple yarding and handling, antibiotic treatments, patches etc.)	**
Prevention	Vaccination deployed in 50% of highly affected, 25% of moderately affected and 15% of lowly affected herds.	*

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of pinkeye in cattle in southern Australia at $10.9M as shown in Table 4-46 below.

Table 4-46 Economic cost of pinkeye – southern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$1.74	$0.47	$0.06	$1.37	$0.68	$0.41	$3.37	$1.35	$0.27	**$6.47**	**$2.50**	**$0.73**
Per Herd	$323	$88	$11	$258	$129	$77	$637	$255	$50	**$1,224**	**$472**	**$138**
Total	**$1.8M**			**$4.2M**			**$4.9M**			**$10.9M**		

The net gain from moving all southern herds experiencing pinkeye to the lowest level of disease is estimated at $4.8M.

Assumptions: Pinkeye – northern

Table 4-47 Assumptions: pinkeye – northern (cattle)

Variable	Value adopted	Confidence
Regional Extent	85% of northern cattle herds are *Bos indicus* or crossbreed. Pinkeye is rarely seen in *Bos Indicus* breeds). Disease incidence is less than for southern industry	**
% herds infected	1% of herds highly infected and previously naive (12.5% of all age groups affected) 3% of herds moderately affected (5% of young stock and 2% of older stock infected) 18% of herds lowly affected (0.5% of young stock and 0% of older stock infected)	*
Mortalities	1% of clinically-affected young stock	**
Weight loss	10 kilograms in young stock (5 kg permanent, 5 kg temporary) 5 kg in older stock (temporary)	*
Fertility	No impact	***
Market avoidance	10% of clinical disease in young stock develop severe corneal scarring precluding them from sale into some markets (e.g. feedlots)	***
Movement restrictions	Nil	***
Treatment	Treatment applied to 25%, 10% and 5% of clinical cases in highly, moderately and lowly affected herds	*
Prevention	Vaccination deployed in 25% of highly affected, 10% of moderately affected and 1% of lowly affected herds.	*

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of pinkeye in cattle in northern Australia at $2.4M (Table 4.48).

Table 4-48 Economic cost of pinkeye – northern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0.93	$0.19	$0.01	$0.68	$0.27	$0.03	$3.15	$1.26	$0.28	**$4.77**	**$1.72**	**$0.32**
Per Herd	$731	$147	$9	$537	$215	$21	$2,469	$987	$220	**$3,736**	**$1,349**	**$250**
Total	**$0.3M**			**$0.3M**			**$1.8M**			**$2.4M**		

The net gain from moving all northern herds experiencing pinkeye to the lowest level of disease is estimated at $1.4M.

Total cost of disease

The total cost of pinkeye in cattle across Australia at the current prevalence of disease is estimated at $13.3M per annum. The net gain from moving all herds experiencing pinkeye to the lowest level of disease is estimated at $6.2M.

4.15 Clostridial diseases (southern)

The disease

The common clostridial diseases of southern beef cattle are tetanus (C. *tetani*), botulism (C. *botulinum*), blackleg (C. *chauvoei*), malignant oedema (C. *septicum*), black disease (C. *novyi*) and entertoxaemia (C. *perfringens* type D). Clostridia bacteria are widespread and can survive in the environment for long periods. The low prevalence of phosphorous deficiency in southern Australia limits bone chewing – the main risk factor for botulism in the northern industry – provides for reduced impact of clostridial diseases in the southern compared to the northern industry (note that botulism is separately discussed in section 4.9). Unhygienic calf castration can precipitate tetanus outbreaks. Disease is invariably fatal however highly effective and cheap vaccines exist against the major variants.

Unknown aetiology — *Known aetiology*

								X	

Prevention

Effective combination vaccines are available and are widely used. This prevents the majority of disease. Black disease is often associated with liver fluke infestations – but fluke areas are generally well known and preventive measures (fluke and black disease) are typically applied.

Low efficacy/ unproven preventives available *Effective preventives available*

							X		

Treatment

Treatment is generally ineffective – most cases are found dead. Tetanus can produce less fulminating disease depending on the dose of toxin absorbed.

Low efficacy/ unproven treatments available *Effective treatments available*

	X								

Distribution

Distribution is found in all cattle farming regions of the south and is an inherent risk of all cattle enterprises in these regions.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

The disease is ever-present.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Clostridial disease (southern)

Table 4-49 Assumptions: clostridial disease – southern (cattle)

Variable	Value adopted	Confidence
Regional Extent	All beef herds are at risk of clostridial disease. However, the majority (85%) of producers use effective vaccination programs and do not see the disease.	***
% herds infected	1% of southern herds experience large-scale outbreaks (generally arising from failure to vaccinate or incorrect vaccine administration/storage) - Up to 10% of young stock and 2.5% of rising two-year-olds affected. No adult losses 4% of southern herds experience moderate outbreak (again due to inadequate vaccination) - Up to 2% of young stock and 0.5% of rising two-year-olds. No adult losses 10% of southern herds experience minor outbreak (again due to inadequate vaccination – generally of individual animals) - Up to 0.5% of young stock affected. No rising two-year-olds or adult losses 85% of southern herds experience no disease	**
Mortalities	100% mortality rate assumed	***
Weight loss	No weight loss or other production effects are assumed; all production losses are due to deaths.	***
Fertility	No impact	***
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Treatment is by antibiotics and support. A cost of $50 per case has been assumed. However only 5% of cases are found alive and treated.	**

Variable	Value adopted	Confidence
Prevention	Prevention is by vaccination. A dose is estimated to cost $1.00 (vaccine plus labour) and 50%, 70% and 90% of highly, moderately and lowly affected herds are assumed to vaccinate.	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of $6.7M in cattle in southern Australia (Table 4-50).

Table 4-50 Economic cost of clostridial disease – southern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0.08	$0.02	$0.00	$0.78	$1.09	$1.40	$21.46	$4.36	$0.72	$22.31	$5.47	$2.12
Per Herd	$15	$3	$1	$146	$204	$262	$4,012	$816	$135	$4,173	$1,023	$397
Total	**$0.0M**			**$2.0M**			**$4.7M**			**$6.7M**		

The net gain from moving all southern herds to the lowest level of clostridial disease is $3.4M. It should be noted that the estimated cost of a complete vaccination program across the southern industry is $15.9M per annum ($291 per herd per year). Whilst this is greater than the expected gain from better control of clostridial diseases the cost of prevention per herd is markedly less than the expected losses from a severe outbreak ($291 pa compared to $4,173 pa).

4.16 Tick fever

The disease

Bock (1999) reviewed tick fever in north Australia. Tick fever is the combined diseases caused by three protozoan parasites (*Babesia bovis, Babesia bigemina, Anaplasma marginale*) that inhabit host red blood cells and are transmitted between cattle by various life stages of the cattle tick, *Rhipicephalus microplus*. Haemolysis is a common feature of each disease. The severity of disease caused is greatest with *Anaplasma* and higher from *B. bovis* than *B. bigemina*, with some variation in virulence of organisms. Increasing *Bos indicus* content generally confers greater resistance to clinical disease. Cattle aged up to at least nine months are not usually susceptible to tick fever. Transmission of disease is affected by parasitaemia rates in ticks and the survival and attachment rates of ticks which are highest in warm moist conditions. In a field transmission study, 20% of infected crossbred steers experienced severe clinical disease, with 2% mortality, which is consistent with reported field outbreaks in northern Australia during 1990-98. There is no published data to support significant permanent weight loss or reduced calf output due to tick fever.

Unknown aetiology — *Known aetiology*

								X	

Prevention

A trivalent vaccine available from DAFF in Queensland is considered to achieve 85-95% immunity (Bock 1999). Managing tick populations to achieve infection in juvenile cattle is a key strategy, which must take account of parasites being present in as few as 0.04% of ticks (Bock 1999). O'Rourke *et al.* (1992) reported that approximately 20% of cattle within the infected region are vaccinated. Based on on-going sales, it is estimated that about one-third of weaners are vaccinated annually. This is consistent with a report that 22% of 16 surveyed north Australian businesses vaccinate against this disease (Levantis and Hooper 2009). Tick control also prevents infection. The widespread adoption of effective vaccination is critical to the prevention of disease and losses would increase markedly if a vaccine was not available.

Low efficacy/ unproven preventives available — *Effective preventives available*

								X	

Treatment

Treatment is rarely instituted under field conditions. Oxytetracycline is reported effective against *Anaplasma*. Imidocarb is effective against *Babesia*.

Low efficacy/ unproven treatments available — *Effective treatments available*

						X			

Distribution

Dry and cool climate areas combined with tick-free zones restricts the vector, thus the disease to eastern and northern areas of Queensland, Northern Territory and Western Australia. Approximately 45% of Queensland's cattle are within the tick-free zone. There is a low prevalence of ticks in Queensland's endemic tick zones beyond 200 km from the coast following droughts in the 1990's, 2000's and current, where approximately 40% of cattle are reared. There has been limited resurgence of ticks during wetter years where dry seasonal conditions have eliminated them.

Distribution contracting — *Distribution stable* — *Distribution increasing*

				X					

<u>Prevalence</u>

Tick fever and the mortality it causes can be dramatic. Bock (1999) reported that 4-23% of over 7,000 cattle surveyed in NW Queensland in the dry years of 1996-97 had tick fever immunity. However, in a sub-coastal herd in central Queensland, immunity in yearlings was 63% to *B bovis* and 95% to *Anaplasma*. Bock (1990) reported that in the period 1990-98, only 25 cases of tick fever were confirmed across north Australia with an average of approximately 50 mortalities per year. Tick fever outbreaks are limited in high-prevalence areas as most juvenile cattle gain immunity, and it is in tick marginal regions where infected ticks are not continually present and may be transported in on cattle that cattle are at most risk. There can be a large seasonal effect on the local amount of disease if seasons favour an increase in tick populations and disease transmission.

Prevalence decreasing *Prevalence increasing*

				X					

<u>Economics</u>

Assumptions: Tick fever – southern

As tick fever is restricted to northern Australia, the annual cost of tick fever in southern Australia is nil.

Assumptions: Tick fever - northern

Table 4-51 Assumptions: tick fever – northern (cattle)

Variable	Value adopted	Confidence
Regional Extent	25%, 40% and 35% of herds with a medium, low and nil incidence	*
% herds infected	An average of 1% of cattle are naïve and have a severe clinical infection annually and once every 5 years in medium and low incidence herds, respectively	*
Mortalities	10% of clinically-affected cattle die	**
Weight loss	No temporary weight loss	*
Fertility	No measurable fertility impacts	**
Market avoidance	Low market impact, though some live export market protocols require no recent tick fever outbreaks	***
Movement restrictions	Nil	***
Treatment	Treatment rarely used	***
Prevention	33% of juvenile cattle within the infected region are vaccinated, plus 25% of bulls in their lifetime	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of tick fever in cattle in northern Australia at $4.3M (Table 4-52). The relatively low impact reflects the high impact of dedicated resources to its control and widespread use of an efficacious vaccine.

Table 4-52 Economic cost of tick fever – northern (cattle)

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	H	M	L
Per Herd	$0	$0	$0	$0	$227	$227	$0	$126	$96	$0	$353	$323
Per Cattle	$0	$0	$0	$0	$0.29	$0.29	$0	$0.16	$0.12	$0	$0.45	$0.41
Total	**$0M**			**$2.9M**			**$1.4M**			**$4.3M**		

There is no apparent net gain from moving all northern herds experiencing tick fever to the lowest level of disease.

Total cost of disease

The total cost of tick fever in cattle across Australia at the current prevalence of disease is estimated at $4.3M per annum. There is no apparent net gain from moving all herds experiencing tick fever to the lowest level of disease.

4.17 Bovine Johne's disease

The disease

Bovine Johne's disease (BJD) is due to infection with *Mycobacterium avium subsp. Paratuberculosis* (MAP). BJD is endemic within the dairy industry of Victoria, Tasmania, South Australia and New South Wales with the highest prevalence of infected dairy herds in the south east of the country. Disease has occasionally been identified in a few beef cattle herds at a low within-herd prevalence in Victoria – generally a result of spill-over contact with dairy animals (cattle strains of MAP). There is however an increasing rate of isolation of sheep strain (S strain) from beef cattle (again at very low within-herd prevalence) in the sheep-beef regions (north east and western districts) of Victoria. Disease was historically absent from Western Australia, Queensland and the Northern Territory however the recent confirmation of a novel bison strain in cattle originating from a large Queensland Brahman stud has resulted in trace forward contacts into each of these jurisdictions.

Johne's disease is a chronic incurable disease however the majority of infected beef cattle do not live long enough to express clinical disease. Diagnostic tests have inadequate sensitivity to detect infected individuals and therefore test-and-cull programs to eradicate disease from infected herds are ineffective. Vaccines to date provide incomplete protection and cross-react with tuberculosis tests (that may be used in other countries). Vaccination may assist to control disease but may not guarantee eradication of disease from infected herds. Many countries ban the importation of cattle from herds confirmed to have diseased and/or BJD vaccinated cattle.

The direct economic impact of clinical BJD in beef cattle herds is small. A recent study estimated that eradication (by destocking) was not feasible until the annual clinical incidence exceeded 5%. The (potential) loss of trade due to regulatory restriction presents the greatest source of loss. Beef stud herds may be limited in ability to sell bulls and live exporters may have cattle excluded from markets due to the presence of disease. Not all infected farms will experience approximately 'average' economic impacts; some infected farms will experience business-threatening loss of incomes if confirmed (or suspected) to have disease.

The disease is well known. The rate and extent of S-strain spillover into southern cattle from infected sheep is unknown as is the likelihood of MAP establishing in the north of Australia following the recent introduction of the bison strain.

Unknown aetiology *Known aetiology*

						X			

Prevention

There are no effective preventive methods besides strict quarantine and selective introductions. The poor sensitivity of diagnostic tests makes introduction of test-negative animals a risk. The persistence of MAP in the environment (and especially water) can negate animal movement controls. A vaccine can assist control but not eradicate disease from most infected herds.

Low efficacy/ unproven preventives available *Effective preventives available*

	X								

Treatment

There are no registered effective treatments.

Low efficacy/ unproven treatments available *Effective treatments available*

X									

Distribution

There appears to be an increasing spread from sheep and dairy cattle to the beef herd in the south. The level of establishment of BJD in the northern industry following introduction and dissemination of the bison strain is unknown.

Distribution contracting *Distribution stable* *Distribution increasing*

						X			

Prevalence

The within-herd prevalence of clinical disease and infection with MAP is low. New Zealand modelling studies suggest the within-herd prevalence of S-strain in beef herds may stabilise at less than 1% infected.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Johne's disease – southern

Table 4-53 Assumptions: Johne's disease – southern (cattle)

Variable	Value adopted	Confidence
Regional Extent	The organism can potentially inhabit a range of environments but is less persistent in dry regions	**
% herds infected	5% of southern cattle properties may be infected at low prevalence: 2% of adult cattle develop clinical disease per year.	**
Mortalities	100% mortalities in clinical cases	***
Weight loss	No weight loss, fertility or other production effects are costed as all production losses are captured in mortality (100%).	***
Fertility	50% of clinical cases fail to provide a calf in the year of their death/culling	***
Market avoidance	Nil – the issue of live export market restrictions is not discussed in this report	N/A
Movement restrictions	Quarantine of studs and infected/suspect herds	***
Treatment	No treatment	**
Prevention	Strict quarantine and selective introductions	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of Johne's disease in cattle in southern Australia at $2.5M as shown in Table 4-54.

Table 4-54 Economic cost of bovine Johne's disease – southern

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Cattle	$0	$0	$0	$0	$0	$0	$0	$0	$4.87	**$0**	**$0**	**$4.87**
Per Herd	$0	$0	$0	$0	$0	$0	$0	$0	$921	**$0**	**$0**	**$921**
Total	**$0M**			**$0M**			**$2.5M**			**$2.5M**		

Assumptions: Johne's disease – northern

Table 4-55 Assumptions: Johne's disease – northern (cattle)

Variable	Value adopted	Confidence
Regional Extent	The organism can potentially inhabit a range of environments but is less persistent in dry regions	**
% herds infected	1% of northern cattle herds may be infected (exposed): 1% of adult cattle develop clinical disease per year.	**
Mortalities	100% mortalities in clinical cases	***
Weight loss	No weight loss, fertility or other production effects are assumed; all production losses are due to deaths.	***
Fertility	50% of clinical cases fail to provide a calf in the year of their death/culling	***
Market avoidance	Nil – the issue of live export market restrictions is not discussed in this report	N/A
Movement restrictions	Quarantine of studs and infected/suspect herds	***
Treatment	No treatment	**
Prevention	Strict quarantine and selective introductions	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of Johne's disease in cattle in northern Australia at $0.3M (Table 4-56).

Table 4-56 Economic cost of bovine Johne's disease – northern

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	H	M	L
Per Cattle	$0	$0	$0	$0	$0	$0	$0	$0	$2.22	$0	$0	$2.22
Per Herd	$0	$0	$0	$0	$0	$0	$0	$0	$1,669	$0	$0	$1,669
Total	**$0M**			**$0M**			**$0.3M**			**$0.3M**		

Total cost of disease

The total cost of Johne's disease in cattle across Australia at the current prevalence of disease is estimated at $2.8M per annum. Currently it is not possible to eradicate Johne's disease. If it were, the net gain for the beef industry is estimated to be up to $4.5M per annum.

5 Results – Sheep diseases

5.1 Neonatal mortalities

<u>The Syndrome</u>

Neonatal mortality is a complex syndrome resulting in the death of new born lambs up to about a week of age. The causes of mortality are numerous with starvation-mismothering, exposure, dystocia and primary predation (foxes, wild dogs, pigs and crows) the most common causes. Other causes include neonatal infection and a group of other minor causes make up the remainder. The syndrome is a complex interaction of nutrition, environmental factors, sheep genotype and management.

Typical neonatal lamb mortalities range from 10-35% (Hinch 2014). Industry recommendations are that losses should not exceed 10% for singles and 20% for twins (www.Lifetimewool.com). Typical industry neonatal losses are 10% from singles and 30% from twins (MLA 2008).

Note that dystocia mortalities are also considered separately (along with ewe mortalities) and are a subset of neonatal lamb mortalities. The causes of neonatal lamb mortalities are well known though complicated by many underlying risk factors.

Unknown aetiology *Known aetiology*

							X		

Prevention

It is unrealistic to prevent all neonatal mortalities, though substantial industry improvements can be made. Prevention requires a multifactorial systems approach including management of the breeding flock, optimising nutrition (Lifetime ewe management), genetic improvement, flock health and farm planning to improve pastures and shelter. Typical feeding costs are about $1.50 per ewe, though is dependent on season and pastures. Long term improvements through genetic improvement are important though the cost is not considered as is the cost of land improvement including shelter, subdivision and breed selection. Supervision of the lambing flock is considered. Management is the key to prevention and must be managed in the context of optimising flock nutrition, other diseases and syndromes.

Low efficacy/ unproven preventives available *Effective preventives available*

						X			

Treatment

Treatment of neonatal mortalities largely relates to supervision of lambing ewes. Intensive supervision must be balanced with interruption of lambing ewes where problems are of low risk.

Low efficacy/ unproven treatments available *Effective treatments available*

						X			

Distribution

The distribution is stable.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

In this study the prevalence of neonatal mortalities was assumed to be 23% for Merinos and 17% for prime lamb flocks. Prevalence is generally constant – but influenced by season. The trend towards more meat sheep breeds may contribute to reducing the number of neonatal mortalities.

Prevalence decreasing *Prevalence increasing*

					X				

Economics

Assumptions: Neonatal mortalities

Table 5-1 Assumptions: neonatal mortalities in sheep

Variable	Value adopted	Confidence
Regional Extent	All regions	***
% flocks affected	Average neonatal lamb losses due to all causes based on ewe flock include: - Merino X Merino: 23% - Dual purpose: 22% - Specialist prime lamb (first cross ewes X terminal sire): 17% (Geenty *et al. 2014*, DEPI Sentinel Flock 2012, Holst *et al. 2002.*)	***
Mortalities	See above. Nil ewe mortalities	***
Weight loss	Ewes that fail to rear lambs are 6% heavier in summer (Lee *et al.* 1995) have a subsequent fertility benefit of 4.5%. No other production losses are attributed to neonatal mortality including impact on flock stocking rate or age structure.	***
Fleece weight	Ewes that lose lambs should produce about 6% more wool due to no lactation (Lee *et al.* 1995).	***
Wool	Ewes that do not rear lambs will produce slightly broader fleece and 2 N/kTex lower staple strength (Scrivener CJ *et al.* 1997)	**
Fertility	4.5% more lambs produced in following year	**
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	There is no treatment considered	***
Prevention	Supervision of flocks to reduce ewe losses primarily due to dystocia is adopted widely. On average, 80% of specialist prime lamb flocks and dual purpose flocks supervise lambing with 50% of Merino flocks supervising lambing at a cost of $0.05/ewe day for 6 weeks. The most important aspects of	**

Variable	Value adopted	Confidence
	prevention relate to genetic improvement and nutritional management, paddock selection and long term investment in shelter which should be undertaken to optimise flock reproductive performance. The average cost of nutrition alone is assumed to be $1.50/ewe. Note that investment in shelter is not included.	

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of neonatal mortalities in sheep in Australia at $540.4M (Table 5-2). If neonatal mortality rates reduce by 5%, an additional $132M income would be produced before considering any extra costs to achieve the reduction. Whilst it is unrealistic to eliminate all losses associated with neonatal lamb mortalities, there are many opportunities to reduce some losses. If neonatal mortality rates are reduced to industry recommendations that losses should not exceed 10% for singles and 20% for twins (www.Lifetimewool.com), an additional $147M income would be produced before considering any extra costs to achieve the reduction. Consideration needs to be given to each strategy to weigh up the cost of reducing losses, the extra income gained, the extra costs of additional lambs and the impacts on flock structure, stocking rate and enterprise mix.

Table 5-2 Economic cost of neonatal mortalities in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$4.69	$0	$0	$23.35	$0	$0	**$28.04**	**$0**	**$0**
Per Flock	$0	$0	$0	$7,235	$0	$0	$36,223	$0	$0	**$43,458**	**$0**	**$0**
Total	**$0M**			**$98.8M**			**$441.6M**			**$540.4M**		

Note that the costs of dystocia and mastitis are also included in Table 5-2 although they are separately discussed in sections 5.3 and 5.8 respectively. The relative contribution of these diseases/conditions to neonatal lamb mortality is shown in Table 5-3. Campylobacter abortions (section 5.22) are considered separately, although some neonatal deaths are likely to be due to campylobacter abortions.

Table 5-3 Relative cost of neonatal mortalities

Disease/syndrome	Direct losses of neonatal lamb mortalities	% of total neonatal losses
Neonatal lamb mortalities	$474M*	
Dystocia	$149M	31.4%
Mastitis	$43M	9.1%

* Note that production losses of $441.6M in Table 5-2 is less than the $474M in Table 5-3 because it includes offsetting costs associated with increased wool production in the ewe as a result of lamb loss.

5.2 Internal parasites

The disease

Gastrointestinal parasites and lungworm occur in all sheep rearing areas of Australia. The amount and distribution of rainfall determines what parasites are predominant and their financial impact, both from lost production and the costs of treatment and control. Infections are more problematic in high rainfall areas (an annual rainfall of >450 mm). The effects of parasitism are more severe in young animals and late pregnant and lactating ewes, especially maiden and older ewes.

Previous estimates of the total costs and losses from gastrointestinal parasitism in the Australian sheep flock have been made including Beck *et al.* (1985), (McLeod, 1995) and (Sackett *et al*, 2006). All three studies ranked gastro-intestinal parasites as the most costly animal health condition in Australia, up to twice the estimated cost of blowfly strike. All studies found that most of the costs associated with internal parasites were attributable to lost production rather than to treatment costs.

The overwhelming conclusion, supported by more recent on-farm demonstration studies (IPMs 2007), is that internal parasites are a major constraint on production in Australian sheep flocks. Production losses in the animal occur primarily as a result of reduced food intake, but also accrue from poor nutrient utilisation and redistribution of protein for tissue repair (Symons and Steel 1978; Sykes and Coop 2001). Less obviously, there may be substantial indirect costs associated with internal parasites. For example, the stocking rate, flock structure and grazing management on farms in high rainfall areas of Australia are often influenced by the producer's attitude to internal parasites (Lean *et al.* 1997).

The sheep most susceptible to the effects of internal parasite infections are young sheep. Uncontrolled clinical infections in young sheep can lead to a mortality approaching 100%, but such severe losses are rare because producers have adopted some form of control program. In contrast, sub-clinical infections are common and may reduce liveweight gains by about 20% and wool growth by up to 30% in both young and adult sheep (Barger 1982).

There have been changes in the distribution and population of sheep in Australia since the work by Sackett *et al.* (2006). In addition, the relative value of sheep meat and wool production has also changed, along with the cost and range of treatments. For example, two new anthelmintic groups have been introduced since 2010, one as a single product (monepantel, marketed as Zolvix™), and another, derquantel, in combination with abamectin (Startect™).

Anthelmintic resistance is potentially a serious constraint to sheep production in the high rainfall areas, although there is some evidence that farms in the high winter rainfall zone are able to manage with worm programs based around strategic timing of drench treatments integrated with other control options, such as testing for drench resistance, monitoring worm egg counts, grazing management and the selection of sheep with enhanced immunity to internal parasites (WormBoss 2014, Larsen *et al.* 2006). Anthelmintic resistance is potentially more serious in uniform and summer dominant rainfall areas where Barbers Pole Worm (*Haemonchus*) is consistently present, as populations can increase rapidly and cause significant mortalities in both ewes and lambs. Effective long-term control strategies seek to minimise the impact of parasites but also reduce the rate of development of anthelmintic resistance, typically by reducing the number of treatments and integrating these with other control options, such as grazing management and selection for sheep with enhanced immunity to internal parasites (Besier and Love 2003, Larsen 2014).

Nevertheless, some production loss is inevitable even when relatively immune sheep are exposed to infection, with from 3-5% lower bodyweights and 10% less wool production in both Merinos and prime lamb breeds (Kahn *et al.* 2007, Barger and Southcott, 1975, Meat & Livestock Australia Project BAHE0045 progress reports 2013-14). Decreased growth rates also occur in rapidly growing prime lambs, although these effects are often small if the amount and quality of pasture is good. For example, prime lambs kept free of internal parasites by continuous suppressive treatment with ivermectin capsules gained 1.6 kg more than untreated lambs (Carmichael *et al.* 2005). Similar but less consistent differences were observed in a more recent project comparing untreated lambs with a cohort treated with long-acting moxidectin injections in four regions of eastern Australia (Meat & Livestock Australia Project BAHE0045 progress reports 2013-14).

In winter and uniform rainfall areas, substantially increased costs accrue from the accumulation of ‘dag’ on breech wool. In adult sheep this is predominantly due to ‘hypersensitivity scouring’, an immune response by certain sheep following challenge with worm larvae (Larsen *et al.* 1994). In addition to direct costs associated with crutching, dag is also a major risk factor for breech strike in these areas (Tyrell *et al.* 2014).

Unknown aetiology *Known aetiology*

									X

Prevention

Effective long-term control strategies seek to minimise the impact of parasites but also reduce the rate of development of anthelmintic resistance. Prevention is based on a combination of strategic treatment, monitoring to determine the timing and need for additional treatments, monitoring the effectiveness of drenches and integrating these with other control options, such as grazing management and selection for sheep with enhanced immunity to internal parasites to reduce the reliance on anthelmintics.

Low efficacy/ unproven preventives available *Effective preventives available*

						X			

Treatment

Treatment in the face of high worm burdens is considered part of prevention programs. The main limitation on the efficacy of anthelmintics is the widespread nature of drench resistance and the limited extent of resistance testing by sheep producers.

Low efficacy/ unproven treatments available *Effective treatments available*

							X		

Distribution

Distribution is stable although, with intensification of production systems, worm problems may increase if effective control programs are not implemented. The occurrence of severe outbreaks may increase in some areas, and the distribution of certain parasites, such as Haemonchus, may be slowly expanding due to climate change.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Prevalence is variable between years depending on climatic conditions. Prevalence may increase without continued monitoring of drench resistance as a result of potential use of products with suboptimal efficacy.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Internal parasites

Table 5-4 Assumptions: internal parasites in sheep

Variable	Value adopted	Confidence
Regional Extent	Distribution Australia wide, though problems are more serious in higher rainfall regions particularly above 450mm rainfall.	***
% Flocks affected	All flocks affected though with differing levels. Different risk zones are considered: High rainfall high risk (41%), Wheat sheep zone medium risk (47%) and Pastoral zone low risk (12%).	***
Mortalities	<u>Merinos</u> High rainfall: Weaners: 3.5% Adults: 1.7% Summer rainfall: Weaners: 6.4% Adults: 3.2% Wheat sheep: Weaners: 1.4% Adults: 0.4% Pastoral: Weaners: 0.2% Adults: 0.05% *Prime lambs: 30% of Merino enterprises*	**
Weight loss	<u>Temporary kg BW loss</u> High rainfall: Weaners: 0.8kg Adults: 1.7kg Summer rainfall: Weaners: 0.8 Adults: 1.7 Wheat sheep: Weaners: 0.3 Adults: 1.0 Pastoral: Weaners: 0.1 Adults: 0 <u>Permanent kg BW loss</u> High rainfall: Weaners: 0.8kg Adults: 1.7kg Summer rainfall: Weaners: 0.8 Adults: 1.7 Wheat sheep: Weaners: 0.3 Adults: 1.0 Pastoral: Weaners: 0.1 Adults: 0 *Prime lambs: 80% of Merino enterprises* (Kahn *et al.* 2007, Barger and Southcott, 1975, Meat & Livestock Australia Project BAHE0045 progress reports 2013-14, Carmichael *et al.* 2005)	**

Variable	Value adopted	Confidence
Fertility decline	1.5% per kg bodyweight loss	**
Fleece weight loss %	Merinos High rainfall: Weaners: 6.1% Adults: 6.1% Summer rainfall: Weaners: 6% Adults: 6% Wheat sheep: Weaners: 2.7% Adults: 2.7% Pastoral: Weaners: 0.5% Adults: 0% *Prime lambs: 2/3rd of Merino enterprises* (Kahn *et al.* 2007, Barger and Southcott 1975, Meat & Livestock Australia Project BAHE0045 progress reports 2013-14)	**
Staple strength discount N/kTex	Merinos High rainfall: Weaners: 8.5 Adults: 8 Summer rainfall: Weaners: 8 Adults: 7 Wheat sheep: Weaners: 3.5 Adults: 0 Pastoral: Weaners: 0 Adults: 0 *Prime lambs: nil* (Sackett *et al.* 2006)	**
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Considered as part of prevention program	***
Prevention	Drench frequency (per year) Weaners / Maiden ewes / Adult ewes / Wethers High rainfall: 3 / 2.2 / 2.7 / 1.8	**

<table>
<tr><th>Variable</th><th>Value adopted</th><th>Confidence</th></tr>
<tr><td></td><td>
<table>
<tr><td>Summer rainfall:</td><td>5</td><td>4</td><td>5.6</td><td>4.0</td></tr>
<tr><td>Wheat sheep:</td><td>2.5</td><td>1.8</td><td>1.5</td><td>1.3</td></tr>
<tr><td>Pastoral</td><td>0.8</td><td>0.3</td><td>0.2</td><td>0</td></tr>
</table>
Note ~ 3% capsule & 10% long acting use in HRZ
Cost of drench including labour & adjusted for long acting: $0.45/dose adults, $0.38/weaner

<u>Monitoring frequency WEC (per year)</u>
<table>
<tr><td></td><td>Weaners</td><td>Ewes</td><td>Wethers</td></tr>
<tr><td>High rainfall:</td><td>0.6</td><td>0.8</td><td>0.5</td></tr>
<tr><td>Summer rainfall:</td><td>0.6</td><td>1</td><td>1</td></tr>
<tr><td>Wheat sheep:</td><td>0.3</td><td>0.7</td><td>0.4</td></tr>
<tr><td>Pastoral</td><td>0.1</td><td>0</td><td>0</td></tr>
</table>
Cost per sheep per monitor: $0.12/sheep
Drench resistance testing: FECRT cost: $600 1% flocks/annum
(Reeve et al. 2014)
</td><td></td></tr>
<tr><td>Dags</td><td>
Proportion with dags due to worms
<table>
<tr><td></td><td>Weaners</td><td>Adults</td><td>Reduction in fleece value</td></tr>
<tr><td>High rainfall:</td><td>38%</td><td>35%</td><td>$0.34</td></tr>
<tr><td>Summer rainfall:</td><td>9%</td><td>5%</td><td>$0.09</td></tr>
<tr><td>Wheat sheep:</td><td>14%</td><td>14%</td><td>$0.15</td></tr>
<tr><td>Pastoral</td><td>0%</td><td>0%</td><td>$0.00</td></tr>
</table>
(Larsen et al. 1994)
Part crutching cost (of $1.40) allocated to dag management in wheat/sheep (10%) and high rainfall zone (25%)
</td><td>**</td></tr>
</table>

Based on the adopted prevalence and impacts of internal parasites on the classes of animals affected, GHD has calculated the annual cost of internal parasites in sheep in Australia at $436M (Table 5-5).

Table 5-5 Economic cost of internal parasites in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$5.63	$3.26	$0.71	$22.66	$9.08	$0.58	**$28.29**	**$12.34**	**$1.29**
Per Flock	$0	$0	$0	$9,317	$5,399	$1,183	$37,566	$15,037	$963	**$46,883**	**$20,436**	**$2,146**
Total	**$0M**			**$93.77M**			**$341.89M**			**$435.92M**		

If the severity of internal parasites is reduced by 50% before extra costs are considered then the gain to the industry would be $164M.

5.3 Dystocia

<u>The disease</u>

The causes of dystocia in sheep are complex but mostly commonly associated with foeto-pelvic disproportion. Risk factors include breed, nutrition, age of dam, metabolic problems such as hypocalcaemia, pasture toxicity (such as clover disease) and gender of lamb. The economic cost of dystocia is associated with increased neonatal mortality, ewe mortality and extra supervision associated with lambing. Apart from the direct loss of lambs due to dystocia, up to 80% of lambs that die within a few days of birth due to starvation-mismothering-exposure are associated with brain injury and difficult birth (Hinch et al 2014), though not all these losses associated with starvation-mismothering-exposure were considered as part of the dystocia complex. Dystocia is a risk in all climatic zones.

Unknown aetiology *Known aetiology*

						X			

Prevention

Prevention of dystocia is largely related to management including nutrition of ewes (avoiding too fat or too light (BCS 3-3.5 target). Avoiding metabolic disease is important and avoiding ewe exposure to toxic pastures will reduce the risk of dystocia. Long term improvement with genetic improvement and breed selection will help reduce dystocia.

Low efficacy/ unproven preventives available *Effective preventives available*

						X			

Treatment

Treatment of dystocia largely relates to supervision of lambing ewes. Intensive supervision must be balanced with interruption of lambing ewes where problems are of low risk.

Low efficacy/ unproven treatments available *Effective treatments available*

							X		

Distribution

Distribution is considered to be stable.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Prevalence is generally constant – but influenced by season. With the trend towards more meat sheep breeds, dystocia will increase but overall lamb losses should decrease.

Prevalence decreasing *Prevalence increasing*

					X				

Economics

Assumptions: Dystocia

Table 5-6 Assumptions: dystocia in sheep

Variable	Value adopted	Confidence
Regional Extent	All regions	***
% flocks affected	Neonatal lamb losses due to dystocia based on ewe flock include: - Merino X Merino: 5.3% - Dual purpose: 8.4% - Specialist prime lamb (first cross ewes by terminal): 5.0% (Geenty *et al. 2014*, Sentinel Flock DEPI 2012, Holst *et al. 2002*)	**
Mortalities	Mortality rates in ewes due to dystocia are assumed to be: - Merino X Merino: 0.26% - Dual purpose: 0.49% - Specialist prime lamb (first cross ewes by terminal): 0.29% - Typical dystocia rates assisted birth: 3.6% (Sentinel Flock DEPI 2012, McGrath *et al. 2013*)	**
Weight loss	Ewes that fail to rear lambs are 6% heavier in summer (Lee *et al.*1995) resulting in a subsequent fertility benefit of 4.5%. No other production losses are attributed to dystocia including impact on flock stocking rate or age structure.	***
Fleece	Ewes that lose lambs should produce about 6% more wool due to no lactation (Lee *et al.* 1995).	***
Wool	Ewes that do not rear lambs will produce slightly broader fleece but their fleece has lower staple strength (2 N/kTex) resulting in a 1% discount in fleece value. (Scrivener CJ *et al.* 1997)	**
Fertility	4.5% more lambs produced in following year	**
Market avoidance	Nil	***
Movement restrictions	Nil	***

Variable	Value adopted	Confidence
Treatment	There is no treatment apart from assisting ewes with dystocia.	***
Prevention	Supervision of flocks to reduce ewe losses with dystocia is adopted widely. On average 80% of specialist prime lamb flocks and dual purpose flocks supervise lambing with 50% of Merino flocks supervising lambing at a cost of $0.05/ewe day for 6 weeks. Further prevention relates to genetic improvement and nutritional management which should be undertaken to optimise flock reproductive performance. The cost of nutrition was not considered as part of this syndrome apart from a small cost of allocation of ewes to paddocks for lambing ($0.30/ewe).	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of dystocia in Australia at $219M (Table 5-7). Reducing dystocia rates by 50% will produce a gain to the industry of $77M before considering extra costs to achieve the benefit. Note that dystocia is a sub-set of neonatal lamb mortalities with additional loss from the mortality of ewes included (see section 5.1).

Table 5-7 Economic cost of dystocia in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$3.09	$0	$0	$8.14	$0	$0.	**$11.23**	**$0**	**$0**
Per Flock	$0	$0	$0	$4,883	$0	$0	$12,814	$0	$0	**$17,697**	**$0**	**$0**
Total	**$0M**			**$64.89M**			**$154.27M**			**$219.16M**		

5.4 Weaner illthrift and mortality

The disease

Weaner illthrift describes the syndrome of young sheep failing to thrive when other stock classes on the farm are in satisfactory health. It is manifested by poor growth and wool production, increased susceptibility to disease, and excessive mortality in young sheep in the first year after weaning. It has multiple, concurrent causes, many of which are related to nutrition and husbandry. Increased post-weaning mortality is a component of the weaner illthrift syndrome and an important contributor to adverse production and animal welfare effects of the condition. Note that a number of disease syndromes contribute to weaner illthrift and mortality including internal parasites, liver fluke, footrot, perennial ryegrass toxicosis, pneumonia, mastitis and flystrike.

Unknown aetiology *Known aetiology*

							X		

Prevention

Recent studies have concentrated on factors that reduce weaner mortality, with nutrition having a significant effect. Improving weaner bodyweight, and growth rates in particular, profoundly reduces post-weaning mortality. It is likely that strategies to improve survival would reduce illthrift in general, as would prevention of specific components of the illthrift syndrome, such as strategic worm control and blowfly strike prevention and treatment.

A national survey of weaner management (Campbell *et al.* 2014) identified that 'excessive' (> 4%) mortality was less likely on farms that subdivided weaner mobs based on body weight or condition score, presumably because this allows lightweight, high mortality risk weaners to receive differential management or improves their access to feed. The same study showed that offering high-protein supplementary feeds, such as lupins, improved survival.

The key barrier to these various strategies, effectively reducing weaner illthrift, appears to still be communicating the key information to farmers and encouraging them to monitor risk factors such as body weight and growth rate, and adjust nutritional management and husbandry accordingly.

Low efficacy/ unproven preventives available *Effective preventives available*

						X			

Treatment

Treatment for specific factors contributing to weaner illthrift, including gastrointestinal parasitism and blowfly strike, exist and are discussed elsewhere in this review.

Low efficacy/ unproven treatments available | *Effective treatments available*

							X		

Distribution

Distribution of weaner mortalities is widespread across climatic zones though more severe in the pastoral zone and in Merinos compared with Merino-cross weaners.

Distribution contracting | *Distribution stable* | *Distribution increasing*

				X					

Prevalence

Based on a single year's survey in 2008 (Campbell *et al.* 2014), weaner mortality appears to be highest in the pastoral zone (average annual post-weaning mortality 7.7%) compared to the wheat-sheep (4.4%) and the high rainfall (4.6%) zones. Average weaner mortality was greater in Queensland (6.1%), Western Australia (5.8%) and Tasmania (5.2%) compared to NSW or Victoria (both 4.4%) or South Australia (3.5%). Greater mortality was reported in Merino enterprises (5.2%) than crossbred flocks (4.6%). Similar results were observed in 2009 and 2010 Wool Desk surveys (K. Curtis, unpublished).

These figures were self-reported by farmers during a telephone survey and are likely to be biased, with actual weaner mortality probably higher than those reported. For example, average weaner mortality has been reported at 11% in Victoria (Mackinnon Project, unpublished, reported in Campbell *et al.* (2009)), 7% Central Tablelands, NSW (Hatcher *et al.* 2010), 15% Yass, NSW (Hatcher *et al.* 2008) and 6–9% in South Australia (Hocking-Edwards *et al.* 2008).

It is also difficult to estimate the prevalence of illthrift, above that of actual weaner mortality. Since post-weaning mortality represents an extreme form of weaner illthrift, it could be reasonable to estimate that the additional prevalence of illthrifty weaners in a flock is 1–2 times the actual weaner mortality.

Prevalence decreasing | *Prevalence increasing*

				X					

Economics

Assumptions: Weaner illthrift and mortality

Table 5-8 Assumptions: weaner illthrift and mortality in sheep

Variable	Value adopted	Confidence
Regional Extent	Regional differences are based on climatic zones with highest risk pastoral zone (12% of the sheep flock), moderate risk high rainfall zone (41% of the sheep flock) and lowest risk in the wheat sheep zone with (47% of the sheep flock)	***
% Flocks affected	Weaners affected with illthrift High rainfall zone: Merino 9.8%; Dual purpose 7.4% Wheat sheep zone: Merino 9.7%; Dual purpose 6.4% Pastoral zone Merino: 17.0%, Dual purpose 12.0% Prime lamb flocks not affected	***
Mortalities	50% mortality in affected weaners (only ewe weaners for dual purpose as wether weaners sold)	**
Weight loss	Temporary weight loss of 5 kg in affected weaners (Merino); 3 kg for crossbred lambs in dual purpose flocks	**
Fertility	3.75% Merino, 3% dual purpose for maidens ewes previously affected by illthrift	*
Fleece weight	13% reduction in Merinos, 7% reduction in dual purpose	**
Wool price	7% reduction in price for Merino weaner wool due to lower staple strength	**
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Considered in specific diseases	**
Prevention	50% flocks in high rainfall and wheat sheep zones adopt grain feeding at a cost including labour of $4.03/animal (2.5 kg/month for 5 months)	*

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of weaner illthrift and mortality in sheep in Australia at $188M (Table 5-9).

Table 5-9 Economic cost of weaner illthrift and mortality in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$0	$1.53	$1.53	$8.71	$5.14	$4.77	**$8.71**	**$6.67**	**$6.30**
Per Flock	$0	$0	$0	$0	$2,529	$2,529	$14,422	$8,498	$7,904	**$14,422**	**$11,027**	**$10,433**
Total	**$0M**			**$36.15M**			**$151.40M**			**$187.55M**		

Note that this syndrome includes a number of different diseases including gastrointestinal parasitism. Hence, when considering the financial cost of weaner mortality and illthrift, it should not be considered in addition to other diseases such as gastrointestinal parasitism.

The net gain from moving all flocks to below an industry standard of 4% mortality rate is estimated at $40.34M.

5.5 Flystrike

<u>The disease</u>

Flystrike is an important disease of sheep with two main presentations: breech strike and body strike. Other strikes include pizzle strike, poll strike and wound strike. Breech, body and pizzle strike are considered as part of the evaluation undertaken. *L. cuprina* is by far the most important fly species accounting for at least 90% of all strikes. There are a number of important risk factors including:

- Susceptible sheep: for breech strike, urine and faecal staining caused by scouring mostly associated with internal parasites, enteritis and pasture. Less wrinkle and more breech bare area reduce the risk as will mulesing. For body strike, sheep that develop fleece rot and dermatophilosis especially in wet conditions are most at risk. Pizzle strike is associated with urine staining of the belly wool. In the long term selection for sheep genetic parameters will reduce sheep susceptibility.
- Suitable weather conditions associated with moisture and warmth with prolonged wet conditions with susceptible sheep resulting in fly strike waves.
- Sheep and farm management: a number of important management factors have a major impact into the risk of flystrike including time of shearing, crutching, chemical prevention, mulesing, tail docking procedures, control of scouring, paddock selection for susceptible sheep, control of fly numbers, and genetic selection of sheep.

The economic cost associated with flystrike is due to mortalities, production losses associated with loss of wool growth and value, weight loss including reproduction penalty, treatment and prevention costs.

Unknown aetiology *Known aetiology*

								X	

Prevention

An integrated approach to flystrike control can be very effective including reducing sheep susceptibility by chemical control, genetic selection and management and reducing fly populations during at-risk periods (Larsen *et al*. 2012a, Larsen *et al*. 2012b, Lucas *et al*. 2013).

Low efficacy/ unproven preventives available *Effective preventives available*

							X		

Treatment

Treatment of individual struck sheep is effective, especially if implemented early. A number of effective and safe chemicals are available to kill fly larvae in association with clipping flystrike affected wool with their use reasonably well adopted. Treatment of severe flystrike cases with antibiotics and anti-inflammatory therapeutics will improve survival rates. The main limitation to effective treatment is the labour requirement for supervision and early intervention.

Low efficacy/ unproven treatments available *Effective treatments available*

							X		

Distribution

Distribution is stable though varies widely with seasonal conditions.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Prevalence is generally constant – but influenced greatly by season. The risk of flystrike will potentially increase if effective preventive treatments are not adopted to counteract the decline in mulesing. Managing flystrike will become more difficult with L. *cuprina* developing chemical resistance.

Prevalence decreasing *Prevalence increasing*

				X					

<u>Economics</u>

Assumptions: Flystrike

Table 5-10 Assumptions: flystrike in sheep

<table>
<tr><th>Variable</th><th>Value adopted</th><th>Confidence</th></tr>
<tr><td>Regional Extent</td><td>High rainfall; wheat-sheep; and pastoral zones are considered as high, medium and low risk respectively.</td><td>***</td></tr>
<tr><td>% flocks infected</td><td>Average flystrike prevalence per property (Reeve et al. 2014, Sackett et al. 2006)
<table>
<tr><th></th><th>High rainfall</th><th>Wheat sheep</th><th>Pastoral</th></tr>
<tr><td><u>Ewes</u></td><td></td><td></td><td></td></tr>
<tr><td>body</td><td>2.1%</td><td>1.5%</td><td>2.3%</td></tr>
<tr><td>breech</td><td>2.4%</td><td>2.3%</td><td>2.1%</td></tr>
<tr><td><u>Weaners</u></td><td></td><td></td><td></td></tr>
<tr><td>body</td><td>3.4%</td><td>2.9%</td><td>3.9%</td></tr>
<tr><td>breech</td><td>2.8%</td><td>2.5%</td><td>2.4%</td></tr>
<tr><td>pizzle</td><td>0.5%</td><td>0.9%</td><td>0.2%</td></tr>
<tr><td><u>Wethers</u></td><td></td><td></td><td></td></tr>
<tr><td>body</td><td>1.5%</td><td>1.6%</td><td>2.8%</td></tr>
<tr><td>breech</td><td>0.9%</td><td>1.3%</td><td>2.1%</td></tr>
<tr><td>pizzle</td><td>0.6%</td><td>0.8%</td><td>1.6%</td></tr>
</table>
Note: It is assumed 40-60% of producers jet at strategic times, 30-40% at high risk times and 20% when fly strike detected. 35% of producers only treat individual struck sheep. 30% cross over between breech and body strike</td><td>**</td></tr>
<tr><td>Mortalities</td><td>10% for adults; 20% for hoggets - averaged across body, breach and pizzle strikes (Lucas et al. 2013, Sackett et al. 2006)</td><td>**</td></tr>
<tr><td>Weight loss</td><td>12% for body, breach and pizzle strike (Lucas et al. 2013)</td><td>***</td></tr>
<tr><td>Fleece</td><td>Clean fleece weight reduction of 8%</td><td>***</td></tr>
<tr><td>Wool</td><td>Fibre diameter penalty of 1.5 micron/kg cfw loss; staple strength reduction 18 N/KTex for 100% of affected sheep (Lucas et al. 2013, Sackett et al. 2006, Colditz et al. 2005). Wool price discount (%) as per below (Nolan 2012).
<table>
<tr><th>Staple strength N/kTex</th><th>Superfine</th><th>Fine</th><th>Medium</th></tr>
<tr><td>28-38</td><td>5%</td><td>2%</td><td>1%</td></tr>
<tr><td>21-28</td><td>9%</td><td>5%</td><td>4%</td></tr>
</table></td><td>***</td></tr>
</table>

Variable	Value adopted	Confidence
	14-21 16% 9% 8% <14 18% 11% 10%	
Fertility	1.5% per kg body weight for 50% of body weight loss	**
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Clip wool and apply chemical to affected sheep ($5.05/sheep mostly labour - 10 minutes/sheep @ $30/hour), 1% treated with antibiotics @$5.00/sheep. 80% of affected pastoral sheep treated; 90% of wheat-sheep and high rainfall affected sheep are treated.	**
Prevention	Between 40-60% of producers jet at strategic times, 30-40% at high risk times and 20% when fly strike detected. 35% of producers only treat individual struck sheep. 30% cross over between breech and body strike. (Reeve *et al.* 2014) Chemical group (from Flyboss 2014) / Cost $/sheep crutch & body / Cost $/sheep body / Cost $/sheep crutch Clik: $1.43 / $0.95 / $0.43 Cyromazine jet: $0.30 Cyromazine spray: $0.59 Spinosad: $0.53 ML: $0.47 Labour costs Shortwool backliner: $0.20 Long wool hand jetting: $0.50 Long wool backliner: $0.30 Jetting race: $0.10	**

Variable	Value adopted		Confidence
	Mulesing:	$0.90 (excluding lamb marking cost, include Clik) (48% producers mulesing 70% for Merinos 20% for self-replacing meat sheep)	
	Trisolvin:	$0.75 (60% use)	
	Crutch:	assume 50% of crutch cost allocated to flystrike at $1.40/animal = $0.70	

Based on the adopted prevalence and impacts of flystrike on the classes of animals affected, GHD has calculated the annual cost of flystrike in sheep in Australia at $173M (Table 5-11). This figure will vary widely in individual years depending on climatic conditions.

Table 5-11 Economic cost of flystrike in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0.49	$0.44	$0.44	$2.38	$2.18	$1.87	$5.06	$4.69	$5.01	**$7.93**	**$7.31**	**$7.31**
Per Flock	$821	$731	$727	$3,956	$3,628	$3,103	$8,387	$7,780	$8,310	**$13,165**	**$12,139**	**$12,140**
Total	**$11.34M**			**$57.30M**			**$104.53M**			**$173.17M**		

Reducing the prevalence of flystrike by 50% before considering extra costs will reduce the cost of flystrike to the industry by $43.5M.

5.6 Perennial rye grass toxicosis

The disease

Perennial ryegrass (PRG) pastures infected with the wild-type (WT) endophyte *Neotyphodium lolii* produces several classes of alkaloids which, when ingested by livestock, cause perennial ryegrass toxicosis (PRGT). The effects of PRGT are widespread and potentially severe, with serious outbreaks causing considerable production losses, animal welfare problems and further indirect costs and subclinical losses resulting in considerable economic losses. Fungal endophytes in ryegrass act in a symbiotic relationship providing resistance to insect pests and thus confer agronomic advantages which enhance the persistence and productivity of ryegrass (Leury *et al*. 2013).

The two main alkaloids that cause toxicosis of livestock include Lolitrem B and Ergovaline. Lolitrem B, a neurotoxin that affects muscle activity, has widespread impact on the respiratory, cardiovascular and digestive systems. It causes tremors and has profound effects on smooth muscle, altering gut motility and severely disrupting digestion. Ergot alkaloids interact with dopamine receptors leading to peripheral vaso-constriction, disruption of thermoregulation and endocrine dysfunction. Reduction of blood circulation to glands, skin and extremities raises blood pressure, temperature and respiration rate causing heat stress, reduced food intake and serum prolactin, and potentially impaired reproductive efficiency (Reed 2005).

It is estimated that six million hectares are sown to PRG predominantly in Victoria, Tasmania southern South Australia and Western Australia and parts of the high rainfall regions of New South Wales, with old populations having a frequency of *N. lolii* infection of 80-90% (Reed *et al.* 2004).

The concentration of toxic alkaloids peaks in summer autumn. Clinical signs vary between years depending on environmental conditions (and consequent pasture growth) and composition of pastures. Symptoms are usually more severe in years when late spring rain results in carryover feed in summer, followed by summer rain that triggers some growth, which is then followed by dry and hot conditions in summer and autumn that stress pasture. Severe outbreaks tend to occur approximately every five years, although in high risk regions some outbreaks occur every year with additional ongoing subclinical effects occurring well after staggers has diminished.

Economic losses are caused by mortalities (misadventure, drowning, chronic recumbency and hyperthermia, as well as secondary consequences due to flystrike and parasitism), production losses associated with lower weight gain, poor reproductive performance, increased dags and reduced fleece values. In outbreak years, substantial labour resources are diverted to husbandry to manage the welfare of affected sheep. Many indirect impacts of PRGT are associated with interference and delay of normal farm husbandry procedures such as worm control and fly control resulting in lower production and higher death rates. From a social perspective, the overwhelming impact of a severe PRGT event causes substantial stress on managers of affected sheep flocks (and cattle herds).

There are several important strategies to minimise the impact of outbreaks and ongoing production losses. In the first instance, supervision of recumbent stock and removal of at risk mobs from toxic to safe pastures will minimise losses. If no safe pastures are available, either supplementing to dilute toxic pastures or, if severe, removal from pasture and feedlotting may be necessary. Novel alkaloid detoxifying agents such as Elitox® or Mycofix® supplemented in a lick appear to have beneficial effects at reducing the impact of PRGT.

In the long term, replacement of PRG pastures infested with wild-type endophytes with safe pastures is the best solution as long as successful establishment is achieved and new pastures are persistent and more productive (Leury *et al.* 2014). Safe pastures include alternative pasture species (such as phalaris, fescues and cocksfoot), PRG with novel endophytes (such as AR37 or Endo 5) that are less toxic to stock and still protect against insect attack. Many persistent cultivars and species of pastures are available that are more productive than PRG infected with wild type endophyte. Some endophyte-free cultivars of PRG are commercially available but poor persistence is an issue. The main limitation to adoption of whole scale replacement of toxic pasture is the cost, risk of failure, concern about persistence of new pasture, concern that new pasture will be re-invaded with wild type PRG and timeframe to achieve an adequate return on investment.

The cause of PRGT is well known though some of the physiological effects and production impacts of toxic alkaloids are not clear. In addition, the importance of alkaloids apart from Lolitrem B and Ergovaline are not as clear.

Unknown aetiology — *Known aetiology*

								X	

Prevention

Prevention relies on removal of stock from toxic to safe pastures, diluting the effects of toxic pastures and by supplementary feeding or feedlotting during severe outbreaks. Alkaloid detoxifying agents are commercially available however the full benefits of compounds available are not well documented. In the long term permanent replacement of toxic pastures with safe pasture is economically viable as long as replacement pastures are persistent and more productive.

Low efficacy/ unproven preventives available — *Effective preventives available*

							X		

Treatment

No therapeutic compound is available to treat PRGT. The only option to treat clinically affected stock is to remove them from toxic pasture and provide supportive husbandry (food and water) whilst they recover.

Low efficacy/ unproven treatments available — *Effective treatments available*

	X								

Distribution

The distribution of PRGT is limited to high rainfall regions (>600 mm) where PRG with wild-type endophyte is grown. PRG with wild-type endophyte is grown on at least six million hectares in southern Australia, particularly in Victoria and Tasmania but also NSW, southern South Australia and southern Western Australia. Increased fertiliser application encourages PRG hence potentially increasing the severity of outbreaks over time. Producers that have previously experienced severe outbreaks of PRGT are actively replacing toxic PRG pasture, though the extent of this is relatively small.

Distribution contracting — *Distribution stable* — *Distribution increasing*

				X					

Prevalence

The prevalence of PRGT varies from season to season. In high risk regions severe outbreaks occur in about 20% of years and moderate impact in 40% of years. In moderate risk regions, outbreaks occur about 30% of the time and in low risk regions outbreaks occur about 10% of the time (Sackett *et al.* 2005). Weaners are more at risk than adult sheep and Merinos appear more susceptible than crossbred sheep and meat breeds. Prevalence is generally stable, though varies between years depending on climatic conditions.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: PRGT

Table 5-12 Assumptions: PRGT in sheep

Variable	Value adopted	Confidence
Regional Extent	About 11.2% of Australia's sheep flock is exposed to a high risk of PRGT, about 3.5% to a medium risk and 9.2% to a low risk of PRGT. The remainder of the sheep population is not exposed to PRGT. PRGT is highest risk in higher rainfall regions of Victoria and Tasmania.	***
% Flocks affected	High risk flocks are exposed to a severe impact in 20% of years, a moderate impact in 40%, a low impact in 20% and no risk in 20% of years. Moderate risk flocks are exposed to a moderate impact in 30% years and low impact 10% of years. Low risk flocks are exposed to a low impact in 10% of years.	**
Mortalities	No accurate published data is available but based on experience and surveys, the following estimates are used: Weaners / Adults High impact: 12% / 7% Moderate impact: 3% / 2% Low impact: 1% / 0%	**
Weight loss	Weight loss data is highly variable between trials and regions though a best estimate of the temporary weight loss attributed to PRGT is: Weaners / Adults High impact: 2 kg / 2 kg Moderate impact: 1 kg / 1 kg	**

<table>
<tr><th>Variable</th><th>Value adopted</th><th>Confidence</th></tr>
<tr><td></td><td>Low impact 0 0</td><td></td></tr>
<tr><td>Fertility</td><td>The impact of PRGT on reproductive performance is highly variable. Based on experience and trials the following estimates have been used (the impact is likely to be due to the direct effects of PRGT and the secondary impacts on lower bodyweight): High impact - 12% reduction; moderate impact - 6%; low impact - 2%.</td><td>*</td></tr>
<tr><td>Fleece weight %</td><td>Little data is available on the effects on wool growth, however in some longer term trials in NZ reduced wool growth has been experienced as is the case in Australia in outbreak years. Fleece weight reductions are assumed to be: 10% for high impact, 4% for moderate and 0.5% for low impact scenarios.</td><td>**</td></tr>
<tr><td>Wool price discounts</td><td>Staple strength reduced by 5 N/kTex in high risk situations.</td><td>*</td></tr>
<tr><td>Market avoidance</td><td>No information is available, although timing of sales is often restricted due to inability to transport staggering stock. 5% of stock sales are assumed to be delayed by 2 months.</td><td>**</td></tr>
<tr><td>Movement restrictions</td><td>Nil</td><td>**</td></tr>
<tr><td>Treatment</td><td>
<table>
<tr><th></th><th>Labour[1]</th><th colspan="2">Supplementary Feed (amount & cost)[2]</th><th colspan="2">Extra drenching[3]</th></tr>
<tr><td></td><td></td><td>Weaners</td><td>Adults</td><td>Weaner</td><td>Adults</td></tr>
<tr><td>High Impact</td><td>$2400</td><td>10 kg $2.50</td><td>5 kg $1.25</td><td>1</td><td>0.5</td></tr>
<tr><td>Moderate Impact</td><td>$1200</td><td>5 kg $1.25</td><td>2 kg $0.50</td><td>0.5</td><td>0</td></tr>
<tr><td>Low Impact</td><td>$400</td><td>3 kg $0.75</td><td>0</td><td>0</td><td>0</td></tr>
</table>
1. The total extra cost of labour to manage a high impact, moderate and low cost scenario ($/flock).
2. Supplementary feeding required over an outbreak at a cost of $250/t ($/head)
3. Likely extra drenching undertaken due to poor timing of drenches and producer response to extra dags. Cost of drenching $0.45/dose adults, $0.38/weaner.
</td><td>**</td></tr>
</table>

<table>
<tr><th>Variable</th><th>Value adopted</th><th>Confidence</th></tr>
<tr><td>Prevention</td><td>No cost considered although pasture renovation costs may be substantial.</td><td>**</td></tr>
<tr><td>Other costs and production losses</td><td>Additional costs associated with PRGT

<u>Increased dags</u>

PRGT increases dag in sheep. The cost associated with this is reduced wool value due to faecal soiling and extra crutching costs

<table><tr><th></th><th>Weaners</th><th>Adults</th></tr><tr><td>High impact</td><td>$0.54</td><td>$0.54</td></tr><tr><td>Moderate impact</td><td>$0.43</td><td>$0.43</td></tr><tr><td>Low impact</td><td>0</td><td>0</td></tr></table>
<u>Other production losses associated with PRGT</u>
<u>Reduced milk production:</u> 13% lower in sheep in high risk flocks resulting in 2.4 kg/lamb decrease in weight; 6.5% lower in moderate impact scenarios 1.2 kg/lamb decrease in weight.

<u>Lower bodyweights:</u> Adult sheep with consistently lower bodyweight when grazing toxic pastures even when clinical staggers is not apparent. This has several potential effects including:
Lower bodyweight of adult sheep so lower sale value (~2 kg high, ~ 1kg moderate) and lower reproduction (3%)
Lifetime wool impact of ewes consistently in lower body condition estimated to produce progeny that have fleeces that have 0.1 kg clean less wool but the fleece is 0.3 micron higher fibre diameter.</td><td>**</td></tr>
</table>

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of PRGT in sheep in Australia at $105M (Table 5-13). This disease was not considered in the Sackett *et al* report, though a separate project undertaken by Sackett and Frances (2006) calculated to cost of PRGT at $63M using similar methodology and assumptions to the Sackett report.

Table 5-13 Economic cost of PRGT in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$1.91	$0.63	$0.07	$31.03	$11.55	$2.32	**$32.94**	**$12.18**	**$2.39**
Per Flock	$0	$0	$0	$3,161	$1,049	$123	$51,369	$19,120	$3,840	**$54,530**	**$20,169**	**$3,964**
Total	**$0M**			**$5.95M**			**$99.05M**			**$104.99M**		

If the area of land affected with PRGT is reduced by 50% before extra costs are considered then the cost to industry would reduce by $52.5M.

5.7 Lice

<u>The disease</u>

Lice infestation caused by *Bovicola ovis* is an important disease of the Australian sheep flock causing significant economic loss through reduction in fleece values, lower bodyweight and the cost of control and prevention. The most recent survey (Reeve *et al.* 2014) indicates that as of 2011, 23.3% of producers Australia-wide reported seeing live lice in their flocks with 27.1% of producers reporting some sheep rubbing and 54.1% reporting no evidence of lice. It appears that the prevalence of lice has increased from 10% in 2006 and the number of flocks reporting no evidence of lice has reduced from 62.6% in 2006 to 54.1% in 2011.

There are several important reasons for the likely increase in prevalence of lice in the Australian sheep flock (James 2011). Firstly, the emergence of chemical resistance to the IGR group of chemicals that was first detected in the early 2000's (until recently the IGR group was important for the control and eradication of lice). It should be noted that the recent introduction of highly effective chemicals onto the market is likely to restrict the development of chemical resistance and result in reduced use of inferior chemicals. Secondly, the withdrawal of the effective chemical diazinon (due to OH&S issues) from the market in 2009 and its replacement with less effective products may have contributed to the increase in prevalence reported at the time. Currently, there are effective chemicals available to control and eradicate lice, so the prevalence is more likely to be stable.

Ongoing poor application technique and poor biosecurity are continuing issues. The emergence of exotic breeds, especially in pastoral areas is likely to increase the prevalence of lice due to the perception that treatment is not necessary and these breeds appear to be less restricted by conventional fencing. The increased use of meat breeds resulting in increased trading of breeding stock will potentially increase transmission and spread of lice.

Unknown aetiology — *Known aetiology*

									X

Prevention

There are effective strategies to prevent lice including on farm biosecurity measures such as quarantining introduced sheep, ensuring secure boundary fencing and proper use of available products. Ongoing development of chemical resistance will result in reduced efficacy of products if reliance on chemicals continues.

Low efficacy/ unproven preventives available — *Effective preventives available*

							X		

Treatment

There are effective chemicals to control lice however effectiveness is reduced due to poor application technique. Ongoing development of chemical resistance will result in reduced efficacy of products if reliance on chemicals continues.

Low efficacy/ unproven treatments available — *Effective treatments available*

						X			

Distribution

Distribution is stable to possibly increasing in pastoral areas as the population of non-woolled breeds increases where less lice control is used.

Distribution contracting — *Distribution stable* — *Distribution increasing*

					X				

Prevalence

Prevalence is generally stable but may possibly increase as chemical resistance emerges. The introduction of new chemical groups may stabilise prevalence until resistance develops to new chemical groups. Recent evidence indicates that lice prevalence is increasing slightly.

Prevalence decreasing *Prevalence increasing*

					X				

Economics

Assumptions: Lice

Table 5-14 Assumptions: lice in sheep

Variable	Value adopted	Confidence
Regional Extent	All sheep regions	***
% flocks infected	Prevalence 43% (pastoral zone) and 29% (wheat/sheep and high rainfall zones) (Reeve 2014).	***
Mortalities	Nil	***
Weight loss	No reduction in bodyweight	**
Fleece weight	Reduction in clean fleece weight of between 2% – 18% (Wilkinson *et al.* 1982, Wilkinson 1988)	***
Wool price	Wool price discount average 2% in pastoral zone and 1% in wheat sheep and high rainfall zones). Discount on cotting range from 0.1 for soft cotts to 17% for severe cotting, depending on micron (Nolan 2012). No fibre diameter discount (Wilkinson *et al.* 1982, Wilkinson 1988).	**
Fertility	Nil	***
Market avoidance	Nil	***
Movement restrictions	Notifiable disease in some states restricts selling opportunities until infestation controlled, although no price discount on sale sheep considered.	**
Treatment	Range of different treatment methods varying from off-shears back lining, short wool dip and long wool back lining. Average treatment cost of $1.42/adult (LiceBoss 2014) with 28%, 10% and 8% treated	***

Variable	Value adopted	Confidence
	to control lice in long wool for pastoral, wheat/sheep and high rainfall zone respectively.	
Prevention	Similar to treatment but effectiveness of lice prevention is restricted due to poor on farm biosecurity and poor application of chemicals to eradicate lice. Average prevention cost of $0.85/adult (LiceBoss 2014) with 68%, 66% and 52% treated for control and eradication after shearing in pastoral, wheat/sheep and high rainfall zone respectively.	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of lice in sheep in Australia at $81M (Table 5-15). The reduction in the cost of lice is consistent with reduced sheep numbers in Australia.

Table 5-15 Economic cost of lice in sheep

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0.50	$0.12	$0.10	$1.92	$1.87	$1.51	$2.00	$0.87	$0.87	**$4.42**	**$2.86**	**$2.48**
Per Flock	$827	$199	$159	$3,182	$3,098	$2,510	$3,333	$1,445	$1,445	**$7,342**	**$4,743**	**$4,115**
Total	**$3.77M**			**$41.19M**			**$25.54M**			**$81.08M**		

The net gain of moving all flocks to the lowest level of lice disease in sheep is estimated at $10.13M.

5.8 Mastitis

The disease

Sheep mastitis is present in the Australian sheep flock in a number of forms. This includes severe forms leading to peracute gangrenous mastitis, predominantly caused by *Mannheimia sp.* and *Staphylococcus aureus*. A number of other bacteria lead to more chronic forms of clinical mastitis leading to changes in milk quality, quantity and udder appearance. Sub-clinical mastitis caused predominantly by Staphylococci and Streptococci is also relatively common in some breeds leading to potential reductions in lamb growth rate due to a reduction in milk quality and quantity during infection. Mastitis can lead to death of ewes and/or death of their lambs or may only result in a reduction in performance due to reductions in ewe bodyweight, lamb weaning rate or lamb and ewe survival rates. The cause of clinical mastitis is well established but more work is needed to elucidate importance of sub-clinical mastitis.

Unknown aetiology *Known aetiology*

						X			

Prevention

There are no current preventive strategies available for sheep producers although some vaccine development work was undertaken in the 1990's and some autogenous vaccines have demonstrated efficacy. No products are commercially available.

Low efficacy/ unproven preventives available *Effective preventives available*

X									

Treatment

Treatment of clinical cases of mastitis is limited to injectable antibiotics with potential use of extra-label intramammary antibiotics. The primary problem with this treatment is in treating animals prior to significant health impacts on the ewe or on their progeny. It is common in peracute cases for both the ewe and lamb to die within a few days of infection leaving minimal time for diagnosis and treatment by the farmer and/or veterinarian.

Low efficacy/ unproven treatments available *Effective treatments available*

					X				

Distribution

Mastitis of sheep is spread widely across all sheep raising areas. Due to a lack of survey data there is no good reference point to know if incidence is changing. A further difficulty is that mastitis rates vary considerably from year to year due to environmental factors, hence measurement is required over several years to monitor any real long term trends.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

The prevalence of mastitis is likely to be increasing as more ewes are bred for prime lamb productions systems. These ewes tend to have higher milk production than Merinos and higher rates of twinning, hence are more likely to develop mastitis.

Prevalence decreasing *Prevalence increasing*

						X			

Economics

Assumptions: Mastitis

Table 5-16 Assumptions: mastitis in sheep

Variable	Value adopted	Confidence
Regional Extent	Generally restricted to high rainfall and sheep/wheat zones	**
% Flocks affected	Clinical mastitis in British Breeds - 5% (such as pure Poll Dorsets hence serious problem in seed stock enterprises) Clinical mastitis in prime lamb maternals - 2.5% Clinical mastitis in Merino - 1% Sub-clinical mastitis in British Breeds - 30% Sub-clinical mastitis in prime lamb maternals - 15% Sub-clinical mastitis in Merino - 7% (Omaleki *et al.* 2011, Barber *et al.* 2011)	*
Mortalities	40% of clinical cases die. Ratio of twin to single dams in this is generally 2:1 with most (80%) lambs dying (Omaleki *et al.* 2011)	**
Weight loss	Significant weight loss in clinically affected ewes (if they survive) estimated at 5kg temporary. Many clinically affected ewes that survive will be culled. Lambs that survive from clinically affected ewes are assumed to be 15% lighter. Sub-clinical mastitis - reduced weaning weight of lambs by 9%. This may have more importance in survivability for Merino lambs due to lower weaning weights (De Olives *et al.* 2013).	**
Fertility	Ewes with clinical mastitis produce 4% less lambs in	*

Variable	Value adopted	Confidence
	following year	
Fleece weight %	Estimate 5% less for clinical cases that survive.	*
Wool price discounts	Large reduction in tensile strength in clinical cases, though not documented (estimate at 15 N/kTex). Presumably some reduction in subclinical but minimal though not documented.	**
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Available, but limited due to low detection rates. Assume 10% clinical cases treated with antibiotics - $10/case.	*
Prevention	Nil available	**
Other costs		

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of mastitis in sheep in Australia at $52M (Table 5-17). This estimate is highly uncertain due to lack of data on prevalence both in terms of prevalence in breeds other than British Breeds and the uncertain impact of subclinical mastitis. Part of the cost of mastitis is a subset of neonatal mortalities.

Table 5-17 Economic cost of mastitis in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0.01	$0	$0	$0	$0	$0	$2.82	$0	$0	**$2.83**	**$0**	**$0**
Per Flock	$19	$0	$0	$0	$0	$0	$4,589	$0	$0	**$4,608**	**$0**	**$0**
Total	**$0.23M**			**$0M**			**$51.97M**			**$52.20M**		

The net gain from moving all flocks to the lowest level of mastitis disease is estimated at $52.20M. This would completely offset the current estimated economic cost of mastitis.

5.9 Footrot

<u>The disease</u>

Footrot is a complex disease caused by the bacteria *Dichelobacter nodosus*. Footrot causes a large spectrum of clinical disease ranging from benign footrot, which is widespread and usually causes mild disease, to virulent footrot which can cause severe disease and substantial economic loss if left uncontrolled. Intermediate footrot is sometimes described and refers to strains between benign and virulent. The clinical expression of the disease is dependent on several important factors including the strain or strains of *D nodosus* present, the local environment (specifically moisture availability, temperature and pasture conditions), the resistance of sheep to footrot and whether control is restricting the clinical expression of the disease. All these factors must be considered when making a diagnosis of the specific strain of footrot present. In most states virulent footrot is a notifiable disease. Diagnosis is usually based on clinical expression although, depending on individual state regulations, additional laboratory tests may be used to classify the strain. However, there are serious limitations on the ability of laboratory tests to classify the strains (Allworth 2014).

Production losses associated with footrot depend on the strain of footrot, breed of sheep, local environment and control measures adopted. The impact of footrot is less severe in years of short growing seasons and low rainfall compared with years of high rainfall and extended growing seasons when more sheep become infected with more severe lesions that affect sheep for a longer period of time. The clinical expression of some intermediate-type strains is benign under lower rainfall conditions and more virulent in high rainfall regions. The analysis in this report is based on the clinical appearance.

Virulent footrot is very costly if not adequately controlled when endemic, with the cost of eradication exceeding $10/sheep (Allworth 1990). Indirect costs can exceed the direct costs of the disease with management distracted by the need to reduce stocking rates or delay other critical management events resulting in increased animal health problems such as worms or flystrike. In contrast, benign footrot has a relatively minor impact on production and control measures are not as expensive.

Unknown aetiology *Known aetiology*

								X	

Prevention

Biosecurity measures to ensure footrot is not introduced include limiting the purchase of new sheep, inspection and quarantine of new sheep, and ensuring boundary fences prevent the introduction of stray sheep. Control of footrot when present depends on the strain of footrot present, the local environment and management skills, but is largely based on the use of footbathing (usually with zinc sulphate) during spread periods to limit the severity of existing lesions and slow the development of new lesions. Vaccines previously registered are no longer available although a new targeted mono/bivalent vaccine (Dhungyel *et al.* 2008) appears very effective at controlling and possibly eradicating footrot in some situations. Eradication of footrot is achieved by inspection and culling of infected sheep during non-spread periods or total destocking.

Low efficacy/ unproven preventives available | *Effective preventives available*

							X		

Treatment

Treatment of footrot is most commonly based on footbathing using zinc sulphate, particularly during wet periods when the disease is progressing. The efficacy of footbathing is limited by the intensive labour required, particularly with virulent strains where regular footbathing is required. There is also the difficulty of footbathing during lambing if this coincides with spread periods. During dry periods, parenteral antibiotics are commonly used to salvage severely affected sheep and may also be part of a footrot eradication program to cure infected sheep thus reducing the number of sheep that require culling.

Low efficacy/ unproven treatments available | *Effective treatments available*

							X		

Distribution

After a period where state based footrot eradication programs successfully reduced the level of virulent footrot, the distribution of footrot is relatively stable. Benign footrot is widespread across all high rainfall regions of Australia and virulent footrot is widespread in Tasmania and to a lesser degree in the high rainfall regions of Victoria. Intermediate strains are widespread in Victoria and to a lesser degree in southern NSW where conditions are less conducive to their expression due to shorter growing seasons. In Tasmania, the widespread distribution of virulent footrot probably overwhelms the level of intermediate strains.

Distribution contracting | *Distribution stable* | *Distribution increasing*

				X					

Prevalence

The prevalence of footrot depends on the strain of footrot present on farm, local environmental and climatic conditions, and control measures adopted. The prevalence of footrot lesions in sheep on a farm can range from very low (<5%) in drought years to over 80% in wet years with extended growing seasons.

Prevalence decreasing … *Prevalence increasing*

				X					

Economics

Assumptions: Footrot

Note that economic costs are calculated separately for benign footrot and for virulent/intermediate footrot

Table 5-18 Assumptions: footrot in sheep

Variable	Value adopted	Confidence
Regional Extent	Distribution of virulent footrot predominantly in high rainfall regions of Victoria and Tasmania. Benign footrot widely distributed across high rainfall zone of Australia.	**
% Flocks affected	Based on state reports and surveys: State – Benign >450mm^ – Virulent (intermediate) NSW – 40% – 0.4%* (5% intermediate in HRZ) Tasmania – 40% – 25% (15%) Victoria – 50% – 4% (10%) SA – 20% – 0.6%* mostly intermediate (3% in south-east SA) WA – 30% – 0.6%* mostly intermediate ^ Benign footrot of limited consequence in low rainfall zone * Based mostly on state reports at national footrot workshop (Anon 2012) - reported figures doubled	*
Mortalities	No published data. Estimate 1% higher in flocks with virulent footrot (mostly due to flystrike, weaner illthrift and delayed management). Note: Marshall *et al.* (1991) indicated 4.5% higher mortality in mobs with uncontrolled virulent strain vs. mobs with footrot controlled.	**

Variable	Value adopted	Confidence
Weight loss	Average across Merino flocks and climatic zones and years considering control programs implemented: Benign: Temporary BW loss 0.5% Intermediate: Temporary kg BW loss 1.25%; Permanent 1.25% Virulent: Temporary kg BW loss 2.5%; Permanent 2.5% *Meat breeds: 50% of impact of Merinos* (Marshall *et al.* 1991, Stewart *et al.* 1984, Symons 1978, Cummins 1991, Glynn 1993)	**
Fertility	1.5% per kg bodyweight loss	**
Fleece weight %	Average across flocks and climatic zones and years considering control programs implemented: Benign footrot: 0.5% Intermediate Footrot: 2% Virulent footrot: 3% (Marshall *et al.* 1991, Stewart *et al.* 1984, Symons 1978, Cummins 1991, Glynn 1993, Abbott 2000)	**
Wool price discounts	None considered, though wool produced is finer in affected sheep due to weight loss	**
Market avoidance	Nil	***
Movement restrictions	Footrot is a notifiable disease in most states that restrict sales: assume $5/sheep discount due to sale restriction on properties with virulent footrot (except Tasmania).	**
Treatment	Considered as part of prevention program	***
Prevention	Footbathing for control ($0.15/sheep incl labour) Benign footrot: 50% footbath 1 time per year Intermediate footrot: Footbath 3 times per year Virulent footrot: Footbath 5 times per year Salvage antibiotics: ($1.00/sheep plus $1.00 labour) Intermediate footrot: 5% of affected flocks treat 5% sheep Virulent footrot: 10% affected flocks treat 10% sheep Eradication:	**

Variable	Value adopted	Confidence
	120 flocks annually. Annual cost of inspections and 20% salvage treatment with antibiotics (3 inspections @ $1.50 per inspection antibiotics $1.00/animal, additional labour $1.03/animal assisting with inspections) Biosecurity shared maintenance of fencing (shared with OJD, Lice and footrot) $0.20/animal 100% properties 3.8% of all properties footbath introduced sheep average 75 sheep. (Reeve *et al.* 2014)	
Other costs	2% additional sheep treated for flystrike (intermediate and virulent footrot (Allworth 1990) Supplementary feed cost considered with weight loss Additional labour costs associated with husbandry $0.25/sheep ($240/1000 sheep) Other indirect costs such as impact of delayed management, such as drenching or lower stocking rate not considered though may be substantial on individual farms	**

Based on the adopted prevalence and impacts of virulent footrot on the classes of animals affected, GHD has calculated the annual cost of virulent footrot in sheep in Australia at $32.28M (Table 5-19). In addition, the cost of benign footrot is calculated to be $12.1M in sheep in Australia (Table 5-20).

Table 5-19 Economic cost of virulent footrot in sheep

	Treatment			**Prevention**			**Production Losses**			**Total**		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0.06	$0.01	$0	$5.02	$1.49	$0	$21.76	$6.03	$0.63	**$26.84**	**$7.53**	**$0.63**
Per flock	$91	$23	$0	$8,286	$2,457	$0	$35,866	$9,952	$1,037	**$44,243**	**$12,432**	**$1,037**
Total	**$0.04M**			**$3.47M**			**$28.76M**			**$32.28M**		

The net gain from moving all flocks experiencing virulent footrot to the lowest level of disease is estimated at $17.21M.

Table 5-20 Economic cost of benign footrot in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$0.37	$0	$0	$1.29	$0	$0	**$1.66**	**$0**	**$0**
Per flock	$0	$0	$0	$605	$0	$0	$2,144	$0	$0	**$2,749**	**$0**	**$0**
Total	**$0M**			**$2.65M**			**$9.45M**			**$12.10M**		

The net gain from moving all flocks experiencing benign footrot to the lowest level of disease is estimated at $12.10M. This would completely offset the current estimated economic cost of benign footrot.

If the prevalence of virulent and intermediate footrot is reduced by 50% before extra costs are considered then the cost to industry would reduce by $8.6M.

5.10 Arthritis

<u>The Disease</u>

Arthritis is a common problem of lambs and occasionally older sheep. There are several major syndromes including *Erysipelas* arthritis, *Chlamydophila* (*Chlamydia*) polyarthritis and purulent arthritis caused by a range of pyogenic bacteria, and many bacteria causing sporadic arthritis (Farquharson 2007, Paton *et al.* 2003, and Watt 2010). *Erysipelas* and *Chlamydophila* polyarthritis are the most common causes, though many laboratory submissions fail to diagnose the underlying cause. In one study, *Fusobacterium necrophorum* was the most important cause of post-mulesing arthritis in western NSW (Curran 2012, Watt 2010). There are a variety of risk factors depending to some extent on the timing of infection including marking, mulesing, shearing and any procedure that damages the skin. Poor hygiene and wet muddy conditions are also important risk factors. Poor nutrition with resulting poor colostrum production of ewes is likely to lead to higher levels of neonatal arthritis in lambs.

The epidemiology of *Chlamydophila* polyarthritis is not well known. Prevalence rates vary but range between 0.63%-3.07% (Farquharson 2007) to 2.4% (Paton *et al*. 2003). Paton *et al*. (2003) reported there was a high correlation between mulesing and shearing and a higher incidence of arthritis which is more likely to occur in merino lambs. In contrast, Farquharson (2007) reported *Chlamydophila* polyarthritis was more common in rapidly growing lambs, favouring meat breeds though was still reported in merino lambs that were growing at lower rates. Economic losses result from on farm mortality, lower production of surviving lambs, treatment and prevention costs and post farm gate condemnation of carcases.

Unknown aetiology *Known aetiology*

					X				

Prevention

An effective vaccine is available to prevent *Erysipelas* arthritis though adoption is not high due to uncertainty of cost effectiveness. General hygiene at marking, mulesing or dipping and other management procedures are undertaken. Avoiding shearing and mulesing of terminal meat lambs will reduce prevalence as well (Paton *et al.* 2003).

Low efficacy/ unproven preventives available — *Effective preventives available*

				X					

Treatment

Early treatment of arthritis with parenteral antibiotics is moderately effective in early cases. In reality many cases are not treated until well advanced when mobs are mustered for other reasons.

Low efficacy/ unproven treatments available — *Effective treatments available*

				X					

Distribution

Distribution is considered to be stable.

Distribution contracting — *Distribution stable* — *Distribution increasing*

				X					

Prevalence

Good on farm data to determine the prevalence of arthritis is limited. On farm data which is available almost certainly under-estimates the true prevalence because many lambs die without the aetiology confirmed. Abattoir surveillance provides good information about the prevalence of arthritis in slaughter sheep without information of aetiology.

Prevalence decreasing — *Prevalence increasing*

				X					

Economics

Assumptions: Arthritis

Table 5-21 Assumptions: Arthritis in sheep

Variable	Value adopted	Confidence
Regional Extent	Widespread across all regions and climatic zones	***
% flocks infected	Average prevalence of lambs/weaners 2%; adults 1% (Farquharson 2007, Paton *et al*. 2003)	**
Mortalities	50% of lambs affected	*
Weight loss	3kg, 4kg and 4.5kg for affected Merino, dual purpose and prime lambs (Farquharson 2007)	*
Fleece	Nil	*
Wool	Nil	*
Fertility	Nil	*
Market avoidance	0.018% carcases condemned, 0.07% carcases trimmed. Average 3kg/affected carcase (Farquharson 2007)	*
Movement restrictions	Nil	***
Treatment	12% of affected lambs treated with antibiotics at a cost of $8.00/lamb (Farquharson 2007)	*
Prevention	16% of 2 yo ewes vaccinated twice and 8% of adult ewes vaccinated once with Eyrvac at a cost of $0.87/dose including labour	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of Arthritis in sheep in Australia at $39M (Table 5-22).

Table 5-22 Economic cost of Arthritis in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0.03	$0	$0	$0.20	$0	$0	$1.31	$0	$0	**$1.54**	**$0**	**$0**
Per Flock	$48	$0	$0	$338	$0	$0	$2,164	$0	$0	**$2,550**	**$0**	**$0**
Total	**$0.66M**			**$4.98M**			**$33.80M**			**$39.44M**		

The net gain from moving all flocks experiencing arthritis to the lowest level of disease is estimated at $39.44M. This would completely offset the current estimated economic cost of arthritis.

5.11 Ovine Johne's disease

<u>The Disease</u>

Ovine Johne's disease (OJD) caused by the sheep strain of *Mycobacterium avium subsp. Paratuberculosis* is a chronic wasting disease of sheep that causes high death rates in adult sheep of well over 10% in uncontrolled situations, lost production and restrictions on trade (Bush *et al.* 2008, Abbott *et al.* 2004). Historically, the disease spread from a focus in the central tablelands of NSW in the early 1980's to become widespread from the mid 1990's in most southern medium to high rainfall regions of eastern and western Australia. A period of attempted eradication in some regions failed, but with the advent of vaccination and a better understanding on management of the disease, OJD appears to be better under control with vaccination reducing mortalities to low levels. Vaccination, risk-based trading and on farm and regional biosecurity measures are now the main strategies to control OJD. Not all properties in high risk regions vaccinate for OJD and over time many presumably will develop clinical disease with varying mortality rates before embarking on vaccination, whilst those that have more recently started vaccination will benefit from reduced clinical disease.

Abattoir surveillance data (Animal Health Australia 2014a) shows the percentage of lines infected with OJD peaked in 2010-11 and now appears to be reducing from 4.8% in 2010-11 to 1.5% in 2014. This data is skewed as not all major abattoirs participate in surveillance.

Apart from the obvious impact of mortalities many producers cull advanced cases of OJD (no commercial value). Early clinical cases have a reduction in fleece weight and lower body weight with potential reproduction consequences (Abbot *et al.* 2004). Trading limitations have reduced but still have some consequence in states such as South Australia. The main prevention cost now is associated with flock vaccination and biosecurity measures. Some regulatory costs are associated with flocks in the SheepMAP (Animal Health Australia 2014a). In addition, other losses are due to carcase trimming (due to vaccination lesions) and condemnation of offal (Hernandez-Jover *et al.* 2013).

Unknown aetiology *Known aetiology*

									X

Prevention

The main strategy to prevent OJD is to vaccinate lambs from infected sheep flocks with Gudair™ vaccine at less than 16 weeks of age (Windsor 2014). If vaccination programs are well adopted, shedding of bacteria substantially reduces and clinical disease reduces to very low levels. Limitations to the effectiveness of vaccination programs include poor vaccination techniques, partial flock vaccination and introducing unvaccinated sheep. Other strategies to manage OJD are to adopt property and regional biosecurity strategies to minimise the risk of introduction of OJD into flocks.

Low efficacy/ unproven preventives available *Effective preventives available*

							X		

Treatment

No treatment is available to treat clinical OJD cases. OJD in clinically affected sheep is uniformly fatal.

Low efficacy/ unproven treatments available *Effective treatments available*

X									

Distribution

Distribution of OJD appears to be stable with current control measures in place, though current surveillance regimes in some areas are somewhat limited.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Prevalence appears to be stable but reducing within flock due to widespread use of vaccine in infected flocks and biosecurity measures.

Prevalence decreasing *Prevalence increasing*

			X						

Economics

Assumptions: OJD

Table 5-23 Assumptions: OJD in sheep

Variable	Value adopted	Confidence
Regional Extent	Generally restricted to high rainfall and sheep/wheat zones	***
% flocks infected	Prevalence regions were broken down in the regions previously used until 2012 with prevalence based on current abattoir monitoring data assuming ~50% sensitivity (70% multibacillary 30% sensitivity paucibacillary) (Bradley et al 2005, GHD 2014). Assumptions for Merinos as follows: - High prevalence: 29% of sheep population, 50% prevalence, 1% mortality in infected flocks - Medium prevalence: 29% of sheep population, 10% prevalence, 0.5% mortality in infected flocks - Low prevalence: 42% of sheep population, 0.2% prevalence, 0.2% mortality in infected flocks *Prime lamb mortality rate 50% of Merinos*	**
Mortalities	See above	**
Weight loss	Production losses 4% body weight loss 8 months prior to death, 11% 6 months prior to death (Abbott *et al.* 2004).	***
Fleece weight	Reduction in clean fleece weight of between 2% – 18%. Assumed 6% fleece weight loss in year prior to death (Abbott *et al.* 2004).	***
Wool quality	No impact	*
Fertility	Body weight loss leads to reduced reproduction rate 1.5%/1 kg BW	***
Market avoidance	0.5%, 0.25%, 0.1% suffer $10 loss of sale value in high, medium, low prevalence areas respectively. OJD trimming costs 1% in	**

Variable	Value adopted	Confidence
	vaccinated lines 0.74kg CW trim (Hernandez-Jover *et al.* 2013). Approx $60K offal condemned	
Movement restrictions	No consideration of cost of livestock trading restrictions due to regulation though could potentially be substantial and devastating for studs in some states	**
Treatment	There is no treatment available	***
Prevention	Vaccination costs $2.50/animal including labour. 5.6 million doses annually	***
Regional control	426 flocks in SheepMAP annual costs $600/flock. $0.20 per animal biosecurity (fencing) cost (shared with lice and footrot).	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of OJD in sheep in Australia at $35M (Table 5-24).

Table 5-24 Economic cost of OJD in sheep

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$1.16	$0.46	$0.04	$1.38	$0.68	$0.60	**$2.54**	**$1.14**	**$0.64**
Per Flock	$0	$0	$0	$1,937	$769	$62	$2,295	$1,126	$999	**$4,232**	**$1,895**	**$1,060**
Total	**$0M**			**$14.06M**			**$20.62M**			**$34.94M**		

The net gain from moving all flocks experiencing OJD to the lowest level of disease, with current levels of vaccination, is estimated at $19.01M.

5.12 Clostridial disease

The disease

The most common clostridial disease of sheep is enterotoxaemia (*C. perfringens* type D) with occasional tetanus (*C. tetani*) and less commonly recognised malignant oedema (*C. septicum*), blackleg (*C. chauvoei*), and black disease (*C. novyi*). Clostridia bacteria are widespread and can survive in the environment for long periods. Enterotoxaemia (or pulpy kidney) is commonly encountered with young sheep grazing lush pasture or in feedlot situations. Sheep on a diet high in carbohydrates which are not completely broken down will pass into the small intestine where bacteria rapidly multiply producing toxins precipitating disease (Farquharson 1994). Poor hygiene at lamb marking will very occasionally cause tetanus outbreaks. Disease is invariably fatal however highly effective and cheap vaccines exist against the major clostridial diseases.

Enterotoxaemia is often blamed for sudden deaths, however, in many situations sudden death resulting in rapid carcass autolysis may be caused by many diseases so the prevalence of clostridial diseases may be over-estimated.

Unknown aetiology *Known aetiology*

							X		

Prevention

Effective combination vaccines are available and are widely used as various trade names (e.g. “5 in 1”, “3 in 1” or “6 in 1”) or in combination with drenches. This prevents the majority of disease. In high risk situations, more frequent vaccination for enterotoxaemia may be necessary. Black disease is often associated with liver fluke infestations – but fluke areas are generally well known and preventive measures (against fluke and black disease) are typically applied.

Low efficacy/ unproven preventives available *Effective preventives available*

							X		

Treatment

Treatment is generally not effective in the broad-acre livestock industries.

Low efficacy/ unproven treatments available *Effective treatments available*

X									

Distribution

The distribution of clostridial diseases is widespread and is stable.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Clostridial diseases risk is ever present though often higher risk in situations of lush pasture or intensive feeding.

Prevalence decreasing *Prevalence increasing*

						X			

Economics

Assumptions: Clostridial diseases

Table 5-25 Assumptions: clostridial diseases in sheep

Variable	Value adopted	Confidence
Regional Extent	All sheep flocks are at risk of clostridial disease. About 75-80% use effective vaccination in ewes and 50% in lambs	**
% Flocks affected	- 1% of flocks experience large-scale outbreaks (generally arising from failure to vaccinate or incorrect vaccine administration/storage). 2% of young stock and 0.25% of adults affected. - 19% of flocks experience moderate outbreak (again due to inadequate vaccination). Up to 0.5% of young stock and 0.1% of adults affected. - 80% of flocks experience no disease	*
Mortalities	100% of clinical cases	***
Weight loss	Nil	***
Fertility	Nil	***
Fleece weight %	Nil	***
Wool price discounts	Nil	***
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Nil	***
Prevention	Prevention is by vaccination. A dose is estimated to cost $0.30 (vaccine plus labour). Few estimates are available	**

Variable	Value adopted	Confidence
	regarding vaccine use. Based on a recent survey of 1600 producers (Thompson 2011), 44% of producers vaccinated once at marking, 54% twice to lambs, 77% vaccinated ewes annually, 21% wethers annually and 55% rams annually. This is probably a reasonable estimate of industry practice.	
Other costs		

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of clostridial diseases in sheep in Australia at $32M (Table 5-26). This estimate is highly uncertain due to lack of data about prevalence of disease and to a certain extent the vaccination programs adopted.

Table 5-26 Economic cost of clostridial diseases in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$0	$0.28	$1.39	$3.49	$0.97	$0	**$3.49**	**$1.25**	**$1.39**
Per Flock	$0	$0	$0	$0	$459	$2,270	$5,689	$1,578	$0	**$5,689**	**$2,037**	**$2,270**
Total	**$0M**			**$26.91M**			**$4.77M**			**$31.69M**		

The net gain from moving all flocks to the lowest level of clostridial diseases is negligible as the cost of vaccination is higher than the losses recorded in low risk flocks as vaccination is effective at controlling the disease.

5.13 Liver fluke

<u>The disease</u>

Liver fluke (*Fasciola hepatica*) is an important disease of sheep in the regions where it occurs. Liver fluke can infect many species in addition to sheep and cattle (including wildlife). Fluke is usually distributed to regions above 600 mm rainfall, although outside this area fluke can occur, particularly in irrigation and swampy areas. Adult fluke live in the bile ducts of the liver, pass eggs out in the faeces and intermediate stages infect snails (most commonly, *Austropeplea tomentosa,* but potentially, *Austropeplea viridis* and *Pseudosuccinea columella* that have a much wider range) (Boray *et al.* 1985) where they multiply and eventually sheep become reinfected from grazing pasture infested with metacercariae. Acute fluke infection can occur where large numbers of larvae are ingested causing severe damage and death. More commonly chronic fluke causes production losses, anaemia and bottle jaw. Rarely, black disease is caused by *Clostridium novyi* in association with larval fluke migrating through the liver (prevented by 5 in 1 vaccination).

Production losses associated with liver fluke include mortalities, weight loss, reduction in wool growth, and in association with lower body weight, lower reproductive performance. Post farm gate offal condemnation in abattoirs is very common. Control is based on strategic and tactical drenching with flukicides, fencing off swampy at risk areas, improving drainage (especially in irrigation areas) and grazing management to avoid high risk animals grazing high risk paddocks.

Unknown aetiology *Known aetiology*

									X

Prevention

Long-term control relies on the strategic use of flukicides that kill immature and adult fluke populations in sheep to prevent production losses and reduce pasture contamination. Specific timing of drenching depends on the level of challenge and regional climate conditions. Monitoring of fluke burdens is useful to fine-tune strategic drenching programs. Additional control can be achieved by fencing off swampy areas or grazing with adult cattle that are less susceptible to fluke. The development of resistance to Triclabendazole, the most commonly used and effective flukicide, will make fluke control more difficult if not managed.

Low efficacy/ unproven preventives available *Effective preventives available*

						X			

Treatment

Treatment in the face of high fluke burdens is considered part of prevention programs. The main limitation on the efficacy of anthelmintics is the widespread nature of drench resistance and the limited extent of resistance testing amongst sheep producers.

Low efficacy/ unproven treatments available *Effective treatments available*

							X		

Distribution

The introduction of new snail species (*Austropeplea viridis* and *Pseudosuccinea columella*) that can survive a wider range of climatic zones and environments may increase the distribution of fluke in future, including in Western Australia where currently no fluke are present. The distribution of liver fluke may be enhanced by climate change, with warmer winters for survival on pasture balanced with higher mortality with hot temperatures.

Distribution contracting | *Distribution stable* | *Distribution increasing*

					X				

Prevalence

Prevalence is generally stable, though the prevalence increases in wet years. Resistance to Triclabendazole will potentially reduce the efficacy of control programs and increase the severity of fluke.

Prevalence decreasing | *Prevalence increasing*

				X					

Economics

Assumptions: Liver fluke

Table 5-27 Assumptions: liver fluke in sheep

<table>
<tr><th>Variable</th><th>Value adopted</th><th>Confidence</th></tr>
<tr><td>Regional Extent</td><td>Distribution predominantly in NSW, Victoria, Southern QLD and Tasmania, rare in South Australia, exotic to Western Australia. More common above 600 mm rainfall and irrigated pasture outside the high rainfall regions. 13.6% sheep flocks considered high risk, 2.1% moderate risk and 84.3% low to nil risk.</td><td>***</td></tr>
<tr><td>% Flocks affected</td><td>Based on abattoir surveillance (Animal Health Australia 2014a):
<table>
<tr><th>State</th><th>% lines positive</th><th>% livers with fluke</th><th>% sheep with fluke in positive lines</th></tr>
<tr><td>NSW</td><td>34%</td><td>26%</td><td>9.25%</td></tr>
<tr><td>QLD</td><td>13%</td><td>25%</td><td>2.56%</td></tr>
<tr><td>Tasmania</td><td>15%</td><td>20%</td><td>3.38%</td></tr>
<tr><td>Victoria</td><td>10%</td><td>8%</td><td>0.97%</td></tr>
<tr><td>SA</td><td>0.4%</td><td>12%</td><td>0.06%</td></tr>
</table>
A survey of NSW and Victoria (Hort 1998) indicated 33% of properties had positive FEC tests.</td><td>**</td></tr>
<tr><td>Mortalities</td><td>No published data. Estimate 0.25% in affected flocks.</td><td>*</td></tr>
</table>

Variable	Value adopted	Confidence
Weight loss	In affected sheep: Temporary weight loss: 5.5% in high risk flocks, 3% mod risk Permanent weight loss: 5.5% high risk, 3% mod risk	*
Fertility	1.5% per kg bodyweight	**
Fleece weight %	In affected sheep, wool production penalty 14% in high risk flocks, 7% mod risk	*
Wool price discounts	Due to reduction in staple strength of 8 N/kTex	*
Market avoidance	0.01302% adult offal (Liver) condemned (GHD 2009) 0.00326% lamb offal (Liver) condemned Average value $0.81/liver	**
Movement restrictions	Nil	***
Treatment	Considered as part of prevention program	**
Prevention	Cost of drench: $0.40/dose including labour Drench frequency: 1.45 drenches per year (Hort 1998) Monitoring costs: $0.12/sheep, 0.25 times per year	**

Total cost of disease

Based on the adopted prevalence and impacts of internal parasites on the classes of animals affected, GHD has calculated the annual cost of liver fluke in sheep in Australia at $25M (Table 5-28).

Table 5-28 Economic cost of liver fluke in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$0.39	$0.08	$0	$7.11	$0.97	$0	**$7.51**	**$1.05**	**$0**
Per Flock	$0	$0	$0	$651	$136	$0	$11,794	$1,609	$6	**$12,445**	**$1,745**	**$6**
Total	**$0M**			**$1.30M**			**$23.48M**			**$24.78M**		

If the severity of Liver fluke is reduced by 50% before extra costs are considered, the cost to industry would reduce by $9.78M.

5.14 Pneumonia

<u>The disease</u>

Pneumonia is usually considered a sporadic disease of sheep affecting both adult sheep and lambs. There are a variety of causes including *Mannheimia haemolytica* which is most commonly isolated (Watt *et al.* 2013) but other causes include *Arcanobacter pyogenes* with primary agents including Mycoplasma sp and viruses such as Parainfluenza 3 virus (St George 1972). Numerous other bacteria have been implicated though none on a widespread basis. Lungworm (*Dictyocaulis filaria, Meullerus capillaris and Protostrongylus rufescens*) was historically commonly reported, however with the use of broad-spectrum anthelmintics it is now relatively uncommon as a cause of pneumonia.

Whilst on farm data is very limited or not available regarding the prevalence of pneumonia, based on abattoir monitoring the disease(s) associated with pneumonia are widespread in Australia. About 4.6% of all carcases inspected showed evidence of damage due to pneumonia with a higher proportion of adults showing evidence of pneumonia compared with lambs. For example in NSW, 42% of lamb consignments and 64% of sheep consignments show some evidence of pneumonia. About 3.3% of all lambs and 5.7% of all sheep showed evidence of pneumonia (Watt *et al.* 2013). Across Australia, 0.016% of adult carcases and 0.0013% of lamb carcases are condemned due to pneumonia (DAFF 2014, Animal Health Australia 2014a). Therefore, the causes of pneumonia are reasonably well known but apart from stress and change of weather, predisposing causes are not always clear.

Unknown aetiology *Known aetiology*

						X			

Prevention

No control measures are used to prevent pneumonia. Lung worm is largely managed with the use of anthelmintics for worm control and any cost is incidental to this. Vaccines are available for cattle and internationally for sheep though none are available in Australia.

Low efficacy/ unproven preventives available *Effective preventives available*

	X								

Treatment

Treatment is based on antibiotic therapy (usually long acting oxytetracyclines). Generally treatment is not common and only implemented with large outbreaks as most “low level” outbreaks are not recognised. Treatment is moderately effective but limited as outbreaks in sheep flocks are usually advanced before treatment is implemented and low level outbreaks are often not detected.

Low efficacy/ unproven treatments available *Effective treatments available*

						X			

Distribution

Distribution seems to be widespread across sheep growing regions.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Prevalence is generally constant.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Pneumonia

Table 5-29 Assumptions: Pneumonia in sheep

Variable	Value adopted	Confidence
Regional Extent	Prevalence is assumed to be constant across regions.	*
% flocks infected	Based on abattoir surveillance, about 3.3% of lambs and 5.7% of adults show evidence of pneumonia (Watt *et al.* 2013 DAFF 2014, Animal Health Australia 2014a)	*
Mortalities	10% of weaners and 5% of adults with clinical pneumonia	*
Weight loss	Production loss data is limited. In New Zealand, Alley (2002) found that lambs with pneumonic lesions had on average 1.5 kg lower carcase weight (3.3 kg liveweight) than control lambs. The penalty for lambs with minor lesions is small but lambs with more than 20% of their lungs affected had severe weight penalties. No penalty has been considered for weight loss in adults.	*
Fleece weight	Nil	*
Wool quality	Nil	*
Fertility	Nil	*
Market avoidance	Carcase and offal condemnation: a. Condemnation: 0.016% of adults, 0.0013% lambs (DAFF 2014) *b.* Carcase trim and offal condemnation 0.49% of adults, 0.039% lambs average 1.1 kg cw/carcase (GHD 2009, Hernandez-Jover M 2013) *c.* Offal value $0.61/offal condemnation (GHD 2009)	***
Movement restrictions	Nil	*
Treatment	Treatment is implemented by antibiotic therapy $10.00 per dose. Only lambs treated, assumed 1% of clinical cases treated	*
Prevention	Prevention is not available	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of pneumonia in sheep in Australia at $20M (Table 5-30).

Table 5-30 Economic cost of pneumonia in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0.05	$0	$0	$0	$0	$0	$1.12	$0	$0	**$1.17**	**$0**	**$0**
Per Flock	$82	$0	$0	$0	$0	$0	$1,860	$0	$0	**$1,942**	**$0**	**$0**
Total	**$0.67M**			**$0M**			**$19.71M**			**$20.38M**		

Reducing prevalence by 50% without extra costs considered would reduce the cost to industry by $10M. Note that no value on potential production losses has been included for adult sheep as they are unknown.

5.15 Caseous lymphadenitis

The Disease

Caseous lymphadenitis (CLA), commonly called cheesy gland, is caused by *Corynebacterium psuedotuberculosis*. Infected sheep develop abscesses in lymph nodes and a variety of organs including the lungs and liver. Initially, abscesses develop after which time wool production may be affected (Paton *et al*. 1988). CLA is widespread affecting sheep in all climatic zones. Infection is thought to most commonly occur at the first or second shearing. Infection via shearing cuts when sheep are in close contact is exacerbated with dipping post shearing even after several months where the bacteria may pass through intact skin (Paton *et al*. 1988, Paton *et al*. 1994, Paton *et al*. 2003).

The prevalence of cheesy gland in the sheep flock is estimated to average 29% in unvaccinated flocks whereas the prevalence in fully vaccinated flocks that receive an annual booster is 3%. Flocks that are only vaccinated as lambs had a similar prevalence to unvaccinated flocks. In one study, 95% of 223 flocks had CLA (Paton *et al*. 2003). The economic effects of CLA are due to lower wool production that occurs in the year of infection (presumably due to the sheep mounting an immune response) and the cost of vaccination. Post farm gate costs include condemnation of between 0.5-1% of adult carcases and additional carcase downgrading and trimming costs.

Unknown aetiology *Known aetiology*

									X

Prevention

Vaccination with CLA vaccine is the most effective strategy to prevent CLA. Hygiene at shearing, shearing young sheep first and avoiding handling freshly shorn sheep is also recommended. The effectiveness of CLA vaccine is limited due to inappropriate usage and the perception that the vaccine is not cost effective.

Low efficacy/ unproven preventives available *Effective preventives available*

						X			

Treatment

There is no known treatment for CLA.

Low efficacy/ unproven treatments available *Effective treatments available*

X									

Distribution

Distribution remains stable to possibly decreasing as fewer mature wethers are present in sheep enterprises.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Prevalence is generally stable to possibly decreasing due to the increase in vaccination use and the use of wet dips (which is a risk factor for CLA) for the control of lice decreases.

Prevalence decreasing *Prevalence increasing*

				X					

<u>Economics</u>

Assumptions: CLA

Table 5-31 Assumptions: CLA in sheep

Variable	Value adopted	Confidence
Regional Extent	22% flocks high risk with no vaccination, 58% moderate risk with partial vaccination and 20% low risk with full vaccination program	**
% flocks infected	Prevalence segregated based on vaccine program adopted (Paton *et al.* 2003): 22% of sheep flocks: no vaccination, prevalence of 29% in adults. 58% of sheep flocks: non-effective vaccination program, prevalence of 28% in adults 20% of sheep flocks: effective vaccination program, prevalence of 3% in adults	**
Mortalities	Nil	***
Weight loss	Nil	***
Fleece weight	5% reduction in clean fleece weight in year of infection with resulting reduction in fibre diameter (Paton *et al.* 1988)	***
Wool quality	Slight reduction in FD	**
Fertility	Nil	***
Market avoidance	0.3% of adult carcases sold condemned, 3% of offal sets condemned and 3% carcases trimmed (0.6kg) (Paton *et al*. 2008, GHD 2009, Pointon 2008)	**
Movement restrictions	Nil	***
Treatment	Nil	***
Prevention	Prevention is by vaccination with CLA vaccine. Marginal cost of $0.12/dose (cost above clostridial vaccine component) with 50% of labour cost $0.12/dose	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of CLA in sheep in Australia at $17.83M as shown in Table 5-32.

Table 5-32 Economic cost of CLA in sheep

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$0	$0.27	$0.85	$0.38	$0.37	$0.04	**$0.37**	**$0.64**	**$0.88**
Per Flock	$0	$0	$0	$0	$454	$1,409	$637	$618	$66	**$637**	**$1,073**	**$1,474**
Total	**$0M**			**$9.43M**			**$8.40M**			**$17.83M**		

The cost of prevention is similar to the total production losses partly because the majority of producers do not implement an adequate control program to prevent the disease, so still bear the cost but are affected by similar production losses as flocks with no control.

There is no apparent net gain from moving all affected flocks experiencing CLA to the lowest level of disease.

5.16 Pregnancy toxaemia

<u>The disease</u>

Pregnancy toxaemia is a common metabolic disease of sheep. Pregnancy toxaemia usually occurs towards the end of the final trimester of pregnancy in ewes carrying multiple pregnancies with very fat or very thin ewes most at risk, particularly older ewes. Twin bearing ewes require 180% of the energy required by single bearing ewes. The condition results from the inability of ewes to consume enough dry matter and energy such that the demand of ewes outstrips the supply. The negative energy balance mobilises fatty acids from body reserves and the liver is unable to produce enough glucose such that the liver is overwhelmed with fatty acids and the production of ketones with resulting outcome being ketosis or pregnancy toxaemia. Other risk factors include: change in diet; sudden feed restriction caused by yarding; and concurrent diseases, especially foot abscess and hypocalcaemia.

Early intervention and treatment is moderately effective, but late treatment is only about 50% effective. Untreated ewes generally die. Prevention usually relates to adequate supply of pasture or, if not available, supplementary feed. Separation of twin bearing and triplet bearing ewes from single bearing ewes with differential feeding will reduce the risk. Controlling concurrent diseases such as hypocalcaemia and foot abscess will reduce the risk of pregnancy toxaemia.

Pregnancy toxaemia is present in all climatic zones though good prevalence data is not available. In the Victorian sentinel flock project (DEPI 2012), 13% of ewe deaths over a three year period were caused by metabolic problems of which 80% were attributed to pregnancy toxaemia. Metabolic disease was more commonly diagnosed as the cause of death in ewes in prime lamb flocks (15.5%) compared to dual purpose (8.7%) and Merino (3.7%) flocks. Surveys in South Australia, Victoria and

New South Wales all identified pregnancy toxaemia as an important cause of death in late pregnant ewes (Anon 2013, McGrath 2013, Harris *et al.* 1988, Trengove 2014).

Unknown aetiology — *Known aetiology*

								X	

Prevention

Prevention usually relates to adequate supply of pasture or if not available supplementary feed. Separation of twins and triplets from single bearing ewes with differential feeding will reduce the risk. Controlling concurrent diseases such as hypocalcaemia and foot abscess will reduce the risk of pregnancy toxaemia.

Low efficacy/ unproven preventives available — *Effective preventives available*

						X			

Treatment

A variety of treatments is available though none are effective if adopted late in the course of the disease.

Low efficacy/ unproven treatments available — *Effective treatments available*

			X						

Distribution

Distribution is considered to be stable.

Distribution contracting — *Distribution stable* — *Distribution increasing*

				X					

Prevalence

Prevalence is generally constant but influenced by season. A trend to meat breeds with high fecundity is likely to lead to an increase in pregnancy toxaemia if nutrition is not well managed.

Prevalence decreasing — *Prevalence increasing*

					X				

Economics

Assumptions: Pregnancy toxaemia

Table 5-33 Assumptions: pregnancy toxaemia in sheep

Variable	Value adopted	Confidence
Regional Extent	The distribution of pregnancy toxaemia is widespread in all regions and sporadic in nature, with higher risk years being drought years and wet years associated with foot abscess.	**
% flocks infected	Pregnancy toxaemia is distributed across all climatic zones and regions with 0.5% of prime lamb flocks affected, 0.4% of dual purpose flocks and 0.25% of Merino flocks with all cases in mature (>2 yo) ewes.	*
Mortalities	A 50% mortality rate has been assumed for pregnancy toxaemia.	**
Weight loss	Temporary weight loss of 2 kg.	*
Fleece weight	No reduction in fleece weight considered	**
Wool quality	Wool price discounts range from 1% - 18% depending on wool micron categories (Nolan 2012). Surviving ewes have a reduction in staple strength of 15 N/kTex.	
Fertility	25% of surviving ewes fail to rear lambs	*
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	The most common treatment is supplied by providing oral or parenteral dextrose or glucose fluids and electrolytes. Providing additional supplementary feed will also help reduce the re-occurrence and prevent new cases. About 25% of cases are assumed to be treated with intensive therapy costing $15/ewe.	*
Prevention	Prevention is by providing adequate pasture or supplementary feed and preventing concurrent disease. The value of supplementary feed is partially considered as it is supplied to ewes as normal farm management (assumed 1 kg/ewe extra for 4 weeks to 20% of mature ewes).	*

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of pregnancy toxaemia in sheep in Australia at $16M (Table 5-34). The Sackett report does not include a cost for pregnancy toxaemia.

Table 5-34 Economic cost of pregnancy toxaemia in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0.02	$0	$0	$0.32	$0	$0	$0.39	$0.00	$0.00	**$0.73**	**$0**	**$0**
Per Flock	$41	$0	$0	$525	$0	$0	$645	$0	$0	**$1,211**	**$0**	**$0**
Total	**$0.52M**			**$7.11M**			**$8.19M**			**$15.82M**		

Due to the sporadic nature of the disease and likely extra costs, there is no apparent net gain from moving all flocks experiencing pregnancy toxaemia to the lowest level of disease.

5.17 Hypocalcaemia

<u>The disease</u>

Hypocalcaemia is a sporadic disease that occasionally causes substantial losses. Ewes which normally mobilize skeletal calcium reserves to meet the foetal demands during late pregnancy are particularly susceptible to hypocalcaemia when intake or absorption of calcium decreases. The young lamb will maintain its plasma calcium concentration at the expense of bone structure when dietary calcium intake is inadequate during growth. Young lambs are unable to absorb sufficient calcium from pasture. Milk intakes that result in growth rates greater than 150 g/day during the first six weeks are necessary to prevent osteoporosis by the time lambs are weaned at 12 weeks (Caple 1989).

Hypocalcaemia has several underlying causes and syndromes (Caple 1989, Watt 2012):

- Hypocalcaemia is regularly encountered in sheep (especially ewes and weaners) that have been supplemented for a long period of time (usually greater than 2-3 months) with cereal grain which is low in calcium or when grazing dual purpose cereal crops such as oats during winter.
- Perhaps the most common syndrome is observed in late pregnant ewes grazing lush grass-dominant pasture, short feed or cereal crops. Older ewes carrying multiple lambs are most at risk and outbreaks are more severe in ewes that have been fed grain for extended periods such as during droughts. Handling ewes in late pregnancy exacerbates the risk. Hypocalcaemia in lactating ewes appears more common in northern regions (Watt B pers com).
- Hypocalcaemia caused by short term interruption of food supply such as with severe weather or when held off feed, such as if held for shearing or transport, with late pregnant ewes most at risk. Conditions such as foot abscess can lead to anorexia with secondary hypocalcaemia.
- Hypocalcaemia is common in weaner sheep when associated with underlying osteoporosis. Osteoporosis in young sheep has many causes but is commonly associated with malnutrition,

poor milk supply, calcium, copper or vitamin D deficiency and gastro intestinal parasitism (Caple *et al.* 1988).

- Whilst hypocalcaemia is widespread there are few detailed reports and surveys indicating the prevalence of hypocalcaemia in ewes and lambs.
- Occasionally hypocalcaemia is induced in sheep grazing pastures such as soursob (oxalis sp) or sorrel high in oxalates that bind calcium thereby inducing hypocalcaemia.

Early treatment is important, particularly in pregnant ewes as delayed therapy will lead to complications such as pregnancy toxaemia.

Unknown aetiology | *Known aetiology*

							X		

Prevention

Prevention is based on ensuring young sheep do not suffer malnutrition and receive adequate milk supply from ewes and prevent any underlying nutritional deficiencies that increase the risk of hypocalcaemia and osteoporosis. Dietary management is the most important factor to reduce the risk of hypocalcaemia in ewes and lambs. The highest risk groups are older twin and triplet bearing ewes and weaners up to 15 months of age in southern states that are poorly grown.

Dietary management of ewes and weaners is the most important strategy to control hypocalcaemia. Providing adequate nutrition to ewes to ensure lambs have growth rates above 150 g/day is important to prevent hypocalcaemia. Limestone supplements are often recommended to ewes fed grain for extended periods and licks to ewes and weaners grazing cereal crops though wheat appears most at risk of deficiency of magnesium. Other prevention strategies include avoiding removal of heavily pregnant ewes from pasture for extended periods.

Low efficacy/ unproven preventives available | *Effective preventives available*

						X			

Treatment

Treatment requires administering a calcium injection as soon as possible. Recovery after treatment is good if not complicated with pregnancy toxaemia.

Low efficacy/ unproven treatments available | *Effective treatments available*

								X	

Distribution

Distribution varies between years and is more common in regions affected with drought (Larsen *et al*. 1986). Distribution has been increasing with a trend to high fertility breeds in merinos and meat sheep and wider adoption of grazing cereals.

Distribution contracting *Distribution stable* *Distribution increasing*

					X				

Prevalence

Prevalence is stable but varies between seasons and is highest risk after droughts.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Hypocalcaemia

Table 5-35 Assumptions: hypocalcaemia in sheep

Variable	Value adopted	Confidence
Regional Extent	Highest risk in high rainfall zone, moderate in wheat sheep and lowest risk in pastoral zone.	**
% flocks infected	a. Ewes HRZ Merinos 0.3% (0.1% for 9 in 10 years, 2% 1 in 10 years), meat breeds 0.4%, all weaners 0.4% b. Ewes Wheat-sheep 0.24% (0.14% for 9 in 10 years, 2% 1 in 10 years), meat breeds 0.3%, all weaners 0.2% c. Ewes Pastoral 0.2%, weaners 0.2% (Sentinel Flock Project DEPI 2012, McGrath *et al.* 2013, Larsen *et al.* 1986)	*
Mortalities	A 40% mortality rate has been assumed for hypocalcaemia (untreated cases). Note that pregnancy toxaemia is considered separately with the underlying cause likely to be hypocalcaemia in many cases.	*
Weight loss	No weight loss, fertility or other production effects are assumed; all production losses are due to deaths	**
Fleece	Nil	***

Variable	Value adopted	Confidence
Wool	Nil	***
Fertility	Nil	*
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Treatment by administering injectable calcium. The cost of calcium injections and labour is $10.00/ewe. 60% of ewes with clinical hypocalcaemia treated.	*
Prevention	Prevention is by provision of adequate dietary nutrients (no cost allocated). About 30% of producers supply lime at 1.5% of diet in drought years (1 in 10 years @$0.60) and 5% of producers provide a supplement in an average year ($0.30). A survey of producers (McGrath *et al.* 2013) in the wheat-sheep zone of southern NSW grazing dual purpose crops found 40% of producers graze cereals. Across Australia this is estimate to be 20% overall. An estimated 55% of producers supplemented with calcium and roughage. Cost of lick supplement 2c/day for 28 days = $0.56/ewe and weaner. In addition roughage costs were estimated to be $0.42/ewe and weaner. Preventive strategies such as Unimix™ or Vitamin D are adopted in such a low level they are not considered.	*

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of hypocalcaemia in sheep in Australia at $11.16M.

Table 5-36 Economics of hypocalcaemia in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0.06	$0.04	$0.03	$0.09	$0.41	$0.00	$0.32	$0.22	$0.19	**$0.47**	**$0.67**	**$0.22**
Per Flock	$99	$68	$58	$145	$676	$0	$533	$366	$312	**$777**	**$1,109**	**$369**
Total	**$1.08M**			**$4.36M**			**$5.72M**			**$11.16M**		

Due to the sporadic nature of the disease the net gain from moving all flocks experiencing hypocalcaemia to the lowest level of disease is difficult to calculate.

5.18 Foot abscess

The disease

Foot abscess is primarily caused by *Fusobacterium necrophorum* although other bacterium such as *Arcanobacterium pyogenes* is considered to have a role (Roberts *et al*. 1968, West 1981, Egerton *et al*. 1989). The disease also includes heel abscess. The infection starts at the basal layers of the skin spreading to subcutaneous tissue and can extend to the distal interphalangeal joint causing suppurative arthritis swelling and severe pain with abscesses bursting leaving a draining sinus. Heavily pregnant older ewes and rams are most at risk in lush wet conditions with dry sheep much less at risk. Toe abscess can occur in all classes of sheep though typically in heavy sheep in wet conditions. Wet conditions and mechanical trauma with breaking of overgrown horn and shelly toe can result in invasion of bacteria into the sensitive lamina and subsequent infection resulting in severe pain.

Foot abscess outbreaks vary from year to year with lush wet seasons resulting in large outbreaks of over 10% of sheep affected. The economic impact of foot abscess can be significant. Affected sheep if pregnant are at risk of secondary pregnancy toxaemia and death. Affected sheep will usually develop a severe break in the wool resulting in lower fleece value and produce less wool. Affected sheep will often be culled prematurely due to chronic lameness and foot deformities. The most effective treatment is parenteral antibiotics though response to treatment is often poor if infection is well established. Resolution usually occurs in about eight weeks. Typical prevalence data is not well documented in the Australian sheep flock (McGrath 2013, Sentinel Flock 2013).

Unknown aetiology *Known aetiology*

							X		

Prevention

Strategies to effectively prevent foot abscess are not well defined. Risk factors are well known; specifically heavily pregnant ewes in lush wet conditions are most at risk. Practical strategies to minimise the risk of foot abscess are difficult to adopt. Managing body weight of ewes must be balanced with reproductive performance and risk of pregnancy toxaemia. Apart from removing at risk mobs to dry paddocks, foot bathing has limited value and usually not a practical outcome. No vaccine is available to prevent foot abscess.

Low efficacy/ unproven preventives available *Effective preventives available*

			X						

Treatment

Early treatment of foot abscess with parenteral antibiotics, anti-inflammatory therapeutics and land drainage are moderately effective in early cases and poor in more advanced cases. Footbathing with zinc sulphate in early stages is of uncertain value and may in fact induce more issues with mustering and handling late pregnant ewes.

Low efficacy/ unproven treatments available *Effective treatments available*

				X					

Distribution

Distribution is considered to be stable and dependant on climatic conditions.

Distribution contracting *Distribution stable* *Distribution increasing*

					X				

Prevalence

Prevalence is generally stable. Intensification of pasture systems in high rainfall regions may, with time, increase the prevalence of foot abscess as could the expanded use of grazing cereals and fodder crops in medium to high rainfall regions. Increasing the Australian sheep flock's fecundity and body size will increase the risk of foot abscess. Exotic breeds run in high rainfall regions appear at high risk of foot abscess. Good data to determine the prevalence of foot abscess is not available apart from some local surveys.

Prevalence decreasing *Prevalence increasing*

					X				

Economics

Assumptions: Foot abscess

Table 5-37 Assumptions: foot abscess in sheep

<table>
<tr><th>Variable</th><th>Value adopted</th><th>Confidence</th></tr>
<tr><td>Regional Extent</td><td>High risk high rainfall zone 41% sheep, wheat sheep moderate risk 47% sheep, pastoral zone low risk 12% sheep</td><td>***</td></tr>
<tr><td>% flocks infected</td><td><table><tr><th></th><th>Adult ewes</th><th>2 yo ewes</th></tr><tr><td>Pastoral low risk</td><td>0.2%</td><td>0%</td></tr><tr><td>Wheat sheep medium risk</td><td>1.5%</td><td>0.3%</td></tr><tr><td>HRZ high risk</td><td>3%</td><td>0.5%</td></tr></table>British breeds 67% of prevalence in Merinos. Rams 50% higher</td><td>*</td></tr>
<tr><td>Mortalities</td><td>5% of affected sheep</td><td>*</td></tr>
<tr><td>Weight loss</td><td>6.7% Merinos 5% meat breeds (Symons 1978)</td><td>*</td></tr>
<tr><td>Fleece</td><td>Fleece weigh reduction 2.5% Merinos, 1.7% meat breed (Symons 1978)</td><td>*</td></tr>
<tr><td>Wool price</td><td>Due to staple strength declines: -15 N/kTex merinos, -10N/kTex meat breeds (Nolan 2012)</td><td>**</td></tr>
<tr><td>Fertility</td><td>20% affected ewes fail to rear lamb</td><td>*</td></tr>
<tr><td>Market avoidance</td><td>Nil</td><td>***</td></tr>
<tr><td>Movement restrictions</td><td>Nil</td><td>***</td></tr>
<tr><td>Treatment</td><td>25% affected ewes in high risk zone and 20% in moderate risk zone @ $10/ewe</td><td>*</td></tr>
<tr><td>Prevention</td><td>Footbath 2% of flocks in high risk zone @ $0.10/sheep</td><td>*</td></tr>
</table>

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of foot abscess in sheep in Australia at $10M (Table 5-38). The annual cost of foot abscess to the sheep industry varies widely and could be three times higher in very wet years.

Table 5-38 Economic cost of foot abscess in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0.12	$0.06	$0	$0.01	$0	$0	$0.51	$0.33	$0.03	**$0.63**	**$0.40**	**$0.04**
Per Flock	$196	$105	$1	$10	$5	$0	$842	$552	$58	**$1,048**	**$662**	**$58**
Total	**$1.81M**			**$0.09M**			**$8.52M**			**$10.42M**		

Due to the sporadic nature of the disease the net gain from moving all flocks experiencing foot abscess to the lowest level of disease is difficult to calculate.

5.19 Bacterial enteritis

The disease

Bacterial enteritis is a combination of several bacterial diseases commonly observed in high rainfall regions in weaned Merino lambs and hoggets and occasionally first cross hoggets but is rarely seen in second cross lambs. The disease in winter is usually caused by *Yersinia pseudotuberculosis.* About 30-90% of weaners shed bacteria with 30-50% having diarrhoea with mortality rates ranging from 0-9% and averaging 3% (K Stanger pers com 2014). *Yersinia enterocolitica* occurs year round with 17% of flocks shedding bacteria. Mortality rates are lower with *Y. enterocolitica* at 1% with up to 30% shedding bacteria although with no clinical disease. Estimated morbidity rates range from 1 - 90% (18% average) and mortality 0 - 6.9% (1.8% average) due to unspecified *Yersinia sp*. Morbidity and mortality rates of the disease in summer are less well documented though equally important.

Weaner colitis in winter is often caused by Yersinia sp and is better understood than the disease in summer which seems to be associated with Campylobacter sp though this is uncertain.

Unknown aetiology *Known aetiology*

					X				

Prevention

No vaccines are available. General flock management to improve nutrition and reduce stress of concurrent disease such as worms is recommended.

Low efficacy/ unproven preventives available *Effective preventives available*

			X						

Treatment

Antibiotic therapy commonly with oral sulphadimidine or injectable oxytetracyclines appears to control Yersinia outbreaks well. Response to treatment of summer outbreaks of campylobacter is not as effective. Antibiotic resistance is emerging as an issue in flocks that have had a long term history of outbreaks of Yersiniosis.

Low efficacy/ unproven treatments available *Effective treatments available*

						X			

Distribution

The disease predominantly occurs in high rainfall regions mostly affecting Merino weaners where 50% of flocks are considered at risk.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Slee and Skilbeck (1992) estimated 5% of flocks (mostly in winter) have *Y. pseudotuberculosis* and 17% of flocks have *Y. enterocolitica* (present throughout the year). Prevalence of disease fluctuates between years. Yersinia appears to be less severe in favourable years with good feed, whereas summer colitis is more severe in wet summers regardless of nutrition.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Bacterial enteritis in sheep

Table 5-39 Assumptions: bacterial enteritis in sheep

Variable	Value adopted	Confidence
Regional Extent	50% of high rainfall zone is at risk	**
% Flocks affected	10% of Merino weaner mobs affected, 5% of first cross weaner mobs 40% of weaners have clinical disease: 10% severe, 30% mild.	*
Mortalities	Average 3% of affected mob (K. Stanger pers com 2014)	*
Weight loss	5 kg severe, 1kg mild (temporary)	*
Fertility	Nil	**
Fleece weight %	5% lower severe, 1% lower mild	*
Wool price discounts	Reduction in FD associated with lower wool production. Staple strength 15 N/kTex lower severe, 10 N/kTex lower mild (Sackett *et al*. 2006).	**
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Antibiotic treatment to affected mob $0.70/sheep. 50% treat but 50% also drench for worms	**
Prevention	Nil	***
Other costs	Additional crutching costs for 50% flocks @ $0.35/sheep. Loss of wool due to dags $0.25/sheep. Summer outbreak - jet for fly control (20%, cost $0.50/sheep)	**

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of weaner bacterial enteritis in sheep in Australia at $10M (Table 5-40). This estimate is highly uncertain due to lack of data about prevalence of disease and the subclinical production losses.

Table 5-40 Economic cost of bacterial enteritis in sheep

	Treatment			**Prevention**			**Production Losses**			**Total**		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0.21	$0	$0	$0	$0	$0	$4.36	$0	$0	**$4.57**	**$0**	**$0**
Per Flock	$347	$0	$0	$0	$0	$0	$7,247	$0	$0	**$7,595**	**$0**	**$0**
Total	**$0.47M**			**$0M**			**$9.80M**			**$10.27M**		

The net gain from moving all flocks experiencing bacterial enteritis is estimated to be $10.27M. This completely offsets the estimated cost of bacterial enteritis.

5.20 Pyrrolizidine alkaloidosis

The disease

Pyrrolizidine alkaloid poisoning of sheep is caused by toxins called pyrrolizidine alkaloids (PA). Two plants, heliotrope (*Heliotropium europaeum*) and Paterson's curse (*Echium plantagineum*), are the most common sources of PA toxicity, with less common poisoning the result of grazing *Senecio sp* and other plants containing PAs. PAs are hepatotoxins but can also cause damage to the brain, kidney and lungs (Salmon 2011). Two disease syndromes are common: liver failure with PA poisoning; and chronic copper poisoning when stored copper is suddenly released from the liver. In a review undertaken by Seaman (1987), Heliotrope and Paterson's curse were equally important in causing PA poisoning whereas Paterson's curse was more important in association with copper poisoning (Seaman 1987). However Salmon (2011) reported that heliotrope was more important in causing disease. When sheep ingest toxic pasture, liver damage occurs within weeks of ingestion. Liver damage is irreversible and cumulative. Chronic copper poisoning usually occurs after several years of ingesting toxic plants, particularly in clover dominant pastures at the end of spring when pastures are senescing and copper becomes more available.

The disease is most common in southern NSW and along the northern fringe of northern Victoria, but is present in all regions where heliotrope and Paterson's curse and other plants that contain PA grow. Seaman (1987) reported over a seven year period from 1978-84 mortality rates of 2.4% from PA poisoning and 2.5% from chronic copper poisoning. At the time in NSW, 64% of sheep were Merinos, 27% crossbred and 9% other breeds though 25% of losses were in Merinos and 52% in crossbreds. Merinos appear more resistant to disease and it appears crossbred sheep are more likely to eat heliotrope. Dorpers appear to readily ingest heliotrope, though their resistance to PA is unknown.

There is no treatment of clinically affected sheep. Control is based on control of weeds. In recent years the release of a number of biological control agents has reduced the distribution of Paterson's curse. In addition heliotrope is better controlled on cropping properties with the more strategic use of herbicides to preserve moisture over summer fallows. In permanent pastures, perennials such as lucerne compete well with both weeds. The removal of stored copper in high risk sheep has been successfully achieved using a loose lick (or drench) of sodium molybdite and sodium sulphate.

Unknown aetiology *Known aetiology*

					X				

Prevention

Prevention is achieved by preventing livestock from having access to toxic plants. Herbicide control in cropping land is now better achieved to preserve moisture for cropping. Biological control of Paterson's Curse is reducing the importance of this weed. Supplying at risk sheep with sodium molybdate and sodium sulphate reduces the risk of chronic copper poisoning. Whilst known preventive measures are available for livestock management, heliotrope in particular is a widespread and important weed that poses challenges for alkaloid poisoning.

Low efficacy/ unproven preventives available *Effective preventives available*

						X			

Treatment

No treatment of affected animals is available; the peracute nature of the disease renders treatment ineffective.

Low efficacy/ unproven treatments available *Effective treatments available*

X									

Distribution

The distribution of PA poisoning is linked to the distribution of toxic weeds. In particular PA poisoning is most common in central and southern NSW and the northern border of Victoria though is present in most areas within the wheat-sheep zones in particular.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

PA risk is ever present though often higher risk in situations of lush pasture or intensive feeding.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Pyrrolizidine alkaloidosis

Table 5-41 Assumptions: pyrrolizidine alkaloidosis in sheep

Variable	Value adopted	Confidence
Regional Extent	The high risk regions include southern NSW and northern Victoria (14% sheep), moderate risk includes remaining wheat-sheep zones and adjoining regions (46% sheep) with remaining regions considered low/nil risk	**
% Flocks affected	High risk: 10% flocks, 10% of sheep affected Moderate impact: 1% flocks, 2% of sheep affected *Double clinical cases in prime lamb flocks*	*
Mortalities	50% of clinical cases	*
Weight loss	5 kg permanent weight loss of clinical cases adults and 2 kg for weaner sheep.	**
Fertility	1.5% decline per kg bodyweight loss	**
Fleece weight %	5.5% decline for adults affected and 2% for weaners	**
Wool price discounts	Nil	**
Market avoidance	Approximately 0.03% of sheep condemned due to jaundice	**
Movement restrictions	Nil	***
Treatment	Nil	***
Prevention	1% flocks provide sodium molybdate and sodium sulphate to reduce the risk of chronic copper poisoning at a cost of $1/sheep	*

Variable	Value adopted	Confidence
Other costs		

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of pyrrolizidine alkaloidosis in sheep in Australia at $6.78M (Table 5-42).

Table 5-42 Economic cost of pyrrolizidine alkaloidosis in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$0.02	$0	$0	$1.99	$0.04	$0	**$2.01**	**$0.04**	**$0**
Per Flock	$0	$0	$0	$32	$0	$0	$3,299	$66	$0	**$3,331**	**$66**	**$0**
Total	**$0M**			**$0.06M**			**$6.71M**			**$6.78M**		

The net gain from moving all flocks to the lowest level of pyrrolizidine alkaloidosis disease is estimated to be $6.78M.

5.21 Sheep measles (*Taenia ovis*)

The disease

Sheep measles is caused by the intermediate stage of *Taenia ovis*, a tapeworm that infects dogs. Sheep grazing pasture ingest eggs that hatch and larvae migrate to muscle tissue, most commonly heart or diaphragm though potentially any muscle in the body. Cysts develop in muscle and if eaten by dogs (or to a lesser degree foxes) will develop into adult tapeworms (Jenkins 2014). In infected sheep, cysts die and develop into small pus-filled abscesses that eventually become mineralised nodules which are not acceptable in meat for human consumption. The financial impact of sheep measles relates to offal (heart) condemnation, carcase trimming and condemnation. There are no health or production impacts in dogs or sheep. Based on abattoir monitoring (NSHMP), sheep measles was detected in 3.65% of carcases Australia wide.

Unknown aetiology *Known aetiology*

									X

Prevention

An effective vaccine to prevent sheep measles has been developed though is not yet registered in Australia. The only effective control at present is to avoid dogs gaining access to uncooked sheep meat and regularly worming dogs (preferably monthly). This is not an option for fox or wild dog control but control of foxes and wild dogs will presumably reduce exposure to sheep. Based on surveys (Jenkins 2014) farmers do not treat dogs regularly and many dogs have access to uncooked meat.

Low efficacy/ unproven preventives available — *Effective preventives available*

						X			

Treatment

The only treatment available is to treat dogs to control tapeworms.

Low efficacy/ unproven treatments available — *Effective treatments available*

X									

Distribution

Distribution seems to be widespread and stable across sheep growing regions.

Distribution contracting — *Distribution stable* — *Distribution increasing*

				X					

Prevalence

Prevalence decreasing — *Prevalence increasing*

				X					

Economics

Assumptions: Sheep measles

Table 5-43 Assumptions: sheep measles

Variable	Value adopted	Confidence
Regional Extent	Distributed across all sheep rearing regions of Australia.	***
% flocks infected	Based on abattoir surveillance (NSHMP) about 3.65% of sheep were infected with sheep measles. Prevalence appears to be slightly higher in southern regions though is averaged across all sheep growing regions.	***
Mortalities	Nil	***
Weight loss	Nil	***
Fleece	Nil	***
Wool	Nil	***
Fertility	Nil	***
Market avoidance	Carcase condemnation: a. Condemnation: 0.019% of adults, 0.012% lambs (DAFF 2014, Animal Health Australia 2014a) *b.* Carcase trim and offal condemnation 0.58% of adults, 0.35% lambs average 0.4 kg cw/carcase (GHD 2009, Hernandez-Jover M *et al.* 2013) c. Offal value $0.61/offal condemnation (GHD 2009)	**
Movement restrictions	Nil	***
Treatment	No treatment is available. However the cost of tapeworm treatment of dogs is considered. On average dogs are treated twice yearly. Assume 3 dogs/farm treated with Droncit @ $12/dog (cost split with hydatids control).	*
Prevention	As for treatment of dogs	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of sheep measles in sheep in Australia at $2.4M (Table 5-44).

Table 5-44 Economic cost of sheep measles

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$0	$0	$0	$0.04	$0	$0	**$0.04**	**$0**	**$0**
Per Flock	$0	$0	$0	$0	$0	$0	$64	$0	$0	**$64**	**$0**	**$0**
Total	**$0M**			**$0M**			**$0.86M**			**$2.44M**		

Reducing prevalence by 50% without extra costs considered would reduce the cost to industry by $0.4M.

5.22 Campylobacter abortion

The disease

Campylobacteriosis (vibriosis) is the most common cause of abortion in sheep. It causes sporadic abortion in the high rainfall regions of southern Australia, particularly Victoria and Tasmania but has been reported in all states except Queensland. The two major abortigenic campylobacter species are *Campylobacter fetus* subsp *fetus* (probably the most common) and *Campylobacter jejuni* subsp *jejuni* which is also commonly isolated (Clough 2003). Both campylobacter species are commensal organisms of the gastrointestinal tract. Susceptible ewes are infected by ingestion of contaminated pasture, water or feed that has been contaminated by aborted foetal fluids, foetuses, placenta or contaminated faeces. Carrier sheep are an important source of maintenance and transmission, but other animals including foxes, crows and other birds have been implicated in the spread of infection, although their importance is unclear compared with carrier ewes. High risk factors for spread include high stocking rates, specifically associated with rotational grazing or feeding grain in a trail that promotes heavy bacterial exposure.

Abortion storms in the last six weeks of pregnancy are the most obvious outcome and typically affect 10-20% of ewes in a mob, although occasional higher levels of up to 50% of ewes aborted are reported. On endemically infected farms, abortion storms typically occur every 5-7 years due to the rise and fall of flock immunity (Clough 2003). Maiden ewes and pregnant ewe lambs tend to be most at risk because they have less immunity. In the absence of the use of vaccines, a common recommendation in endemically infected flocks is to ensure maidens ewes are combined with mature ewes well before mating to ensure they are exposed to campylobacter and develop immunity before pregnancy, thus reducing the risk of abortion storms.

The extent of perinatal lamb losses from stillbirths and congenitally infected lambs that are weak and die within a day of birth is less clear. In New Zealand, Anderson (2001) demonstrated endemically infected flocks suffer ongoing perinatal lamb losses of 9-10% regardless of whether abortions are detected, with losses being reduced by vaccination. Very little evidence of this phenomenon exists in Australia although one trial (5 flocks only) using “Guardian” campylobacter vaccine resulted in a 6.8% increase in lamb marking percentage for vaccinated ewes (Thompson 2011). In this same trial, if the one mob of adults in which no response was recorded was removed from the analysis, the increased lamb marking percentage in the four remaining maiden flocks was 8.6%, i.e. similar to the New Zealand experience.

A new vaccine has recently been released (Coopers Ovilus Campyvax®) that protects against the most common strains of campylobacter present in Australia.

Unknown aetiology — *Known aetiology*

							X		

Prevention

There are two method of prevention in endemic flocks. A new vaccine Coopers Ovilus Campyvax® which protects against *Campylobacter fetus subsp fetus* and *Campylobacter jejuni subsp jejuni* is available though not yet widely used (assumed partly due to the fact it is relatively new and partly because many producers do not perceive the disease is a problem). The vaccine is most commonly used in maiden ewes. Producers can also reduce the risk of abortion storms by ensuring young ewes are mixed with older ewes well before mating so they develop immunity before they become pregnant. Other factors that may reduce the risk of exposure are to avoid intense stocking rate rotational grazing (this may not be practical or cost effective) with late pregnant ewes and avoid grain feeding on the same trail to minimise bacterial contamination.

Low efficacy/ unproven preventives available — *Effective preventives available*

						X			

Treatment

In the face of abortion outbreaks, antibiotic therapy for exposed pregnant ewes is the only option to reduce the impact, though the efficacy of this procedure is not clear and in any case rarely adopted. No proven treatment is available to reduce the impact of an abortion storm caused by campylobacter apart from antibiotic therapy of at risk ewes with uncertain efficacy.

Low efficacy/ unproven treatments available — *Effective treatments available*

X									

Distribution

The distribution of campylobacter abortion appears stable. Campylobacter abortion is observed most commonly in high rainfall regions, especially cool moist climates such as Tasmania and southern Victoria, although has been observed in the pastoral zone under intensive feeding conditions.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

There is no good data available about the prevalence of campylobacter abortion. Clough (2003) summarised surveys investigating causes of abortion and perinatal lamb loss and of five surveys, 13% of farms investigated were positive to campylobacter and of samples submitted from eight surveys, 15% were positive to campylobacter. In the wider industry there are no estimates of the prevalence of campylobacter, however, industry expert opinion considers about 5% of Tasmanian flocks have noticeable abortions due to campylobacter and possibly 1% of flocks in high rainfall regions in NSW, Victoria, South Australia and Western Australia with outbreaks with an estimated 10% of maidens and 5% of adults aborting. No estimates are available of subclinical losses.

Prevalence is generally stable, although with widespread industry recommendations that promote rotational grazing and mating of ewe lambs, the prevalence of campylobacter abortion will almost certainly increase.

Prevalence decreasing *Prevalence increasing*

						X			

Economics

Assumptions: Campylobacter abortion

Table 5-45 Assumptions: campylobacter abortion in sheep

Variable	Value adopted	Confidence
Regional Extent	Tasmania is considered the highest risk region (3.2% sheep), followed by high rainfall regions of mainland states excluding Queensland (37.2% sheep). The wheat sheep zone is low risk (45.9% sheep).	**
% Flocks affected	High risk: 5% flocks Moderate risk: 1.5% flocks Low risk: 0.5% flocks	*
Mortalities	Ewes aborting / Maidens / Adults High risk: 15% / 5% Moderate impact: 12% / 2.5% Low impact: 5% / 0%	*
Weight loss	Nil	***
Fertility	Ewes that abort produce 3% more lambs the following year as they are heavier at joining	**
Fleece weight %	Ewes that abort produce 5% more wool	***
Wool price discounts	Staple strength reduced: 1% clean discount.	**
Market avoidance	Nil	***
Movement restrictions	Nil	***
Treatment	Nil	***
Prevention	1% at risk flocks vaccinate maidens with Ovilus Campyvax in high risk and moderate risk zones and 0.2% adults vaccinated	*
Other costs	Nil	

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of campylobacter abortion in sheep in Australia at $1.63M (Table 5-46).

This estimate is highly uncertain due to lack of data on prevalence both in terms of frequency of abortion storms and impact of subclinical perinatal lamb loss associated with campylobacter.

Table 5-46 Economic cost of campylobacter abortion in sheep

	Treatment			Prevention			Production Losses			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$0.01	$0.01	$0	$14.21	$9.52	$2.70	**$14.22**	**$9.53**	**$2.70**
Per Flock	$0	$0	$0	$21	$21	$0	$21,715	$14,546	$4,129	**$21,736**	**$14,567**	**$4,129**
Total	**$0M**			**$0M**			**$2.73M**			**$1.63M**		

The net gain from moving all flocks experiencing campylobacter abortion to the lowest level of disease is estimated at $1.12M.

5.23 Sarcocystis (*Sarcocystis spp*)

The disease

Sarcocystis (sarcosporidiosis or sheep measles) is caused by a group of protozoon parasites (*Sarcocystis* spp). Infected cats, dogs and foxes (infected from ingesting infected meat) act as the definitive host that produce sporocysts that pass in the faeces that are subsequently ingested by sheep where the sarcocyst develops in muscle and offal. Cats, dogs and foxes become reinfected by ingesting carcase or when fed uncooked meat. Meat with established *Sarcocystis* infection is not acceptable for human consumption (Munday 1990). The financial impact of sarcosporidiosis relates to offal condemnation, carcase trimming and condemnation. There are no apparent health or production impacts in sheep, although experimental infection can cause serious wool and bodyweight production losses in previously naive animals and occasional reports of abortions are documented (Munday 1986). Based on abattoir monitoring (Animal Health Australia 2014a), *Sarcocystis* was detected in 0.88% of carcases with southern regions at highest risk, particularly Tasmania where *Sarcocystis* was detected in 13.7% of carcases.

Unknown aetiology — *Known aetiology*

									X

Prevention

There is no preventive strategy available to prevent *Sarcocystis* apart from control of feral cats and avoid feeding raw meat to cats and dogs and remove carcases.

Low efficacy/ unproven preventives available — *Effective preventives available*

	X								

Treatment

No treatment is available.

Low efficacy/ unproven treatments available *Effective treatments available*

X									

Distribution

Distribution seems to be widespread across sheep growing regions, although more common in southern regions. In Tasmania it is noted to be more common around townships presumably due to the association with higher cat populations.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Prevalence is generally constant.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Sarcocystis

Table 5-47 Assumptions: *Sarcocystis* in sheep

Variable	Value adopted	Confidence
Regional Extent	Distribution Australia wide	***
% Flocks affected	Based on abattoir surveillance, about 0.88% of sheep were infected with sarcocystis. Prevalence appears to be higher in southern regions though is averaged across all sheep growing regions.	**
Mortalities	Nil	**
Weight loss	Nil	***
Fertility	Nil	***
Fleece weight	Nil	***
Wool price	Nil	***
Market avoidance	Carcase condemnation: a. Condemnation: 0.01% of adults, (DAFF 2014) *b.* Carcase trim 0.3% of adults. Average 5.6 kg trim/carcase (GHD 2009, Hernandez-Jover M et al. 2013)	**
Movement restrictions	Nil	***
Treatment	Nil	***
Prevention	Avoid offal feeding to cat, dogs and foxes. Control of feral cats, dogs and foxes (no cost considered as definitive hosts controlled for other reasons).	***

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of *Sarcocystis* in sheep in Australia at $0.89M (Table 5-48).

Table 5-48 Economic cost of sarcocystis in sheep

	Treatment			**Prevention**			**Production Losses**			**Total**		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Sheep	$0	$0	$0	$0	$0	$0	$0.02	$0	$0	**$0.02**	**$**	**$0**
Per Flock	$0	$0	$0	$0	$0	$0	$35	$0	$0	**$35**	**$0**	**$0**
Total	**$0M**			**$0M**			**$0.60M**			**$0.89M**		

If the prevalence of sarcocystis is reduced by 50% then the cost to industry would reduce by $0.45M. Note that no value on potential production losses has been considered as they have not been proven in field conditions.

6 Results – Goat diseases

6.1 Internal parasites

<u>The disease</u>

A wide range of gastrointestinal worms can affect goats in Australia but the most important ones are the barber's pole worm and the nodule worm, especially in summer rainfall zones, and the small brown stomach worm and the scour worms, especially in the winter rainfall and temperate zones.

Risk factors for worms include high or summer rainfall, higher stocking rates and co-grazing with sheep. Sparing factors are low rainfall, low stocking rates, the presence of browse, and rotational grazing with cattle.

Goats are affected by the same worms as sheep but when grazed with sheep, goats tend to carry heavier worm burdens and suffer more pathology than sheep (Sangster 1990). The heavier worm burdens of goats compared with sheep when co-grazed are due in part to greater rates of infection associated with different grazing patterns as well as susceptibility (Jallow *et al.* 1994).

Production costs may be associated with deaths and reduced growth, conception rates and fibre production. Processing costs do not apply except perhaps in the very rare case of nodule worm damage to intestines that may be used for sausage casings.

Other costs may be associated with buyer resistance if they are aware of drench resistance being a serious problem and animal welfare investigation by authorities concerned about deaths or condition of stock.

Unknown aetiology *Known aetiology*

								X	

Prevention

Prevention may involve:

- monitoring worm burdens and drench resistance
- strategic drenching and grazing management to reduce worm burdens and drench resistance
- selection of resistant goats
- using browse and supplements to reduce worm burdens
- extra nutrition to strengthen immunity
- quarantine and drenching of introduced goats

Low efficacy/ unproven preventives available *Effective preventives available*

								X	

Treatment

Worm affected sheep are treated with a range of chemicals by a range of routes of administration. Resistance to worm drenches is making treatments increasingly less effective.

Low efficacy/ unproven treatments available *Effective treatments available*

				X					

Distribution

Lyndal-Murphy *et al.* (1997) concluded that gastrointestinal parasites present little problem to goats run on extensive rangeland properties, however for the 10% of Australian goats grazed on grass and improved pastures in the higher rainfall agricultural zones (>380mm annual rainfall), parasitism is a frequent occurrence with severe outbreaks of disease linked to rainfall events.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

The only data found to assist estimates of prevalence or seriousness of worms in goats was the MLA sponsored survey by Lyndal-Murphy *et al.* (1997) addressing the extent of problems from endo and ectoparasites, and control practices that was circulated to 1500 goat producers. Useable responses were returned from 195. Gastrointestinal parasites were always or mostly a problem on 26% of properties and sometimes a problem on 59% and 15% never experienced a problem. Of those enterprises that sometimes had a problem, 3% were extensive rangeland, 28% moderate inputs, 63% intensive and 0.9% depots while seven respondents were in the education and hobby sectors. Of the 15% of producers who never had a problem with worms 28% ran an extensive rangeland type enterprise, 25% a moderate inputs enterprise and 32% ran intensive type enterprise. Three per cent were depots and 12% belonged to the education and hobby sectors.

Eighty-eight percent of respondents used drenches to control worms. Of the 12% of respondents who did not use drenches to control worms, 41% ran extensive type enterprises, 36% enterprises with moderate inputs, 18% intensive type grazing enterprise while the remaining 5% were from the education and hobby sectors.

The economic cost of worms in goats in Australia is believed to be low because of the small proportion of the goat population in high and summer rainfall areas of Australia. However in herds in the high or summer rainfall areas, many of which will have higher stocking rates, little browse, co-grazing with sheep and drench resistance, significant production losses and control and treatment costs could be expected especially if barber's pole worm was involved.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Internal parasites

Table 6-1 Assumptions: gastrointestinal worms in goats

Variable	Values adopted		Confidence
	Rangeland (n=4M)	Farmed meat (n=250K), fibre (n=150K)	
Regional Extent	Nil herds affected	All farmed goats other than young kids are at risk	**
% herds affected	Nil	100% herds affected with greatest impact on the 30% of the farmed goat population residing in the high and summer rainfall zone.	**
Case fatality rate	Nil	Weaners 3%; adults 0.6%	*
BW weight loss	Nil	Permanent & temporary: 1.0 kg weaners; 1.0 kg adults	*
Fleece weight loss	Nil	5% in fibre goats	*
Fertility	Nil	1.5% reduction in pregnancy rate/kg BW lost	*
Market avoidance	Nil	Nil	***
Movement restrictions	Nil	Nil	***
Treatment	Nil	Considered as part of prevention program	*
Prevention	Nil	Assumes negligible worm egg counting or drench resistance testing being carried out and 100% of goats and herds treated at $1.50/goat/yr (includes cost of drench and labour)	*

Total cost of disease

Based on the prevalence and impacts of the disease on the classes of animal affected, GHD has calculated the annual cost of internal parasites in goats in Australia at $2.54M as shown in Table 6-2.

Table 6-2 Economic cost of internal parasites in goats

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Goat	$0	$0	$0	$1.50	$1.50	$1.50	$0	$3.93	$3.60	**$5.34**	**$5.34**	**$0**
Per Herd	$0	$0	$0	$294	$294	$294	$0	$752	$706	**$1,046**	**$1,046**	**$0**
Total	**$0M**			**$0.71M**			**$1.83M**			**$2.54M**		

6.2 Enterotoxaemia

The disease

Enterotoxaemia is a well-known, vaccinable, clostridial disease of goats manifesting as diarrhoea and or rapid death. Under favourable conditions, the *Clostridium perfringens* types involved, normally resident in the gut, multiply rapidly and produce toxins.

Sudden changes onto readily fermentable carbohydrate-rich feeds or overeating will trigger outbreaks but are not prerequisite. Rolling outbreaks have occurred where feed, management or weather changes have not occurred but a heavily contaminated environment has been suspected. Death is likely in affected kids, chronic diarrhoea and illthrift is likely in affected adults.

Production costs may be associated with deaths, long term illthrift in survivors and reduced growth associated with reduced supplementary feeding to reduce incidence.

Tissue reactions at vaccine injection sites can be a costly aesthetic problem for show goats.

Unknown aetiology *Known aetiology*

Prevention

Reduced feeding of carbohydrates to herd mates, with associated reduced production, is usually recommended when a case occurs.

More frequent vaccinations than are required for sheep are necessary to protect goats. Vaccination is often with the more expensive polyvalent vaccines every 4 months in problem herds and every 6 months in other herds is often recommended.

Some vaccine site reactions develop into abscesses, sometimes sterile, that must be differentiated from caseous lymphadenitis. Rarely there is carcase trim or hide damage associated with vaccination site reactions and abscesses.

Low efficacy/ unproven preventives available — *Effective preventives available*

							X		

Treatment

The prognosis is usually grave and therefore treatment, which is expensive and time consuming (usually involving rehydration, antibiotics, analgesics, adsorbents and possibly antitoxins), is not normally attempted except in highly valued animals.

Low efficacy/ unproven treatments available — *Effective treatments available*

						X			

Distribution

All goat populations are susceptible however the risk factors of overfeeding, supplementary feeding, introduction to lush feed and heavily contaminated environments from previous diarrhoeic cases would probably only be present in the estimated 10% of the Australian goat population that is farmed.

Distribution contracting — *Distribution stable* — *Distribution increasing*

				X					

Prevalence

Enterotoxaemia does cause death and illthrift in farmed goat herds in Australia however no data was found upon which to confidently estimate losses.

Although enterotoxaemia is often raised in discussions as a serious disease of goats there is little documentation of this in the literature; most mention is related to intensively managed dairy goats.

Logically, the incidence in rangeland goats is likely to be close to zero given the absence of risk factors. The incidence in farmed goats is likely to be similar to the incidence in farmed sheep.

A clue to the incidence is offered by the published comments of Uzal *et al.* (1998) from a 1995 survey of 397 mainly fibre goat owners and four state diagnostic laboratories. The owners attributed 2% of deaths to enterotoxaemia and the laboratories suspected enterotoxaemia in 6.8% of goat autopsies. Uzal *et al.* (1998) also found that 40% of goat owners did not vaccinate and more than half of goat owners only gave one dose of vaccine.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Enterotoxaemia

Table 6-3 Assumptions: enterotoxaemia in goats

Variable	Values adopted		Confidence
	Rangeland (N=4M)	Farmed goats (N=250K meat, 150K fibre)	
Regional Extent	Nil	5% herds low incidence; 95% herds nil incidence	*
% herds affected	Nil	0.2%	*
Mortalities	Nil	100% case fatality rate	*
Weight loss	Nil	Nil	***
Fertility	Nil	No fertility reduction with 100% mortality	*
Market avoidance	Nil	Nil	***
Movement restrictions	Nil	Nil	***
Treatment	Nil	Nil	**
Prevention	Nil	95% herds vaccinate all animals at cost of $0.3/yr (5:1)	*

Total cost of disease

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of enterotoxaemia in goats in Australia to be $0.35M as shown in Table 6-4.

Table 6-4 Economic cost of enterotoxaemia

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Goat	$0	$0	$0	$0.71	$0.71	$00	$0.19	$0.00	$0.00	**$0.89**	**$0.71**	**$0.00**
Per Herd	$0	$0	$0	$141	$141	$0	$37	$0	$0	**$176**	**$141**	**$176**
Total	**$0M**			**$0.34M**			**$0.00M**			**$0.35M**		

6.3 Lice

<u>The disease</u>

Lice, depending on species, cause disease in goats by irritating the skin and causing them to scratch, or by sucking blood causing illthrift. In rare cases massive infestations cause death.

The lice of goats are generally specific to goats, and sheep lice although known to transfer to Angora goats are not a significant pest of goats except under rare conditions.

The production costs of lice are associated with illthrift from sucking lice, and reduced quantity and quality of mohair production from biting lice (that bite through mohair fibres).

The review by Lyndal-Murphy *et al.* (2007) mentioned notations in the literature of reductions in mohair clips of as much as 10% to 25% and reductions of 230g/animal attributed to biting lice.

Deaths associated with massive infestations of sucking lice in kids do occur, but probably very rarely.

Processing costs may be associated with downgrading of matted and stained mohair or cashmere from fibre goats and of rubbed and scratched skins from meat goats though the impact of this is not considered due to lack of information.

Unknown aetiology *Known aetiology*

									X

Prevention

Preventive costs may be associated with efforts to avoid purchasing infested goats, increasing boundary security to prevent strays and monitoring the existing herd for lice.

Low efficacy/ unproven preventives available *Effective preventives available*

								X	

Treatment

The review by Lyndal-Murphy *et al.* (2007) which included a survey, indicates that a wide range of chemicals including some that are unregistered for use in goats are administered by backline pour-on, injection, spray, dip and dusting. Organic methods and nutritional supplementation methods are used sometimes with unknown efficacy. There may be costs associated with treatments to meet live export, interstate movement or show entry protocols even if goats are free of lice.

In the survey by Lyndal-Murphy *et al.* (2007), fifty seven percent of respondents indicated they had treated for lice in the past two years; most producers indicated they treated once per year, 36% indicated they treated more than once per year and some indicated they treated three times. Approximately 36% and 64% used registered and unregistered products respectively. The survey indicated the most common method of application was by backline pour-on, used by 66% of those treating lice. Based on survey results it appears prevention is adopted in meat and dairy herds even though the direct economic impact is likely to be mostly in fibre herds. The justification of this is unclear given the uncertain economic cost of lice in non-fibre herds.

Low efficacy/ unproven treatments available *Effective treatments available*

								X	

Distribution

Species of biting and sucking lice, with the potential for economic impact, are present in all sectors of the goat industry including in rangeland goats (Lyndal-Murphy *et al.* 2007).

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

Lyndal-Murphy *et al.* (2007) in their review of the lice situation in Australian goats for MLA, found there was little data on the prevalence or economic impact of lice in goats in Australia.

In their producer survey of 1500 goat producer where there were 195 useful responses, 30% of respondents produced fibre for the fibre market with 6% going into the domestic market, 14% to the export market and 10% not sure of the final market. Of the 195 useful responses, lice were always or mostly a problem for 9% of producers, sometimes a problem for 53% and never a problem for 37% of respondents. However, 56% of producers treated for lice and 9% of respondents had needed to treat for lice within six weeks of sale.

Prevalence decreasing *Prevalence increasing*

				X					

<u>Economics</u>

Assumptions: Lice

Table 6-5 Assumptions: Lice in goats

Variable	Values adopted		Confidence
	Rangeland (N=4M)	Farmed goats (N=250K meat, 150K fibre)	
Regional Extent	All rangeland populations exposed	All farmed populations exposed	**
% animals in infected herds affected	30% prevalence	30% prevalence in meat and fibre herds	*
Case fatality rate	Nil	Nil	***
Weight loss	Nil	Nil	***
Fertility	Nil	Nil	***
Downgrading hides or mohair	Nil	Nil reported 7% reduced fleece weight and 10% reduced fleece value for affected fibre goats	*
Market avoidance	Nil	Negligible	***
Movement restrictions	Nil (all slaughtered)	Negligible	***
Treatment	Nil	Refer to prevention	*
Prevention	Nil	Average prevention cost of $1.00/adult (slightly higher than sheep); 43% of meat goat herds and 57% of fibre herds actively prevent	*

Total cost of disease

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of lice in goats in Australia at $0.34M as shown in Table 6-6.

Table 6-6 Economic cost of Lice

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Goat	$0	$0	$0	$0.43	$0.57	$0.00	$0.20	$0.34	$0.00	**$0.63**	**$0.85**	**$0.00**
Per Herd	$0	$0	$0	$85	$113	$0	$39	$56	$0	**$125**	**$169**	**$0**
Total $M	**$0.00M**			**$0.23M**			**$0.11M**			**$0.34M**		

The net gain from moving all herds experiencing lice to the lowest level of disease is estimated at $30,000.

6.4 Pregnancy toxaemia

The disease

Pregnancy toxaemia is a highly fatal metabolic disease of older does associated with under-nutrition in late pregnancy.

Obesity, large or multiple foetuses, sudden dietary changes or illness during late pregnancy are predisposing factors as is being of an "improved" higher-producing breed.

Production costs may be associated with deaths of affected does and loss of the pregnancy and lowered production of surviving does (they are prone to dystocia, do not milk well and have higher kid mortality).

Processing costs do not apply. There may be other costs to the business associated with animal welfare investigation if a confronting outbreak occurs.

Unknown aetiology *Known aetiology*

								X	

Prevention

Careful management of nutrition can reduce the incidence. Management costs may be associated with monitoring and supplementary feeding to prevent cases in higher risk does.

Low efficacy/ unproven preventives available *Effective preventives available*

					X				

Treatment

Treatment is rarely successful once clinical signs are evident. Treatment of valuable animals may involve inducing parturition, caesarean section and oral propylene glycol.

Low efficacy/ unproven treatments available *Effective treatments available*

		X							

Distribution

Pregnancy toxaemia is thought not to occur in rangeland goats. Farmed goats in the higher rainfall areas are likely to be most affected.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

No solid data was found upon which to base estimates of incidence or morbidity or mortality rates. Seasonal variation in pasture conditions and managers' acumen will have a bearing on incidence from year to year.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Pregnancy toxaemia

Table 6-7 Assumptions: pregnancy toxaemia in goats

Variable	Values adopted		Confidence
	Rangeland (N=4M)	Farmed goats (N=250K meat, 150K fibre)	
Regional Extent	Nil occurrence	All farmed herds at risk	*
% herds affected	Nil	0.3% of mature breeding does affected	*
Case fatality rate	Nil	80%	*
Weight loss	Nil	Temporary weight loss of 2 kg	*
Fertility	Nil	80% surviving does fail to wean a kid in next 12 mo	*
Fleece weight	Nil	10% reduction in affected fibre does	*
Market avoidance	Nil	Negligible	***
Movement restrictions	Nil	Negligible	***
Treatment	Nil	80% cases treated at $15/case (proplyene glycol, nursing)	*
Prevention	Nil	20% herds supplementary feed high-risk does at $1.00/hd	*

Total cost of disease

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of pregnancy toxaemia in goats in Australia to be $0.10M as shown in Table 6-8.

Table 6-8 **Economic cost of pregnancy toxaemia**

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Goat	$0.01	$0.01	$0.01	$0.07	$0.07	$0.00	$0.12	$0.12	$0.00	**$0.21**	**$0.21**	**$0**
Per Herd	$3	$3	$3	$15	$15	$0	$24	$24	$0	**$41**	**$42**	**$0**
Total	**$0.01M**			**$0.04M**			**$0.06M**			**$0.10M**		

There is no apparent net gain from moving all affected herds experiencing pregnancy toxaemia to the lowest level of disease.

6.5 Caseous lymphadenitis (CLA)

<u>The disease</u>

Caseous lymphadenitis (CLA) is a slowly developing, contagious, abscessating, incurable, vaccinable disease that has been reported in dairy and feral goats in Australia. Infection from goats can infect humans.

The causative bacterium, after entering the body through breaks in the skin or mucous membranes, disseminates and multiplies to cause abscesses in the drainage pattern of regional lymph nodes and beyond. Most abscesses are under the skin of the head and neck and in the chest; infrequently abscesses are in other locations such as the abdomen, udder and limbs.

The abscesses can range from the size of a golf ball to a large grapefruit. The production effects on an animal are presumed related to inappetance associated with toxaemia and sometimes from local physical interference to organ function to do with compression or space occupation. This will mainly occur in adult goats and then mainly toward the end of their expected productive life.

Rupture of skin and lung abscesses contaminate the environment and skin creating a source of infection for herd mates that can last for months. Moisture and shade support environmental persistence.

Congregating goats for husbandry reasons such as feeding, shearing, dipping predisposes to spread.

The potential for cross infection is present for co-grazing sheep and goats. Production costs may be associated with:

- mortalities, as some goats will die on farm or be euthanased
- premature culling of sick goats with breathing difficulty or wasting
- infertility from lower conception rates in illthrifty does, usually older does
- slower growth and fibre production over the lifetime of goats infected at a young age.

Processing costs may be associated with condemnation and trim of infected carcasses and offal, and downgrading of hides damaged by burst or surgerised abscesses

Other costs may be associated with zoonotic infection if workers or contractors become infected. Surgery, antibiotics, time off work and compensation may be required.

Unknown aetiology									*Known aetiology*
								X	

Prevention

Prevention may involve implementing hygiene and disinfection measures at shearing and dipping, removing hazards that cause skin breaks, handling infected animals last, vaccination of young stock, preferential culling of higher risk older animals and separation of newborn kids from infected dams.

Bioexclusion of CLA may involve avoiding introductions from infected herds, and applying hygiene and disinfection procedures to contractors and their equipment

Low efficacy/ unproven preventives available									*Effective preventives available*
							X		

Treatment

CLA is considered incurable however treatment involving isolation, surgical drainage and antibiotics may be attempted to achieve temporary reprieve in animals with peripheral abscesses.

Low efficacy/ unproven treatments available									*Effective treatments available*
X									

Distribution

CLA abscesses can be found in all populations of goats including in rangeland goats.

Distribution contracting				*Distribution stable*					*Distribution increasing*
				X					

Prevalence

In Australia, prevalence of CLA in feral goats determined by presence of lesions found at abattoir slaughter has ranged from 0.3% to 18.8% (Williams 1978; McKenzie *et al.* 1979; Hein and Cargill 1981; Anderson and Nairn 1985, Batey 1986).

Anderson and Nairn (1985) found a prevalence of 3.1% in 900 feral goats in WA. Most goats (~61%) had just peripheral abscesses, 25% had internal abscesses and 15% had peripheral and internal abscesses. A similar distribution was found by Hein and Carghill (1981) in feral goats from western NSW.

Batey (1986) found a prevalence of 7.8% in 2920 feral goats in WA with head, body and visceral lesions present in 49.5%, 46.7% and 12.3% of affected goats respectively.

In abattoir surveillance data gathered as part of the National Sheep Health Monitoring Program in the years 2008 to 2014 inclusive (Animal Health Australia 2014a), CLA was detected in 7% of the nearly 400,000 goats inspected, and 96% of the 1653 lines inspected. Prevalences were up to 20% in some lines.

In abattoir data collected by DAFF (2014) over three years from 2011 to 2013 inclusive, there were 1465 goat carcasses wholly condemned out of 5.6 million goats slaughtered. The number trimmed or partially condemned was not available.

No specific data was found on prevalence in farmed goats in Australia.

Outbreak prevalence decreasing *Outbreak prevalence increasing*

				X					

Economics

Assumptions: Caseous lymphadenitis

Table 6-9 Assumptions: caseous lymphadenitis in goats

Variable	Values adopted		Confidence
	Rangeland (N=4M)	Farmed goats (N=250K meat, 150K fibre)	
Regional Extent	Rangeland and farmed goats affected equally; all populations at risk		**
% herds affected	7% of goats at abattoir inspection detected with CLA lesions across all populations; all herds affected		*
Mortalities	Nil	Nil	***
Weight loss	Nil	Nil	***
Fleece weight	Nil	5% reduction in fleece weight in year of infection (same as sheep)	*
Fertility	Nil	Nil	***
Market avoidance	0.03% carcasses wholly condemned at $3.50/kg x 17 kg carcass weight 3% have offal sets condemned at net loss of $3.00/set 3% have carcase trim at 1 kg trimmed x $3.50/kg carcass BW (margin after consigned to pet food)		*
Movement restrictions	Nil	Nil	***
Treatment	Nil	Nil	***
Prevention	Nil	5% of farmed goats use CLA 6 in 1 or 3 in1 vaccine	**

Total cost of disease

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of CLA in goats in Australia to be $0.11M as shown in Table 6-10.

Table 6-10 Economic cost of caseous lymphadenitis

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Goat	$0	$0	$0	$0	$0.02	$0	$0.02	$0.02	$0	**$0.02**	**$0.04**	**$0**
Per Herd	$0	$0	$0	$0	$4	$0	$4	$4	$0	**$4**	**$9**	**$0**
Total	**$0M**			**$0.01M**			**$0.11M**			**$0.11M**		

6.6 Liver fluke

The disease

For part of their lifecycle, liver fluke live in the liver where they cause local injury and feed on blood. Infections manifest as illthrift or sudden death including from black disease caused by *Clostridium novyi* in unvaccinated goats. Risk factors for disease from liver fluke are associated with the presence of its partner snail which it depends on to complete its life cycle.

Risk factors for disease from liver fluke are associated with the presence of its partner snail which it depends on to complete its life cycle.

The snail is largely confined to the tablelands, coastal regions and irrigation areas of south eastern Australia. The habitat of the snail on farms is limited to marshes and swamps, springs, water courses and irrigated pastures. Goats are at risk if they graze these habitats.

The production costs of liver fluke are associated with deaths from anaemia, the massive damage from migrating immature fluke and black disease, and in chronic fluke infections, illthrift, and reduced conception rates and fibre production.

There are processor costs associated with damaged livers which are unfit for human consumption yet suitable for pet food. Other costs may be associated with restrictions on interstate movements to WA and investigations by authorities if animal welfare is threatened.

Unknown aetiology *Known aetiology*

									X

Prevention

Prevention involves avoiding introduction of infected animals including infected sheep, cattle, horses and alpacas, fencing-off flukey areas, monitoring fluke status using faecal egg counts, strategic drenching and rotational grazing.

Low efficacy/ unproven preventives available *Effective preventives available*

								X	

Treatment

Treatment involves drenching or injecting with a flukicide.

Low efficacy/ unproven treatments available *Effective treatments available*

							X		

Distribution

For lifecycle completion, liver fluke are dependent on certain snails which determine the distribution of the disease. The main snail involved, *Austropeplea tomentosa*, is largely confined to the tablelands, coastal regions and irrigation areas of south eastern Australia. The habitat of this snail on farms is limited to marshes and swamps, springs, water courses and irrigated pastures. Goats are at risk if they graze these habitats. Some introduced snail species, escapees from the aquarium industry, are less fastidious than *A. tomentosa* which creates the potential for liver fluke to become more widely distributed. The distribution may be slowly widening with spread of introduced snail species.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

In abattoir surveillance data gathered as part of the National Sheep Health Monitoring Program in the years 2008 to 2014 inclusive (Animal Health Australia 2014a), liver fluke was detected in 4% of nearly 400,000 goats slaughtered. Of 1653 lines slaughtered, 21% were positive for liver fluke, an average of 28% goats were affected per positive line, and up to 100% of goats were infected in some lines.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Liver fluke

Table 6-11 Assumptions: Liver fluke in goats

Variable	Values adopted		Confidence
	Rangeland (N=4M)	Farmed meat (n=250K) and fibre (n=150K)	
Regional Extent	Nil herds affected	Mainly a problem of herds in south eastern Australia	***
% herds affected	Nil	10% of farmed herds infected *(20% of goat lines in NSHMP data had fluke)*	*
Case fatality rate	Nil	3% in all age classes	*
Weight loss	Nil	Permanent: 1 kg weaners and 3 kg adults Temporary: 1 kg weaners and 3 kg adults	*
Fleece weight & value	Nil	In fibre goats only, reduced fleece weight of 5% in weaners and 10% in adults; and reduced fleece value of 10% in all fibre goat age classes	*
Fertility	Nil	1.5% reduction in pregnancy rate/kg BW lost	*
Market avoidance	Nil	28% livers in goats from affected herds are downgraded to pet food or meat meal at cost of $2.00/liver	*
Movement restrictions	Nil	May occur occasionally but considered negligible because of other readily available selling options	*
Treatment	Nil	All costs assigned to prevention	**
Prevention	Nil	Prevention/control costs of $1/goat in infected herds for fencing, monitoring, rotational grazing.	*

Total cost of disease

Based on the prevalence and impacts of the disease on the classes of animal affected, GHD has calculated the annual cost of liver fluke in goats in Australia at $0.11M as shown in Table 6-12.

Table 6-12 Economic cost of liver fluke in goats

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Goat	$0	$0	$0	$1	$1	$0	$1.28	$1.31	$0.00	**$2.28**	**$2.31**	**$2.31**
Per Herd	$0	$0	$0	$197	$197	$0	$253	$258	$0	**$450**	**$455**	**$455**
Total	**$0M**			**$0.05M**			**$0.06M**			**$0.11M**		

There is negligible net gain from moving all affected herds experiencing liver fluke to the lowest level of disease.

6.7 Footrot

<u>The disease</u>

Footrot is a highly contagious bacterial disease affecting the ruminant foot that can cause serious lameness in goats from interdigital infection and under-running of the horn of the claw. Most problems are seen in high rainfall areas in spring in association with warmer temperatures and wet conditions underfoot. Footrot is not a problem in arid regions.

Cross transmission between goats and sheep is possible. Goats are believed to be less susceptible to footrot than sheep, and prevalence in goats is believed to be lower than in sheep.

The legal requirements for notification and management of footrot, and thus compliance costs imposed, vary between states.

Production costs may be associated with premature culling of goats with obstinate chronic infections or that are not worthwhile treating. There are also costs associated with the reduced growth, conception rates and fibre production that are a consequence of inability to graze freely.

Processing costs do not apply.

Restrictions on interstate movements, buyer resistance, ineligibility for shows, business relationships and if an animal welfare investigation is launched by authorities are other areas where costs may apply.

Unknown aetiology *Known aetiology*

								X	

Prevention

Footbathing introduced goats (and sheep), additionally securing of boundary fencing and efforts involved to avoid sourcing introductions from infected herds and sheep flocks are biosecurity measures used.

Low efficacy/ unproven preventives available *Effective preventives available*

								X	

Treatment

Footbathing, inspections using footparing, and antibiotics are used to attempt to suppress or eradicate footrot.

Low efficacy/ unproven treatments available *Effective treatments available*

								X	

Distribution

Problems with footrot are largely restricted to goats grazing in higher rainfall areas. Distribution is considered to be stable.

Distribution contracting *Distribution stable* *Distribution increasing*

				X					

Prevalence

No data was found on prevalence, morbidity and mortality rates associated with footrot in goats in Australia however anecdotal evidence suggests these rates are very low and prevalence is stable.

Prevalence decreasing *Prevalence increasing*

				X					

Economics

Assumptions: Footrot

It is estimated from ABS data, that there are about 50,000 goats in about 1000 herds in the high rainfall areas.

The proportions of meat, fibre and dairy goats in the high rainfall zone are unknown but the majority are believed to be dairy and fibre goats.

The economic cost of footrot in goats in Australia is believed to be very low because of the small proportion of the farmed and fibre goat population in high rainfall areas and the greater resistance of goats to footrot compared to sheep. Notwithstanding a low prevalence are the significant production losses or considerable control and treatment costs or both in some individual goat herds in very wet years in the high rainfall area.

Table 6-13 Assumptions: footrot in rangeland and farmed goats

Variable	Values adopted		Confidence
	Rangeland (N=4M)	Farmed goats (N=250K meat, 150K fibre)	
Regional Extent	Nil	The 6% of farmed goats resident in medium and high rainfall areas are most affected	*
% herds affected	Nil	Assumed 6% of farmed goat herds infected	*
Case fatality rate	Nil	1% due to secondary problems	*
Weight loss	Nil	Average of 0.2 kg permanent and 0.2 kg temporary per clinical case	*
Fertility	Nil	1.5% reduction in pregnancy rate per kg of permanent weight loss	*
Fibre	Nil	2% fleece weight loss and 10% value loss in clinical cases	*
Market avoidance	Nil	Not applied	*
Movement restrictions	Nil	Occurs occasionally but considered negligible because of other disposal options	*
Treatment	Nil	1% of goats treated $2/case (antibiotics, footbathing)	*
Prevention	Nil	3% of herds implement control measures at $0.30/animal	*

Total cost of disease

Based on the prevalence and impacts of the disease on the classes of animal affected, GHD has calculated the annual cost of footrot in goats Australia at $70,000 as shown in Table 6-14.

Table 6-14 Economic cost of footrot in farmed goats

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Goat	$0.02	$0.02	$0.00	$0.01	$0.01	$0.00	$2.41	$2.44	$0.00	**$2.44**	**$2.47**	**$0.00**
Per Herd	$4	$4	$0	$2	$2	$0	$475	$481	$197	**$481**	**$487**	**$0**
Total	**$0M**			**$0M**			**$0.07M**			**$0.07M**		

6.8 Johne's disease

<u>The disease</u>

Johne's disease in goats, should it become clinically apparent (which is rarely), is slowly fatal after a period of several weeks or few months of wasting. The clinical disease is usually only seen in adult goats, many of which are already reaching the end of their productive life.

The causal mycobacterium can survive outside the animal for extended periods, which can be a year or more in cooler, wetter, shadier environments, and be the main source of infection for goats by the ingestion of pasture or water contaminated with faeces from infected goats (and other infected ruminants such as cattle, deer and alpacas).

Production costs may be associated with reduced or lost production for a period of weeks or months before a relatively slightly premature death in an occasional older goat.

Processing costs may include carcase trim from unsightly, injuring or abscessating lumps caused by vaccination.

Other costs may include:

- Restrictions on interstate movements, live export and access to shows, and buyer resistance.
- Participation in voluntary testing and culling programs in infected herds
- Participation in the GoatMAP. Free herds may want to promote their status by participating in the Johne's disease market assurance program for goat herds (GoatMAP). Currently there are 30 goat herds participating in the GoatMAP of which 7 are meat goat herds and the remainders are dairy goat herds.

Unknown aetiology *Known aetiology*

								X	

Prevention

Vaccination is available to prevent or reduce new infections and delay the clinical effects of existing infections in infected herds. Grazing management can be used to reduce within herd transmission.

Low efficacy/ unproven preventives available — *Effective preventives available*

							X		

Treatment

Effective treatments are unavailable. The disease is considered incurable in livestock.

Low efficacy/ unproven treatments available — *Effective treatments available*

	X								

Distribution

Climate and stocking rate are likely to be strong determinants of the distribution of the disease, as they are known to be for Johne's disease in sheep and cattle.

Logically, fibre and meat goats are most likely to become infected if co-grazing with infected sheep and cattle, especially dairy cattle, however they may be spared if significant browse is available given the preference of goats to browse rather than graze.

The extent to which meat and fibre goats closely co-graze with infected sheep or cattle is unknown but is thought to be rare.

Distribution contracting — *Distribution stable* — *Distribution increasing*

				X					

Prevalence

According to National Animal Health Information System (NAHIS) (Animal Health Australia 2014b) reports, there are currently 19 infected goat herds in Australia; all are believed to be dairy goat herds.

In Australia the disease is well known in the dairy goat industry but is little known in the goat meat and fibre industry; solid estimates of prevalence are absent.

Prevalence decreasing — *Prevalence increasing*

				X					

Economics

Assumptions: Johne's disease

Table 6-15 Assumptions: Johne's disease in rangeland goats, and farmed meat, fibre and dairy goats

Variable	Values adopted		Confidence
	Rangeland (N=4M)	Farmed goats (N=250K meat, 150K fibre)	
Regional Extent	Nil	Probably restricted to the higher rainfall zone where 10% of farmed goats reside	*
% herds infected	Nil	5% of the 10% herds in high rainfall zone infected with 0.2% annual incidence of clinical cases	*
Case mortality rate	Nil	100%	***
Weight loss	Nil	0% (100% mortality captures this loss already)	*
Fertility	Nil	Negligible due to low prevalence	*
Market avoidance	Nil	Occurs occasionally but considered negligible	*
Movement restrictions	Nil	Occurs occasionally but considered negligible	*
Treatment	Nil	Nil	***
Prevention	Nil	Vaccination and grazing management in 1% of herds costing $2.50/animal	*

Total cost of disease

Based on the adopted prevalence and impacts of the disease on the classes of animals affected, GHD has calculated the annual cost of Johne's disease in goats in Australia to be $20,000 as shown in Table 6-16.

Table 6-16 Economic cost of Johne's disease in farmed goats

	Treatment			Prevention			Production			Total		
	H	M	L	H	M	L	H	M	L	**H**	**M**	**L**
Per Goat	$0	$0	$0	$0.01	$0.01	$0.00	$0.03	$0.03	$0	**$0.04**	**$0.05**	**$0**
Per Herd	$0	$0	$0	$1	$3	$0	$7	$7	$0	**$8**	**$9**	**$0**
Total	**$0M**			**$0.00M**			**$0.02M**			**$0.02M**		

6.9 Caprine arthritis-encephalitis (CAE)

The disease

Caprine arthritis encephalitis is a viral disease of goats manifesting as one or more of arthritis, pneumonia or mastitis, mainly in adult goats, and nervous disease, mainly in kids. Only 10% of infected goats will ever show signs of disease. It is one of the Small Ruminant Lentivirus (SRLV) group of diseases.

Transmission is mainly trans-mammary, sometimes respiratory and sometimes via fomites such as shared feed and water troughs.

Risk factors are those associated with intensive management including periods of close confinement of groups of goats, feeding pooled milk and colostrum, sharing unsterilised equipment and co-mingling of goats from different farms. Reduced risk is associated with more extensive management, where single doe-kid units are the norm and close congregation of units less frequent.

Production costs may be associated with premature culling of illthrifty adults, and mortalities in kids with neurological disease. Processing costs do not apply. Other costs may be associated with CAE being a legally notifiable disease in some but not all states with restrictions on interstate movements and eligibility for live export and shows. Buyers may avoid purchasing from herds where CAE is suspected.

Unknown aetiology — *Known aetiology*

								X	

Prevention

Preventing or controlling CAE can involve:

- participation in voluntary accreditation schemes for which there are annual laboratory, veterinary and accreditation costs
- participation in control programs involving blood testing and culling of positive animals, removal of kids at birth and organising and providing virus free feeding,
- hygiene precautions to prevent within herd spread
- hygiene measures to prevent entry of virus on fomites
- precautions to avoid introducing infected animals

Low efficacy/ unproven preventives available — *Effective preventives available*

								X	

Treatment

Treatment costs do not apply – CAE is untreatable

Low efficacy/ unproven treatments available — *Effective treatments available*

X									

Distribution

CAE is thought to be mainly confined to dairy goat herds, and to be very rare in meat, fibre and rangeland goats.

Distribution contracting				*Distribution stable*					*Distribution increasing*
				X					

Economics

CAE is not considered to be an economic cost in non-dairy goats.

7 Discussion / conclusions

This report has considered a range of diseases and disease conditions that are impacting on the red meat industries (cattle, sheep and goats) in Australia and has estimated the economic costs of selected priority diseases. Initial lists of priority diseases were obtained from surveys of livestock producers, state governments, livestock veterinarians, processors, Animal Health Australia and animal health companies (see Appendix for the lists compiled from each group). The surveys captured a wide cross section of stakeholders with knowledge of disease costs, and while the sample sizes may not have been sufficient form a statistical perspective, they provided an invaluable starting point to the consultants to further refine the priority lists.

The process adopted by the consultants in refining the lists has been explained earlier in this report. In summary, the list compiled from producer surveys was accepted as the starting point. The list was then modified considering the priorities of the other survey groups and the professional knowledge and experience of the team members in consultation with MLA staff.

For each disease, a literature review was completed by the consultants to identify current knowledge of distribution, prevalence, costs of prevention/treatment and impacts on production. In many instances such information is incomplete or unknown, and where these gaps occurred the project team members used professional judgement to estimate the various parameters. The key assumptions for each disease were then used to populate an Excel model spreadsheet template of the red meat industries to calculate the economic costs of the disease. The spreadsheet template was then adapted as required in order to better fit the disease being studied.

As such, the outputs from the study are estimates only as the confidence in the assumptions used are variable. In addition, the calculations rely on modelling a “typical” herd/flock for the various livestock regions in Australia and extrapolating these across the assumed distribution extent of the disease. The calculated disease costs therefore show the average cost of the disease per year but do not show the complexity of disease expression that often occurs, for example with latency in a number of years followed by a disease “storm” with catastrophic consequences to the livestock enterprise. Also, the averaging approach may not fully capture the regional-specific impacts of certain diseases which may be impacting local producers but are not reflected at the national level.

Further research would be required to better understand these situations, especially where there is substantial variance between the report and general industry perceptions; examples of this are BVDV and vibriosis in beef cattle.

This section summarises the estimated disease costs and the gives consideration to implications for the future management of the priority diseases for cattle, sheep and goats. It should be read in full knowledge of the limitations described above. Despite these limitations, the results provide valuable guidance to the industries on the need for future expenditure to improve knowledge of the diseases to reduce their impacts and increase profitability.

7.1 Cattle

Figure 3 and Figure 4 show the annual cost of the 17 priority cattle diseases for the northern and southern cattle industries respectively. Cattle tick has the highest estimated economic impact in the north ($156 million) while internal parasites has the highest impact in the south ($82 million). As shown in Figure 3, the majority of the economic costs for diseases in the north are due to impacts related to production losses.

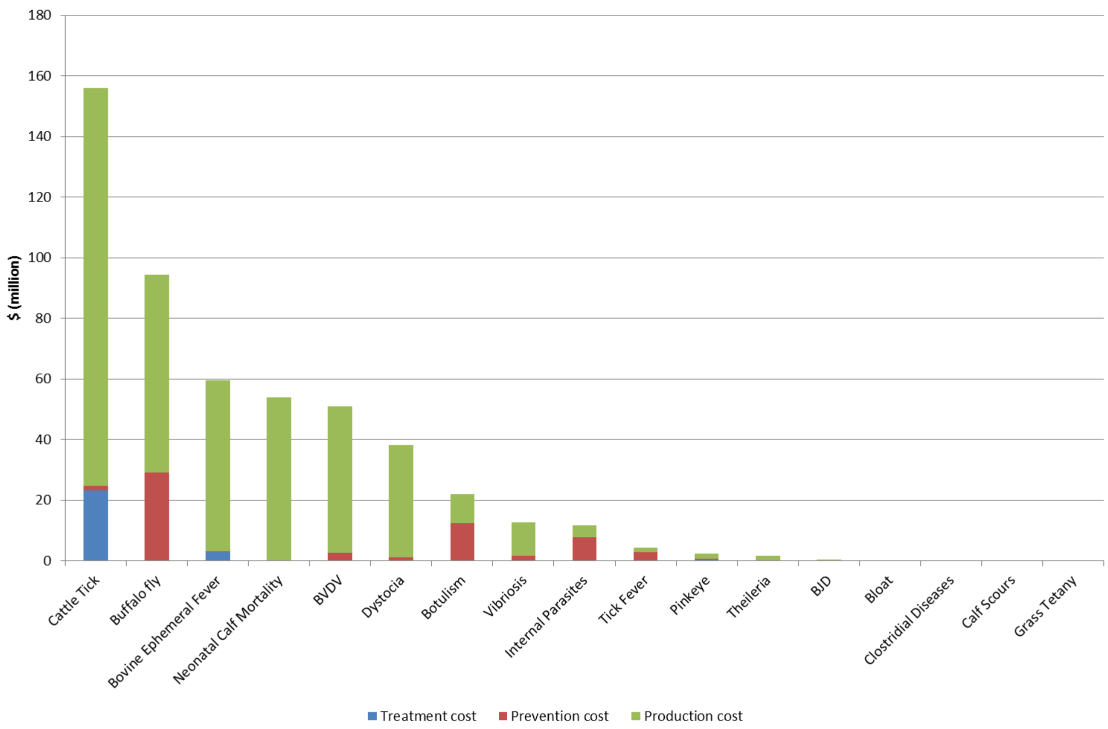


Figure 3 Estimated economic cost of priority diseases in cattle (northern only)

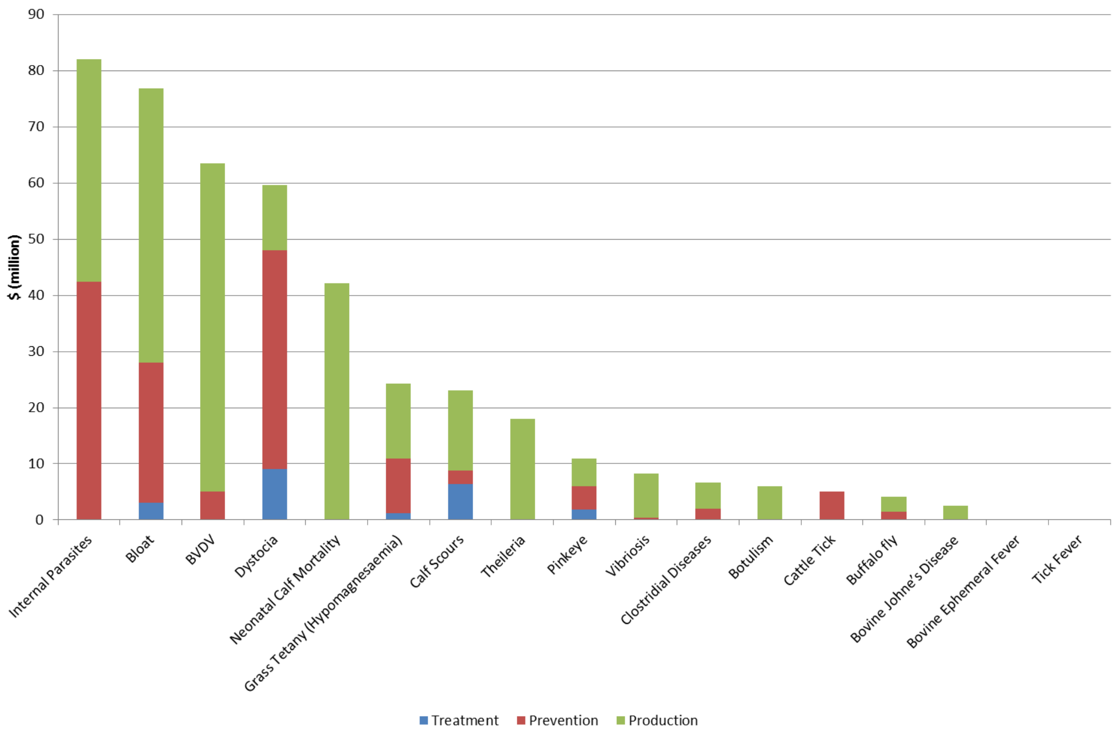


Figure 4 Estimated economist cost of priority diseases in cattle (southern only)

Figure 4 shows there are four diseases with annual economic impacts ranging from $82 to $60 million (Internal parasites, bloat, BVDV and dystocia). For internal parasites, bloat and dystocia, prevention costs contribute significantly to the total costs of each disease. Table 7-1 and Table 7-2 show each of the diseases in cost order and with an additional analysis that provides an overall rating of the disease with respect to current knowledge (aetiology, distribution and prevalence) and the ability to manage the disease (availability of effective preventive and treatment agents). The scores are sourced from the ratings provided by the consultants for each of these attributes in section 0. This information is important because it provides guidance on those aspects of the diseases that will most benefit from future research, development and/or extension.

For aetiology, effective preventives and effective treatments, the scores are as provided in the summary score table for each disease (i.e. 1 to 10 on the green/orange scale). For distribution and prevalence confidence, the confidence ratings in the assumptions table for each disease is used based on multiplying each star rating by three (i.e. three stars = 9, two stars = 6 and one star = 3). An overall rating is calculated using the summation of each rating score and expressing this as a percentage out of a possible score of 50. For example, cattle tick is 39/50 = 78%. Table 7-1 shows that while cattle ticks cost $156 million per year, the industry's knowledge of the disease and tools available for management are quite high, as represented by the overall rating score of 78%. This indicates that there may be a reduced need for further disease surveys to get a better understanding of distribution and prevalence, and that extension could be the most effective approach to reducing costs.

Each disease can be considered in a similar manner. For example, vibriosis has an estimated cost of $12.7 million per year but has an overall rating of 48% as a result of low rating for each attribute. This signals the potential for further research to improve knowledge of the disease (aetiology, distribution and prevalence) and its effective management (preventives and treatments). For BJD, while there is a similarly low overall rating (44%) that demonstrates lack of understanding of distribution, prevalence, prevention and treatment, the annual cost is $0.3 million (not including regulatory impacts) and thus the cost of further research may not be justified by the potential benefits.

Note that the calculation of the overall rating score is largely based on subjective opinions of the authors to assist in guiding future investment decisions. As such it should be used with caution – as a qualitative ranking score – and combined with other methods of decision making with regard to expenditure on future research, development and extension.

Table 7-1 Northern cattle cost of diseases and knowledge ratings

Disease	Cost ($M)	Rating of knowledge of disease and control mechanisms (out of 10)					Overall rating
		Aetiology	Effective preventives	Effective treatments	Distribution confidence	Prevalence confidence	
Cattle Tick	156	9	8	7	9	6	78%
Buffalo fly	95	8	4	8	6	6	64%
Bovine Ephemeral Fever	60	8	4	8	9	3	64%
Neonatal Calf Mortality	54	2	2	5	9	9	54%
BVDV	50.9	10	7	1	6	6	60%
Dystocia	38.1	9	9	8	9	1	72%
Botulism	22	7	10	1	9	3	60%
Vibriosis	12.7	4	4	7	6	3	48%
Internal Parasites	11.6	8	7	7	9	6	74%
Tick Fever	4.3	9	9	7	3	3	62%
Pinkeye	2.4	10	8	8	6	3	70%
Theileria	1.7	6	3	3	6	6	48%
BJD	0.3	7	2	1	6	6	44%

Table 7-2 provides similar information for the southern cattle industry, with internal parasites being estimated to have the highest annual cost ($82 million per year) but this is combined with a relatively high overall rating of the knowledge of the disease and the availability of control mechanisms. Diseases and conditions with relatively high annual costs (> $5 million) and lower overall ratings of knowledge and available controls (< 50%) include neonatal calf mortality, vibriosis and theileria.

While the analyses provided in Table 7-1 and Table 7-2 provides useful guidance on potential future research, development and extension activities required, the consultants considered that further inputs are required before finalising such decisions. In the first instance, a workshop of selected research and industry personnel would be useful to explore opportunities in more detail.

Table 7-2 Southern cattle cost of diseases and knowledge ratings

Disease	Cost ($M)	Rating of knowledge of disease and control mechanisms (out of 10)					Overall rating
		Aetiology	Effective preventives	Effective treatment	Distribution confidence	Prevalence confidence	
Internal Parasites	82	8	7	7	9	6	74%
Bloat	77	9	7	2	6	6	60%
BVDV	63	10	7	1	6	6	60%
Dystocia	59.6	9	9	8	9	6	82%
Neonatal Calf Mortality	42	2	2	5	6	3	36%
Grass Tetany	24	9	8	6	9	6	76%
Calf Scours	23	7	6	7	9	6	70%
Theileria	18	6	3	3	6	6	48%
Pinkeye	11	10	8	8	6	6	76%
Vibriosis	8.3	4	4	7	3	3	42%
Clostridial Diseases	6.7	9	8	2	9	6	68%
Botulism	6.0	7	10	1	9	3	60%
Cattle Tick	5.0	9	9	7	9	9	86%
Buffalo fly	4.1	8	4	8	6	6	64%
Bovine Johne's Disease	2.5	7	2	1	6	6	44%
Bovine Ephemeral Fever	0.1	8	4	8	9	6	70%

7.2 Sheep

Figure 5 shows the annual cost of the 23 priority sheep diseases and conditions. Neonatal mortalities ($540 million) and internal parasites ($436 million) have the highest estimated annual economic impacts. It should be noted that neonatal mortality losses also include some costs that are also included separately in dystocia and mastitis. The contribution of these two diseases is explained in section 5.1 and should be referred to in order to avoid the risk of double counting.

Figure 5 also shows that the majority of the economic costs for all diseases are due to impacts related to production losses, except for lice where prevention costs are higher. Other diseases also have significant prevention costs (neonatal mortalities, internal parasites, dystocia and flystrike).

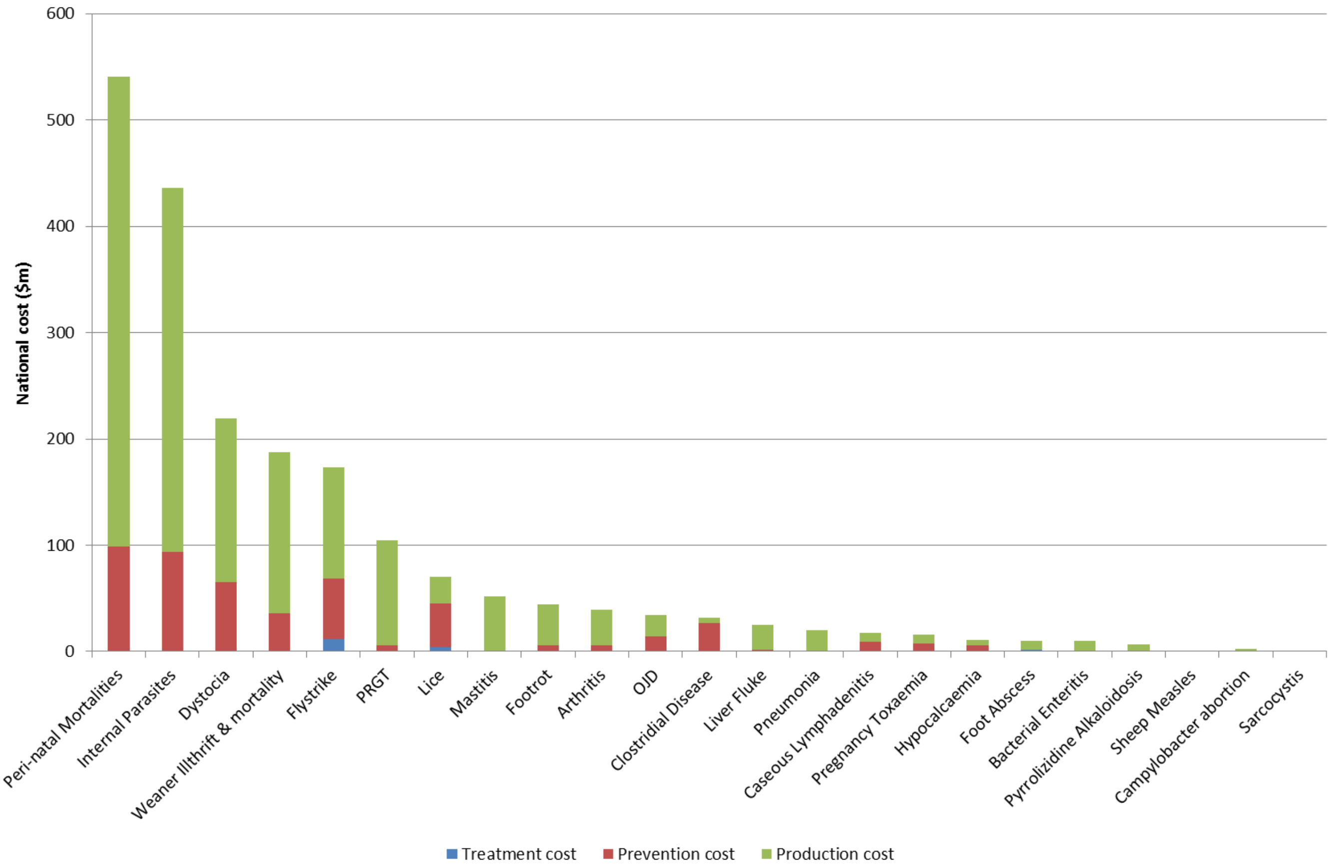


Figure 5 Estimated economic cost of priority diseases in sheep

Similarly for cattle diseases above, Table 7-3 shows each of the diseases in cost order and with an additional analysis that provides an overall rating of the disease with respect to current knowledge (aetiology, distribution and prevalence) and the ability to manage the disease (availability of effective preventive and treatment agents). The scores are sourced from the ratings provided by the consultants for each of these attributes in section 5. This information is important because it provides guidance on those aspects of the diseases that will most benefit from future research, development and/or extension.

Of the seven highest cost sheep diseases, six have an overall rating score with respect to current knowledge and the ability to manage the disease of 80% or higher. The exception is perennial ryegrass toxicity with a rating of 68% which is largely due to the fact there is no therapeutic compound available to treat PRGT, with the only option being to remove clinically affected stock from toxic pasture and provide supportive husbandry (food and water) whilst they recover.

As discussed for cattle above, while the analysis provided in Table 7-3 provides useful guidance on potential future research, development and extension activities required, the consultants considered that further inputs are required before finalising such decisions. In the first instance, a workshop of selected research and industry personnel would be useful to explore opportunities in more detail.

Table 7-3 Sheep cost of diseases and knowledge ratings

Disease	Cost ($M)	Rating of knowledge of disease and control mechanisms (out of 10)					Overall rating
		Aetiology	Effective preventives	Effective treatments	Distribution confidence	Prevalence confidence	
Neonatal Mortalities	540	8	7	7	9	9	80%
Internal Parasites	436	10	7	8	9	9	86%
Dystocia	219	7	7	8	9	9	80%
Weaner Illthrift & mortality	188	8	7	8	9	9	82%
Flystrike	173	9	8	8	9	6	80%
PRGT	105	9	8	2	9	6	68%
Lice	81	10	8	7	9	9	86%
Mastitis	52	7	1	6	6	3	46%
Footrot	44	9	8	8	6	3	68%
Arthritis	39	6	5	5	9	6	62%
OJD	35	10	8	1	9	6	68%
Clostridial Disease	31.7	8	8	1	6	3	52%
Liver Fluke	25	10	7	8	9	6	80%
Pneumonia	20	7	2	7	3	3	44%
Caseous Lymphadenitis	18	10	7	1	6	6	60%
Pregnancy Toxaemia	16	9	7	4	6	3	58%
Hypocalcaemia	11	8	7	9	6	3	66%
Foot Abscess	10	8	4	5	9	3	58%

Disease	Cost ($M)	Rating of knowledge of disease and control mechanisms (out of 10)					Overall rating
		Aetiology	Effective preventives	Effective treatments	Distribution confidence	Prevalence confidence	
Bacterial Enteritis	10	6	4	7	6	3	52%
Pyrrolizidine alkaloidosis	6.8	6	7	1	6	3	46%
Sheep Measles	2.4	10	7	1	9	9	72%
Campylobacter abortion	1.6	8	7	1	6	3	50%
Sarcocystis	0.9	10	2	1	9	6	56%

7.3 Goats

Figure 6 shows the annual cost of the nine priority goat diseases and conditions. Internal parasites ($2.5 million) have the highest estimated annual economic impact. Figure 6 also shows that the majority of the economic cost for internal parasites is due to impacts related to production losses, although prevention costs are substantial. The costs of the next two diseases in priority order, enterotoxaemia and lice, are associated more with prevention costs and not production losses.

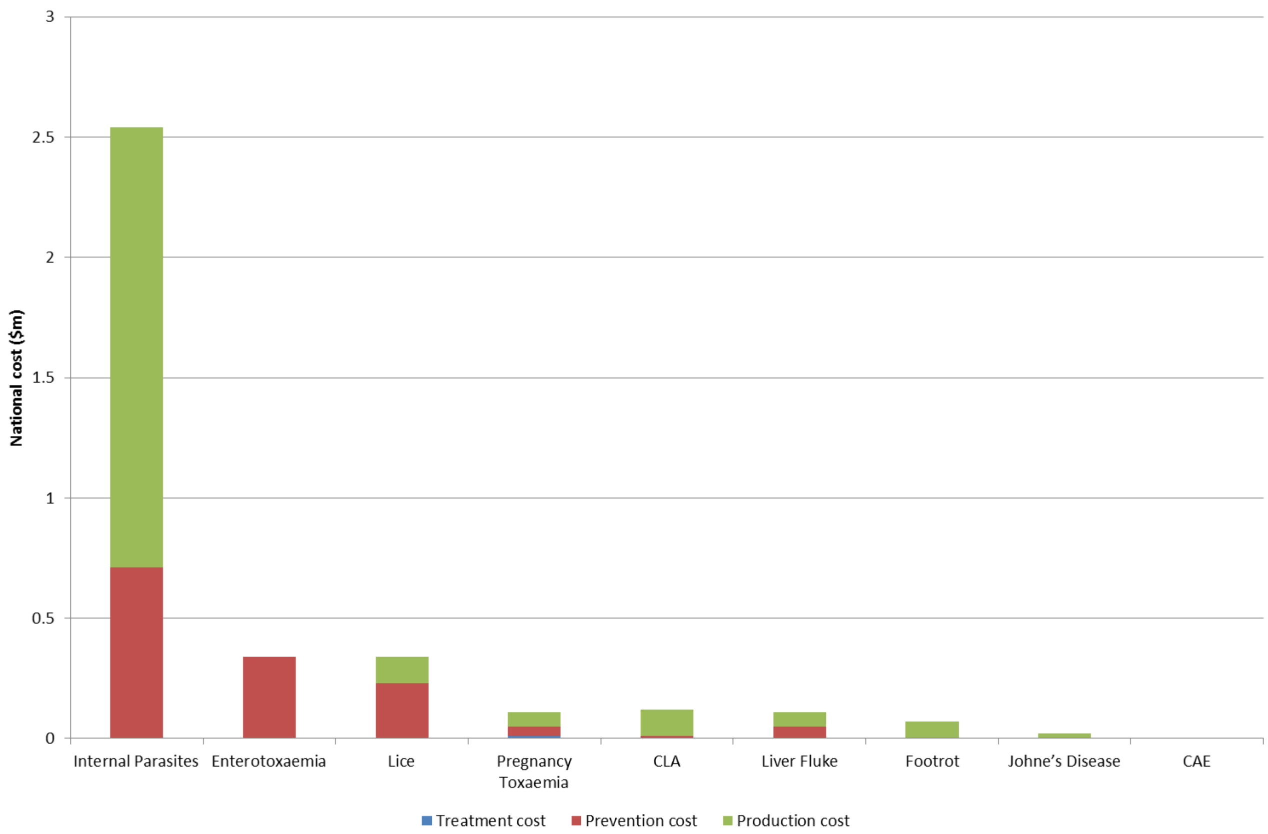


Figure 6 Estimated economic cost of priority diseases in goats

Table 7-4 shows each of the diseases in cost order and with an additional analysis that provides an overall rating of the disease with respect to current knowledge (aetiology, distribution and prevalence) and the ability to manage the disease (availability of effective preventive and treatment agents). The scores are sourced from the ratings provided by the consultants for each of these attributes in section 6. This information provides guidance on those aspects of the diseases that will most benefit from future research, development and/or extension.

A notable feature in Table 7-4 is the fact that confidence levels for distribution and prevalence are generally low. This most likely reflects the fact that the majority of goats are located in rangelands which increases the difficulty of obtaining data on diseases. While surveys could provide more accurate data, the cost of conducting the surveys would need to be weighed against the gains provided.

As previously discussed, while the analysis provided in Table 7-4 provides useful guidance on potential future research, development and extension activities required, the consultants considered that further inputs are required before finalising such decisions. In the first instance, a workshop of selected research and industry personnel would be useful to explore opportunities in more detail.

Table 7-4 Goat cost of diseases and knowledge ratings

Disease	Cost (M)	Rating of knowledge of disease and control mechanisms (out of 10)					Overall rating
		Aetiology	Effective preventives	Effective treatments	Distribution confidence	Prevalence confidence	
Internal Parasites	2.54	9	9	5	3	6	64%
Enterotoxaemia	0.34	6	8	7	3	3	54%
Lice	0.34	10	9	9	6	3	74%
Pregnancy Toxaemia	0.11	9	6	3	3	3	48%
CLA	0.11	9	8	1	6	3	54%
Liver Fluke	0.1	10	9	8	9	3	78%
Footrot	0.07	9	9	9	3	3	66%
Johne’s Disease	0.02	9	8	2	3	3	50%

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9 Appendix

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1 Questionnaires

1.1 Producer questionnaire

1.2 Cattle and Sheep Vets questionnaire

1.3 Chief Veterinary Officer questionnaire

1.4 Animal Health Companies

1.1 Producer questionnaire

Livestock disease survey - producers

Introduction –

Hello – I am (John Smith) and we have been contracted by Meat & Livestock Australia (MLA) to do a survey of producers on what are the most important livestock diseases to determine priorities for future research.

Are you available to do a short (10 minute) survey of livestock diseases you think are important in your area? If not, can I phone at a more suitable time?

We are interested in what you consider the important diseases and conditions affecting stock..... in your district ....during the past 5 years. We are not covering droughts, floods and feed shortages.

Can we start by getting an idea of the type of enterprise you run?

(Note that phone lists will be split into the following categories so the interviewer will know they are talking with one of the following – and also possibly by state):

- Cattle
- Sheep and goats

Question 1. Establish enterprise type, location etc. (for cattle, sheep, goats)

Enterprise types	**Which livestock enterprises are present? Could be more than one** ✓	**Total number of animals?** 1. 0-50 2. 50-500 3. 500-1,000 4. > 1,000	**State? (may be available)** 1. Vic 2. NSW / ACT 3. WA 4. Tas 5. NT 6. SA 7. Qld	**Location within state?** 1. North 2. North-east 3. North-west 4. South 5. South-east 6. South-west 7. East 8. West 9. Central 10. Central-west	**Average annual rainfall (mm)?**	**Comments**
Cattle stud						
Cattle commercial - breeding						
Cattle commercial - backgrounding/finishing/trading						
Cattle live exports						
Sheep wool stud						
Sheep wool commercial						
Sheep meat stud						
Sheep meat commercial						

Enterprise types	Which livestock enterprises are present? Could be more than one ✓	Total number of animals? 1. 0-50 2. 50-500 3. 500-1,000 4. > 1,000	State? (may be available) 1. Vic 2. NSW / ACT 3. WA 4. Tas 5. NT 6. SA 7. Qld	Location within state? 1. North 2. North-east 3. North-west 4. South 5. South-east 6. South-west 7. East 8. West 9. Central 10. Central-west	Average annual rainfall (mm)?	Comments
Sheep live export						
Goats meat						
Goats wool (cashmere, angora)						
Goats live export						
Sheep or goat dairies						

Question 2: What specific diseases or conditions do you consider important ...with respect to their affect on herd/flock profitability... in your **district...** in the past five years? (for each enterprise type). This might be in terms of expenditure to control or prevent the disease/condition, ... or losses from reduced performance, value of the animal or its products.

- We ask for conditions affecting 'the district' and not the producer's own herd as this may reduce bias in answering (embarrassed to admit X,Y,Z) and allows diseases perceived to be present in the district but not necessarily in the herd to be captured. Five years to prevent a 'last year' bias. No limit to number of diseases – producer may list zero to whatever number they think relevant or pertinent. For each disease/condition nomination by the producer the interviewer captures how important this disease is, how it impacts on herds and the capacity to control/reduce production

A	***B***	***C***	***D***	***E***
Disease record number	***Disease / condition /syndrome name*** ***(See lists of diseases by enterprise below)***	***How much cost or other effort does it take to control or prevent the disease/condition .... affecting the profitability ... of the herd/flock?*** ***By cost and effort we mean the amount of money, time, and energy spent to keep the disease under control or to prevent it entering the herd/flock.*** *(It may include costs of labour, medicines, vaccines, biosecurity measures etc)* ***Would you rate the overall cost and effort to be:*** ***1. Negligible*** ***2. Minor*** ***3. Moderate*** ***4. High*** ***5. Very high***	***How much do losses from this disease/ condition ... affect profitability... of the herd/flock?*** ***By losses we mean production losses or reduced value of the animal or its products.*** *(It may include sickness, deaths, reduced growth, reproduction, reduced value of carcass, offal, hides, wool etc)* ***Would you rate the overall losses to be:*** ***1. Negligible*** ***2. Minor*** ***3. Moderate*** ***4. Severe*** ***5. Catastrophic***	***Can you rank each of the diseases/conditions you mentioned - from most important*** ***to least important*** ***1->N***
Disease 1	X	2	3	1
Disease 2	Y	3	2	2

Disease lists

A comprehensive disease lists will be made available to the interviewer. The interviewer will not be reading out the list to the producer. Rather, the interviewer will be searching the list (in alphabetical order) in response to a disease/condition/syndrome nominated by the producer. The interviewer will then ask questions for columns C, D and E for each disease nominated.

General

Is there any other information you would like to add on disease control or treatment for livestock.

Thank you - Smartaskers to add typical closing. Perhaps state that report will be publicly available on MLA website when finalised.

Disease lists

The following disease lists will be available to the interviewer. The interviewer will not be reading out the list to the producer. Rather, the interviewer will be searching the list (in alphabetical order) in response to a disease/condition/syndrome nominated by the producer. The interviewer will then ask questions for columns C, D and E for each disease nominated.

Combined cattle disease, condition and syndrome list

1.2 Cattle and Sheep Vets questionnaire

B.AHE.0010: **Assessing the most economically damaging endemic diseases for cattle, sheep and goats**

Dear Cattle and Sheep Vets,

GHD and a consortium of vets is completing a project for MLA on the most economically damaging endemic diseases for cattle, sheep and goats (project number: B.AHE.0010).

The consortium is seeking feedback from members of the Australian Cattle Veterinarians (ACV) and Australian Sheep Veterinarians (ASV) to assist in developing a list of priority diseases or conditions.

GHD is asking ACV and ASV members to complete a survey of diseases/conditions/syndromes covering four main areas:

1) The economic importance of each disease (high, medium or low) from the list provided in the link below (NB: there is one list of cattle diseases and one list of sheep & goat diseases)
2) The extent to which more extension (awareness) of currently available treatment and prevention options could reduce economic impact
3) The extent to which more research is required to identify better treatment and control options to reduce economic impact
4) Any comments about the disease/condition/syndrome especially if it relates to any emerging trends that will require attention in the near future

Once the following survey is completed please post to: Attn: Paul Dellow GHD Pty Ltd Level 15, 133 Castlereagh St Sydney NSW 2000

Alternatively, this survey can be scanned and emailed to diseasesurvey@ghd.com

Please note all responses will be treated confidentially and will remain anonymous. All information will be collated at a regional or state level.

If you have any questions or would like to expand on any aspects of specific endemic diseases, please contact a member of the consortium from the list below:

Dr Tristan Jubb.	Email: tristan@livestockhealthsystems.com.	Mobile: 0448 403 600
Dr Richard Shephard.	Email: richard@herdhealth.com.au.	Mobile: 0418 515 498
Dr John Webb-Ware.	Email: j.webbware@unimelb.edu.au.	Mobile: 0418748600
Dr Geoffry Fordyce.	Email: g.fordyce@uq.edu.au.	Mobile: 0428 109 062
Joe Lane (GHD).	Email: joe.lane@ghd.com.	Mobile: 0415269934

A. LIVESTOCK DISEASE SURVEY (ENDEMIC DISEASES) - CATTLE. MLA Project B.AHE.0010

Your Location – State________________________

Region:________________________________

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
	Against each disease or condition, in your experience please rate their economic importance as low (L), medium (M) or high (H). If the disease is not relevant to your area or experience please leave blank. This may be in terms of production or product losses, or costs of control and prevention, or both.	For the diseases and conditions you have ranked as Medium and High, indicate on a scale of 1-5 the importance of more extension (awareness) of currently available treatment and prevention options to reduce economic impact. 1. Not important 2. Low importance 3. Moderately important 4. Highly important 5. Crtically important	For the diseases and conditions you have ranked as Medium and High, indicate on a scale of 1-5 the importance of more research to identify better treatment and control options to reduce economic impact. 1. Not important 2. Low importance 3. Moderately important 4. Highly important 5. Crtically important	Any comments about this disease/condition/syndrome especially if it relates to any emerging trends that will require attention in the near future.
3D syndrome				
Abortion -				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
stillbirths				
Abortion dt Neospora				
Abscesses - liver				
Abscesses - neck/lymphnode/grass seed				
Abscesses - skin				
Abscesses - vaccination/injection site				
Acidosis (grain poisoning)				
Akabane virus (Crooked calf disease)				
Alopecia - hair loss				
Annual ryegrass toxicity (ARGT)				
Anthelmintic resistance (Drench resistance)				
Anthrax				
Acaricide Resistance				
Atypical interstitial pneumonia				
Balanitis				
Balanoposthitis				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Barbers Pole Worm				
BJD - Bovine Johne's Disease (Johne's disease)				
Black livers - melanosis, mulga livers, bore water livers				
Blackleg				
Bloat				
Bone chewing				
Botulism				
Bovine respiratory disease (BRD)				
Bracken fern poisoning				
Broken pizzle				
Bruising				
Buffalo fly skin lesions				
Buffalo fly worry				
Calf pneumonia				
Calf scours - Cryptosporidia				
Calf scours - General				
Calf scours - E coli				
Calf scours -				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Rotavirus				
Calf scours - Salmonella				
Campylobacteriosis - vibriosis				
Cast (eg on irrigation checkbank)				
Castration losses				
Chemical residues - meat				
Chemical residues - offal				
Clostidial infection				
Cobalt deficiency				
Coccidiosis				
Copper deficiency				
Deformed calves (congenital defects)				
Dehorning losses				
Dog bites - dog attack				
Downers - downer cows				
Drooling				
Dystocia (calving problems)				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Ear infection - head tilt				
Ephemeral fever (Three-day sickness)				
Eye cancer (Cancer eye)				
Eye problems				
Facial eczema				
Feet problems				
Fluke (Internal parasites/worms)				
Footrot				
Grass seed abscesses				
Grass tetany				
Haemorrhage (blood loss, bleeding)				
Heat stress				
IBR - infectious bovine rhinotracheitis				
Illthrift				
Illthrift weaners				
Infectious pustular vulvovaginitis (IPV)				
Infertility - Vibriosis -				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Campylobacteriosis				
Infertility bulls				
Infertility cows				
Infertility heifers				
Iodine deficiency				
Joint ill				
Lameness				
Laminitis				
Lantana poisoning				
Lead poisoning				
Leptospirosis				
Lice				
Listeriosis				
Liver abscesses				
Liver fluke (Fascioliasis)				
Lumpy jaw				
Lungworm				
Malignant catarrhal fever (MCF)				
Mastitis				
Milk fever (Hypocalcaemia)				
Navel infections				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Necrobacillosis - oral, laryngeal				
Nitrate-nitrite poisoning				
Onion grass balls				
Oral necrobacillosis				
Overgrown claws (overgrown feet)				
Penile/penis haematoma/swollen/injured				
Perennial ryegrass staggers				
Pestivirus (Bovine viral diarrhoea)				
Phalaris staggers				
Phosphorus deficiency				
Photosensitisation				
Pinkeye (Moraxella bovis)				
Plant poisoning				
Pneumonia				
Pneumonia in calves				
Pregnancy toxaemia (fatty liver disease)				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Prepuce injury/infection - posthitis				
Pulpy kidney (enterotoxaemia)				
Red nose (Infectious bovine rhinotracheitis)				
Red water - red urine				
Retained foetal membranes - RFMs				
Rickets				
Ringworm				
Salmonellosis				
Sand impaction - sand in rumen, sand in paunch				
Sarcocystis				
Selenium deficiency				
Shipping fever				
Sporadic Bovine Encephalomyelitis (SBE)				
Starvation ketosis				
Stephanofilariasis				
Sudden death				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Swollen joints				
Tetanus				
Theiliera				
Tick fever				
Tick worry				
Trace element deficiency				
Transit tetany				
Trichomoniasis				
Umbilical hernia				
Urea poisoning				
Urolithiasis (waterbelly)				
Vaginal prolapse - prolapsed vagina				
Vaginitis - vulvovaginitis				
Vibriosis - Campylobacteriosis				
Warts - papillomatosis				
Weaner illthrift				
Woody tongue - Actinobacillosis				
Worms (Internal parasites)				
Yersiniosis				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Zamia poisoning				
Any Others? (Please specify below)				

B. LIVESTOCK DISEASE SURVEY (ENDEMIC DISEASES) - SHEEP & GOATS. MLA Project B.AHE.0010

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
	Against each disease or condition, in your experience please rate their economic importance as low (L), medium (M) or high (H). If the disease is not relevant to your area or experience please leave blank. This may be in terms of production or product losses, or costs of control and prevention, or both.	For the diseases and conditions you have ranked as Medium and High, indicate on a scale of 1-5 the importance of more extension (awareness) of currently available treatment and prevention options to reduce economic impact. 1. Not important 2. Low importance 3. Moderately important 4. Highly important 5. Critically important	For the diseases and conditions you have ranked as Medium and High, indicate on a scale of 1-5 the importance of more research to identify better treatment and control options to reduce economic impact. 1. Not important 2. Low importance 3. Moderately important 4. Highly important 5. Critically important	Any comments about this disease/condition/syndrome especially if it relates to any emerging trends that will require attention in the near future.
Abortion - still birth				
Abscesses – vaccination injection site				
Acidosis (grain poisoning)				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Actinobacillosis of epididymis/infertility				
Actinobacillosis of muzzle/head				
Agalactia (Mastitis/hard udder)				
Anaemia from Mycoplasma infection (formerly Eperythrozoonosis)				
Annual ryegrass toxicity				
Anthelmintic resistance (Drench resistance)				
Anthrax				
Arthritis of lambs				
Bacterial enteritis				
Bacterial enteritis – Campylobacter				
Bacterial enteritis – Salmonella				
Bacterial enteritis – Yersiniosis				
Barbers Pole Worm				
Benign footrot				
Bent leg				
Black livers – melanosis, mulga livers, bore water livers				
Black mastitis				
Blue-green algae poisoning				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Brucella ovis (Brucellosis)				
Campylobacter				
Cancer ears				
Cancer vulva				
Caprine arthritis-encephalitis (CAE)				
Caseous lymphadenitis ('CLA', 'Cheesy gland')				
Chemical residues – meat				
Chemical residues – wool				
Chorioptic mange				
Clostridial disease - big head, malignant oedema				
Clostridial disease (Black disease)				
Clostridial disease (Pulpy kidney, enterotoxaemia)				
Clostridial disease – Tetanus				
Clover disease infertility				
Cobalt deficiency				
Coccidiosis				
Cold stress post shearing				
Copper deficiency				
Copper poisoning				
Dead lambs – cold stress				
Dead lambs – difficult birth				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Dead lambs – mismothering				
Dead lambs – predation				
Dermotophilosis ('Dermo', 'Lumpy wool')				
Diarrhoea - scours				
Downers				
Dystocia (Difficult birth)				
Facial eczema				
Fleece rot				
Flystrike – Body & breech				
Foot abscess				
Footrot – benign				
Footrot – intermediate				
Footrot – Virulent				
Fox attack				
Fractured ribs				
Gastrointestinal Parasites				
Goitre				
Grass seeds				
Heat stress – hyperthermia				
Heliotrope poisoning				
Hydatids				
Hypocalcaemia				
Infertility - female: Ewe, Doe				
Infertility – male: Ram, buck				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Iodine deficiency				
Itch mite				
Jaundice – yellows				
Balanitis/posthitis				
Lameness				
Lameness post dipping				
Lice				
Listeriosis				
Liver disease				
Liver Fluke				
Lungworm				
Lupinosis				
Mismothering				
OJD – ovine Johne's disease				
Perennial ryegrass staggers				
Periodontal disease				
Phalaris poisoning - sudden death				
Phalaris staggers				
Photosensitisation				
Pinkeye				
Pizzle rot				
Plant poisoning – uncertain or other than specified				
Pneumonia				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Polioencephalomalacia – PEM				
Post weaning mortality				
Pregnancy toxaemia				
Prolapsed rectum				
Prolapsed uterus				
Prolapsed vagina				
Pyrrolizidine alkaloid poisoning				
Redgut				
Rickets				
Salmonellosis				
Sarcocystis				
Scabby mouth				
Scald - foot scald				
Scrotal mange				
Selenium deficiency				
Sheep measles				
Shelly toe				
Teeth wear				
Toxoplasma				
Trace element deficiencies				
Trachymene poisoning				
Twin lamb disease				
Urolithiasis - water belly				

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Other comments
Vitamin D deficiency				
Vitamin E deficiency				
Weaner ill-thrift				
White muscle disease				
Wild dog attack				
Worms / Internal Parasites				
Yersiniosis				
Any Others? (Please specify below)				

Thank your for your participation

1.3 Chief Veterinary Officer questionnaire

A. LIVESTOCK DISEASE SURVEY (ENDEMIC DISEASES) - CATTLE. MLA Project B.AHE.0010				
List of endemic diseases, conditions, syndromes	**Q1. Economic importance**	**Q2. Need for extension**	**Q3. Need for research**	**Q4. Other comments**
	Against each disease or condition, please rate their economic importance in your jurisdiction as low (L) medium (M) or high (H). This may be in terms of production or product losses, or costs of control and prevention, or both.	For the diseases and conditions you have ranked as Moderate and High, indicate on a scale of 1-5 the importance of more **extension** (awareness) of currently available treatment and prevention options to reduce economic impact. 1. Not important 2. Low importance 3. Moderately important 4. Highly important 5. Crtically important	For the diseases and conditions you have ranked as Moderate and High, indicate on a scale of 1-5 the importance of more **research** to identify better treatment and control options to reduce economic impact. 1. Not important 2. Low importance 3. Moderately important 4. Highly important 5. Crtically important	Any comments about this disease/condition/syndrome
3D syndrome				
Abortion				
Abortion dt Neospora				
Abscesses - liver				
Abscesses - neck/lymphnode/grass seed				
Abscesses - skin				
Abscesses - vaccination/injection site				
Acidosis (grain poisoning)				
Actinobacillosis - woody tongue				
Akabane virus (Crooked calf disease)				
Alopecia - hair loss				
Annual ryegrass toxicity (ARGT)				
Anthelmintic resistance (Drench resistance)				
Anthrax				
Atypical interstitial pneumonia				
Balanitis				
Balanoposthitis				
BJD - bovine Johne's disease (Johne's disease)				
Black livers - melanosis, mulga livers, bore water livers				
Blackleg				
Bleeding (blood loss, haemorrhage)				
Bloat				
Bogged - stuck				
Bone chewing				
Botulism				
Bovine respiratory disease (BRD)				
Bovine viral diarrhoea (Pestivirus)				
Bracken fern poisoning				
Broken pizzle				
Bruising				
Buffalo fly skin lesions				
Buffalo fly worry				
Calf pneumonia				
Calf scours - Cryptosporidia				
Calf scours - E coli				
Calf scours - Rotavirus				
Calf scours - Salmonella				
Campylobacteriosis - vibriosis				
Cancer eye				
Cast (eg on irrigation checkbank)				
Castration losses				
Chemical residues - meat				
Chemical residues - offal				
Circling				
Clostidial infection				
Cobalt deficiency				
Coccidiosis				
Constipation				
Copper deficiency				
Cryptosporidiosis - (calf scours complex)				
Deformed calves (congenital defects)				
Dehorning losses				
Diarrhoea (Scours)				
Dog bites - dog attack				
Downers - downer cows				
Drooling				
Dystocia (calving problems)				
Ear infection - head tilt				
Enterotoxaemia (pulpy kidney)				
Ephemeral fever (Three-day sickness)				
Eye cancer (Cancer eye)				
Eye problems				
Facial eczema				
Fascioliasis (Liver fluke)				
Feet problems				
Fluke (Internal parasites/worms)				
Footrot				
Grass seed abscesses				
Grass tetany				
Gut problems				
Haemorrhage (blood loss, bleeding)				
Hair loss - alopecia				
Head tilt - ear infection				
Heat stress				
Hit by vehicle - road accident, road trauma				
Horn damage				
Hypocalcaemia (Milk fever)				
IBR - infectious bovine rhinotracheitis				
Illthrift				
Illthrift weaners				
Infectious pustular vulvovaginitis (IPV)				
Infertility - Vibriosis - Campylobacteriosis				
Infertility bulls				
Infertility cows				
Infertility heifers				
Internal parasites (worms)				
Iodine deficiency				
IPV - infectious pustular vulvovaginitis				
Joint ill				
Lameness				
Laminitis				
Lantana poisoning				
Lead poisoning				
Leptospirosis				

Listeriosis				
Liver abscesses				
Liver fluke (fascioliasis)				
Lumpy jaw				
Lung problems				
Lungworm				
Malignant catarrhal fever - MCF				
Mastitis				
MCF (Malignant catarrhal fever)				
Milk fever (Hypocalcaemia)				
Moraxella bovis (Pinkeye)				
Navel infections				
Necrobacillosis - oral, laryngeal				
Nervous signs				
Nervous signs (neurological disease)				
Neurological disease (nervous signs)				
Nitrate-nitrite poisoning				
Onion grass balls				
Oral necrobacillosis				
Other				
Overgrown claws (overgrown feet)				
Papillomatosis - warts				
Paralysis				
Penile/penis haematoma/swollen/injured				
Penis injury				
Perennial ryegrass staggers				
Perennial ryegrass toxicosis				
Pestivirus (Bovine viral diarrhoea)				
Phalaris staggers				
Phalaris toxicity				
Phosphorus deficiency				
Photosensitisation				
Pinkeye (Moraxella bovis)				
Plant poisoning				
Pneumonia				
Pneumonia in calves				
Poisoning				
Posthitis - prepuce injury/infection				
Pregnancy toxaemia (fatty liver disease)				
Prepuce injury/infection - posthitis				
Pulpy kidney (enterotoxaemia)				
Red nose (Infectious bovine rhinotracheitis)				
Red urine - red water				
Red water - red urine				
Retained foetal membranes - RFMs				
RFMs - retained foetal membranes				
Rickets				
Ringworm				
Road accidents- road trauma - hit by vehicle				
Ryegrass staggers				
Salmonellosis				
Sand impaction - sand in rumen, sand in paunch				
Sarcocystis				
Selenium deficiency				
Septic wounds				
Shipping fever				
Skin problem				
Snake bite				
Sporadic bovine encephalomyelitis (SBE)				
Staggers				
Starvation ketosis				
Stephanofilariasis				
Stillbirths				
Stuck - bogged				
Sudden death				
Swollen joints				
Tetanus				
Theiliera				
Three-day sickness (Ephemeral fever)				
Tick fever				
Tick resistance				
Tick worry				
Trace element deficiency				
Transit tetany				
Trichomoniasis				
Umbilical hernia				
Urea poisoning				
Urolithiasis (waterbelly)				
Vaginal prolapse - prolapsed vagina				
Vaginitis - vulvovaginitis				
Vibriosis -Campylobacteriosis				
Warts - papillomatosis				
Weaner illthrift				
Woody tongue - Actinobacillosis				
Worms (Internal parasites)				
Wound infections				
Yersiniosis				
Zamia poisoning				

B. LIVESTOCK DISEASE SURVEY (ENDEMIC DISEASES) - SHEEP & GOATS. MLA Project B.AHE.0010				
List of endemic diseases, conditions, syndromes	**Q1. Economic importance**	**Q2. Need for extension**	**Q3. Need for research**	**Q4. Other comments**
	Against each disease or condition, please rate their economic importance in your jurisdiction as low (L) medium (M) or high (H). This may be in terms of production or product losses, or costs of control and prevention, or both.	For the diseases and conditions you have ranked as Moderate and High, indicate on a scale of 1-5 the importance of more **extension** (awareness) of currently available treatment and prevention options to reduce economic impact. 1. Not important 2. Low importance 3. Moderately important 4. Highly important 5. Crtically important	For the diseases and conditions you have ranked as Moderate and High, indicate on a scale of 1-5 the importance of more **research** to identify better treatment and control options to reduce economic impact. 1. Not important 2. Low importance 3. Moderately important 4. Highly important 5. Crtically important	Any comments about this disease/condition/syndrome
Abortion				
Abscesses – vaccination injection site				
Acidosis (grain poisoning)				
Actinobacillosis of epididymis/infertility				
Actinobacillosis of muzzle/head				
Agalactia (Mastitis/hard udder) (Goats)				
Anaemia from Mycoplasma infection (formerly Eperythrozoonosis)				
Annual ryegrass toxicity				
Anthrax				
Arthritis of lambs				
Bacterial enteritis				
Bacterial enteritis – Campylobacter				
Bacterial enteritis – Salmonella				
Bacterial enteritis – Yersiniosis				
Barbers pole worm				
Benign footrot				
Bent leg				
Bird attack (crow pick)				
Black livers – melanosis, mulga livers, bore water livers				
Black mastitis				
Blue-green algae poisoning				
Bottle jaw				
Brucella ovis (Brucellosis)				
Campylobacter				
Cancer				
Cancer ears				
Cancer vulva				
Caprine arthritis-encephalitis (CAE)				
Caseous lymphadenitis ('CLA', 'Cheesy gland')				
Cast				
Chemical residues – meat				
Chemical residues – wool				
Chorioptic mange				
Circling				
Clostridial disease - big head, malignant oedema				
Clostridial disease (Black disease)				
Clostridial disease (Pulpy kidney, enterotoxaemia)				
Clostridial disease – Tetanus				
Clover disease infertility				
Cobalt deficiency				
Coccidiosis				
Cold stress				
Cold stress post shearing				
Copper deficiency				
Copper poisoning				
Dead lambs – cold stress				
Dead lambs – difficult birth				
Dead lambs – mismothering				
Dead lambs – predation				
Dermotophilosis ('Dermo', 'Lumpy wool')				
Diarrhoea				
Dog bites				
Downers				
Drooling				
Dystocia (Difficult birth)				
Eperythrozoonosis (Anaemia from Mycoplasma infection)				
Facial eczema				
Fleece damage – wool loss				
Fleece rot				
Flystrike – Body & breech				
Foot abscess				
Footrot – benign				
Footrot – intermediate				
Footrot – Virulent				
Fox attack				
Fractured ribs				
Goitre				
Grass seeds				
Gut problems				
Hard udder (Agalactia/Mastitis)				
Heat stress – hyperthermia				
Heliotrope poisoning				
Hydatids				
Hypocalcaemia				
Hypothermia				
Illthrift				
Infertility - female: Ewe, Doe				
Infertility – male: Ram, buck				
Internal parasites (worms - liver fluke separate)				
Iodine deficiency				
Itch mite				
Itching/rubbing				
Jaundice – yellows				
Knob rot – balanitis/posthitis				

Lamb marking losses				
Lameness				
Lameness post dipping				
Lice				
Listeriosis				
Liver disease				
Liver fluke (worms – Internal parasites)				
Lung problems				
Lungworm				
Lupinosis				
Mastitis				
Melanosis				
Mismothering				
Nervous disease				
Neurological problems				
OJD – ovine Johne's disease				
Osteoporosis				
Other				
Perennial ryegrass staggers				
Perennial ryegrass toxicosis				
Periodontal disease				
Phalaris poisoning				
Phalaris staggers				
Photosensitisation				
Pinkeye				
Pizzle rot				
Plant poisoning – uncertain or other than specified				
Pneumonia				
Polio				
Polioencephalomalacia – PEM				
Post weaning mortality				
Pregnancy toxaemia				
Prolapsed rectum				
Prolapsed uterus				
Prolapsed vagina				
Pyrrolizidine alkaloid poisoning				
Redgut				
Rib fractures				
Rickets				
Rubbing/itching				
Ryegrass staggers				
Salmonellosis				
Sarcocystis				
Scabby mouth				
Scald				
Scours				
Scrotal mange				
Selenium deficiency				
Sheep measles				
Shelly toe				
Skin cancer				
Skin problems				
Snake bite				
Staggers				
Still birth				
Sudden death				
Teeth problems				
Teeth wear				
Tender wool				
Toxoplasma				
Trace element deficiencies				
Trachymene poisoning				
Twin lamb disease				
Urinary tract blockage				
Urolithiasis				
Vitamin D deficiency				
Vitamin E deficiency				
Water belly				
Weaner ill-thrift/ post weaning mortality				
White muscle disease				
Wild dog attack				
Wool loss - fleece damage				
Worms (Internal parasites - Liver fluke)				
Wound infections				
Yersiniosis				

C. LIVESTOCK DISEASE SURVEY (ENDEMIC DISEASES) - LABORATORY DIAGNOSES. MLA Project B.AHE.0010

Year 2009 (Cattle)

List of laboratory diagnoses (name of disease)	Date of the index submission	Number of animals affected	Number of animals exposed	Program under which the submission was made ie NSDIP; NTSESP, VSDIP (Victorian Sudden Death Investigation Program), general surveillance (GS) etc.
a				
b				
c				
d				
etc				

Year 2009 (Sheep)

List of laboratory diagnoses (name of disease)	Date of the index submission	Number of animals affected	Number of animals exposed	Program under which the submission was made ie NSDIP; NTSESP, VSDIP (Victorian Sudden Death Investigation Program), general surveillance (GS) etc.
a				
b				
c				
d				
etc				

Year 2009 (Goats)

List of laboratory diagnoses (name of disease)	Date of the index submission	Number of animals affected	Number of animals exposed	Program under which the submission was made ie NSDIP; NTSESP, VSDIP (Victorian Sudden Death Investigation Program), general surveillance (GS) etc.
a				
b				
c				
d				
etc				

Year 2010 (Cattle)

List of laboratory diagnoses (name of disease)	Date of the index submission	Number of animals affected	Number of animals exposed	Program under which the submission was made ie NSDIP; NTSESP, VSDIP (Victorian Sudden Death Investigation Program), general surveillance (GS) etc.
a				
b				
c				
d				
etc				

Year 2010 (Sheep)

List of laboratory diagnoses (name of disease)	Date of the index submission	Number of animals affected	Number of animals exposed	Program under which the submission was made ie NSDIP; NTSESP, VSDIP (Victorian Sudden Death Investigation Program), general surveillance (GS) etc.
a				
b				
c				
d				
etc				

Year 2010 (Goats)

List of laboratory diagnoses (name of disease)	Date of the index submission	Number of animals affected	Number of animals exposed	Program under which the submission was made ie NSDIP; NTSESP, VSDIP (Victorian Sudden Death Investigation Program), general surveillance (GS) etc.
a				
b				
c				
d				
etc				

Repeat for years 2011, 2012, 2013

1.4 Animal Health Companies questionnaire

B.AHE.0010 Assessing the most economically damaging endemic diseases for cattle, sheep and goats

Dear Animal Health Company Technical Manager,

GHD and a consortium of vets is completing a project for MLA on the most economically damaging endemic diseases for cattle, sheep and goats (project number: B.AHE.0010).
The consortium is seeking feedback from Animal Health Company representatives to assist in developing a list of priority diseases or conditions.

GHD is asking you to complete a survey of diseases/conditions/syndromes covering six (6) main areas:
1. The economic importance of each disease (high, medium or low) from the lists in the two worksheets provided (NB: there is one list of cattle diseases and one list of sheep & goat diseases)
2. The extent to which more extension (awareness) of currently available treatment and prevention options could reduce economic impact
3. The extent to which more research is required to identify better treatment and control options to reduce economic impact
4. For the diseases and conditions listed, please state what product(s) your company has available for use in Australia.
5. For the products you provided in Question 4, what is the standard price per animal of the recommended dose or application rate?
6. Any comments about the disease/condition/syndrome especially if it relates to any emerging trends that will require attention in the near future

Completing the survey:
There are two excel tabs after this page containing a list of damaging endemic diseases for **cattle** and another tab for **sheep and goats**.
Please complete each worksheet with your responses.
diseasesurvey@ghd.com

Please note all responses will be treated confidentially and will remain anonymous. All information will be collated at a regional or state leve

If you have any questions or would like to expand on any aspects of specific endemic diseases, please contact a member of the consortium from the list below:

Dr Tristan Jubb. Email: tristan@livestockhealthsystems.com. Mobile: 0448 403 600
Dr Richard Shephard. Email: richard@herdhealth.com.au. Mobile: 0418 515 498
Dr John Webb-Ware. Email: j.webbware@unimelb.edu.au. Mobile: 0418748600
Dr Geoffry Fordyce. Email: g.fordyce@uq.edu.au. Mobile: 0428 109 062
Joe Lane (GHD). Email: joe.lane@ghd.com. Mobile: 0415269934

A. LIVESTOCK DISEASE SURVEY (ENDEMIC DISEASES) - CATTLE. MLA Project B.AHE.0010

Your location:
State
Region

You can type the response directly into the cell (e.g. L, M or H or 1-5) or select from the drop down list

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Your company's product(s)	Q5. Product price	Q6. Other comments
	Against each disease or condition, in your experience please rate their economic importance as low (L), medium (M) or high (H). If the disease is not relevant to your area or experience please leave blank. This may be in terms of production or product losses, or costs of control and prevention, or both.	For the diseases and conditions you have ranked as Medium and High, indicate on a scale of 1-5 the importance of more **extension** (awareness) of currently available treatment and prevention options to reduce economic impact. 1. Not important 2. Low importance 3. Moderately important 4. Highly important 5. Crtically important	For the diseases and conditions you have ranked as Medium and High, indicate on a scale of 1-5 the importance of more **research** to identify better treatment and control options to reduce economic impact. 1. Not important 2. Low importance 3. Moderately important 4. Highly important 5. Crtically important	For the diseases and conditions listed, please state what product(s) your company has available for use in Australia.	For the products you provided in Question 4, what is the standard price per animal of the recommended dose or application rate?	Any comments about this disease/condition/syndrome especially if it relates to any emerging trends that will require attention in the near future.
3D syndrome						
Abortion - stillbirths						
Abortion dt Neospora						
Abscesses - liver						
Abscesses - neck/lymphnode/grass seed						
Abscesses - skin						
Abscesses - vaccination/injection site						
Acidosis (grain poisoning)						
Akabane virus (Crooked calf disease)						
Alopecia - hair loss						
Annual ryegrass toxicity (ARGT)						
Anthelmintic resistance (Drench resistance)						
Anthrax						
Acaricide Resistance						
Atypical interstitial pneumonia						
Balanitis						
Balanoposthitis						
Barbers Pole Worm						
BJD - Bovine Johne's Disease (Johne's disease)						
Black livers - melanosis, mulga livers, bore water livers						
Blackleg						
Bloat						
Bone chewing						
Botulism						
Bovine respiratory disease (BRD)						
Bracken fern poisoning						
Broken pizzle						
Bruising						
Buffalo fly skin lesions						
Buffalo fly worry						
Calf pneumonia						
Calf scours - Cryptosporidia						
Calf scours - General						
Calf scours - E coli						
Calf scours - Rotavirus						
Calf scours - Salmonella						
Campylobacteriosis - vibriosis						
Cast (eg on irrigation checkbank)						
Castration losses						
Chemical residues - meat						
Chemical residues - offal						
Clostidial infection						
Cobalt deficiency						
Coccidiosis						
Copper deficiency						
Deformed calves (congenital defects)						
Dehorning losses						
Dog bites - dog attack						
Downers - downer cows						
Drooling						
Dystocia (calving problems)						
Ear infection - head tilt						
Ephemeral fever (Three-day sickness)						
Eye cancer (Cancer eye)						
Eye problems						
Facial eczema						
Feet problems						
Fluke (Internal parasites/worms)						
Footrot						
Grass seed abscesses						
Grass tetany						
Haemorrhage (blood loss, bleeding)						
Heat stress						
IBR - infectious bovine rhinotracheitis						
Illthrift						
Illthrift weaners						
Infectious pustular vulvovaginitis (IPV)						
Infertility - Vibriosis - Campylobacteriosis						
Infertility bulls						
Infertility cows						
Infertility heifers						
Iodine deficiency						
Joint ill						
Lameness						
Laminitis						
Lantana poisoning						
Lead poisoning						
Leptospirosis						
Lice						
Listeriosis						
Liver abscesses						
Liver fluke (Fascioliasis)						
Lumpy jaw						
Lungworm						
Malignant catarrhal fever (MCF)						
Mastitis						
Milk fever (Hypocalcaemia)						
Navel infections						
Necrobacillosis - oral, laryngeal						
Nitrate-nitrite poisoning						
Onion grass balls						
Oral necrobacillosis						
Overgrown claws (overgrown feet)						
Penile/penis haematoma/swollen/injured						
Perennial ryegrass staggers						
Pestivirus (Bovine viral diarrhoea)						
Phalaris staggers						
Phosphorus deficiency						
Photosensitisation						
Pinkeye (Moraxella bovis)						
Plant poisoning						
Pneumonia						
Pneumonia in calves						
Pregnancy toxaemia (fatty liver disease)						
Prepuce injury/infection - posthitis						
Pulpy kidney (enterotoxaemia)						
Red nose (Infectious bovine rhinotracheitis)						
Red water - red urine						
Retained foetal membranes - RFMs						
Rickets						
Ringworm						
Salmonellosis						
Sand impaction - sand in rumen, sand in paunch						
Sarcocystis						
Selenium deficiency						
Shipping fever						
Sporadic Bovine Encephalomyelitis (SBE)						
Starvation ketosis						
Stephanofilariasis						
Sudden death						
Swollen joints						
Tetanus						
Theiliera						
Tick fever						
Tick worry						
Trace element deficiency						
Transit tetany						
Trichomoniasis						
Umbilical hernia						
Urea poisoning						
Urolithiasis (waterbelly)						
Vaginal prolapse - prolapsed vagina						
Vaginitis - vulvovaginitis						
Vibriosis - Campylobacteriosis						
Warts - papillomatosis						
Weaner illthrift						
Woody tongue - Actinobacillosis						
Worms (Internal parasites)						
Yersiniosis						
Zamia poisoning						
Any Others? (Please specify below)						

B. LIVESTOCK DISEASE SURVEY (ENDEMIC DISEASES) - SHEEP & GOATS. MLA Project B.AHE.0010

Your location:
State
Region

You can type the response directly into the cell (e.g. L, M or H or 1-5) or select from the drop down list

List of endemic diseases, conditions, syndromes	Q1. Economic importance	Q2. Need for extension	Q3. Need for research	Q4. Your company's product(s)	Q5. Product price	Q6. Other comments
	Against each disease or condition, in your experience please rate their economic importance as low (L), medium (M) or high (H). If the disease is not relevant to your area or experience please leave blank. This may be in terms of production or product losses, or costs of control and prevention, or both.	For the diseases and conditions you have ranked as Medium and High, indicate on a scale of 1-5 the importance of more **extension** (awareness) of currently available treatment and prevention options to reduce economic impact. 1. Not important 2. Low importance 3. Moderately important 4. Highly important 5. Critically important	For the diseases and conditions you have ranked as Medium and High, indicate on a scale of 1-5 the importance of more **research** to identify better treatment and control options to reduce economic impact. 1. Not important 2. Low importance 3. Moderately important 4. Highly important 5. Critically important	For the diseases and conditions listed, please state what product(s) your company has available for use in Australia.	For the products you provided in Question 4, what is the standard price per animal of the recommended dose or application rate?	Any comments about this disease/condition/syndrome especially if it relates to any emerging trends that will require attention in the near future.
Abortion - still birth						
Abscesses – vaccination injection site						
Acidosis (grain poisoning)						
Actinobacillosis of epididymis/infertility						
Actinobacillosis of muzzle/head						
Agalactia (Mastitis/hard udder)						
Anaemia from Mycoplasma infection (formerly Eperythrozoonosis)						
Annual ryegrass toxicity						
Anthelmintic resistance (Drench resistance)						
Anthrax						
Arthritis of lambs						
Bacterial enteritis						
Bacterial enteritis – Campylobacter						
Bacterial enteritis – Salmonella						
Bacterial enteritis – Yersiniosis						
Barbers Pole Worm						
Benign footrot						
Bent leg						
Black livers – melanosis, mulga livers, bore water livers						
Black mastitis						
Blue-green algae poisoning						
Brucella ovis (Brucellosis)						
Campylobacter						
Cancer ears						
Cancer vulva						
Caprine arthritis-encephalitis (CAE)						
Caseous lymphadenitis ('CLA', 'Cheesy gland')						
Chemical residues – meat						
Chemical residues – wool						
Chorioptic mange						
Clostridial disease - big head, malignant oedema						
Clostridial disease (Black disease)						
Clostridial disease (Pulpy kidney, enterotoxaemia)						
Clostridial disease – Tetanus						
Clover disease infertility						
Cobalt deficiency						
Coccidiosis						
Cold stress post shearing						
Copper deficiency						
Copper poisoning						
Dead lambs – cold stress						
Dead lambs – difficult birth						
Dead lambs – mismothering						
Dead lambs – predation						
Dermotophilosis ('Dermo', 'Lumpy wool')						
Diarrhoea - scours						
Downers						
Dystocia (Difficult birth)						
Facial eczema						
Fleece rot						
Flystrike – Body & breech						
Foot abscess						
Footrot – benign						
Footrot – intermediate						
Footrot – Virulent						
Fox attack						
Fractured ribs						
Gastrointestinal Parasites						
Goitre						
Grass seeds						
Heat stress – hyperthermia						
Heliotrope poisoning						
Hydatids						
Hypocalcaemia						
Infertility - female: Ewe, Doe						
Infertility – male: Ram, buck						
Iodine deficiency						
Itch mite						
Jaundice – yellows						
Balanitis/posthitis						
Lameness						
Lameness post dipping						
Lice						
Listeriosis						
Liver disease						
Liver Fluke						
Lungworm						
Lupinosis						
Mismothering						
OJD – ovine Johne's disease						
Perennial ryegrass staggers						
Periodontal disease						
Phalaris poisoning - sudden death						
Phalaris staggers						
Photosensitisation						
Pinkeye						
Pizzle rot						
Plant poisoning – uncertain or other than specified						
Pneumonia						
Polioencephalomalacia – PEM						
Post weaning mortality						
Pregnancy toxaemia						
Prolapsed rectum						
Prolapsed uterus						
Prolapsed vagina						
Pyrrolizidine alkaloid poisoning						
Redgut						
Rickets						
Salmonellosis						
Sarcocystis						
Scabby mouth						
Scald - foot scald						
Scrotal mange						
Selenium deficiency						
Sheep measles						
Shelly toe						
Teeth wear						
Toxoplasma						
Trace element deficiencies						
Trachymene poisoning						
Twin lamb disease						
Urolithiasis - water belly						
Vitamin D deficiency						
Vitamin E deficiency						
Weaner ill-thrift						
White muscle disease						
Wild dog attack						
Worms / Internal Parasites						
Yersiniosis						
Any Others? (Please specify below)						

2 Questionnaire results

2.1 Cattle

	Producers (Northern)		Producers (Southern)		Cattle and Sheep Vets	
Responses	**70**		**110**		**12**	
1	Bovine ephemeral fever	28	Internal parasites (worms)	40	Pestivirus (Bovine viral diarrhoea)	6
2	Botulism	20	Pinkeye (Moraxella bovis)	20	Acidosis (grain poisoning)	5
3	Tick fever	17	Other	19	Anthelmintic resistance (Drench resistance)	4
4	Leptospirosis	14	Liver fluke (fascioliasis)	14	Feet problems	4
5	Blackleg	10	Pestivirus (Bovine viral diarrhoea)	14	Heat stress	4
6	Buffalo fly worry	10	Enterotoxaemia	13	Infertility cows	4
7	Vibriosis - Campylobacteriosis	9	Blackleg	12	Mastitis	4
8	Tick worry	8	Grass tetany	10	Pinkeye (Moraxella bovis)	4
9	BJD - bovine Johne's disease (Johne's disease)	6	Bovine ephemeral fever	10	Bovine respiratory disease (BRD)	3
10	Other	6	Bloat	7	Calf pneumonia	3
11	Internal parasites (worms)	5	Footrot	7	Calf scours - E coli	3
12	Pestivirus (Bovine viral diarrhoea)	5	BJD - bovine Johne's disease (Johne's disease)	6	Calf scours - Rotavirus	3
13	Buffalo fly skin lesions	4	Buffalo fly worry	5	Campylobacteriosis - vibriosis	3
14	Pinkeye (Moraxella bovis)	4	Clostridial infection	5	Clostidial infection	3
15	Plant poisoning	3	Calf scours - E coli	4	Downers - downer cows	3
16	Tetanus	3	Diarrhoea (Scours)	4	Illthrift	3
17	Abortion	2	Mastitis	4	Illthrift weaners	3
18	Lantana poisoning	2	Tick worry	4	Infertility - Vibriosis - Campylobacteriosis	3
19	Acaracide resistance	2	Vibriosis -Campylobacteriosis	4	Infertility bulls	3
20			Buffalo fly skin lesions	3	Theiliera	3
21			Leptospirosis	3	Vibriosis - Campylobacteriosis	3
22			Milk fever (Hypocalcaemia)	3	Worms (Internal parasites)	3
23			Tetanus	3		
24			Tick fever	3		

	CVOs (Southern)		Laboratory Results CVOs		Processors
Responses	**4**		**4**		**1**
1	Bovine respiratory disease (BRD)	2	Mastitis	2218	Abscesses - vaccination/injection site
2	Infertility cows	2	Salmonellosis	953	Abscesses - liver
3	Infertility heifers	2	Johne's Disease	599	Eye cancer (Cancer eye)
4	Mastitis	2	Pestivirus (Bovine viral diarrhoea)	594	Worms (Internal parasites)
5	Pinkeye (Moraxella bovis)	2	Unknown (exotic disease excluded)	584	Anthelmintic resistance (Drench resistance)
6	Circling	2	Cryptosporidiosis - (calf scours complex)	534	Anthrax
7	Perennial ryegrass toxicosis	2	Pneumonia	316	Downers - downer cows
8	Calf scours - Rotavirus	1	Streptococcus infection	293	Acaricide Resistance
9	Acute Bovine Liver Disease	1	Staphylococcus infection	273	Black livers - melanosis, mulga livers, bore water livers
10	Calf scours - Cryptosporidia	1	Selenium deficiency	219	Chemical residues - offal
11	Calf scours - E coli	1	Hypocalcaemia	217	Lumpy jaw
12	Annual ryegrass toxicity (ARGT)	1	Clinical pathology abnormality	206	Bovine respiratory disease (BRD)
13	Dehorning losses	1	Other	206	Eosinophillic Myositis
14	Facial eczema	1	Salmonellosis Clinical	203	Eye problems
15	Grass seed abscesses	1	Pestivirus exposure	178	Shipping fever
16	Lameness	1	Coronavirus	158	Bracken fern poisoning
17	Pestivirus (Bovine viral diarrhoea)	1	Copper deficiency	138	Atypical interstitial pneumonia
18	Anthrax	1	Bovine viral diarrhoea/pestivirus (not type 2)	135	Calf scours - General
19	Milk fever (Hypocalcaemia)	1	Calf scours - Rotavirus	131	Calf scours - E coli
20	Phalaris staggers	1	Calf scours - E coli	130	Calf scours - Salmonella
21	Phosphorus deficiency	1	Hard udder (Agalactia/Mastitis)	127	Pregnancy toxaemia (fatty liver disease)
22	Woody tongue - Actinobacillosis	1	Salmonellosis (general)	127	Woody tongue - Actinobacillosis
23			Hepatic abnormality	119	
24			Worms (Internal parasites)	111	

2.2 Sheep and Goats

	Producers (Sheep)		Producers (Goats)		Cattle and Sheep Vets	
Responses	**90**		**30**		**11**	
1	Internal parasites (worms)	37	Liver fluke	14	Barbers Pole Worm	7
2	Lice	35	Barbers pole worm	10	Flystrike – Body & breech	6
3	Flystrike - Body & breech	26	Footrot	5	OJD – ovine Johne's disease	6
4	Johne's disease	23	Worms	5	Weaner ill-thrift	6
5	Pulpy kidney (Clostridial diseases)	18	Cheesy gland (Caseous lymphadenitis - CLA)	4	Worms / Internal Parasites	6
6	Footrot	9	Caprine arthritis-encephalitis (CAE)	3	Clostridial disease (Pulpy kidney, enterotoxaemia)	5
7	Pregnancy toxaemia	8	Johne's disease	3	Footrot – Virulent	5
8	Arthritis of lambs	7	Lice	2	Mismothering	5
9	Barbers pole worm	7	Pregnancy toxaemia	2	Dead lambs – predation	4
10	Brucella ovis (Brucellosis)	4	Pulpy kidney (Clostridial diseases)	2	Abortion - still birth	3
11	Cheesy gland (Caseous lymphadenitis - CLA)	3			Dead lambs – cold stress	3
12	Foot abscess	3			Dead lambs – mismothering	3
13	Footrot - benign	3			Diarrhoea - scours	3
14	Footrot - Virulent	3			Foot abscess	3
15	Other	3			Lameness	3
16	Scabby mouth	3			Post weaning mortality	3
17	Cancer	2			Pregnancy toxaemia	3
18	Copper deficiency	2			Wild dog attack	3
19	Hypocalcaemia	2			Lice	2
20	Liver fluke	2			Brucella ovis (Brucellosis)	2
21	Mastitis	2			Caseous lymphadenitis ('CLA', 'Cheesy gland')	2
22	Pinkeye	2				
23	Perennial Ryegrass Staggers	2				
24	Twin lamb disease	2				

	CVO's		Laboratory Results - CVOs (SHEEP)		Laboratory Results - CVOs (Goats)		Processors
Responses	**4**		**4**		**4**		**1**
1	Internal parasites (worms)	2	Brucella ovis (Brucellosis)	6587	Caprine arthritis-encephalitis (CAE)	342	Sheep measles
2	Footrot – Virulent	2	Worms (Internal parasites)	1107	Unknown (exotic disease excluded)	101	Caseous lymphadenitis (‘CLA’, ‘Cheesy gland’)
3	Dead lambs – cold stress	2	Unknown (exotic disease excluded)	600	Helminth parasites	91	Grass seeds
4	Dead lambs – difficult birth	2	Helminth parasites	413	Internal parasitism	61	Wild dog attack
5	Abortion	2	Hypocalcaemia	267	Johne's disease	46	Abscesses – vaccination injection site
6	Barbers pole worm	2	Other	234	Worms (Internal parasites)	38	Anthelmintic resistance (Drench resistance)
7	Caseous lymphadenitis (‘CLA’, ‘Cheesy gland’)	1	Footrot – Virulent	229	Haematological abnormality	35	Anthrax
8	Flystrike – Body & breech	1	Paratuberculosis (Johnes disease)	213	Internal parasites-protozoa	32	Gastrointestinal Parasites
9	Brucella ovis (Brucellosis)	1	Johne's Disease	204	Other	29	Worms / Internal Parasites
10	Dead lambs – mismothering	1	Liver disease	180	Anaemia	21	Barbers Pole Worm
11	Lice	1	Internal parasitism	173	Coccidiosis	19	Fox attack
12	Post weaning mortality	1	Copper deficiency	160	Clinical pathology abnormality	18	Fractured ribs
13	Sheep measles	1	Trauma	152	Mastitis	18	OJD – ovine Johne’s disease
14	Weaner ill-thrift/ post weaning mortality	1	Cobalt Deficiency	132	Staphylococcus infection	16	Hydatids
15	Liver Fluke	1	Coccidiosis	120	CAE	14	Sarcocystis
16	Bacterial enteritis – Campylobacter	1	Footrot – benign	111	Trauma	14	Chemical residues – meat
17	Bacterial enteritis – Salmonella	1	Pregnancy toxaemia	111	Enterotoxaemia (pulpy kidney)	13	Chemical residues – wool
18	Foot abscess	1	Johnes untyped !$	105	Corynbacteria	12	Bacterial enteritis –

	CVO's		Laboratory Results - CVOs (SHEEP)		Laboratory Results - CVOs (Goats)		Processors
							Salmonella
19	Footrot – intermediate	1	Pneumonia	96	Salmonellosis (general)	11	
20	Perennial ryegrass staggers	1	Selenium deficiency	81	Hypocalcaemia	9	
21	Sarcocystis	1	OJD – ovine Johne's disease	79	Copper deficiency	8	
22	Twin lamb disease	1	Mastitis	76	Nematodirus	8	
23			Toxicity - phalaris	72	Nervous system abnormality	8	
24			Enterotoxaemia (pulpy kidney)	70	Ostertagiasis	8	

2.3 Carcase condemnations 2011-2013 - Cattle

Cattle by Total Condemnations				Total Slaughtered			21,509,537			
	2011	2012	2013	Total	ACT	NSW	Qld	SA	Tas	Vic	WA
ABSCESS	119	120	241	**480**	0	33	253	2	14	172	6
ACTINO	24	20	32	**76**	0	17	6	2	8	43	0
ANAEMI	12	11	14	**37**	0	7	10	2	3	13	2
ARTHRITIS	14	8	3	**25**	0	3	4	0	1	16	1
AT ANTEMORTEM	75	101	84	**260**	0	15	16	0	8	212	9
BRUISING	276	280	390	**946**	0	304	174	25	24	392	27
C.BOVIS	6	0	0	**6**	0	3	0	0	0	2	1
CANCER EYE	1167	920	756	**2843**	25	1110	318	96	76	1120	98
CELLULITIS	2	2	2	**6**	0	0	0	0	0	5	1
COMPANY CONDEMN	25	21	37	**83**	0	0	0	0	4	79	0
ECCHYMOSIS	1	4	5	**10**	0	1	2	1	2	4	0
EMACIATION	192	299	328	**819**	0	119	88	2	33	571	6
EOSINOPHILS MYOSITIS	131	128	116	**375**	0	151	120	62	2	33	7
FEVER	1690	1742	1961	**5393**	0	187	501	29	142	4473	61
GANGRENE	147	198	236	**581**	0	123	187	16	7	142	106
GROSS CONTAMINATION	45	82	267	**394**	0	13	5	2	6	368	0
HYDATIDS	5	2	2	**9**	0	1	8	0	0	0	0
IMMATURITY	28	20	26	**74**	0	0	0	0	23	51	0
JAUNDICE	311	403	724	**1438**	0	136	463	0	106	725	8
MALIGNANC	1831	2077	2347	**6255**	0	1111	4054	78	102	799	111
MELANOSIS	33	36	34	**103**	0	31	37	12	3	16	4
METRITIS	107	114	125	**346**	0	14	121	1	15	183	12
NAVEL	19	56	76	**151**	0	0	0	0	0	151	0
NEUROFIBROMA	46	60	53	**159**	0	15	43	36	17	48	0
OTHER CAUSES	118	237	293	**648**	0	188	138	9	55	254	4

Cattle by Total Condemnations					**Total Slaughtered**			**21,509,537**			
PERITONITIS	79	63	86	**228**	0	9	62	4	5	142	6
POLYARTHRITIS	117	157	128	**402**	0	130	60	0	35	170	7
PYAEMIA	285	211	282	**778**	0	329	98	0	27	310	14
SEPTIC PNEUMONIA	229	199	273	**701**	0	107	376	23	8	151	36
SEPTICAEMIA	322	385	588	**1295**	0	207	570	38	29	398	53
TOXAEMIA	40	40	49	**129**	0	119	6	1	0	2	1
URAEMIA	109	98	105	**312**	0	49	105	4	8	144	2
WOUNDS	1	4	2	**7**	0	2	2	0	0	3	0
XANTHOSIS	8	18	21	**47**	0	16	10	0	0	21	0
Total	**7614**	**8116**	**9686**	**25416**	**25**	**4550**	**7837**	**445**	**763**	**11213**	**583**

2.4 Carcase condemnations 2011-2013 - Sheep

Sheep by Total Condemnations					Total Slaughtered				17,940,514	
Reason	**2011**	**2012**	**2013**	**Total**	**ACT**	**NSW**	**Qld**	**SA**	**Tas**	**Vic**	**WA**
ANAEMI	76	64	69	**209**	0	0	9	86	4	49	61
AT ANTEMORTEM	485	458	781	**1724**	0	506	53	5	4	47	1109
BRUISING	468	485	1043	**1996**	2	486	73	406	15	879	135
C.OVIS	770	862	1834	**3466**	0	887	97	331	44	784	1323
CLA	1516	1424	2115	**5055**	0	1307	78	112	139	2582	837
COMPANY CONDEMN	3306	3229	5998	**12533**	0	5493	2525	1534	19	2748	214
DOG BITE	0	100	33	**133**	0	0	132	0	0	1	0
ECCHYMOSIS	27	45	29	**101**	0	26	1	1	0	63	10
EMACIATION	6840	8413	14551	**29804**	0	1927	1354	2251	495	22009	1768
FEVER	1639	1455	2446	**5540**	0	817	476	649	19	3143	436
GANGRENE	11	55	55	**121**	0	12	31	6	5	48	19
GROSS CONTAMINATION	2409	2914	5619	**10942**	0	1464	978	1269	147	6823	261
HYDATIDS	16	8	7	**31**	0	13	3	6	0	9	0
JAUNDICE	1709	1737	2479	**5925**	0	1278	386	1315	67	2406	473
MALIGNANC	5282	6886	10827	**22995**	0	8840	1516	1853	94	7810	2882
METRITIS	118	370	454	**942**	0	0	3	787	6	93	53
MUSCLE CONDITIONS	7	3	3	**13**	0	0	1	1	1	0	10
OTHER CAUSES	585	669	1116	**2370**	0	67	338	159	497	909	400
PERITONITIS	1	32	68	**101**	0	4	8	13	4	69	3
POLYARTHRITIS	1129	1599	3569	**6297**	0	3578	220	553	51	1686	209
PYAEMIA	36	58	331	**425**	0	1	8	23	16	316	61
SARCOSPORIDIA	231	627	951	**1809**	0	520	18	28	814	385	44
SEPTIC PNEUMONIA	947	904	1104	**2955**	0	5	14	268	3	157	2508
SEPTICAEMIA	1231	1471	2807	**5509**	0	2379	565	1923	42	359	241
WOUNDS	11	16	9	**36**	0	0	21	9	0	4	2
Total	**28850**	**33884**	**58298**	**121032**	**2**	**29610**	**8908**	**13588**	**2486**	**53379**	**13059**

2.5 Carcase condemnations 2011-2013 - Lambs

Lambs by Total Condemnation					**Total Slaughtered**				**39,086,005**		
Reason	**2011**	**2012**	**2013**	**Total**	**ACT**	**NSW**	**Qld**	**SA**	**Tas**	**Vic**	**WA**
AT ANTEMORTEM	174	62	78	**314**	0	25	0	41	0	25	223
BRUISING	64	48	76	**188**	0	30	0	27	0	113	18
C.OVIS	1416	1285	1880	**4581**	0	856	23	826	58	2031	787
CLA	185	92	71	**348**	0	63	4	9	1	251	20
COMPANY CONDEMN	1195	934	1174	**3303**	0	802	117	417	0	1798	169
DOG BITE	0	32	5	**37**	0	0	34	0	0	3	0
ECCHYMOSIS	6	11	1	**18**	0	1	0	2	0	13	2
EMACIATION	314	278	296	**888**	0	61	17	56	0	720	34
FEVER	700	782	1108	**2590**	0	533	65	349	3	1143	497
GANGRENE	6	10	15	**31**	0	1	2	3	0	21	4
GROSS CONTAMINATION	677	602	978	**2257**	0	254	94	387	5	1464	53
JAUNDICE	3020	3458	2129	**8607**	0	2354	608	2516	88	2096	945
MALIGNANC	226	179	213	**618**	0	241	12	102	2	157	104
OTHER CAUSES	326	328	258	**912**	0	47	63	205	15	411	171
POLYARTHRITIS	2101	1844	1967	**5912**	0	922	44	579	126	4002	239
SARCOSPORIDIA	9	2	0	**11**	0	3	0	0	0	7	1
SEPTIC PNEUMONIA	219	148	136	**503**	0	10	2	92	1	66	332
SEPTICAEMIA	408	385	620	**1413**	0	455	67	640	4	211	36
WOUNDS	0	0	0	**0**	0	0	0	0	0	0	0
Total	**11046**	**10480**	**11005**	**32531**	**0**	**6658**	**1152**	**6251**	**303**	**14532**	**3635**

2.6 Carcase condemnations 2011-2013 - Goats

Goats by Total Condemnation					**Total Slaughtered**				**5,593,254**		
	2011	**2012**	**2013**	**Total**	**ACT**	**NSW**	**Qld**	**SA**	**Tas**	**Vic**	**WA**
AT ANTEMORTEM	57	7	28	**92**	0	0	28	7	0	55	2
BRUISING	60	84	160	**304**	0	0	101	29	0	150	24
C.OVIS	3	5	5	**13**	0	0	1	6	0	6	0
CLA	565	386	514	**1465**	0	0	886	65	0	506	8
COMPANY CONDEMN	2307	1368	2320	**5995**	0	0	1593	4	0	4234	164
DOG BITE	0	19	13	**32**	0	0	21	0	0	11	0
ECCHYMOSIS	0	35	16	**51**	0	0	50	1	0	0	0
EMACIATION	602	1361	1669	**3632**	0	0	1728	834	0	957	113
FEVER	1332	1579	1171	**4082**	0	0	1152	749	0	2114	67
GANGRENE	23	33	44	**100**	0	0	73	6	0	19	2
GROSS CONTAMINATION	1185	2121	4062	**7368**	0	0	905	992	0	4951	520
JAUNDICE	117	169	268	**554**	0	0	291	35	0	227	1
MALIGNANC	72	88	76	**236**	0	0	138	27	0	134	6
METRITIS	9	8	1	**18**	0	0	1	14	0	6	1
OTHER CAUSES	147	241	154	**542**	0	0	259	26	0	305	11
POLYARTHRITIS	93	109	153	**355**	0	0	236	16	0	151	9
PYAEMIA	13	15	0	**28**	0	0	6	0	0	27	3
SARCOSPORIDIA	1	0	0	**1**	0	0	1	8	0	15	0
SEPTIC PNEUMONIA	50	127	112	**289**	0	1	37	203	0	27	23
SEPTICAEMIA	453	401	389	**1243**	0	0	1024	50	0	127	42
WOUNDS	0	0	1	**1**	0	0	0	1	0	0	0
Total	**7089**	**8156**	**11156**	**26401**	**0**	**1**	**8531**	**3073**	**0**	**14022**	**996**

3 Livestock disease modelling

Example – Buffalo Fly (northern beef)

NORTHERN BEEF											
No Herds	19,743		High	Moderate	Low	Nil					
No Head	15,706,803		10%	50%	30%	10%					
(instructions on data entry are located in columns to the right) =>		No Herds	1,974	9,872	5,923	1,974					
Buffalo fly		No animals	1,570,680	7,853,402	4,712,041	1,570,680					
Clinical prevalence (All age groups)			98.9%	33.0%	10.0%	0.0%	29.39%	(regional clinical prevalence)			
INPUTS	**Avg herd size**		**291**	Breeders							
HERD		**Females**				Bulls		**Steers**			
CHARACTERISTICS	Calves	0.5-1.5	1.5-2.5	2.5-3.5	Mature >3.5	Mature	Calves	0.5-1.5	1.5-2.5	>2.5-3.5	Mature >3.5
Cohort size (as proportion of cow herd)	47%	43%	33%	25%	42%	4%	47%	43%	41%	26%	17%
Calving rate			74%	88%	87%						
Avg. no. (high)	136	124	95	74	122	12	136	124	118	76	49
Avg. no. (medium)	136	124	95	74	122	12	136	124	118	76	49
Avg. no. (Low)	136	124	95	74	122	12	136	124	118	76	49
Background Mortality rate	9%	3%	3%	3%	3%	4%	9%	2%	2%	2%	1%
proportion of group sold	0%	20%	19%	12%	below	18%	0%	2%	34%	34%	below
				H	35%					H	100%
				M	35%					M	100%
				L	35%					L	100%
Animal value	$300	$465	$619	$648	$648	$865	$339	$547	$852	$961	$980
number sold (high)	0	25	18	9	43	2	0	3	40	26	33
number sold (med)	0	25	18	9	43	2	0	3	40	26	33
number sold (low)	0	25	18	9	43	2	0	3	40	26	33
DISEASE PREVALENCE											
Within-herd prevalence - highly affected	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Avg. no.	136.0	124.0	95.0	74.0	122.0	0.0	136.0	124.0	118.0	76.0	49.0
Within-herd prevalence - moderately affected	33.0%	33.0%	33.0%	33.0%	33.0%	33.0%	33.0%	33.0%	33.0%	33.0%	33.0%
Avg. no.	44.9	40.9	31.4	24.4	40.3	4.0	44.9	40.9	38.9	25.1	16.2
Within-herd prevalence - lowly affected	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%	10.0%
Avg. no.	13.6	12.4	9.5	7.4	12.2	1.2	13.6	12.4	11.8	7.6	4.9
DIRECT COSTS											
TREATMENT COSTS											
Treatment costs ($ per head treated + handling etc.)	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Treatment proportion - highly affected	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Treatment proportion - moderately affected	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Treatment proportion - lowly affected	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
MANAGEMENT AND PREVENTION COSTS APPLIED											
Herd control costs - highly affected (applied to each animal in cohort $/head)	$3.60	$7.20	$7.20	$7.20	$7.20	$7.20	$3.60	$7.20	$7.20	$7.20	$7.20
Control proportion herds implementing - highly affected	90%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%	90.0%
Herd control costs - moderately affected (applied to each animal in cohort $/head)	$1.19	$2.38	$2.38	$2.38	$2.38	$2.38	$1.19	$2.38	$2.38	$2.38	$2.38
Control proportion herds implementing - moderately affected	70%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%	70.0%
Herd control costs - lowly affected (applied to each animal in cohort $/head)	$0.36	$0.72	$0.72	$0.72	$0.72	$0.72	$0.36	$0.72	$0.72	$0.72	$0.72
Control proportion herds implementing - lowly affected	50%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%

REGULATORY COSTS											
Fixed	$0.00										
Variable (per cow)	$0.00										
INDIRECT COSTS											
Fixed or one off per herd	$0.00										
Indirect costs - highly affected	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Indirect costs - moderately affected	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Indirect costs - lowly affected	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Proportion herds implementing/impacted- highly affected	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Proportion herds implementing/impacted - moderately affected	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Proportion herds implementing/impacted - lowly affected	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%	0%
PRODUCTION LOSSES											
MORTALITY											
Mortality value (animal)	$300	$465	$619	$648	$648	$865	$339	$547	$852	$961	$980
Mortality rate (% of clinical cases that die)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total deaths (high)	12.2	4.0	3.0	2.4	3.9	0.5	12.2	2.9	1.9	1.2	0.7
Total deaths (med)	12.2	4.0	3.0	2.4	3.9	0.5	12.2	2.9	1.9	1.2	0.7
Total deaths (low)	12.2	4.0	3.0	2.4	3.9	0.5	12.2	2.9	1.9	1.2	0.7
LIVEWEIGHT											
Permanent weight loss (kg) Clinicals High	6.4	12.8	12.8	12.8	12.8	5.0	6.4	12.8	12.8	12.8	12.8
Permanent weight loss (kg) Clinicals Moderate	2.1	4.2	4.2	4.2	4.2	5.0	2.1	4.2	4.2	4.2	4.2
Permanent weight loss (kg) Clinicals Low	0.6	1.3	1.3	1.3	1.3	5.0	0.6	1.3	1.3	1.3	1.3
Permament weight loss value kg (clinicals)	$2.00	$1.50	$1.50	$1.50	$1.50	$1.50	$2.00	$2.00	$2.00	$2.00	$2.00
Permanent weight loss - proportion cases affected (clinicals)	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Temporary weight loss (kg) Clinicals High	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0
Temporary weight loss (kg) Clinicals Moderate	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0
Temporary weight loss (kg) Clinicals Low	0.0	0.0	0.0	0.0	0.0	5.0	0.0	0.0	0.0	0.0	0.0
Temporary weight loss value kg (clinicals)	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00	$1.00
Temporary wt loss opportunity interest value	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%	6%
Temporary weight loss Agistment cost ($/week	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Temporary weight loss Time to resume wt loss (weeks)	0	0	0	0	0	0	0	0	0	0	0
Temporary weight loss - proportion cases affected (clinicals)	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
REPRODUCTION											
Failure to calve cost	-	-	$300	$300	$300	-	-	-			-
Pregnancy rate reduction (clinical) High	-	-	0.0%	0.0%	0.0%	-	-	-			-
Pregnancy rate reduction (clinical) Moderate			0.0%	0.0%	0.0%						
Pregnancy rate reduction (clinical) Low			0.0%	0.0%	0.0%						
MARKET SPECIFICATIONS											
Failure to meet market specifications value	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10	$0.10
Proportion affected	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%
REDUCED PRODUCT VALUE											
Loss of hide value (clinical)	$0.00	$6.00	$7.00	$8.00	$8.00	$8.00	$5.00	$6.00	$7.00	$8.00	$8.00
Damaged hides - proportion clinicals affected	0.0%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%	4.1%
Loss of meat value (e.g. MSA-downgrade) in clinicals	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00

OUTPUTS		Females				Bulls		Steers			
	Calves	0.5-1.5	1.5-2.5	2.5-3.5	Mature >3.5	Mature	Calves	0.5-1.5	1.5-2.5	>2.5-3.5	Mature >3.5
Cohort size (as proportion of cow herd)	47%	43%	33%	25%	42%	4%	47%	43%	41%	26%	17%
No. Animals (high)	136	124	95	74	122	12	136	124	118	76	49
No. Animals (med)	136	124	95	74	122	12	136	124	118	76	49
No. Animals (low)	136	124	95	74	122	12	136	124	118	76	49
Prevalence	Calves	0.5-1.5	1.5-2.5	2.5-3.5	Mature >3.5	Mature	Calves	0.5-1.5	1.5-2.5	>2.5-3.5	Mature >3.5
Highly affected herd	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Moderately affected herd	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%	33%
Lowly affedted herd	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%	10%
Treatment and Control costs											
Total clinical case treatment costs - highly affected herd	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total clinical case treatment costs - moderately affected herd	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total clinical case treatment costs - lowly affected herd	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Control costs - highly affected	*$440.64*	*$803.52*	*$615.60*	*$479.52*	*$790.56*	*$77.76*	*$440.64*	*$803.52*	*$764.64*	*$492.48*	*$317.52*
Control costs - moderately affected	*$113.10*	*$206.24*	*$158.00*	*$123.08*	*$202.91*	*$19.96*	*$113.10*	*$206.24*	*$196.26*	*$126.40*	*$81.50*
Control costs - lowly affected	*$24.48*	*$44.64*	*$34.20*	*$26.64*	*$43.92*	*$4.32*	*$24.48*	*$44.64*	*$42.48*	*$27.36*	*$17.64*
Indirect costs											
Fixed or one off per herd	*$0.00*										
Total indirect costs - high	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*
Total indirect costs - moderate	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*
Total indirect costs - low	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*	*$0.00*
Production/financial losses											
Live weight permanent loss - high	$1,734.00	$2,371.50	$1,816.88	$1,415.25	$2,333.25	$90.00	$1,734.00	$3,162.00	$3,009.00	$1,938.00	$1,249.50
Live weight permanent loss - moderate	$188.83	$258.26	$197.86	$154.12	$254.09	$29.70	$188.83	$344.34	$327.68	$211.05	$136.07
Live weight permanent loss - low	$17.34	$23.72	$18.17	$14.15	$23.33	$9.00	$17.34	$31.62	$30.09	$19.38	$12.50
Live weight temporary loss - high	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Live weight temporary loss - moderate	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Live weight temporary loss - low	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total weight loss - highly affected	*$1,734.00*	*$2,371.50*	*$1,816.88*	*$1,415.25*	*$2,333.25*	*$90.00*	*$1,734.00*	*$3,162.00*	*$3,009.00*	*$1,938.00*	*$1,249.50*
Total weight loss - moderately affected	*$188.83*	*$258.26*	*$197.86*	*$154.12*	*$254.09*	*$29.70*	*$188.83*	*$344.34*	*$327.68*	*$211.05*	*$136.07*
Total weight loss - lowly affected	*$17.34*	*$23.72*	*$18.17*	*$14.15*	*$23.33*	*$9.00*	*$17.34*	*$31.62*	*$30.09*	*$19.38*	*$12.50*
Regulatory cost											
Fixed	$0										
Variable	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0

Discount on value of affected animals sold											
Discounted value sales - highly affected	$0.00	$0.10	$0.07	$0.04	$0.18	$0.01	$0.00	$0.01	$0.16	$0.11	$0.14
Discounted value sales - moderately affected	$0.00	$0.03	$0.02	$0.01	$0.06	$0.00	$0.00	$0.00	$0.05	$0.04	$0.04
Discounted value sales - lowly affected	$0.00	$0.01	$0.01	$0.00	$0.02	$0.00	$0.00	$0.00	$0.02	$0.01	$0.01
Value of reproductive wastage											
Reproductive losses - highly affected	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reproductive losses - moderately affected	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Reproductive losses - lowly affected	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Value of mortality losses											
Mortality losses (direct) - highly affected	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Mortality losses (direct) - moderately affected	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Mortality losses (direct) - lowly affected	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Product devaluation losses											
Discount on hide/skin value - highly affected	$0.00	$6.15	$5.17	$2.95	$14.10	$0.66	$0.00	$0.74	$11.48	$8.53	$10.82
Discount on hide/skin value - moderately affected	$0.00	$2.03	$1.70	$0.97	$4.65	$0.22	$0.00	$0.24	$3.79	$2.81	$3.57
Discount on hide/skin value - lowly affected	$0.00	$0.62	$0.52	$0.30	$1.41	$0.07	$0.00	$0.07	$1.15	$0.85	$1.08
Discount on carcase value - highly affected	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Discount on carcase value - moderately affected	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Discount on carcase value - lowly affected	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00
Total indirect costs - highly affected	$0.00	$6.25	$5.24	$2.99	$14.28	$0.66	$0.00	$0.75	$11.64	$8.63	$10.96
Total indirect costs - moderately affected	$0.00	$2.06	$1.73	$0.99	$4.71	$0.22	$0.00	$0.25	$3.84	$2.85	$3.62
Total indirect costs - lowly affected	$0.00	$0.63	$0.52	$0.30	$1.43	$0.07	$0.00	$0.08	$1.16	$0.86	$1.10

TOTAL - AFFECTED HERD	Total	Per head
Highly affected	$26,941.19	$33.93
Moderately affected	$3,857.87	$4.86
Lowly affected	$557.58	$0.70
TOTAL - INDUSTRY SECTOR LEVEL (PER HERD)	$4,790.33	$6.03
TOTAL - REGIONAL SECTOR LEVEL	$94,575,455	

Gain from better control	Total	Per head
Highly affected	$26,383.61	$33.23
Moderately affected	$3,300.30	$4.16
INDUSTRY SECTOR GAIN (PER HERD)	$4,288.51	$5.40
POTENTIAL INDUSTRY SECTOR GAIN	$84,668,070	