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Animal Health Australia

Report quantifying the benefits and costs of E-Surveillance

Sheep and goats

March 2009

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List of Acronyms

AHA	Animal Health Australia
AMIC	Australian Meat Industry Council
AMPC	Australian Meat Processor Corporation
ANZFRMC	Australia and New Zealand Food Regulation Ministerial Council
AQIS	Australian Quarantine and Inspection Service
BCA	Benefit Cost Analysis
HACCP	Hazard Analysis Critical Control Point
MLA	Meat & Livestock Australia
NLIS	National Livestock Identification System
NSHMP	National Sheep Health Monitoring Program
OJD	Ovine Johne's disease
PIC	Property Identification Code
RFID	Radio Frequency Identification Device
SAFEMEAT	Safe Meat (Australia's Meat Safety System)
SCA	Sheepmeat Council of Australia

Executive Summary

GHD Hassall completed a benefit cost analysis of the potential implementation of an E-Surveillance system on the small stock chain of Australian abattoirs. For this project, the description given to E-Surveillance is the process of collecting and recording information on carcases and offal during the abattoir meat inspection process using computer-based systems, with the information made available to producers, processors and animal health authorities to improve farm productivity and market access.

Ten important diseases/conditions of sheep, goats and lambs detectable by routine meat inspection processes were chosen for the study. The economic losses of these, to both the producer and processor sectors, were calculated using disease prevalence and carcase condemnation data, as well as via a survey of selected abattoirs. The financial benefits to farmers and processors of managing the diseases/conditions on-farm were calculated.

A benefit cost ratio (BCR) of 3.3 was calculated for an E-Surveillance system for the 10 diseases/conditions. Both sensitivity and threshold analyses provide confidence in the assessment that there would be net benefits to the industry. Particular findings include:

- Most (80%) of the benefits of the system would be gained by producers. This compares to 86% of the costs of the disease being borne by producers which suggests there may subsidisation of processor benefits by producers implementing on-farm preventive measures.
- Demonstration of the financial impacts on typical processors, by size, shows the benefit of economies of scale. Larger processors are expected to gain net financial benefits from the introduction on an E-Surveillance system while medium to small processors may not.

An E-Surveillance system relies on the introduction of trial-proven RFID technology and touch-screen collection pads in small stock abattoirs. It also relies on producers electronically accessing data on the disease/condition status of their slaughter animals and applying remedial management in their flocks to reduce both on-farm and slaughter losses. Assumptions on the costs of establishing the system and improved management adoption rates are included in the analysis.

Current impediments to the implementation of an E-Surveillance system are discussed, with the need to maintain existing chain speeds in abattoirs and the complexity of handling mixed mobs in the absence of individual animal identification devices prominent. Also important is the equivalence of the meat inspection data between abattoirs with varying capacities, species mixes and market requirements. Other considerations revolve around the regional and seasonal differences in disease prevalence and how this can be best accommodated within a system.

Acknowledgements

GHD Hassall would like to thank the processors who responded to the survey and provided confidential information on their operations so that the costs and benefits of E-Surveillance could be more accurately considered. Many of these processors provided information on the practical issues of an E-Surveillance system and their insights have contributed to our understanding of its potential operation.

GHD Hassall would also like to thank the various agencies and individuals who supplied data on a range of issues without which our analysis would not have been possible.

1. Introduction and Terms of Reference

1.1 Purpose

GHD Hassall was contracted by Animal Health Australia (AHA) to assess the benefits and costs of 'E-Surveillance' for the sheep and goat industries. The term E-Surveillance describes the process of collecting and recording information on carcases and offal during the abattoir meat inspection process using computer-based systems.

It is proposed that the information collected would be available to provide feedback to processors, producers and government agencies including animal health authorities to improve production and utilisation efficiency. It is considered that the collection of data for a range of endemic diseases and conditions of wastage in sheep and goats in Australia has the potential to improve farm productivity, inform strategic decision making about animal health priorities, and to expand the surveillance data currently collected.

1.2 Background

The E-Surveillance project was developed by a range of producer and processor organisations and animal health authorities, and resulted in the formation of a Coordinating Group convened by AHA to guide its development and implementation.

E-Surveillance potentially provides a fast, efficient and cost-effective means of recording, reporting and disseminating information to relevant stakeholders using computer-based technologies. This in turn has the potential to: improve farm and processor productivity; support maintenance and access to international markets; and expand the surveillance data currently available to inform animal health management decisions.

A number of projects on abattoir surveillance and reporting of disease conditions to producers have been completed in Australia[1]. The results have indicated benefits to the producing sector but no benefit-cost analysis for the whole supply chain has been completed.

Currently abattoir surveillance in sheep comprises:

- the national ovine Johne's disease (OJD) surveillance program conducted in selected abattoirs
- the National Sheep Health Monitoring Program conducted in selected sheep abattoirs and which reports the prevalence of 22 diseases and/or conditions

[1] [1] a) A pilot study of a sheep health monitoring scheme, Bejnarowicz L.1990. Department of Agriculture. South Australia

b) Enhanced control of caseous lymphadenitis through improved farm management. Report to the Meat Research Corporation. Paton M. 1996 Agriculture Western Australia

- the partial surveillance data relating to animals and carcases condemned at export abattoirs collected by the Australian Quarantine and Inspection Service (AQIS) and reported through its Export Production and Condemnation Statistics (EPACS) database.

The experience gained from these programs, especially the Monitoring Program will provide valuable lessons to possible implementation of an E-Surveillance system.

1.3 Scope

This consultancy considered the concept of E-Surveillance for the sheep and goat industries with a particular requirement to:

- Identify the animal health conditions that cause wastage in abattoirs, loss of production 'on-farm' or affect human health and would be appropriate for inclusion in an E-Surveillance system; and
- Quantify the costs to the supply chain resulting from the presence of these conditions and the likely benefits that will accrue from providing feedback to producers.

1.4 Terms of Reference

The detailed Terms of Reference for the consultancy are as follows:

With respect to the Australian small stock (sheep, lambs & goat) industries,

a) Identify endemic diseases and conditions of sheep and goats, detectable by routine meat inspection processes, which cause economic losses within the production and processing sector, both regionally and nationally;

b) Quantify the costs to the different stages of the small stock sectors' production and processing chain from endemic disease and conditions of economic or human health significance;

c) Identify current impediments to the implementation of an electronic system of data collection;

d) Quantify the likely savings and benefits to stakeholders in each of the production and processing sectors of the sheep and goat industries flowing from the implementation of an E-Surveillance system;

e) Present a draft report to the E-Surveillance Coordinating Group for consideration and comment; and

f) Provide a final report to the E-Surveillance Coordinating Group after comments have been received.

1.5 Funding

This project is funded through the Meat & Livestock Australia (MLA) Donor Company with funds provided by the Australian Meat Processors Council and the Australian red meat and wool producing industries through Animal Health Australia.

1.6 Methodology

The methodology adopted for the consultancy was designed to ensure the terms of reference were completed. Progress was monitored by AHA and a Coordinating Group that also had input to a number of decisions. Members of the Coordinating Group were:

- Lorna Citer, AHA;
- Carol Sheridan, Australian Quarantine and Inspection Service (AQIS);
- Christian Mulders, Australian Meat Industry Council (AMIC);
- John McGuren, Australian Meat Processors Council (AMPC);
- Ian Jenson, Meat & Livestock Australia (MLA); and
- Maria Butler, Sheepmeat Council of Australia (SCA).

GHD Hassall met with the Coordinating Group for a project inception meeting on 26 September 2008 with correspondence afterwards by email and phone.

The benefit cost calculations were completed using data that was collected from a number of sources. Because of the widely varying conditions that operate at individual farm and processor levels, it was necessary to make a number of assumptions on the potential benefits and costs expected from E-Surveillance. These assumptions are documented within the report.

Additional data was obtained from a selection of processors using a questionnaire (see Appendix A) and one abattoir was inspected so that the practical implementation of E-Surveillance could be considered.

Discussions were also held with other people having relevant industry experience to ensure the accuracy of the assumptions used in the analysis.

2. Context of E-Surveillance

2.1 Slaughter numbers

The E-Surveillance project was completed within the context of the processing of sheep, lambs and goats at export and domestic abattoirs throughout Australia. Annual throughput at abattoirs, of sheep, lambs and goats, is shown in Table 1.

Note that information for goats is not readily available and is reported at a national level for one year only.

Total annual slaughter is more than 12 million sheep, about 20 million lambs and 1.1 million goats. The majority of sheep and lambs (75% and 61% respectively) are slaughtered in AQIS-accredited export works.

It is acknowledged that sheep and lamb population numbers in Australia have declined from their peaks in the 1990s but total annual sheep and lamb slaughters have remained relatively consistent over that time. For this reason we have chosen to conduct this study using average slaughter numbers over the last three years.

Table 1 Annual throughput at abattoirs

Slaughters	2005/06			2006/07			2007/08			3-year average		
	Sheep	Lambs	Goats	Sheep	Lambs	Goats	Sheep	Lambs	Goats	**Sheep**	**Lambs**	**Goats**
National	11,829,689	18,665,621	n/a*	13,271,161	20,158,344	1,120,000	11,928,599	20,899,067	n/a	**12,343,150**	**19,907,677**	**n/a**
AQIS-accredited	8,475,173	11,689,380	n/a	9,692,648	12,234,757	n/a	9,592,931	12,400,944	n/a	**9,253,584**	**12,108,360**	**n/a**
Domestic	3,354,516	6,976,241	n/a	3,578,513	7,923,587	n/a	2,335,668	8,498,123	n/a	**3,089,566**	**7,799,317**	**n/a**

Source: MLA Market Statistics Database, AQIS, and GHD Hassall's own calculation. *n/a- not available

2.2 Meat inspection

Export and domestic abattoirs adopt a range of animal and meat inspection procedures to ensure the production of wholesome meat and meat products for human consumption. Inspection procedures are conducted under guidelines contained in the "Australian Standard for the hygienic production and transportation of meat and meat products for human consumption" approved by the Australia and New Zealand Food Regulation Ministerial Council (ANZFRMC).

The Standard harmonises standards for the production and transportation of meat and meat products (offal) within Australia regardless of whether the products are for export or domestic use. The prime objective of the Standard is to ensure that meat and offal comply with food safety requirements and that product not meeting the standards are removed from the food chain and dealt with separately.

The Standard is based on a shared responsibility between industry and governments for food safety such that management and production practices have an emphasis on risk assessment and risk management through a hazard analysis critical control point (HACCP) approach (p. iv of the Standard).

For export works, inspection systems are staffed and overseen by the Australian Quarantine and Inspection Service (AQIS) while additional company inspectors are employed to ensure product quality.

For domestic works, processors employ their own company meat inspectors under guidelines provided by the relevant state-based food safety authority.

Inspectors conduct pre- and post-slaughter inspections, and provide a daily report to the abattoir's livestock manager.

Export abattoirs can have specific AQIS inspectors for each of the following:

- Carcases;
- Offal;
- Retains (where trimming of carcases occurs); and
- OJD.

Inspectors are supervised by an on-plant veterinary officer (OPVO) at all times.

2.3 Issues of disease in the Australian sheep and goat sectors

2.3.1 Broad overview

The SAFEMEAT Committee, a partnership of the Australian government and industry, has stated the following:

> *When customers purchase beef or sheepmeat products from Australia they are receiving product from one of the most stringently controlled meat industries in the world. Independently audited systems are in place throughout the supply chain, from animal production to transport, processing and export.*
>
> *Healthy livestock are the basis for Australia's broad market access and high productivity. As an island, Australia has a natural barrier to animal and crop disease.*
>
> *Australia has an internationally acknowledged status of being free of all major epidemic diseases of cattle and sheep (SAFEMEAT, undated, "Well Red").*

There are, however, a number of endemic diseases of sheep and goats which reduce farm-based productivity. The on-farm costs of the four costliest diseases for sheep and lambs (internal parasites, flystrike, lice and post-weaning mortality) were estimated to be $848 million per year (MLA, 2006). Additional costs occur during processing at abattoirs if diseased parts of the animal must be removed to prevent them entering the human food chain (Paton, 1994).

There are many diseases which are not obvious on-farm and where examination of the carcase and viscera during abattoir processing is the most effective method of detection. Some of these diseases (eg hydatids) may affect human health.

The analysis in this report provides an estimate of the extent of losses due to abattoir detectable diseases and conditions at:

(i) **the farm level** where diseases and conditions reduce growth rates, wool cut, fibre quality and in some instances reproduction rate; and,

(ii) **at the abattoir level** where diseases and conditions result in visible carcase lesions requiring the inspection, trimming, condemnation and classification of lesions to enable sale of suitable quality meat (and offal) for domestic consumption and export (Bejnarowicz, 1990).

The benefits of preventive management of diseases and conditions at the farm level to productivity at farm and abattoir levels are calculated.

2.3.2 Sheep and lamb diseases affecting livestock production

MLA (2006) assessed the economic cost of endemic disease on the profitability of Australian sheep producers. The costs included the reduced income from flocks as a result of productivity losses including reduction in: fleece weight and quality; liveweight gains; and reproduction. Increased expenses as a result of the disease were also calculated including costs of: drenches, vaccines, supplementary fodder and labour for husbandry activities.

Many of the diseases in the MLA study are readily identifiable on-farm (eg footrot, flystrike) and do not require detection at abattoir for corrective husbandry action to be taken.

For sheep diseases that are either sub-clinical or which are difficult to detect on-farm, the “National Sheep Health Monitoring Program (NSHMP) – Other Conditions” project monitored 22 diseases or conditions at a range of abattoirs. The project was established in conjunction with the ovine Johne’s disease (OJD) abattoir surveillance project.

The NSHMP project involves existing AQIS abattoir meat inspectors recording prevalence of the 22 diseases and conditions of sheep by estimating the percentage of affected lines and the percentage of affected animals within affected lines. Prevalence data was not collected for lambs.

The data for the period July 2007 to June 2008 for each disease and condition in individual animals is shown in Table 2, while prevalence estimates for lines of sheep are shown in Appendix B.

Both tables show that prevalence varies by state. For example, liver fluke is present in close to 10% of sheep in NSW, is absent in WA and is recorded as having prevalence of less than 1% in SA and Queensland. Other data from the NSHMP also show that prevalence varies by season.

This variability in prevalence is important when considering abattoir detection and feedback to producers but this level of detail is beyond the scope of this study. This study has considered average national prevalence levels only.

Some diseases and conditions selected for this project do not have prevalence data from the NSHMP; nor was it available from carcase condemnation data supplied by AQIS (see Section 2.3.3). Estimates of prevalence of these diseases and conditions were obtained from alternative sources and consultation.

Table 2 Prevalence of diseases and conditions in sheep, NSHMP 2007/08 – estimated % of affected animals

Disease / condition	NSW (%)	QLD (%)	SA (%)	TAS (%)	VIC (%)	WA (%)	National (%)
Bladder worm	18.48	4.01	31.26	1.91	32.26	40.86	**20.40**
Liver fluke	9.66	0.49	0.30	7.75	1.96	0.00	**7.44**
Pleurisy / pneumonia	4.79	2.29	9.15	0.00	5.27	9.09	**5.03**
Cheesy gland	4.38	4.53	6.94	11.16	3.55	3.19	**4.38**
Sheep measles	4.19	0.75	5.12	5.42	4.88	6.67	**4.20**
Melanosis	0.36	3.71	0.00	0.00	0.00	0.00	**0.52**
Lungworm	0.00	0.00	11.79	0.00	0.00	0.00	**0.42**
Sarcocystis	0.21	0.01	2.76	0.03	0.71	0.02	**0.32**
Knotty gut	0.29	0.17	0.32	0.00	0.03	0.01	**0.24**
Arthritis	0.03	0.41	2.25	0.00	0.06	0.00	**0.13**
Hydatids	0.16	0.12	0.00	0.00	0.06	0.01	**0.13**
Cancer	0.13	0.05	0.13	0.02	0.09	0.07	**0.12**
OJD vaccine lesions	0.13	0.00	0.19	0.00	0.02	0.00	**0.10**
Other vaccine abscesses	0.08	0.09	0.00	0.00	0.00	0.00	**0.07**
Emaciation	0.01	0.00	0.07	0.01	0.00	0.00	**0.01**
Fever/ septicaemia	0.00	0.01	0.06	0.00	0.00	0.00	**0.01**
Jaundice	0.00	0.00	0.02	0.01	0.04	0.00	**0.01**

Source: National Sheep Health Monitoring Program, 2008. Anaemia, bruising, dog bites, grass seeds, worms (general) are also listed as part of the program however no recorded data is available.

2.3.3 Issues of disease in Australian livestock processing

For sheep, lamb and goat carcases and carcase products (offal) that do not meet the Australian Standard, product is condemned from human consumption. Depending on the degree to which carcase and offal are affected, product is either fully or partially condemned by meat inspectors. Where carcases are partially condemned they are diverted to the 'retain' rail where meat inspectors remove the condemned product. Condemned product is diverted to the rendering process to be manufactured as meat and bone meal and tallow. There is a consequent reduction in value of product that is recognised in this report.

Condemnation of carcases and offal results in a financial loss to the processor as the value of condemned product is less than that for human consumption. Paton (1994) states that "*buyers of slaughter livestock accommodate this situation, in most cases, by allowing for the losses occurring in the abattoir and paying lower prices to all producers. Producers are therefore not rewarded for producing a quality product and are also not informed of quality deficits in their stock*" (p.6).

AQIS collects meat inspection data from all export abattoirs on the number of sheep and lamb carcases wholly condemned for human consumption. Condemnations are recorded by AQIS for a list of 24 diseases and conditions. It should be noted that there are differences in the lists of diseases and conditions recorded by AQIS and for the NSHMP.

Table 3 shows the annual condemnations for sheep and lambs in export abattoirs based on the 3-year average of data to June 2008. Carcase condemnations total 0.7% of sheep and 0.11% of lambs slaughtered in export abattoirs. Table 3 also shows the individual diseases and conditions responsible for condemnations of sheep and lamb carcases. Emaciation, malignancy and company condemns are most important for sheep, while *Cysticercus ovis* (sheep measles), jaundice and polyarthritis are most important for lambs.

Table 3 Full condemnations for sheep and lambs in export abattoirs, 3-year average to June 2008

Disease / condition	Number of Sheep	% of slaughter	% of disease contribution to condemnations	Number of Lambs	% of slaughter	% of disease contribution to condemnations
Anaemia	97	0.00%	0.15%	6	0.00%	0.05%
At antemortem	986	0.01%	1.53%	215	0.00%	1.68%
Bruising	636	0.01%	0.98%	60	0.00%	0.47%
C. ovis (sheep measles)	1,755	0.02%	2.72%	2,029	0.02%	15.87%
CLA	5,294	0.06%	8.19%	218	0.00%	1.71%
Company condemn	8,664	0.09%	13.40%	926	0.01%	7.24%
Ecchymosis	75	0.00%	0.12%	12	0.00%	0.09%
Emaciation	17,986	0.19%	27.83%	497	0.00%	3.88%
Fever	4,098	0.04%	6.34%	1,215	0.01%	9.50%
Gangrene	136	0.00%	0.21%	38	0.00%	0.30%
Gross contamination	4,176	0.05%	6.46%	1,260	0.01%	9.85%
Hydatids	38	0.00%	0.06%	0	0.00%	0.00%
Jaundice	2,892	0.03%	4.47%	2,712	0.02%	21.21%
Malignancy	8,353	0.09%	12.92%	254	0.00%	1.99%
Metritis	314	0.00%	0.49%	0	0.00%	0.00%
Muscle condition	7	0.00%	0.01%	0	0.00%	0.00%
Other causes	1,645	0.02%	2.54%	447	0.00%	3.50%
Peritonitis	33	0.00%	0.05%	0	0.00%	0.00%
Polyarthritis	1,976	0.02%	3.06%	2,220	0.02%	17.36%
Pyaemia	234	0.00%	0.36%	0	0.00%	0.00%
Sarcosporidia	758	0.01%	1.17%	6	0.00%	0.05%
Septic pneumonia	1,027	0.01%	1.59%	240	0.00%	1.88%
Septicaemia	3,448	0.04%	5.34%	431	0.00%	3.37%
Wounds	7	0.00%	0.01%	0	0.00%	0.00%
Total condemnations	**64,636**	**0.70%**		**12,787**	**0.11%**	
Total slaughters	**9,253,584**	**100%**		**12,108,360**	**100%**	

Source: AQIS

Table 3 includes condemnations from export abattoirs only. In general, state meat inspection authorities do not collect condemnation data from domestic abattoirs.

It is reasonable to assume that the condemnation rate of sheep and lambs slaughtered in domestic abattoirs would be similar to the rate in export abattoirs. On this basis, the number of condemnations of sheep and lamb carcases in all Australian abattoirs is assumed to be as shown in Table 4.

A total of about 86,000 sheep carcases and 21,000 lamb carcases are condemned each year representing about 0.7% and 0.1% of national slaughter numbers respectively.

Table 4 Estimated condemnations for sheep and lambs in Australian abattoirs, 3-year average to June 2008

Disease / condition	Sheep	% of slaughter	% of disease contribution to condemnations	Lambs	% of slaughter	% of disease contribution to condemnations
Anaemia	129	0.00%	0.15%	10	0.00%	0.05%
At antemortem	1,315	0.01%	1.53%	353	0.00%	1.68%
Bruising	848	0.01%	0.98%	99	0.00%	0.47%
C. ovis (sheep measles)	2,341	0.02%	2.72%	3,335	0.02%	15.87%
CLA	7,062	0.06%	8.19%	359	0.00%	1.71%
Company condemn*	11,556	0.09%	13.40%	1,522	0.01%	7.24%
Ecchymosis	100	0.00%	0.12%	20	0.00%	0.09%
Emaciation	23,992	0.19%	27.83%	817	0.00%	3.88%
Fever	5,466	0.04%	6.34%	1,997	0.01%	9.50%
Gangrene	181	0.00%	0.21%	63	0.00%	0.30%
Gross contamination	5,570	0.05%	6.46%	2,072	0.01%	9.85%
Hydatids	51	0.00%	0.06%	0	0.00%	0.00%
Jaundice	3,858	0.03%	4.47%	4,459	0.02%	21.21%
Malignancy	11,142	0.09%	12.92%	418	0.00%	1.99%
Metritis	419	0.00%	0.49%	0	0.00%	0.00%
Muscle condition	9	0.00%	0.01%	0	0.00%	0.00%
Other causes	2,194	0.02%	2.54%	735	0.00%	3.50%
Peritonitis	44	0.00%	0.05%	0	0.00%	0.00%
Polyarthritis	2,635	0.02%	3.06%	3,651	0.02%	17.36%
Pyaemia	313	0.00%	0.36%	0	0.00%	0.00%
Sarcosporidia	1,011	0.01%	1.17%	10	0.00%	0.05%
Septic pneumonia	1,370	0.01%	1.59%	395	0.00%	1.88%
Septicaemia	4,600	0.04%	5.34%	709	0.00%	3.37%
Wounds	9	0.00%	0.01%	0	0.00%	0.00%
Total condemnations	**86,216**	**0.70%**	**100%**	**21,023**	**0.11%**	**100%**
Total slaughters	**12,343,150**			**19,907,677**		

Source: GHD Hassall calculation based on MLA and AQIS data

* Condemned by company employees prior to carcasses being inspected by AQIS staff. Various reasons for condemnation including unacceptable slaughter condition, falls from slaughter chain etc.

Table 4 is for the number of whole carcase condemnations and does not provide information on partial carcase condemnations or on offal condemnations. These two additional, unreported sources of loss are reported to be significant and need to be considered in relation to the benefits and costs of an E-Surveillance system.

It should however be noted that reduced recovery of offal is not only due to condemnations by meat inspectors. MLA (2008) reported that labour issues are a major cause of reduced offal collection stating that "at some locations lack of labour meant that offal collection was the first job dropped off in favour of continuing slaughter-floor activities…the lowest value products or highest labour input products were the first to go" (p. 3).

Appendix C provides 3-year average goat carcase condemnations (skin off and skin on respectively), in AQIS export abattoirs. Condemnations are approximately 1% of slaughter numbers in both instances. Company condemnations, fever and gross contamination are the major reasons for condemnations.

2.3.4 Comparison of disease and condition lists

As noted above, the list of diseases and conditions reported by AQIS and the NSHMP project differ. The major reason for the difference is that the list for NSHMP was primarily designed for those diseases and conditions which could be managed by producers to improve on-farm productivity or more directly reduce losses at the abattoir level. It is also likely that some diseases and conditions may have different names but refer to the same condition (eg wounds and dog bites).

Ten diseases and conditions have been selected for this analysis to demonstrate the benefits and costs associated with the introduction of an E-Surveillance system. The diseases and conditions from both lists (AQIS and NSHMP) were considered for inclusion.

2.3.5 Selection of diseases and conditions

The criteria used by Bejnarowicz (1990) were used to select the 10 diseases and conditions to be included in the analysis, with priority given to diseases and conditions which were:

- of economic importance (at both abattoir and producer levels);
- of zoonotic (transferable to humans) importance;
- readily detectable visually; and
- amenable to reduction through prevention or treatment.

The selection process included input by the Coordinating Group and is fully described in Appendix D. The process resulted in the list of 10 diseases and conditions shown in Table 5. Table 5 provides a general description of each disease/condition, why it is a problem, and information on diagnosis and prevention. These 10 diseases provide the basis for the analysis starting in Chapter 5.

Table 5 Top 10 diseases/conditions

Disease/Condition	Description	Why is it a problem	Diagnosis	Prevention
Liver fluke (*Fasciola hepatica)*	Liver flukes damage the liver. They have a life-cycle involving certain species of snail. Their intermediate stages emerge from snails and infest water logged vegetation which if grazed by sheep results in liver fluke infestation.	On-farm, production losses can be severe associated with illthrift, reduced wool production and deaths. Liver fluke can predispose to black disease in unvaccinated sheep. At slaughter, scarring of the liver caused by migrating and mature flukes require livers to be condemned.	Symptoms include anaemia, illthrift, oedema and death. Damaged livers are readily seen at slaughter. Microscopic examination will find eggs in faeces and a serological test (ELISA) is available for flock diagnosis.	Sheep are treated one to three times per year with a drench such as triclabendazole to prevent acute and chronic infections and the output of fluke eggs for development of future disease. Additional management of grazing and snail habitat may be cost-effective on some farms.
Pleurisy-pneumonia	Pneumonia is an inflammation of the lungs caused by a variety of agents, most often bacteria viruses, and lung worms and sometimes from inhaling improperly administered oral drenches. Pleurisy usually accompanies severe pneumonia when extensive inflammation causes the lungs to adhere to the chest wall.	On-farm, production losses are associated with illthrift and deaths. At slaughter, if pneumonia is present, lungs are condemned; if there is extensive pus or multiple abscesses, the carcase and all its parts are condemned. If pleurisy is present, the lungs adhere to the chest and cannot easily be removed. The adhesions must be trimmed but more often, the entire rib cage must be cut out and condemned. If there is pus or fibrin the carcase and all its parts are condemned.	Most affected sheep show no symptoms. Severely affected sheep are often found dead. Some sheep may cough, have respiratory distress or low exercise tolerance. Persistent coughing may cause rectal prolapse.	A veterinary investigation will be required to differentiate the cause of pleuro-pneumonia. The pleuro-pneumonia associated with bacteria and viruses can be reduced by minimising stress particularly stress associated with mustering and transport. Major risk factors include exhaustion, overcrowding, sudden temperature and humidity fluctuations and mixing of lines of sheep from different origins. Minimise skin injuries and increase hygiene at shearing, dipping and marking to reduce the CLA and other lung abscesses that can develop into focal pleuro-pneumonia. CLA vaccination is recommended. Improve drenching technique and parasite control to prevent aspiration and lungworm pneumonias, respectively.
Bladder worm (*Cysticercus tenuicollis*)	Bladder worms are the cystic intermediate stages of the tapeworm, *Taenia hydatigena*. The cysts contain clear jelly-like fluid loosely attached to the surface of the liver, mesentery and abdominal wall. The tapeworms live in the intestine of dogs and dingoes. Sheep become infested by grazing pasture contaminated with faeces from dogs or dingos.	There are no on-farm production losses. At slaughter, cysts and affected membranes are trimmed from carcases or carcase parts (mainly liver) and condemned. Livers with scarring from migratory stages are condemned.	In live sheep there are no clinical symptoms, no simple method of diagnosing infection and no treatment available.	Don't feed viscera from sheep to dogs. Promptly dispose of dead sheep to prevent scavenging by dogs and dingoes. Stop stray or wild dogs defecating on pastures by baiting, trapping, fencing or guardian animals such as alpacas or Maremma dogs.

Disease/Condition	Description	Why is it a problem	Diagnosis	Prevention
Sheep measles (*Cysticercus ovis*)	Sheep measles is caused by the intermediate cystic stages of the tapeworm, *Taenia ovis* and manifest as small, whitish, soft cysts or gritty nodules found at slaughter in the heart, muscle or diaphragm of some sheep. The parent tapeworms live in the intestine of dogs and sometimes foxes. Sheep become infested by grazing pasture contaminated with faeces from a dog or fox.	There are no on-farm production impacts. At slaughter, with light infestations, carcases may require heavy trimming. In general infestations where more than five cysts are found in meat, the carcase is condemned.	There are no outward signs of ill health, no simple method of diagnosing the infections in live animals and no treatment for infected sheep.	Don't feed raw meat including hearts from sheep to dogs. Promptly dispose of dead sheep to prevent scavenging by dogs and foxes. Stop stray or wild dogs and foxes defecating on pastures by baiting, trapping, fencing or using guardian animals such as alpacas or Maremma dogs. Domestic dogs should be treated regularly for tapeworms.
Cheesy gland (Caseous lymphadenitis - CLA)	Cheesy gland is caused by the bacterium, *Corynebacterium pseudotuberculosis.* Infection is acquired via skin injuries. Most spread is thought to occur at shearing when sheep with lung abscesses cough or breathe onto sheep with fresh skin cuts. Spread may also occur during plunge or shower dipping.	On-farm, cheesy gland infection causes illthrift and reduced wool production, particularly in older sheep. At slaughter, where there is general involvement in carcase and viscera with evidence of systemic effects such as emaciation, the carcase is condemned. With less extensive distribution of lesions, the affected carcase and carcase parts are condemned.	Infection typically causes the development of abscesses in lymph nodes throughout the body. There is no effective treatment for cheesy gland.	Vaccinate lambs twice at an interval of four to six weeks. Give sheep a yearly booster, ideally a month or so prior to shearing. Improve hygiene during husbandry operations such as shearing and marking where skin injuries occur.
Arthritis	Arthritis is an inflammation of one or more joints, affecting sheep of any age. There are a number of causes including bacteria such as erysipelas, chlamydia and mycoplasma, pyogenic bacteria associated with skin injuries and rickets associated with vitamin D deficiency.	On-farm, arthritis causes illthrift and deformed or crippled animals may be rejected at sale. At slaughter, animals showing chronic arthritis in multiple limbs with cachexia and loathsome appearance are condemned. Otherwise, affected joints are condemned.	Lameness, swollen joints or deformed limbs are indicative of arthritis. Treatment with high doses of long acting antibiotics may be warranted in individual animals of high value however on a flock basis treatment is usually not cost effective. Vitamin D injections may assist some early cases where vitamin D deficiency is causal.	A veterinary investigation will be required to differentiate the cause of arthritis. There are a number of preventative options depending on cause. Mark lambs in temporary yards at new sites each season disinfect instruments frequently. Consider pre-mating vaccination of ewes against erysipelas to protect their lambs. Consider administering vitamin D injections to lambs grazing cereal crops in winter.

Disease/Condition	Description	Why is it a problem	Diagnosis	Prevention
Hydatid tapeworm (*Echinococcus granulosus*)	Hydatid disease is caused by the cystic intermediate stages of the tapeworm *Echinococcus granulosus*. The hydatid tapeworm lives in the intestine of dogs, foxes and dingoes. Sheep become infected by grazing pasture contaminated with dog, dingo or fox faeces bearing the tapeworm eggs.	On-farm there are no production losses except rarely in heavily infested older sheep which will show illthrift. Sheep, cattle, goats, pigs, kangaroos, wallabies and humans can become infected with hydatid cysts. Hydatid disease is potentially fatal in humans. At slaughter, cysts are usually found in the offals, mainly liver and lungs; affected organs are condemned.	Infected animals rarely show signs, and diagnosis in live animals is not attempted. Sheep are not treated.	Don't feed offal including lungs from sheep to dogs. Promptly dispose of dead sheep to prevent scavenging by dogs and foxes. Stop stray or wild dogs and foxes defecating on pastures by baiting, trapping, fencing or using guardian animals such as alpacas or Maremma dogs. Treat domestic dogs with praziquantel every six weeks.
Grass seeds	The main grasses that can cause grass seed problems in sheep are barley grass, wild geranium (Erodium), wire grass, brome grass, Chilean needle grass, silver grass and spear grass. These grasses cause problems when the seed is mature. Infestation is most severe when seasonal conditions favour high seed production or long retention of seed.	On-farm, sheep with heavy seed infestations, will become illthrifty because of chronic pain causing reluctance to graze and walk. Common are mouth injuries, blindness, lameness and secondary infections especially after dipping. At slaughter, grass seeds are a major cause of damage to and downgrading of wool and skins. They also present a major problem for hygienic meat production and require extensive trimming. Carcases with general signs such as fever or sepsis are condemned.	Affected sheep may be illthrifty, lame, reluctant to move or blind. Grass seed puncture wounds predispose to other diseases including scabby mouth, CLA, tetanus, malignant oedema, erysipelas, footrot and flystrike. Shearing may be of some value.	There are a number of options to reduce grass seed infestation: Prepare suitable pastures for lambs by heavy grazing or herbicide application. Match time of lambing more closely to pasture growth. Use feedlots, specialty crops or lucerne during high risk periods. Shear in advance of the grass seed season.
Ovine Johne's disease (OJD)	Ovine Johne's disease (OJD) is a chronic wasting disease caused by the bacterium *Mycobacterium paratuberculosis*. The bacterium causes inflammation and thickening of the intestinal wall, reducing absorption of nutrients leading to illthrift and death. Infected sheep shed the bacteria in their faeces. Sheep become infected by grazing contaminated pastures or drinking from contaminated dams.	On-farm, OJD can cause illthrift and mortalities. At slaughter, intestines are condemned (they are unsuitable for sausage casings), emaciated carcases and discoloured livers are condemned.	Infected sheep are usually asymptomatic for months or years before becoming illthrifty. Diagnosis in live animals is not simple, requiring faecal culture and serology, which are available for flock but not individual animal diagnosis. Abattoir surveillance of culled sheep is a practical and cost-effective means of detecting the disease. No treatments are available	Control is by vaccination and grazing management which can reduce deaths and shedding to negligible levels after a 10-15 year program.

Disease/Condition	Description	Why is it a problem	Diagnosis	Prevention
Nephritis	Nephritis is inflammation of the kidneys and may be caused by bacterial infections (entering the blood stream from infected skin injuries), poisonous plants and urinary calculi (bladder and kidney stones).	On-farm, nephritis associated with urinary calculi or poisonous plants may cause illthrift and death but in many cases there is no affect on production. Nephritis may manifest as white spots on the kidney, where bacterial damage has occurred after infection has entered the blood stream from skin injuries. These infections are usually asymptomatic. At slaughter, the kidneys are condemned.	Affected sheep may show various signs of sickness or no signs at all depending on the cause. Sheep may die shortly after eating poisoned plants or suffering blockages from calculi but some will recover and their kidneys will be discoloured or misshapen when examined at abattoir. Treatment is rarely undertaken.	A veterinary investigation will be required to differentiate the cause of nephritis. Change the diet if urinary calculi or poisonous plants are involved. Minimise skin injuries and their infection if bacterial infections are involved.

Adapted from:

1. Fletcher International WA and Meat & Livestock Australia (2002) "A partnership for growth in Western Australia - A guide to improving performance and increasing value through a partnership with Fletcher International WA"; and,

2. “Australian Standard for the hygienic production and transportation of meat and meat products for human consumption” FRSC Technical Report No. 3 AS4696: 2007.

3. Sheep, lamb and goat abattoirs in Australia

3.1 Type and number of abattoirs

Table 6 is an estimate of the number of abattoirs slaughtering sheep, lambs and goats in Australia. This data was extracted from Australian Meat Processor Corporation (AMPC) data and may be incomplete as it includes only those abattoirs with AMPC membership. The data does not indicate whether abattoirs are licensed for export or domestic operations.

According to the data, there are 12 large sheep- and/or lamb-only abattoirs (with an estimated 1.2 million slaughters per year per enterprise), one small goat-only abattoir and 25 large mixed abattoirs (estimated at 500,000 sheep and lamb slaughters per year per enterprise). Mixed abattoirs refer to multi-species abattoirs which may include cattle, sheep, lambs and goat slaughtering. There are 74 small mixed abattoirs (estimated at 200,000 sheep and lamb slaughters per year per enterprise) with almost half of these located in Queensland. It has been estimated that approximately half of these latter abattoirs specialise in cattle slaughters and are not slaughtering any sheep or lambs. Therefore, the estimated number of Queensland abattoirs (and hence total abattoirs) has been revised downwards (from 35 to 18). There are no small abattoirs exclusively slaughtering sheep and lambs.

Table 6 Number of abattoirs in Australia slaughtering sheep, lambs &/or goats

	Large (sheep only)	Medium (mixed large)	Small (mixed small)	Goat small	Total
NSW	8	4	8	0	20
NT	0	0	0	0	0
QLD	0	2	18	0	20
SA	0	3	9	0	12
TAS	0	0	2	0	2
VIC	3	11	12	1	27
WA	1	4	6	0	11
State unknown	0	1	2	0	3
Total	**12**	**25**	**57**	**1**	**95**

Source: AMPC, and GHD Hassall estimate based on AMPC data

3.2 Survey of selected abattoirs

A survey of selected abattoirs was completed to gain further information on their operations with specific reference to carcase and offal condemnations. Information on their operating costs was also obtained so that any costs associated with the introduction of an E-Surveillance system could be considered in comparison to their total costs. Table 7 provides a summary of some typical characteristics of sheep and lamb abattoirs based on consultation with six large export abattoirs and five large domestic abattoirs. The questionnaire used during this consultation is available at Appendix A.

On the basis of the survey, carcase condemnations were estimated at about 1.6% and 0.3% for export and domestic abattoirs respectively. It is likely that this is a reflection of the higher proportion of lambs slaughtered in domestic works and the lower condemnation rate of lamb carcases.

For export abattoirs, the 1.6% estimate for the proportion of carcase condemnations compares to the AQIS condemnation rates of 0.7% for sheep and 0.11% for lambs (from Table 3). The most likely reason for this difference is that the AQIS data refers to full carcase condemnations only and does not include partial condemnation of product as a result of trimming.

Discussion with processors indicated that as a 'rule of thumb' for each carcase totally condemned a further 30 carcases are trimmed for that disease/condition, and for each trimmed carcase an average of 2.5kg of carcase weight is condemned.

Offal condemnations are estimated at 5% and 10% respectively for export and domestic abattoirs. It should be noted that offal condemnations are not solely the result of disease but may be due to a shortage of labour (see section 2.3.3).

The annual operating costs of export abattoirs averaged about $23 per head slaughtered compared to $31 for domestic abattoirs. The difference is likely to be as a result of the economies of scale achieved in the larger export abattoirs (1.7 million annual throughput) compared to the domestic works (600,000 annual throughput). The throughput of surveyed abattoirs is not related to the categorisation of abattoirs by size in section 3.1

Table 7 shows survey respondent estimates of the additional capital and annual operating costs to abattoirs of introducing an E-Surveillance system. The operating costs were estimated to be about 0.15% or less of total annual operating costs.

Table 7 Abattoir characteristics – *averages based on survey*

	Export abattoir		Large domestic abattoir	
Annual sheep slaughter (head)	887,095		42,382	
Annual lamb slaughter (head)	767,539		584,410	
Annual production of offal for human consumption (kg)	1,771,047		320,614	
Annual production of offal for pet food (kg)	272,497		253,613	
Annual production of rendering material (kg)	6,548,768		1,489,822	
Average price of offal for human consumption ($/kg)	$1.47		$2.10	
Average price of offal for pet food ($/kg)	$0.33		$0.30	
Average price of offal as meat meal [a] ($/kg)	$0.07		$0.16	
Proportion of carcase condemnations as a percentage of total production	1.56%		0.30%	
Proportion of offal condemnations as a percentage of total offal production	5%		10%	
Average annual operating costs	**$**	**% range of costs**	**$**	**% range of costs**
Labour	21,387,004	42-70	9,251,983	49-85
Admin	3,228,478	1-12	1,278,766	1-10
Surveillance / Accreditation [b]	461,223	0-5	122,528	0-2
Effluent management	275,568	0-4	160,300	0-2
Maintenance	1,954,854	4-10	704,831	2-15
Other [c]	10,872,724	12-48	8,180,394	0-45
Total	38,179,850	100	19,698,802	100
Number of inspectors (FTE)	10		5	
Number of OPVOs [d] (FTEs)	2		0	
Estimate of changes to costs if E-Surveillance is introduced	**$**	**% change**	**$**	**% change**
a. Annual operating costs (% change or $)	60,000	1%	18,333	0%
b. Capital costs as a result of software upgrade, touch screen, etc	135,000		50,000	

Notes: [a] internal transfer price, [b] "Surveillance/Accreditation" was designed to gather data on meat inspection and licensing costs but there may be some variance in the interpretation of this by different processors. [c] "Other" was not defined explicitly and produced large differences between export and domestic abattoirs. [d] On-plant veterinary officers
Some cost and price items were difficult for abattoirs to supply with their limited resources and results may vary from what would normally be expected. For example, it was expected that the average price of offal for human consumption would be higher from export works while the reverse was the case.

4. A proposed E-Surveillance system

4.1 The broad concept

The concept of an E-Surveillance system is for disease or condition information of sheep, lamb and goat carcases and offal at abattoirs to be recorded electronically and stored in a central database for later retrieval by authorised producers, processors, farm advisors and animal health authorities.

As the National Livestock Identification System (NLIS) for sheep and goats is currently based on whole of property identification using visually readable eartags (compared to cattle which have individual electronic devices), it is considered that information will be stored using the Property Identification Code (PIC) of individual slaughter lines.

It is considered that this information will allow the following:

- Producers to adopt management practices to reduce or eradicate diseases and thereby improve productivity and profitability of their flocks;
- Increase the awareness of processors to diseases and conditions that cause waste and reduce profitability within their abattoir(s) and take corrective actions;
- Animal health authorities to monitor diseases and conditions from a food safety perspective and use the information to provide assurance to customers;
- Animal health authorities to monitor trends in prevalence of certain conditions to aid the early detection of new, emerging or exotic diseases;
- Animal health authorities to measure the effects of regional disease control and extension programs; and
- Farm advisors to measure the effectiveness of control programs on client's farms.

4.2 Previous experiences

Bejnarowicz (1990) reported the results of a pilot study of a sheep health monitoring scheme in South Australia. This study used a manual recording system for 14 diseases and conditions of sheep. Meat inspectors used a standardised reporting system whereby information for each carcase was recorded, results collated and information forwarded to co-operating farmers. Farmers also received information on the prevention and control of the diseases.

The above study identified a number of limitations of abattoir surveillance including:

1. The lack of an abattoir trace back system for sheep;
2. The fact that special arrangements were needed to prevent lines of sheep of different origins being mixed (boxed) on road transports and at the abattoirs;
3. The high speed of slaughtering chains limits the pathology that can be visually diagnosed by inspectors; and

4. The use of laboratory confirmation of diseases was not practical or cost effective.

Changes in technology and National Vendor Declaration protocols since 1990 will assist to address the first two points. Radio Frequency Identification Devices (RFIDs) on gambrels in abattoirs can be linked to PICs to enable trace back. Mixed mobs require that any trace back information will need to be assessed by a producer before confirmation of the disease or condition is established and consequently managed.

High chain speed is likely to continue to limit the accuracy of diagnosis by inspectors and this is addressed in this report through the sensitivity analysis of disease detection. The impracticality and cost of laboratory confirmation of diseases is also addressed by assuming a conservative adoption rate by producers after receipt of E-Surveillance feedback.

Paton (1994) reported on a project utilising meat inspection findings to improve livestock production. This project reported the prevalence of 13 conditions in sheep and 20 conditions in cattle and monitored the reduction in prevalence in flocks where producers received reports compared to producers who had not received reports.

Disease information was captured by meat inspectors located on the carcase and viscera chains using electronic, 12-button key pads. Information was stored on computer with reports containing some advice on disease control sent to producers.

Lamb producers receiving reports had 22 to 38% lower average disease prevalence compared to producers who did not receive reports. The project also found that 25% of producers who received reports planned changes in management that directly related to the report. Only 6% were uninterested in the report and 48% supported its development into some type of national program.

Based on the above, this study assumes that 25% of producers receiving reports on diseases or conditions in sheep and lambs will take corrective management action. However, it is acknowledged that the above adoption rate was achieved after reports were provided free of charge. If the introduction of E-Surveillance requires that individual producers pay for the report, this could reduce the adoption rate.

Currently, the “National Sheep Health Monitoring Program – Other Conditions” project is collecting information at abattoirs on 22 diseases and conditions of sheep. The prevalence information is being estimated on a line basis only by meat inspectors with reports faxed daily to a coordinator. The information is being provided to abattoirs to assist with their quality assurance and to animal health authorities who use the information for disease control extension programs for producers, however the information is not being fed-back to individual producers.

4.3 Assumptions in implementing an E-Surveillance system

The previous experiences discussed above listed a number of limitations regarding the implementation of an E-Surveillance system. These limitations need to be considered and assumptions made on how they are to be addressed.

The assumptions are based on information from similar projects and on discussions between the consultants and abattoir meat inspection staff.

4.3.1 Abattoir tracing

Sheep CRC (2008) investigated a system of tracing in an abattoir that slaughtered approximately 5,000 sheep and lambs per day in two shifts. The aim was to assess if sheep carcases could be accurately linked to the property of consignment (using PICs) and for this link to be maintained throughout the meat inspection process. The project tested the accuracy of gambrels[2] fitted with an individual Radio Frequency Identification Device (RFID) combined with electronic readers to track consignments.

The system uses an electronic mob card (based on PIC) to accompany the first carcase of the mob. This card triggers the RFID devices in the gambrels to be dedicated to that mob and any subsequent information relating to the mob can be captured electronically. Gambrel readers can also be placed on the condemn and retain rails so that all carcases are counted.

The project also included a touch pad screen for AQIS meat inspectors to enter reasons for condemnation of carcases and the capacity exists for this information to be transferred electronically to the processor's computer system.

The project demonstrated the successful electronic tracking of sheep carcases within a high-speed sheep abattoir with the ability to relate individual carcases to a mob PIC, or PICs in the case of a mixed mob, and to relate carcase data to individual carcases.

The estimated cost of the equipment and installation for this abattoir was $215,000.

This benefit cost analysis assumes that an E-Surveillance system would be based on a similar system to that described above. The costs for equipment will be assumed as being proportional to the above-mentioned cost based on abattoir capacity.

Consultation with abattoir owners and meat inspection staff generally indicated that the installation and operation of such a system was feasible. Meat inspection staff also indicated that disease and condition information for carcases and viscera could be captured on suitably located touch screens without the need for more staff or the need to slow the chain. However, this response was not unanimous and would need to be discussed further prior to implementation of the system.

[2] a gambrel is a metal or plastic device used in abattoirs to hang a slaughtered animal by the hindlegs

4.3.2 Mixed mobs

Sheep and lambs are slaughtered as either individual or mixed mobs in abattoirs. Individual mobs will have a single PIC against which disease and other conditions can be recorded, and the producer with that PIC could access the data if it was available on a central database. Individual mobs are generally those sold over-the-hooks or from paddock sales.

Mixed mobs arise when sheep and lambs are purchased at saleyards and individual mobs are combined to improve the efficiency of handling and transport. Mixed mobs are generally slaughtered as single lines and will contain animals originating from two or more PICs. Access to data on prevalence of diseases and conditions for mixed mobs will be less useful to individual producers because of the uncertainty of the origin of the sheep in the line. Producers would need to conduct an investigation of their flocks to establish if the recorded condition applied to that flock or another within the boxed line.

Consultation indicated that the proportion of individual and mixed mobs in abattoir lines was about equal, but that this varied due to seasonal and market influences.

4.3.3 Chain speed

Productivity and profitability in abattoirs is largely a function of chain speed with many designed to operate at 10 carcases per minute. An inspection process that requires detailed pathological conditions to be reported has the potential to slow the chain and reduce productivity.

An assumption has been made that a slowdown in chain speed would not be acceptable and therefore the number and degree of diseases and conditions needs to be limited. We have assumed a limit of 10 diseases or conditions for reporting, with each recorded as being present or absent.

Assumptions for other aspects of E-Surveillance, particularly the choice of diseases and conditions for the BCA, are provided in the following sections.

4.4 Other considerations

4.4.1 Losses during transport and lairage

This study does not take into account losses that may occur between the farm gate and the abattoir, which at times may be considerable particularly after seasons of poor pasture growth or during inclement weather. Mortalities from hypothermia in emaciated sheep, pregnancy toxaemia in pregnant sheep and hypocalcaemia in lambs during transport and lairage, can be significant. Post mortem condemnations for fractures bruising, wounds, and dog bites may have occurred during transport or lairage. Astute inspectors may be able to age the lesions to determine whether they occurred on-farm or post farm gate.

4.4.2 Training of inspectors

The on-plant veterinary officers (OPVOs) spoken to were concerned about the accuracy of the AQIS condemnation data suggesting they were a guide only because of the large variation in gross pathology skills among OPVOs and inspectors within and between abattoirs. The difference in diagnostic capability between export and domestic abattoirs is likely to be large because veterinarians are employed at the former but not at the latter. If E-Surveillance were to be adopted, training of OPVOs and inspectors to standardise procedures and interpretations would be necessary as would the capability to submit a selected sample of representative lesions to a veterinary diagnostic laboratory for quality control of gross diagnoses.

Some OPVOs were also of the view that an additional dedicated inspector was necessary to: (i) increase the ability to detect diseased carcases and viscera; and (ii) to determine more accurately the prevalence of lesions in a line. This was because of the limitations imposed by the speed of the chain and the extra time required for close examination of viscera, particularly intestines, periodic collection of specimens for quality control of diagnoses, entry of information on a touch pad and observation of hygiene standards.

OPVOs and inspectors currently receive training for diagnosis of the standard list of diseases in abattoirs. If the introduction of E-Surveillance results in a change to that list there will be a need for further training but this is likely to be only a marginal increase to the existing training regime.

There was a difference in opinion on the need for additional inspectors to capture data with some indicating that if the touch pad screens were correctly located existing staffing levels would suffice. This would especially be the case in abattoirs slaughtering lambs only where diseases and conditions for condemnation are relatively rare.

4.4.3 Support to on-farm investigations

Each of the conditions of pleurisy-pneumonia, arthritis and nephritis can have a number of different causal agents and risk factors. For example, arthritis may be a degenerative condition caused by excessive weight gain in lambs or vitamin D deficiency, or an infectious condition caused by bacteria such as mycoplasma, chlamydia and erysipelas. Submission of abattoir-collected samples from selected conditions such as these for specific diagnosis at a veterinary laboratory would very important if not essential to the ensuing on-farm investigation. Consideration should be given to providing for such submissions to assist the on-farm disease investigator or farm advisor.

4.4.4 Legal ownership of data

The legal ownership of data generated by E-Surveillance would have to be clarified to all stakeholders.

4.4.5 The National Pig Health Monitoring Scheme

The National Pig Health Monitoring Scheme has been in operation since the early 1990s. The scheme began by looking at snouts, lungs and livers of normal-looking pigs at slaughter for evidence of atrophic rhinitis, pneumonia and internal parasites to check the effectiveness of control programs. It has now expanded to 13 diseases and conditions but remains a manual data collection and reporting system.

There are lessons to be learned from the National Pig Health Monitoring Scheme about the factors affecting level of adoption and value placed on abattoir surveillance by farmers and processors.

5. Analysis of the costs of disease

5.1 Basis for analysis

The costs of the diseases and conditions will vary with a range of factors. The primary factors influencing the costs will be the age of sheep and type of production system or enterprise. For this reason, the costs of the disease have been estimated separately at the farm level on the basis of a Self-Replacing Merino flock and a 1st Cross Terminal Sire operation. At processing, the distinction is made between costs for grown sheep (mutton market) and prime lambs (lamb market).

5.1.1 On farm

The gross margins assumed for both the Self-Replacing Merino flock and a 1st Cross Terminal Sire operation have been used as the 'base' case for each of the enterprises with the net return reported on a per head basis (DPI, 2007). The base case gross margins are shown in the following table.

Table 8 Base case Gross Margins

	Self-Replacing Merino	1st Cross Terminal Sire
Enterprise Gross Margin	$65,450	$71,250
$/ewe	$65.45	$71.25
Average $/head across 'entire' flock[1]	$35.38	$32.10

Source: Adapted from NSW DPI (2007)

[1] On the basis of 1,850 and 2,220 total annual stock numbers in the self-replacing merino and prime lamb enterprise respectively.

The average gross margin per head within individual flocks is used as the base case because the impact of most diseases/conditions is borne across the enterprises and affect the dynamics of the biology of the flock as well as broader productivity. Further, this is consistent with estimating the national costs of disease on the basis of detected individual animal prevalence. It is acknowledged that disease prevalence varies between states and regions and this will impact on the costs of disease in individual flocks. This study considers the benefits and costs at a national level only so that results will need to be further interpreted for diseases with marked variability.

For each of the diseases and conditions reported in Table 5, the productivity impacts and control measures, based on a review of the literature and consultation, were applied to each gross margin and the reduced annual return per head was calculated. The assumptions for these assessments of cost and control are shown in Table 9 with the estimated per head losses summarised in Table 10.

Table 9 Disease on-farm assumptions

Disease/ Condition	Productivity and/or profitability losses if not treated/ controlled	Methods and costs of control	References
Liver fluke (*Fasciola hepatica*)	20% reduction in wool weight and lambing percentage	Drenching with triclabendazole – one dose/animal/year @ $0.35/dose plus 2 days extra labour. Grazing management and snail control not costed as not considered to provide extra control.	Hawkins, C and Morris, R. (1978) Depression of productivity in sheep infected with Fasciola hepatica. Veterinary Parasitology, 4: 341 – 351. MLA (2003) Validation of French Antibody ELISA for Liver Fluke. Final Report AHW.021 NSW Agriculture (2003) Liver fluke disease in sheep and cattle. Primefact 446 (Revised by Dr GW Hutchinson and Stephen Love, March 2007)
Pleurisy-pneumonia	On-farm loss equivalent to $1.18 per sale sheep and lambs	Reduce stressors especially exertion (such as from forced running during mustering), exhaustion (such as from prolonged yarding or transport), and sudden large changes in temperature (such as with sudden onset of heat wave or cold snap). Cost 3 days extra labour.	Meat & Wool NZ (2006) Pneumonia and pleurisy in sheep: Studies of the effect of growth rate, prevalence, risk factors, vaccine efficacy and economic impact. Project 97AH/AG188
Bladder worm (*Cysticercus tenuicollis*)	No on-farm production losses	De-worm farm dogs with praziquantel $32/year. Install offal disposal pit. Conduct wild dog and/or fox baiting program. Control of predation and other cysticercus achieved so assume shared cost with this objective. $270/year for baits and labour.	WA Department of Agriculture and Food (2006) Condemnation of carcasses due to tapeworm cysts. Agricultural Memo 41: 9.
Sheep measles (*Cysticercus ovis*)	No on-farm production losses	De-worm farm dogs with praziquantel $32/year. Install offal disposal pit. Conduct wild dog and/or fox baiting program. Control of predation and other cysticercus achieved so assume shared cost with this objective. $270/year for baits and labour.	WA Department of Agriculture and Food (2006) Condemnation of carcasses due to tapeworm cysts. Agricultural Memo 41: 9.
Cheesy gland (Caseous lymphadenitis - CLA)	3% reduction in wool weight and lambing percentage	Annual vaccination using appropriate vaccine @ $0.05 extra compared to clostridial vaccine. No extra labour	Paton, M. (1994) Utilization of meat inspection findings to improve livestock production' Research Project DAW.034 Report to the Meat Research Corporation

Disease/ Condition	Productivity and/or profitability losses if not treated/ controlled	Methods and costs of control	References
Arthritis	$0.18 per sheep for Merino enterprise, $0.57 per lamb sold for prime lamb enterprise	Eryvac vaccine @ $0.50/dose (for control) plus long acting oxytetracycline (antibiotic) injection @ $0.35/dose (for treatment). Cost of labour for administration of vaccine and/or antibiotic.	MLA (2007) Arthritis in prime lamb sheep - a review. AHW 123; MLA (2006) Assessing the economic cost of endemic disease on the profitability of Australian beef cattle and sheep producers. AHW 087; Paton et al (2003) Effect of mulesing and shearing on the prevalence of Erysipelothrix rhusiopathiae arthritis in lambs. Aust Vet J 81, 11, 694 - 697
Hydatid tapeworm (*Echinococcus granulosus*)	No production loss	De-worm farm dogs with praziquantel $32/year. Install offal disposal pit. Conduct wild dog and/or fox baiting program. Control of predation and other cysticercus achieved so assume shared cost with this objective. $270/year for baits and labour.	WA Department of Agriculture and Food (2006) Condemnation of carcasses due to tapeworm cysts. Agricultural Memo 41: 9.
Grass seeds	30% reduction in wool weight and lambing percentage	Recognise seasonality of barley grass and other grass seeds and apply grazing management and pasture renovation.	Holst et al (1996) Barley grass seed and shearing effects on summer lamb growth and pelt quality. Australian Journal of Experimental Agriculture 36(7) 777 – 780; Sallur N and Dunlop L. (2002) Are grass seeds affecting your sheep and wool? QDPI&F (revised 2006); MLA (2005) Winning against seeds. Tips and Tools Fitzsummons P (2001) Seed damage to skins costly. Stock Journal July 12
Ovine Johne's disease (OJD)	$0.81/sheep reduced income from Merino flocks. $0.56/ewe reduced income for prime lamb flocks	90% reduction in mortalities over 7 years achievable with annual vaccination. Therefore assume 100% reduction in detectable abattoir gross intestinal lesions over 10 years.	MLA (2006) Assessing the economic cost of endemic disease on the profitability of Australian beef cattle and sheep producers. AHW 087; MLA (2005) The economic impact of OJD infection on sheep farms. Animal health and Welfare series.
Nephritis	15% reduction in wool weight and lambing percentage	Increased hygiene at marking and shearing will reduce incidence by 30%. Cost:3 days/year extra labour to improve management.	Paton, M. (1994) Utilization of meat inspection findings to improve livestock production' Research Project DAW.034 Report to the Meat Research Corporation

Table 10 On-farm losses of unmanaged disease/conditions – *average $ per head across entire flock*

Disease/Condition	Self Replacing Merino Flock	1st Cross Terminal Sire
Liver fluke (*Fasciola hepatica*)	$7.08	$6.42
Pleurisy-pneumonia	$1.08	$1.18
Bladder worm (*Cysticercus tenuicollis*)	$0	$0
Sheep measles (*Cysticercus ovis*)	$0	$0
Cheesy gland (Caseous lymphadenitis - CLA)	$1.06	$0.96
Arthritis	$0.18	$0.57
Hydatid tapeworm (*Echinococcus granulosus*)	$0	$0
Grass seeds	$2.65	$2.40
Ovine Johne's disease (OJD)	$0.81	$0.56
Nephritis	$5.31	$4.82

On the assumption that all sheep in the flock are affected, the base case average on-farm per head loss is estimated as the broad percent reduction in the average per head gross margin across the entire flock ($35.38). In the case of liver fluke in a self-replacing merino flock for example, where losses are reported to be a 20% reduction in wool weight and lambing percentage, the base case loss is $7.08 per head per annum. This approach has been used for all of the diseases / conditions and reported losses shown in Table 9. The exception is for grass seeds (where the estimated loss on this basis is then divided by four, to reflect the seasonality of reported on-farm losses) and for arthritis and OJD (where $/head estimates from the literature have been adopted).

In order to calculate the impact of these diseases at a national level, the percentage of the Australian sheep population represented by each flock type (self-replacing Merino flock or 1st cross terminal sire flock) was calculated and disease prevalence[3] assumed as shown in Table 11. For the purpose of this study, it is assumed that all sheep in Australia are represented within a Merino or a prime lamb enterprise category although in reality enterprises are more complex.

[3] Animal prevalence is applied to the total sheep population to identify the number of head where losses are being incurred. The average annual losses per head are then applied to this number to estimate the national impact. Use of animal prevalence provides for estimation of the total productivity losses, and changes to it, based on numbers of animals affected. Use of line prevalence would over-estimate the base productivity losses because it would attribute losses to all animals within an affected line.

Table 11 Disease prevalence – on the basis of NSHMP & supplementary data

Disease/Condition	Self Replacing Merino Flock	1st Cross Terminal Sire
Liver fluke (*Fasciola hepatica*)	7.44%	1.86%
Pleurisy-pneumonia	5.03%	5.57%
Bladder worm (*Cysticercus tenuicollis*)	20.40%	5.60%
Sheep measles (*Cysticercus ovis*)	4.20%	1.93%
Cheesy gland (Caseous lymphadenitis - CLA)	4.38%	1.37%
Arthritis	0.13%	2.00%
Hydatid tapeworm (*Echinococcus granulosus*)	0.13%	0.03%
Grass seeds	2.47%	5.00%
Ovine Johne's disease (OJD)	1.00%	0.10%
Nephritis	3.33%	1.40%

On the basis of estimates of the numbers of ewes joined (see Appendix E), 61% of the national flock is assumed to be represented within self-replacing Merino enterprises, and the balance of 39% is represented by 1st cross terminal sire enterprises. Table 12 summarises the value of losses nationally based on our assumptions of total flock size and reported disease prevalence.

Table 12 On-farm losses – *annual national cost estimates ($'million) on the basis of prevalence (Table 11)*

Disease/Condition	Self Replacing Merino Flock	1st Cross Terminal Sire	Total
Liver fluke (*Fasciola hepatica)*	35.22	3.08	38.3
Pleurisy-pneumonia	3.97	1.69	5.7
Bladder worm (*Cysticercus tenuicollis*)	-	-	-
Sheep measles (*Cysticercus ovis*)	-	-	-
Cheesy gland (Caseous lymphadenitis - CLA)	3.10	0.34	3.4
Arthritis [a]	16.12	6.65	22.8
Hydatid tapeworm (*Echinococcus granulosus*)	-	-	
Grass seeds	4.38	3.09	7.5
Ovine Johne's disease (OJD) [a]	3.85	0.56	4.4
Nephritis	11.82	1.74	13.6
Total			**$95.6**
Average per disease / condition			**$9.6**

[a] Review of the literature revealed that MLA (2007) found the costs of arthritis on-farm to be significantly higher than that estimated on the basis of prevalence data as did MLA (2006) for the costs of OJD on-farm. These estimates have been adopted here to provide a total valuation of the costs of the diseases/conditions. The benefits of E-Surveillance, assessed as avoided prevalence on-farm are however estimated on the basis of the changes in the prevalence.

Disease costs have been estimated for on-farm impacts only and do not consider any flow-on impacts beyond animal production. For example, on-farm losses in sheep from hydatid cysts are zero but as this is a zoonotic disease there is the possibility of infection in the human population. This potentially results in a cost within the human health system that could be attributable to the lack of detection and control of disease within the small stock system.

The other *Cysticercus* diseases have been estimated to have no impact on productivity of the sheep flock but were included in the analysis because of the impact on carcase and offal condemnations.

5.1.2 Processing

The costs of diseases at the processing level are caused by condemnation of carcases (full and partial), loss of offal and downgrading of skins. The estimation of losses at processing have been primarily based on AQIS condemnation data and disease prevalence data (see Table 4 and 11). Other assumptions are listed in Table 13.

Table 13 Costs of disease at processing – assumptions at processor-level

Assumption	Source
For each condemned carcase, another 30 need to be trimmed.	Consultation with abattoirs
Average trimming is 2.5 kg per carcase.	Consultation with abattoirs
Wholesale prices of carcases are the purchase value in $/kg carcase weight plus $0.50 per kg.	Consultation with abattoirs
The value of a sheep carcase that has not been condemned is $1.80/kg.	The Land newspaper, December 2008
The value of a lamb carcase that has not been condemned is $3.90/kg.	The Land newspaper, December 2008
Offal accounts for 7% of carcase weight.	Consultation with abattoirs
A 'package' of offal for pet consumption is comprised of lungs.	Consultation with abattoirs
A pet food offal package is valued at $0.65/kg and weighs 824g (total value equals $0.54)	Consultation with abattoirs Spooncer W F (1992) By-product yields from sheep and cattle. Meat Research Report 2/92 CSIRO
A 'package' of offal for human consumption is comprised of hearts, tripe, runners, kidneys, livers and tongues.	Consultation with abattoirs
An offal package for human consumption is valued at $1.35/kg and weighs 2kg (total value equals $2.70)	Consultation with abattoirs. Spooncer W F (1992) By-product yields from sheep and cattle. Meat Research Report 2/92 CSIRO.
The total value of offal from an animal (i.e. the value of offal for pet food and the value of offal for humans) is $3.24.	GHD Hassall calculation based on industry consultation and Spooncer (1992).
The net loss of a total offal package when downgraded to meat meal is $3.00.	GHD Hassall consultation.
Grass seed affected skins downgraded by $3	GHD Hassall consultation.
Value of condemned and trimmed product $0.0875/kg	GHD Hassall consultation.

Table 14 provides an estimate of annual total condemnations and carcases trimmed for sheep and lambs. This estimate is GHD Hassall's own calculation based on prevalence data from the NSHMP and Paton (1994), slaughter data from MLA and AQIS, and consultation with industry stakeholders and processors.

Table 14 Sheep and lamb carcase and offal condemnations (total and partial) and carcases trimmed

Disease/Condition	No. of sheep carcase condemns	No. of sheep carcases trimmed based on 30 per condemn	Number of sheep offal sets condemned (human consumption)	No. of sheep offal sets condemned (pet food consumption)	No. of lamb carcase condemns	No. of lamb carcases trimmed based on 30 per condemn	Number of lamb offal sets condemned (human consumption)	No. of lamb offal sets condemned (pet food consumption)
Liver fluke (*Fasciola hepatica*)	-	-	229,583	-	-	-	92,571	-
Pleurisy-pneumonia	1,370	41,097	-	41,097	395	11,854	-	11,854
Bladder worm (*Cysticercus tenuicollis*)	-	-	629,501	-	-	-	278,707	-
Sheep measles (Cysticercus ovis)	2,341	70,229	70,229	70,229	3,335	100,062	100,062	100,062
Cheesy gland (Caseous lymphadenitis - CLA)	7,062	211,846	211,846	211,846	359	10,769	10,769	10,769
Arthritis	2,635	79,059	-	-	3,651	109,515	-	-
Hydatid tapeworm (*Echinococcus granulosus*)	51	1,534	1,534	1,534	-	-	-	-
Grass seeds - carcase	-	304,876	-	-	-	969,504	-	-
Grass seeds - skins	-	304,876	-	-	-	969,504	-	-
Ovine Johne's disease (OJD)	-	-	30,858	-	-	-	7,963	-
Nephritis	-	-	102,757	-	-	-	69,677	-

Source: GHD Hassall calculation based on data from NSHMP, Paton, MLA and AQIS.

Total losses at processing are estimated as the total number of slaughtered (sheep & lambs) multiplied by a condemnation rate for carcases and offal multiplied by the lost value of the carcase and offal respectively. The condemnation rates as used in the analysis of costs are shown in Table 15.

Table 15 Proportion of carcases and offal condemned at slaughter

	Sheep		Lambs	
	Full carcases	**Offal**	**Full carcases**	**Offal**
Liverfluke	0.0000%	0.01302%	0.0000%	0.00326%
Pleurisy-Pneumonia	0.0111%	0.00100%	0.0020%	0.00018%
Bladder Worm	0.0000%	0.03570%	0.0000%	0.00980%
Sheep Measles	0.0190%	0.00569%	0.0168%	0.00503%
Cheesy Gland	0.0572%	0.01716%	0.0018%	0.00054%
Arthritis	0.0214%	0.00000%	0.0183%	0.00000%
Hydatid Tapeworm	0.0004%	0.00012%	0.0000%	0.00000%
Grass Seeds	2.4700%	0.00000%	5.0000%	0.00000%
OJD	0.0000%	0.00175%	0.0000%	0.00028%
Nephritis	0.0000%	0.00583%	0.0000%	0.00245%

Source: Estimated on the basis of AQIS data & consultation with processors (refer to Appendix F for detail of estimated total condemnations).

Table 16 Costs at processing by disease/condition ($'million per annum)

	Sheep	Lamb	Total
Liver fluke	0.005	0.002	0.007
Pleurisy-pneumonia	0.226	0.143	0.369
Bladder worm	0.013	0.006	0.019
Sheep measles	0.387	1.211	1.598
Cheesy gland	1.17	0.130	1.298
Arthritis	0.443	1.322	1.755
Hydatid tapeworm	0.008	-	0.008
Grass seeds	2.22	7.734	9.954
OJD	0.001	0.000	0.001
Nephritis	0.002	0.001	0.004
Total			**15.01**
Average per disease			**1.5**

5.1.3 Industry/National

On the basis of the assumptions presented, the total calculated cost of the 10 diseases/conditions is estimated to be over $110 million (Table 17) to the small stock industry as a whole, annually. This equates to an average annual cost of just over $11 million per disease. The burden of cost from the incidence of disease varies by disease/condition but overall, the on-farm sector bears 86% of the cost of these diseases/conditions.

Table 17 Disease costs – total to industry as a whole ($'million per annum)

	Total costs to small stock industry
Liver fluke	38.30
Pleurisy-pneumonia	6.03
Bladder worm	0.02
Sheep measles	1.63
Cheesy gland	4.74
Arthritis	24.53
Hydatid tapeworm	0.01
Grass seeds	17.42
OJD	4.41
Nephritis	13.56
Total	**110.62**
Average per disease	**11.06**

Except for arthritis and OJD reported in MLA (2006), these costs have been assessed on the basis of reported on-farm incidence of each of the diseases/conditions as reported by the NSHMP and condemnations reported by AQIS with the various assumptions applied by the consultants. The absence of estimates from the literature for most diseases and conditions means that comparisons are not available to check the accuracy of these estimates.

Despite the lack of comparative data, it is still appropriate for the assessment of the value of an E-Surveillance system to be based on reported prevalence costs because it is the marginal change in what is reported that is of primary relevance to a benefit cost analysis. On this basis benefits outlined in the analysis in Chapter 6 are likely to be conservative estimates of the benefits available from the introduction of an E-Surveillance system. Further considerations in the interpretation of the above estimates should note that:

- the estimates are based on broad averages across the country and do not take account of the variance in condition by state or region or that management will vary by manager. This has the potential to over or under-estimate the costs.
- the summation of the costs of diseases/conditions has the potential to over-estimate costs if a single animal/carcase is reported to have more than one condition.

6. Introducing an E-Surveillance System: benefit cost analysis

6.1 Identification of the costs and benefits

The benefits and costs associated with the proposed E-Surveillance system are listed in Table 18. The costs and benefits are premised on the basis of the mandatory introduction of the system across the small stock processing sector of Australia and the system providing for feedback to producers who in turn are responsive to the information and take action to manage the identified conditions.

Table 18 Costs and benefits considered in relation to the introduction of an E-Surveillance system

Costs	Benefits
System installation in abattoirs	Avoided on-farm costs of conditions
Additional labour for operation	Reduced carcase condemnations (full and trim)
Transfer of data to primary producers	Reduced offal and skin condemnations
Cost of implementing management practices on-farm	Avoided industry/market closures

These costs and benefits and relevant assumptions are now discussed.

6.1.1 System installation in abattoirs and establishment

The costs of installation of system requirements in abattoirs are based on the experience of Peel Valley Exporters (Sheep CRC, 2008). Equipment and installation for an abattoir that is similar in size to that of Peel Valley Exporters would be approximately $215,000. Table 19 shows the individual components and the price associated with the E-Surveillance system. The majority of the costs are similar for all types of abattoirs regardless of throughput but with costs of replacement gambrels dependent on size of operations. Gambrels cost an average of $5.50 each with 8,000 required in a plant slaughtering 5,000 animals per day.

Table 19 System installation - component costs

Item	Estimated cost
Fixed	
11 RFID* readers, antennas, sensors	$40,000
PLC hardware and nodes	$30,000
PC with proprietary software	$10,000
Touch screens (each)	$ 4,000
Site investigation, Project Management, Drawings etc	$22,000
Software licenses and development	$30,000
Commissioning	$35,000
Variable with Abattoir Size	
Gambrels Average price of $5.50 and assuming 8,000 required in a large abattoir	$44,000
Total -	**$215,000**

Source: Based on Sheep CRC (2008). * RFID is Radio Frequency Identification Device

The total cost of establishing the system will vary by abattoir size. Based on the assumptions in Table 19, the cost of establishment of a system in a small (200,000 head small stock p.a), medium (500,000 head small stock p.a.) and large (1.2 million head small stock p.a.) abattoir are estimated to be $178,333, $189,333 and $215,000 respectively. The annual operation costs will also vary by size of the abattoir and in this analysis the annual costs are assumed to be $25,000, $35,000 and $45,000 for small, medium and large operations respectively.

Based on experience with improved product monitoring in cattle abattoirs, this study considers that the introduction of an electronic carcass monitoring system into a sheep abattoir will have benefits beyond disease surveillance. Tracking of carcasses in the chillers and boning rooms can potentially improve processing efficiencies, improve the management of downstream processes and improve product control for individual processors. For this reason, this study has conservatively assumed that only 75% of the capital and operating costs of an E-Surveillance system are attributed to disease control to benefit the industry generally, with the remaining 25% being attributed to benefits accruing to individual processors through other efficiencies.

In addition to the in-abattoir costs of the system, a secure central data system/portal or link to an existing system would be required. Based on broad consultation, the most cost-effective approach would be for the system to link into the existing AHA central database, including provision for producer and abattoir access.

The data would be stored in the existing AHA central database and used in conjunction with the National Animal Health Information System (NAHIS) and other national surveillance data. The data to be recorded is similar to that currently recorded in the abattoir monitoring "other conditions" project associated with OJD monitoring, so that rather than setting up a completely new system only minor modifications would be required. On this basis, the following indicative costs are anticipated:

A. Establishment costs for database including*:*

1) Development of user log-in system, password management, security and display pages;
2) Registration system for producer and abattoir access; and
3) Database modifications, data input systems, data reporting structures, etc.

Establishment costs will differ depending on which of the following two options for a secure registration process for producers is chosen:

a) Linkage to the existing NLIS system for cattle (in the absence of a sheep NLIS system on the basis that there will be a high proportion of overlapping PICs) to provide an initial secure login protocol: estimated to cost $50,000 - $100,000; or

b) Mail out passwords to producers after an on-line request for registration: estimated to cost $100,000 - $200,000.

B. Annual operating costs of database

The level of technical support required will depend on the level of usage and assistance required, but is estimated to range between $15,000 - $ 30,000 per year.

System maintenance and development is an additional marginal cost to the existing AHA system, with $10,000 - $20,000 per year anticipated for on-going development and system maintenance.

The BCA calculation is based on a one-off database establishment cost of $100,000 and annual operation and technical support costs for the database of $25,000 per annum.

6.1.2 Additional items not costed

A number of additional costs have not been included in the analysis due to the aspects not being scoped. These include:

- *Farmer education.* For the effective operation of the system and to achieve responsiveness to the information on-farm, it is considered that an education program (including initial and ongoing elements) would be necessary. This has not been included in the benefit cost analysis because it has not been scoped but is considered in terms of sensitivity analysis.
- *Abattoir implementation.* Similarly, an education program for abattoir operators/inspectors would be valuable to ensure appropriate implementation of the system.
- *Additional labour in abattoirs*. Indications from consultation varied in respect to additional labour costs, especially for meat inspectors, to operate the system. As such, none have been included in the system. However this is considered a potential cost that may warrant further investigation.
- *Training of inspectors at domestic abattoirs and OPVOs at export abattoirs.* Some extra training for inspectors at domestic works (where a veterinarian is not present) and for OPVOs may be required to standardise their interpretation of gross changes. Training is considered to be a marginal increase to existing training requirements. *This was not scoped but is considered in the sensitivity analysis.*

6.1.3 Data transfer and adoption of management practices

A key assumption to the accrual of benefits from the implementation of an E-Surveillance system is the proportion of producers who adopt management strategies as a result of being made aware of the condition of the stock they have recently sold to slaughter. In the analysis, an adoption/responsiveness rate of 30% is used on the basis of Paton (1994). This value is tested in the sensitivity analysis.

Another key assumption is the rate at which the on-farm incidence of diseases/conditions is detected at processing. This rate will vary by disease, the experience of inspectors and the speed of the chain. Theoretically, this rate could be 100%, however this is conservatively assumed to be 80% for the analysis. Sensitivity analysis is undertaken on this assumption.

6.1.4 Costs & benefits of management on-farm

The costs and benefits of the system are reliant not only on the adoption of management practices by farmers, but also the effectiveness of the treatments. The costs of treatment together with their effectiveness are listed in Table 20.

Table 20 Costs ($/hd) & effectiveness (%) of on-farm control practices

Disease/ Condition	Methods and costs of control	Self Replacing Merino		Prime lamb	
		Annualised cost per head used in analysis ($/hd) [a]	Effectiveness (%)	Annualised cost per head used in analysis ($/hd) [a]	Effectiveness (%)
Liver fluke (*Fasciola hepatica*)	Drenching with triclabendazole – one dose/animal/year @ $0.35/dose plus 2 days extra labour. Grazing management and snail control not costed as not considered to provide extra control.	0.56	90	0.42	90
Pleurisy-pneumonia	Reduce stressors especially exertion (such as from forced running during mustering), exhaustion (such as from prolonged yarding or transport), and sudden large changes in temperature (such as with sudden onset of heat wave or cold snap). Cost 3 days extra labour.	0.33	50	0.17	50
Bladder worm	De-worm farm dogs with praziquantel $32/year. Install offal disposal pit. Conduct wild dog and/or fox baiting program. Control of predation and other cysticercus achieved so assume shared cost with this objective. $270/year for baits and labour.	0.17	50	0.13	50
Sheep measles	De-worm farm dogs with praziquantel $32/year. Install offal disposal pit. Conduct wild dog and/or fox baiting program. Control of predation and other cysticercus achieved so assume shared cost with this objective. $270/year for baits and labour.	0.17	50	0.17	50
Cheesy gland	Annual vaccination using appropriate vaccine @ $0.05 extra compared to clostridial vaccine. No extra labour	0.07	100	0.04	100
Arthritis	Eryvac vaccine @ $0.50/dose plus long acting oxytetracycline (antibiotic) injection @ $0.35/dose. Cost of labour for administration of vaccine and/or antibiotic.	0.32	60	0.32	60
Hydatid tapeworm	De-worm farm dogs with praziquantel $32/year. Install offal disposal pit. Conduct wild dog and/or fox baiting program. Control of predation and other cysticercus achieved so assume shared cost with this objective. $270/year for baits and labour.	0.17	50	0.17	50
Grass seeds	Recognise seasonality of barley grass and other grass seeds and apply grazing management and	0.78	70	0.78	70

Disease/ Condition	Methods and costs of control	Self Replacing Merino		Prime lamb	
		Annualised cost per head used in analysis ($/hd) [a]	Effectiveness (%)	Annualised cost per head used in analysis ($/hd) [a]	Effectiveness (%)
	pasture renovation.				
OJD	90% reduction in mortalities over 7 years achievable with annual vaccination. Therefore assume 100% reduction in detectable abattoir gross intestinal lesions over 10 years.	0.29	90	0.29	90
Nephritis	Increased hygiene at marking and shearing will reduce incidence by 30%. Cost:3 days/year extra labour to improve management.	0.33	30	0.33	30

[a] attributable to management of the disease.

6.1.5 Carcase and offal condemnation reduction

The benefits of the on-farm management of the diseases to processors are estimated in terms of a reduction in carcase, offal and skin condemnations. Reduced condemnations are assessed as being directly related to the detection of diseases, adoption of management practices and the effectiveness of management practices by producers. The reductions, expressed as a percentage of the base case are shown in the following table, and are applied to the benefits of reduced condemnations in the processing of sheep and lambs.

Table 21 Benefit of E-Surveillance to processors by reduced condemnations (%)

Disease / condition	Reduced Condemnations (%)
Liver fluke	21.6%
Pleurisy-pneumonia	12.0%
Bladder worm	12.0%
Sheep measles	12.0%
Cheesy gland	24.0%
Arthritis	14.4%
Hydatid tapeworm	12.0%
Grass seeds	16.8%
OJD	21.6%
Nephritis	7.20%

6.1.6 Avoided industry/market closures

An E-Surveillance system has the potential to reduce the occurrence or likelihood of market closures that may result if a disease or condition is detected in an export market. The benefit of this reduced occurrence or likelihood can be considered in relation to the lost sales that are avoided as a result.

The United States is an important export market for Australian sheep and lamb. In November 2008, Australia exported 1,104 tonnes of mutton to the United States as well as 3,882 tonnes of lamb (DAFF, 2008). According to ABARE, the value of lamb exports to the United States is forecast to be $876 million in 2008-09 (ABARE 2008). On the simplifying assumption of consistent export sale volumes and values throughout the year, this is implies a monthly value of $73 million in exports of lamb to the United States.

Some markets such as the European Union require the feedback of disease information to producers. An E-Surveillance system will therefore underpin access to these markets in the future.

The benefit of avoiding the potential closure of markets is not included explicitly in the analysis but is considered in the threshold analysis.

6.1.7 Benefit of E-Surveillance to inspection

There is a case to argue that this is a value adding exercise which will improve the status of inspection services to farmers, processors and inspectors themselves. This will also allow ongoing reviews of the adequacy of inspection to ensure relevance thus ensuring efficiency and effectiveness.

6.2 Analysis

The economic benefits of an E-Surveillance system to the Australian small stock industry have been assessed in a benefit cost framework. Key features of the analysis include:

- benefits and costs are discounted at a base rate of 7% per year;
- assessment over 10 years;
- benefits accruing from year 2 to reflect the information/adoption lag;
- on-farm benefits are net of the costs of management practices. On-farm benefits have been assessed this way to accommodate flock dynamics and the variable nature and application of management practices;
- assessment of benefits on the basis of changes in the incidence on-farm and condemnation of carcasses and offal at processing; and
- other assumptions as described in Section 6.1.

The annual industry benefit of E-Surveillance is estimated to be $12.57 million, with 80% of this benefit accruing to the production sector and the balance accruing to the processing

sector. The benefit at processing is estimated to be an average of just $0.08 per head slaughtered. Over 10 years and discounted at 7%, the present value of industry total industry benefits is estimated to be $88.32 million.

The cost of establishing E-Surveillance is estimated to be $13.34 million in year 1and $2.15 million annually in years 2 – 10. The present value of these costs over 10 years using a 7% discount rate is $26.57 million. These costs are shared by processors and the industry body responsible for operation of the central database system. The costs of increased management on-farm are not included in this total as they are incorporated in the estimation of net benefits on-farm (as discussed earlier).

On the basis of these costs and benefits, the net present value of the introduction of an E-Surveillance system for the Australian small stock industry is estimated to be $61.74 million over 10 years discounted at 7%. The benefit cost ratio for the proposed introduction is 3.3.

6.2.1 Sensitivity analysis

The above analysis is reliant on a number of key assumptions. The following table shows the sensitivity of the results to these assumptions listed.

Table 22 Sensitivity of results to key assumptions

	Base assumption	Low	High	Breakeven
Adoption/ responsiveness	***30%***	***5%***	***50%***	***9%***
NPV	$61.74 mill	-$11.85 mill	$120.62 mill	-
BCR	3.3	0.6	5.5	1.0
Detection	***80%***	***50%***	***100%***	***24%***
NPV	$61.74 mill	$28.62 mill	$83.82 mill	-
BCR	3.3	2.1	4.2	1.0
Proportion of E-Surveillance system attributable to disease management alone	***75%***	***60%***	***100%***	***250%***
NPV	$61.74 mill	$67.04 mill	$52.91 mill	-
BCR	3.3	4.2	2.5	1.0
Discount rate	***7%***	***4%***	***10%***	***1350%***
NPV	$61.74mill	$72.4 mill	$53.13 mill	-
BCR	3.3	3.4	3.2	1.0

These results show the analysis to be insensitive to these key assumptions. In particular, detection of conditions could fall to 24% before there would be no net benefits. And the

on-farm adoption of management practices in response to E-Surveillance identification of diseases could fall to 9% before the benefit cost ratio would be 1.0. Similarly, the results are not sensitive to the discount rate. Finally, the analysis is not sensitive to the assumption that the benefits of an E-Surveillance system to processors would extend beyond disease management and reduction of carcase and offal condemnations.

These sensitivity analyses, together with the conservative basis for assessment of the base case costs, provides confidence in the estimated net benefits that could be expected from the introduction of an E-Surveillance system as assumed in this report.

6.2.2 Threshold analysis

Threshold analysis can be used to consider uncertain factors not explicitly included in a benefit cost analysis. Education, the diseases included/not included in the system and market closures are now considered.

Education of producers and processors is likely to be necessary to achieve the benefits estimated in this study. The extent and approach required warrants investigation outside of the scope of this study. The cost would however need to exceed more than $70 million in the early years of the system's introduction before there would be no net benefits from the introduction of the system.

The number of diseases/conditions, and which diseases/conditions, are included in an E-Surveillance system will impact on the economic benefit of the system. On the simplifying assumption that the 10 diseases/conditions are representative of the likely diseases/conditions that could be incorporated in the system, the average annual total benefit per disease/condition is in the order of $1.25 million. On this basis, the system would need to include just four diseases/conditions for there to still be net benefits from the introduction on an E-Surveillance system. Similarly, the average benefit per disease could fall to as low as $0.38 million annually for a system including 10 diseases to still deliver net benefits.

A key industry benefit not included in the base analysis is that of the reduced likelihood of market closures. On the basis of avoiding a single monthly market closure, such as closure of the United States lamb export market ($73 million per month, see section 6.1.6), in year 10 of the analysis, the benefit cost ratio associated with the introduction of an E-Surveillance system increases from 3.3 to 4.7.

6.2.3 Financial analysis for processors

An estimated 80% of the benefits of the introduction of an E-Surveillance system are to the production sector. However, the system has significant costs for its installation and operation by processors. The following table illustrates the financial costs and benefits for three processors with the key variable being throughput. The costs used are as per the assumptions in section 6.1.1, while benefits are extrapolated on the basis of the average per head benefit of $0.08.

Table 23 Financial analysis of impact on processors

	Large	Medium	Small
Annual smallstock throughput	1,200,000	500,000	200,000
NPV	$188,339	- $79,363	- $163,020
BCR	**1.59**	**0.81**	**0.40**

As shown, medium and small typical processors would be expected to incur a net loss from the implementation of an E-Surveillance system. Reflecting economies of scale, a larger processor might expect net financial benefits, with a BCR of 1.59, from inclusion of E-Surveillance in their operations. For a smaller processor, the average per head benefit would need to increase to $0.24 for the benefits to the processor to approach the costs incurred by the processor.

7. Findings

7.1 Summary of findings

The establishment of an E-Surveillance system for the small stock (sheep, lamb and goats) supply chain is anticipated to have a benefit cost ratio of 3.3, with most (80%) of the benefits gained at the producer level and the balance by processors. This compares to 86% of costs of the diseases/conditions being borne by producers and the balance by processors. This suggests a subsidisation of processor benefits by the actions of producer management on-farm, especially given that on-farm benefits in this analysis have been assessed as net of the cost of management.

The benefit cost analysis has been shown to be relatively insensitive to changes in the major assumptions including the adoption by industry of management practices to reduce the prevalence of diseases and conditions on-farm, with such improvements then flowing through to the processing sector. In addition, the estimates of improvements in diseases/conditions on-farm are conservative and therefore the BCR is expected to be robust under changing circumstances.

The threshold analysis provides further evidence of this, as there is a need to include just four diseases/conditions for there to be net benefits from the introduction on an E-Surveillance system. Similarly, the average benefit per disease could fall to as low as $0.38 million annually for a system including 10 diseases to still deliver net benefits.

Demonstration of the financial impacts on typical processors, by size, shows the benefit of economies of scale. Larger processors are expected to gain net financial benefits from the introduction on an E-Surveillance system while medium to small processors would not. The average benefit per head processed would need to increase from $0.08 to $0.24 before their investment in E-Surveillance would breakeven.

However, prior to introducing the system, a number of factors would need further investigation and these are discussed below.

7.2 Factors for further investigation

The factors requiring further investigation include:

- extending the system to more diseases: This BCR was based on improvements if 10 diseases/conditions were targeted but both the AQIS and NSHMP report on more than 22 diseases/conditions. Extension to cover more diseases/conditions is likely to improve the BCR as there would be only small increases in system costs required while feedback would allow an increased scope for on-farm improvement, albeit with diminishing returns. An assessment of the practicality of capturing information for an extended list of diseases/conditions would be needed, particularly the ability for this to be achieved with similar labour assumptions.

- capturing AQIS data via an E-Surveillance process: Currently AQIS data on carcase condemnations is captured manually before being uploaded to its database. Direct capture via an E-Surveillance system could improve the efficiency of data handling and this benefit has not been considered in this study.

- equivalence between plants: The analysis has been completed on the basis that the meat inspection process and capture of data will provide information to producers with equivalent accuracy. This may not be the case given differences in sizes, specialisation (mixed species/lamb/sheep) and market destination (export/domestic). For system integrity, users would need to be confident that information was equivalent and the means of achieving this through education and training require further investigation.

- asymmetry of information: because of the relatively small number of processors and large number of producers, there is reduced competition for stock supply in periods of relative oversupply. Information on disease status could potentially provide greater market power to processors and reduced competition for suppliers.

- mandatory versus voluntary: this analysis has been completed on the assumption that all small stock abattoirs in Australia introduce an E-Surveillance system. This reduces the BCR as smaller, mixed species abattoirs are required to expend capital to establish the system and have reduced chances of capturing benefits. A voluntary system could lead to an improved BCR for individual abattoirs but is unlikely to provide sufficient information to satisfy market access requirements for export markets in the absence of a parallel national system.

- additional cost of labour: this analysis has been completed on the assumption that no extra labour need be employed for inspections. Some but not all OPVOs consulted suggested that an extra dedicated inspector may be required if consistently high quality and meaningful data is to be collected.

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Appendix A

Questionnaire

Questionnaire used during consultation with abattoirs

E-Surveillance Phone Survey for Abattoirs

STRICTLY CONFIDENTIAL

GHD Hassall understands the commercial sensitivity of much of the information being sought and we will ensure that all information will be treated in strictest confidence. Information from individual plants will not be shared with any agencies or other plants and will be used solely for the purpose of completing this analysis. Our benefit cost report will be written so that identities of contributors will be protected.

This survey will be completed by phone. We will contact you in the near future to arrange a suitable interview date and time. If you have any questions please contact the Project Manager, Joe Lane, on 0415 269 934. Thank you for your participation.

Questions

Overview of the company:

1. Name of abattoir	
2. What is your abattoir's core area of operation? e.g. sheep/lambs/other livestock, export, large domestic, small domestic	

Annual production:

3. How many sheep does the abattoir slaughter each year? (head)	
4. What is your annual production of sheep meat (cwt)?	
5. How many lambs does the abattoir slaughter- each year? (head)	
6. What is your annual production of lamb (cwt)?	
7. What is your annual production of the following offal products, *for human consumption*?	
a. Liver (kg)	
b. Heart (kg)	
c. Kidneys (kg)	
d. Tripe (kg)	
e. Runners (kg)	
f. Other (kg)	

8. What is your annual production of the following, *for pet food consumption*?	
a. Offal (kg)	
b. Other (kg)	
9. How much rendering/meat meal do you produce each year? (kg)	

Offal, pet food and meat meal prices:

10. What is the average price of offal for human consumption ($/kg)?	
11. What is the average price of offal for pet food ($/kg)?	
12. What is the average price of offal as meat meal ($/kg)?	

Condemnations:

13. How many kilos of carcase condemnations do you have each year?	
14. What is the proportion of carcase condemnations as a percentage of total production?	
15. How many kilos of offal condemnations do you have each year?	
16. What is the proportion of offal condemnations as a percentage of total offal production?	

17. How important are the following diseases/conditions in partial or total condemnation?

Disease/condition	**Sheep: High, Medium or Low importance**	**Lambs: High, Medium or Low importance**
Liver fluke (*Fasciola hepatica)*		
Pneumonia / pleurisy		
Bladder worm (*Cysticercus tenuicollis*)		
Sheep measles (*Cysticercus ovis*)		
Cheesy gland (Caseous lymphadenitis - CLA)		
Arthritis		

Hydatid tapeworm (*Echinococcus granulosus*)		
Grass seeds		
OJD		
Nephritis		

Operating costs:

18. Please provide an estimate of your annual operating costs:

Variable cost item	**Annual costs ($) *OR***	**% of total costs**
Labour		
Admin		
Surveillance / Accreditation		
Effluent Management		
Maintenance		
Other		
Total	$	100%

19. How many meat safety inspectors do you employ?

Number of inspectors (Full Time Equivalents)	
Number OPVOs – on-plant vet officers (FTEs)	

20. Costs of E-Surveillance:

If E-Surveillance was introduced on a slaughter line basis (using PICs for the lines, not individual animal ID), what impact would you expect this to have on your:	
a. Annual operating costs? (% change or $)	
b. Capital costs? E.g. as a result of associated software upgrade, touch screen, etc (% change or $)	

21. Do you have any other comments or queries regarding the introduction of E-Surveillance in abattoirs?

Appendix B

Disease prevalence in lines of sheep

Prevalence estimates from the NSHMP

Table B1 Prevalence of diseases and conditions in sheep, NSHMP 2007/08 – affected lines as a % of total inspected

Disease / condition	NSW (%)	QLD (%)	SA (%)	TAS (%)	VIC (%)	WA (%)	National (%)
Bladder worm	67.22	37.30	78.67	58.82	89.74	98.83	**69.29**
Sheep measles	47.83	10.29	68.89	31.37	77.14	96.11	**51.11**
Pleurisy / pneumonia	48.34	25.40	69.78	0.00	60.47	92.61	**50.56**
Cheesy gland	33.02	23.79	50.22	92.16	59.83	44.75	**36.53**
Liver fluke	34.22	3.22	3.11	31.37	17.74	0.00	**28.23**
Cancer	16.19	8.68	19.11	3.92	15.17	14.01	**15.59**
Sarcocystis	2.28	0.64	11.11	1.96	9.83	1.56	**3.14**
Hydatids	1.90	1.61	0.00	0.00	2.14	1.95	**1.81**
Arthritis	0.35	2.25	29.78	0.00	0.21	0.00	**1.62**
Knotty gut	1.22	1.93	3.11	0.00	2.78	0.39	**1.42**
Lungworm	0.00	0.00	26.22	0.00	0.00	0.00	**1.06**
Melanosis	0.68	6.43	0.00	0.00	0.00	0.00	**0.88**
Fever/ septicaemia	0.19	0.64	8.89	0.00	0.00	0.00	**0.54**
OJD vaccine lesions	0.61	0.00	1.33	0.00	0.21	0.00	**0.54**
Jaundice	0.33	0.64	3.11	1.96	0.64	0.00	**0.48**
Emaciation	0.09	0.00	2.67	1.96	0.00	0.00	**0.20**
Other vaccine abscesses	0.12	0.64	0.00	0.00	0.00	0.00	**0.13**
Bruising	0.02	0.00	0.89	0.00	0.00	0.00	**0.05**
Dog bites	0.00	0.00	0.00	0.00	0.43	0.00	**0.04**
Anaemia	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Grass seeds	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**
Worms general	0.00	0.00	0.00	0.00	0.00	0.00	**0.00**

Source: National Sheep Health Monitoring Program, 2008

Appendix C

Goat Condemnations

Table C1 Goat condemnations (skin off), 3-year average

Disease / condition skin off	Goats	% of slaughter
Anaemia	0	0.00
At antemortem	9	0.00
Bruising	71	0.01
C.ovis	4	0.00
CLA	679	0.11
Company condemn	2,071	0.33
Ecchymosis	3	0.00
Emaciation	384	0.06
Fever	1,269	0.20
Gangrene	23	0.00
Gross contamination	690	0.11
Hydatids	-	0.00
Jaundice	166	0.03
Malignancy	81	0.01
Metritis	4	0.00
Muscle condition	6	0.00
Other causes	27	0.00
Peritonitis	-	0.00
Polyarthritis	37	0.01
Pyaemia	18	0.00
Sarcosporidia	1	0.00
Septic pneumonia	27	0.00
Septicaemia	249	0.04
Wounds	2	0.00
Total condemnations	**5,823**	**0.92%**
Total slaughters	**630,253**	

Source: AQIS Condemnation Summary Reports

Table C2 Goat condemnations (skin on), 3-year average

Disease / condition skin on	Goats	% of slaughter
Anaemia	-	0.00
At antemortem	283	0.06
Bruising	80	0.02
C.ovis	18	0.00
CLA	283	0.06
Company condemn	297	0.06
Ecchymosis	0	0.00
Emaciation	254	0.05
Fever	907	0.18
Gangrene	77	0.02
Gross contamination	2,140	0.42
Hydatids	-	0.00
Jaundice	178	0.03
Malignancy	32	0.01
Metritis	8	0.00
Muscle condition	-	0.00
Other causes	48	0.01
Peritonitis	-	0.00
Polyarthritis	33	0.01
Pyaemia	-	0.00
Sarcosporidia	-	0.00
Septic pneumonia	69	0.01
Septicaemia	292	0.06
Wounds	-	0.00
Total condemnations	**4,999**	**0.98%**
Total slaughters	**511,455**	

Source: AQIS Condemnation Summary Reports

Appendix D

Methodology for Disease Selection

Method used to select Top 10 diseases / conditions to be included in the benefit cost analysis

Method for selecting 10 diseases/conditions for the benefit cost analysis

The method used to select a draft list of diseases/conditions for consideration by the Coordinating Group has been a combination of objective and subjective assessment. The objective assessment was based on prevalence data in combination with assessments of on-farm productivity impact, value of carcase and offal condemnation and market access implications including zoonotic impact to produce a 'score' for each disease/condition. Diseases/conditions were then ranked in descending order on that score with the assumption that those with the highest score should be selected.

Objective assessment

This objective assessment was conducted for two lists of diseases/conditions: List A included all diseases within the National Sheep Health Monitoring Program; and List B was an additional list created from a 'brainstorming' exercise conducted by the consultant.

The score for each disease/condition was developed from the following parameters:

A. Animal prevalence. For List A, data from the National Sheep Health Monitoring Program. For List B, no prevalence data was available so an assumed value of 0.01% was used for all diseases/conditions in the list. Note that some diseases/conditions in List A did not have prevalence data and their inclusion/exclusion for analysis was based on a subjective assessment only (see below).

B. On-farm productivity impact. A nominal rating between 5 (high impact) and 0.1 (low impact) was ascribed to each disease/condition with the rating determined using professional judgement.

C. Carcase factor. If the disease/condition was likely to lead to a condemnation of the carcase (whole or part) a value of 5 was ascribed (based on $5/kg for the carcase component). A value of 0.1 if no carcase impact.

D. Offal factor. If the disease/condition was likely to lead to a condemnation of offal (ie downgraded to use as rendering only) a value of 1.5 was ascribed (based on $1.50/kg for the offal component). A value of 0.1 if no offal impact.

E. Market factor. A value of 10 was ascribed to diseases/conditions with actual or perceived market access issues related to human health. A value of 1 if not.

The 'score' was then calculated using the formula:

$$\text{Score} = A \times B \times (C + D) \times E$$

This objective analysis resulted in the following ranking of the diseases/conditions in each list:

List A objective ranking

1. *Fasciola hepatica* - liver fluke
2. Pneumonia-pleurisy
3. *Cysticercus tenuicollis* - bladder worm
4. Caseous lymphadenitis (CLA) - cheesy gland
5. *Cysticercus ovis* - sheep measles
6. Lung worm

7. Arthritis
8. *Oesophagostomum columbianum* - knotty gut
9. Jaundice
10. *Echinococcus granulosus* - hydatid tapeworm
11. Sarcosporidiosis - sarcocystis
12. Melanosis
13. Cancer
14. OJD vaccine lesions
15. Vaccination lesions and abscess
16. Fever / septicaemia
17. Emaciation
18. Bruising
19. Dog bites
20. Grass seed
21. Anaemia
22. Worms general

For List A, it should be noted that the low ranking of the last five diseases/conditions (bruising, dog bites, grass seed, anaemia and worms) was because zero prevalence was recorded in the monitoring program.

List B objective ranking

1. OJD
2. White liver disease (cobalt deficiency)
3. Urolithiasis - bladder stones
4. Oedema
5. Ectoparasites (lice, mites)
6. Fractures
7. Nephritis - kidney damage
8. Nodular livers - small fibrotic liver
9. Peritonitis
10. Congenital anomalies (ie cystic kidneys)
11. Fatty liver
12. Gut atrophy

Subjective assessment

The objective ranking alone was not considered to be acceptable for selecting the 10 diseases/conditions for benefit cost analysis as some in List A and all in List B did not have prevalence data available. In addition, the factors used for calculating the ranking scores were relatively arbitrary.

Therefore, adjustments were made after informal discussion with a range of veterinary practitioners and abattoir inspectors based on their experiences. Selection commenced with the 'top 10' List A diseases/conditions and their inclusion or replacement with an alternative was based on merit.

Draft list – for endorsement by E-Surveillance Coordinating Group

Using this approach, the draft list of diseases/conditions presented to the Coordinating Group to consider was:

1. Fasciola hepatica - liver fluke
2. Pneumonia-pleurisy (a condition which has a range of causal agents and factors and hence would need on-farm investigation for management)
3. a) *Cysticercus tenuicollis* (bladder worm) and b) *Cysticercus ovis* (sheep measles) – two diseases combined as management on-farm is similar for both ie dog control
4. Caseous lymphadenitis (CLA) - cheesy gland
5. a) Lung worm and b) *Oesophagostomum columbianum* - knotty gut. Two diseases combined as they are grossly visible indicators of a general worm problem with management on-farm similar for each
6. Arthritis
7. *Echinococcus granulosus* - hydatid tapeworm
8. Grass seeds
9. OJD
10. Nephritis (a condition which has a range of causal agents and factors and hence would need on-farm investigation for management)

The two diseases/conditions of next importance but not included in this analysis were:

1. Dog bites
2. Vaccination lesions

Appendix E

Selected Flock Characteristics

Table E1 Estimated number of ewes joined

Ewes joined to produce lambs		% of total ewes joined
First-cross system	9,413,503	
Second-cross system	6,510,868	
Total 'prime' lamb	**15,924,371**	39%
Merino ewes	**25,327,412**	61%
Total ewes joined	**41,251,783**	

Source: MLA 2007 lamb survey

Table E2 Lamb slaughters in Australia

Enterprises from which lambs sold for slaughter		% of total lambs slaughtered
First cross	8,586,295	
Second-cross	7,321,008	
Total 'prime' lamb	**15,907,303**	74%
Merino	**5,711,213**	26%
Total lambs slaughtered	**21,618,516**	

Source: MLA 2007 lamb survey

GHD

10 Bond Street Sydney NSW 2000

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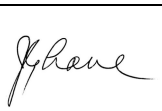
T: 2 9239 7100F: 2 9239 7199E: sydmail@ghd.com.au

Document Status

Rev No.	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
1	Joe Lane	Cheryl K Gordon		Joe Lane		19/12/08
2	Joe Lane	Emily Ray		Joe Lane		30/01/09
3	Joe Lane			Joe Lane		22/03/09