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Cost benefit analysis of Health4Wealth

A report for the Health4Wealth Project Steering Committee | 12 November 2021

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Limitations on the capture and sharing of pre-slaughter information on disease and conditions results in lost value across the pig and red meat supply chains

Diseases and conditions that cannot be easily identified pre-slaughter impact on productivity. This comes at a cost to the whole supply chain in both the pig and red meat industries. If information about diseases and conditions identified pre-slaughter could be captured and shared this would enable producers to take the most appropriate actions to address these diseases and conditions.

Health4Wealth is a partnership between Australian Pork Limited, Meat & Livestock Australia, Australian Meat Processor Corporation, Agriculture Victoria and the South Australian Research and Development Institute. Health4Wealth aims to develop a standardised approach to data collection and producer feedback for visible disease-related carcass and offal condemnations for sheep, cattle, pig and goat meat.

What value would information collection and sharing deliver to producers and processors across the pig and red meat industries? Sharing information will allow producers to make informed decisions about disease management to maximise yield outcomes, delivering benefits across the supply chain. However, a better understanding of the benefits across the supply chain relative to the costs of a national rollout is required. This will confirm the value of a national rollout and identify the tools and enablers required to facilitate this rollout. It will also motivate the continued efforts of producers, processors, rural research development corporations and governments to improve the quality of animals within the supply chain.

Background and scope

This business case summarises a body of work involving the preparation of case studies and development of cost-benefit analyses, in consultation with rural and research development corporations

Frontier Economics was appointed to assess the potential value to the industry of a national rollout of the Health4Wealth program. This business case confirms there is very significant potential value of a national rollout for the industry as a whole, and specifically for producers and processors across the sheep, cattle and pig industries.

This business case sets out our analysis and findings. More information is provided in the attached report. This business case summarises a significant body of work over a 12 month period, involving consultation with processors, rural and research development corporations and industry experts. Frontier Economics analysis involved preparing case studies and undertaking cost-benefit analyses, in consultation with Australian Pork Limited and Meat & Livestock Australia (see **Figure 1**).

Figure 1: Scope

Source: Frontier Economics

Health4Wealth pilot trial

The Health4Wealth pilot trial delivered value to processors and identified tools and enablers required to facilitate a successful national rollout. It is too early to identify the value of the pilot trial to producers

Frontier Economics undertook a cost-benefit analysis of the Health4Wealth pilot trials. This cost-benefit analysis focussed on the observed costs and benefits from the Health4 Wealth pilot trials.

Nine case studies were prepared to better understand the impacts of the Health4Wealth pilot program. Data and insights from the case studies informed the analysis and recommendations for tools and enablers required to facilitate a national rollout.

The cost-benefit analysis of the Health4Wealth pilot trial confirmed that peri-mortem data collection is relatively low cost, and therefore beneficial, for processors.

There is limited information available to measure the producer benefit as a result of the pilot program. Frontier Economics developed a methodology to quantify the potential producer benefit of the national rollout. Information collection to improve this estimate is an important enabler for the national rollout. We have set up a template for analysing and monitoring producer benefits from improved disease and defect control. Demonstrating the potential benefit of a national rollout to producers will be important in securing their participation.

National rollout of Health4Wealth

A structured approach was adopted to identify relevant and quantifiable conditions and estimate the potential value of a national rollout

The potential value of a national rollout of the Health4Wealth program was estimated in a series of steps, set out in **Figure 5**:

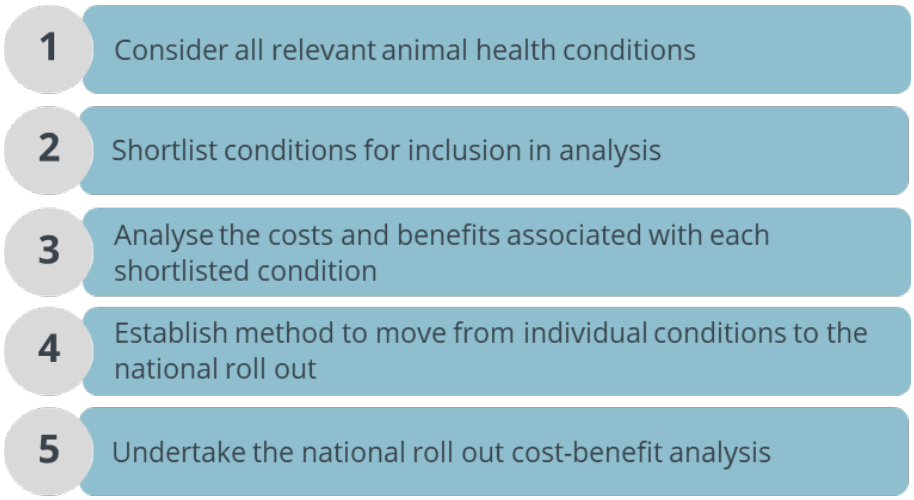
1. 40 potential animal health conditions which could be ascertained by peri-mortem inspections were identified.
2. Filters were applied to identify the most relevant and significant animal health conditions for valuation, and remove those conditions where no information is available to inform the analysis. This identified 6 sheep conditions, 3 cattle conditions and 7 pig conditions which pose the most significant costs for producers and processors for valuation.

3. The costs and benefits for each condition were estimated, drawing on the best available information and discussions with industry experts.
4. The parameters for a national rollout were established, including the time required for processors to rollout a national system, for producers to respond to feedback and for disease addressing actions to take effect.
5. Finally, the potential benefit of a national rollout was estimated for the pig and red meat industries together, and for producers and processors in the sheep, cattle and pig industries.

This analysis is informed by insights from the Health4Wealth pilot trials, published studies into the costs and benefits of animal health conditions, and consultation with industry experts. In many cases it was necessary to develop assumptions in order to estimate the potential benefit of a national rollout. A conservative approach was adopted in each case, consistent with cost-benefit analysis best practice.

The methodology adopted in this report provides a framework that can be used to update the analysis with more accurate information as it becomes available, and to test that the potential benefits are being realised as the national rollout progresses.

Figure 2: Cost-benefit analysis assessment process



A national rollout has the potential to deliver significant value across the supply chain in the sheep, cattle and pig industries

Our analysis finds there is significant value in a national rollout of the Health4Wealth program for the industry as a whole. The national rollout cost-benefit analysis results across the sheep, cattle and pig industries are presented in **Table 1**. In total across the industry the present value of the benefits of a national rollout exceeds the present value of the costs by over three times. This is a very significant finding – it demonstrates there are large potential benefits across the supply chain of a national rollout.

Both producers and processors are likely to benefit from a national rollout

The results demonstrate there is likely to be a strong value proposition for both producers and processors. For both groups the present value of the potential benefits exceed the present value of the costs by a substantial amount – over two times in the case of processors and more than six times for producers. This provides strong evidence that participants across the supply chain can

derive significant value from a national rollout. In practice the benefit to individual producers will vary, reflecting the conditions present, the prevalence in their herds and the effectiveness of their controls.

The analysis finds producers have a higher benefit-cost ratio than processors. This may be because the up-front and ongoing costs of capturing and feeding back the peri-mortem data are incurred by processors rather than producers. However, there is still a very material value proposition for processors to record and disseminate peri-mortem data, with the present value of benefits exceeding costs by more than two times.

Table 1: National rollout CBA results

	Present value of benefits ($m)	Present value of costs ($m)	Net Present Value ($m)	Benefit-Cost Ratio
Producers	461.80	75.85	385.95	6.09
Processors	297.79	134.53	163.26	2.21
Total	759.59	210.38	549.21	3.61

Frontier Economics tested the impact of changes in key assumptions. The sensitivity analysis shows that the findings are robust to changes in key assumptions including the discount rate and disease prevalence, which could act as a proxy for producer take up and response. This gives further weight to the significant potential value that could be delivered through a national rollout of the Health4Wealth program.

There is a strong value proposition of a national rollout for sheep, cattle and pig producers and processors

The value of a national rollout is reported separately for sheep, cattle and pig producers and processors. The results demonstrate strong value propositions for each industry:

- The results for the sheep industry demonstrate the value proposition of a national rollout are very strong – even stronger than the total across the sheep, cattle and pig industries. The results show the present value of the benefits for sheep producers and processors in total exceed the present value of the costs by more than four times.
- The results for cattle largely align with the overarching national rollout results. The results demonstrate that the industry has the potential to derive benefits from the national rollout that exceed costs by more than three times.
- The results for the pig industry demonstrate there is a very strong value proposition for a national rollout for both producers and processors. Across the industry the present value of benefits exceeds the present value of costs by nearly four times.

Work needs to be done to collect the information required to confirm and deliver these benefits. We have developed a framework to assess (and monitor) farm-level benefits across industry once this information comes to hand.

This analysis drew on the best available data and information. However, a number of assumptions and estimates were required in this analysis. This underlines the importance of

improving the evidence base, collecting robust data through a Health4Wealth rollout and ensuring the right tools and enablers are in place to realise the forecast benefits.

Tools and enablers

A series of tools and enablers required to facilitate the national rollout of the Health4Wealth program and to enable the benefits to be monitored and communicated to key stakeholders were identified drawing on the case studies and the data gaps identified during the cost-benefit analysis. These tools and enablers identify areas where further analysis and support is required to ensure the take up and therefore potential benefits of a national rollout are realised.

Standardised application of meat inspection classification system

Ensuring the integrity of the data is critical for a successful national rollout of the Health4Wealth program. Differences in reporting between meat inspectors has the capacity to undermine the effectiveness of the Health4Wealth program. Ongoing effort is required to deliver a standardised meat inspection classification system — this extends beyond the production of the disease and defect classification standard to standardising use and delivery of the standard. This will ensure the information collected and shared with producers will drive effective actions and deliver the potential benefits of the Health4Wealth program.

Integration of plant data recording into existing systems

Many abattoirs have invested in data recording and management systems to meet their own needs, and the needs of their customers. Part of the challenge of embedding the national disease and defect standards into existing abattoirs is meshing the national standard into the bespoke systems already in place. A key component for consistency of classification will therefore be training of meat inspectors in conditions and classification schemes.

Actions to facilitate take up (with both processors and producers)

Additional peri-mortem data can help producers reduce disease/defects in animals, but education and support are needed to ensure that both producers and processers know how to best utilise the data. This can be encouraged through extension activities and improved price signalling around conditions.

There is a role for research development corporations to assist in developing a suite of extension tools to promote awareness of peri-mortem disease information:

- Rural research development corporation-driven local field days and workshops featuring disease management experts and farm management consultants who can work with and describe to farmers the best way to control specific diseases and defects in the local region
- Supplier benchmarking by the processor (e.g. Your line of cattle was ranked in the bottom 40% of supply to use for disease X)
- Establishment of local producer demonstration sites (showcasing local control)
- Producer case studies
- Access to disease fact sheets
- Processor-driven follow-up for producers who implement change on their farm to explore change in performance.

Strong collaboration between processors, rural and research development corporations, and local disease experts and farm consultants to improve the quality of animals within the supply chain is required.

For some conditions, the benefits principally relate to the improvements in the quality of the offal, but there is often no price signal for producers related to these improvements. Reform in this space, such as processors paying a premium to producers for higher quality offal, could lead to better outcomes and further increase the value proposition for peri-mortem data collection.

Address data gaps around the costs and benefits of conditions

Several conditions were filtered out of the analysis based on a lack of data. Developing an understanding of the causes, costs and benefits associated with these conditions (such as nephritis for cattle and abscess and colitis for pigs) will assist producers with comprehend their likely returns from reducing prevalence of these conditions, and to also allow the evaluation of the national rollout to be broadened to cover additional conditions.

Further research in the pig industry is required to improve the understanding of the impact of conditions and the effectiveness and cost of actions to prevent, treat and control these conditions. This will improve the estimated potential value of a national rollout and provide a valuable resource to the industry.

The development and refinement of individual disease economic models both at farm level, and with output scalable to industry level, are recommended. These models will combine the physical impact of disease and disease controls with important economic parameters. This will enable the likely benefit accruing to a producer from increased/improved control of disease within their herd or flock to be modelled. There are economies of scale from addressing this across the key diseases of each industry. Construction of the first disease model takes time, but this disease and economic framework then becomes a template for modelling the next disease. Models should be built at farm-level. Output can be easily scaled to estimate industry impact. The converse is rarely true due to the way industry-level models are typically constructed. A scalable farm-level model can be used by industry to identify diseases that take the most profit from industry and control methods that have the best cost-benefit. Basic models of this form were built for many diseases as part of this project. Their ongoing refinement and extension are recommended to industry.

Development of a monitoring and evaluation system

The national rollout CBA is a forward-looking analysis based on the best available evidence. The analysis identified several key areas where further data is required:

- Producer impacts: including the additional cost (treatment costs, herd management etc.) and benefits (increased production), and the profiling of these costs and benefits to test assumptions around take up, prevalence and effectiveness. It may be that a survey of producers could be undertaken at an appropriate point in time.
- Processor impacts: including additional meat inspector costs of a processor participating in the pilot program and the cost for support and education programs. Additional data for productivity related benefits would be highly desirable.

Systems and processes are required to collect this baseline information. This will enable analysis to confirm the intended benefits are being realised, and inform action as required to address any issues or barriers.

1 Introduction

1.1 Background and scope

This report establishes a methodology and estimates the potential benefit of Health4Wealth national rollout

Diseases and conditions that cannot be easily identified pre-slaughter impact on productivity. This comes at a cost to the whole supply chain, affecting both the pig and red meat industries.

Health4Wealth aims to develop a standardised approach to data collection and producer feedback for visible disease-related carcass and offal condemnations for sheep, cattle, pig and goat meat. Sharing information will allow producers to make informed decisions about disease management to maximise yield outcomes, delivering benefits across the supply chain. Health4Wealth is a partnership between Australian Pork Limited, Meat & Livestock Australia, Australian Meat Processor Corporation, Agriculture Victoria and the South Australian Research and Development Institute.

In this context Australian Pork Limited, on behalf of the Health4Wealth Project Steering Committee, appointed Frontier Economics to undertake *ex-post* and *ex-ante* cost benefit analyses (CBAs) of the disease and defect data, undertake case studies, update the business case and prepare a final report (see **Figure 3**).

This report establishes a methodology for valuing the benefits of Health4Wealth, quantifies this potential value and identifies key tools and enablers to ensure a successful national rollout. It summarises a significant body of work over a 12 month period, involving consultation with processors, rural and research development corporations and experts.

Figure 3: Scope

Source: Frontier Economics

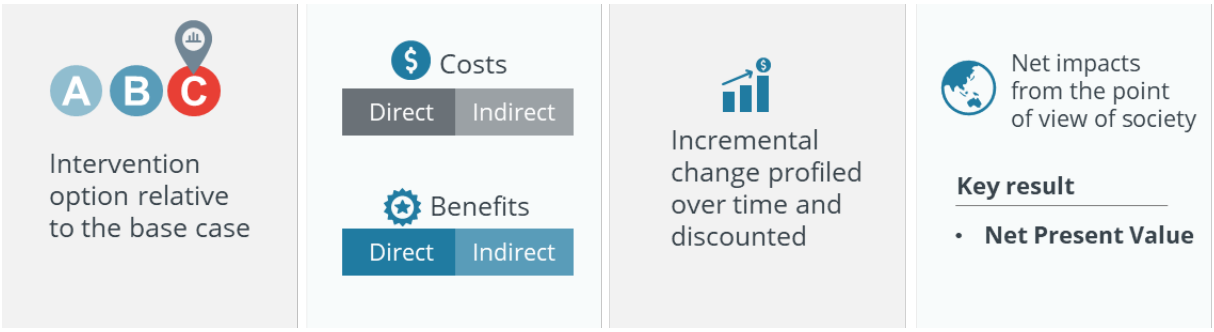
1.2 Methodology

A cost-benefit analysis methodology is adopted to estimate the benefits of Health4Wealth

A cost-benefit analysis (CBA) provides a robust framework to assess the impacts of a national rollout of the Health4Wealth program. A CBA is an assessment tool that compares the costs associated with the Health4Wealth program with the benefits. The analysis is incremental in that

it looks at additional costs and benefits over and above a base case scenario where the Health4Wealth program is not rolled out nationally. The process is shown in **Figure 4** below.

Figure 4: CBA overview



Source: Frontier Economics.

The CBA looks at impacts over time for cattle, sheep and pigs. The analysis splits out costs and benefits which will be incurred by processors and producers respectively.

A series of case studies were prepared on the Health4Wealth pilot trials

Nine case studies were prepared to better understand the impacts of the Health4Wealth pilot program. The case studies demonstrated that the benefits of Health4Wealth are clear for processors. However, the benefits for producers, and the actions at a farm-level required to deliver those benefits, are less clear. The findings from the case studies are summarised in Box 1, and the case studies are included in **Appendix A**. Data and insights from the case studies informed the national rollout CBA and the recommendations around tools and enablers.

Frontier Economics undertook a qualitative CBA of the Health4Wealth pilot trials

The analysis starting point was the undertaking of an *ex-post* CBA of the Health4Wealth pilot trails. The *ex-post* CBA focussed on the observed costs and benefits from the Health4 Wealth pilot trials, and is provided in **Appendix B**.

This analysis found that the introduction of peri-mortem data collection is relatively low cost, and therefore beneficial, for processors.

There is limited qualitative evidence available to assess additional producer benefit as a result of the pilot program. A methodology to address this information gap was developed for the national rollout and information collection was identified as an important tool for the national rollout. Demonstrating the potential benefit of a national rollout to producers will be important in securing their participation.

Box 1: Key findings from case studies

Processor perspective: Processors experience losses from the slaughter of diseased/defective animals in several ways:

- The direct loss of saleable meat and offal (condemnation and trim)
- The cost of extra processing
- The need to process extra animals to meet consignment specifications
- The costs of (extra) disposal of condemned material.

As such, there is a clear value proposition for them to use peri-mortem data to increase the productivity of processing.

Producer perspective: The situation for producers is more complex:

- On one hand they clearly get higher returns from reducing disease/defects in animals sent for processing.
- On the other hand, many conditions that result in carcase downgrades or trim are endemic and cannot be eradicated.

This results in a trade-off between additional expenditure to reduce disease/defects and the incremental financial gain. Additional peri-mortem data can help producers reduce disease/defects in animals, but education and support are needed to ensure that both producers and processers know how to best utilise the data.

A structured approach was adopted to identify relevant and quantifiable conditions and estimate the benefits of a national rollout

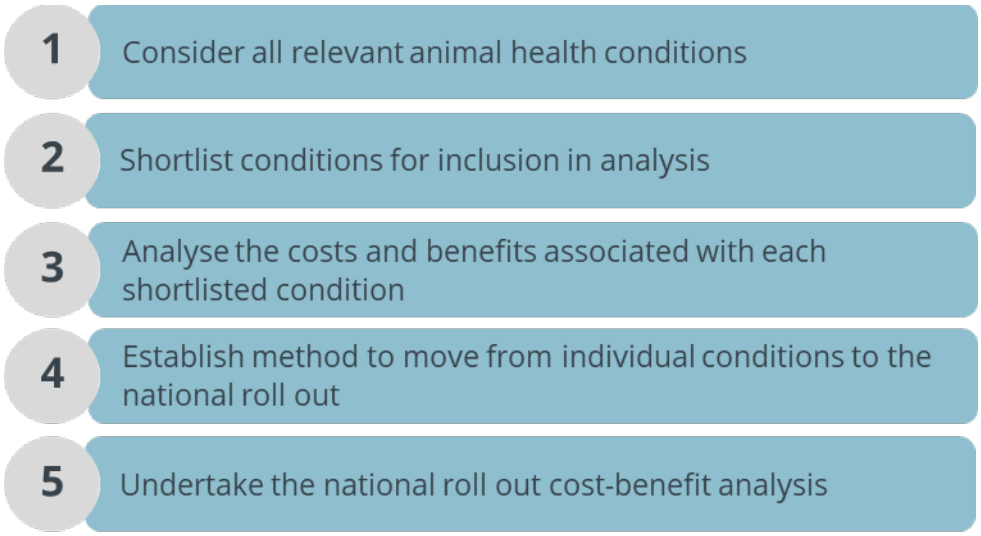
Frontier Economics developed a methodology to assess the benefit of a national rollout of the Health4Wealth program, set out in **Figure 5**. The first stage developed a long list of potential animal health conditions which could be impacted by peri-mortem inspections. Second was the application of filters to identify the most relevant and material animal health conditions for valuation in the CBA. Third was the analysis of costs and benefits for each condition included in the CBA. Finally, parameters for a national rollout were established, before estimating the potential benefit of a national rollout.

This analysis is informed by insights from the Health4Wealth pilot trials, published studies into the costs and benefits of animal health conditions and consultation with industry experts. In many cases it was necessary to develop assumptions to estimate the potential benefit of a national rollout. A conservative approach was adopted in each case, consistent with CBA best practice.

Frontier Economics found a national rollout of the Health4Wealth program is likely to deliver very significant benefit for both processors and producers across the sheep, cattle and pig industries. For each industry, both producers and processors stand to derive very material benefit from a national rollout.

The methodology adopted in this report provides a framework that can be used to confirm the magnitude of potential benefits with more accurate information as it becomes available, and to test that the potential benefits are being realised as the national rollout progresses.

Figure 5: CBA assessment process



The study concludes by identifying tools and enablers to facilitate the successful national rollout

Frontier Economics drew on the case studies and data gaps identified in preparing the case studies to identify a series of tools and enablers required to facilitate the national rollout of the Health4Wealth program, and to enable the benefits to be monitored and communicated to key stakeholders.

1.3 About this report

This report is structured as follows:

- **Section 2** provides an overview of relevant animal conditions and filtering conditions for analysis
- **Section 3** analyses the costs and benefits by condition
- **Section 4** sets out the approach to move from individual conditions to a CBA of the national rollout
- **Section 5** summarises the national rollout CBA results
- **Section 6** identifies key tools and enablers for the identified benefits to be delivered in practice.

Additional information is provided in a series of appendices:

- **Appendix A** presents the case studies
- **Appendix B** presents the ex-post CBA of the Health4Wealth pilot trials
- **Appendix C** presents more detail on the ex-ante CBA of the national rollout.

2 Relevant animal health conditions

This section discusses the selection of animal health conditions for inclusion in the CBA. The reasons for this were twofold. First, there is a limit to the number of conditions that can be captured by inspectors in peri-mortem data collection – this was an insight from the case studies. Second, the available data on the costs and benefits of treating conditions is mixed. This analysis focuses on conditions where impacts are better understood.

The starting point for the analysis was to develop a long list of potential animal health conditions which could be impacted by peri-mortem inspections (Section 2.1). A series of filters were developed to ensure both information is available, and that the most relevant and material health conditions are valued in the CBA (Section 2.2). These filters were then applied to identify those conditions for inclusion in the CBA (Section 2.3).

2.1 Long list of conditions

Frontier Economics developed a long list of potential animal health conditions for inclusion in the analysis. This long list of more than 40 conditions is presented in **Table 2**. The long list was developed by referring to industry data, including Animal Health Australia's National Sheep Health Monitoring Project data, , and previous studies in this area.

Table 2: Longlist of potential animal health conditions for inclusion in analysis

Sheep	Cattle	Pigs
Liver fluke	Liver fluke	Mycoplasma
Pneumonia/ pleurisy	Nephritis	Ileitis
Caseous lymphadenitis (CLA)	Hydatids	Pleurisy/Pneumonia
Sheep measles	Liver abscess	Ascaris
Sarcocystis	Pneumonia	Arthritis
Grass seed lesions	Bovine viral diarrhoea	Dermatitis
Arthritis	Bloat	Melanoma
Cancer	Bovine ephemeral fever	Bruising
Dog bite lesions	Botulism	Erysipelas
Hydatids	Vibrio	Abscess
Lung worm	Pink eye	Colitis
Ovine Johne's Disease	Clostridial	Contamination
	BJD	Hernia
	Dystocia	Fever
		Nephritis
		Peritonitis
		Tail Bite

Source: National Sheep Health Monitoring Project data, Animal Health Australia data, and Greenleaf (2019), Revision of supply chain model supporting objective measurement (OM) strategy & value proposition to stakeholders

2.2 Filters applied to develop short list of conditions

A series of filters were applied to identify conditions for valuation in the CBA. The filters ensure those animal health conditions which are most relevant and material are included in the CBA. They also ensure information will be available under the Health4Wealth program to support the CBA.

Four filters were identified:

1) **Identified at abattoir?** If a disease is not exclusively detectable at the peri-mortem inspection, then the Health4Wealth program will not add value by providing data on these conditions. For example, while tail bite in pigs can be detected peri-mortem it can also be directly observed by producers. More broadly, tail bite in pigs is not a condition which is understood very well. As such, this condition has been excluded under this filter.

   Diseases which are not exclusively identified in peri-mortem inspection will therefore not be included in the economic analysis.

2) **Information available?** For a disease or condition to be included in the economic analysis, there needs to be reliable information about the costs associated with the disease, and its prevalence. For example, there isn't robust data available on cause (and therefore the controls) or the impacts of nephritis in cattle to allow the costs and benefits of changing prevalence of the condition to be valued. Another example is ileitis in pigs where expert opinion and available data suggests that reducing herd prevalence would both reduce overall producer costs and increase their production gains as in severely affected herds producers spend more controlling the symptoms of disease than would be incurred if they implemented effective controls for disease. Therefore, in this case, there is only benefit and no cost. As such, nephritis in cattle and ileitis in pigs are excluded under this filter.

   Although assumptions could be made to assist in the modelling, a disease will not be included in the analysis where no reliable foundation valuation could be identified – especially the effectiveness and cost of controls.

3) **Material?** Some diseases are detectable and have sufficient data to be included in the model but have no economically significant impact on the industry. Such diseases are not included for analysis.

4) **Controllable and value proposition?** Some diseases are detectable and have sufficient data to be included in the model, but cannot be reasonable controlled by producers or available data shows that costs to producers exceed benefits to producers (i.e. the available data suggests there isn't a value proposition for producers to reduce prevalence). Such diseases are not included for analysis.

The conditions removed by filter are detailed in **Table 3**.

Table 3: Filtering of potential animal health conditions for inclusion in analysis

Filter	Sheep	Cattle	Pigs
Identified at abattoir?	-	Bovine ephemeral fever Bloat Bovine viral diarrhoea virus Botulism/clostridial diseases Dog bites Vibrio Pink eye Dystocia BJD	Fever Tail Bite Mycoplasma Arthritis
Information available?	Dog bite lesions Hydatids	Nephritis Peritonitis Clostridial	Abscess Colitis Contamination Hernia Ileitis
Material?	Ovine Johne's Disease Cancer Lung worm	-	Peritonitis Nephritis
Controllable and value proposition?	Liver fluke	Liver abscess	-

2.3 Conditions for valuation in the CBA

Having applied the filters, a list of animal health conditions for inclusion the CBA were reached. These are presented in **Table 4**. The analysis identified 6 sheep conditions, 3 cattle conditions and 7 pig conditions for valuation in the CBA. While it may be that peri-mortem data collection and feedback allows for more conditions to be addressed, there are two key points here. First, this analysis captures a number of the most significant conditions identified in previous analyses for

sheep.[1] Similar studies on the costs of key conditions are not available for cattle and pigs. Second, this makes the CBA conservative. That is to say, if the CBA for these conditions shows a value proposition for a national rollout of the Health4Wealth program, that there is upside in this result.

Table 4: Animal health conditions to be included in the analysis

Sheep	Cattle	Pigs
Pneumonia/ pleurisy	Liver fluke	Pleurisy/Pneumonia
Caseous lymphadenitis (CLA)	Hydatids	Melanoma
Sheep measles	Pneumonia	Ascaris
Sarcocystis		Dermatitis
Arthritis		Bruising
Grass seed lesions		Erysipelas

Table 5 presents the annual real undiscounted benefits and costs to producers after the ramp up period has ended, and the new steady state has been reached.

[1] Greenleaf Enterprises for Australian Pork Limited (2017), *Enhancing supply chain profitability through reporting and utilisation of peri-mortem information by livestock producers – business case development.*

Table 5: Annual Value of Disease Reduction Post Ramp-up

		2030 Annual Benefit ($m)	2030 Annual Costs ($m)	Net Value ($m)
Cattle	Hydatids	11.37	-	11.37
	Liver fluke	6.62	3.12	3.50
	Pneumonia	8.72	0.65	8.07
Sheep	CLA	1.33	0.07	1.26
	Pneumonia	2.23	0.05	2.18
	Sarcosystis	2.20	0.05	2.15
	Sheep Measles	1.83	-	1.83
	Arthritis	5.22	0.03	5.19
	Grass Seeds	1.84	0.05	1.79
Pigs	Ascaris	1.18	0.05	1.13
	Pleurisy	3.69	0.72	2.97
	Arthritis	1.75	0.73	1.02
	Erysipelas	1.41	-	1.41
	Bruising	0.12	0.05	0.07
	Dermatitis	1.10	-	1.10
	Melanoma	0.01	-	0.01

3 Costs and benefits by condition

Having identified the conditions to be valued in the CBA, the next step is to understand the costs and benefits of each condition. In this Section each of the conditions for valuation in the CBA are considered in turn. For each condition this section presents:

- An overview of the condition
- An overview of condition prevalence, control measures and high-level impacts of the condition on carcase weight, organs etc.
- Quantitative values for the cost of treatment, cost of prevention and management, production losses and offal loss by disease prevalence

The prevalence of a condition within a herd is the key consideration when determining the cost of control, treatment, and production losses due to the nature of disease costs. Beyond the larger number of infected animals, higher disease prevalence can require more costly interventions to manage outbreaks, distribute vaccinations, and prevent extreme outcomes of clinical cases. Consider the example of a single diseased animal in an otherwise healthy herd. The single case can be safely quarantined from the rest of the herd with minimal cost. Compare this to a herd with the majority of animals already infected. Quarantining the infected animals may no longer be effective or may be significantly more costly to implement.

The costs and benefits by condition draw on the best available evidence and have been discussed with industry experts including Animal Health Australia, SARDI and veterinary consultants. In the cattle and sheep industries the information presented drew on resources that have been developed by industry experts and in consultation with a wide range of stakeholders to provide a comprehensive economic assessment of the most significant endemic diseases currently affecting the red meat industries. In particular, for cattle the key reference was the *Priority list of endemic diseases for the red meat industries* and for sheep on the recently launched *Sheep health tool*.[2]

Similar resources on the costs and benefits by condition were not available for pigs. Published studies were referred to where information was available, and assumptions were developed in cooperation with industry experts where information was not available. While the assumptions on the costs and benefits by condition for pigs draw on the best available knowledge in the industry at the current time, there is scope for further research in this area. Research to improve the understanding of condition impacts and the effectiveness and cost of actions to avoid, treat and control these conditions will provide a valuable resource for the industry. This will improve the estimated potential value of a national rollout and provide a valuable resource as they seek to realise those benefits.

[2] GHD Pty Ltd (Joe Lane) with Tristan Jubb, Richard Shephard, John Webb-Ware, Geoffry Fordyce (2015), *Priority list of endemic diseases for the red meat industries*, 20 March, Meat & Livestock Australia; Meat and Livestock Australia, *Sheep health tool*, Available at: https://tools.mla.com.au/SheepHealth/home

Sheep conditions (Section 3.1), cattle conditions (Section 3.2) and pig conditions (Section 3.3) are considered in turn below. We present the assumptions on the costs and benefits by condition used in the CBA. For each disease:

- Benefits and costs are reported per head within a herd of a given prevalence
- Benefits are based on moving from a higher to moderate or moderate to low level of prevalence
- It is assumed if prevalence is low, producers will not take action (eradication for most conditions is not economically viable or possible).

For example, for pneumonia/pleurisy in sheep a producer with a highly affected herd is incurring a production loss of $4.39/head. The producer could spend $0.11/head on treatment and $0.10/head on prevention, generating a net benefit of $4.18/head in avoided production losses for each highly affected animal. Processors would receive an additional benefit of $1.84/head in avoided offal loss for each affected animal. Similar assumptions are presented for each condition below.

3.1 Sheep conditions

Pneumonia/pleurisy

Condition overview	Pneumonia is an infection and inflammation of the lungs which in severe cases can extend to the pleura (pleurisy). Disease results in damage to the lungs and airways, and can result in adhesions between the lungs and the chest wall. Management is mostly by stress control, good nutrition, prevention of mixing of mobs, careful drench techniques, and managing outbreaks.	

Overview of condition prevalence, control measures and impacts of condition	• 25% of national flock endemically affected
	• 7.5% of sheep from affected farms identified with pleurisy at meat inspection
	  ○ Uncontrolled flock prevalence = 10%
	  ○ Controlled flock prevalence = 2%
	• Control by managing risk and treating those affected with antibiotics
	• Some vaccines available
	• 1% mortality
	• Affected lungs: condemned organ
	• Affected carcases: 7% lighter and 2 kg trim	

Producer cost of treatment	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.11 / head $0.03 / head $0.01 / head
Producer cost of prevention and management	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.10 / head $0.08 / head $0.05 / head
Producer production loss	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$4.39 / head $2.92 / head $2.26 / head
Producer benefit from improved control	• High to medium affected • Medium to lowly affected	$1.57 / head $0.71 / head
Processor offal loss	• Value of offal lost per infected head:	$1.84 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts. See B.AHE.00100 page 150.

Caseous lymphadenitis (CLA or 'cheesy gland')

Condition overview	CLA is ubiquitous. Infection results in the formation of lymph node abscesses throughout the body. There are no effective treatments, but controls include managing spread risks like proper shearing techniques, managing stocking density and there is a vaccination that is partially effective. Good control measures can lower prevalence of disease, but it is impossible to eradicate.	

Overview of condition prevalence, control measures and impacts of condition	• 100% of national flock endemically affected
	• 7% of sheep from affected farms identified with CLA at meat inspection
	  ○ Uncontrolled flock prevalence = 10%
	  ○ Controlled flock prevalence = 2%
	• Control by managing risk and treating affected animals early
	• Affected organs: lungs, liver, spleen condemned. (50% affected carcases lose all offal)
	• No weight loss or reproductive impact
	• Severely affected carcases: 0.3% affected condemned, avg. 1kg trim	

Producer cost of treatment	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.00 / head $0.00 / head $0.00 / head
Producer cost of prevention and management	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.18 / head $0.14 / head $0.11 / head
Producer production loss	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$1.78 / head $0.89 / head $0.44 / head
Producer benefit from improved control	• High to medium affected • Medium to lowly affected	$1.29 / head $0.48 / head
Processor offal loss	• Value of offal lost per infected head:	$7.81 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.
See B.AHE.00100 page 153

Sheep measles

Condition overview	Sheep measles affect sheep infected with a tapeworm from dogs, dingoes or foxes. These cysts produce no obvious effects on the animal's life but are visible at meat inspection and this results in trim and condemnation. Control is by regular tapeworm control of farm and pet dogs, disposal of sheep offal, and effective management of stray and wild dogs and foxes on farm.

Overview of condition prevalence, control measures and impacts of condition	• 100% of national flock endemically affected; 50% of lines affected
	• 5% of sheep from affected farms identified with sheep measles at meat inspection
	  ○ Uncontrolled flock prevalence = 12%
	  ○ Controlled flock prevalence = 2%
	• Control by wild dog control, worming farm dogs and home kill offal control
	• Affected organs: heart and diaphragm condemned (10% affected carcases)
	• Severely affected carcases (more than 5 cysts): condemned (5%), avg 1 kg trim

Producer cost of treatment	• Highly affected herds: $0.00 / head • Moderately affected herds: $0.00 / head • Lowly affected herds: $0.00 / head
Producer cost of prevention and management	• Highly affected herds: $0.01 / head • Moderately affected herds: $0.01 / head • Lowly affected herds: $0.01 / head
Producer production loss	• Highly affected herds: $2.20 / head • Moderately affected herds: $1.28 / head • Lowly affected herds: $0.37 / head
Producer benefit from improved control	• High to medium affected $0.92 / head • Medium to lowly affected $0.91 / head
Processor offal loss	• Value of offal lost per infected head: $1.64 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.
See B.AHE.00100 page 172

Sarcocystis

Condition overview	Sarcocystis, like sheep measles, are cysts in tissues passed from cats. Infection is more common in southern Australia where there are high cat populations. The cysts produce no determinantal impacts on sheep health or productivity but are readily detected at meat inspection. Control revolves around excluding unwanted cats from sheep areas – both domestic and wild, and not feeding uncooked sheep meats to farm cats.	

Overview of condition prevalence, control measures and impacts of condition	• 50% of national flock endemically affected; 5% of lines affected
	• 5% of sheep from affected farms identified with sheep measles at meat inspection
	  ○ Uncontrolled flock prevalence = 12%
	  ○ Controlled flock prevalence = 2%
	• Cat management
	• Affected organs: condemned (2%)
	• Affected muscle: trimmed
	• Severely affected carcases: condemned (5%), avg 2 kg trim retained carcases	

Producer cost of treatment	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.00 / head $0.00 / head $0.00 / head
Producer cost of prevention and management	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.10 / head $0.08 / head $0.05 / head
Producer production loss	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$2.94 / head $1.71 / head $0.73 / head
Producer benefit from improved control	• High to medium affected • Medium to lowly affected	$1.25 / head $1.01 / head
Processor offal loss	• Value of offal lost per infected head:	$0.39 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.
See B.AHE.00100 page 179

Arthritis

Condition overview	Arthritis is a common problem of lambs and occasionally older sheep. Causes include **several bacteria and risk factors include marking, mulesing, shearing, and any procedure that damages the skin** in addition to: • Poor hygiene • Wet muddy conditions • Poor nutrition Economic losses result from on farm mortality, lower production of surviving lambs, treatment and prevention costs, and post farm gate condemnation of carcases.

Overview of condition prevalence, control measures and impacts of condition	• 100% of national flock at risk; 5% of lines affected, around 1% of sheep affected
	• 5% of sheep from affected farms identified with sheep measles at meat inspection
	  ○ Uncontrolled flock prevalence = 5%
	  ○ Controlled flock prevalence = 0.5%
	• Hygiene, management and vaccination can help control
	• Affected organs and joints: condemned
	• Affected muscle: trimmed
	• Severely affected carcases: condemned (2%), trimmed (7%) averaging 2 kg trim

Producer cost of treatment	• Highly affected herds: $0.00 / head • Moderately affected herds: $0.00 / head • Lowly affected herds: $0.00 / head
Producer cost of prevention and management	• Highly affected herds: $0.45 / head • Moderately affected herds: $0.42 / head • Lowly affected herds: $0.42 / head
Producer production loss	• Highly affected herds: $5.80 / head • Moderately affected herds: $1.16 / head • Lowly affected herds: $0.58 / head
Producer benefit from improved control	• High to medium affected $4.67 / head • Medium to lowly affected $0.58 / head
Processor offal loss	• Value of offal lost per infected head: $0.26 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.
See B.AHE.00100 page 137

Grass seed lesions

Condition overview	Grass seeds can cause several serious production and health problems in sheep, affecting the eyes, skin, meat and wool. Controls range from the simple (exclusion grazing, topping, spraying) to more complex (early lambing/weaning/shearing/sale) to system-level (changing the enterprise - feeder lambs versus fat lambs).	
Overview of condition prevalence, control measures and impacts of condition	• 100% of national flock at risk; 50% flocks low prevalence (1% sheep affected), 30% flocks moderate prevalence (2% sheep affected) and 20% flocks highly affected (5% sheep affected); overall 2% sheep affected nationally • Grazing management, spraying/topping, shearing and lambing change, turnoff change and enterprise change are options available for affected producers • Affected skin, organs: condemned • Affected muscle: trimmed (heavily) • Severely affected carcases: condemned (2%), trimmed (7%) averaging 2 kg trim	
Producer cost of treatment	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.00 / head $0.00 / head $0.00 / head
Producer cost of prevention and management	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.20 / head $0.15 / head $0.15 / head
Producer production loss	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$2.30 / head $1.15 / head $0.46 / head
Producer benefit from improved control	• High to medium affected • Medium to lowly affected	$1.20 / head $0.69 / head
Processor offal loss	• Value of offal lost per infected head:	$0.26 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts and Animal Health Australia regional disease mapping. See MLA web resources

3.2 Cattle conditions

Liver fluke

Condition overview	Approximately 35% of Australia's southern beef industry may be periodically exposed to liver fluke. Beef herds with a significant fluke problem can reduce (but not eradicate) liver fluke. This can be done through a control program of strategic drenching, fencing off high-risk (swampy) ground, and management of younger animals.

Overview of condition prevalence, control measures and impacts of condition	• 35% of southern cattle farms potentially exposed to fluke; 5% of southern herd endemically affected
	• 7% of cattle from affected farms identified with liver fluke at meat inspection
	  ○ Uncontrolled flock prevalence = 15%
	  ○ Controlled flock prevalence = 2%
	• Control by drenching, monitoring and fencing
	• Affected livers: condemned organ
	• Affected carcases: 5% lighter

Producer cost of treatment	• Highly affected herds: $1.04 / head • Moderately affected herds: $0.31 / head • Lowly affected herds: $0.03 / head
Producer cost of prevention and management	• Highly affected herds: $10.24 / head • Moderately affected herds: $5.12 / head • Lowly affected herds: $4.14 / head
Producer production loss	• Highly affected herds: $12.91 / head • Moderately affected herds: $5.64 / head • Lowly affected herds: $0.98 / head
Producer benefit from improved control	• High to medium affected $13.12 / head • Medium to lowly affected $5.92 / head
Processor offal loss	• Value of offal lost per infected head: $9.57 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.

Hydatids

Condition overview	Hydatids is a disease caused by tapeworms passed from dogs, dingoes and foxes, making hydatids ubiquitous where these hosts are in abundance. Control is via management of dogs. Domestic dogs need to be excluded from accessing raw meat and offal, and be regularly wormed with a tapeworm treatment. Wild dog and fox control is required to support these measures.

Overview of condition prevalence, control measures and impacts of condition	• 90% of national flock endemically affected; 50% of lines affected
	• 5% of cattle from affected farms identified Hydatids at meat inspection
	  ○ Uncontrolled flock prevalence = 12%
	  ○ Controlled flock prevalence = 2%
	• Control by wild dog control, worming farm dogs and home kill offal control
	• Affected organs: heart and diaphragm condemned
	• Affected carcases: 5-10% lighter
	• Severely affected carcases: condemned

Producer cost of treatment	Northern Beef • Highly affected herds: $0.00 / head • Moderately affected herds: $0.00 / head • Lowly affected herds: $0.00 / head Southern Beef • Highly affected herds: $0.00 / head • Moderately affected herds: $0.00 / head • Lowly affected herds: $0.00 / head
Producer cost of prevention and management	Northern Beef • Highly affected herds: $0.00 / head • Moderately affected herds: $0.00 / head • Lowly affected herds: $0.00 / head Southern Beef • Highly affected herds: $0.00 / head • Moderately affected herds: $0.00 / head • Lowly affected herds: $0.00 / head
Producer production loss	Northern Beef • Highly affected herds: $11.94 / head • Moderately affected herds: $1.19 / head • Lowly affected herds: $0.15 / head Southern Beef • Highly affected herds:

	• Moderately affected herds: • Lowly affected herds:	$4.16 / head $0.21 / head $0.04 / head
Producer benefit from improved control	• High to medium affected • Medium to lowly affected	$10.78 / head $1.04 / head
Processor offal loss	Northern Beef • Value of offal lost per infected head: Southern Beef • Value of offal lost per infected head:	 $20.23 / infected $20.23 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.

Pneumonia

Condition overview	Bovine respiratory disease (BRD) is the most common disease of feedlot cattle. It is a multifactorial infectious disease predisposed by stress, co-mingling, diet, transport, weather and immunity status. Control is complex and includes careful animal selection, transport, vaccination and nutrition. Early diagnosis and treatment are essential for speedy recovery in affected animals.	

Overview of condition prevalence, control measures and impacts of condition	• 10-15% of national herd within a feedlot annually affected (2.6 M head annually)
	• 10% of cattle affected in feedlots
	  ○ High prevalence lot = 20%
	  ○ Low prevalence lot = 5%
	• Control by nutritional management and medications. Up to $70 per treatment course
	• Affected organs: Lungs condemned
	• Carcase trim: pleurisy linked, condemned
	• Affected carcases: 5-10% lighter	

Producer cost of treatment	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$7.50 / head $4.50 / head $3.00 / head
Producer cost of prevention and management	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$5.00 / head $2.50 / head $0.00 / head
Producer production loss	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$68.38 / head $27.76 / head $5.82 / head
Producer benefit from improved control	• High to medium affected • Medium to lowly affected	$46.12 / head $ 25.94 / head
Processor offal loss	• Value of offal lost per infected head:	$6.03 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.

3.3 Pig conditions

Pleurisy/Pneumonia

Condition overview	Mycoplasma infection is a common cause of serious pleurisy/pneumonia. It is endemic in most national pig herds. Vaccination is the most effective control, but reducing overcrowding, improving ventilation, and managing thermal conditions inside sheds are also key to limiting disease.	
Overview of condition prevalence, control measures and impacts of condition	• 50% herds assumed to be disease free • 25% low prevalence (10% pigs affected) • 15% medium prevalence (20% pigs affected) • 10% high prevalence (30% pigs affected) • Control by vaccination, medicated feed, treatment of sick pigs • Affected organs: Lungs condemned, ribs if pleura involved • Carcase: 2% fully condemned. Average affected carcase loss $25.13 (to producer) • Affected herds take 2-6 days longer to finish a batch of pigs • National average cost per pig is $1.54 per annum	
Producer cost of treatment	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.60 / head $0.40 / head $0.20 / head
Producer cost of prevention and management	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$4.76 / head $3.18 / head $1.69 / head
Producer production loss	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$21.29 / head $13.15 / head $5.93 / head
Producer benefit from improved control	• High to medium affected • Medium to lowly affected	$9.92 / head $ 8.91 / head
Processor offal loss	• Value of offal lost per infected head:	$0.74 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.

Ascaris

Condition overview	*Ascaris suum* is a parasitic worm found in the small intestine, causing not only diarrhea, but widespread damage to the liver and lungs. At the slaughterhouse, livers of affected pigs are confiscated.
Overview of condition prevalence, control measures and impacts of condition	• 75% herds assumed disease free • 25% low prevalence (50% pigs affected) • 7% medium prevalence (60% pigs affected) • 3% high prevalence (80% pigs affected) • Control by worming pigs (and avoiding soil contact). Worming sows in bad herds, treatment of sick pigs (pneumonia) - national average cost per pig is $0.24 per annum • Affected organs: liver, lung, intestines • Carcase: 0.21% fully condemned, average loss from condemned/trimmed carcase is $16.24 • Affected herds take 1-3 days longer to finish a batch of pigs • Feed conversion efficiency worsens in affected batches (2.8 vs 2.7) • Piglet mortality 1-3% • National average loss per pig: $0.06 (to producer)
Producer cost of treatment	• Highly affected herds: $0.14 / head • Moderately affected herds: $0.11 / head • Lowly affected herds: $0.09 / head
Producer cost of prevention and management	• Highly affected herds: $0.40 / head • Moderately affected herds: $0.15 / head • Lowly affected herds: $0.08 / head
Producer production loss	• Highly affected herds: $11.05 / head • Moderately affected herds: $7.41 / head • Lowly affected herds: $4.57 / head
Producer benefit from improved control	• High to medium affected $3.92 / head • Medium to lowly affected $2.93 / head
Processor offal loss	• Value of offal lost per infected head: $3.11 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.

Arthritis

Condition overview	Arthritis is inflammation of the joints and is usually caused by bacterial infection, exacerbated by hygiene and pen environment risk factors. Treatment is via antibiotics. Prevention is via hygiene and vaccination against pathogens.	
Overview of condition prevalence, control measures and impacts of condition	• 0% herds disease free • 60% low prevalence (5% pigs affected) • 30% medium prevalence (10% pigs affected) • 10% high prevalence (20% pigs affected) • Control by maintaining a clean environment, not overstocking, limiting skin lesions and vaccination (*S suis*, Improvac for severely affected herd) - national average cost per pig is $0.26 per annum • Affected organs: joints, primals, skin, organs (abscess) • Carcase: 7.9% fully condemned, average loss from condemned/trimmed carcase is $81.29 • Affected herds take 1-3 days longer to finish a batch of pigs • Feed conversion efficiency worsens in affected batches (2.8 vs 2.7) • Piglet mortality 1-3% • National average loss per pig: $0.90 (to producer)	
Producer cost of treatment	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.05 / head $0.03 / head $0.01 / head
Producer cost of prevention and management	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$3.28 / head $1.52 / head $0.16 / head
Producer production loss	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$10.13 / head $5.87 / head $2.69 / head
Producer benefit from improved control	• High to medium affected • Medium to lowly affected	$ 6.04 / head $ 4.56 / head
Processor offal loss	• Value of offal lost per infected head:	$0.90 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.

Dermatitis

Condition overview	Skin lesions can be the result of parasitic disease, infectious agents, physical damage by the environment or other pigs, and developmental causes. The risks to outdoor pigs are likely to be different to those suffered by pigs kept in enclosed environments. Control is via environmental and group management, and hygiene.	
Overview of condition prevalence, control measures and impacts of condition	• 0% herds disease free • 70% low prevalence (1% pigs affected) • 20% medium prevalence (2% pigs affected) • 10% high prevalence (5% pigs affected) • Control by maintaining a clean environment, not overstocking, limiting skin lesions - national average cost per pig is $0.17 per annum • Affected organs: joints, primals, skin, organs (abscess) • Carcase: 1.8% fully condemned, average loss from condemned/trimmed carcase is $39.73 (to producer) • Affected herds take 1-3 days longer to finish a batch of pigs • Feed conversion efficiency worsens in affected batches (2.8 vs 2.7) • No increase in piglet mortality • National average loss per pig: $0.13 (to producer)	
Producer cost of treatment	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.00 / head $0.00 / head $0.00 / head
Producer cost of prevention and management	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.13 / head $0.13 / head $0.13 / head
Producer production loss	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$7.02 / head $4.60 / head $2.30 / head
Producer benefit from improved control	• High to medium affected • Medium to lowly affected	$2.42 / head $2.30 / head
Processor offal loss	• Value of offal lost per infected head:	$0.20 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.

Melanoma

Condition overview	Melanoma is a form of skin cancer impacting melanocytes, which normally produce melanin to protect the skin from UV radiation. There is no effective treatment; some tumours naturally regress. Prevention is by changing genetics (not breeding from affected pigs)	
Overview of condition prevalence, control measures and impacts of condition	• 70% herds disease free • 15% low prevalence (5% pigs affected) • 10% medium prevalence (10% pigs affected) • 5% high prevalence (20% pigs affected) • Control by not breeding from affected pigs and choosing boars that are not carriers • Affected organs: skin, primals, joints, organs (via metastases) • Carcase: 1.1% fully condemned, average loss from condemned/trimmed carcase is $10.08 • Affected herds take no longer to finish a batch of pigs • Feed conversion efficiency is unaffected • Piglet mortality unaffected • 75% of melanomas detected • National average loss per pig: $0.01 (to producer)	
Producer cost of treatment	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.00 / head $0.00 / head $0.00 / head
Producer cost of prevention and management	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.03 / head $0.03 / head $0.03 / head
Producer production loss	• Highly affected herds: • Moderately affected herds: • Lowly affected herds:	$0.04 / head $0.02 / head $0.01 / head
Producer benefit from improved control	• High to medium affected • Medium to lowly affected	$0.02 / head $0.01 / head
Processor offal loss	• Value of offal lost per infected head:	$0.12 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.

Bruising

Condition overview	Bruising is caused by damage to skin and muscle tissue and results in substantial losses to the pig industry. Quiet handling and well-designed facilities, yards, races and transport facilities can significantly reduce this loss. The handling of pigs on-farm, during transportation and at the abattoir is not only dependent on the relationship between the animal and the stockperson but also on the surrounding environment. Controls therefore are systemic.
Overview of condition prevalence, control measures and impacts of condition	• 0% herds disease free • 70% low prevalence (2% pigs affected) • 20% medium prevalence (5% pigs affected) • 10% high prevalence (10% pigs affected) • Control by maintaining safe environment, not overstocking, gentle stock movement and transport, good facilities • Affected organs: skin, primals, joints (via septicaemia/abscess) • Carcase: 16.8% fully condemned, average loss from condemned/trimmed carcase is $66.57 • Affected herds take no longer to finish a batch of pigs • Feed conversion efficiency is unaffected • Piglet mortality unaffected • 50% of bruises require trimming • National average loss per pig: $0.12 (to producer)
Producer cost of treatment	• Highly affected herds: $0.00 / head • Moderately affected herds: $0.00 / head • Lowly affected herds: $0.00 / head
Producer cost of prevention and management	• Highly affected herds: $0.30 / head • Moderately affected herds: $0.10 / head • Lowly affected herds: $0.10 / head
Producer production loss	• Highly affected herds: $0.65 / head • Moderately affected herds: $0.32 / head • Lowly affected herds: $0.13 / head
Producer benefit from improved control	• High to medium affected $0.53 / head • Medium to lowly affected $0.19 / head
Processor offal loss	• Value of offal lost per infected head: $1.91 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.

Erysipelas

Condition overview	Swine erysipelas is an infectious disease caused by the bacteria ***E. rhusopathiae***. Stress factors such as overstocking, mixing pigs after weaning and sudden changes in temperature can trigger clinical erysipelas. Environmental contamination is common because bacteria are excreted via saliva, nasal secretions, faeces, and urine. Routine vaccination of growing pigs is not usually recommended but may be necessary in some pig herds.
Overview of condition prevalence, control measures and impacts of condition	• 0% herds disease free • 60% low prevalence (2% pigs affected) • 30% medium prevalence (5% pigs affected) • 10% high prevalence (10% pigs affected) • Control by maintaining a clean environment, not overstocking, limiting skin lesions, vaccination - national average cost per pig is $1.00 per annum • Affected organs: joints, primals, skin, organs (abscess) • Carcase: 1.2% fully condemned, average loss from condemned/trimmed carcase is $19.51 • Affected herds take 1-3 days longer to finish a batch of pigs • Feed conversion efficiency worsens in affected batches (2.8 vs 2.7) • Piglet/grower mortality 1-6% • National average loss per pig: $0.61 (to producer)
Producer cost of treatment	• Highly affected herds: $0.03 / head • Moderately affected herds: $0.01 / head • Lowly affected herds: $0.01 / head
Producer cost of prevention and management	• Highly affected herds: $1.00 / head • Moderately affected herds: $1.00 / head • Lowly affected herds: $1.00 / head
Producer production loss	• Highly affected herds: $8.44 / head • Moderately affected herds: $5.18 / head • Lowly affected herds: $2.46 / head
Producer benefit from improved control	• High to medium affected $3.28 / head • Medium to lowly affected $2.72 / head
Processor offal loss	• Value of offal lost per infected head: $0.14 / infected

Sources: Frontier Economics and Herd Health analysis based on available studies and consultations with industry experts.

4 Moving from individual conditions to national rollout

The costs and benefits by condition provides a useful snapshot of the potential impacts of actioning insights from peri-mortem data. To move to a CBA of the national rollout, there is a need to build up a profile of the impacts over time. The scope of the analysis also needs to broaden to factor in the impact on processors.

This Section discusses the method used to move from the costs and benefits of individual conditions to an assessment of the potential value in providing feedback to producers on these conditions through a national rollout. Section 4.1 discusses the impacts of a national rollout from a processor perspective, drawing on the insights from the Health4Wealth pilot. Section 4.2 presents the scenarios modelled relating to processor rollout timeline and processor response ramp up. Section 4.3 outlines other key CBA parameters.

4.1 Processor impacts

The costs and benefits by condition presented in Section 3 largely focus on producer impacts. The exception is processor offal loss which is included in the condition impact tables.

National rollout of peri-mortem data collection and dissemination would result in a number of costs and benefits being incurred by processors. On the cost side, a processor would have costs associated with peri-mortem data collection including:

- IT hardware and software costs to record peri-mortem data
- Inspector training costs to record peri-mortem data in an updated IT system
- Additional inspector costs from the increased complexity of reporting and recording which will require additional inspectors in some instances
- Additional liaison costs arising from the need to work with producers to convert peri-mortem data into actionable insights.

In addition to the reduction in offal loss, as identified above, the national rollout would also result in several processor benefits including:

- Increased line speeds as decreased condition/defect prevalence should reduce processing time per carcass, as evidenced in the case studies (Appendix A)
- More productive carcasses. This relates to the “avoided production loss” experienced by producers with uplift being partially passed through to processors through prices
- Avoided carcass condemns as decreased condition/defect prevalence should result in fewer carcasses being identified as condemns.

Details of the specific valuation of these costs and benefits together, with the number of processors impacted in the national rollout CBA, are presented in Appendix C.

4.2 Profiling costs and benefits

As previously stated, the conducted CBA is incremental in that it considers additional costs and benefits over and above a base case scenario. The scenarios tested in this CBA are:

- Base case – where the Health4Wealth program is not rolled out nationally
- National rollout – where the Health4Wealth program is rolled out nationally over time

The timing of the national rollout and associated response from producers are key drivers of costs and benefits. Ideally the profiling of costs and benefits would be based on industry experience. However, limited information was available from the Health4Wealth trials or other sources to inform this analysis. Accordingly, assumptions have been developed for the profiling of costs and benefits in discussion with industry experts. The approach to the processor rollout and producer response ramp up has been developed to provide a realistic profile of the costs and benefits of the national rollout. Conservative assumptions have been adopted, consistent with CBA best practice.

The approach adopted in the CBA covers, in turn:

- The timing of the rollout of the peri-mortem data collection by processors
- The time taken for producers to action the data
- The actions taken by producers to reduce disease.

Further detail on assumptions adopted are presented in Appendix C.

Processor rollout timeline

In the CBA, it is assumed that export processors will start to rollout the Health4Wealth program in the first year of analysis, and domestic processors in the fourth year. Each processor will invest in installing the new technology, training existing staff and hiring additional staff as needed over a period of three years.[3] This means that the processor rollout is assumed to occur over a period of seven years.

This is illustrated in **Figure 6** below.

Producer response ramp up

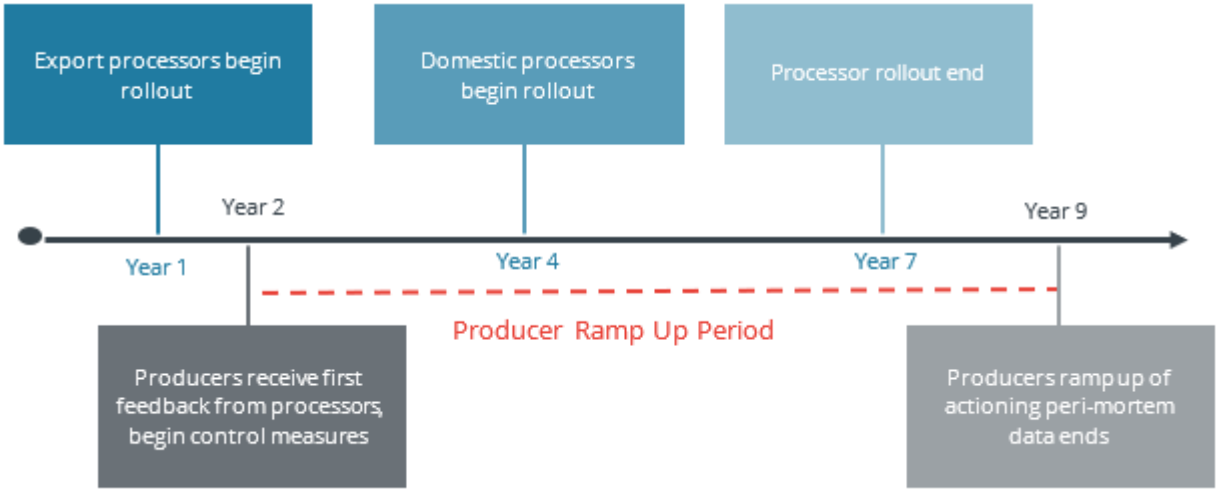
As processors adopt and incorporate the new technologies for the Health4Wealth program, they will begin to pass on some information to producers, however this takes time. It is assumed that the first producer is informed of a disease prevalence issue no earlier than one year after the initial rollout of the program. For each year of the processor rollout, it is assumed that additional producers will become informed of disease prevalence issues, until by the end of the ramp up period all producers are informed of their disease prevalence.

It also takes time for producers to action disease data. Given this, it is assumed that the ramp up for producers actioning peri-mortem data occurs from year two to year nine of the appraisal period.

This is illustrated below in **Figure 6**.

[3] The assumptions adopted for these costs are detailed in Appendix C.

Figure 6: Rollout and Ramp Up Timeline



Producer disease reduction

A producer uses the peri-mortem data to assess whether action is necessary. Our analysis distinguishes between the actions adopted for low, medium and high prevalence herds:

- Low prevalence herds are assumed not to take any action.
- High and medium prevalence herds are assumed to respond to the information from the peri-mortem inspections by investing in control measures for their herds.

Control measures are assumed to be introduced over a period of years, based on the lifecycle of the animal.

Based on consultation with industry experts, it is not expected that these control efforts will be entirely effective, as some conditions are endemic to a region, and control measures might be flawed in their execution. Therefore, the analysis does not assume that all high or moderately affected herds will transition to low prevalence.

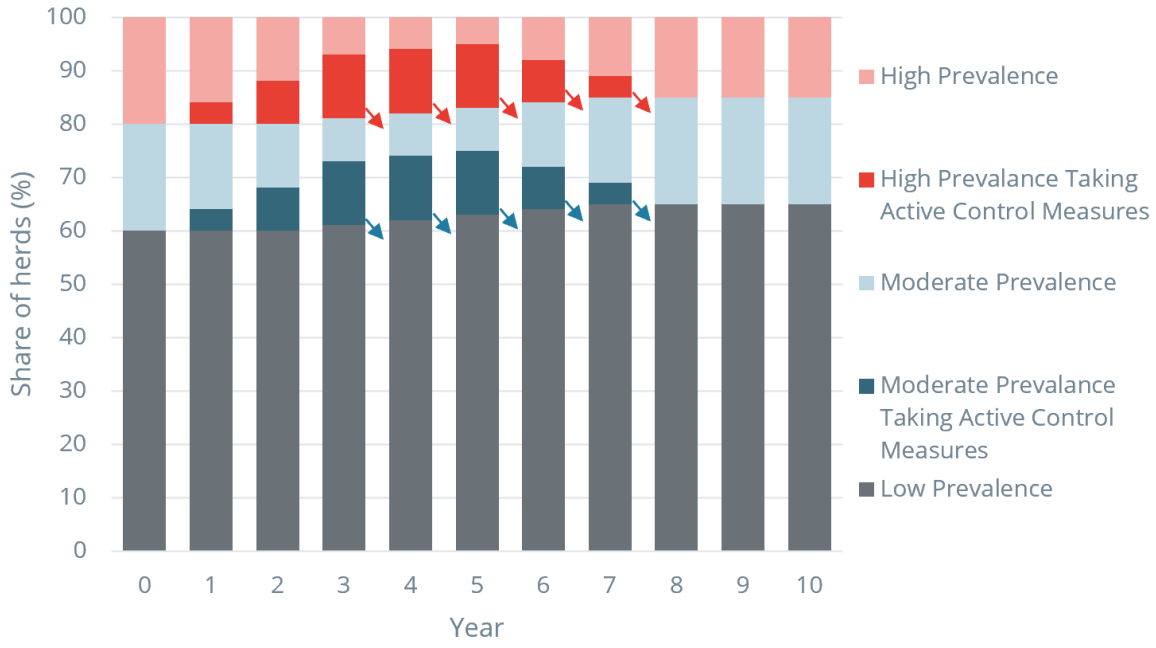
Consistent with CBA best practice of adopting conservative assumptions, our modelling assumes that 5% of herds with a detected condition will transition from highly affected to moderately affected, and 5% of herds with a detected condition will transition from moderately affected to lowly affected.[4] This approach reflects the inherent difficulty in addressing some of these conditions. Frontier Economics analysis shows that even under these conservative assumptions the Health4Wealth program has substantial potential net benefits. We present a sensitivity on this assumption in Appendix C.

Figure 7 illustrates this process over the first 10 years of the CBA. During the ramp up period producers will begin to incur the cost of control measures. They will continue this investment across a three-year period. Over this time they will see a share of the treated herds transition

[4] Where there are less than 5% of herds which are highly or moderately affected then it is assumed all are reduced. For example, if a condition has 4% of herds highly impacted in the base case then it is assumed that all 4% transition from highly affected to moderately affected.

from high to moderate, and moderate to low prevalence. Details of the modelled reduction in cases of health conditions in the analysis are provide in Appendix C.

Figure 7: Illustrative Example of Producer Control Activity and Disease Prevalence



4.3 Key parameters for CBA

In addition to the impacts by condition detailed in Section 3 and the approach to profiling costs and benefits set out above, there are several other key parameters for the CBA. These are presented in **Table 6**.

Table 6: Cost Benefit Analysis overarching parameters

Input	Value
Discount Rate	5%
Appraisal period	20 years
Appraisal start date	1 January 2022
Appraisal end date	1 January 2042

Source: MLA

5 The value of national rollout

This Section summarises the results of the CBA of a national rollout. It begins by presenting the results across the sheep, cattle and pig industries (Section 5.1). It then considers in turn the benefits for processors and producers in the sheep (Section 5.2), cattle (Section 5.3) and pig (Section 5.4) industries. More detailed results are presented in Appendix C.

5.1 National rollout results

A national rollout has the potential to deliver significant value across the supply chain in the sheep, cattle and pig industries

The analysis finds there is significant value in a national rollout of the Health4Wealth program for the industries. The national rollout CBA results across the sheep, cattle and pig industries are presented in **Table 7**. **Box 2** explains a number of the key terms used in the CBA results and outlines how to interpret the results.

In total across the industries the present value of the benefits of a national rollout exceed the costs by over three times. This is a very significant finding – it demonstrates that there are large potential benefits across the supply chain of a national rollout.

Box 2: Interpreting CBA results

In order to directly compare costs and benefits over time, there is a need to apply a discount rate (5% per annum for this analysis). This discount rate reflects society's preference for a dollar of benefit today rather than a dollar of benefit in a year's time. Once costs and benefits have been discounted they are in present values and can be directly compared. All CBA results are presented as present values.

Once the costs and benefits have been profiled and discounted, the key results of the CBA emerge. The two key results are the benefit-cost ratio and the net present value. The **benefit-cost ratio** is the total present value of benefits divided by the total present value of costs. The **net present value** is the total present value of benefits minus the total present value of costs. An option with a benefit-cost ratio greater than one and a positive net present value is net beneficial to society i.e. the benefits of the option outweigh the costs.

Both producers and processors will benefit from a national rollout

The results demonstrate there is a strong value proposition for both producers and processors. For both groups the present value of the potential benefit exceed the present value of the costs by a substantial amount – over two times in the case of processors and more than six times for producers. This provides strong evidence that participants across the supply chain will derive significant value from a national rollout.

The analysis found producers have a higher benefit-cost ratio than processors. This may be because several of the key costs around capturing and feeding back the peri-mortem data are incurred by processors rather than producers. However, given that processors also have a benefit-cost ratio of greater than 1, there is still a material value proposition for them to incur costs associated with recording and disseminating peri-mortem data.

Table 7: National rollout CBA results

	Present value of benefits ($m)	Present value of costs ($m)	Net Present Value ($m)	Benefit-Cost Ratio
Producers	461.80	75.85	385.95	6.09
Processors	297.79	134.53	163.26	2.21
Total	759.59	210.38	549.21	3.61

The finding the national rollout will deliver significant value is robust to changes in key assumptions.

Appendix C includes further details on the CBA results, including the profile of costs and benefits over time (**Figure 11**-**Figure 14**) and the results of the sensitivity analysis. The profiling shows that the key costs are incurred early in the appraisal period (including processors' upfront costs and key producer costs of lowering condition prevalence) while benefits ramp up in 2029 and then are held constant (prior to discounting). The sensitivity analysis finds that the CBA findings are robust to altering discount rate and disease prevalence assumptions. The benefit-cost ratio is greater than 1 in all sensitivity analyses. This gives further weight to the significant potential value that could be delivered through a national rollout of the Health4Wealth program.

5.2 Sheep results

There is a strong value proposition of a national rollout for both sheep producers and processors

The results for the sheep industry demonstrate the value proposition of a national rollout are very strong – even stronger than the total across the sheep, cattle and pig industries as a whole. The results presented in **Table 8** show the present value of the benefits for sheep producers and processors in total exceed the present value of the costs by more than four times. The key driver of this is the very significant level of producer benefits that could be gained from using peri-mortem data to reduce condition prevalence, as explored in more detail below. Importantly, there is potential for sheep processors to also derive significant value from a national rollout – with the present value of benefits exceeding the present value of costs by nearly two times.

The 2030 Annual Net Benefit shows the real undiscounted benefit received annually after the ramp-up has completed.

Table 8: Sheep CBA results

	Present value of benefits ($m)	Present value of costs ($m)	Net Present Value ($m)	Benefit-Cost Ratio	2030 Annual Net Benefit ($m)
Producers	137.90	4.06	133.84	33.98	14.41
Processors	79.65	43.61	36.03	1.83	5.27
Total	217.54	47.67	169.87	4.56	19.69

Table 9 considers the costs and benefits by condition for sheep producers. The table demonstrates improved control of all six conditions modelled will drive significant producer benefits, while also being relatively cheap to implement. While the analysis draws on the best available data, the results being so favourable for producers does pose the question as to why they aren't taking actions to reduce prevalence at present. It may be that there are barriers to adoption etc. which extend beyond the scope of this study.

Table 9: Sheep present values by condition for producers

	Present value of benefits ($m)	Present value of costs ($m)	2030 Annual Net Benefit ($m)
CLA	12.55	1.10	1.26
Pneumonia	20.99	0.64	2.18
Sarcosystis	20.71	0.60	2.15
Sheep Measles	17.24	-	1.83
Arthritis	49.07	0.38	5.19
Grass Seeds	17.33	0.81	1.79

5.3 Cattle results

Cattle producers and processors stand to derive very material value from a national rollout

The CBA results for cattle largely align with the overarching national rollout CBA results (see Table 10). The results demonstrate that the industry has the potential to derive benefits from the national rollout that exceed costs by more than three times.

Consistent with the sheep industry the analysis demonstrates producers have a higher benefit-cost ratio than processors. For producers the potential benefit of a national rollout exceeds costs by five times. The contribution by condition is discussed in more detail below.

There is a clear value proposition for cattle processors for a national rollout of the Health4Wealth program. The results demonstrate the present value of the benefits exceeds the present value of the costs by more than two times.

Table 10: Cattle CBA results

	Present value of benefits ($m)	Present value of costs ($m)	Net Present Value ($m)	Benefit-Cost Ratio	2030 Annual Net Benefit ($m)
Producers	229.09	45.84	183.25	5.00	22.94
Processors	166.30	79.54	86.76	2.09	14.43
Total	395.39	125.38	270.01	3.15	37.37

Reducing the prevalence of disease for each of the three cattle conditions considered delivers very significant benefits for producers (see **Table 11**). The cost side varies considerably between conditions. Hydatids do not have specific treatment and control costs, since it is assumed controls of wild dogs population is undertaken as a part of broader farm management and the effectiveness of controls within wild dog regions is unknown. In contrast, liver fluke has relatively high costs, though these costs are significantly less than the potential benefits of lowering prevalence of the condition. Given these relatively high costs, producers would need to be confident in the benefits they would gain before committing to the expenditure. This highlights the importance of a strong evidence base to guide producer decision making.

Table 11: Cattle present values by condition for producers

	Present value of benefits ($m)	Present value of costs ($m)	2030 Annual Net Benefit ($m)
Hydatids	97.52	-	11.37
Liver fluke	56.78	35.71	3.50
Pneumonia	74.79	9.60	8.07

5.4 Pig results

Both pig producers and processors stand to capture significant value from a national rollout to export abattoirs

The CBA results for the pig industry demonstrates a very strong value proposition for a national rollout for both producers and processors. Across the industry, the present value of benefits exceeds the present value of costs by nearly four times.

The national rollout has the potential to deliver significant value to both pig producers and processors. The net present value of the benefits exceeds the present value of the costs by more than 3.6 times for producers and 4.6 times for processors.

The notable difference with the CBA results for pigs compared to sheep and cattle is that the benefit-cost ratio for producers and processors are more closely aligned. The key driver here is the lower cost of rollout for processors as this analysis focuses on the 7 export abattoirs for pigs which cover about 85% of pigs processed. This is a relatively efficient way to rollout the Health4Wealth program. This finding could be informative in developing the proposed rollout strategy in the sheep and cattle industries.

Table 12: Pigs CBA results

	Present value of benefits ($m)	Present value of costs ($m)	Net Present Value ($m)	Benefit-Cost Ratio	2030 Annual Net Benefit ($m)
Producers	94.82	25.95	68.87	3.65	14.41
Processors	51.83	11.37	40.46	4.56	5.27
Total	146.65	37.32	109.33	3.93	19.69

The present value of pig disease by condition are presented in **Table 13**. The results indicate key gains can be realised from reducing prevalence of pleurisy followed by arthritis, erysipelas, ascaris and dermatitis. Bruising and melanoma have an order of magnitude lower benefit. This is largely driven by the production loss of these conditions being significantly less that the other conditions assessed.

Table 13: Pigs present values by condition for producers

	Present value of benefits ($m)	Present value of costs ($m)	2030 Annual Net Benefit ($m)
Ascaris	12.13	0.63	1.13
Pleurisy	37.75	11.83	2.97
Arthritis	17.92	12.31	1.02
Erysipelas	14.39	-	1.41
Bruising	1.24	0.65	0.07
Dermatitis	11.31	-	1.10
Melanoma	0.07	-	0.01

5.5 Summary and conclusions

This national rollout CBA is the culmination of an extensive analysis process, which heavily drew on insights from industry experts. The key finding is that there is a clear value proposition for the national rollout of the Health4Wealth program with benefits exceeding costs for producers and processors for sheep, cattle and pigs. The fact that peri-mortem data collection would cover more conditions than it was possible to value in this analysis only adds upside to the findings.

This analysis drew on the best available data and information. However, a number of assumptions and estimates were required in this analysis. This underlines the importance of improving the evidence base, collecting robust data through a Health4Wealth rollout and ensuring the right tools and enablers are in place to realise the forecast benefits. Tools and enablers are covered in more detail in Section 6.

6 Tools and enablers

Tools and enablers are required to ensure the benefits can be realised in practice

Section 5 demonstrated there is significant potential value associated with a national rollout the Health4Wealth program. During the consultation and analysis a number of tools and enablers have been identified which need to occur to ensure these benefits can be realised in practice.

This section discusses these tools and enablers, considering in turn:

- The standardised application of a meat classification system (Section 6.1)
- The integration of plant data recording into existing systems (Section 6.2)
- Extension activities required to facilitate take up (Section 6.3)
- Addressing data gaps around the costs and benefits of conditions (Section 6.4)
- Development of a monitoring and evaluation system (Section 6.5).

6.1 Standardised application of meat inspection classification system

Ensuring the integrity of the data is critical for a successful national rollout of the Health4Wealth program. Differences in reporting between meat inspectors has the capacity to undermine the effectiveness of the Health4Wealth program.

In order for peri-mortem data to be actionable, a producer needs to be confident that where the data shows that they have a relatively high prevalence of a condition that this is not due to variation in how inspectors report conditions. This requires a concerted and ongoing effort to ensure a standardised application of the respective meat inspection classification systems.

Whilst a draft disease and defect classification standard is progressing, differences in prevalence as reported by abattoirs processing similar lines of animals suggest the standards are not being universally interpreted in a consistent manner.

Ongoing effort is required to develop and apply a standardised meat inspection classification system. This will ensure the information collected and shared with producers will drive effective actions and deliver the potential benefits of the Health4Wealth program.

6.2 Integration of plant data recording into existing systems

Many abattoirs have invested in data recording and management systems to meet their own needs, and the needs of their customers. Part of the challenge of embedding the national disease and defect standard into existing abattoirs is meshing the national standard into the bespoke systems already in place. Securing the participation of processors therefore requires that any overlay of a centralised (voluntary) system must be both seamless, technically easy to implement and compatible with the needs of individual companies.

Whilst most companies can embed APIs that can link local bespoke systems to the national system, this requires a universal interpretation of the disease and defect standard. There may be

valid reasons why an individual processor may wish to persist with their interpretation of meat inspection findings. However, this brings an interpretive challenge to any centralised data if the mapping of local findings to the draft national disease and defect standard is not consistent across processors.

A key component for consistency of classification will therefore be training of meat inspectors in conditions and classification schemes.

6.3 Actions to facilitate take up (with both processors and producers)

Realising the benefits from a national rollout requires both effective communication of information to producers, and actions from producers in response to this information in order to avoid, treat and control disease. This can be encouraged through extension activities and improved price signalling around conditions.

Extension activities

While the national rollout CBA shows a clear value proposition for peri-mortem data collection and feedback, there is a need for extension activities to facilitate take up. Part of this stems from the specialisation that exists in the meat supply chain. Processors are experts and procuring and processing animals and at meeting supplier requirements. They are less skilled in the practicality of endemic disease control at farm level.

Often the barrier is that the processor can quantify to the producer how much a disease or defect has or can cost them during processing, but is unable to describe the pre-processing impact that the disease may have had on farm performance. More critically, processors may not have the knowledge to tell producers the most cost-effective way to control disease on their farm. Similarly, producers are only partly informed when they receive the losses at processing due to disease and defects. Some of this is because components of animals are not paid to the producer (e.g. offal) but more importantly, the processor losses are only for animals that are sent for processing. Losses due to fertility, mortality and failure to meet specifications are not captured in processor data.

Both the processor and the producer will benefit from improved information flow about disease and defects along the supply chain. This must be supported by information on the pre-farm-gate cost of disease and the effectiveness of controls to enable producers to understand and respond to this improved information flow.

There is a role for research and development corporations to assist develop a suite of extension tools to promote take up of peri-mortem disease information:

- RDC-driven local field days and workshops with engagement of disease management experts and farm management consultants who can work with and describe to farmers the best way to control specific diseases and defects in the local region. Gains often can be achieved through a more strategic and planned set of interventions. This means that benefits can accrue for the same (or cheaper) control costs. Solutions are often local and access to a network of experts can often be the missing component.
- Supplier benchmarking by the processor (e.g. Your line of cattle was ranked in the bottom 40% of supply to use for disease X)
- Establishment of local producer demonstration sites (showcasing local control)

- Producer case studies
- Access to disease fact sheets
- Processor-driven follow-up for producers who implement change on their farm to explore change in performance.

The extension vision requires strong collaboration between processors, rural research development corporations, ,local disease experts, and farm consultants to improve the quality of animals within the supply chain.

Improve price signalling around conditions

For some conditions, the benefits principally relate to the improvements in the quality of the offal. As processors don't explicitly pay producers for offal, there is no price signal related to any improvements. Liver abscess in cattle is an example of a condition excluded from the analysis in this study as with current arrangements producers do not have an incentive to spend additional money to improve the quality of livers. Reform in this space, such as processors paying a premium to producers for higher quality offal, could lead to better outcomes and further increase the value proposition for peri-mortem data collection.

6.4 Address data gaps around the costs and benefits of conditions

As part of this analysis, several conditions were filtered out of the analysis based on a lack of data. Developing an understanding of the causes, costs and benefits associated with these conditions (such as nephritis for cattle and abscess and colitis for pigs) will have two benefits:

- First, it will assist producers with making decisions based on the likely returns of reducing prevalence of these conditions
- Second, it will allow the evaluation of the national rollout to be broadened to cover additional conditions.

Further research in the pig industry is required to improve the understanding of the impact of conditions, and the effectiveness and costs of actions to avoid, treat and control these conditions. This will improve the estimated potential value of a national rollout and provide a valuable resource to the industry as they seek to realise those benefits.

The development and refinement of individual disease economic models at farm level, and with output scalable to industry level are recommended. These models will combine the physical impact of disease and disease controls with important economic parameters so that the likely benefit accruing to a producer from increased/improved control of disease within their herd or flock can be modelled. There are economies of scale from addressing this across the key diseases of each industry. Construction of the first disease model takes time, but this disease and economic framework becomes a template for modelling the next disease. Models should be built at farm-level. Output can be easily scaled to estimate industry impact. The converse is rarely true due to the way industry-level models are typically constructed. A scalable farm-level model can be used by industry to identify those diseases that take the most profit from industry and those controls that have the best cost-benefit. Basic models of this form were built for many diseases as part of this project. Their ongoing refinement and extension is recommended to industry.

6.5 Development of a monitoring and evaluation system

The national rollout CBA is a forward-looking analysis based on the best available evidence. As with all analyses, actual impacts (both costs and benefits) should be monitored and evaluated across the rollout. The CBA model which accompanies this report could be updated over time to reflect actual costs and benefits. For example, further analysis could be taken following several full production cycles of producers being provided with peri-mortem data. More broadly, MLA have a well-developed valuation approach which could be applied to the national rollout.

Our analysis identified several key areas where further data is required:

- **Producer impacts:** this covers both the additional costs (treatment costs, herd management etc.) and benefits (increased production), and the profiling of these costs and benefits to test assumptions around take up, prevalence, and effectiveness. An *ex-post* CBA focusses on actual impacts which have occurred, so this data needs to be obtained from producers who supply processors participating in the pilot. It may be that a survey of producers could be undertaken at an appropriate point in time.
- **Processor ongoing costs:** At present there are two conflicting data points on additional meat inspector costs of a processor participating in the pilot program. Ideally, data could be obtained for all processors in the pilot program. Qualitative insights were also received. These insights determine that it is not sufficient for processors to only provide peri-mortem data to producers as they will also require support and education to use the data. Cost data for support and education programs would also be desirable.
- **Processor benefits:** At present numerous expected benefit streams have been identified qualitatively by processors. Obtaining quantitative data for the tangible benefits (i.e. those which relate to productivity) would be highly desirable. Processors could also benefit from using the peri-mortem data as something akin to a "buying guide", allowing them to identify the most productive regions and/or producers.

Frontier Economics recommend developing systems and processes to collect this baseline information. This will enable benefits realisation analysis to confirm the intended benefits are being realised, and inform action as required to address any issues or barriers.

Appendices

A Ex-post CBA

This section presents the *ex-post* CBA of the pilot trials, drawing on the insights gleaned from the case studies.

Scope of analysis

The *ex-post* CBA is focussed on the incremental costs and benefits of the Health4Wealth pilot programs to date. Given this, the base case and option for this analysis are:

- Base case – business as usual scenario i.e. a future with no systematic approach to the reporting and utilisation of peri-mortem information
- Option – pilot programs of peri-mortem data reporting and utilisation introduced.

Data and approach to data gaps

A cost-benefit analysis (CBA) is an assessment tool that compares the costs associated with a potential investment with the benefits over time. Appendix C sets out the CBA methodology.

The confidential nature of much of the cost information and current status of the pilot trials means there were some gaps in the data required to undertake an *ex-post* CBA. **Table 14** and Costs such as program administration, the integration of IT equipment, and the initial training of inspectors, occur over a small number of years as processors enrol in the Health4Wealth program. Once these integration costs are incurred, they are not repeated in subsequent periods.

Ongoing costs are the costs of maintaining the new system, and adequately staffing businesses to meet the demands of the new system (additional inspection time and administrative cost of liaising with producers), which are incurred over the life of the project. These costs start only after the processor has enrolled in the program.

Table 15 outline the data available for each cost and benefit category, respectively.

Table 14: Costs identified for the pilot programs and available data

Costs	Available data
Program administration and related costs	APL and MLA data provided
Upfront processor costs (e.g. electronic capture of data, IT equipment and integration, training inspectors)[5]	Actual spend data provided for red meat pilot processors. No data for pork.
Ongoing processor costs (e.g. increased inspection costs, interaction with producers to communicate information and findings, producer training/workshops)	Benchmark data available from case study processors.
Upfront and ongoing producer costs (e.g. treatment, changes in production management, specialist consultant/vet costs)	No quantitative data available. Most pilot programs haven't been in place for a full production cycle over which costs should be observed.
Any base case benefits foregone e.g. blood-and-bone sales	No quantitative data available.

Costs such as program administration, the integration of IT equipment, and the initial training of inspectors, occur over a small number of years as processors enrol in the Health4Wealth program. Once these integration costs are incurred, they are not repeated in subsequent periods.

Ongoing costs are the costs of maintaining the new system, and adequately staffing businesses to meet the demands of the new system (additional inspection time and administrative cost of liaising with producers), which are incurred over the life of the project. These costs start only after the processor has enrolled in the program.

[5] These costs are not amortised – they are assumed to be incurred upfront.

Table 15: Benefits identified for the pilot programs and available data

Benefits	Data available
Benefits for producers (e.g. increased production through growth rates, FCE, reproduction, morbidity, survival, stocking rate etc., changed quality such as hides, wool, marbling, even lines, assurances)	No quantitative data available. Some qualitative insights from case studies.
Benefits for processors (e.g. increased quality of meat, increased productivity e.g. fewer retains and trims, fewer condemns, faster chains, fewer workers etc.)	No quantitative data available. Some qualitative insights from case studies.

Ideally an *ex-post* CBA would be based on historic, observed data. However, as outlined above, there are gaps in data available to quantify and value the costs and benefits of the pilot programs. Given this limitation, the next best solution is to follow the framework of a CBA, defining the known incremental cost of the pilot programs and to qualitatively describing other costs and benefits. This method aligns with CBA practice where quantitative and qualitative assessment methods are both used, depending on what evidence is available.

Analysis

Table 16 and **Table 17** below present the qualitative *ex-post* CBA for the pilot programs.

Table 16: Analysis of costs identified for the pilot programs

Costs	Impact of pilot programs compared to base case
Program administration and related costs	The program administration costs are entirely additional to the base case where the pilot programs do not take place. Program administration and running of the APL pilots was around $390k. From the red meat perspective, they have allowed around $150k in total on a technical advisor to support the adoption of standards and specification and a further $80k to develop a draft national disease and defect data standard.
Upfront processor costs (e.g. electronic capture of data, IT equipment and integration, training inspectors)	Data received for red meat processors show a total of $480k spending on pilot trials across eight participants; an average of $60k per pilot participant. Within this amount the key cost related to software amendments ($239k) and meat inspector training ($67k). In terms of pork the industry has made more use of meat inspection data outside of the Health4Wealth program. Given

	this, it may be that the pork pilot processors would have had lower costs to implement peri-mortem data.
Ongoing processor costs (e.g. increased inspection costs, interaction with producers to communicate information and findings, producer training/workshops)	One pork case study (Diamond Valley Pork) identified that they required additional meat inspectors to generate the peri-mortem data. They estimated an additional cost of $0.3-0.5m per year. In contrast, another case study processor (Bindaree Beef) reported that they are recording peri-mortem data without additional meat inspectors or making a change to the line speed. In terms of generalising, it seems likely that processors would generally require additional meat inspectors, and hence additional labour costs, in order to diagnose animal disease/defects in excess of their primarily human health focussed role in the base case. The addition of extra diseases/defects for recording by inspectors (beyond pilot studies) will most likely require more inspectors per shift to maintain throughput. Case studies referenced the need for processors to provide education and support to assist producers with understanding and making changes to their herd management based on peri-mortem data. There would be costs associated with education and support programs. It is understood that pilot trials included funding for producer workshops but these did not happen due to the covid-19 pandemic.
Upfront and ongoing producer costs (e.g. treatment, changes in production management, specialist consultant/vet costs)	The key insight from the case studies is that the process of providing peri-mortem data from processors to producers is at an early stage. It is noted that in general pork processors are more advanced than red meat processors in terms of recording peri-mortem data. Some qualitative examples of changes to herd management because of peri-mortem data were provided in the case studies. These tended to focus on vertically integrated producer/processors. Given this, there is no basis to characterise the level of additional producer cost incurred. Intuitively the cost will vary from producer to producer depending on whether the peri-mortem data identifies cost effective interventions for them to execute.
Any base case benefits foregone e.g. blood-and-bone sales or costs saved	As noted above, the provision of peri-mortem data from processors to producers is at an early stage. As such, there is a lack of evidence of the extent to which base case benefits are foregone.

Table 17: Analysis of benefits identified for the pilot programs

Benefits	Impact of pilot programs compared to base case
Benefits for producers (e.g. increased production through growth rates, FCE, reproduction, morbidity, survival, stocking rate etc., changed quality such as hides, wool, marbling, even lines, assurances)	In line with the analysis of upfront and ongoing producer costs, there is limited qualitative evidence to draw on to assess additional producer benefit as a result of the pilot program. Case studies were provided some examples of producers changing their herd management based on peri-mortem but no quantitative estimates on the value added were provided. It would be expected that producers would only undertake interventions where the financial benefits to producer exceed the financial costs. Moreover, based on some anecdotal evidence from pilot processors, it is expected that there will be a range of responses from producers with some enthusiastic to engage with peri-mortem data, some needing a clear financial case to be made to them before engaging and others uninterested in the data.
Benefits for processors (e.g. increased quality of meat, increased productivity e.g. fewer retains and trims, fewer condemns, faster chains, fewer workers etc.)	From the case studies of pilot program processors, qualitative benefits identified covered a range of impacts including: • Some early examples of positive feedback loop to producers • Better understanding of patterns of disease by region, season and year. • Improved consistency of carcase grading • Improved relationship with producers • Improved documentation of animal health and welfare Given that a number of the pilots are at an early stage it may be that more tangible benefits, such as increased quality of meat and increased productivity, become more apparent once producers have had more time to respond to peri-mortem data.

B Detailed CBA methodology, CBA inputs and sensitivity results

Modelled reduction in health conditions

Figure 8-**Figure 10** show the avoided infections over time for conditions included in the national rollout CBA. Note that this includes infected cases across high, moderate and low prevalence herds, as such the cost or benefit per avoided infection cannot be inferred from these graphs. Our modelling accounts for a rate of detection of disease by the processors of 80%. See **Section 4** for details of how the processor rollout and producer response ramp up which impacts before they reach a steady state.

For the purposes of this analysis it is assumed that once a condition is treated it will not recur. In practice it is possible that conditions may recur and therefore require further treatment in the future.

Average by spread

Figure 8: Modelled Avoided Infections among Sheep

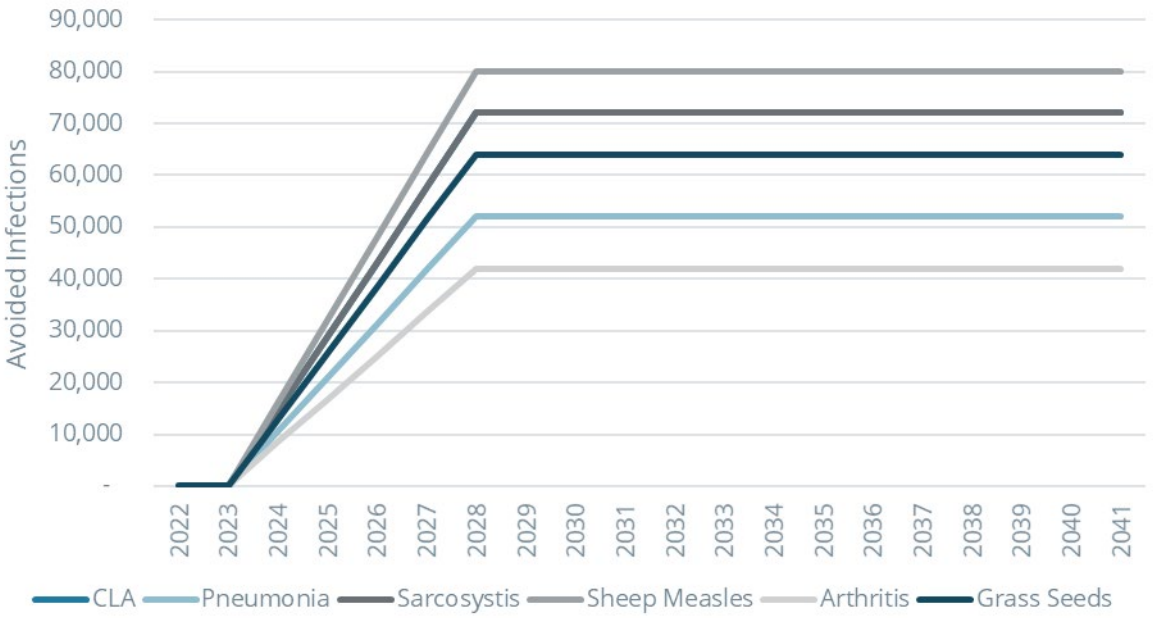


Figure 9: Modelled Avoided Infections among Cattle

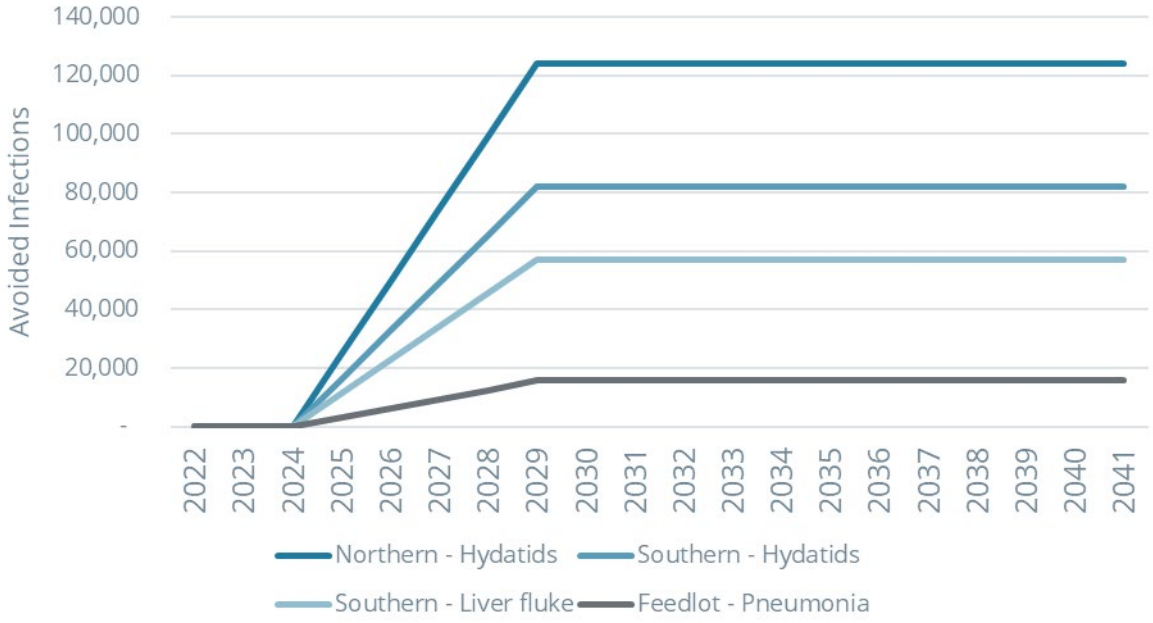
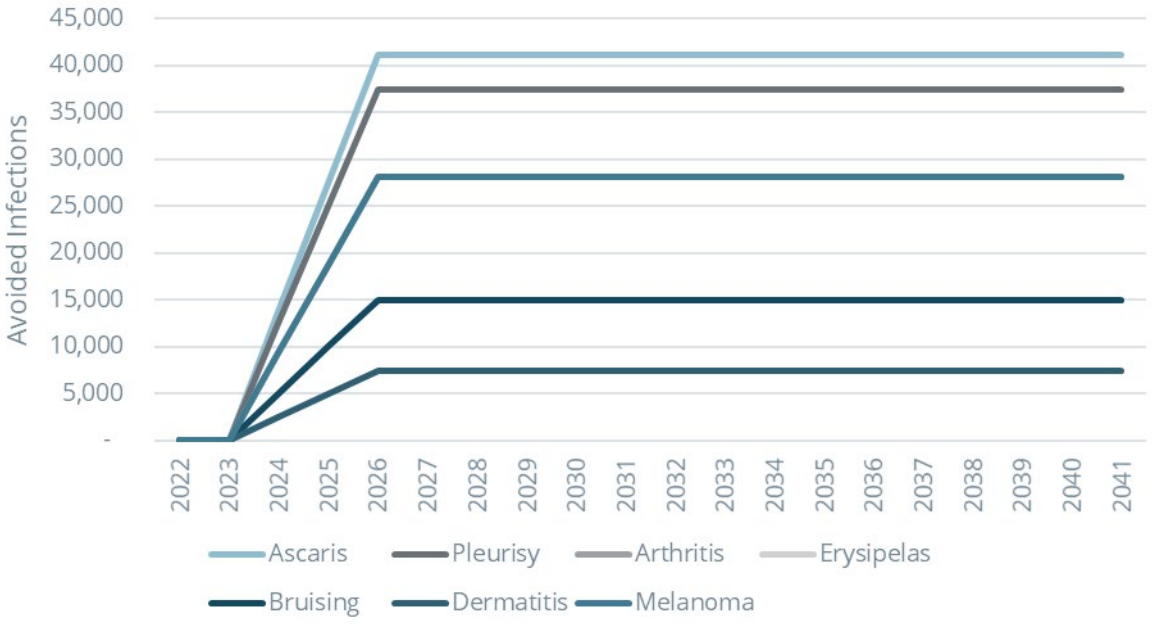


Figure 10: Modelled Avoided Infections among Pigs



National rollout CBA inputs

Table 18-**Table 23** detail the inputs used for the national rollout CBA.

Overarching parameters

Table 18: Overarching parameters

	Input	Unit
Project start	1-Jan-22	Date
Pilot Project appraisal timeline	20	Years
End Appraisal Date	1-Jan-42	Date
Discount rate (real)	5%	%

Processor Inputs

Table 19: Processor rollout inputs

	Input	Unit	Source
Beef			
Rollout to export processors time	3	years	
Rollout to export processors start	1-Jan-22	Date	
Rollout to domestic processors time	3	years	
Rollout to domestic processors start	1-Jan-25	Date	
Sheep			
Rollout to export processors time	3	years	
Rollout to export processors start	1-Jan-22	Date	
Rollout to domestic processors time	3	years	
Rollout to domestic processors start	1-Jan-25	Date	
Pigs			
Rollout to export processors time	3	years	
Rollout to export processors start	1-Jan-22	Date	
Rollout to domestic processors time	3	years	
Rollout to domestic processors start	1-Jan-22	Date	

Table 20: Processor characteristics

	Input	Unit	Source
Total Export Processors			
Northern Beef	38	processors	Australian Abattoirs
Southern Beef	24	processors	Australian Abattoirs
Feedlot Beef	6	processors	Australian Abattoirs
Sheep (Prime lamb)	18	processors	Australian Abattoirs
Pigs	7	processors	APL
Total animals processed for export			
Northern Beef	11,937,170	heads	Beef exports are 76% of production MLA Report
Southern Beef	7,774,323	heads	Beef exports are 76% of production MLA Report
Feedlot Beef	1,976,000	heads	Beef exports are 76% of production MLA Report
Sheep (Prime lamb)	13,333,333	heads	Lamb exports are 66% of production MLA
Pigs	4,680,000	heads	APL
Total Domestic Processors			
Northern Beef	25	processors	Australian Abattoirs
Southern Beef	16	processors	Australian Abattoirs
Feedlot Beef	4	processors	Australian Abattoirs
Sheep (Prime lamb)	12	processors	Australian Abattoirs
Pigs	-	processors	APL
Total animals processed for Domestic			
Northern Beef	3,769,633	heads	Beef exports are 76% of production MLA Report
Southern Beef	2,455,050	heads	Beef exports are 76% of production MLA Report

Feedlot Beef	624,000	heads	Beef exports are 76% of production MLA Report
Sheep (Prime lamb)	6,666,667	heads	Lamb exports are 66% of production MLA Report
Pigs	-	heads	APL
Share of processors by quartile of animals processed			
First Quartile	7%	%	MLA
Second Quartile	15%	%	MLA
Third Quartile	19%	%	MLA
Fourth Quartile	59%	%	MLA

Table 21: Program costs and inspector costs

	Input	Unit	Source
Program costs			
Annual Program coordination costs	300,000.00	$	APL data of around $200k in pilot. Assumed slightly lower in rollout ($150k per annum) with MLA at the same level
Upfront IT costs	29,879.91	$	Average costs from H4W red mean pilot trials
Meat inspector training costs	8,480.00	$	Average costs from H4W red meat pilot trials
Admin costs	21,522.50	$	Average costs from H4W red mean pilot trials
Annual IT costs	2,987.99	$/year	Assume 10% of initial cost continues over time
Inspector salary	60.00	$/hour	APL
Factor of liaison costs to inspector costs	94%	%	Assumption of an FTE providing data to producers, education etc.
Inspection Assumptions			

	Additional Processing time from Introduced Technology	0.00	hours/ head	Based on Teys and Bindaree case studies
	Additional Processing Time for Infected cases	0.02	hours/ infected	FE Assumption
	Processor Margin on Producer Benefit plus offal[6]	33%	%	DAWE/MLA (2016)
	Disease Detection by Inspectors	80%	%	FE Assumption
	Disease Infection Multiplier[7]	1.20	multiplier	FE Assumption

[6] The statistics used to determine the producer gains from reducing disease prevalence account for the producer's ability to sell higher quality meat to abattoirs. Based on the DAWE/MLA 2016 report, we have estimated that the ratio of gains to producers versus processors from increased sale prices is approximately 2:1. As such, all benefits received by producers are matched with a benefit to processors, at this ratio.

[7] Based on consultations, we have assumed that for each infected animal identified by processors, more offal is condemned than just the infected case, due to potential contamination. We have assumed that for every 1 identified case, the offal of 1.2 animals is condemned.

Producer Inputs

Table 22: Timing of Producer Activity

	Input	Unit	Source
Producer response lag behind processors			
Cattle	1	years	FE Assumption
Sheep	1	years	FE Assumption
Pigs	1	years	FE Assumption
Producer benefits lag behind costs			
Cattle	2	years	FE Assumption
Sheep	1	years	FE Assumption
Pigs	1	years	FE Assumption
Disease Prevalence Transition within herd			
Cattle	3	years	FE Assumption
Sheep	2	years	FE Assumption
Pigs	2	years	FE Assumption
Producers ramp up duration			
Cattle	5	years	FE Assumption
Sheep	5	years	FE Assumption
Pigs	3	years	FE Assumption

Table 23: Assumed Number of Animals (Total heads)

	Input	Unit	Source
Northern Beef	15,706,803	heads	MLA report B.AHE.0010
Southern Beef	10,229,373	heads	MLA report B.AHE.0010
Feedlot Beef	2,600,000	heads	MLA report B.AHE.0010
Sheep	20,000,000	heads	MLA report B.AHE.0010
Pigs	4,680,000	heads	APL annual report

National rollout CBA profile of costs and benefits over time

Profiles of the national rollout CBA profile of costs and benefits over time are presented below in **Figure 11**-**Figure 14**.

Figure 11: Undiscounted Costs

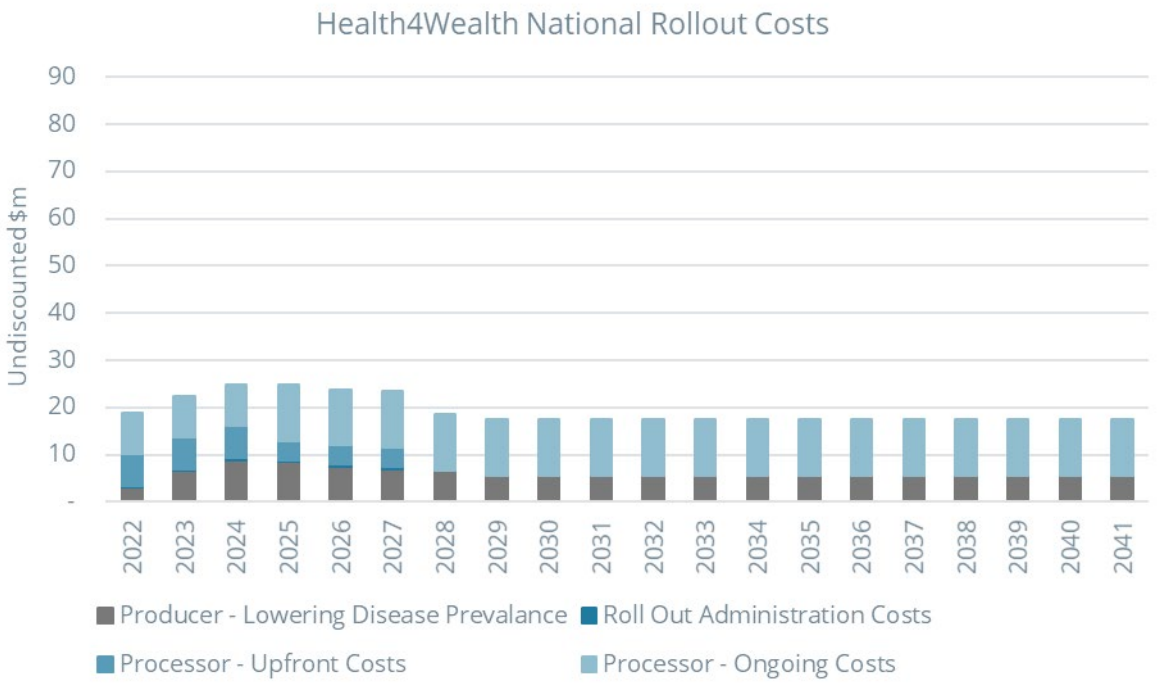


Figure 12: Undiscounted Benefits

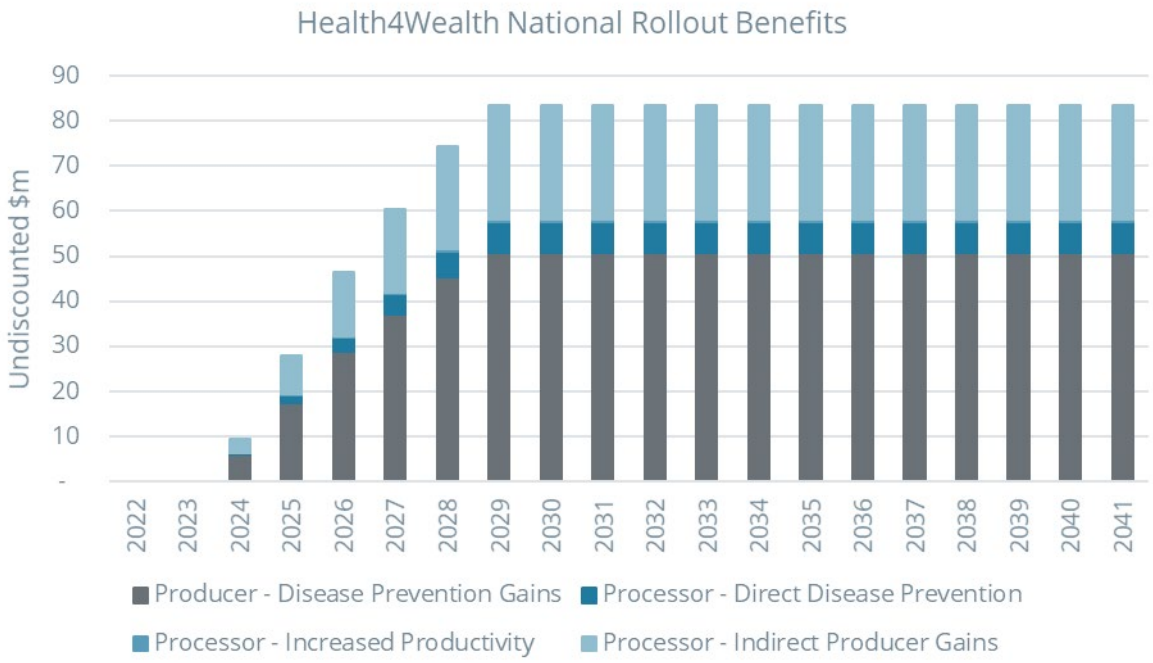


Figure 13: Discounted Costs

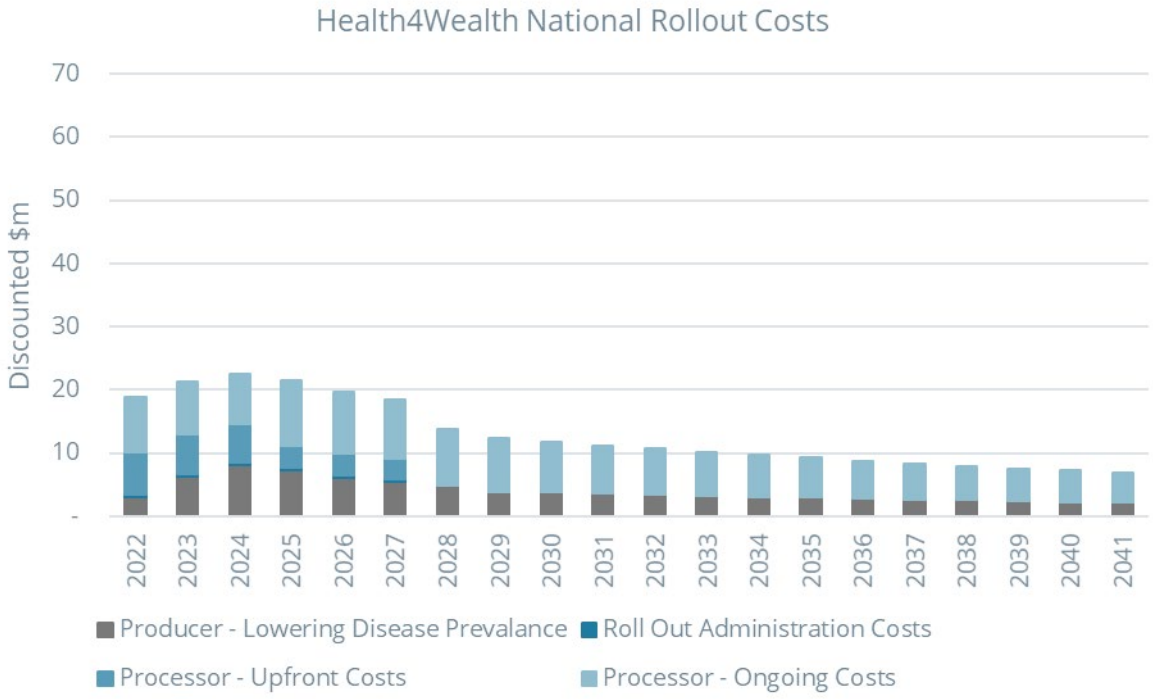
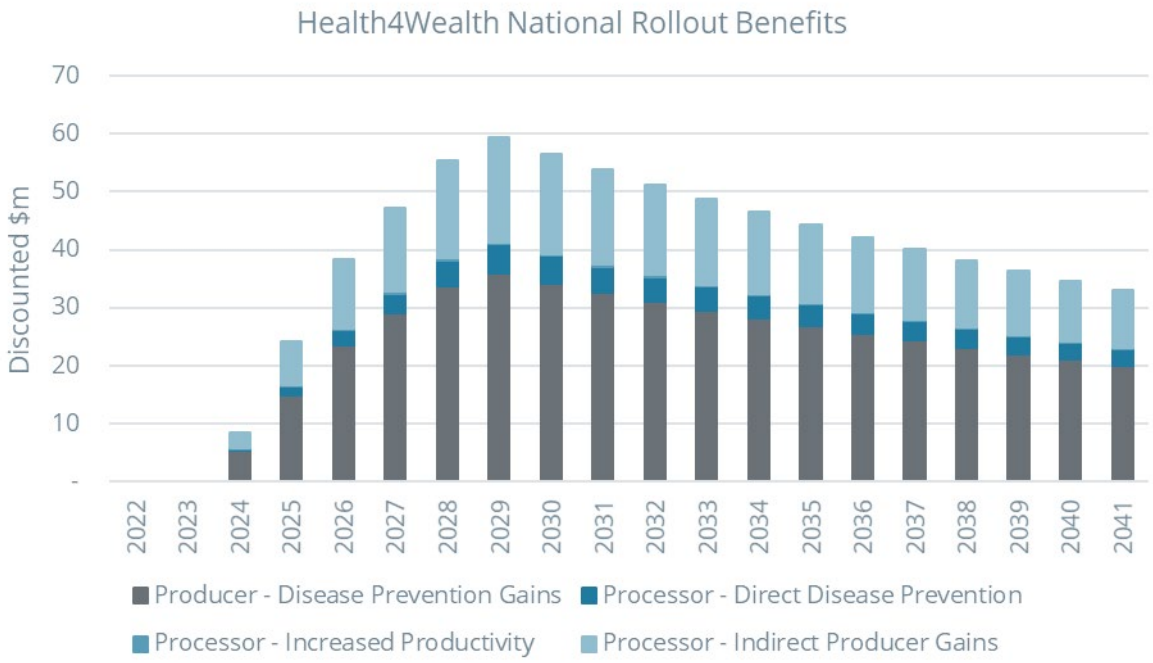


Figure 14: Discounted Benefits



Sensitivity analysis

Although most national rollout CBA inputs have been informed by data and consultations, some key assumptions were made, which will affect the analysis. The primary assumptions which will affect our analysis include:

- Discount Rate
- Assumed Disease Reduction Rate (which could also be a proxy for the annual adoption level)

Table 24 presents the assumptions used in the central scenario presented in Section 5, as well as the variations of these assumptions used for sensitivity analysis.

Table 24: Inputs for Sensitivity Analysis

Input	Central Scenario	Discount Rate 3%	Discount Rate 7%	High Disease Reduction	Low Disease Reduction
Discount Rate	5%	**3%**	**7%**	5%	5%
Reduction in High Prevalence Herds (to Moderate and Low)	5%	5%	5%	**10%**	**3%**

A lower discount rate means that payments in the future have a higher present value. Given that the Health4Wealth national rollout has high initial costs, and a delay in received benefits, reducing the discount rate would increase the value of this program. Conversely, a higher discount rate will reduce the value of the future benefits from the program, lowering the benefit cost ratio. If producers can more effectively respond to information for processors, and more herds are assumed to transition from high prevalence to moderate or low prevalence, the benefits of this program would increase for both producers and processors. As this doesn't reflect an increase in costs, this would result in a higher benefit cost ratio. Conversely, if information is not appropriately transferred from processors to producers, and disease reduction efforts are not effective, fewer benefits will result from the program. These results are reported in **Table 25**-**Table 26**.

Table 25: Sensitivity of Nation Rollout Benefit Cost Ratio to Key Assumptions

Benefit Cost Ratio		Central Scenario	Discount Rate 3%	Discount Rate 7%	High Disease Reduction	Low Disease Reduction
Cattle	Producers	5.00	5.20	4.80	6.95	4.76
	Processors	2.09	2.26	1.93	3.43	1.45
	Total	3.15	3.36	2.95	4.79	2.46
Sheep	Producers	33.98	36.00	32.04	42.04	26.53
	Processors	1.83	1.92	1.74	3.32	1.10
	Total	4.56	4.79	4.33	7.96	2.79
Pigs	Producers	3.65	3.86	3.46	4.36	2.99
	Processors	4.56	4.79	4.33	8.54	2.87
	Total	3.93	4.14	3.72	5.26	2.94

Table 26: Sensitivity of Nation Rollout Net Present Value to Key Assumptions

Net Present Value ($m)		Central Scenario	Discount Rate 3%	Discount Rate 7%	High Disease Reduction	Low Disease Reduction
Cattle	Producers	183.78	229.88	148.44	298.68	132.76
	Processors	86.76	114.82	65.42	193.37	35.59
	Total	270.01	344.14	213.35	491.52	167.82
Sheep	Producers	134.37	164.83	110.82	244.27	80.15
	Processors	36.03	46.68	27.88	101.36	4.18
	Total	170.40	211.51	138.70	345.64	84.33
Pigs	Producers	69.40	85.74	56.77	139.39	39.79
	Processors	40.46	49.73	33.27	85.72	21.22
	Total	109.86	135.47	90.04	225.11	61.01

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