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Ex-post benefit-cost assessment of MLA's Product Integrity Programs

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Abstract

Marsden Jacob Associates undertook an ex-post benefit cost assessment of three of MLA's product integrity programs: the National Livestock Identification System (NLIS); the Livestock Product Assurance (LPA) program; and the scientific research program.

Under base case assumptions, the total net benefits from the combined programs are estimated to range between $8.7 billion and $10.6 billion in 2014 dollars, depending upon the counterfactuals for the on-farm food safety systems (LPA). The benefit cost ratio for the combined programs varies between 7.4 and 8.8. The NLIS contributes the large majority of the net benefits, although the benefit cost ratio's for all three programs are greater than one.

The net benefits include those that have occurred since inception for the first two programs (mid-2000s for NLIS, 2002 for LPA) and from 2001 for the scientific research component. The net benefits also include those that are likely to accrue into the future as a result of the investments undertaken to date.

Executive Summary

The Meat and Livestock Australia (MLA) product integrity programs have contributed to the maintenance of a high standard of food safety in Australia via quality systems and product and animal monitoring. The programs include:

- development and support of a central database and associated support systems for livestock traceability, which operates as the National Livestock Identification System (NLIS);
- development and support for on-farm food safety systems, which operates as the Livestock Product Assurance (LPA); and
- scientific research, which involves a range of projects related to researching and communicating food safety risks and management approaches for incorporation into risk management programs.

The total net benefits from the combined programs are estimated to range between $8.7 billion and $10.6 billion in 2014 dollars (Table 1), depending upon the counterfactuals for the on-farm food safety systems (LPA). The benefit cost ratio for the combined programs varies between 7.4 and 8.8.

The net benefits include those that have occurred since inception for the first two components (mid-2000s for NLIS[1], 2002 for LPA) and from 2001 for the scientific research component. The net benefits also include those that are likely to accrue into the future as a result of the investments undertaken to date. The net benefits in Table 1 are based on benefits being projected forward for thirty years, with 2014 defined as the current year of analysis.

Table 1: Product integrity programs: summary of net benefits

Product Integrity Program		Net benefits ($m)	Benefit-cost ratio
Livestock traceability: NLIS		$8,291.7	8.3
On-farm food safety assurance: LPA	Counterfactual 1 for LPA	$29.4	1.3
	Counterfactual 2 for LPA	$1,918.2	18.2
Scientific research		$368.0	4.4
Total	**Counterfactual 1 for LPA**	**$8,689.2**	**7.4**
	Counterfactual 2 for LPA	**$10,577.9**	**8.8**

Source: MJA analysis

In accordance with the CRRDCs Impact Assessment Guidelines[2], we have also prepared a variety of investment performance statistics (Table 2)[3]. These illustrate how the returns from the project vary with different assumed time horizons into the future. This is important since some benefits and costs are assumed to continue into the future.

[1] Note that the estimated net benefits excludes the costs and benefits of the earlier NLIS pilot program.

[2] Council of Rural Research and Development Corporation (2014), Impact Assessment Guidelines, Version 1, May 2014.

[3] Note that detailed information is contained in PART E of this report.

Table 2: Product integrity Programs: investment performance statistics

	Net benefits ($m)		Benefit cost ratio		Internal rate of return		Modified internal rate of return	
	LPA Counter-factual 1	LPA Counter-factual 2	LPA Counter-factual 1	LPA Counter-factual 2	LPA Counter-factual 1	LPA Counter-factual 2	LPA Counter-factual 1	LPA Counter-factual 2
At 'final year'	-$427.0	$455.0	0.3	1.8	n.a.	481%	-100%	26%
5 year forward horizon	$2,181.7	$3,347.3	3.7	5.2	24%	481%	14%	31%
10 year forward horizon	$4,207.5	$5,595.2	5.3	6.7	27%	481%	15%	27%
20 year forward horizon	$7,003.1	$8,701.2	6.8	8.2	28%	481%	14%	22%
30 year forward horizon	$8,689.2	$10,577.9	7.4	8.8	28%	481%	12%	18%

Source: MJA analysis

This report is structured into separate benefit cost evaluations of each program. In some areas there are strong inter-connections between the programs. Where this is the case, we identify the inter-connection and make appropriate attribution to the other program.

In this report estimates of benefits and costs are defined as incremental because they reflect what would have occurred with the programs relative to what would have occurred without the programs.

Livestock traceability: NLIS

We estimate that the NLIS is likely to deliver net benefits over the next 30 years of $8,291.7 million in present value terms with an associated benefit-cost ratio of 8.3 (Table 3). The net benefits involve incremental benefits of $9,433.2 million and incremental costs of $1,141.5 million in present value terms. The investment performance statistics for NLIS are illustrated in Table 4. These are lower bound estimates as they predominantly reflect the benefits of reducing the impacts of foot and mouth disease and exclude the benefits of reducing the costs of a wide array of other potential exotic and endemic diseases.

Table 3: NLIS: summary of net benefits

Incremental benefits ($m)	$9,433.2
Incremental Costs ($m)	-$1,141.5
Net benefits ($m)	$8,291.7
Benefit-cost ratio	**8.3**

Source: MJA analysis

Table 4: NLIS: investment performance statistics

	Net benefits ($m)	Benefit cost ratio	Internal rate of return	Modified internal rate of return
At 'final year'	-$474.8	0.0	n.a.	-100%
5 year forward horizon	$2,003.6	4.0	23%	14%
10 year forward horizon	$3,941.4	5.9	27%	14%
20 year forward horizon	$6,641.3	7.5	28%	13%
30 year forward horizon	$8,291.7	8.3	28%	12%

Source: MJA

We have tested the sensitivity of our results for livestock traceability to variations in the key assumptions. By varying the values of some key variables we believe that the net benefits (over a 30 year forward horizon) are likely to lie between $2.0 and $14.5 billion with an associated benefit cost ratio between 2.8 and 13.7.

On-farm food safety assurance: LPA

We estimate that the LPA will deliver net benefits over the next 30 years valued at between $29.4 million and $1,918.2 million in present value terms with an associated benefit-cost ratio ranging between 1.3 and 18.2 (Table 5).

This range in potential net benefits reflects two possible counterfactuals to the LPA[4]:

- counterfactual 1: product assurance processes under the LPA are operated by individual state and territory governments instead of nationally by the MLA; and
- counterfactual 2: product assurance is pursued through privately audited assurance regimes.

The net benefits of the LPA are considerably larger under counterfactual 2 than counterfactual 1 reflecting the significantly larger avoided costs of commercial assurance regimes.

The net benefits under counterfactual 1 involve incremental benefits of $141.1 million and incremental costs of $111.7 million in present value terms. In contrast, net benefits under counterfactual 2 involve incremental benefits of $2,029.8 million and incremental costs of $111.7 million in present value terms.

The investment performance statistics for livestock production assurance are summarised in Table 6.

Table 5: LPA: summary of net benefits

	Counter-factual 1	Counter-factual 2
Incremental benefits ($m)	$141.1	$2,029.8
Incremental Costs ($m)	-$111.7	-$111.7
Net benefits ($m)	$29.4	$1,918.2
Benefit-cost ratio	**1.3**	**18.2**

Source: MJA analysis

Table 6: LPA: investment performance statistics

	Net benefits ($m)		Benefit cost ratio		Internal rate of return		Modified internal rate of return	
	Counter-factual 1	Counter-factual 2	Counter-factual 1	Counter-factual 2	Counter-factual 1	Counter-factual 2	Counter-factual 1	Counter-factual 2
At 'final year'	$7.9	$890.0	1.1	16.7	10%	808%	7%	47%
5 year forward horizon	$14.0	$1,179.6	1.2	17.3	12%	808%	8%	35%
10 year forward horizon	$18.7	$1,406.5	1.2	17.7	13%	808%	8%	29%
20 year forward horizon	$25.4	$1,723.5	1.3	18.0	14%	808%	8%	22%
30 year forward horizon	$29.4	$1,918.2	1.3	18.2	14%	808%	7%	18%

4 These counterfactuals assume equivalent outcomes for product conformity on criteria for food safety, contamination and livestock health and welfare.

Source: MJA analysis

We have tested the sensitivity of our results for the LPA to variations in the key assumptions. Most of the variability of results to key assumptions relates to the how we have estimated the avoided costs. One of the key assumptions we made under counterfactual 2 is that each farmer has one audit each year. By examining less frequent audits than one per year, since this is what occurs under the current LPA system, we found that the net benefits move closer to those achieved assuming counterfactual 1. This supports the case that the net benefits lie somewhere between our estimated values under counterfactual 1 and counterfactual 2.

Scientific research

We estimate that the scientific research program will deliver net benefits of $368.0 million in present value terms from the year 2000 with an associated benefit-cost ratio of 4.4 (Table 7) – over a 30 year forward horizon. The net benefits involve benefits of $477.1 million and costs of $109.1 million in present value terms.

However, we note that this result is significantly influenced by a project on transmissible spongiform encephalopathies (TSEs) which had large net benefits. If we exclude this project, the net benefits are $148.3 million with a benefit-cost ratio of 2.4 (Table 8).

The types of benefits that have been delivered by the scientific research program include:

- cost savings for meat processors and/or avoided processing costs;
- increase in profits from higher meat sales;
- lower health costs which result from lower food safety incidents;
- disease testing cost savings for government (in the case of the TSE project); and
- a price premium on export sales.

We note that our estimate of net benefits may be slightly understated because we were not able to quantify the benefits for some of the projects for which we believe there are likely to be positive benefits. For example, there are consumer health benefits for some projects which have not been quantified due to a lack of available research on red meat food safety outbreaks.

The investment performance statistics for the scientific research program are summarised in Table 9.

Table 7: Scientific research: summary of net benefits (including the TSE project)

Incremental benefits ($m)	$477.1
Incremental costs ($m)	-$109.1
Net benefits ($m)	**$368.0**
Benefit-cost ratio	**4.4**

Source: MJA analysis

Table 8: Scientific research: summary of net benefits (excluding the TSE project)

Incremental benefits ($m)	$256.1
Incremental costs ($m)	-$107.8
Net benefits ($m)	**$148.3**
Benefit-cost ratio	**2.4**

Source: MJA analysis

Table 9: Scientific research: investment performance statistics

	Net benefits ($m)		Benefit cost ratio		Internal rate of return		Modified internal rate of return	
	Including TSE project	Excluding TSE project	Including TSE project	Excluding TSE project	Including TSE project	Excluding TSE project	Including TSE project	Excluding TSE project
At 'final year'	$39.9	$41.0	1.7	1.8	39%	41%	21%	22%
5 year forward horizon	$164.1	$71.8	3.4	2.1	44%	42%	24%	20%
10 year forward horizon	$247.3	$95.3	4.0	2.2	44%	42%	22%	17%
20 year forward horizon	$336.5	$128.2	4.4	2.3	44%	42%	17%	14%
30 year forward horizon	$368.0	$148.3	4.4	2.4	44%	42%	15%	13%

Source: MJA analysis

We believe that most of the variability of results to key assumptions is with the benefits part of the calculation. By testing how these assumptions may change the outcome of the analysis, we found that the base case benefit cost ratio is likely to be between 2.2 and 6.6 if we include the TSE project in our calculations or between 1.2 and 3.6 if we exclude the TSE project from our calculations – assuming a 30 year forward horizon.

Our estimate of net benefits for the scientific research component is based on analysis of a sample of projects, representing approximately 43 per cent of the program (measured by total funding by MLA). We attempted to apply a non-biased approach to selecting these projects, taking into consideration available project information.

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1. Introduction

Food safety in Australia and the red meat industry's product integrity programs

A range of measures have been developed and supported by MLA and implemented through the red meat industry to ensure the safety, quality and integrity of Australian beef, sheep meat and goat meat. These measures ensure that Australia's red meat continues to gain access to important export markets and provide domestic consumers with assurance of meat safety and quality..

MLA's three key product integrity programs are outlined in Table 10. These programs contribute to the maintenance of a high standard of food safety via quality systems and product and animal monitoring. They are supported where appropriate by government regulations. They also enhance Australia's competitive position in exporting to quality sensitive markets.

We note that the National Livestock Identification System (NLIS) for cattle is different to sheep and goats. In particular, unlike the electronic identification of individual animals in place in cattle, the current NLIS for sheep and goats relies on visual identification of ear tags, coupled with recording movements of mobs of animals.

Table 10: Core components of the product integrity programs

Component	Key aspects
Livestock traceability National Livestock Identification System	**National Livestock Identification System (NLIS)** ▪ The NLIS is Australia's system for rapid identification and traceability of livestock. The NLIS was first implemented in 1999 as a trial in Victoria and then introduced in 2006 as mandatory in all states and territories. ▪ NLIS for cattle involves radio frequency identification (RFID) tag technology. This technology was introduced to align with the whole-of-life identification demands of the EU.
On-farm food safety systems LIVESTOCK PRODUCTION ASSURANCE	**Livestock Production Assurance (LPA)** ▪ LPA aims to provide an assurance of the safety of red meat grown on Australian farms. AUS-MEAT administers the LPA program on behalf of industry, and carries out all LPA audits. ▪ The LPA National Vendor Declaration (LPA NVD) is required for any movement of stock – to processors, to saleyards or between properties if they have different Property Identification Codes (PICs). ▪ When an LPA NVD is signed, the producer is sharing information on livestock history and declaring the food safety status of the animal(s).
Food safety scientific research	**MLA's Food Safety Research Program** ▪ The research program focuses on gaining an understanding and communicating knowledge about food safety risks, and their control, in the red meat supply chain so that industry, regulators and the marketplace worldwide are aware and satisfied that risks are understood and effectively controlled.

MLA has indicated to us that the product integrity programs have been funded through a variety of sources (Table 11).

Table 11: Funding sources for product integrity programs

Component	Funding sources
Livestock traceability	▪ Grassfed cattle levy ▪ Grainfed cattle levy ▪ Sheep levy ▪ Goat levy ▪ Processor levy through the Australian Meat Processor Corporation ▪ Commonwealth government through matching R&D funds and Commonwealth grants.
On-farm food safety systems	▪ Grassfed cattle levy ▪ Grainfed cattle levy ▪ Sheep levy ▪ Goat levy ▪ Processor levy through the Australian Meat Processor Corporation ▪ Commonwealth government through matching R&D funds ▪ Funds raised through the sale of LPA NVD books.
Food safety scientific research	▪ Grassfed cattle levy ▪ Grainfed cattle levy ▪ Sheep levy ▪ Processor levy through the Australian Meat Processor Corporation ▪ Commonwealth government through matching R&D funds

Project methodology and approach

Marsden Jacob Associates was engaged by MLA to undertake an ex-post impact assessment of the red meat industry's product integrity programs. Our impact assessment is a social benefit cost analysis in that we attempt to value all of the relevant benefits and costs to society of the programs.

We have separately valued the three programs:

- Livestock traceability: NLIS;
- On-farm food safety assurance: LPA; and
- Scientific research.

We note that there is some overlap between these three components (especially for the NLIS and LPA components). These overlaps are addressed in our analysis.

Our benefit cost analysis closely follows the CRRDCs Impact Assessment Guidelines[5]. In particular, in estimating benefits and costs we have:

- inflated historical values to base year (2014) values by using the implicit price deflator for national gross domestic product (GDP) – as published by the Australian Bureau of Statistics (ABS, 2012a, Table 4, series A2420916F); and
- calculated the present value of future costs and benefits by the real discount rate – set at 5 per cent; and
- estimated net benefits for 5, 10, 20 and 30 year net present value horizons, noting that our 'headline' net benefits will apply a 30 year time horizon.

In undertaking this analysis we have, where appropriate, defined what would have occurred without the MLA investment – referred to as the 'counterfactual'. We have also examined the sensitivity of the results to the key assumptions via sensitivity analysis. Additionally, we have estimated the flow of the net benefits for the three components of the program to different market participants along the red meat chain.

Our impact assessment has drawn on a range of sources including previous reports and consultation with a wider range of stakeholders. Our stakeholder consultation has included government, meat processors, industry experts and MLA staff.

Report structure

There are four parts to this impact assessment:

- **Part A: Livestock traceability: NLIS.** This section estimates the benefits and costs of the livestock traceability component;
- **Part B: On-farm food safety assurance: LPA.** This section estimates the benefits and costs of the on-farm food safety assurance component with a specific focus on LPA;
- **Part C: Scientific research.** This section estimates the benefits and costs of the scientific research component;
- **Part D: Impact on market participants along the chain.** This section assesses the impact on different market participants in the beef, sheep and goats value chains for each of the three components of the programs; and,
- **Part E: Detailed investment performance information in aggregate for all three product integrity programs:** this section contains detailed investment performance information for the program (including all three components combined).

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5 Council of Rural Research and Development Corporation (2014), Impact Assessment Guidelines, Version 1, May 2014.

PART A: LIVESTOCK TRACEABILITY: NLIS

This section examines the benefits and costs of the livestock traceability (NLIS) program.

2. Overview of NLIS and traceability

In this section we summarise the key features of the NLIS and the effect of the NLIS on livestock traceability and the incremental value of improved livestock traceability.

2.1 The NLIS

The NLIS is Australia's system for rapid identification of cattle sheep and goats and recording their movement. The NLIS is comprised of two components:

- The NLIS for cattle — an electronic, radio frequency identification for all cattle in Australia linked to records of location information from birth to death of each animal.
- The NLIS for sheep and goats — a mob-based identification system linked to records of the origin and movements of animals between locations.

After an initial trial in 1999, the implementation of the NLIS system for cattle was staggered over time and across States starting around 2004. States and territories progressively required cattle movements to be recorded on the NLIS database (starting around 2004) and since 2006 has been mandatory in all states and territories. The NLIS for sheep and goats was introduced on 1 January 2006.

The NLIS is underpinned by complementary state and territory legislation, which provides the regulatory framework for the system. We note that there are some minor differences in the legislative approach taken which has some impact on the operation of the NLIS. For example, in some states there is no supporting legislation relating to property to property movements of sheep[6].

Under the NLIS (cattle) system, when an animal is moved between properties or is slaughtered or exported, a record is entered on the national database.

Under the NLIS (sheep and goats) system, when a group of animals is moved between properties or are killed a record is entered on the national database.

The saleyard and abattoir sectors are the major users of the database being the major points for the recording of movements and kill records. Jurisdictions monitor all sectors of the supply chain to ensure movements and kills are reported to the NLIS database in accordance with business rules.

In this way, the NLIS provides a national traceability system for all cattle, sheep and goats for whole of life to point of slaughter. [7]

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6 NSW Government (2013), Response from the NSW Government to the Consultation Regulation Impact Statement 'Implementation of improvements to the National Livestock Identification System for sheep and goats', Prepared by NSW Department of Primary Industries, December 2013, page 6.

7 Jurisdictions monitor performance of industry against business rule KPIs and are expected to undertake compliance action to ensure integrity of the database.

2.1.1 Supporting and facilitating mechanisms

Two key facilitating programs underpin the NLIS:

- the Property Identification Code (PIC); and the
- National Vendor Declaration (NVD).

The PIC is a unique alphanumeric property identifier issued by state and territory jurisdictions to primary producers and facilities that handle livestock. Where certain classes of livestock owners (types of livestock and numbers owned) do not have a property, the livestock owners are issued with a Livestock PIC. The PIC is administered separately by individual states and territories. The PIC is used by jurisdictions for a range of policy and service delivery purposes.

The National Vendor Declaration (NVD) was introduced in 1996 primarily to enable market access in response to residue concerns by some destination countries. Most, but not all jurisdictions, accept the NVD as a waybill to be completed when animals are transferred between properties with a different PIC.

A waybill is a document required under legislation in most jurisdictions and accompanies stock moved from a holding, saleyard or place of origin. A waybill:

- identifies the owner of the stock;
- describes the stock being moved; and
- provides details of the movement.

The main use of the waybill has been to record of movement and enable the tracing of stock. In Victoria there is no requirement for a waybill as the NVD and NLIS suffices, whereas in the Northern Territory a waybill is required in addition to an NVD.

Among others, the NVD declaration addresses:

- the type of feed system the animal has been produced on;
- whether it has been treated with hormonal growth promotants;
- the management of and exposure to agricultural chemical and antibiotics;
- the time off feed and water has aligned with appropriate animal welfare standards; and
- whether the producer has adhered to appropriate withholding periods.

By signing and processing, the NVD performs two key functions:

- the seller can provide the buyer with a guarantee relating to the food safety status of the animals they are purchasing; and
- livestock movements can be traced if necessary — in effect the NVD acts as an additional mechanism for traceability in addition to the NLIS.

The NVD also underpins the LPA and the various QA systems that sit under its umbrella. One of the components of the declaration is that animal management arrangements have met LPA standards. As such the NVD acts as a mechanism to explicitly record the food safety status of the animal and give effect to the LPA.

3. Estimating net benefits of the NLIS

In this section we estimate the net benefits of the NLIS. This involves examining the incremental benefits and costs associated with the NLIS. To do this we need to understand what is likely to have occurred without the NLIS, which we will refer to as the 'counterfactual'. The incremental benefits and costs are the difference between the benefits and costs with the NLIS and those without the NLIS (the counterfactual).

3.1 The counterfactual

In this evaluation we assume that in the absence of the NLIS (the 'counterfactual') there is a mob-based system with visual tags (tail for cattle and ear for sheep and goats). The mob-based system means that the tags are printed with PIC of the property of birth or consignment and are not linked to any particular animal.

This counterfactual is to be contrasted with the current system in which cattle are identified with individual electronic devices and an NLIS central database for cattle, sheep and goats. Therefore, without the NLIS, the tracing of cattle, sheep and goats would be undertaken via a paper based system and not supported by the NLIS database tools. The differences between the current system and assumed counterfactual is summarised in Table 12.

Table 12: Comparison of current system with counterfactual

Characteristic of system	Current system	Counterfactual
Type of system	Individual cattle identification for cattle Mob-based identification for sheep and goats	Mob-based identification for cattle Mob-based identification for sheep and goats
Devices	Electronic RFID ear tag or rumen bolus for cattle Ear tag for sheep and goats	Tail tag for cattle Ear tag for sheep and goats
Supporting tracking system	NLIS database for cattle, sheep and goats	No NLIS database: paper-based NVD

The selection of this counterfactual was discussed with and supported by a wide range of stakeholders consulted during this study. Additionally, we have considered what was in existence prior to the introduction of the NLIS for cattle.

3.2 Incremental benefits and costs of NLIS

The estimated incremental benefits and costs for the NLIS are contained in Table 13. The net benefits in Table 13 have been estimated over a period of thirty years into the future.

Table 13: NLIS: net benefits

Incremental benefits ($m)	$9,433.2
Incremental Costs ($m)	-$1,141.5
Net benefits ($m)	$8,291.7
Benefit-cost ratio	**8.3**

Source: MJA analysis

In accordance with the CRRDCs Impact Assessment Guidelines[8], we have also prepared a variety of investment performance information (Table 14). These illustrate how the returns from the project vary with different assumed time horizons into the future. This is important since some benefits and costs are assumed to continue into the future. Section 7 contains detailed investment performance information.

Table 14: NLIS: investment performance statistics

	Net benefits ($m)	Benefit cost ratio	Internal rate of return	Modified internal rate of return
At 'final year'	-$474.8	0.0	n.a.	-100%
5 year forward horizon	$2,003.6	4.0	23%	14%
10 year forward horizon	$3,941.4	5.9	27%	14%
20 year forward horizon	$6,641.3	7.5	28%	13%
30 year forward horizon	$8,291.7	8.3	28%	12%

Source: MJA analysis

The incremental benefits are discussed in more detail in section 4 and the incremental costs in section 5.

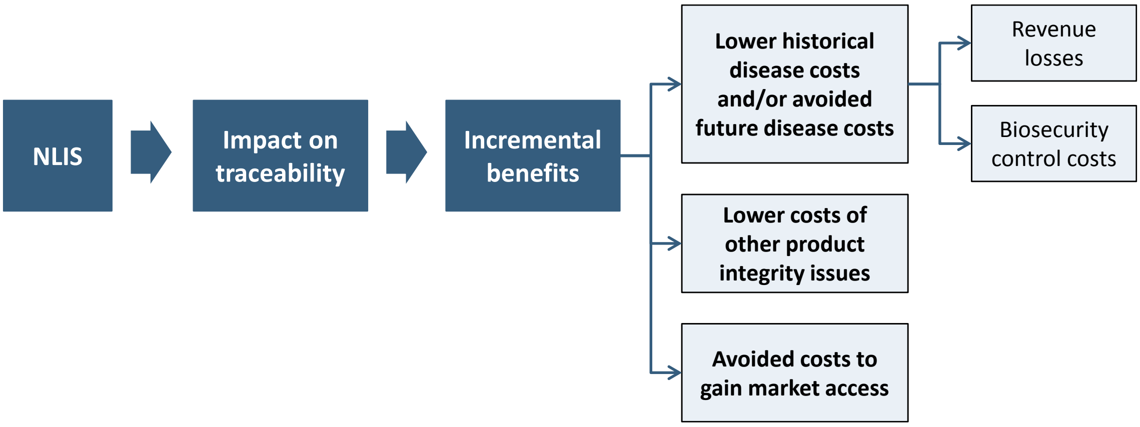
8 Council of Rural Research and Development Corporation (2014), Impact Assessment Guidelines, Version 1, May 2014.

4. Incremental benefits of NLIS

The introduction of the NLIS has improved the level of traceability of cattle, sheep and goats. This improvement has led to a range of 'incremental' benefits which we have considered in three categories (Figure 1):

- lower historical costs and/or avoided future costs;
- lower costs of other product integrity issues (e.g. chemical residues); and
- the avoided costs of gaining market access.

Figure 1: Incremental benefits



The size of the benefits depends on the scale of the improvements in traceability. The impact on traceability is discussed in more detail in section 4.1. Our estimates of the incremental benefits that flow from this are contained in section 4.2.

4.1 Impact on traceability

4.1.1 Definition of traceability

Traceability is defined as:

> '*the proportion of animals that can be successfully traced between defined points in the supply chain or over time*'[9].

Livestock traceability is defined against the 'National Livestock Traceability Performance Standards' (NLTPS) that were endorsed by PIMC in May 2004. The standards are contained in section 8. The standards are defined to reflect the capacity of animal tracing systems to be able to respond effectively to the management requirements of biosecurity agencies in the event of emergency disease outbreaks.

Traceability percentage is commonly measured as a simple average of performance against each of the criteria. Under the NTLPS, full compliance with the standards is defined as 98 per cent traceability.

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[9] ABARES 2014, Implementation of improvements to the National Livestock Identification System for sheep and goats: Decision Regulation Impact Statement ABARES research report, Canberra, August, page viii.

4.1.2 Improvements in traceability

We have examined the impact of the NLIS on traceability by comparing the level of traceability under NLIS with the counterfactual outlined in section 3.1. We have estimated the level of traceability under the counterfactual to be 65% while we have assumed traceability under NLIS to be 97 per cent for cattle and 90 per cent for sheep and goats (Table 15).

Table 15: Assumed traceability levels: comparison of current system with counterfactual

Animal	Current system	Counterfactual
Cattle	97 per cent	65 per cent
Sheep and goats	90 per cent	65 per cent

Source: Refer to discussion later in this section.

Traceability under counterfactual

Under the counterfactual we assume that traceability would have been 65 per cent.

We have assumed this based on stakeholder consultation which revealed that traceability under a mob based system is likely to be similar to those that were achieved under Exercise Sheepcatcher in 2007 (Box 1) which estimated the traceability of sheep at 57 per cent.

We have adjusted the Exercise Sheepcatcher level of traceability up to 65 per cent assuming that there would have been minor incremental improvements to traceability under the Exercise Sheep Catcher Levels from 2007 to 2014.

Box 1: Sheepcatcher

In 2007 there was an exercise called 'Sheepcatcher' which was undertaken nationally (excluding the Northern Territory and the ACT). Sheepcatcher examined the performance of the existing mob-based NLIS for sheep[10].

Traceability with NLIS

There is no clear evidence of the current combined traceability of cattle, sheep and goats. For this analysis we have separated traceability with NLIS into cattle, which is based on individual animal traceability, and sheep and goats, which uses a mob based system.

Cattle

There is widespread acknowledgement by stakeholders that we consulted during this evaluation that NLIS' cattle database (NLIS Cattle) is currently achieving traceability in the order of 95 to 98 per cent.

There has been no recent formal on-ground exercise testing the traceability of cattle. Estimates of traceability are based on underlying performance of the electronic database and desk bound

10 ABARES (2014(, Implementation of improvements to the National Livestock Identification System for sheep and goats: Decision Regulation Impact Statement, ABARES research report, Canberra, August, page 8.

exercises to identify records. The most recent exercise was Exercise CowCatcher II in 2007[11]. This exercise demonstrated that NLIS Cattle was achieving 97.8 per cent traceability across all NLTPS. While the test suggested traceability in the order of 98 per cent, some stakeholders have expressed concerns that this is overstated given non-compliance with scanning and uploading data to the database by some producers and processors.

As a result, we take a mid-point and assume a NLIS Cattle traceability of 97 per cent.

Sheep and goats

Identifying the current traceability of sheep and goats is more challenging. There is a range of conclusions in recent studies and investigations that indicate there is some uncertainty over the current extent of traceability for sheep and goats.

The results of Sheepcatcher indicated a number of issues with the NLIS system for sheep and goats that existed in 2007, in particular:

> *'the NLIS did not enable complete tracing of animals (or their cohorts) to the standard the NLTPS required. The main defects were in the ability to trace cohorts' whole-of-life and the considerable number of staff needed (mainly from saleyards, abattoirs and stock agents) to locate and interpret the paperwork collected in the NLIS to facilitate tracing of sheep at that time'*[12].

In April 2012 following improvements to the mob-based system, which included establishing an NLIS database, the New South Wales Department of Primary Industries conducted an exercise called 'Tuckerbox'[13]. The exercise tested the mob-based tracing system for sheep and goats and compared it to the electronic identification (EID) NLIS for cattle. The 'Tuckerbox' study concluded that both systems were capable of tracing for foot and mouth disease (FMD) and '*meeting national tracing standards using the NLIS database as the primary tracing tool*[14]'.

We note that there were several limitations to this study. For example, the exercise did not assess the '*whole-of-life traceability requirements of the NLTPS*[15]' and as such increases in traceability measured by such an exercises may not reflect all the potential gains in reducing disease costs. Additionally, the exercise did not undertake a manual inspection of animals or tags and demonstrated the traceability of animals recorded on the database rather than the precision of traceability per se. While this latter approach was also adopted in Cowcatcher I and II the lack of inspection is more problematic for sheep given the sheep system relies of physical inspection and manual recording. The exercise also demonstrated the large number of sheep movements and the importance of sheep as a potential vector for disease spread.

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11 Department of Agriculture Fisheries and Forestry and Animal Health Australia (2007), Exercise Cowcatcher II Final Report, May. http://www.agriculture.gov.au/SiteCollectionDocuments/animal-plant/emergency/cowcatcher/cowcatcher2-report.pdf

12 ABARES (2014), Implementation of improvements to the National Livestock Identification System for sheep and goats: Decision Regulation Impact Statement, ABARES research report, Canberra, August 2014, page 7.

13 Bell, I.G., Ozols, O., Davison, L., (2013), Exercise Tuckerbox - a foot – and - mouth disease desk - top tracing exercise conducted in New South Wales in April 2012, NSW Government.

14 Bell, I.G., Ozols, O., Davison, L., (2013), Exercise Tuckerbox - a foot – and - mouth disease desk - top tracing exercise conducted in New South Wales in April 2012, NSW Government, page 2.

15 ABARES (2014), Implementation of improvements to the National Livestock Identification System for sheep and goats: Decision Regulation Impact Statement, ABARES research report, Canberra, August, page 8.

Since 2013, further testing has been undertaken in New South Wales. In particular, the Livestock and Health and Pest Authority (LHPA) and NSW Agriculture rangers and veterinarians conducted saleyard audits at sheep sales across NSW (NSW Agriculture 2013). This examination found that '*compliance on initial inspection of non-vendor bred lots of around 95% is being achieved*' and that '*NSW DPI and LHPA are confident that with continued saleyard audits over the next six months a level of 98% compliance will be achieved*[16]'. Therefore, there is continuing evidence of full compliance with the NTLPS requirements in New South Wales.

However, while exercise Tuckerbox provided evidence that the NLIS Sheep and Goats was working effectively in New South Wales, there is evidence from other sources that suggests that the results in New South Wales are not reflective of performance in other states. In particular, our consultation with stakeholders indicated that traceability in Victoria and Queensland is likely to be less than has been identified in New South Wales. We discuss the current traceability levels in Victoria and Queensland in Box 2.

ABARES, in its recent Decision Regulation Impact Statement, adopted an average traceability for sheep and goats of 90 per cent

> *… the current traceability is assumed to average 90 per cent based on discussions with jurisdictions and feedback received during the consultation phase. This represents a national average across the individual traceability standards relevant to sheep and goats, noting that some jurisdictions may currently achieve higher levels and others lower levels of traceability. For example, evidence from past saleyard audits suggests that the prevalence of inaccurate or incomplete movement documentation is lower in New South Wales than other jurisdictions, suggesting a higher level of traceability than the national average.*

Discussions with ABARES and the Chief Veterinary Office indicate that ABARES adopted the 90 per cent as *an assumed average across all jurisdictions* after accounting for differences in compliance and industry size.

In our analysis we will also assume 90 per cent for the current level of traceability of sheep and goats across Australia. However, our sensitivity analysis in section 6 examines a lower bound to take into account stakeholder feedback.

Box 2: Traceability levels in Victoria and Queensland

In 2014 the Department of Environment and Primary Industries (DEPI) in Victoria assessed sheep and goat traceability compliance across a range of processing plants that were slaughtering sheep from both Victorian and interstate sources. The exercise involved the collection of all tags for a day's kill from five abattoirs around Victoria, along with accompanying NVDs and post-sale summaries (PSS). The result showed that;

- 41 per cent of all tags collected had a PIC that had not been recorded on the accompanying paperwork;
- 31 per cent of PICs listed on the paperwork were not present on any of the collected tags; and
- 25 per cent of additional PICs recorded on NVDs supplied contained a transcription error meaning

[16] NSW Government (2013), Response from the NSW Government to the Consultation Regulation Impact Statement 'Implementation of improvements to the National Livestock Identification System for sheep and goats', Prepared by NSW Department of Primary Industries, December 2013, page 5.

that they had been mis-transcribed by the vendor.

Given that many of the sheep processed by plants involved in the survey had sourced sheep from interstate saleyards, DEPI concluded that there are serious issues with the traceability of sheep and goat traceability within each of the eastern States.

DAFF Queensland (2013) noted improvements in compliance as a result of extension but nonetheless remained concerned by current compliance levels:

> *DAFF has experienced an increase in compliance with the current system since beginning extension program. An example is the reduction from 80% to 20 - 30% for incomplete NVD's for non-vendor bred sheep and goats. Queensland stills finds non-vendor bred lines of sheep and goats having incomplete travel documents. Through an extension effort, there has been a reduction in the percentage of travel documents that are not fully completed from 80% to 20 - 30% incomplete. Monitoring carried out at Queensland saleyards and abattoirs has identified this risk to traceability. DAFF considers Queensland without further improvement would experience great difficulty in meeting the NLTPS in the event of a disease incursion such as FMD utilising the existing visual tag mob based system. Despite extension and engagement with supply chain sectors on the importance of reporting mob based movement to the NLIS database, DAFF considers further improvement to the current system is required to meet the agreed National Livestock Tracing Queensland DAFF 2013).*

4.2 Incremental benefits

This improvement has led to a range of 'incremental' benefits which we have considered in two categories (Figure 1):

- lower historical disease costs and/or avoided future disease costs;
- other product integrity issues; and
- avoided costs to gain market access.

We have estimated the total incremental benefits from these two categories at $9,433.2 million in present value terms (assuming a thirty year forward period). We note that this relates entirely to avoided future disease costs and is likely to be a lower bound value for reasons explained later in this section.

We have not assumed any benefits from NLIS in gaining access to, say, European markets since it is likely that Australia would gain access to European markets without the NLIS in the same way that other countries have done so. We assume the European Union and other market access would have been achieved under the counterfactual. It is possible this could have required additional negotiation and organisational effort on the part of government which we have not quantified. Additionally, the avoided cost of a higher level of quality assurance to gain access to European markets is likely to be equivalent to the current LPA system in place.

These benefits are discussed in more detail below.

We note that there are difficulties in comparing these results to other studies since previous studies which have examined the benefits of the NLIS (including regulatory impact statements) have not estimated the benefits of incremental changes to Australia's biosecurity system over time.

We also note that the NLIS does not reduce the likelihood of a disease outbreak. The benefit of NLIS in the event of a disease outbreak is to reduce the cost of the occurrence of an outbreak.

4.2.1 Disease costs

By improving traceability levels the NLIS reduces the impact of disease outbreaks. The impact of improved traceability has benefits in the case of fast and slow moving diseases. We estimated that the total incremental benefit from these two categories is $9,433.2 million in present value terms (Table 16). The benefits have been estimated based on the traceability levels for the current system and without the NLIS as contained in Table 12.

Noticeably, most of the benefits of past NLIS investments are likely to occur in the future. This is because there have been few product integrity (disease, residue or contamination) incidences since the inception of the NLIS but there remains a risk they could occur in the future. Moreover, there have been no major exotic disease outbreaks since the inception of the program and as a result there are no benefits between 2006 and 2015 – other than the security of knowing that the industry had a capacity to respond to a serious risk.

However, we note that an anthrax outbreak occurred in northern Victoria in 2007 and recently in 2015. The affected properties were flagged on the NLIS for a 5 year period to ensure appropriate vaccination and product withholding periods were observed. We have not estimated the benefit from this occurrence since our approach to illustrating the benefits of a slow moving disease is based on the disease bovine spongiform encephalopathy (BSE) which would have much greater costs for the cattle industry than these occurrences of anthrax.

We also note that there were a number of disease outbreaks that occurred prior to 2005 that created market access issues that are currently being addressed through the NLIS. This includes properties that were infected by anthrax outbreaks prior to 2005. These properties are flagged on the NLIS system and are required to vaccinate livestock 42 days prior to transfer from the property.

We note that there is significant uncertainty over the size of these benefits because the incremental benefit from the NLIS is reliant on assumptions made around the relative size of the benefits under different traceability levels. However, our estimate of the net benefits is likely to understate the value of NLIS since we have only estimated the avoided cost for one fast moving disease, foot and mouth disease (FMD) and one slow moving disease (BSE), noting that these are typically the diseases that are thought of as having the highest cost impact.

For our analysis, we have distinguished between historical benefits and future benefits. We have defined historical benefits as those that have led to reduced disease costs from disease outbreaks that have occurred from 2006 to 2014. We have defined future benefits as those costs that will be avoided in the future if there is a disease outbreak.

The estimation of benefits for each of the three categories of benefits is discussed in more detail below.

Table 16: Disease benefits (in present value terms)

Category of benefit	Historical benefits (lower costs) ($m)	Future benefits (avoided costs) ($m)	Total benefits ($m)
Fast moving disease (FMD)	$0	$9,366.0	$9,366.0
Slow moving disease (BSE)	$0	$67.2	$67.2
Total	**$0**	$9,433.2	$9,433.2

Source: MJA analysis.

Fast moving diseases

Fast-moving, highly contagious diseases, such as FMD, are one of a range of diseases that could affect the Australian red meat sector. It is beyond the scope of this study to assess the likelihood and possible impact of all exotic diseases and the role the NLIS would play in identifying affected animals. NLIS' contribution to constraining loss of markets, isolating meat supplied from disease-free animals and enabling more rapid market re-access will differ for each disease and each outbreak scenario. Each potential disease outbreak could have its own unique circumstances for location, spread, containment and eradication.

For this evaluation we will use FMD as an indicative example of the potential benefits of the NLIS for addressing the impacts of a fast-moving, highly contagious disease. FMD is a high cost, but low risk, fast moving disease that is highly infectious and rapidly spread between animals as they come in contact with one another.

With a fast-moving disease, such as FMD, traceability can aid containment by demonstrating the extent of spread, thereby enabling establishment of reliable quarantine, buffer and management zones. This zoning can act to reduce the spread of the disease and costs of eradication, enabling non-diseased areas to demonstrate absence of the disease resulting in market access issues to be resolved quicker than otherwise.

We note that the focus on FMD is the approach taken in ABARES (2014)[17] and that there has been no comprehensive risk modelling to date of all potential disease scenarios that could occur in the red meat sector. Moreover, our estimates of potential benefits related to fast moving diseases are a lower bound since we have only modelled the impact of FMD.

The historical benefits of the NLIS are estimated to be zero in present value terms since there have been no FMD outbreaks since the introduction of the NLIS.

The benefits from future avoided costs are estimated to be $9,366.0 million in present value terms. This is based on comparing the impact of an FMD outbreak on the value of production of

[17] ABARES (2014), Implementation of improvements to the National Livestock Identification System for sheep and goats: Decision Regulation Impact Statement, ABARES research report, Canberra, August.

the Australian red meat supply chain in the absence of the NLIS and with the NLIS. This is explained in more detail in Box 3.

We note that while ABARES estimated the total direct costs to primary producers of an FMD outbreak at $52 billion over a ten year period, general equilibrium modelling (using Ausregion) also undertaken by ABARES found the long term costs to the economy as a whole to be substantially lower, at $23 billion.

We have adopted the $52 billion estimate based on advice from ABARES, our understanding of the Ausregion modelling that was undertaken and its consistency with previous benefit cost analysis of the NLIS undertaken by ABARES in “Implementation of improvements to the National Livestock Identification System for sheep and goats: Decision regulation impact statement”. The substantial reduction in cost (more than halving the direct cost estimate) does not align with previous comparative direct and general equilibrium modelling previously conducted by ABARES and the Productivity Commission. The major difference can be traced to Ausregion modelling assumptions relating to red meat producer adjustment to other agricultural enterprise activities and the benefits to Australian consumers of lower domestic red meat prices as a result of loss of export market access.

ABARES believes the direct impact estimates are the best approximation of the costs of an FMD outbreak and that the Ausregion results rely on a wider array of modelling assumptions and as such the direct impact estimates should be used in this analysis. This assumption has a reasonably substantial impact on the results. We note that the assumption increases the net benefits of the NLIS when compared to the application of the social benefit cost methodology envisaged by the CRRDC guidelines and reflected in the sensitivity analysis in section 6.

As a result, to account for the likelihood of lower economy wide impacts we use the $23 billion Ausregion estimate in sensitivity testing as a lower bound estimate of the costs of FMD. We note that the $23 billion is also closer to previous estimates produced by the Productivity Commission and revised and updated by ABARES for the Matthews Review.

In this benefit cost evaluation we have adopted $52 billion based on a large outbreak and, as with ABARES, we consider this the standard assumption. ABARES also estimates that costs of a small FMD outbreak to be in the order of $6 billion. We exclude these small outbreak scenarios from our analysis given their cost estimates are highly contingent on the underlying incidence, spread and containment assumptions.

Box 3: Estimating future avoided costs of FMD

We have estimated the future avoided disease costs by comparing disease costs with traceability at current levels to disease costs with traceability levels without the NLIS. The traceability levels that we have applied are contained in Table 15.

The disease cost at different traceability levels (in present value terms) have been calculated by discounting the annual economic cost of FMD over thirty years. The annual economic cost has been estimated by multiplying the disease outbreak cost by the probability of an outbreak. Note that the ‘disease cost’ is different to the ‘disease outbreak cost’ since it captures the potential economic costs over the thirty year period rather than just for one disease outbreak.

The disease outbreak cost for differing levels of traceability has been estimated in the following way:

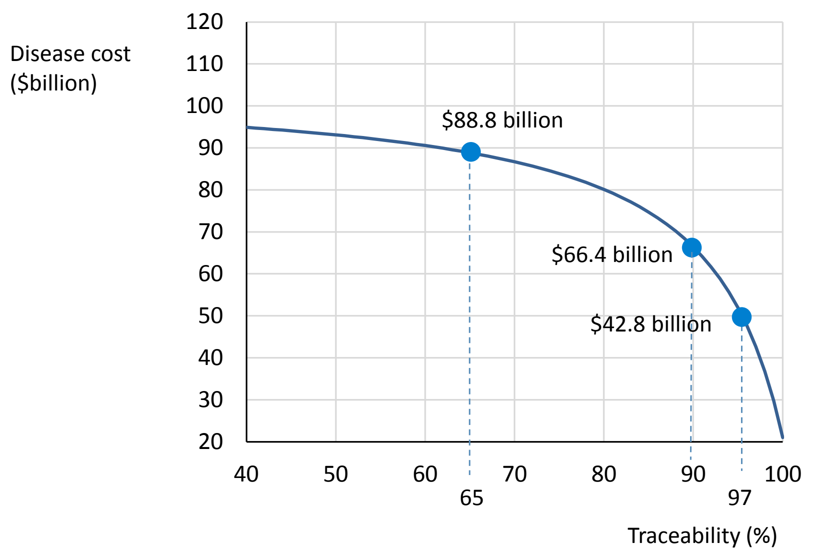
- traceability level at 97 per cent: we have estimated the disease cost of an outbreak at $42.8 billion. This is our estimate of the beef and sheep share of the $52 billion disease cost estimated by ABARES

(2013)[18] and ABARES (2014)[19].

- traceability levels at 90 and 65 per cent: we have estimated the disease cost of a fast moving outbreak at these levels by applying a similar relationship between FMD disease cost of an outbreak and traceability levels as per the CIE (2010) report[20]. The disease cost of an outbreak that results from this approach is outlined in Figure 2.

The disease outbreak costs in the ABARES reports comprises 'control costs' and 'revenue losses'[21], which is consistent with our methodology for estimating avoided costs in Figure 1. In the ABARES modelling, control costs '*the cost of eradication for each scenario is broken into cost of labour, decontamination, slaughter and disposal, hire of equipment and facilities, stores and laundry'*[22]. *Revenue losses are defined as 'revenue losses to livestock producers due to export suspensions'*[23]. We note that revenue losses in the ABARES modelling also include the cost of compensation to the government. We further note that 99 per cent of total disease outbreak costs relate to revenue losses in the ABARES modelling.

Figure 2: FMD disease outbreak cost at different traceability levels



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18 ABARES (2013), Potential socio-economic impacts of an outbreak of foot-and-mouth disease in Australia, Canberra.

19 ABARES (2014), Implementation of improvements to the National Livestock Identification System for sheep and goats: Decision Regulation Impact Statement, ABARES research report, Canberra, August 2014, page 37.

20 Centre for International Economics (2010), NLIS (sheep and goats) business plan: the costs of full compliance with NLTPS, research report, Centre for International Economics, Canberra, page 187.

21 ABARES (2013), Potential socio-economic impacts of an outbreak of foot-and-mouth disease in Australia, Canberra.

22 ABARES (2013), Potential socio-economic impacts of an outbreak of foot-and-mouth disease in Australia, Canberra, page 12.

23 ABARES (2013), Potential socio-economic impacts of an outbreak of foot-and-mouth disease in Australia, Canberra, page 18.

Source: MJA analysis

The probability each year of an FMD outbreak has been assumed to be 1.5 per cent[24].

Using these disease outbreak costs and probability of an outbreak, we have estimated the avoided disease cost by:

- estimating the disease cost at differing traceability levels in present value terms (Table 17); and
- then calculating the difference between disease costs with current traceability levels and what they would have been with the NLIS.

Note that we have applied the same annualised disease cost in real terms into the future. The distribution of net benefits is assumed to be 76 per cent for the beef cattle sector and 24 per for the sheep sector. This is based on ABARES (2013) modelling of a large outbreak of FMD and the distribution of revenue losses between these two sectors[25].

Table 17: Avoided disease cost

Sector	Estimation approach	Present value of benefits ($m)
Cattle	Avoided disease cost = disease cost at 97 per cent traceability minus disease cost at 65 per cent traceability.	$8,117.8
Sheep and goats	Avoided disease cost = disease cost at 90 per cent traceability minus disease cost at 65 per cent traceability.	$1,248.2
Total		$9,366.0

Source: MJA analysis.

Slow moving diseases

For this evaluation we use BSE as an indicative example of the potential benefits of the NLIS for addressing the impacts of a slow moving highly contagious disease. BSE, commonly known as 'mad cow' disease is a '*fatal chronic degenerative disease affecting the central nervous system of cattle'. It has a long incubation period and a slow rate of spread*[26]'. BSE is not infectious per se but is spread through inappropriate management and feeding regimes.

Similar benefits exist for a slow moving disease compared to a fast moving disease. However, the focus is more demonstrating absence of diseases to enable market access. Moreover, containing spread and reducing eradication costs are priorities as the rate of disease spread is slower.

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[24] This is based on the estimate of an outbreak of FMD in Australia as reported in ABARES (2014), Implementation of improvements to the National Livestock Identification System for sheep and goats: Decision Regulation Impact Statement, ABARES research report, Canberra, August, xvii.

[25] ABARES (2013), Potential socio-economic impacts of an outbreak of foot-and-mouth disease in Australia, Canberra, page 25. The revenue losses we have used in this analysis refer to a large multi-state outbreak with stamping out.

[26] Yainshet, A., Cao, L. and Elliston, L. 2006, A Hypothetical Case of BSE in Australia: Economic Impact of a Temporary Loss of Market Access, ABARE Report Prepared for the Product Integrity, Animal and Plant Health, Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, October.

Our estimates of potential benefits related to slow moving diseases are a lower bound since we have only modelled BSE. We note that there are other slow moving diseases which have a higher likelihood of occurring but have much lower outbreak costs, such as anthrax.

The historical BSE disease benefits of the NLIS are estimated to be zero in present value terms since there have been no BSE outbreaks since the introduction of the NLIS.

The benefits from future avoided costs are estimated to be $67.2 million in present value terms. This is based on comparing the impact of a BSE outbreak on the value of production of the Australian red meat supply chain in the absence of the NLIS and with the NLIS. This is explained in more detail in Box 4.

Box 4: Estimating future avoided costs of BSE

We have estimated the future avoided disease costs via the same approach that was applied to FMD in Box 3.

The disease outbreak cost for differing levels of traceability has been estimated in the following way:

- traceability level at 97 per cent: we have estimated the disease cost of an outbreak at $4.2 billion. This is based on $3.3 billion (2006 dollars) estimated by Yainshet, Cao & Elliston (2006)[27] and adjusted by the GDP price deflator to convert to 2014 dollars. We note that this may slightly overestimate disease costs since in 2006 the NLIS was only just beginning. However, this will not affect our estimate of avoided costs since it is an estimated as the difference between disease costs at varying traceability levels.
- traceability levels at 90 and 65 per cent: we have estimated the disease cost of an outbreak at these levels by applying a similar relationship between BSE disease cost of a slow moving outbreak and traceability levels as per the CIE (2010) report[28]. The disease cost of an outbreak that results from this approach is outlined in
-
-
- **Figure** 3**.**

The disease costs in the Yainshet, Cao & Elliston (2006) report comprise the economic costs to the national economy. However, the focus in Yainshet, Cao & Elliston (2006) report is on beef prices and production and not on control costs. This exclusion of biosecurity control costs is unlikely to influence the result in a material way since they are likely to be a small portion of total costs – as per the FMD example in Box 3.

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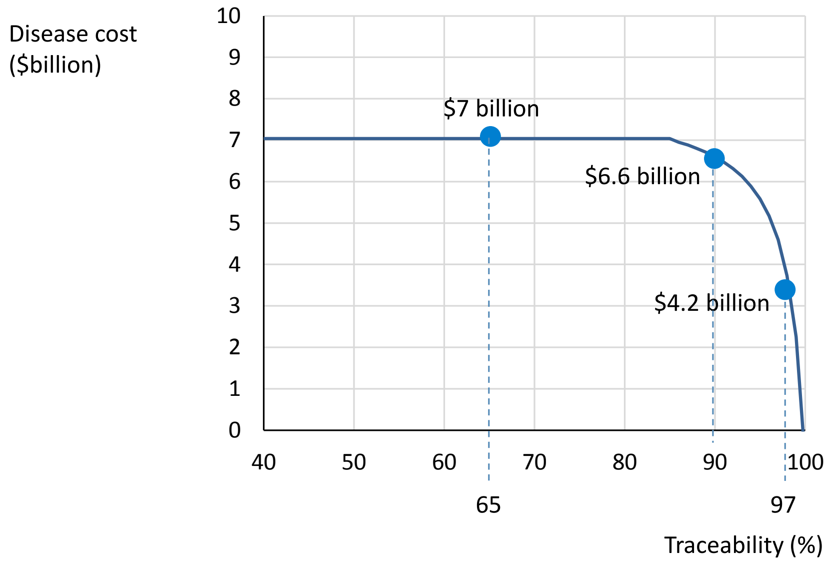
27 Yainshet, A., Cao, L. and Elliston, L. 2006, A Hypothetical Case of BSE in Australia: Economic Impact of a Temporary Loss of Market Access, ABARE Report Prepared for the Product Integrity, Animal and Plant Health, Australian Government Department of Agriculture, Fisheries and Forestry, Canberra, October, page 18.

28 Centre for International Economics (2010), NLIS (sheep and goats) business plan: the costs of full compliance with NLTPS, research report, Centre for International Economics, Canberra, page 187.

Figure 3: BSE disease outbreak cost at different traceability levels



Source: MJA analysis

The probability each year of a BSE outbreak has been assumed to be 1 per cent in 2004 reducing to 0.25 per cent in 2014 and then reducing to 0.002 per cent by 2044[29].

Using these disease outbreak costs and probability of an outbreak, we have estimated the avoided disease cost by:

- estimating the disease cost at differing traceability levels in present value terms; and
- then calculating the difference between disease costs with current traceability levels and what they

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29 We have assumed that the likelihood of an outbreak is small and has been declining over time, noting that there is uncertainty over the appropriate likelihood that should be applied. This is consistent with literature that indicates that prevalence of BSE has been declining since the epidemic in the United Kingdom in the 1980s and 1990s (Centre for Food Security & Public Health, 2012, Retrieved from http://www.cfsph.iastate.edu/Factsheets/pdfs/bovine_spongiform_encephalopathy.pdf).
We have assumed that the likelihood was around 1 per cent in 2004 (based on Synergies, 2004, The implications for the Queensland beef industry from NLIS implementation, A report to the Department of Primary Industries & Fisheries) reducing to 0.25 per cent in 2014 and then reducing to 0.002 per cent in 2043. The 0.002 per cent reflects that the World Organization for Animal Health (OIE) currently has designated Australia a “negligible risk” status and therefore requires Australia to undertake sampling to allow detection of at least one BSE case per 50,000 in the adult cattle population at a confidence level of 95 per cent – noting that this is not specifically evidence of the likelihood of a BSE outbreak. We have applied 0.25 per cent in 2014 to reflect that the OIE designation does not include atypical BSE (that is, it relates to classical BSE) and that the OIE designation is a sampling methodology and not evidence of potential future prevalence.

would have been with the NLIS.

The avoided cost has only been estimated for cattle (since BSE is a cattle disease) and is estimated at $430.4 million using this methodology.

We note that the estimates of loss in economic value used for the FMD are an approximation of the value added effect in the absence of robust economy wide modelling. As such in the broader benefit costs assessment of the NLIS we consider the FMD costs to be additive to the GDP estimates for BSE.

4.2.2 Other product integrity issues

The NLIS in combination with NVDs and quality assurance mechanisms is an effective way of addressing non-disease related quality assurance issues. These issues can include chemical residues and other contaminants in red meat. Market access benefits can arise from the NLIS where the system provides the tracing mechanism to:

- provide a mechanism to claim assurance;
- provide a mechanism to efficiently trace an incident back through the supply chain to identify the source and cause of an incident and resolve the matter to the satisfaction of customers;
- provide a mechanism to enforce assurance; and
- assess a claimed quality assurance incident.

Discussions with the Department of Agriculture indicated most export markets require a system of quality assurance. Moreover, data indicate that residue incidents occur frequently (around 5 per month). Most are at a batch scale and the NLIS in combination with assurance systems including the LPA, NVDs and National Residue Survey provide an effective tool to quickly resolve claims. The Department of Agriculture data indicate that Australian red meat has a relatively low level of incidence of chemical residue violations. In particular, since 2005 product integrity incidents that have occurred and where traceability has enabled market access to be maintained include:

- anti-microbial residues in bobby calves — properties are flagged when incidents arise and further testing is required at the abattoir of calves from the property;
- localised incidents of organo-chlorine residues— livestock from known risk properties are identified for targeted residue testing at point of slaughter; and
- localised incidents of lead contamination — there are a small number of highly contaminated sites flagged on the NLIS and there are rare incidents of accidental ingestion of lead.

We have not quantified these benefits in our evaluation (for historical or future avoided costs) because discussions with stakeholders revealed that the benefits of managing these incidents has been relatively minor given that the historical incidents themselves have been minor and largely affect acceptance of product batches rather than large scale rejection of product or whole market access exclusions. Additionally, the value of future avoided costs is also likely to be low.

Therefore, our estimate of the total benefit of NLIS is likely to slightly understate the benefits. Indeed, stakeholders were of the view that the NLIS in combination with the assurance systems provides an effective incentive and compliance mechanism contributing to the low level of incidents and high level of market access.

4.2.3 Avoided costs to gain market access — EUCAS

Benefits from past traceability include the avoided loss of market access because traceability has been able to demonstrate compliance with food quality standards. This includes:

- access to the European Union market through the European Union Cattle Accreditation Scheme (EUCAS) program; and
- access to other countries that from time to time may require EU like standards such as requiring meat come from European Union (EU) accredited facilities — these are small in number and do not represent a high value added.

There were divergent views among stakeholders about the contribution of the NLIS to EUCAS market access. Two perspectives were that:

- EU access expressly requires a national electronic traceability system and as a consequence the NLIS in concert with the LPA provides for EU access. For example, Animal Health Australia observes:

  'In the late 1990s the European Union demanded a 'closed system' for HGP- free cattle destined to that market and that the animals be whole-of-life traceable. The Australian Government Department of Agriculture developed the European Union Cattle Accreditation Scheme to accommodate the EU demands...

  Radio frequency (RF) tag technology was introduced as the mechanism to comply with the whole-of-life identification demands of the EU. The program designed to satisfy the Europeans was called the National Livestock Identification System.

  The NLIS (Cattle) system that had been introduced on a voluntary basis in Victoria was adopted as the method for tracking cattle throughout Australia for EU market access purposes'.[30]

- in the absence of the NLIS other tracing mechanisms are likely to have created access — other countries, such as New Zealand and the United States have access to EU markets in the absence of an individual electronic tagging system. For example, the United States developed a protocol that presently does not require electronic traceability. Under this protocol, product assurance mechanisms are used as the basis for traceability.

We note that the EUCAS system is supported by the LPA and as such we assume that the benefits of EUCAS are most attributable to the LPA. In the evaluation of the LPA we consider the counterfactual that, in the absence of the LPA, individual assurance programs would have occurred, and we value the benefit of the LPA as the avoided cost of individual compliance. Our discussions with stakeholders indicated general acceptance of the proposition that robust individual product assurance, which also enables traceability, would have been sufficient for EU access. As a consequence, we value the benefit of EU access as an outcome of the LPA rather than of the NLIS per se and that the benefit of EU access is captured within the avoided cost of individual compliance in section 10.

While this approach is reasonable for the period 2005 to 2015, there is some debate about how well this might hold between 2015 and 2045. Stakeholders noted that the traceability expectations of importing countries are generally increasing.

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[30] Sourced from http://www.animalhealthaustralia.com.au/programs/biosecurity/national-livestock-identification-system/, accessed 29 January 2015.

For example, Animal Health Australia note:

> *Recent livestock disease and welfare incidents around the world have caused Australia's major customers and competitors to look more closely at improved traceability systems. International developments include:*

- Canada has implemented a mandatory individual ID and has adopted permanent Radio Frequency Identification tags effective 1 January 2005.
- Uruguay has had an individual traceability system for exports to EU since 2001. Uruguay has decided to trial an "improved" system. It involves double tagging of cattle (a visual tag and an electronic tag), and recording of movements on a central database.
- The EU already has an individual animal radio frequency identification device (RFID) and passport system.
- Japan has individual ID through the supply chain.
- The US is currently considering a full individual animal ID proposal. A new draft of the USA Animal Identification Plan has been released with the objective of "48-hour" trace-back.
- New Zealand has implemented an electronic identification system for their deer and cattle industries.
- Brazil has an individual animal scheme for the EU.[31]

It is possible that beyond 2015, individual electronic traceability may become a minimum requirement for European access for all countries and traceability through individual product assurance frameworks such as under the LPA counterfactual would not be sufficient. Such a change in access requirements is beyond the scope of this evaluation and as such we value the future forward benefit of EU access in the same manner as the benefits between 2005 and 2015.

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[31] Sourced from http://www.animalhealthaustralia.com.au/programs/biosecurity/national-livestock-identification-system/, accessed 29 January 2015.

5. Incremental costs of NLIS

The total incremental costs of the NLIS over the period of evaluation are $1,141.5 million in present value terms (Table 18). The total incremental cost comprises development costs and ongoing costs. The incremental costs include those costs that are over and above that which would have occurred without the NLIS. This is why there are no incremental costs relating to state government. Additionally, industry would still incur significant costs under our counterfactual which consists of mob and paper-based tracking systems for cattle, goats and sheep.

We note that there is some level of inaccuracy in the costs, especially since the government and industry costs were estimated based on information at a point in time and then projected either back or forward in time. In the case of industry costs we have adjusted for cattle and sheep numbers where appropriate.

We discuss these costs in more detail in the following sections.

Table 18: NLIS incremental costs (in present value terms)

Category of cost	Costs with NLIS	Cost without NLIS	Incremental cost
Development costs			
Development and establishment costs	-$64.9	$0.0	-$64.9
Sub-total	-$64.9	$0.0	-$64.9
Ongoing costs			
MLA	-$142.7	$0.0	-$142.7
State government	-$352.1	-$352.1	$0.0
On-farm and supply chain costs	-$2,533.6	-$1,599.8	-$933.9
Sub-total	-$3,028.4	-$1,951.9	-$1,076.5
Grand-total	-$3,093.4	-$1,951.9	-$1,141.5

Source: MJA analysis.

5.1 Development and establishment costs

Development costs expended by MLA on the NLIS system (cattle, sheep and goats) are estimated to be $64.9 million in present value terms. This is based on an estimate of $51 million (Table 19) in 2006 dollars. The vast majority of these costs relate to the development of NLIS Cattle. These development costs also equal incremental costs because they would not have been expended under the counterfactual.

There is no available data on the distribution of these costs over time. To address discount issues and the absence of these cost items over time we assume all the costs were incurred in the first year of operation of the NLIS (2006).

Table 19: Development costs of the NLIS expended by the MLA

NLIS development activities	Cost ($million)
Research into the database	16
Development of the database	2
Program implementation	30
NLIS sheep specific costs	3
Total	**51**

Source: Yates, W., Winter, S., and Morrison, J. (2014), SAFEMEAT Initiatives Review, Final Report to Meat & Livestock Australia, page 82.

Note: we assume that the development costs quoted in the Yates, Winter & Morrison (2012) report are in nominal dollars which means that we will assume that they are in 2006 dollars.

5.2 Program operating costs

Program operating cost includes the costs incurred by the MLA and state governments to operate the NLIS system. These costs include costs associated with the administration of the NLIS program, management of the database, auditing and operation of supporting mechanisms.

5.2.1 MLA operating costs

MLA operating costs are estimated to be $142.7 million in present value terms. Annual operating costs of the NLIS incurred by MLA in nominal dollars are summarised in Table 20. These costs include both NLIS cattle and NLIS Sheep and goats. The costs vary from year to year, but are close to $5 million in 2012/13 and include costs of:

- database development;
- communications;
- help desk operations;
- industry support services; and
- management and administration.

The MLA operating costs are also equal to incremental costs because they would not have been expended under the counterfactual.

In this evaluation we assume annual operating costs continue at the levels incurred in 2012-13 (in real terms) for the remainder of the evaluation period. Note that we have spread the costs for the period 2000-01 to 2004-05 across the five years equally.

Table 20: NLIS business unit operating costs ($million)

Period	Total
2000- 01 to 2004-05	11.950
2005-06	4.908
2006-07	4.578
2007-08	5.091
2008-09	5.621
2009-10	4.393
2010-11	3.936
2011-12	4.961
2012-13	4.979

Source: MLA

5.2.2 State governments

State government operating costs under the NLIS are estimated to be $392.2 million in present value terms. We have estimated the annual costs of the NLIS incurred by state governments at $15.9 million per annum in 2012/13 dollar terms (Table 21). We have projected these costs to previous and forward years in real terms.

However, the incremental state government costs have been set to zero since they would likely also have been expended under the counterfactual. Moreover, we are assuming that state governments would spend a similar resource effort on mob and paper-based systems for cattle, goats and sheep. We note that in the case of a disease outbreak state governments could incur additional costs as they draw on additional resources to undertake the traceability. It is unclear what these additional costs would be and they are not included in this evaluation. As a result our cost estimate of the counterfactual is likely to be an under-estimate.

Table 21: State government annual operating costs for NLIS ($million)

State government	Sheep and Goats	Cattle	Total
New South Wales	2.3	3.1	5.4
Victoria	0.6	0.7	1.4
South Australia	0.4	0.4	0.8
Western Australia	0.2	0.3	0.5
Queensland*	0.2	4.8	5.0
Tasmania*	0.2	0.4	0.6
Northern Territory	0.1	0.5	0.5
Total	**4.0**	**10.3**	**14.3**

**MJA have estimate based on 2013 cattle and sheep numbers (as per ABARES (2014), Agricultural commodity statistics, Australian Bureau of Agricultural and Resource, Economics and Sciences, December, Canberra).*

Source: Report of PIMC Working Group on NLIS to Standing Committee on Primary Industries August2012

5.3 On-farm and supply chain costs

On-farm and supply chain costs are estimated to be $2,533.6 million in present value terms, comprising -$1,984.9 for the cattle sector and -$548.7 for the sheep sector. These costs are incurred by cattle producers, sheep and goats producers, agents and processors — including costs associated with the purchase of scanning and tagging equipment and the recording and processing of animals.

However, incremental costs on-farm and supply chain costs have been estimated at $933.9 million in present value terms, all of which is for the cattle sector. The incremental cost is lower than the total industry costs under the NLIS because ear tags that are not electronic would still be required for cattle, sheep and goats under the counterfactual and there would still be some associated labour costs.

5.3.1 NLIS Cattle

On-farm and supply chain costs for the cattle sector include:

- capital costs associated with the purchase and maintenance of tagging and scanning equipment; and
- variable costs associated with tagging, scanning, processing and meeting compliance requirements associated with the exchange of animals.

In 2005, the Queensland Government undertook a regulatory impact assessment (RIS) of introducing the NLIS. The RIS estimated the annualised on-farm and supply chain costs of the scheme to Queensland cattle producers and processors at $31.6 million per annum[32].

Based on these estimates the annualised costs of NLIS to cattle producers and the supply chain for all jurisdictions is estimated to be approximately $75 million per annum in 2005 dollars[33].

However, the incremental industry costs have been estimated at $38.3 million per annum in 2014 dollar terms. The incremental cost has been estimated as the difference in the cost of electronic tags compared to visual ear tags and the additional labour costs that result from the electronic system. Therefore, the incremental cost reflects that industry would incur some costs under the counterfactual, which is a mob and paper-based system with visual ear tags (or equivalent).

The difference in the cost of electronic and visual tags has been estimated at $2.25 per ear tag[34], which applies across around 15.7 million cattle per year[35]. The difference in labour costs is

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32 Queensland Government (2005), Stock Identification Regulation 2005, Regulatory Impact Statement for SL 2005 No. 101, page 33.

33 This has been estimated on the basis that 42 per cent of cattle in Australia are located in Queensland – as per 2013 cattle numbers in ABARES (2014), Agricultural commodity statistics, Australian Bureau of Agricultural and Resource, Economics and Sciences, December, Canberra.

34 This is based on information provided by MLA.

35 This has been estimated based on using the proportion of all cattle that we estimate require tags per year. Total cattle are derived from ABARES (2014), Agricultural commodity statistics, Australian Bureau of Agricultural and Resource, Economics and Sciences, December, Canberra. The number of cattle requiring tags is estimated later in this section.

based on the difference in labour cost between options 1 and 3 in ABARES (2014)[36] adjusted taking into account total cattle to sheep numbers – as per ABARES (2014) discussed earlier in the document.

5.3.2 NLIS Sheep and goats

The on-farm and supply chain costs of mob based system for sheep and goats are calculated by using estimates of the NVD cattle system and the costs of tags and tagging.

We estimate the annual on-farm and supply chain operating costs to the sheep and goats sector as $22.5 million in 2014 dollar terms, comprising:

- $7.7 million per annum for NVD operational costs. This is based on an annual cost of processing NVDs for cattle and sheep of $10.6 million[37] and the sheep share of this being 72 per cent[38]; and
- $10 million ear tags costs — based 0.35 cents per ear tag and 40.5 million sheep and 2 million goats sold off farms each year[39].

However, the incremental NLIS sheep and goats for industry have been set to zero since similar costs would be incurred under the counterfactual. This is because the NLIS scenario and the counterfactual both assume a mob and paper-based system for sheep and goats.

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36 ABARES (2014), Implementation of improvements to the National Livestock Identification System for sheep and goats: Decision Regulation Impact Statement *ABARES* research report, Canberra, August, xvi.

37 Yates, W., Winter, S., and Morrison, J. (2014), SAFEMEAT Initiatives Review, Final Report to Meat & Livestock Australia, page 71.

38 72 per cent is based on 2013 cattle and sheep numbers contained in ABARES (2014), Agricultural commodity statistics, Australian Bureau of Agricultural and Resource, Economics and Sciences, December, Canberra.

39 ABARES 2014, Implementation of improvements to the National Livestock Identification System for sheep and goats: Decision Regulation Impact Statement *ABARES* research report, Canberra, August, page 76 and 77.

6. Sensitivity analysis for NLIS

This section examines sensitivity of the results to changes in the key variables that we believe have the most uncertainty in their estimated value in our analysis.

6.1.1 Sensitivity of benefits to key assumptions

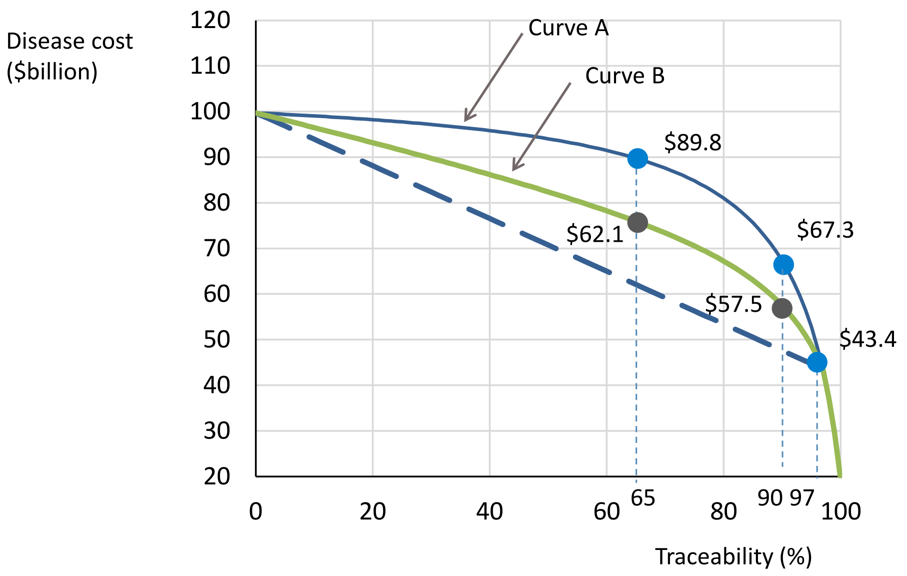
In the sensitivity analysis of the NLIS counterfactual we varied three different assumptions:

- the shape of the FMD costs to traceability relationship for FMD. We have tested the impact of a new curve that is half way between the curve we estimated based on CIE (2010) report[40] (as per Box 3) and a linear curve. This is outlined in Box 5. While we believe in the 'curved' nature of the relationship there is uncertainty over its shape;
- the current level of sheep and goat traceability. We have tested the impact of a current traceability level of 80 per cent instead of 90 per cent assumed in Table 15. The reason for testing this assumption is further explained in section 4.1.2; and
- the probability of an FMD outbreak. We have tested the impact of lower and higher probability levels. In particular, we have tested 0.5 per cent and 2.5 per cent.
- the cost of an FMD outbreak. As discussed in section 4.2.1we have examined the impact of the cost an FMD outbreak being $23 billion instead of $52 billion.

Box 5: Varying the shape of the cost index to traceability relationship

Our sensitivity analysis tests the impact of a change in the relationship between FMD costs and traceability from "Curve A" to "Curve B".

Figure 4: Assumed relationship between cost index and traceability



Source: MJA analysis

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40 Centre for International Economics (2010), NLIS (sheep and goats) business plan: the costs of full compliance with NLTPS, research report, Centre for International Economics, Canberra, page 187.

The impact of varying these assumptions on net benefits and key statistics is contained in Table 22. Based on our chosen scenarios, this illustrates that net benefits are likely to lie between $2.0 and $14.5 billion with an associated benefit cost ratio between 2.8 and 13.7.

Table 22: NLIS sensitivity analysis

Scenario	Net benefits ($m)	Benefit cost ratio	Internal rate of return	Modified internal rate of return
Base case	$8,291.7	8.3	28%	12%
Variation in relationship between FMD costs and traceability level	$2,448.2	3.1	17%	9%
Current sheep and goat traceability level is 80 per cent	$7,531.7	7.6	27%	11%
Probability of FMD outbreak is 0.5 per cent	$2,047.7	2.8	16%	9%
Probability of FMD outbreak is 2.5 per cent	$14,535.8	13.7	34%	13%
FMD disease outbreak cost of $23 billion	$3,796.8	4.3	20%	10%

Source: MJA analysis

7. NLIS detailed investment performance information

This section provides more detailed investment performance information (Figure 5).

Figure 5: NLIS detailed investment performance information

Finance and reinvestment rate	5%
IRR	28%
Modified IRR	12%

Real dollars ($m)

Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
INCREMENTAL BENEFITS														
Avoided costs	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total benefits	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**
INCREMENTAL COSTS														
Development costs														
Development and establishment cost	0.0	0.0	0.0	0.0	0.0	-64.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-total	0.0	0.0	0.0	0.0	0.0	-64.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ongoing costs														
MLA	-$3.6	-$3.5	-$3.4	-$3.3	-$3.2	-$6.3	-$5.6	-$5.9	-$6.2	-$4.8	-$4.1	-$5.0	-$5.1	-$5.1
State government	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Industry	$0.0	$0.0	$0.0	$0.0	$0.0	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3
Sub-total	-$3.6	-$3.5	-$3.4	-$3.3	-$3.2	-$44.6	-$43.9	-$44.2	-$44.5	-$43.1	-$42.4	-$43.3	-$43.4	-$43.4
Total costs	**-$3.6**	**-$3.5**	**-$3.4**	**-$3.3**	**-$3.2**	**-$109.5**	**-$43.9**	**-$44.2**	**-$44.5**	**-$43.1**	**-$42.4**	**-$43.3**	**-$43.4**	**-$43.4**
NET BENEFITS	**-$3.6**	**-$3.5**	**-$3.4**	**-$3.3**	**-$3.2**	**-$109.5**	**-$43.9**	**-$44.2**	**-$44.5**	**-$43.1**	**-$42.4**	**-$43.3**	**-$43.4**	**-$43.4**

Time from base year (years)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
INCREMENTAL BENEFITS																
Avoided costs	$616.3	$616.0	$615.8	$615.6	$615.3	$615.1	$614.8	$614.6	$614.4	$614.1	$613.9	$613.6	$613.4	$613.2	$612.9	$612.7
Total benefits	**$616.3**	**$616.0**	**$615.8**	**$615.6**	**$615.3**	**$615.1**	**$614.8**	**$614.6**	**$614.4**	**$614.1**	**$613.9**	**$613.6**	**$613.4**	**$613.2**	**$612.9**	**$612.7**
INCREMENTAL COSTS																
Development costs																
Development and establishment cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ongoing costs																
MLA	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1
State government	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Industry	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3
Sub-total	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4
Total costs	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**
NET BENEFITS	**$572.9**	**$572.7**	**$572.4**	**$572.2**	**$571.9**	**$571.7**	**$571.5**	**$571.2**	**$571.0**	**$570.7**	**$570.5**	**$570.3**	**$570.0**	**$569.8**	**$569.6**	**$569.3**

Time from base year (years)	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Year	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**
INCREMENTAL BENEFITS														
Avoided costs	$612.4	$612.2	$612.0	$611.7	$611.5	$611.2	$611.0	$610.8	$610.5	$610.3	$610.0	$609.8	$609.6	$609.3
Total benefits	**$612.4**	**$612.2**	**$612.0**	**$611.7**	**$611.5**	**$611.2**	**$611.0**	**$610.8**	**$610.5**	**$610.3**	**$610.0**	**$609.8**	**$609.6**	**$609.3**
INCREMENTAL COSTS														
Development costs														
Development and establishment cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Sub-total	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Ongoing costs														
MLA	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1	-$5.1
State government	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Industry	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3
Sub-total	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4
Total costs	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**	**-$43.4**
NET BENEFITS	**$569.1**	**$568.8**	**$568.6**	**$568.4**	**$568.1**	**$567.9**	**$567.6**	**$567.4**	**$567.2**	**$566.9**	**$566.7**	**$566.4**	**$566.2**	**$566.0**

Discounted dollars ($m)

Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
INCREMENTAL BENEFITS														
Avoided fixed costs	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total benefits	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**
INCREMENTAL COSTS														
Development costs														
Development and establishment cost	$0.0	$0.0	$0.0	$0.0	$0.0	-$64.9	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Sub-total	$0.0	$0.0	$0.0	$0.0	$0.0	-$64.9	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Ongoing costs														
MLA	-$3.6	-$3.5	-$3.4	-$3.3	-$3.2	-$6.3	-$5.6	-$5.9	-$6.2	-$4.8	-$4.1	-$5.0	-$5.1	-$5.1
State government	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Industry	$0.0	$0.0	$0.0	$0.0	$0.0	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3	-$38.3
Sub-total	-$3.6	-$3.5	-$3.4	-$3.3	-$3.2	-$44.6	-$43.9	-$44.2	-$44.5	-$43.1	-$42.4	-$43.3	-$43.4	-$43.4
Total costs	**-$3.6**	**-$3.5**	**-$3.4**	**-$3.3**	**-$3.2**	**-$109.5**	**-$43.9**	**-$44.2**	**-$44.5**	**-$43.1**	**-$42.4**	**-$43.3**	**-$43.4**	**-$43.4**
NET BENEFITS	**-$3.6**	**-$3.5**	**-$3.4**	**-$3.3**	**-$3.2**	**-$109.5**	**-$43.9**	**-$44.2**	**-$44.5**	**-$43.1**	**-$42.4**	**-$43.3**	**-$43.4**	**-$43.4**
Benefit-cost ratio														

Time from base year (years)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**
INCREMENTAL BENEFITS																
Avoided fixed costs	$586.9	$558.8	$531.9	$506.4	$482.1	$459.0	$437.0	$416.0	$396.0	$377.0	$358.9	$341.7	$325.3	$309.7	$294.8	$280.7
Total benefits	**$586.9**	**$558.8**	**$531.9**	**$506.4**	**$482.1**	**$459.0**	**$437.0**	**$416.0**	**$396.0**	**$377.0**	**$358.9**	**$341.7**	**$325.3**	**$309.7**	**$294.8**	**$280.7**
INCREMENTAL COSTS																
Development costs																
Development and establishment cost	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Sub-total	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Ongoing costs																
MLA	-$4.8	-$4.6	-$4.4	-$4.2	-$4.0	-$3.8	-$3.6	-$3.4	-$3.3	-$3.1	-$3.0	-$2.8	-$2.7	-$2.6	-$2.4	-$2.3
State government	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Industry	-$36.5	-$34.8	-$33.1	-$31.5	-$30.0	-$28.6	-$27.2	-$25.9	-$24.7	-$23.5	-$22.4	-$21.3	-$20.3	-$19.4	-$18.4	-$17.6
Sub-total	-$41.3	-$39.3	-$37.5	-$35.7	-$34.0	-$32.4	-$30.8	-$29.4	-$28.0	-$26.6	-$25.4	-$24.1	-$23.0	-$21.9	-$20.9	-$19.9
Total costs	**-$41.3**	**-$39.3**	**-$37.5**	**-$35.7**	**-$34.0**	**-$32.4**	**-$30.8**	**-$29.4**	**-$28.0**	**-$26.6**	**-$25.4**	**-$24.1**	**-$23.0**	**-$21.9**	**-$20.9**	**-$19.9**
NET BENEFITS	**$545.6**	**$519.4**	**$494.5**	**$470.7**	**$448.1**	**$426.6**	**$406.1**	**$386.6**	**$368.1**	**$350.4**	**$333.6**	**$317.5**	**$302.3**	**$287.8**	**$274.0**	**$260.8**
Benefit-cost ratio																

Time from base year (years)	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Year	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**TOTAL**
INCREMENTAL BENEFITS															
Avoided fixed costs	$267.2	$254.4	$242.2	$230.6	$219.5	$209.0	$198.9	$189.4	$180.3	$171.6	$163.4	$155.6	$148.1	$141.0	$9,433.2
Total benefits	**$267.2**	**$254.4**	**$242.2**	**$230.6**	**$219.5**	**$209.0**	**$198.9**	**$189.4**	**$180.3**	**$171.6**	**$163.4**	**$155.6**	**$148.1**	**$141.0**	**$9,433.2**
INCREMENTAL COSTS															
Development costs															
Development and establishment cost	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	-$64.9
Sub-total	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	-$64.9
Ongoing costs															
MLA	-$2.2	-$2.1	-$2.0	-$1.9	-$1.8	-$1.7	-$1.6	-$1.6	-$1.5	-$1.4	-$1.4	-$1.3	-$1.2	-$1.2	-$142.7
State government	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Industry	-$16.7	-$15.9	-$15.2	-$14.4	-$13.8	-$13.1	-$12.5	-$11.9	-$11.3	-$10.8	-$10.3	-$9.8	-$9.3	-$8.9	-$933.9
Sub-total	-$18.9	-$18.0	-$17.2	-$16.3	-$15.6	-$14.8	-$14.1	-$13.4	-$12.8	-$12.2	-$11.6	-$11.1	-$10.5	-$10.0	-$1,076.5
Total costs	**-$18.9**	**-$18.0**	**-$17.2**	**-$16.3**	**-$15.6**	**-$14.8**	**-$14.1**	**-$13.4**	**-$12.8**	**-$12.2**	**-$11.6**	**-$11.1**	**-$10.5**	**-$10.0**	**-$1,141.5**
NET BENEFITS	**$248.3**	**$236.4**	**$225.0**	**$214.2**	**$203.9**	**$194.1**	**$184.8**	**$175.9**	**$167.5**	**$159.4**	**$151.8**	**$144.5**	**$137.6**	**$131.0**	**$8,291.7**
Benefit-cost ratio															**8.3**

Source: MJA analysis

8. National Livestock Traceability Performance Standards

The 'National Livestock Traceability Performance Standards' that were endorsed by PIMC in May 2004 are outlined in Table 23.

Table 23: National Livestock Traceability Performance Standards

Criteria	Standard
Applicable to all FMD susceptible livestock species[1]	
1.1	▪ Within 24 hours of the relevant CVO[2] being notified[3], it must be possible to determine the location(s)[4] where a specified animal was resident during the previous 30 days.
1.2	▪ Within 24 hours it must be also possible to determine the location(s)[4] where all susceptible animals that resided concurrently and/or subsequently on any of the properties on which a specified animal has resided in the last 30 days.
Applicable to cattle only[5]	
2.1	▪ Within 48 hours of the relevant CVO2 being notified[3], it must be possible to establish the location(s)[4] where a specified animal has been resident during its life.
2.2	▪ Within 48 hours of the relevant CVO2 being notified[3], it must be possible to establish a listing of all cattle that have lived on the same property as the specified animal at any stage during those animals' lives.
2.3	▪ Within 48 hours of the relevant CVO2 being notified[3], it must also be possible to determine the current location[4] of all cattle that resided on the same property as the specified animal at any time during those animals' lives.
Applicable to all FMD susceptible livestock species except cattle (lifetime traceability excluding the preceding 30 days – addressed by 1.1 and 1.2 above)	
3.1	▪ Within 14 days of the relevant CVO[2] being notified[3], it must be possible to determine all locations[4] where a specified animal has been resident during its life.
3.2	▪ Within 21 days of the relevant CVO[2] being notified[3], it must also be possible to determine the location[4] of all susceptible animals that resided concurrently with a specified animal at any time during the specified animal's life.

Notes:

1. *For the purposes of these Standards, 'FMD susceptible species' means cattle, sheep, goats, and domesticated buffalo, deer, pigs, camels and camelids. 2. 'The relevant CVO' means the state or territory Chief Veterinary Officer, or their delegate, in the jurisdiction where the specified animal is located or has been traced to. 3. For the purposes of these Standards, the term 'notified' means the relevant CVO is aware of an incident that required tracing. 4. 'Location' means any definable parcel of land including (but not limited to): any parcel of land with a Property Identification Code, travelling stock routes, saleyards, abattoirs, feedlots, live export collection depots, show grounds,*

Crown land and transport staging depots. 5. Given the risks posed by BSE, it was considered appropriate to establish separate Standards for cattle.

The standards are defined to reflect the capacity of animal tracing systems to be able to respond effectively to the management requirements of biosecurity agencies in the event of emergency disease outbreaks. In achieving these standards the effects of disease outbreaks can be managed to best practice levels and in doing so enable Australian livestock sector to meet requirements of key trading partners.

Traceability percentage is commonly measured as a simple average of performance against each of the criteria. Under the NTLPS full compliance with the standards is defined as 98 per cent traceability.

PART B: ON-FARM FOOD SAFETY ASSURANCE: LPA

This section examines the benefits and costs of the on-farm food safety program: Livestock Production Assurance (LPA).

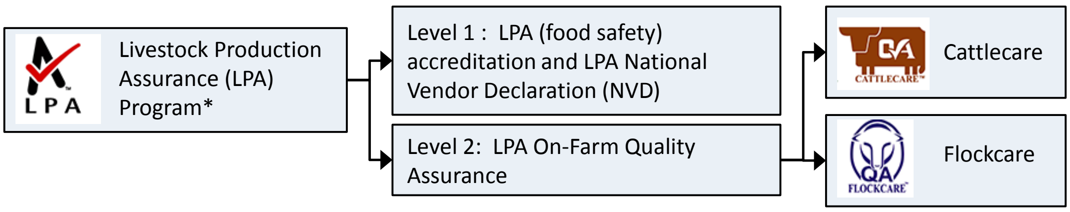
9. Overview of LPA

LPA is an assurance system based on the declarations of animal management and farm practices by owners and the tracking of those animals through the supply chain. The current LPA program was established in 2004 in response to a review of quality assurance in the livestock sector. LPA is structured into two levels of assurance.

Declarations are made and animals are traced by a national vendor declaration (NVD and described in more detail in the following section).

There are two tiers to the LPA: level 1 and level 2 (Figure 6). This evaluation focusses on LPA Level 1. An overview of how the LPA fits in with other industry quality assurance schemes is contained in section 13.

Figure 6: Components of the LPA



**AUSMEAT managed*

LPA Level 1 is a voluntary minimum level of assurance. There are currently 208,000 properties registered with the level 1 program. Most producers are registered with LPA as registration and accreditation is required to access the National Vendor Declaration (NVD). The NVD is required for any movement of stock – to processors, to saleyards or between properties if they have different Property Identification Codes (PICs). Most meat processors require suppliers of cattle to have sourced them from LPA accredited properties.

Producers who become LPA-accredited commit to carrying out on-farm practices in five key areas in order to fulfil their responsibility to produce safe red meat:

- property risk assessments — The producer is responsible for minimising the risk of livestock being exposed to sites that are unacceptably contaminated with persistent chemicals or physical contaminants;
- safe and responsible animal treatments —The producer is responsible for ensuring animal treatments are administered in a safe and responsible manner that minimises the risk of chemical residues and physical hazards;

- stock foods, fodder crops, grain and pasture treatments — The producer is responsible for minimising exposure of livestock to foods containing unacceptable chemical contamination and guarantee livestock are not fed animal products;
- preparation for dispatch of livestock — The producer is responsible for ensuring livestock are fit for transport and minimise the risk of stress and contamination of livestock during assembly and transport; and
- livestock transactions and movements — The producer is responsible for ensuring traceability requirements, with respect to treatments or exposure to food safety hazards, have been fulfilled for all livestock movements - between farms and feedlots, and including to slaughter and live export.

Level 1 is recognised by the Department of Agriculture as an 'approved program' enabling access to some markets depending on the declarations made by the owner.

LPA is a minimum requirement for other assurance programs such as the EUCAS program administered by the Department of Agriculture, which enables access for beef and veal products to the European Union.

10. Estimating net benefits of LPA

In this section we estimate the net benefits of LPA. This involves examining the incremental benefits and costs associated with LPA. To do this we need to understand what would have occurred without LPA, which we will refer to as the 'counterfactual'. The incremental benefits and costs are the difference between the benefits and costs with the LPA and those without LPA (the counterfactual).

10.1 The counterfactual

Our consultation with stakeholders has revealed that there are a variety of opinions on what may have occurred in the absence of the LPA. Based on this consultation, we have defined three alternative counterfactuals[41]:

- Counterfactual option 1: individual state and territory governments operate a registration and certification program similar to the national LPA;
- Counterfactual option 2: privately established and maintained quality assurance arrangement; and
- Counterfactual option 3: additional government regulation and compliance of on-farm food safety assurance.

Under all counterfactual scenarios we assume:

- the continuance of the NVD paper based traceability and PIC system that supports the operation of the individual and group compliance under counterfactual options 1 and 2; and
- the same market access arrangements as the LPA.

The alternative counterfactual options are discussed in more detail below.

10.1.1 Counterfactual option 1

Under this counterfactual option, each state and territory government is assumed to operate a separate registration and audit system within their jurisdiction. Moreover, all current LPA functions are replicated across each jurisdiction, noting that we assume ACT is incorporated into a NSW system.

10.1.2 Counterfactual option 2

Under this counterfactual option, individual farmers or groups of farmers establish and maintain on-farm quality assurance systems. Our discussions with stakeholders revealed that the Safe Quality Food 1000 is a reasonable equivalent farm level quality assurance program to apply for this counterfactual.

The Safe Quality Food (SQF) is a Hazard Analysis Critical Control Point (HACCP) food quality assurance system for food and fibre businesses developed by the University of Western Australia. The system was launched in 1995 by Agriculture Western Australia as an alternative

[41] These counterfactuals assume equivalent outcomes for product conformity on criteria for food safety, contamination and livestock health and welfare.

to what was seen as the more complex and costly ISO 9000 (Evans and Karlsson 2001)[42]. Prior to the introduction of the LPA, the SQF system was being used by small number of beef producers to demonstrate compliance with food quality standards. Currently there are approximately 87 producers in Australia that are SQF 1000 certified (Galloway 2012)[43].

The Food Marketing Institute (FMI) acquired the rights to the SQF program and established the SQF Institute Division to manage the program. The SQF system enables producers to demonstrate that they have implemented responsible production practices and to deliver product that meets the quality standards specified by their customers.

SQF 1000 is divided into three levels:

- Level 1: Food safety fundamentals;
- Level 2: Level 1 plus systems to prevent and reduce the occurrence of risk; and
- Level 3: Comprehensive food safety and quality assurance.

For this evaluation we assume Level 1 is the relevant counterfactual.

The system requires individual producers register, undertake management activities to comply with the system and undertake certification. Certification is demonstrated through an annual audit. Certification is a statement that the producer's "food safety plans have been implemented in accordance with the HACCP method and applicable regulatory requirements and that they have been validated and verified and determined effective to manage food safety"[44].

There are eight steps to certification

1. Register the business with the SQF database;
2. Choose the level of certification;
3. Designate an internal SQF practitioner;
4. Hire an external SQF consultant (optional);
5. Identify training needs;
6. Develop, document and implement an SQF system;
7. Choose a certification body; and
8. Successfully complete an SQF audit with a certifier.

10.1.3 Counterfactual option 3

Under this counterfactual option, we assume that governments introduce additional regulation and compliance systems that result in farmers being mandated to introduce on-farm food safety assurance. Our discussions with stakeholders note that Food Standards Australia New Zealand (FSANZ) had considered food safety standard regulation in their recent review

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42 Evans, D.L. and Karlsson, J.L.E 2001 'The potential application of HACCP based management systems', Proceedings of the FLICS Conference, Launceston, June.

43 Galloway, J. 2012, 'JAS- ANZ Submission to the Inquiry into the Impact on Food Safety Regulation', Parliament of Victoria, Rural and Regional Affairs Committee.

44 Safe Quality Food Institute (2010). SQF 1000 Code, A HACCP-Based Supplier Assurance Code for the Primary Producer, 5th Edition, JANUARY 2010, Page 3.

(FSANZ 2009[45]). More detail on the recent reviews of food safety regulation is contained in Box 6.

Our choice of the counterfactual is consistent with the review, which observed that there are a number of farm based quality assurance systems within the meat industry that may mean the additional costs were not significant of moving to a system of food regulatory measures that could apply to primary production and food processing if those on farm assurance programs were in place.

Taking this into consideration we believe that for evaluation purposes, counterfactual option 3 has the same economic impact as counterfactual 2. Therefore, we will only report on the incremental benefits of counterfactual options 1 and 2.

Box 6: Recent FSANZ food regulation reviews

In 2009 as part of assessment proposal P1005, FSANZ considered the following future regulatory arrangements for cattle sheep and goats:

- current status quo arrangements;
- status quo arrangements with enhanced regulation; and
- the development of food regulatory measures that could apply to primary production and food processing.

In 2013 FSANZ combined this proposal review with a parallel proposal P1014 covering other animals and wild game. Under the proposal FSANZ consolidated the options to two:

- Option 1: Status quo; and
- Option 2: Regulatory option.

Under option 2 standards are implemented to control for food safety hazards and to require producers to demonstrate compliance. Three requirements were identified, a meat producer must:

- take all reasonable measures to ensure that inputs do not adversely affect the safety or suitability of meat or meat products;
- store, handle and dispose of waste in a manner that will not adversely affect the safety and suitability of meat or meat products; and
- have a system to identify the persons from whom the animals were received and to whom all the animals were supplied.

FSANZ noted that under this option government could act on non-compliance as is the case with the current arrangements. However there would be increased cost associated with enforcement and compliance that could be incurred by both government and industry. Costs for primary producers were identified as:

- one-off expenses for capital equipment;
- start-up costs for implementing required control measures; and
- on-going costs.

45 Food Standards Australia New Zealand 2009, Proposal P1005 Primary Production and Processing Standard for Meat and Meat Products 1st Assessment Report, September, p.46.

10.2 Incremental benefits and costs of LPA

The incremental benefits and costs for LPA are dependent on the chosen counterfactual (Table 24). The net benefits in Table 24 estimate the benefits and costs over a period of thirty years into the future.

Table 24: LPA: net benefits under alternative counterfactuals

	Counter-factual 1	Counter-factual 2
Incremental benefits ($m)	$141.1	$2,029.8
Incremental Costs ($m)	-$111.7	-$111.7
Net benefits ($m)	$29.4	$1,918.2
Benefit-cost ratio	**1.3**	**18.2**

Source: MJA analysis

In accordance with the CRRDCs Impact Assessment Guidelines[46], we have also prepared a variety of investment performance information (Table 25). These illustrate how the returns from the project vary with different time horizons into the future. This is important since some benefits and costs are assumed to continue into the future. Section 12 contains detailed investment performance information.

Table 25: LPA: investment performance statistics

	Net benefits ($m)		Benefit cost ratio		Internal rate of return		Modified internal rate of return	
	Counter-factual 1	Counter-factual 2	Counter-factual 1	Counter-factual 2	Counter-factual 1	Counter-factual 2	Counter-factual 1	Counter-factual 2
At 'final year'	$7.9	$890.0	1.1	16.7	10%	808%	7%	47%
5 year forward horizon	$14.0	$1,179.6	1.2	17.3	12%	808%	8%	35%
10 year forward horizon	$18.7	$1,406.5	1.2	17.7	13%	808%	8%	29%
20 year forward horizon	$25.4	$1,723.5	1.3	18.0	14%	808%	8%	22%
30 year forward horizon	$29.4	$1,918.2	1.3	18.2	14%	808%	7%	18%

10.2.1 Incremental benefits and costs under counterfactual 1

Under counterfactual 1, **the incremental benefits** are valued at $141.1 million in present value terms and are the costs of seven state governments (assuming ACT is rolled into NSW) operating LPA equivalent schemes which are avoided with the LPA scheme. We have valued these avoided costs by assuming that the seven state governments replicate the administrative functions of the current national LPA.

We understand from MLA that the current fixed costs for administering LPA are approximately $200,000 per annum. The avoided cost is estimated to be the current cost of the LPA plus the additional fixed costs of $1.4 million per annum (which equals 7 times $200,000 since there are seven jurisdictions that would set up schemes for this counterfactual)[47].

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[46] Council of Rural Research and Development Corporation (2014), Impact Assessment Guidelines, Version 1, May 2014.

[47] This assumes the current level of compliance is not increased under a model in which seven state governments replicate the administrative functions of the current national LPA. Arguably, it could be assumed that under a state-based model a higher number of audits may be required in each jurisdiction in order to achieve the same level of statistical significance at a state level than what is required nationally.

The current cost of administering the LPA is contained in section 10.2.2. Our analysis assumes that:

- there is an increase in total fixed operating costs and no change in total variable operating costs with each state governments operating scheme;
- the variable costs of LPA are distributed across the jurisdictions reflecting their share of membership;
- the same quantum of auditing across the states as currently occurs nationally;
- participation by producers is equivalent;
- that States recover all costs from producers (full cost recovery);
- producer's compliance costs are the same for both assurance schemes; and
- that there is mutual recognition of state schemes so that there are no inter-jurisdictional transaction costs.

We have assumed that the benefits start from the beginning of the LPA. This implicitly assumes that at this point in time the state and territory governments would have established their own schemes if an industry operated scheme had not been established.

In this evaluation we exclude the costs of the development and operation of the NVD as the NVD incorporates the waybill which is a requirement under most jurisdiction regulations.

Under counterfactual 1, **the incremental costs** are the total costs of administering the LPA scheme. These are contained in section 10.1.2. The incremental costs are $111.7 million in present value terms.

10.2.2 Incremental benefits and costs under counterfactual 2

Under counterfactual 2, **the incremental benefits** are valued at $2,029.8 million in present value terms and are the costs of the SQF 1000 quality assurance system which are avoided with the LPA scheme. We have valued these avoided costs by assuming that equivalent SQF 1000 HACCP quality assurance systems are used by all farmers.

The total benefit (or avoided cost) is the mid-point of two scenarios which yield benefits between $587.8 and $3,471.9 million.

The first scenario assumes that there is the same level of auditing under the SQF system as under the LPA. The second scenario assumes that the counterfactual involves each farm property being audited once each year, which is the same level of auditing that occurs currently under the SQF system.

The reason for the two scenarios is that it is not clear as to what level of auditing may occur under the counterfactual. Additionally, it is difficult to predict how privately operated food safety systems would operate with much larger scale than the current SQF system. We have assigned a 50 per cent probability to each of these scenarios given the level of uncertainty as to which scenario is more likely.

In estimating the avoided cost we have focused on two costs:

- registration costs; and
- auditing costs.

The reason for assuming these costs is that under the SQF, farmers must register with the SQF system each year and undertake an annual audit. In the audit, producers are graded against the standard, with poorer grades requiring more frequent surveillance auditing or being deemed not to comply with the standard. In the counterfactual we assume a membership of the LPA incur the costs of registering and certifying to SQF1000 level 1. We have ignored farm management time. This is because it is difficult to value and the avoided costs are not likely to be significantly different to current practices.

To calculate registration costs we have considered the SQF 1000 registration cost table as summarised in Table 26. The annual registration fees are based on the gross sales of the producer. We have applied the $100 USD registration cost to represent farmers in Australia since most farmers fit into this category. This equates to around $127 AUD (as at 24 March 2015).

In this evaluation we assume there are 130,000 relevant properties registered with the level 1 LPA program[48], this equates to a total annual registration cost of $16.4 million for 2014 and $474.3 million in present value terms.

Table 26: SQF 1000 registration costs

Classification	Description of classification	Fee USD
A	Suppliers with a gross sales < $100,000 USD	$100
B	Suppliers with a gross sales > $100,000 USD < $5 million USD	$250
C	Suppliers with a gross sales > 5 million USD < 25 million USD	$350
D	Suppliers with a gross sales > 25 million USD < 50 million USD	$500
E	Suppliers with a gross sales > 50 million USD	$600
M	Multi-site Organisation	
	Central-site	$1000
	Each Sub-site	$25

Source: SQF Institute 2015. http://www.sqfi.com/suppliers/costs/

In terms of audit costs, the costs of audit are determined by individual accredited auditors. There are a number of accredited auditors in Australia. Estimates of individual audits cost range between US$600 and US$1000 or on average US$800. We assume future SQF audit costs are A$800.

We have assumed two alternative scenarios for the number of audits under the counterfactual. The first scenario, which involves the same number of audits as per the existing LPA scheme, results in total audit costs of $113.5 million in present value terms. The second scenario, which involves an annual audit for all properties, results in total audit costs of $2,997.6 million in present value terms. Under the first scenario we have assumed that there are 5,000 audits per year[49]. Under the second scenario we have assume that all of the 130,000 properties are audited.

48 This estimate is based on 200,000 PIC registered with the MLA and ABS estimates of 70-80,000 livestock and mixed farming businesses. PICs are likely to overestimate SQF auditing requirements that focus at an enterprise management level. ABS business estimates are likely to under estimate auditing requirements given small enterprises will be under accounted for and large businesses operate across multiple properties.

49 This is sourced from MLA.

Note that we have estimated the number of properties from 2001 to 2013 for estimating both registration and audit costs taking into account the number of sheep, lamb and cattle establishments as reported by the Australian Bureau of Statistics[50].

Under counterfactual 2, the incremental costs of LPA have been valued at $111.7 million in present value terms. The costs have been estimated using information provided by MLA. The costs include activities such as administration, random audits, NVD book fulfilment, LPA help desk, LPA communications, providing education and training materials, research and development activities and provision of the electronic NVD system. The total LPA costs made available to us by MLA is represented in Table 27. We have estimated back to 2001 and after 2015 using the cumulative average growth rate from 2008-09 to 2014-15 (2.1 per cent).

Table 27: LPA costs (nominal dollars)

Year	NVD book revenue ($million)
2008-09	$3.23
2009-10	$3.25
2010-11	$3.31
2011-12	$3.35
2012-13	$3.52
2013-14	$3.57
2014-15 (budget)	$3.67

Source: MLA

We note some jurisdictions run mirror livestock waybill programs but this is for their own traceability and biosecurity purposes and do not relate to the operation or benefit of the LPA.

We have assumed that the first year's operational costs are twice that of other years to allow for some start-up costs.

50 Australian Bureau of Statistics (various issues from 2001 to 2013), Agricultural Commodities, 7121.0.

11. Sensitivity analysis for the LPA

This section examines sensitivity of the results to changes in the key variables that we believe have the most uncertainty in their estimated value in our analysis.

We have focused our analysis in this section on counterfactual 2. In particular, we have tested the impact on net benefits (assuming a 30 year time horizon) of a different frequency of audits under the situation where there is no LPA and an SQF equivalent system in place. We note that our base case results in section 10 assumed one audit per annum for each farmer registered in the SQF equivalent. We have specifically tested for less frequent audits than one per year since this is what occurs under the current LPA system.

Our analysis indicates that less frequent audits than that which occurs under the base case will reduce the net benefits closer to those achieved assuming counterfactual 1 (Table 28). This supports the case that the net benefits lie somewhere between our estimated values under counterfactual 1 and counterfactual 2.

Table 28: Sensitivity analysis under counterfactual 2

Scenario	Net benefits ($m)	Benefit cost ratio	Internal rate of return	Modified internal rate of return
Base case (1 audit each year)	$1,918.2	18.2	808%	18%
1 audit every 2 years	$931.6	9.3	391%	16%
1 audit every 3 years	$602.8	6.4	253%	15%
1 audit every 4 years	$438.4	4.9	183%	14%

Source: MJA analysis

12. LPA detailed investment performance information

This section provides more detailed investment performance information for the LPA. We present information for both counterfactual 1 (Figure 7) and counterfactual 2 (Figure 8).

Figure 7: LPA investment performance information (counterfactual 1)

Benefits and costs (counterfactual 1)

Finance and reinvestment rate	5%
IRR	14%
Modified IRR	7%

Real dollars ($m)

Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
INCREMENTAL BENEFITS																						
Avoided fixed costs	$0.0	$3.5	$5.5	$5.4	$5.4	$5.3	$5.2	$5.1	$5.0	$5.0	$4.8	$4.8	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0
Total benefits	**$0.0**	**$3.5**	**$5.5**	**$5.4**	**$5.4**	**$5.3**	**$5.2**	**$5.1**	**$5.0**	**$5.0**	**$4.8**	**$4.8**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**
INCREMENTAL COSTS																						
LPA costs	-$8.2	-$4.1	-$4.1	-$4.0	-$4.0	-$3.9	-$3.8	-$3.7	-$3.6	-$3.6	-$3.4	-$3.4	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Total costs	**-$8.2**	**-$4.1**	**-$4.1**	**-$4.0**	**-$4.0**	**-$3.9**	**-$3.8**	**-$3.7**	**-$3.6**	**-$3.6**	**-$3.4**	**-$3.4**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**
NET BENEFITS	**-$8.2**	**-$0.7**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**

Time from base year (years)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**
INCREMENTAL BENEFITS																						
Avoided fixed costs	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0
Total benefits	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**	**$5.0**
INCREMENTAL COSTS																						
LPA costs	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Total costs	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**
NET BENEFITS	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**

Discounted dollars ($m)

Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
INCREMENTAL BENEFITS																						
Avoided fixed costs	$0.0	$3.5	$5.5	$5.4	$5.4	$5.3	$5.2	$5.1	$5.0	$5.0	$4.8	$4.8	$5.0	$5.0	$4.7	$4.5	$4.3	$4.1	$3.9	$3.7	$3.5	$3.4
Total benefits	**$0.0**	**$3.5**	**$5.5**	**$5.4**	**$5.4**	**$5.3**	**$5.2**	**$5.1**	**$5.0**	**$5.0**	**$4.8**	**$4.8**	**$5.0**	**$5.0**	**$4.7**	**$4.5**	**$4.3**	**$4.1**	**$3.9**	**$3.7**	**$3.5**	**$3.4**
INCREMENTAL COSTS																						
LPA costs	-$8.2	-$4.1	-$4.1	-$4.0	-$4.0	-$3.9	-$3.8	-$3.7	-$3.6	-$3.6	-$3.4	-$3.4	-$3.6	-$3.6	-$3.4	-$3.2	-$3.1	-$2.9	-$2.8	-$2.7	-$2.5	-$2.4
Total costs	**-$8.2**	**-$4.1**	**-$4.1**	**-$4.0**	**-$4.0**	**-$3.9**	**-$3.8**	**-$3.7**	**-$3.6**	**-$3.6**	**-$3.4**	**-$3.4**	**-$3.6**	**-$3.6**	**-$3.4**	**-$3.2**	**-$3.1**	**-$2.9**	**-$2.8**	**-$2.7**	**-$2.5**	**-$2.4**
NET BENEFITS	**-$8.2**	**-$0.7**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.4**	**$1.3**	**$1.3**	**$1.2**	**$1.2**	**$1.1**	**$1.0**	**$1.0**	**$0.9**

Time from base year (years)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**TOTAL**
INCREMENTAL BENEFITS																							
Avoided fixed costs	$3.2	$3.1	$2.9	$2.8	$2.6	$2.5	$2.4	$2.3	$2.2	$2.1	$2.0	$1.9	$1.8	$1.7	$1.6	$1.5	$1.5	$1.4	$1.3	$1.3	$1.2	$1.2	$141.1
Total benefits	**$3.2**	**$3.1**	**$2.9**	**$2.8**	**$2.6**	**$2.5**	**$2.4**	**$2.3**	**$2.2**	**$2.1**	**$2.0**	**$1.9**	**$1.8**	**$1.7**	**$1.6**	**$1.5**	**$1.5**	**$1.4**	**$1.3**	**$1.3**	**$1.2**	**$1.2**	**$141.1**
INCREMENTAL COSTS																							
LPA costs	-$2.3	-$2.2	-$2.1	-$2.0	-$1.9	-$1.8	-$1.7	-$1.6	-$1.6	-$1.5	-$1.4	-$1.3	-$1.3	-$1.2	-$1.2	-$1.1	-$1.1	-$1.0	-$1.0	-$0.9	-$0.9	-$0.8	-$111.7
Total costs	**-$2.3**	**-$2.2**	**-$2.1**	**-$2.0**	**-$1.9**	**-$1.8**	**-$1.7**	**-$1.6**	**-$1.6**	**-$1.5**	**-$1.4**	**-$1.3**	**-$1.3**	**-$1.2**	**-$1.2**	**-$1.1**	**-$1.1**	**-$1.0**	**-$1.0**	**-$0.9**	**-$0.9**	**-$0.8**	**-$111.7**
NET BENEFITS	**$0.9**	**$0.9**	**$0.8**	**$0.8**	**$0.7**	**$0.7**	**$0.7**	**$0.6**	**$0.6**	**$0.6**	**$0.6**	**$0.5**	**$0.5**	**$0.5**	**$0.5**	**$0.4**	**$0.4**	**$0.4**	**$0.4**	**$0.4**	**$0.3**	**$0.3**	**$29.4**
Benefit-cost ratio																							**1.3**

Source: MJA analysis

Figure 8: LPA investment performance information (counterfactual 2)

Benefits and costs (counterfactual 2)

Finance and reinvestment rate	5%
IRR	808%
Modified IRR	18%

Real dollars ($m)

Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
INCREMENTAL BENEFITS																						
Avoided costs	$0.0	$70.4	$71.3	$69.2	$68.3	$80.1	$79.2	$76.0	$72.8	$75.2	$72.7	$70.8	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5
Total benefits	**$0.0**	**$70.4**	**$71.3**	**$69.2**	**$68.3**	**$80.1**	**$79.2**	**$76.0**	**$72.8**	**$75.2**	**$72.7**	**$70.8**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**
INCREMENTAL COSTS																						
LPA costs	-$8.2	-$4.1	-$4.1	-$4.0	-$4.0	-$3.9	-$3.8	-$3.7	-$3.6	-$3.6	-$3.4	-$3.4	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Total costs	**-$8.2**	**-$4.1**	**-$4.1**	**-$4.0**	**-$4.0**	**-$3.9**	**-$3.8**	**-$3.7**	**-$3.6**	**-$3.6**	**-$3.4**	**-$3.4**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**
NET BENEFITS	**-$8.2**	**$66.3**	**$67.2**	**$65.2**	**$64.3**	**$76.2**	**$75.5**	**$72.3**	**$69.2**	**$71.6**	**$69.3**	**$67.4**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**

Time from base year (years)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**
INCREMENTAL BENEFITS																						
Avoided costs	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5
Total benefits	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**	**$70.5**
INCREMENTAL COSTS																						
LPA costs	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Total costs	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**
NET BENEFITS	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**	**$66.9**

Discounted dollars ($m)

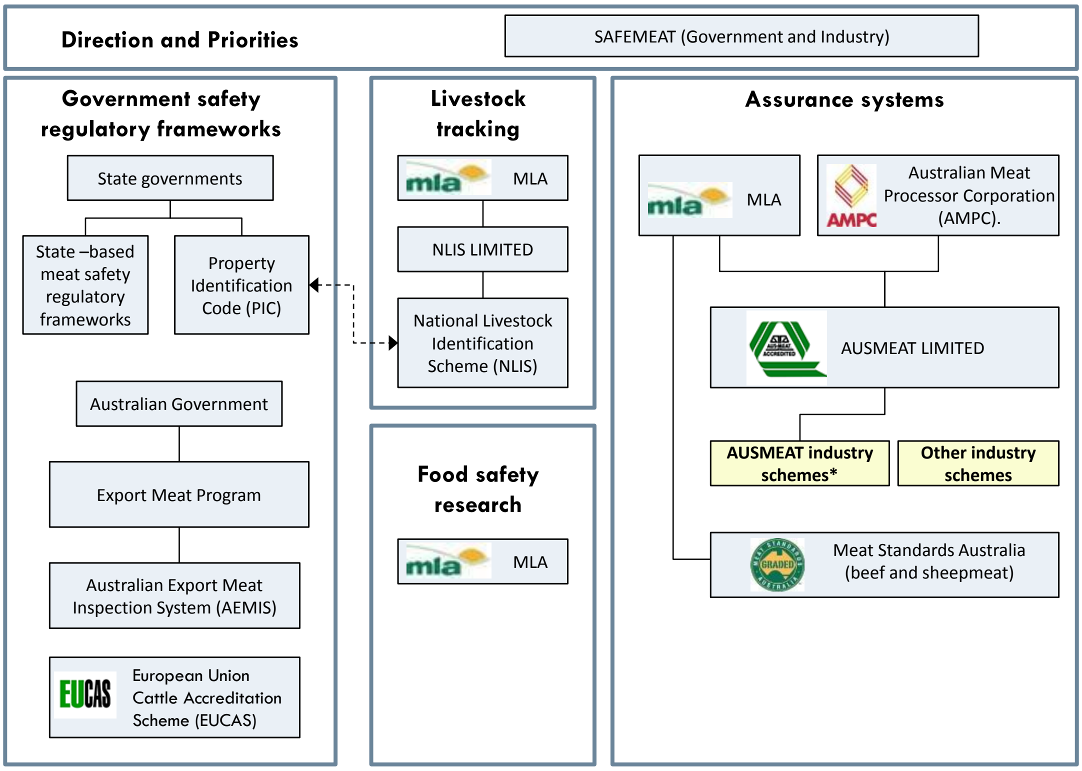
Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
INCREMENTAL BENEFITS																						
Avoided costs	$0.0	$70.4	$71.3	$69.2	$68.3	$80.1	$79.2	$76.0	$72.8	$75.2	$72.7	$70.8	$70.5	$70.5	$67.1	$63.9	$60.9	$58.0	$55.2	$52.6	$50.1	$47.7
Total benefits	**$0.0**	**$70.4**	**$71.3**	**$69.2**	**$68.3**	**$80.1**	**$79.2**	**$76.0**	**$72.8**	**$75.2**	**$72.7**	**$70.8**	**$70.5**	**$70.5**	**$67.1**	**$63.9**	**$60.9**	**$58.0**	**$55.2**	**$52.6**	**$50.1**	**$47.7**
INCREMENTAL COSTS																						
LPA costs	-$8.2	-$4.1	-$4.1	-$4.0	-$4.0	-$3.9	-$3.8	-$3.7	-$3.6	-$3.6	-$3.4	-$3.4	-$3.6	-$3.6	-$3.4	-$3.2	-$3.1	-$2.9	-$2.8	-$2.7	-$2.5	-$2.4
Total costs	**-$8.2**	**-$4.1**	**-$4.1**	**-$4.0**	**-$4.0**	**-$3.9**	**-$3.8**	**-$3.7**	**-$3.6**	**-$3.6**	**-$3.4**	**-$3.4**	**-$3.6**	**-$3.6**	**-$3.4**	**-$3.2**	**-$3.1**	**-$2.9**	**-$2.8**	**-$2.7**	**-$2.5**	**-$2.4**
NET BENEFITS	**-$8.2**	**$66.3**	**$67.2**	**$65.2**	**$64.3**	**$76.2**	**$75.5**	**$72.3**	**$69.2**	**$71.6**	**$69.3**	**$67.4**	**$66.9**	**$66.9**	**$63.7**	**$60.7**	**$57.8**	**$55.0**	**$52.4**	**$49.9**	**$47.5**	**$45.3**
Benefit-cost ratio																						

Time from base year (years)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**TOTAL**
INCREMENTAL BENEFITS																							
Avoided costs	$45.4	$43.3	$41.2	$39.2	$37.4	$35.6	$33.9	$32.3	$30.7	$29.3	$27.9	$26.6	$25.3	$24.1	$22.9	$21.8	$20.8	$19.8	$18.9	$18.0	$17.1	$16.3	$2,029.8
Total benefits	**$45.4**	**$43.3**	**$41.2**	**$39.2**	**$37.4**	**$35.6**	**$33.9**	**$32.3**	**$30.7**	**$29.3**	**$27.9**	**$26.6**	**$25.3**	**$24.1**	**$22.9**	**$21.8**	**$20.8**	**$19.8**	**$18.9**	**$18.0**	**$17.1**	**$16.3**	**$2,029.8**
INCREMENTAL COSTS																							
LPA costs	-$2.3	-$2.2	-$2.1	-$2.0	-$1.9	-$1.8	-$1.7	-$1.6	-$1.6	-$1.5	-$1.4	-$1.3	-$1.3	-$1.2	-$1.2	-$1.1	-$1.1	-$1.0	-$1.0	-$0.9	-$0.9	-$0.8	-$111.7
Total costs	**-$2.3**	**-$2.2**	**-$2.1**	**-$2.0**	**-$1.9**	**-$1.8**	**-$1.7**	**-$1.6**	**-$1.6**	**-$1.5**	**-$1.4**	**-$1.3**	**-$1.3**	**-$1.2**	**-$1.2**	**-$1.1**	**-$1.1**	**-$1.0**	**-$1.0**	**-$0.9**	**-$0.9**	**-$0.8**	**-$111.7**
NET BENEFITS	**$43.1**	**$41.1**	**$39.1**	**$37.2**	**$35.5**	**$33.8**	**$32.2**	**$30.6**	**$29.2**	**$27.8**	**$26.5**	**$25.2**	**$24.0**	**$22.9**	**$21.8**	**$20.7**	**$19.8**	**$18.8**	**$17.9**	**$17.1**	**$16.2**	**$15.5**	**$1,918.2**
Benefit-cost ratio																							**18.2**

Source: MJA analysis

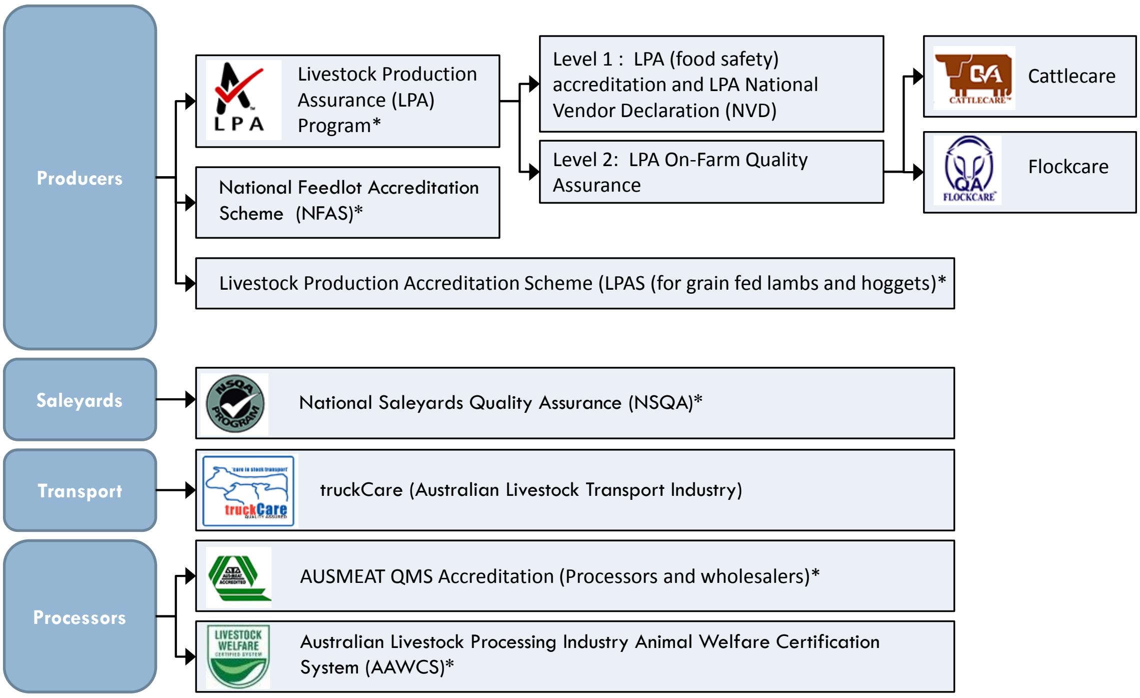
13. Overview of meat industry food safety and assurance systems

Figure 9: Overview of meat industry food safety governance and quality systems



* Some government schemes are managed by AUSMEAT on behalf of government

Figure 10: Industry quality assurance schemes



* AUSMEAT managed.

Table 29: Meat industry food safety systems: explanation of key schemes and terms

Key Terms	Explanation
State government regulatory frameworks	▪ State governments have regulatory frameworks to ensure a safe food supply. The legislation typically covers areas such as primary production, transportation, processing and retailing.
Property Identification Code (PIC)	▪ PICs are issued by state and territory agencies responsible for livestock health, to identify properties keeping livestock for production purposes. ▪ The NLIS links all registered livestock to a PIC. Therefore, PICs enable the NLIS to monitor movements of cattle, beef and sheep from one property to another. ▪ PICs were in place prior to the introduction of the NLIS.
Australian Government Export Meat Program[51]	▪ The Department of Agriculture operates an Export Meat Program which provides inspection, verification and certification services to the export meat industry in Australia. Underpinning this program is the Australian Export Meat Inspection System (AEMIS) which is an integrated set of controls specified and verified by Government that ensure the safety, suitability and integrity of Australian meat and meat products. ▪ AEMIS was implemented on 1 October 2011 and rewards meat plants that are compliant with export and certification requirements with reduced regulatory audits.
National Livestock Identification	▪ The NLIS is Australia's system for rapid identification and traceability of livestock. The NLIS was first implemented in 1999 as a trial in Victoria. ▪ The implementation of the NLIS system (for cattle) was staggered over time and

[51] Department of Agriculture, www.daff.gov.au, accessed September 29 2014.

Key Terms	Explanation
Scheme (NLIS)	across States starting around 2004. States and territories progressively required cattle movements to be recorded on the NLIS database (starting around 2004) and since 2006 has been mandatory in all states and territories. ▪ NLIS for cattle involves radio frequency identification (RFID) tag technology. This technology was introduced to align with the whole-of-life identification demands of the EU. ▪ NLIS is underpinned by complementary State and Territory legislation, which provides the regulatory framework for the system. ▪ The NLIS for sheep and goats was created in 2006 and relies on arrangements based on visual identification coupled with documentation recording movements of mobs of animals. In 2011 the PIMC noted the NLIS for sheep and goats does not enable tracing of animals to the standard the National Livestock Traceability Performance Standards (NLTPS) requires. The PIMC subsequently established a working group to consider the feasibility of electronic identification devices for sheep and goats.
NLIS LIMITED	▪ In April 2009, MLA established NLIS Limited, a wholly-owned subsidiary company. NLIS Limited operates the central NLIS Database on which livestock movements are recorded.
AUSMEAT LIMITED	▪ AUS-MEAT Limited is an industry owned company operating as a joint venture between Meat & Livestock Australia (MLA) and the Australian Meat Processor Corporation (AMPC). ▪ AUS-MEAT manages Industry Standards for trade description through the Australian Meat Industry Classification System (AUS-MEAT Language) and the AUS-MEAT National Accreditation Standards for AUS-MEAT Accredited Enterprises. ▪ AUS-MEAT Limited also offers accreditation programs for the Australian and New Zealand Meat Industry as well as providing management, auditing and administration services for the implementation of other industry owned, QMS based accreditation programs.
Meat Standards Australia	▪ Meat Standards Australia (MSA) is a beef and sheepmeat eating quality program requires standards to be maintained from paddock to plate and a grading system based on eating quality.
European Union Cattle Accreditation Scheme (EUCAS)	▪ To be eligible for export to the European Union (EU), beef or meat products and some by-products must be sourced from a supply chain (including producers, feedlots and saleyards) that is accredited under the EU Cattle Accreditation Scheme (EUCAS). ▪ Producers wanting to supply the EU market must have their properties accredited under the EUCAS. The Department of Agriculture administers EUCAS. This is a voluntary scheme and there is no application fee. ▪ EUCAS requires accredited farms to[52]: ▪ have only eligible cattle on their property at all times; that is cattle that have lifetime traceability and have never been treated with HGPs (with the exception of breeding bulls and a small number of house cows) ▪ only purchase cattle from other accredited properties or saleyards (with the exception of approved non-EU breeding females and bulls)

52 MLA Tips and Tools Marketing Brochure, undated.

Key Terms	Explanation
	▪ identify all cattle on the property with NLIS devices. For cattle born on the property this is to be done at the time of or before weaning (this requirement is different to state or territory National Livestock Identification Scheme (NLIS) requirements) ▪ use LPA European Union Vendor Declaration (EUVD) forms and specific Scheme transaction tail tags to identify Scheme cattle that are being moved ▪ ensure their NLIS database account is kept up to date. The EUVD can be used as a waybill the same way as the NVD (see NVD section below).
Livestock Production Assurance Program (LPA)	▪ The LPA program aims to provide an assurance of the safety of red meat grown on Australian farms. LPA is an on-farm food safety program that comprises two levels and is operated by AUSMEAT. Level 1 is LPA (food safety accreditation) and Level 2 is LPA on-farm quality assurance (QA) program. Both Levels 1 and 2 are voluntary. ▪ Producers who become LPA-accredited commit to carrying out specific on-farm practices in order to fulfil their responsibility to produce safe red meat. ▪ AUS-MEAT administers the LPA program on behalf of industry, and carries out all LPA audits.
LPA Level 1 food safety accreditation	▪ Producers who become LPA-accredited (Level 1) commit to carrying out specific on-farm practices in five key areas in order to fulfil their responsibility to produce safe red meat: ▪ Property risk assessment ▪ Safe and responsible animal treatments ▪ Stock foods, fodder crops, grain and pasture treatments ▪ Preparation for dispatch of livestock ▪ Livestock transactions and movements. The majority of meat processors require livestock to be sourced from LPA-accredited properties. Other processors discount non-LPA-accredited stock, reportedly by as much as 40%, compared with LPA-accredited stock. LPA is a vital component in managing on-farm risk[53].
LPA Level 2 on-farm quality assurance (QA) program.	▪ The Livestock Production Assurance On-Farm Quality Assurance (LPA QA) program, incorporating the Cattlecare and Flockcare programs, represents Level 2 of the LPA framework. The quality standards required under this level of assurance is outlined on the MLA web site[54]. A higher level of assurance is required than under Level 1. ▪ The LPA on-farm QA program consists of three modules: Food Safety Management (LPA Level 1), Systems Management and Livestock Management.
LPA National Vendor Declaration (LPA NVD)	▪ The LPA NVD is a voluntary food safety declaration completed by the person responsible for the husbandry of the stock. The NVD also provides information about movement of stock – to processors, to saleyards or between properties if they have different Property Identification Codes (PICs).

53 MLA (2014), web site, accessed 6 Oct 2014, "On-farm practices" section.

54 MLA (2014), LPA On-Farm Quality Assurance Standards, Incorporating CATTLECARE and FLOCKCARE APPROVED STANDARDS, Approved by the Livestock Production Assurance Advisory Committee (LPAAC), April 2013, Version: V12.

Key Terms	Explanation
	▪ Producers must be accredited under Level 1 LPA to use the LPA NVD. Producers use the LPA NVD to declare valuable information about the food safety status of the livestock being sold. In particular, the LPA NVD provides a declaration about whether: ▪ the animal(s) has used hormonal growth promotant (HGP) in their lives ▪ the animal(s)s has been fed feed containing animal fats ▪ the owner has owned the animal(s) since birth ▪ the animal(s) has been fed by-product stockfeeds in the past 60 days ▪ the animal(s) has been on a property listed on the ERP database or placed under any restrictions because of chemical residues ▪ the animal(s) is within a Withholding Period (WHP) or Export Slaughter Interval (ESI) as set by APVMA or SAFEMEAT, following treatment with any veterinary drug or chemical. ▪ in the past 60 days, the animal(s) has consumed any material that was still within a withholding period when harvested, collected or first grazed ▪ in the past 42 days the animal(s) was grazed in a spray risk area or fed by fodders cut from a spray drift risk area ▪ the animal(s) was not fed any restricted animal material (including meat and bone meal) ▪ In some States and Territories a waybill is required for movement of animals. Waybills are only required when cattle, sheep or lambs are moved in the Australia Capital Territory (ACT), Northern Territory (NT), New South Wales (NSW), Queensland (QLD), South Australia (SA) and Tasmania (TAS)[55]. The NVD can be used as a waybill in these States and Territories (instead of the standard waybill document). Hence the term 'NVD/Waybill'. Note that the Northern Territory only accepts its own waybill and not the NVD.
Cattlecare	▪ Accreditation in LPA QA (Level 2) enables an accredited producer to utilise the following Cattlecare logo[56]. Cattlecare includes live cattle and calves and their products.
Flockcare	▪ Accreditation in LPA QA (Level 2) enables an accredited producer to utilise the following Flockcare logo. Flockcare includes sheep and lamb and their products.
National Feedlot Accreditation Scheme (NFAS)	▪ The NFAS is an industry self-regulatory quality assurance scheme that is owned by the Australian Lot Feeding Industry and managed by AUS-MEAT Limited. Under the scheme, beef feedlots are accredited if they meet a range of quality requirements.
Livestock Production Accreditation Scheme (LPAS – for grain fed lambs and hoggets)	▪ The LPAS is a certification scheme for grain fed lambs and hoggets. To be certified, the producer must comply with a prescribed feeding and carcase criteria. LPA QA (Level 2) accreditation is a prerequisite to progressing LPAS certification.

55 MLA (2014), example of "National Vendor Declaration and Waybill", MLA web site, accessed 6 Oct 2014.

56 MLA (2006), LPA On-Farm Quality Assurance Manual, MLA web site, accessed 6 Oct 2014.

Key Terms	Explanation
National Saleyards Quality Assurance (NSQA)	▪ The National Saleyards Quality Assurance Program (NSQA) is owned and operated by National Saleyards Quality Assurance Ltd, which is a company in its own right owned by members of NSQA. ▪ NSQA Accreditation is a commitment by a Saleyard to meet and maintain recognised national standards in the handling of livestock through all stages of the saleyard system. ▪ AUS-MEAT is responsible for ensuring that both the Quality Assurance System developed by each Saleyard and the Saleyard facilities themselves meet the requirements of the National Standard for the Construction and Operation of Australian Saleyards.
truckCare	▪ truckCare is the Australian Livestock Transport Industry's independently-audited quality assurance program. truckCare members are audited to agreed standards that meet all of the latest livestock transport laws in Australia.
AUSMEAT QMS Accreditation (Processors and wholesalers)	▪ Each Accredited Enterprise (Abattoir, Boning Room, Cold Store, Wholesale /Food Service operation) must establish and maintain a QMS approved by AUS-MEAT, which covers all activities conducted within the Enterprise which use or may impinge on the AUS-MEAT Language. All QMS documentation, including the QMS Manual must be approved by AUS-MEAT prior to Accreditation.
Australian Livestock Processing Industry Animal Welfare Certification System (AAWCS)	▪ The Australian Livestock Processing Industry Animal Welfare Certification System (AAWCS) is an independently audited certification program used to demonstrate compliance with the industry best practice animal welfare standards titled the 'Industry Animal Welfare Standards for Livestock Processing Establishments Preparing Meat for Human Consumption' (The Standards), the content of which is managed by the Australian Meat Industry Council (AMIC). ▪ The AAWCS has been developed to help Australian livestock processing establishments demonstrate to Industry, Australian and overseas regulators, and above all customers and consumers of Australian meat products their commitment to Industry's best practice animal welfare system at their establishment. ▪ AMIC has entered into a Memorandum of Understanding with AUS-MEAT Limited giving AUS-MEAT the authority to administer and manage the certification program on behalf of the Australian Livestock Processing Industry. ▪ AUS-MEAT's role is to approve suitably qualified auditors for the program, administer an audit program to verify conformance with the Standards and to maintain a register of participating establishments. AUS-MEAT also administer the use of the AAWCS Trademark on behalf of Industry. AUS-MEAT will also institute corrective actions where breaches occur in accordance with the Rules.

Source: Unless otherwise stated the information in this table has been developed based on our knowledge of the key terms and/or information sourced from the MLA and AUSMEAT web sites.

PART C: SCIENTIFIC RESEARCH

This section examines the benefits and costs of the scientific research program.

14. Overview of scientific research component

The objectives of the scientific research program can be summarised as[57]:

- to understand food safety risks through the use of scientific approaches;
- to manage identified risks through the development of systems and new technologies; and
- to development and disseminate information relating to risk management.

Since 2000, MLA has undertaken almost 350 projects[58] within this stream of work. These projects have typically been defined on a contract basis. For the purpose of analysis, we have grouped the 350 projects into 'project groups'. Project groups were developed in consultation with MLA based on grouping together projects with similar objectives. A total of thirteen project groups were established:

- Understanding hazards;
- Process analysis / improvement;
- *E. coli* O157[59] manufacturing beef;
- Shelf life;
- Transmissible spongiform encephalopathies (TSEs);
- Value added product safety;
- Other STEC;
- Predicting chilling;
- Understanding post mortem process;
- Red meat biotechnology;
- Product integrity;
- Residue for trade barrier; and
- Other.

A description of the objectives for each of the first seven project groups in this list is contained in section 17. These seven project groups account for more than 90 per cent of historical MLA funding for the scientific research program [60].

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57 These objectives build on information outlined in MLA (2014), Program achievement report, Food safety 2013/14.

58 Note that each project typically relates to a specific MLA contract with an external service provider.

59 Note that we have shortened *E. coli* O157:H7 to *E. coli* O157 throughout this document.

60 Note that the MLA funding costs of the first seven projects relative to funding of all projects is illustrated in Table 36.

15. Estimating net benefits for the scientific research component

15.1 Estimating benefits for the whole scientific research component

The estimated net benefits for the whole program are estimated to be $368.0 million in present value terms since the year 2000 with an associated benefit-cost ratio of 4.4 (Table 30). The net benefits involve benefits of $477.1 million and costs of $109.1 million in present value terms. These net benefits include past benefits and costs as well as future benefits that are likely to be derived from the program. Furthermore, these net benefits are based on benefits being projected forward for thirty years.

However, we note that this result was significantly influence by a project on transmissible spongiform encephalopathies (TSEs) which had large net benefits. If we exclude this project, the net benefits are $148.3 million with a benefit-cost ratio of 2.4 (Table 30). It is important to make the TSE distinction because of the impact that one of the projects we examined, which relates to transmissible spongiform encephalopathies (TSEs), has on the benefit cost results.

The net benefits include past benefits and costs as well as future benefits that are likely to be derived from the program. Furthermore, net benefits are based on benefits being projected forward for thirty years.

Table 30: Scientific research: net benefits ($million)

	Include TSE project	Exclude TSE project
Incremental benefits ($m)	$477.1	$256.1
Incremental costs ($m)	-$109.1	-$107.8
Net benefits ($m)	$368.0	$148.3
Benefit-cost ratio	**4.4**	**2.4**

Source: MJA analysis.

To estimate net benefits, we examined the benefits and costs for a selection of projects within the scientific research program and then used this to draw conclusions for those project groups and projects that we have not directly estimated the benefits. Therefore, the net benefits for the entire food safety research program have been estimated by adding together the following components:

- **the net benefits for the 28 selected projects,** noting that the benefits part of the net benefit calculation for the 28 selected projects only relates to cost savings and/or avoided costs (and not the price premiums);
- **the net benefits for those projects that we did not examine (the "other projects").** We applied a benefit cost ratio of 2.1 for those projects we did not examine to estimate their net benefits. This benefit cost ratio is applied since it is the benefit cost ratio for our 28 selected projects with the exclusion of TSEs. It is important to apply the benefit cost ratio which

excludes TSEs since the large majority of the projects we have not examined in detail relate to meat processing and post processing practices rather than animal disease issues[61]; and

- **a price premium** which reflects the impact of the research program on Australia's reputation for being able to deliver meat supported by food safety systems that ensure a low risk of contamination by pathogens such as *E. coli* and *Salmonella*. This price premium spans across all scientific research projects, noting that some projects have more impact than others.

The separation of net benefits into these three components is illustrated in Table 31. The framework for estimating total benefits for these components is summarised in Figure 11. The net benefit calculation for the selected 28 projects is discussed in more detail in section 15.2 and the price premium is discussed in more detail in section 20.11.

Table 31: Scientific research: net benefits by component ($million)

$m	Net benefits (including TSEs)	Net benefits (excluding TSEs)
INCREMENTAL BENEFITS		
28 selected projects	$423.3	$202.8
Other projects based on BCR for selected projects	$26.7	$26.2
Price premium across projects	$27.1	$27.1
Total incremental benefits	$477.1	$256.1
INCREMENTAL COSTS		
28 selected projects		
MLA funding costs	-$9.3	-$8.3
Other costs	-$87.2	-$87.2
Other projects (MLA funding costs)	-$12.6	-$12.3
Total incremental costs	-$109.1	-$107.8
NET BENEFITS	**$368.0**	**$148.3**
Benefit-cost ratio	**4.4**	**2.4**
Internal rate of return	**44%**	**42%**
Modified internal rate of return	**15%**	**13%**

Source: MJA analysis

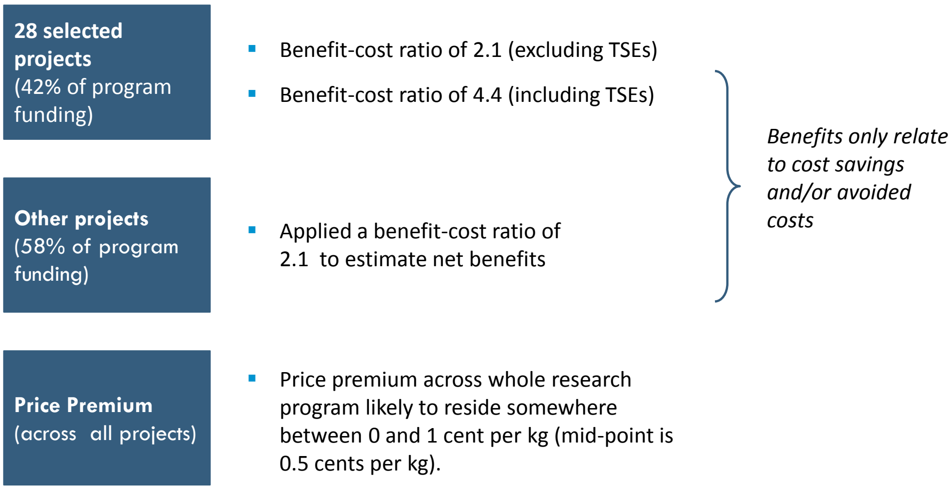
Notes:

1. *The "other costs" for the 28 selected projects in the above table relates to additive costs for a project involving Listeria. This is explained in more detail in section 20.7.*

2. *Total MLA funding (including TSEs) is $22.0 million. This includes $9.2 million for the selected projects and $12.7 for the other projects (note that the totals do not add to $22.0 million due to rounding). More information is contained in Table 36.*

61 Note that this can be seen with reference to section 22 which illustrates the type of projects within the 'understanding hazards' project group.

Figure 11: Estimating benefits for the whole program



Source: MJA analysis.

In accordance with the CRRDCs Impact Assessment Guidelines[62], we have also prepared a variety of investment performance statistics (Table 32). These illustrate how the returns from the project vary with different assumed time horizons into the future. This is important since some benefits and costs are assumed to continue into the future. Section 23 contains detailed investment performance information.

Table 32: Scientific research: investment performance statistics

	Net benefits ($m)		Benefit cost ratio		Internal rate of return		Modified internal rate of return	
	Including TSE project	Excluding TSE project	Including TSE project	Excluding TSE project	Including TSE project	Excluding TSE project	Including TSE project	Excluding TSE project
At 'final year'	$39.9	$41.0	1.7	1.8	39%	41%	21%	22%
5 year forward horizon	$164.1	$71.8	3.4	2.1	44%	42%	24%	20%
10 year forward horizon	$247.3	$95.3	4.0	2.2	44%	42%	22%	17%
20 year forward horizon	$336.5	$128.2	4.4	2.3	44%	42%	17%	14%
30 year forward horizon	$368.0	$148.3	4.4	2.4	44%	42%	15%	13%

Source: MJA analysis

15.2 Examining a selection of projects

A total of 28 projects were selected to analyse the benefits and costs. These projects are contained within six of the project groups. The six groups are discussed in more detail in section17. Projects were only chosen from these six project groups because these groups represent more than 50 per cent of total MLA funding costs and the MLA had a reasonable amount of historical documentation on projects within these project groups.

The 28 projects were chosen from within these six project groups for similar reasons – that is, they either represent a large proportion of expenditure within a project group or there is a reasonable amount of historical information on the project.

62 Council of Rural Research and Development Corporation (2014), Impact Assessment Guidelines, Version 1, May 2014.

In total, the 28 projects we examine represent approximately 43 per cent of total MLA program costs since 2001 (Table 36) and cover a diverse range of scientific research projects on food safety undertaken by the MLA. A description of each of the 28 projects and their research outputs is contained in section 21.

By sampling 28 projects our net benefits for the scientific research component are estimated to have a 14 per cent margin of error with a 95 per cent level of confidence. This assumes that all of those projects that we have not examined are of an equal size on average to the 28 projects we have examined. This is not an unreasonable approach given that many of the smaller projects are likely to be similar in nature and could be grouped up to a similar expenditure size relative to the 28 projects.

We note that there may be some biases in our approach since we have not randomly selected projects within the program. However, to mitigate these biases we selected enough projects to cover a large proportion of total expenditure on the program (around 43 per cent of the total) and ensured that the selected projects are reasonably representative of the type of projects that are undertaken within the program and the type of benefits that are obtained from these projects.

We also note that we have not included any projects from the ‘understanding hazards’ project in our 28 selected projects. The reason for this is that the first set of information on the scientific research program provided to us by the MLA was for the six project groups containing the 28 projects and we concluded that this provided us with the basis for an appropriate cross-section of projects across the scientific research program.

Moreover, the ‘understanding hazards’ project group contains projects that are similar in nature to the 28 selected projects. For example, some of the projects within this group examine the potential for improvements to meat processing practices and prevalence of particular pathogens in red meat – these are similar to the type of benefits within the 28 selected projects and therefore are likely to deliver a similar size of benefit relative to the cost. Additionally, unlike for some of the 28 selected projects, we are not aware of any previous evaluations of projects within the ‘understanding hazards’ project group which would have aided in examining these projects.

The benefit cost ratio for the 28 projects is estimated at 4.4. However, we note that this result was significantly influenced by a project on transmissible spongiform encephalopathies (TSEs) which had large benefits. If we exclude this project, the benefit-cost ratio of the remaining 27 projects is 2.1 (Table 33). Additionally, this ratio only includes benefits in the form of cost savings and avoided costs. It does not include a price premium which we have estimated separately since the price premium relates to the whole research program and not just the 28 selected projects.

A summary of the benefits and costs for each of the 28 projects is contained in section19. A more detailed overview of these projects and their outputs is contained in section 21.

Table 33: Summary of benefits-cost ratio (based on cost savings and/or avoided costs) for 28 selected projects

	Include TSE project	Exclude TSE project
Benefit-cost ratio	**4.4**	**2.1**

Source: MJA analysis

Note: the benefits exclude price premiums.

The types of benefits that result from the selected projects are:

- cost savings for meat processors and/or avoided processing costs;
- increase in profits from higher meat sales;
- lower health costs which result from lower food safety incidents; and
- a price premium on export sales.

The benefit category that applies for each of the 28 selected projects is illustrated in Table 37 in section19. We note that one project, related to transmissible spongiform encephalopathies (TSEs), had very large projected cost savings. However, the cost savings were reliant on an outbreak occurring sometime in the future.

16. Sensitivity analysis for scientific research

This section examines the sensitivity of the results to changes in a range of key variables. We believe that most of the variability of results to key assumptions relates to the benefits part of the calculation. This is because a range of variables related to the benefits were estimated through a mix of stakeholder discussions, previous evaluations and our expert judgment. For example:

- the likelihood of technical trade barriers being removed (projects P17, P18 and P19);
- the likelihood of an outbreak of TSEs (project P20);
- the potential fall in demand for smallgoods in the case of an outbreak of listeriosis (project P22);
- the likelihood of a listeriosis outbreak (project P20); and
- the likelihood of the United States imposing stricter controls on the Big 6 non-O157 *E. coli* strains in the near future and/or Australian processors ceasing testing for the Big 6.

Taking into consideration the nature of the possible inaccuracy and its impact across most of the selected 28 projects, we have adjusted benefits up and down by 50 per cent of the base case values outlined in section 15 to assess the robustness of the base case results (Table 34). Moreover, based on our experience, we believe this range ensures that we appropriately consider the type of uncertainty associated with these types of assumptions. This variation in benefits results in the net benefits ranging from $129.5 to $606.6 million if the TSE project is included in the calculations. Additionally, it results in the net benefits ranging from $20.3 million to $276.4 million if the TSE project is excluded from calculations. We have also estimated the net benefits at $341.3 million (Table 34) if the TSE project is included (and $122.1. million if it is excluded) and we exclude the benefits for those scientific research projects we did not examine (the “other projects”).

We also note that the lowest value of the benefit cost ratio is 1.2 under the scenario of a 50 per cent reduction in benefits and with the exclusion of the TSE project from the calculations.

Table 34: Sensitivity analysis on benefits

	Net benefits ($m)		Benefit cost ratio		Internal rate of return		Modified internal rate of return	
	Including TSE project	Excluding TSE project	Including TSE project	Excluding TSE project	Including TSE project	Excluding TSE project	Including TSE project	Excluding TSE project
50% lower benefits	$129.5	$20.3	2.2	1.2	21%	10%	11%	7%
Base case	$368.0	$148.3	4.4	2.4	44%	42%	15%	13%
50% higher benefits	$606.6	$276.4	6.6	3.6	61%	61%	16%	14%
Excluding 'other project' benefits	$341.3	$122.1	4.1	2.1	40%	37%	14%	12%

17. Objectives of scientific research project groups

This section outlines the key objectives for each of the major project groups within the scientific research component of the MLA's product integrity programs (Table 35).

Table 35: Objectives for key project groups

Project group	Key objectives
Understanding hazards	▪ develop an improved understanding of the prevalence of different pathogens in the red meat supply chain to better understand food safety risks. ▪ examine the likely drivers of risks (such as pathogens and antibiotic resistance) in the red meat supply chain. ▪ illustrate red meat food safety attributes and Australian processing practices to customers.
Process analysis / improvement	▪ examine ways to reduce the incidence of pathogens in the processing and transporting of livestock to ensure the retention of market access. ▪ examine ways to reduce costs of managing the incidence of pathogens in the processing and transporting of livestock.
E. coli O157 manufacturing beef	▪ support the Australian beef export sector in maintaining market access to the United States (principally). ▪ support the Australian beef export sector in minimising the costs of meeting access requirements to the United States. ▪ develop knowledge and capability around *E. coli* O157 in an Australian context.
Shelf life	▪ understand the shelf life of vacuum packed meats and the factors that influence shelf life. ▪ understand the microbiological flora associated with vacuum packed meats.
TSE	▪ ensure that Australia has the capability to identify animals at risk from diseases, such as transmissible spongiform encephalopathies (TSEs), and quickly deploy surveillance methods requiring post-mortem sampling. ▪ develop testing techniques that can be used to ensure that ruminant stockfeeds are not contaminated with restricted animal materials.
Value added product safety	▪ understand the key factors that result in activation and inactivation of pathogens in processed meats. ▪ developing risk mitigation strategies to reduce the risk of pathogens in processed meats.

Project group	Key objectives
	▪ assess the impact of new technologies on pathogens in processed meats.
Other STEC	▪ understand the prevalence of non-O157 Shiga toxin-producing *E. coli* (STEC). ▪ explore optimal testing techniques for non-O157 STECs.

Source: MJA summation of information provided by MLA

18. MLA scientific research funding costs

This section outlines the project costs that have been funded by the MLA for each of the major project groups within the scientific research program and those costs for the 28 selected projects that were chosen to directly analyse the benefits and costs (as discussed in section 15.2).

MLA funding costs for the 28 selected projects represents approximately 43 per cent of the total MLA funding for the scientific research program (Table 36). Note that the MLA funding costs in Table 36 do not include the additive costs for a project involving *Listeria* (as discussed in section 20.7). The additive costs were funded by processors.

We note that approximately 10 per cent of the total $22 million has been funded by the MLA Donor Company (MDC) which is fully owned subsidiary company of the MLA. The MDC provides a mechanism for attracting commercial investment from individual enterprises and matching this with surplus Australian Government R&D funds.

Table 36: MLA funding costs for project groups

Project group	Total project funding cost (in real 2014 dollars)	28 selected project funding costs
Understanding hazards	$5,482	
Process analysis / improvement	$3,342	$3,056
E. coli O157 manufacturing beef	$2,705	$1,966
Shelf life	$1,762	$1,123
TSE	$1,309	$1,063
Value added product safety	$1,128	$1,128
Other STEC	$1,402	$1,002
Predicting chilling	$935	
Understanding Post mortem process	$408	
Red meat Biotechnology	$292	
Product integrity	$259	
Residue for trade barrier	$65	
General	$2,828	
Total	**$21,916**	**$9,338**
% of total funding cost		**43%**

Source: MJA analysis

19. Summary of benefit cost analysis for selected projects

This section provides a summary of the benefits and costs for the selected 28 projects that we examined in detail. This section does not discuss the price premium, which is discussed in section 20.11.

Net benefits are defined as the benefits of the project minus the costs associated with the project. The benefit cost ratio is defined as the benefits divided by the costs. Project benefits have been estimated from the point of project completion to thirty years into the future from the current year (that is up to 2044). We have applied a discount rate of a real discount rate of 5 per cent to bring estimates of future benefits and costs into present values in 2014 dollar terms and the gross domestic product price deflator to convert historical benefits and costs into current dollars. This process is consistent with the CRRDCs Impact Assessment Guidelines.

The estimated net benefits and benefit cost ratio vary considerably (Table 37) across the 28 projects. Moreover, the results show that:

- 11 of the 28 projects deliver positive net benefits based on historical benefits or projected future benefits.
- 17 of the 28 projects are likely to not have delivered benefits to date nor are they likely to in the foreseeable future;
- a small number of the projects are estimated to have delivered very large benefits.

Of the 11 that have delivered positive net benefits, we have quantified the value of benefits for nine of these projects. This means that there are two projects for which there are positive benefits but which we were not able to able to quantify the benefits.

The benefits and costs for each project for which the benefits are greater than zero are discussed in more detail in section 20.

We assigned a net benefit value of zero for 17 projects based on consultation with MLA staff and external stakeholders which revealed that for these projects there was: no practice changes that resulted from the project; no changes to market conditions (e.g. market access or sales); and no costs that had been avoided by undertaking the project.

Table 37: Benefit and costs for each of the 28 projects

Project group	Project	Project number	BENEFITS ($'000)	COSTS ($'000)	NET BENEFITS (Benefits - Costs)	BENEFIT COST RATIO (BCR)	Type of benefit
Process analysis/ improvement							
	Process analysis: safe feeding strategies for beef production in Northern Australia	P1	$0	$800	-$800	0.0	
	Process analysis: Curfew in livestock transport	P2	$0	$212	-$212	0.0	
	Process analysis: Tag score at Australian cattle abattoirs	P3	$0	$23	-$23	0.0	
	Process analysis: Salmonella in goat and goat meat	P4	$0	$281	-$281	0.0	
	Process analysis: Carcase contamination process control	P5	$0	$387	-$387	0.0	
	Process analysis: alternatives to 82°C water	P6	$0	$577	-$577	0.0	
	Process analysis: surface sponging method	P7	$0	$14	-$14	0.0	
	Process analysis: consolidated customer audits	P8	$0	$103	-$103	0.0	
	Analysis of ESAM data: examining the microbiological settings for the ESAM program	P9	$0	$29	-$29	0.0	
	Analysis of ESAM data: ESAM reporting system	P10	$0	$479	-$479	0.0	Cost savings
	Process data analysis: development of assessment tools for beef and sheep	P11	$0	$153	-$153	0.0	
	Sub-total		***$0***	***$3,056***	***-$3,056***	**0.0**	
E. coli O157 manufacturing beef							
	E. coli O157 and Salmonella in red meat animals and processing	P12	$1,672	$1,206	$466	1.4	Avoided costs
	E. coli O157 testing implementation	P13	$1,672	$338	$1,334	4.9	Avoided costs
	E. coli O157 positive lots	P14	$0	$193	-$193	0.0	
	Effect of Freezing on the Survival of Escherichia coli O157:H7	P15	$0	$150	-$150	0.0	
	E. coli O157 low volume enrichment validation	P16	$495	$79	$416	6.3	Cost savings
	Sub-total		***$3,839***	***$1,966***	***$1,873***	**2.0**	
Shelf life							
	Understanding shelf-life for vacuum packed meat	P17	$0	$626	-$626	0.0	
	Vacuum packed beef shelf-life	P18	$0	$378	-$378	0.0	
	Vacuum packed lamb shelf-life	P19	$0	$119	-$119	0.0	
	Combined P17, P18 & P19	P17, P18, P19	$1,781	$1,123	$658	1.6	Higher profits
	Sub-total		***$1,781***	***$1,123***	***$658***	**1.6**	
Transmissible spongiform encephalopathies (TSEs)							
	Rapid Response Surveillance Capability Development for TSEs	P20	$220,502	$1,063	$219,439	207.5	Cost savings
	Sub-total		***$220,502***	***$1,063***	***$219,439***	**207.5**	
Value added product safety							
	E. coli in fermented meats	P21	$0	$424	-$424	0.0	Health benefits
	Risk management - Listeria in smallgoods	P22	$190,012	$87,553	$102,460	2.2	Higher profits and health benefits
	High pressure processing (HPP) of smallgoods	P23	$0	$200	-$200	0.0	
	Environmental control of L. monocytogenes	P24	$119	$119	$0	1.0	Cost savings
	Cooling of cooked meat	P25	$6,215	$16	$6,199	393.3	Avoided costs
	Low temperature cooking of meats	P26	$0	$10	-$10	0.0	
	Sub-total		***$196,346***	***$88,322***	***$108,024***	**2.2**	
Other STEC							
	Epidemiology of human EHEC infection in Australia	P27	$0	$115	-$115	0.0	
	Survey and testing	P28	$866	$886	-$21	1.0	Cost savings
	Sub-total		***$866***	***$1,002***	***-$136***	**0.9**	
Total			**$423,333**	**$96,531**	**$326,802**	**4.4**	
Total (excluding P20)			**$202,832**	**$95,468**	**$107,363**	**2.1**	

Source: MJA analysis.

Note: The net benefits in this table do not include the price premium.

20. Benefit cost analysis of selected projects

This section outlines our detailed examination of the benefits and costs for those projects that have benefits greater than zero.

20.1 P10: ESAM reporting system

The impetus for the project was to leverage the information within the 'ESAM' (or *E. coli* and *Salmonella* Monitoring Program) database and provide processors with the ability to see where they can make changes to improve their performance. The key output of this project has been the development of a reporting system for *E. coli* and *Salmonella* that shows how individual processing establishments are tracking against industry averages.

The ESAM database contains information from all export slaughter establishments on carcase samples for *E. coli* and *Salmonella.* The information in the database is derived from information collected by the Department of Agriculture and is managed by South Australian Research and Development Institute (SARDI). SARDI provide around 60 processing establishments with monthly reports using information in the database.

Our consultation with SARDI indicated that a small number of processors had made changes because the monthly reports indicated a relatively high prevalence of *E. coli* and/or *Salmonella* for these establishments. We understand that the changes that were subsequently made were minor in scale.

We have not quantified the benefits for this project since a survey across processors has not been undertaken and those processors we did consult indicated that there had not been a direct quantifiable benefit for them. However, our consultation did indicate that the benefits of this project are likely to reside with smaller processing facilities which do not have the sophisticated reporting systems that are in place with larger processors.

20.2 P12 & P13: *E.* coli and *Salmonella* in red meat animals and processing and *E. coli* O157 testing implementation

MLA undertook research into *E. coli* O157 in the early to mid-2000's. This research was undertaken because it was perceived by the Australian meat sector that the United States may impose new requirements in the future on importers because of ongoing issues with *E. coli* O157. The research examined the prevalence of *E. coli* O157 in cattle presenting for slaughter (and in transport) and illustrated that Australia has a low risk of *E. coli* O157. The research is discussed in more detail in section 17.

The research became relevant because of changed circumstances in the United States. Moreover, during 2007 "*the United States Food Safety Inspection Service (FSIS) made a number of policy decisions and issued a number of Notices that caused considerable change in the way that Australian suppliers of beef trim to the USA operate*" [63]. The projects P12 and P13 on *E. coli* O157 contributed to Australia being able to negotiate a better outcome in terms of the number of port of entry tests for beef trim (also referred to as 'manufactured meat'). It also may have led to the United States not introducing other measures that could have added costs to

[63] http://www.agriculture.gov.au/about/annualreport/2007-2008/report_on_performance, Case study 8.

Australian processors. The research was important because it illustrated low prevalence of *E. Coli* O157 in Australian production systems and that Australia had appropriate testing systems in place that were equivalent to what was required by the United States.

The CIE undertook an ex-ante evaluation of the impact of this research in 2006[64]. Their analysis was mostly focused on examining the benefits for processors that result from less sampling. In developing benefits for this project we have built on this evaluation, noting that the counterfactual (i.e. what would have occurred without the P12 and P13 MLA projects) we have developed for this project is different to that within the CIE report. This counterfactual is based on consultation with stakeholders (government and industry).

Our general counterfactual assumes that, in the absence of the P12 and P13 MLA projects, the port of entry meat sampling by FSIS in the United States would have comprised:

- the number of lots tested being 8 times higher in the absence of the P12 and P13 MLA projects;
- a rejected shipment from one processor leading to the whole day's shipments from that processor being rejected; and
- an increase in the number of cartons that are sampled in a lot. This is because the number of cartons tested would likely to have been a function of factors such as the number of different packing dates for meat across the lot and/or the number of different types of meat in the lot.

Additionally, under our counterfactual the number of cartons sampled in a lot by Australian processors (prior to the meat being sent overseas) could have been higher, which would have been reflected in the Australian Meat Notice.

Our general observation is that any difference in our counterfactual compared to CIE is because the counterfactual is likely to have evolved beyond the CIE report as a result of negotiations with the United States. Additionally, stakeholder consultation also revealed that there is some uncertainty as to what the counterfactual would have been.

Using this general counterfactual we estimate that the total benefits from the two MLA projects (P12 and P13) are $3.3 million in present value terms. The benefits comprise several components, including:

- less rejections by the FSIS because there is less product being tested. This means that less product has to be diverted to other markets;
- lower sampling costs for Australian processors; and
- less rejections by Australian processors because there is less product being tested. Again, this means that less product has to be diverted to other markets.

In estimating these benefits we assume:

- the likelihood of *E. coli* O157 showing up in lots is 0.1%[65];

[64] CIE (2006), E. coli O157:H7 in beef trim exports to the US, An Ex-ante benefit-cost evaluation, Prepared for Meat and Livestock Australia.

[65] Sumner, J., Kiermeier, A., Jenson I. (2011), Verification of Hygiene in Australian Manufacturing Beef Processing — Focus on Escherichia coli O157, 2011, Food Protection Trends, Vol. 31, No. 8, Pages 514–520.

- there are 350 cartons typically in one lot and typically 9.5 tonnes in a lot. This was sourced based on discussions with a couple of processors. We also assume that there are 50 lots per individual shipment for a processor on a particular day (sourced from a processor).
- there are 25 lots of Australian beef tested by FSIS each year. This would have increased to 200 without the MLA project and associated negotiations with the United States. This is 8 times the number of lots tested.
- there are approximately 18,000 lots tested per year by processors for the years 2008, 2009 and 2010. This equates to approximately 171,000[66] tonnes of beef trim exported to the United States.
- The number of cartons in a lot that is tested for *E. coli* 0157 increases by 3 times without the MLA project and associated negotiations with the United States. This increases the likelihood of *E. coli* O157 showing up in lots by 3 times. We made the assumption of '3 times' on the basis that FSIS will undertake additional samples if there are sufficiently different packing dates for meat across the lot and/or there are different types of meat in the lot. We have based the '3 times' assumption on the basis of stakeholder discussions and examination of a small number of shipment plans for one processor. This assumption applies both to FSIS and Australian processor testing.
- the sampling cost for Australian processors is $50 per sample in 2014 dollars (which covers one lot) with a lower amount of $35 applying to the scenario in which there is more sampling by processors under the counterfactual. The $50 per sample was developed based on discussions with two processors and the $35 per sample is based on the same discount for a higher sample number as per the CIE report.
- the value of product is assumed to be $3.47 per kg in 2008 dollar terms over the period 2008 to 2010[67]. Half of this value is assumed to be lost if product has to be diverted to other markets due to a rejection as a result of a positive test for *E. coli* O157 in a lot (sourced from a processor).

We further note that there may be additional benefits of the P12 and P13 MLA projects on *E. coli* O157 by improving the confidence in Australian produce thereby resulting in a small price premium on sales of Australian meat to the United States. We discuss this further in section 20.11.

Additionally, we have attributed 50 per cent of the total benefit that resulted from the negotiations with FSIS to the two MLA projects. This is because there are other factors that have contributed to the benefits outlined above, including the effort and resources that were devoted by the Australian government to negotiate with the United States[68].

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66 This is estimated based on a three year average of exports to the United States as sourced from ABARES (2014), Agricultural commodity statistics 2014, Table 136, United States frozen boneless. Additionally, the three year average has been multiplied by 70 per cent to reflect the approximate export share of beef trim.

67 This is estimated based on ABARES (2014), Agricultural commodity statistics 2014, Table 138, United States frozen boneless.

68 We have attributed a proportion of the benefits to MLA on the basis that there are factors other than the MLA research that play a role in improving market access, including negotiations and discussions with customers. The 50 per cent attribution to MLA reflects the relative amount of effort that is undertaken by MLA relative to other Australian organisations that are involved in facilitating changes to market access (e.g. Australian Government and meat processors). Arguably, this is a conservative approach since without the research it is likely that the Australian Government would not have been able to negotiate preferred access arrangements. However, it could also be argued that the 50 per cent reflects some uncertainty over the degree to which the Australian Government may have been able to negotiate some preferred arrangements without the research.

In terms of the timing of benefits, we have only assumed that the benefits last for three years from 2008 since at this point FSIS is likely to revise the number of samples for Australian meat to reflect the actual prevalence of E. coli.

Following discussion with the MLA, we attributed the benefits of the P12 and P13 MLA projects equally between these two projects.

20.3 P16: *E. coli* O157 low volume enrichment validation

This project established that a sampling technique ('low enrichment volume sampling') that used less enrichment broth than the new sampling requirements of the United States to achieve similar testing outcomes. This research was used by MLA to gain acceptance from the National Association of Testing Authorities and the Department of Agriculture. Subsequently, the Australian Government obtained acceptance to the sampling technique from the United States Food Safety Inspection Service (FSIS).

The benefits of this technique are lower sampling costs associated with low enrichment volume sampling. We estimate the total benefits from this project to be approximately $495,000. We estimated this benefit using information provided by a sampling company which has indicated that:

- there are around 18,000 tests[69] of *E. coli* O157 undertaken in Australian each year; and
- the cost saving per sample (including handling, labour, autoclave, water and waste disposal) is approximately $5 to $6 per sample.

This equates to a total saving per annum of between $90,000 to 108,000 (or on average $99k per year). We assume that the benefit of this project lasts from 2009 to 2013 as since then, the new technique has become standard FSIS methodology.

20.4 P17, P18 and P 19: Shelf life

MLA undertook a range of research projects examining the shelf life of vacuum packed meat products, in particular beef and lamb. These projects illustrated that the shelf life of vacuum packed beef and lamb is longer than the current market restrictions in place in some parts of the world to which Australia exports vacuum packed meat.

There is significant potential for gains from this research. We have focused our estimate of benefits on the Middle East, because this has been a focus of Australia in improving market access where shelf life is the constraining factor. Additionally, research of the Middle Eastern markets has recently been undertaken which enables valuation of potential benefits.

In particular, a recent research report prepared by D. N. Harris and Associates (2013)[70] found that there are potential benefits across a range of countries in the Middle East by increasing product shelf life. Their report highlights two types of technical barriers:

69 The 18,000 tests is based on approximately 171,000 tonnes of beef trim exported to the United States (as discussed in section 20.2) and an average of 9.5 tonnes per lot.

70 D. N. Harris and Associates (2013). Comparative evaluation of technical barriers to trade for Australian red meat, Report prepared for Meat & Livestock Australia Ltd (MLA) and the Australian Meat Industry Council (AMIC), Melbourne, June 2013.

- restrictions on product entry age. This means that the meat must be less than a set age. This type of restriction reduces the opportunities for export sales and there is a risk that markets will reject the product if the threshold is exceeded.
- limits on the expiry date of meat products. This can act to restrict the demand for imported products which have a longer actual shelf life.

The impact of the technical barriers to trade estimated by D. N. Harris and Associates (2013) for all of the countries in the Middle East is contained in Table 38.

Our stakeholder consultation with MLA, processors and government has indicated the MLA research projects on vacuum packed meat (beef and sheep) are a very important tool in negotiating with countries to remove these barriers. Indeed, one processor indicated that the research had contributed to them being able to improve access to a South American country and that the research is an integral part of convincing other countries about changing their shelf life regulations.

However, these same discussions indicated that there is significant uncertainty over the likelihood of changes to the technical barriers for shelf life in the Middle East.

Our estimate of total benefits from this project is $1.8 million in present value terms. The estimated benefits for this project from 2016 assume:

- a 10 per cent probability of technical trade barriers being removed starting in 2016. We set this figure based on our view of a suitably low likelihood given the level of uncertainty.
- a 20 per cent attribution to the MLA research of any change to the technical barriers starting in 2016. This reflects that while the research was an important component of being able to present a convincing case for change to international markets, there are a range of other factors which require expenditure to facilitate improvements to market access[71].
- the markets that have technical trade barriers removed from 2016 being Egypt and UAE, taking into account their high priority in Table 38 (total impact of $123.5 million).
- a 10 per cent total additional profit gain (or 'producer surplus') to farmers, producers and marketers along the chain. The D. N. Harris and Associates (2013) paper states that the trade impact for the shelf life trade barriers is estimated based on trade volumes and the prices received. Assuming that most of the impact is due to lower sales (as per the Saudi Arabia example on page 9), the benefit for Australia should equate to the additional sales revenue minus the additional costs of getting the meat to customers – essentially additional profits. Using our experience in other sectors and allowing for product to be shifted from other markets, we have set the additional profits at 5 per cent of the total sales price.

Note the benefits for projects P17, P18 and P 19 are grouped together. We also note that our estimate of benefits are likely to be understated since we have only analysed Middle East markets and we are aware of other markets where there have been, or there is potential for, benefits from improvements in market access where shelf life is the constraining factor.

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71 We have attributed a proportion of the benefits to MLA on the basis that there are factors other than the MLA research that play a role in improving market access, including negotiations and discussions with customers. The 20 per cent attribution to MLA reflects the relative amount of effort that is undertaken by MLA relative to other Australian organisations that are involved in facilitating changes to market access (e.g. Australian Government and meat processors). This approach has been taken because there is considerable uncertainty as to what would occur without the MLA research. For example, it may be that without the research processors would have undertaken similar research at a later point in time. We have not modelled this possible counterfactual outcome.

Table 38: Impact of technical trade barriers (Middle Eastern countries)

Reform priority	Country	Industry impact ($m)	Primary benefit	Technical trade barrier
Initial reform priority	UAE	$48.3	Beef & sheep meat	Max entry age for vacuum packed meat 40 days
	UAE	$18.0	Beef	Max expiry period for vacuum packed beef 70 days
	Egypt	$36.8	Beef & sheep meat	Maximum entry age for vacuum packed meat of 14 to 24 days
	Egypt	$20.4	Beef & sheep meat	Maximum expiry period for vacuum packed meat of 28 to 49 days
Subsequent priorities for reform	Saudi Arabia	$28.3	Beef & sheep meat	Max entry age for vacuum packed meat 40 days
	Saudi Arabia	$6.0	Beef	Max expiry period for vacuum packed beef 70 days
	Qatar	$27.4	Beef & sheep meat	Max entry age for vacuum packed meat 40 days
	Qatar	$7.9	Beef	Max expiry period for vacuum packed beef 70 days
No stated priority	Iran	$25.3	Beef & sheep meat	Max entry age for vacuum packed meat 50 days
	Iran	$5.9	Beef	Max expiry period for vacuum packed beef 70 days
	Kuwait	$14.6	Beef & sheep meat	Max entry age for vacuum packed meat 40 days
	Kuwait	$4.6	Beef	Max expiry period for vacuum packed beef 70 days
	Bahrain	$11.4	Beef & sheep meat	Max entry age for vacuum packed meat 40 days
	Bahrain	$4.9	Beef	Max expiry period for vacuum packed beef 70 days
	Oman	$8.2	Beef & sheep meat	Max entry age for vacuum packed meat 40 days
	Oman	$2.9	Beef	Max expiry period for vacuum packed beef 70 days
	Lebanon	$13.7	Beef	Max entry age for vacuum packed meat of 15 to 50 days
	Lebanon	$6.8	Beef	Max expiry period for vacuum packed beef 84 days
	Jordan	$16.9	Beef & sheep meat	Max entry age for vacuum packed meat 42 days
	Syria	$25.4	Beef & sheep meat	Max entry age for chilled, vacuum packed meat 2 to 3 days

Source: D. N. Harris and Associates (2013). Comparative evaluation of technical barriers to trade for Australian red meat, Report prepared for Meat & Livestock Australia Ltd (MLA) and the Australian Meat Industry Council (AMIC), Melbourne, June 2013.

20.5 P20: Rapid Response Surveillance Capability Development for TSEs

This project established a plan for how Australia could respond more rapidly and cost effectively in the case of an outbreak of TSEs. This plan resulted in new testing equipment being purchased which was able to more rapidly and cost effectively test for TSEs in beef and sheep – in particular Bovine spongiform encephalopathy (BSE) in beef and scrapie in sheep.

The benefits of this project are estimated based on the differences in testing costs using the old and new testing equipment. The benefit is estimated at $220.5 million in present value terms based on:

- the probability each year of a TSE outbreak (applying separately to beef and sheep) is 1 per cent in 2004 reducing to 0.25 per cent in 2014 and then reducing to 0.002 per cent by 2044[72];
- the differences in testing costs equating to around $227 per test (sourced from an industry expert);
- the number of beef cattle that would need to be tested equating to around 40 per cent of the total Australian cattle population (sourced from an industry expert), reflecting that all cattle over 24 months old would likely need to be tested. We estimate that this equates to around 10.2 million cattle[73];
- the number of sheep that would need to be tested equating to around 45 per cent of the total Australian sheep population (sourced from an industry expert), reflecting that all sheep over 18 months old would likely need to be tested. We estimate that this equates to around 33.6 million sheep[74]; and
- the project cost being repeated every five years to take into account deterioration of the assets and allowing for laboratory rental costs.

We note that the new testing equipment also provides benefits from rapid testing for TSEs. We have not estimated these benefits, partly because these benefits overlap with the benefits from the NLIS and partly because these benefits are difficult to value since many other factors play a role in how quickly market access would be regained in the event of an outbreak. However, our stakeholder consultation revealed that the new testing equipment should result in significant reductions in the time taken to test the expected number of animals under an outbreak. Therefore, the benefits we have estimated from testing costs underestimate the benefits from this particular project.

Additionally, the benefits of this project have been estimated from 2014 forward since there have been no outbreaks of TSEs since this project began in 2005.

20.6 P21: E. coli in fermented meats

This project involved MLA developing a new tool that estimates how effective a fermented meat process is at killing *E. coli*. The "*model uses the temperature and time parameters of the fermentation and maturation/drying steps of the UCFM production process to predict the capacity of the production process in destroying E. coli organisms*"[75]. UCFM refers to

[72] This estimate is explained further in section 4.2.1. We have applied the same likelihood of an outbreak to both beef and sheep which reflects that both seem to have similar OIE status in terms of BSE and scrapie.

[73] The total Australian beef cattle population is sourced from ABARES (2013), Agricultural commodity statistics 2013, Table 138, 2013 figure.

[74] The total Australian sheep population is sourced from ABARES (2013), Agricultural commodity statistics 2013, Table 152, 2012 figure.

[75] FSANZ (Food Standards Australia and New Zealand) (2002), Review of processing requirements for uncooked comminuted fermented meat products: Draft assessment report, Proposal P251, December 2002, page 12.

Uncooked Comminuted Fermented Meat (such as salami). The model was developed to assist the assessment of industry compliance with the requirements of the Australia New Zealand Food Standards Code.

The project was evaluated by the CIE in their predictive microbiology evaluation report in 2006[76]. They drew on the FSANZ (2002) report which found that the "model is regarded as the most appropriate tool currently available to assess industry compliance by both the joint expert panels and the Meat Standards Committee (MSC)"[77].

However, although there were benefits in terms of process change, CIE report was unable to quantify the benefits since:

> *"The ability to evaluate processes, using the predictive model, resulted in a marked improvement in the number of processes that achieved the required reduction in E.coli. The improvement in health outcomes is less certain, as even a single E. coli organism can cause illness in some cases. No study has yet quantified the public health risk due to E.coli in UCFM, nor the effect of changing E.coli levels. As such, the value of Predictive Microbiology in lowering E.Coli in UCFM was unable to be calculated."*

We have not quantified the benefits of this project since we are not aware of any recent research that assists in quantifying this benefit and we note that the annual OzFoodNet reports do not provide any further evidence on this issue.

20.7 P22: Risk management - *Listeria* in smallgoods

This project involved a range of research studies that examined ways to reduce the risk of *Listeria* in smallgoods. One of the key research outputs showed that an additive could be used by meat processors to lower the risk of listeriosis. The project was evaluated by the CIE in their predictive microbiology evaluation report in 2006[78].

Using the CIE report as the basis for estimating benefits and costs, we estimate that the benefits of the research are $162.4 million in present value terms. However, in addition to the MLA costs for this project, there are also costs associated with the additive, which also need to be added to the project costs. We estimate the additional costs (incurred by meat processors) of the additive at $87 million in present value terms.

The benefits of the research comprise two components. First, a listeriosis[79] outbreak is likely to lead to lower demand for smallgoods products and hence lower profits overall. The use of the additive has reduced the likelihood of this occurring and hence provided a benefit to the smallgoods industry. Second, the use of the additive has led to health benefits since it has led to a lower risk of illness.

The CIE report states that the two benefits to some degree count the same benefits and therefore cannot be added together. Therefore, we have averaged the two benefits on the basis that the

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[76] CIE (2006). MLA and predictive microbiology, An evaluation of the industry wide impacts, prepared for Meat and Livestock Australia, page 10.

[77] FSANZ (Food Standards Australia and New Zealand) (2002), Review of processing requirements for uncooked comminuted fermented meat products: Draft assessment report, Proposal P251, December 2002, page 12.

[78] CIE (2006). MLA and predictive microbiology, An evaluation of the industry wide impacts, prepared for Meat and Livestock Australia, page 9.

[79] Listeriosis is a bacterial infection caused by *Listeria*.

demand benefit is likely to be a lower bound and the health benefit an upper bound. The lower bound is estimated to be $62.4 million and the upper bound is $317.6 million in present value terms. The average of the lower and upper bound is $190.0 million.

We have estimated these benefits using updated assumptions from the CIE report and some slight methodology adjustments. The key assumptions in estimating the demand benefit are:

- the demand for smallgoods falls by 10 per cent[80] into the foreseeable future in the case of an outbreak of listeriosis (as per the CIE report), although we have assumed that sales return to normal after five years. We note that we believe the CIE estimate is subject to much uncertainty given the difficulties in estimating the impact. We examine this further in our sensitivity analysis;
- profits are assumed to represent 10 per cent of the sales value of smallgoods;
- the probability of a listeriosis outbreak is 2 per cent (as per the CIE report, noting that they define an outbreak as an event that causes two or more illnesses). We believe the CIE estimate is subject to much uncertainty given the difficulties in estimating the impact and we examine this further in our sensitivity analysis;
- total smallgoods consumption is assumed to be 5 per cent of the total domestic beef market (as per the CIE report);
- beef production and the domestic market share of total Australian beef production have been estimated for the period 2006 to 2013 based on ABARES data[81] and then assumed to be the same as 2013 for subsequent years. This is an update on the CIE model. The domestic share varies between 32 and 35 per cent over this period;
- the price of beef has been estimated for the period 2006 to 2013 based on ABARES data[82] and then assumed to be the same as 2013 for subsequent years. The price varies between $15.32 and $16.13 per kg over this period in nominal dollars; and
- the additive reduces the incidence of a listeriosis outbreak from 2 per cent to 0.27 per cent (as per the CIE report which states that the addition of the additive is assumed to reduce the number of cases of listeriosis per year due to smallgoods from 44 to 6).

We have estimated the health benefits using updated assumptions from the CIE report. The key assumptions in estimating the health benefit are:

- the additive saves 290 disability adjusted life years (DALYS) or the equivalent of four lifetimes every year (as per the CIE report);
- one DALY is value at $252,000 in 2008 dollars[83].

The additive cost is assumed to be 7.5 cents per kg in 2006 dollars (same as the CIE report).

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80 We have used two different sources of information to develop our assumed 10 per cent fall. First, we note that the CIE report assumed a 20 per cent fall in demand following an outbreak. Second, we note that dairy sales of 'mould cheese' fell by around 10 per cent from 2012/13 to 2013/14 (as per Dairy Australia web site) and there was a well-publicised listeria incident in 2012/13 that may have contributed to this fall.

81 ABARES (2014), Australian Commodity Statistics, Table 134.

82 ABARES (2014), Australian Commodity Statistics, Table 129.

83 Australian Government (2008), Health of Nations: The value of a statistical life, Australian Safety and Compensation Council, Canberra, page xxi.

20.8 P24: Environmental control of *L. monocytogenes*

This project found that meat chillers, when operated in a particular way during processing, can result in significant reduction in the occurrence of *Listeria* in smallgoods. We estimate that the benefits of this project are likely to be equal to, or greater than the costs. On this basis we have set the benefits to be equal to project costs which are around $119,000 in present value terms.

Our consultation with an industry expert indicated that there were benefits from the use of the meat chillers for at least two processors (one large and one small). However, the industry expert indicated there is no evidence that this change has been adopted by other processors and it is unclear as to whether there will be further adoption of this new approach by other processors. For the benefits to be greater than the costs, the reduction in product rejected would have to be greater than 4 per cent. This seems reasonable based on figures provided by the industry expert. We note that this assumes that:

- the cost of a new meat chiller is around $10,000;
- there are only two processors that have adopted the new technique;
- there are around 160 smallgoods processors in Australia[84] which means that only 1.25 per cent of processors have adopted the new technique;
- the total volume of smallgoods produced and sold in Australia is approximately 36,600 tonnes which means that the new technique only to 458 tonnes of produce; and
- prices are around $15.50 per kg[85] and 50 per cent of produce is lost if there is a product rejection.

20.9 P25: Cooling of cooked meat

This project was established because many processors were having difficulty meeting the Australian standard for cooling down cooked meat such as hams, roast beef and large processed meats. The purpose of the Australian standard was to reduce the risk of issues with pathogens, such as *Listeria,* resulting from meat not being cooled down in an adequate timeframe.

The project led to changes in the Australian standard[86]. In the absence of change, regulators may have enforced the stricter cooling regime in the previous Australian Standard[87]. We understand, based on our consultation with an industry expert and the CIE (2006) report, that this might have led to processors having to purchase accelerated chillers in order to cool the meat in the required timeframe. Using assumptions in the CIE (2006) report we have estimated the benefit to be $6.2 million in present value terms. We have used the following assumptions from the CIE (2006) report[88]:

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84 Sourced from MINTRAC, National Meat Industry Training Advisory Council Limited, web site, http://www.mintrac.net.au/car-sg.asp, accessed 21 December 2014.

85 Refer to section 20.7 for more details on current smallgoods sales and prices.

86 Australian Standard for the hygienic production and transportation of meat and meat products for human consumption (AS 4696: 2007)

87 CIE (2006), MLA and predictive microbiology, An evaluation of the industry wide impacts, prepared for Meat and Livestock Australia, page 9.

88 Ibid.

- beef processors can avoid capital costs of accelerated chillers of $185 000 (in 2006 dollars);
- beef processors can avoid additional electricity costs associated with accelerated chillers equating to 1.8 per cent of total processing costs per annum for the beef processing of large smallgoods; and
- large smallgoods beef production is 3,920 tonnes per annum (based on beef making up 14 per cent of 28,000 tonnes of all large smallgoods).

Additionally, we assume that beef processing costs are $2.73 per kg[89].

20.10 P28: Survey and testing

This project demonstrated that there is low prevalence of the non-O157 *E. coli* strains referred to as the 'Big 6' (O26, O45, O103, O111, O121, and O145) in Australian beef exports. Two important benefits of this research are:

- the data demonstrates the good food safety attributes of Australian meat; and
- a justification for lower sampling costs if processors decide to cease testing for the Big 6.

The benefit of demonstrating food safety attributes is discussed in more detail in section 20.11. There is some evidence that the research has influenced whether a processor tests for the Big 6. One large processor indicated to us that they were considering ceasing sampling of the Big 6, particularly since they believe they have very good food safety systems in place and testing for the Big 6 is not mandatory for exporting to the United States. We estimate that the benefit of not testing for the Big 6 for this one processor could be in the order of $400,000 per annum.

The FSIS began testing of beef imports for the Big 6 in 2012 and there is a risk that they will place mandatory testing requirements on processors in Australia prior to export to the United States. This would mean that the benefit that would be achieved by the processor in ceasing testing would become irrelevant since testing would be mandatory. Taking into account this uncertainty we assign a 50 per cent probability that mandatory testing will occur in the future, which reduces the benefit for the one processor to $200,000. We further assume that this benefit lasts for five years given the level of uncertainty. This equates to a total benefit in present value terms of approximately $866,000.

We have not estimated likely benefits for other processors in the absence of a more complete survey of processors being available. Additionally, we note that discussions with those involved in the ESAM reporting process indicate that they have not noticed any significant change in the reporting by processors of information on the Big 6, thereby indicated that there has likely been no recent change in the number of processors that test for the Big 6. We note that not all processors currently test for the Big 6 in any case.

20.11 Price premium across a range of projects

In addition to cost savings, a number of MLA food safety projects may have improved Australia's reputation for being able to deliver meat supported by food safety systems that ensure a low risk of contamination by pathogens such as *E. coli* and *Salmonella*. These projects include P3, P12, P13, P14, P15, P27 and P28.

89 http://futurebeef.com.au/topics/markets-and-marketing/beef-supply-chain-costs/, accessed 12 December 2014.

Moreover, the result of this is that markets such as the United States may be prepared to pay more for Australian meat compared to meat sourced from other markets. Using information provided by the MLA on the landed price of meat in the United States from Australia compared to another key competitor, we note that the United States pays around 8.5 cents per kg more for Australian processed beef than for a key competitor.

Our stakeholder consultation indicated that there is likely to be a price premium (that is, a higher price for meat exports) as a result of the research projects. While none of the stakeholders we consulted were able to provide an estimate in dollar terms, our general observation from these discussions was that the price premium is likely to reside somewhere between 0 and 1 cent per kg. On this basis, the total annual benefit is likely to be between $0 and $2.6 million (in 2014 dollars) if we just focus on the United States export market – or on average $1.3 million. This equates to a total benefit in present value terms of $27.1 million on the basis that the combined research projects started having an impact from 2010 onwards.

Our estimate of benefits assumes that annual exports of beef to the United States market are approximately 265,900 tonnes[90]. The focus on the United States is reasonable given that many research projects (e.g. *E. coli* O157 research) have been targeted at this market.

We have not been able to allocate the likely benefit across the seven MLA projects as stakeholder consultation indicated that customers take into account many factors in determining their willingness to pay for Australian meat and it is very difficult to attribute between research projects for this type of benefit. Additionally, there are likely to be scientific research projects that we have not examined in detail that are also contributing to this price premium.

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90 ABARES (2014), Australian Commodity Statistics, Table 136.

21. Selected project groups - key tasks and research outputs

This section outlines the key tasks and research outputs for each of the 28 selected projects within 6 project groups.

21.1 Process analysis / improvement

Table 39: Key tasks in process analysis/improvement project group

Key tasks	Project number	Key research outputs
Process analysis. This project comprises a number of sub-projects which examined: the prevalence of pathogens in the processing and transporting of livestock; the factors that cause pathogenic issues in the processing and transporting of livestock; and examined the quality assurance audit frameworks for potential efficiencies.	▪ P1	*Safe feeding strategies for beef production in Northern Australia:* ▪ The research showed a reduction in *E. coli* in the faeces of cattle under different feeds (and the potential to use this as a finishing diet prior to slaughter) albeit with reduced weight gains compared to conventional diets.
	▪ P2	*Curfew in livestock transport*: ▪ The research recommended suitable curfew times for cattle and sheep based on the scientific literature and recommended further research to optimise curfew recommendations[91]. ▪ The research showed that food and water deprivation (FWD) for 12 and 24 hours prior to transport has little impact on the presence of *E. coli* and Salmonella in sheep faeces[92].
	▪ P3	*Tag score at Australian cattle abattoirs:* ▪ The research concluded that tag, i.e. mud and faeces, on cattle was a lot less in Australia than in the United States.
	▪ P4	*Salmonella in goat and goat meat:* ▪ The research resulted in a scientific

[91] Pethick, D. (2006), Investigating feed and water curfews for the transport of livestock within Australia - A literature review, Met & Livestock Australia, LIVE.122.A, Murdoch University.

[92] Food Science Australia (2007), Effect of curfew on the microbiology of sheep, A report prepared for Meat & Livestock Australia, Project A.MFS.0119, Cannon Hill, Queensland.

Key tasks	Project number	Key research outputs
		publication on the prevalence and serotypes of *Salmonella* in goats at two abattoirs.
	▪ P5	*Carcase contamination process control:* ▪ The research showed that[93]: ▪ the hide is the most significant potential source of contamination, carrying the greatest microbial load; and ▪ there is no apparent relationship between the operations at each individual dressing station and the final microbial load on the carcases at ESAM sampling.
	▪ P6	*Alternatives to 82^{O}C water:* ▪ The research demonstrated that temperatures cooler than 82°C could be used to clean knives between carcases providing knives were immersed for longer than the momentary dip currently used[94]. ▪ Developed a guide on how to implement and apply this new technique.
	▪ P7	*Surface sponging method:* ▪ The research showed considerable variation in the Total Viable Counts between operators each sponging a carcass[95&96].
	▪ P8	Consolidated customer audits ▪ The research examined possible options within the current framework for consolidating multiple commercial audits of

93 Keller, J. Small, A. (2008), Identifying important points of contamination, A.MFS.0149, Food Science Australia.

94 Sourced from case study provided by the MLA.

95 Seager, T., Tamplin, M., Simmons, J. and Sumner, J., Food Safety Centre, Tasmanian Institute of Agricultural Research, University of Tasmania, Meat and Livestock Australia (2008), Recovery efficiency of total viable counts from beef carcases using the surface sponge sampling method, A.MFS.0140, Meat & Livestock Australia Limited, North Sydney.

96 Seager, T., Tamplin, M.L., Lorimer, M., Jenson, I., and Sumner, J.L., How Effective is Sponge Sampling for Removing Bacteria from Beef Carcasses? Food Protection Trends: 30, (6) pp. 336-339. ISSN 1541-9576 (2010).

Key tasks	Project number	Key research outputs
		quality assurance and certification schemes[97].
Analysis of ESAM data. This project examined the microbiological settings for the *E. coli* and *Salmonella* monitoring program (ESAM)[98] and database (ESAM) with a view to revising the revising the ESAM Meat Notice 2003/6. Additionally, this project developed an ESAM report format and reporting software to be used to report monthly to abattoir quality assurance staff on the their *E. Coli* and *Salmonella* microbiological performance (and compared against other processors). This project was commenced to examine the scientific underpinnings of the ESAM program, especially since the industry considered that the 2000 Meat Notice was too stringent. Additionally, it was commenced because there was a belief that more value could be gained from the ESAM database.	▪ P9 ▪ P10	▪ The research examined the microbiological settings for the *E. coli* and *Salmonella* monitoring (ESAM) program. ▪ Analysis of the levels of *E. coli* and *Salmonella* at individual plants and across the industry over the period 1 January 2000 to 31 December 2005. The analysis is used in the ESAM database[99]. ▪ Development of an ESAM report format and reporting software to be used to report monthly to abattoir quality assurance staff. This included industry training in understanding microbiological data. The report allows for the comparison of a processing establishment's performance with other establishments. ▪ Report on the development and implementation of the new ESAM reporting system which provides more in-depth analysis of the ESAM data to individual establishments on a regular basis, thereby enabling them to compare their results against national benchmarks[100]. ▪ The research[101] indicated that the higher than normal Total Viable Counts (TVCs) and *E. coli* prevalence during 2010-11 is likely linked to the adverse rain events during 2010-11 in eastern Australia.

97 Symbio Alliance (2008), Scoping study to investigate options for consolidating commercial audits in the Australian beef processing industry, A.MFS.0102, Meat & Livestock Australia Limited.

98 Meat export establishments must be export-registered, and must conform to Australian Standards and Australian monitoring programs such as the National Residue Survey (NRS) and *E. coli* and *Salmonella* Monitoring Program (ESAM).

99 Jordan, D., Morris, S. (2006), Analysis of ESAM data, NSW Department of Primary Industries, A.MFS.0109, Meat & Livestock Australia Limited.

100 Lorimer, M., Kiermeier, A., South Australian Research and Development Institute (2010), National Microbiological Database Analysis Tool – Final Report, A.MFS.0169, Meat & Livestock Australia Limited.

101 MLA (2011), Program achievement report, Food safety 2010-11, page 27.

Key tasks	Project number	Key research outputs

Process data analysis: development of assessment tools for beef and sheep. This project examined the factors that influenced the microbiological quality of carcases and developed a spreadsheet assessment tool which can be used by processors to assist them to improve microbiological quality. The project was commenced because there was a desire to determine the factors that could result in better or poorer microbiological quality of carcases.	▪ P11	▪ The research examined the factors that influenced the microbiological quality of carcases[102].
		▪ A spreadsheet assessment tool which can be used by processors to assist them to:
		  ▪ improve their understanding of how the condition of incoming livestock can affect the hygiene of carcases and end products (via a 'Problem Score'); and
		  ▪ improve their understanding of how the processing systems used can affect the hygiene of carcases and end products (via a 'Process Score').

Source: MJA summation of information provided by MLA

21.2 *E. coli* O157 manufacturing beef

Table 40: Key tasks in *E. coli* 0157 project group

Key tasks	Project number	Key research outputs
***E. coli* O157 and *Salmonella* in red meat animals and processing.** This project examined the prevalence of *E. coli* and *Salmonella* in livestock and carcasses, as well as the validity of the ESAM sampling method for larger carcasses. The project was commenced because *Salmonella* and pathogenic *E. coli* were known to be shed by cattle, but little was known about the pattern of shedding.	▪ P12	▪ The research[103] showed that few cattle presenting for slaughter were shedding *E. coli* and *Salmonella* and those that were usually had only low numbers of *E. coli* O157 and *Salmonella*. ▪ The research[104] showed that the *E. coli* and *Salmonella* Monitoring (ESAM) method of sampling was found to be superior to sampling larger areas of carcases for determining numbers of *E. coli* and *Salmonella* on cattle and sheep. Therefore, the ESAM method remains an adequate tool for monitoring process hygiene. At the time, sampling larger areas of carcases was

[102] MLA (2004), Factors contributing to the microbiological contamination of beef carcases, PRMS.048, Meat & Livestock Australia.

[103] Food Science Australia (2004), Final Report: Ecology of EHEC and Salmonella in cattle, A report prepared for Meat & Livestock Australia, Project PRMS.030 Cannon Hill, Queensland.

[104] Food Science Australia (2007), Final Report: EHEC and Salmonella in red meat production and processing, A report prepared for Meat & Livestock Australia, Project A.MFS.0060, Cannon Hill, Queensland.

Key tasks	Project number	Key research outputs
		being investigated in the United States as a possible future testing requirement. ▪ The research[105] showed that trucks used for transporting cattle and abattoir holding pens were contaminated with *E. coli* O157 and *Salmonella*, but at low levels. Subsequent to the research, industry was provided with knowledge about trucks and holding pens as potential contamination sources. Additionally, education was provided around needing to ensure the cleanliness of trucks and holding pens to limit cross contamination during further downstream processing. ▪ The presence of pathogens on sheep carcases was found to be low[106]. ▪ Ongoing development of research capability and depth of knowledge on *E. coli* O157 in the Australian beef industry.
***E. coli* O157 testing implementation.** This project provided information and assistance to processors in the implementation of the protocol for the sampling and testing for *E. coli O157* in beef trim. They also contributed to the development of a guide for industry on the implementation of the protocol. The project was commenced because of moves in the United States towards more stringent requirements for *E. coli* O157 in beef trim and other components of ground beef.	▪ P13	▪ This project[107] provided information and assistance to processors in the implementation of the protocol for the sampling and testing for *E. coli O157* in beef trim. The project also contributed to the development of a guide for industry on the implementation of the protocol. ▪ Additionally, this project collected a number of baseline pathogen samples collected from a variety of processors (A.MFS.0134-8).
***E. coli* positive lots.** The project examined the prevalence of *E. coli O157* in beef lots. The project was	▪ P14	▪ The research showed that contamination of *E. coli O157* was at a low level and not widespread in contaminated lots[108]. The

105 Food Science Australia (2007). Final Report: EHEC and Salmonella in red meat production and processing, A report prepared for Meat & Livestock Australia, Project A.MFS.0060, Cannon Hill, Queensland.

106 Food Science Australia (2007). Final Report: EHEC and Salmonella in red meat production and processing, A report prepared for Meat & Livestock Australia, Project A.MFS.0060, Cannon Hill, Queensland.

107 Information provided by MLA.

108 Kiermeier, A. (2009). Positive lot sampling for *E. coli* O157, A.MFS.0158, South Australian Research and Development Institute, Meat & Livestock Australia Limited, North Sydney.

Key tasks	Project number	Key research outputs
commenced because there was a need to better understand and explain contamination that occurred in lots of manufacturing beef.		research was communicated to government and commercial groups.
Effect of freezing on the survival of *Escherichia coli* O157:H7. This project examined the effect of freezing on the numbers of *E. coli* O157 on beef. The project commenced because of the opportunity for the industry to demonstrate an intervention for *E. coli* O157.	▪ P15	▪ Using a previously developed testing method, the research[109] established that there was no significant reduction in numbers of *E. coli* O157 on beef during simulations of industry freezing profiles. Moreover, the results showed small non-significant reductions in numbers of all strains after freezing under the conditions of the study. ▪ The results were presented to US stakeholders to illustrate the quality attributes of Australian meat.
***E. coli O157* low volume enrichment validation.** The project examined whether an alternative testing technique for *E. coli O157* is able to produce a similar outcome. The project was commenced because testing large sample sizes for *E. coli* for O157 required large volumes of enrichment broth.	▪ P16	▪ The research showed that to test larger sample sizes (and meet the new United States testing requirements for raw beef) a 1:3 ratio (375g in 1 litre of enrichment broth) is just as effective for testing as the current 1:9 ratio (25 g to 375ml)[110]. This reduces testing costs and enables more rapid testing.

Source: MJA summation of information provided by MLA

21.3 Shelf life

Table 41: Key tasks in shelf life project group

Key tasks		Key research outputs
Understanding shelf-life for vacuum packed meat. This project examined the effect of storage temperature and	▪ P17	▪ The research[111] examined the effect of storage temperature and packaging atmosphere on microbial growth in vacuum

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[109] Dykes, G. A. (2007). Factors effecting survival of *Escherichia coli* O157:H7 during freezing, Project PRMS.097, Food Science Australia, Cannon Hill, Queensland.

[110] DH Micro Consulting (2008), Validation of low volume enrichment for rapid *E. coli* O157 screening tests, Meat & Livestock Australia Limited, North Sydney.

[111] Tamplin, M. (2009). Ensuring the quality of exported meat primals using a predictive tool for specific spoilage organisms, A.MFS.0147, Prepared for the MLA, Meat & Livestock Australia, North Sydney.

Key tasks		Key research outputs
packaging atmosphere on microbial growth in beef primals over time and developed a predictive model. The project was commenced because there were no modern data on the microbial population in vacuum packed product or predictive models for how those bacteria grew in vacuum packed meat.		packed beef primals over time and developed a predictive model. ▪ The research[112] showed for vacuum packed beef primals that: bacterial communities at six different abattoirs were different; bacterial communities varied over storage time; and there were different bacteria on cube roll compared to striploin. However, the research concluded that the differences lie at the strain level. ▪ The research[113] examined the link between a range of vacuum packed beef primal properties (intrinsic and extrinsic) and lower levels of bacteria growth over time. ▪ The research was used MLA to assist processors and exporters with export problems and to explain the shelf-life to customer audiences.
Vacuum packed beef shelf-life. This project examined the microbiological flora of vacuum packed beef over time and the relationship between the microbiological attributes of the meat and consumer acceptance (e.g. e.g. taste, smell, colour and appearance). The project was commenced because there were no recent data collected under controlled conditions to attest to the shelf-life of chilled, vacuum packed beef.	▪ P18	▪ The research[114] showed that vacuum packed beef primals from Australian export processors can be stored confidently for 26 weeks or more, under appropriate conditions – noting that the initial microbial load and strict temperature control will remain critical influences on overall product quality. The research considered both microbial and consumer acceptability impacts.
Vacuum packed lamb shelf-life. This project examined the microbiological	▪ P19	▪ The research[115] examined the microbiological flora of vacuum packed

[112] Tamplin, M. (2011). Microbial communities in stored vacuum packed primals, A.MFS.0194, Prepared for the MLA, Meat & Livestock Australia, North Sydney.

[113] Tamplin, M., Williams, M., Dann, A., Tasmanian Institute of Agriculture. (2012). A.MFS.0237, Vacuum-Packed Beef Bacteria: Extrinsic and Intrinsic Factors that Determine Microbial Communities, Prepared for the MLA. Meat & Livestock Australia, North Sydney.

[114] Small, A. (2011). Investigation of the storage life of vacuum packaged beef, A.MFS.0132 and A.MFS.0139, Prepared for the MLA, Meat & Livestock Australia, North Sydney and Small, A., O'Callaghan, D., & Beilken, S. (2011). Shelf-life of chilled vacuum packed beef, Prepared for the MLA, Meat & Livestock Australia, North Sydney.

[115] Kiermeier, A., Eddie, S., & Holds, G. (2009). Shelf-life evaluation of sliced lamb shoulders, A.MFS.0185, Prepared for the MLA, Meat & Livestock Australia, North Sydney and Holds, G., Eddie, S., Colby, P., &

Key tasks		Key research outputs
flora of vacuum packed lamb over time and the relationship between the microbiological attributes of the meat and consumer acceptance (e.g. e.g. taste, smell, colour and appearance). The project was commenced because there were no recent data collected under controlled conditions to attest to the shelf-life of chilled, vacuum packed lamb.		lamb shoulders and established that: consumer acceptability remains high for product that has been vacuum packed for up to 84 days; and that microbiological flora on the sliced product consisted predominantly of lactic acid bacteria. ▪ The research[116] found that for lamb shoulders there is no evidence could be found to support anecdotal reports that bone-in product has a shorter shelf-life than the corresponding boneless primal. ▪ The research was used by MLA to support product promotion and by the Department of Agriculture in arguing for changes in regulations in importing countries.

Source: MJA summation of information provided by MLA

21.4 TSE

Table 42: Key tasks in TSE project group

Key tasks		Key research outputs
Rapid Response Surveillance Capability Development for TSEs. This project examined cost-effective and rapid surveillance methods for the identification of animals that may be at risk of diseases, such as transmissible spongiform encephalopathies (TSEs), and the collection, transport and processing of fully traceable tissue samples collected post-mortem.	▪ P20	▪ This project resulted in a plan for cost effective and rapid surveillance methods to identify and test animals that may be at risk of TSEs. This included establishing laboratory requirements, including testing equipment.

Source: MJA summation of information provided by MLA.

Kiermeier, A. 2010. Extended shelf life evaluation of sliced lamb shoulders, A.MFS.0196, Prepared for the MLA, Meat & Livestock Australia, North Sydney.

116 Kiermeier, A., Holds, G., & May, D. (2011). Microbial growth and communities of packed lamb shoulders, A.MFS.0238, Prepared for the MLA, Meat & Livestock Australia, North Sydney.

21.5 Value added product safety

Table 43: Key tasks in value added product safety project group

Key tasks		Key research outputs
***E. coli* in fermented meats:** This project examined the impact of a range of factors associated with fermented meat processes on the prevalence of *E. coli.* The project was commenced because of the need to be able to control *E. coli* in fermented meat products, such as Salami following outbreaks.	▪ P21	▪ The research[117] examined the key factors that result in inactivation of *E. coli* in uncooked, comminuted fermented meat products (e.g. salami) – including temperature, timing, water and pH levels. ▪ The project delivered a tool/calculator which gives an estimate of how effective a fermented meat process is at killing *E. coli*[118]. ▪ The research was communicated to industry and regulators at workshops.
Risk management - *Listeria* in smallgoods. This project examined the prevalence of *Listeria monocytogenes* in smallgoods and appropriate risk mitigation strategies and technologies. The project was commenced to assess the risk of listeriosis from Australian smallgoods, following large outbreaks in the USA, and went on to evaluate the use of compounds such as lactate and diacetate to prevent the growth of *Listeria* in processed meats.	▪ P22	▪ A range of research was undertaken on *Listeria* in small goods. The research resulted in a risk assessment that was published in a scientific journal and practical work that was presented in industry workshops and in industry publications on control of *Listeria* in processed meats. This includes a *Listeria* monocytogenes Growth Model[119]. Some of the key research included: ▪ A quantitative risk assessment which examined the risk of contracting listeriosis from ready to eat meats and explored risk reductions strategies[120]. The work showed that only some smallgoods presented a risk of listeriosis and that the most effective means of reducing the risk of listeriosis from Australian processed meats would be to

[117] For example, Ross, T., & Shadbolt, C.T. (undated). Predicting Escherichia coli inactivation in uncooked comminuted fermented meat products, School of Agricultural Science, University of Tasmania, Meat & Livestock Australia, North Sydney.

[118] Food Safety Centre (2014), Retrieved from http://www.foodsafetycentre.com.au/fermenter.php, 16 October 2014.

[119] MLA (undated), Reducing the risk of Listeria monocytogenes in smallgoods, Version 1, Retrieved from http://www.mla.com.au/off-farm/Project-outcomes/Food-Safety/Practical-control-of-Listeria-monocytogenes-in-smallgoods. The Listeria monocytogenes Growth Model is software into which you enter a number of key parameters about your product and it predicts how long it can stop the growth of L. monocytogenes.

[120] Ross, T., Rasmussen, S., Sumner, J., Paoli, G., Fazil, A. (2004). Listeria monocytogenes in Australian processed meat products: risks and their management. PRMS.012. Unpublished report for Meat & Livestock Australia.

Key tasks		Key research outputs
		reduce initial contamination levels, using technologies, such as HPP and in-pack pasteurisation. ▪ A study[121] that showed that the addition of preservatives can reduce the risk of listeriosis from smallgoods as well as storing the goods at low temperatures (the study compared 4⁰C to 8⁰C.)
High pressure processing (HPP)[122] of small goods. This project examined how high pressure processing could be applied to reduce *Listeria monocytogenes* to an appropriate level and to examine the effect of in-package HPP on the refrigerated shelf life of smallgoods (Strassburg, export sausage, low-fat pastrami, and Cajun beef). The project was commenced because high pressure processing was seen as a way to allow smallgoods to be processed at low temperatures and without the use of preservatives.	▪ P23	▪ The research[123] examined the required process criteria (pressure and time parameters) for high pressure processing to meet an appropriate reduction in *Listeria monocytogenes*. ▪ Additionally, this research found that HPP could effectively extend the refrigerated shelf life of smallgoods (Strassburg, export sausage, low-fat pastrami, and Cajun beef). ▪ The research was presented at industry workshops. High pressure processing was shown to be effective in treating three products with good inactivation of *Listeria* and good product quality and shelf-life.
Environmental control of L. monocytogenes. This project examined whether applying heat in post cook smallgood meat chillers can result in significant reductions in *Listeria monocytogenes*. The project was commenced because control of *Listeria*	▪ P24	▪ The research[124] showed that incorporation into good manufacturing practice of two heating protocols for smallgoods in meat chillers can result in significant reductions in *Listeria monocytogenes*. ▪ The research resulted in industry presentations, scientific conference

121 Mellefont, L., Ross, T. (2007). The efficacy of weak acid salts for the reduction or prevention of growth of Listeria monocytogenes in processed meat products, A.MFS.0071 (PRMS. 071A), Final Report, Report prepared for the MLA.

122 The high pressure processing project was commenced because high pressure allows smallgoods to be processed at low temperatures and without the use of preservatives. Additionally, it was a technique that was already being used in other countries. High pressure processing - HPP - is a technology that applies hydraulic pressures in excess of 6,000 atmospheres to products immersed in a liquid medium. This process inactivates food-borne pathogens while maintaining the integrity and freshness of the food.

123 Stewart, C., Hayman, M., O'Riordan, P. (2003). High Pressure Processing of Smallgoods, PRMS.033, Prepared by: Food Science Australia, Meat and Livestock Australia, North Sydney.

124 Eglezos, S. (2011). Application of heat in post cook chillers as a means for Listeria reduction in processed meat, A.MFS.0219, Prepared by EML Consulting Services QLD Pty Ltd for the MLA, Meat & Livestock Australia Limited, North Sydney.

Key tasks		Key research outputs
in smallgoods production environments is difficult, and an idea was presented that seemed to have merit.		presentations and a scientific publication, showing that heating and drying production areas could eliminate *Listeria*. ▪ The research was used by the MLA for informing the industry of this approach.
Cooling of cooked meat. The project examined appropriate cooling regimes for cooked meats. The project was commenced because the Meat Standards Committee had a concern that cooked meats were not being cooled according to the requirements of the Australian Standard.	▪ P25	▪ The research resulted in an industry publication and conference presentation which showed a low risk for cooked meats not being cooled according to the requirements of the Australian Standard. Additionally, the research suggested an alternative cooling regime that should be more easily achieved and safe. ▪ The research was used by the MLA to change the Australian Standard.
Low temperature cooking of meats. This project examined the time and temperature requirements for cooking meets to ensure an appropriate reduction in *Listeria monocytogenes*. The project was commenced because available tables of times and temperatures for acceptable cooking of meats did not extend over the whole range of temperatures that might be used.	▪ P26	▪ The research[125] showed the temperatures and times in cooking meats that should apply to ensure an appropriate reduction in *Listeria monocytogenes*. ▪ The research was used by MLA to update the smallgoods guidelines.

Source: MJA summation of information provided by MLA

21.6 Non-O157 STEC

Table 44: Key tasks in non-O157 STEC project group

Key tasks		Key research outputs
Epidemiology of human EHEC infection in Australia. This project examined the incidence and burden of disease due to Shiga toxin-producing *E. coli* (STEC). The project was commenced because there	▪ P27	▪ The research[126] found that the incidence and burden of disease due to STEC (Shiga toxigenic *E. coli*) and HUS (Haemolytic uraemic syndrome) in Australia appears comparable or lower than similar developed

125 Warne, D. (2011). Low temperature cooking of meats, A.MFS.0248, Final report, Prepared for the MLA, Meat & Livestock Australia Limited, North Sydney.

126 Vally, H., Hall, G., Dyda, A., Raupach, J., Knope, K., Combs, B., Desmarchelier, P. (2012). Epidemiology of Shiga toxin producing Escherichia coli in Australia, 2000-2010, BMC Public Health, 12:63.

Key tasks		Key research outputs
was no single source of information about the occurrence of disease due to STEC in Australia.		countries. ▪ The research also showed that STEC infections in Australia have remained fairly steady over the past 11 years. ▪ The research was used MLA to support Australia's strong position as a safe provider of beef.
▪ **Survey and testing.** This project examined the prevalence of non-O157 *E. coli* strains and optimal testing techniques for these pathogens. The project was commenced because of the potential introduction of rules concerning non-O157 *E. coli* strains by countries to which Australia exports beef products. In particular, the United States had suggested that non-O157 enterohaemorrhagic *E. coli* (EHEC) were likely to be declared an adulterant in beef products in the near future.	▪ P28	▪ The research[127] showed that the prevalence of EHEC (enterohaemorrhagic *E. coli*) serotypes other than *E. coli* O157 in the Australian beef cattle population is low. ▪ The research[128] showed that the prevalence of the Shiga toxin-producing *E. coli* (STEC) in Australian beef belonging to serotypes referred to as the Big 6 (O26, O45, O103, O111, O121, and O145), was estimated to be low (at approximately 0.02%). ▪ This research also applied four different screening methods, which were compared for their suitability in screening Australian manufacturing beef. ▪ The research was used by MLA to promote Australia's good position to customers and by AQIS to negotiate requirements with the US when rules were introduced there.

Source: MJA summation of information provided by MLA

[127] Barlow, R., (2011). Pathogenic E.coli in the red meat industry, A.MFS.0128, Prepared for the MLA, Meat & Livestock Australia, North Sydney.

[128] MLA (2014). Pathogenic Shiga toxin producing *E. coli* (pSTEC) other than O157 (non-O157 STEC) in manufacturing beef - Baseline survey and method comparison, Retrieved from http://www.mla.com.au/off-farm/Project-outcomes/Food-Safety/Pathogenic-Shiga-toxin-producing-E-coli-pSTEC-other-than-O157-non-O157-STEC-in-manufacturing-beef-Baseline-survey-and-method-comparison. A.MFS.0267 & A.MFS.0270.

22. Understanding hazards – key tasks

This section outlines the key tasks and research outputs for the 'understanding hazards' project group.

Table 45: Key tasks in understanding hazards project group

Key tasks
Overviewing risk. This project developed a consolidated profile of the risks associated with red meat and developed a risk assessment framework to be used to rapidly assess the potential for a new or emerging disease of livestock to infect humans via meat consumption or handling. This project was commenced because regulators were interested in a consolidated understanding of risks associated with red meat and there was no agreed approach to assessing the potential for a new animal disease to be a foodborne hazard.
Investigating risk. This project comprised a number of sub-projects which investigated a range of risk issues such as: the prevalence of a range of pathogens in red meat (*E. coli* O111 and O26, *Arcobacter* and *Aeromonas*); the possible processing practices that has resulted in high levels of *Staphylococcus aureus* to be found in retail meat; the prevalence of *Mycobacterium paratuberculosis* in red meat and inactivation during cooking practices; the prevalence of *Clostridium difficile* and *Toxoplasma gondii* in red meat; the prevalence of antimicrobial resistant bacteria in red meat production animals, carcasses and retail meat; and whether lymph nodes contain significant numbers of microorganisms including pathogens.
Demonstrating control. This project involved a number of sub-projects that illustrated red meat food safety attributes and the quality of Australian processing practices to customers. This included: a survey of the microbiological quality of Australian beef and sheepmeat; and examining microbiological counts at a small sample of retail butcher operations.

Source: MJA summation of information provided by MLA

23. Scientific research detailed investment performance information

This section provides more detailed investment performance information. We present information both including (Figure 12) and excluding the TSE project (Figure 13).

Figure 12: Scientific research investment performance information (including TSE project)

Benefits and costs (including TSE project)

Finance and reinvestment rate	5%
IRR	44%
Modified IRR	15%

Real dollars ($m)

Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
INCREMENTAL BENEFITS																					
28 selected projects	$0.0	$0.0	$0.0	$0.0	$0.0	$8.5	$8.2	$9.3	$9.4	$9.3	$8.2	$8.1	$8.1	$8.0	$31.5	$30.8	$30.0	$29.2	$27.3	$27.4	$26.6
Other projects based on BCR for sele	$0.0	$0.0	$0.0	$0.0	$0.0	$1.1	$1.1	$1.2	$1.2	$1.2	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1
Price premium across projects	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3
Total benefits	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$9.6**	**$9.3**	**$10.5**	**$10.6**	**$11.9**	**$10.6**	**$10.5**	**$10.5**	**$10.4**	**$33.9**	**$33.2**	**$32.4**	**$31.6**	**$29.8**	**$29.8**	**$29.0**
INCREMENTAL COSTS																					
28 selected projects																					
MLA funding costs	-$0.6	-$0.4	-$1.4	-$0.4	-$0.9	-$0.8	-$0.9	-$1.0	-$0.8	-$0.7	-$0.5	-$0.6	-$0.1	-$0.2	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Other costs	$0.0	$0.0	$0.0	$0.0	$0.0	-$3.7	-$3.7	-$3.5	-$3.5	-$3.7	-$3.5	-$3.5	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Other projects (MLA funding costs)	-$0.4	-$0.3	$0.1	-$0.4	-$0.5	-$1.5	-$1.0	-$1.0	-$0.9	-$0.9	-$1.4	-$1.5	-$1.1	-$1.6	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total costs	**-$1.1**	**-$0.7**	**-$1.3**	**-$0.8**	**-$1.4**	**-$6.1**	**-$5.7**	**-$5.5**	**-$5.2**	**-$5.3**	**-$5.4**	**-$5.5**	**-$4.8**	**-$5.4**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**
NET BENEFITS	**-$1.1**	**-$0.7**	**-$1.3**	**-$0.8**	**-$1.4**	**$3.5**	**$3.6**	**$5.0**	**$5.4**	**$6.6**	**$5.3**	**$5.0**	**$5.7**	**$5.0**	**$30.3**	**$29.6**	**$28.9**	**$28.1**	**$26.2**	**$26.2**	**$25.4**
Total MLA funding (including MDC)	-$1.1	-$0.7	-$1.3	-$0.8	-$1.4	-$2.4	-$2.0	-$2.0	-$1.6	-$1.6	-$1.9	-$2.0	-$1.2	-$1.8	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Time from base year (years)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Year	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**
INCREMENTAL BENEFITS																							
28 selected projects	$25.8	$25.0	$23.2	$23.4	$22.6	$21.8	$21.0	$19.2	$19.5	$18.7	$17.9	$17.1	$15.2	$15.5	$14.7	$13.9	$13.1	$11.2	$11.5	$10.7	$9.9	$9.1	$7.2
Other projects based on BCR for sele	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1	$1.1
Price premium across projects	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3
Total benefits	**$28.2**	**$27.4**	**$25.6**	**$25.8**	**$25.0**	**$24.2**	**$23.4**	**$21.6**	**$21.9**	**$21.1**	**$20.3**	**$19.5**	**$17.6**	**$17.9**	**$17.1**	**$16.3**	**$15.5**	**$13.6**	**$13.9**	**$13.1**	**$12.3**	**$11.5**	**$9.6**
INCREMENTAL COSTS																							
28 selected projects																							
MLA funding costs	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Other costs	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Other projects (MLA funding costs)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total costs	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**
NET BENEFITS	**$24.6**	**$23.8**	**$22.0**	**$22.3**	**$21.5**	**$20.7**	**$19.9**	**$18.0**	**$18.3**	**$17.5**	**$16.7**	**$15.9**	**$14.0**	**$14.3**	**$13.5**	**$12.7**	**$11.9**	**$10.1**	**$10.3**	**$9.5**	**$8.7**	**$7.9**	**$6.1**
Total MLA funding (including MDC)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Discounted dollars ($m)

Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**
INCREMENTAL BENEFITS																					
28 selected projects	$0.0	$0.0	$0.0	$0.0	$0.0	$8.5	$8.2	$9.3	$9.4	$9.3	$8.2	$8.1	$8.1	$8.0	$30.0	$27.9	$25.9	$24.0	$21.4	$20.5	$18.9
Other projects based on BCR for sele	$0.0	$0.0	$0.0	$0.0	$0.0	$1.1	$1.1	$1.2	$1.2	$1.2	$1.1	$1.1	$1.1	$1.1	$1.0	$1.0	$0.9	$0.9	$0.9	$0.8	$0.8
Price premium across projects	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.2	$1.1	$1.1	$1.0	$1.0	$0.9
Total benefits	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$9.6**	**$9.3**	**$10.5**	**$10.6**	**$11.9**	**$10.6**	**$10.5**	**$10.5**	**$10.4**	**$32.3**	**$30.1**	**$28.0**	**$26.0**	**$23.3**	**$22.2**	**$20.6**
INCREMENTAL COSTS																					
28 selected projects																					
MLA funding costs	-$0.6	-$0.4	-$1.4	-$0.4	-$0.9	-$0.8	-$0.9	-$1.0	-$0.8	-$0.7	-$0.5	-$0.6	-$0.1	-$0.2	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Other costs	$0.0	$0.0	$0.0	$0.0	$0.0	-$3.7	-$3.7	-$3.5	-$3.5	-$3.7	-$3.5	-$3.5	-$3.6	-$3.6	-$3.4	-$3.2	-$3.1	-$2.9	-$2.8	-$2.7	-$2.5
Other projects (MLA funding costs)	-$0.4	-$0.3	$0.1	-$0.4	-$0.5	-$1.5	-$1.0	-$1.0	-$0.9	-$0.9	-$1.4	-$1.5	-$1.1	-$1.6	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total costs	**-$1.1**	**-$0.7**	**-$1.3**	**-$0.8**	**-$1.4**	**-$6.1**	**-$5.7**	**-$5.5**	**-$5.2**	**-$5.3**	**-$5.4**	**-$5.5**	**-$4.8**	**-$5.4**	**-$3.4**	**-$3.2**	**-$3.1**	**-$2.9**	**-$2.8**	**-$2.7**	**-$2.5**
NET BENEFITS	**-$1.1**	**-$0.7**	**-$1.3**	**-$0.8**	**-$1.4**	**$3.5**	**$3.6**	**$5.0**	**$5.4**	**$6.6**	**$5.3**	**$5.0**	**$5.7**	**$5.0**	**$28.9**	**$26.9**	**$24.9**	**$23.1**	**$20.5**	**$19.6**	**$18.1**
Benefit-cost ratio																					
Total MLA funding (including MDC)	-$1.1	-$0.7	-$1.3	-$0.8	-$1.4	-$2.4	-$2.0	-$2.0	-$1.6	-$1.6	-$1.9	-$2.0	-$1.2	-$1.8	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Time from base year (years)	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Year	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**TOTAL**
INCREMENTAL BENEFITS																								
28 selected projects	$17.5	$16.1	$14.2	$13.7	$12.6	$11.6	$10.6	$9.2	$8.9	$8.1	$7.4	$6.8	$5.7	$5.6	$5.0	$4.5	$4.1	$3.3	$3.2	$2.9	$2.5	$2.2	$1.7	$423.3
Other projects based on BCR for sele	$0.7	$0.7	$0.7	$0.6	$0.6	$0.6	$0.5	$0.5	$0.5	$0.5	$0.4	$0.4	$0.4	$0.4	$0.4	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3	$0.2	$26.7
Price premium across projects	$0.9	$0.9	$0.8	$0.8	$0.7	$0.7	$0.7	$0.6	$0.6	$0.6	$0.6	$0.5	$0.5	$0.5	$0.5	$0.4	$0.4	$0.4	$0.4	$0.4	$0.3	$0.3	$0.3	$27.1
Total benefits	**$19.1**	**$17.7**	**$15.7**	**$15.1**	**$13.9**	**$12.9**	**$11.8**	**$10.4**	**$10.0**	**$9.2**	**$8.4**	**$7.7**	**$6.6**	**$6.4**	**$5.8**	**$5.3**	**$4.8**	**$4.0**	**$3.9**	**$3.5**	**$3.1**	**$2.8**	**$2.2**	**$477.1**
INCREMENTAL COSTS																								
28 selected projects																								
MLA funding costs	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	-$9.3
Other costs	-$2.4	-$2.3	-$2.2	-$2.1	-$2.0	-$1.9	-$1.8	-$1.7	-$1.6	-$1.6	-$1.5	-$1.4	-$1.3	-$1.3	-$1.2	-$1.2	-$1.1	-$1.1	-$1.0	-$1.0	-$0.9	-$0.9	-$0.8	-$87.2
Other projects (MLA funding costs)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	-$12.6
Total costs	**-$2.4**	**-$2.3**	**-$2.2**	**-$2.1**	**-$2.0**	**-$1.9**	**-$1.8**	**-$1.7**	**-$1.6**	**-$1.6**	**-$1.5**	**-$1.4**	**-$1.3**	**-$1.3**	**-$1.2**	**-$1.2**	**-$1.1**	**-$1.1**	**-$1.0**	**-$1.0**	**-$0.9**	**-$0.9**	**-$0.8**	**-$109.1**
NET BENEFITS	**$16.7**	**$15.4**	**$13.5**	**$13.0**	**$12.0**	**$11.0**	**$10.0**	**$8.7**	**$8.4**	**$7.6**	**$6.9**	**$6.3**	**$5.3**	**$5.1**	**$4.6**	**$4.1**	**$3.7**	**$3.0**	**$2.9**	**$2.6**	**$2.2**	**$1.9**	**$1.4**	**$368.0**
Benefit-cost ratio																								**4.4**
Total MLA funding (including MDC)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	**-$21.9**

Source: MJA analysis

Figure 13: Scientific research investment performance information (excluding TSE project)

Benefits and costs (excluding TSE project)

Finance and reinvestment rate	5%
IRR	42%
Modified IRR	13%

Real dollars ($m)

Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
INCREMENTAL BENEFITS																						
28 selected projects	$0.0	$0.0	$0.0	$0.0	$0.0	$8.5	$8.2	$9.3	$9.4	$9.3	$8.2	$8.1	$8.1	$8.0	$8.2	$8.3	$8.3	$8.3	$8.3	$8.1	$8.1	$8.1
Other projects based on BCR for sele	$0.0	$0.0	$0.0	$0.0	$0.0	$1.1	$1.1	$1.2	$1.2	$1.2	$1.1	$1.0	$1.0	$1.0	$1.1	$1.1	$1.1	$1.1	$1.1	$1.0	$1.0	$1.0
Price premium across projects	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3
Total benefits	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$9.6**	**$9.3**	**$10.5**	**$10.6**	**$11.9**	**$10.6**	**$10.5**	**$10.5**	**$10.4**	**$10.6**	**$10.7**	**$10.7**	**$10.7**	**$10.7**	**$10.5**	**$10.5**	**$10.5**
INCREMENTAL COSTS																						
28 selected projects																						
MLA funding costs	-$0.6	-$0.4	-$1.4	-$0.4	-$0.6	-$0.4	-$0.7	-$1.0	-$0.8	-$0.7	-$0.5	-$0.6	-$0.1	-$0.2	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Other costs	$0.0	$0.0	$0.0	$0.0	$0.0	-$3.7	-$3.7	-$3.5	-$3.5	-$3.7	-$3.5	-$3.5	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Other projects (MLA funding costs)	-$0.4	-$0.3	$0.1	-$0.4	-$0.4	-$1.5	-$1.0	-$0.9	-$0.9	-$0.9	-$1.4	-$1.5	-$1.1	-$1.6	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total costs	**-$1.1**	**-$0.7**	**-$1.3**	**-$0.8**	**-$1.0**	**-$5.6**	**-$5.4**	**-$5.4**	**-$5.2**	**-$5.3**	**-$5.4**	**-$5.5**	**-$4.8**	**-$5.4**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**
NET BENEFITS	**-$1.1**	**-$0.7**	**-$1.3**	**-$0.8**	**-$1.0**	**$4.0**	**$3.9**	**$5.1**	**$5.4**	**$6.6**	**$5.2**	**$5.0**	**$5.7**	**$5.0**	**$7.0**	**$7.2**	**$7.2**	**$7.2**	**$7.2**	**$6.9**	**$6.9**	**$6.9**
Total MLA funding (including MDC)	-$1.1	-$0.7	-$1.3	-$0.8	-$1.0	-$1.9	-$1.7	-$2.0	-$1.6	-$1.6	-$1.9	-$2.0	-$1.2	-$1.8	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Time from base year (years)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**
INCREMENTAL BENEFITS																						
28 selected projects	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1	$8.1
Other projects based on BCR for sele	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0	$1.0
Price premium across projects	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3	$1.3
Total benefits	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**	**$10.5**
INCREMENTAL COSTS																						
28 selected projects																						
MLA funding costs	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Other costs	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Other projects (MLA funding costs)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total costs	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**	**-$3.6**
NET BENEFITS	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**	**$6.9**
Total MLA funding (including MDC)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Discounted dollars ($m)

Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
INCREMENTAL BENEFITS																						
28 selected projects	$0.0	$0.0	$0.0	$0.0	$0.0	$8.5	$8.2	$9.3	$9.4	$9.3	$8.2	$8.1	$8.1	$8.0	$7.81	$7.5	$7.2	$6.8	$6.5	$6.1	$5.8	$5.5
Other projects based on BCR for sele	$0.0	$0.0	$0.0	$0.0	$0.0	$1.1	$1.1	$1.2	$1.2	$1.2	$1.1	$1.0	$1.0	$1.0	$1.01	$1.0	$0.9	$0.9	$0.8	$0.8	$0.7	$0.7
Price premium across projects	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$1.3	$1.3	$1.3	$1.3	$1.3	$1.27	$1.2	$1.1	$1.1	$1.0	$1.0	$0.9	$0.9
Total benefits	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$0.0**	**$9.6**	**$9.3**	**$10.5**	**$10.6**	**$11.9**	**$10.6**	**$10.5**	**$10.5**	**$10.4**	**$10.1**	**$9.7**	**$9.3**	**$8.8**	**$8.4**	**$7.8**	**$7.5**	**$7.1**
INCREMENTAL COSTS																						
28 selected projects																						
MLA funding costs	-$0.6	-$0.4	-$1.4	-$0.4	-$0.6	-$0.4	-$0.7	-$1.0	-$0.8	-$0.7	-$0.5	-$0.6	-$0.1	-$0.2	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Other costs	$0.0	$0.0	$0.0	$0.0	$0.0	-$3.7	-$3.7	-$3.5	-$3.5	-$3.7	-$3.5	-$3.5	-$3.6	-$3.6	-$3.4	-$3.2	-$3.1	-$2.9	-$2.8	-$2.7	-$2.5	-$2.4
Other projects (MLA funding costs)	-$0.4	-$0.3	$0.1	-$0.4	-$0.4	-$1.5	-$1.0	-$0.9	-$0.9	-$0.9	-$1.4	-$1.5	-$1.1	-$1.6	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
Total costs	**-$1.1**	**-$0.7**	**-$1.3**	**-$0.8**	**-$1.0**	**-$5.6**	**-$5.4**	**-$5.4**	**-$5.2**	**-$5.3**	**-$5.4**	**-$5.5**	**-$4.8**	**-$5.4**	**-$3.4**	**-$3.2**	**-$3.1**	**-$2.9**	**-$2.8**	**-$2.7**	**-$2.5**	**-$2.4**
NET BENEFITS	**-$1.1**	**-$0.7**	**-$1.3**	**-$0.8**	**-$1.0**	**$4.0**	**$3.9**	**$5.1**	**$5.4**	**$6.6**	**$5.2**	**$5.0**	**$5.7**	**$5.0**	**$6.681**	**$6.5**	**$6.2**	**$5.9**	**$5.6**	**$5.2**	**$4.9**	**$4.7**
Benefit-cost ratio																						
Total MLA funding (including MDC)	-$1.1	-$0.7	-$1.3	-$0.8	-$1.0	-$1.9	-$1.7	-$2.0	-$1.6	-$1.6	-$1.9	-$2.0	-$1.2	-$1.8	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0

Time from base year (years)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**TOTAL**
INCREMENTAL BENEFITS																							
28 selected projects	$5.2	$5.0	$4.7	$4.5	$4.3	$4.1	$3.9	$3.7	$3.5	$3.4	$3.2	$3.1	$2.9	$2.8	$2.6	$2.5	$2.4	$2.3	$2.2	$2.1	$2.0	$1.9	$202.8
Other projects based on BCR for sele	$0.7	$0.6	$0.6	$0.6	$0.6	$0.5	$0.5	$0.5	$0.5	$0.4	$0.4	$0.4	$0.4	$0.4	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3	$0.3	$0.2	$26.2
Price premium across projects	$0.9	$0.8	$0.8	$0.7	$0.7	$0.7	$0.6	$0.6	$0.6	$0.6	$0.5	$0.5	$0.5	$0.5	$0.4	$0.4	$0.4	$0.4	$0.4	$0.3	$0.3	$0.3	$27.1
Total benefits	**$6.8**	**$6.4**	**$6.1**	**$5.8**	**$5.6**	**$5.3**	**$5.1**	**$4.8**	**$4.6**	**$4.4**	**$4.2**	**$4.0**	**$3.8**	**$3.6**	**$3.4**	**$3.3**	**$3.1**	**$3.0**	**$2.8**	**$2.7**	**$2.6**	**$2.4**	**$256.1**
INCREMENTAL COSTS																							
28 selected projects																							
MLA funding costs	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	-$8.3
Other costs	-$2.3	-$2.2	-$2.1	-$2.0	-$1.9	-$1.8	-$1.7	-$1.6	-$1.6	-$1.5	-$1.4	-$1.3	-$1.3	-$1.2	-$1.2	-$1.1	-$1.1	-$1.0	-$1.0	-$0.9	-$0.9	-$0.8	-$87.2
Other projects (MLA funding costs)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	-$12.3
Total costs	**-$2.3**	**-$2.2**	**-$2.1**	**-$2.0**	**-$1.9**	**-$1.8**	**-$1.7**	**-$1.6**	**-$1.6**	**-$1.5**	**-$1.4**	**-$1.3**	**-$1.3**	**-$1.2**	**-$1.2**	**-$1.1**	**-$1.1**	**-$1.0**	**-$1.0**	**-$0.9**	**-$0.9**	**-$0.8**	**-$107.8**
NET BENEFITS	**$4.5**	**$4.3**	**$4.1**	**$3.9**	**$3.7**	**$3.5**	**$3.3**	**$3.2**	**$3.0**	**$2.9**	**$2.7**	**$2.6**	**$2.5**	**$2.4**	**$2.3**	**$2.1**	**$2.0**	**$1.9**	**$1.9**	**$1.8**	**$1.7**	**$1.6**	**$148.3**
Benefit-cost ratio																							**2.4**
Total MLA funding (including MDC)	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	**-$20.6**

Source: MJA analysis

PART D: IMPACT ON MARKET PARTICIPANTS ALONG THE CHAIN

24. Distribution of net benefits

In this section we assess the impact on different market participants in the beef, sheep and goats value chains for each of the three product integrity programs.

The net benefits of each of the components have been distributed to market participants differently for the beef and sheep sectors. This reflects the specific characteristics of each of these markets. The net benefits have been distributed in the following way:

- beef cattle: the benefits are distributed as per the results in Mounter, Tighe, Pollock & Griffith (2012). The NLIS and the LPA programs have applied 'scenario 8' which relates to export market research[129]. We chose this scenario because the focus of NLIS and LPA is to assist in facilitating export market access and emergency disease preparedness. The major beneficiary of this is the export market. The scientific research component has applied 'scenario 6' which relates to processing research. These scenarios are discussed in more detail in section 0.
- sheep: The NLIS, LPA and scientific research programs have applied the lamb production research scenario from Mounter, Griffith, Piggott, Fleming & Zhao (2008). These scenarios are discussed in more detail in section 24.2.

We have allocated the net benefits for the NLIS and LPA to the beef cattle and sheep sector as per the Box 3 estimate of future avoided cost of FMD (76 per cent for the beef cattle sector and 24 per for the sheep sector). Of the net benefits for the scientific research program, 77 per cent have been allocated to the beef sector (and 23 per cent to the sheep sector) if we include the TSE project and 100 per cent to the beef sector if we exclude the TSE project. These were estimated based on some simple analysis of the type of projects that comprise the 28 selected projects that were used to estimate benefits for the scientific research program.

Note that we have not modelled the goats sector given lack of information on the flow of benefits for this sector.

The estimated flow of net benefits to different market participants for the beef and sheep sector is illustrated in Table 46 and Table 47.

We note that our distribution of benefits is consistent with previous illustrations of benefit flows to different market participants, including MLA (2007) which shows that around 42 per cent of the benefits flow to industry – this is similar to the Mounter, Tighe, Pollock & Griffith (2012) results which show that 40 per cent of the benefits flow to industry (including farmers, processors, exporters, retailers etc.).

[129] Export market research is defined in Mounter et al. as "Other cost reductions in export marketing due to research for investments that increase export marketing efficiency."

Table 46: Distribution of benefits to market participants – beef sector

Market participant	NLIS	LPA		Scientific research	
		Counter-factual 1	Counter-factual 2	Include TSE project	Exclude TSE project
Farmers					
Weaner producers	*$1,738.7*	*$6.8*	*$390.0*	*$63.1*	*$33.0*
Grass-finishers	*$232.3*	*$0.9*	*$52.1*	*$6.5*	*$3.4*
Backgrounders	*$33.2*	*$0.1*	*$7.4*	*$2.8*	*$1.5*
sub-total	$2,004.1	$7.8	$449.5	$72.5	$37.9
Feedgrain grower	$139.4	$0.5	$31.3	$12.2	$6.4
Feedlotters	$19.9	$0.1	$4.5	$0.3	$0.1
Processors	$79.6	$0.3	$17.9	$10.8	$5.6
Exporters	$172.5	$0.7	$38.7	$0.0	$0.0
Domestic retailers	$238.9	$0.9	$53.6	$16.7	$8.7
Overseas consumers					
grainfed beef	*$285.4*	*$1.1*	*$64.0*	*$15.0*	*$7.9*
grassfed beef	*$491.1*	*$1.9*	*$110.1*	*$13.0*	*$6.8*
sub-total	$776.4	$3.0	$174.1	$28.0	$14.7
Domestic consumers	$3,205.3	$12.5	$718.9	$143.0	$74.8
Total net benefit	$6,636.1	$25.8	$1,488.5	$283.4	$148.3

Source: MJA analysis

Table 47: Distribution of benefits to market participants – sheep sector

Market participant	NLIS	LPA		Scientific research	
		Counter-factual 1	Counter-factual 2	Include TSE project	Exclude TSE project
Farmers	$497.1	$1.9	$111.5	$20.1	$0.0
Wool warehouse/brokers	$8.6	$0.0	$1.9	$0.3	$0.0
Wool processors	$11.5	$0.0	$2.6	$0.5	$0.0
Wool exporters	$10.7	$0.0	$2.4	$0.4	$0.0
Sheepmeat processors	$160.1	$0.6	$35.9	$6.5	$0.0
Sheepmeat exporters	$4.4	$0.0	$1.0	$0.2	$0.0
Domestic sheepmeat retailers	$115.5	$0.4	$25.9	$4.7	$0.0
Overseas customers	$641.9	$2.5	$144.0	$25.9	$0.0
Domestic consumers	$645.9	$2.5	$144.9	$26.1	$0.0
Total net benefit	$2,095.6	$8.1	$470.0	$84.6	$0.0

Source: MJA analysis

24.1 Beef cattle

The most recent analysis of the distribution of benefit flows for the beef industry was undertaken by Mounter, Tighe, Pollock & Griffith (2012)[130]. This study updated the analysis undertaken in Zhao, Mullen, Griffith, Griffiths, & Piggott (2000)[131]. However, the most recent study only provides updated values for some of the scenarios in the earlier study.

Both of these studies illustrated the flow of benefits to different market participants (e.g. farmers, processors, retailers, consumers) for a combined total of 12 activities (which it refers to as 'scenarios'). The study applied an equilibrium displacement model to estimate the flow of benefits to each of the market participants. The results of the studies are summarised in Table 48.

The year of the study that has been used is indicated in the first row of this table. The most recent values for a scenario have been used where available.

Table 48: Impact on different segments and the community

	2012	2012	2000	2000	2000	2012	2012	2000	2000	2000	2012	2012
Market participant	**Scenario 1**	**Scenario 2**	**Scenario 3**	**Scenario 4**	**Scenario 5**	**Scenario 6**	**Scenario 7**	**Scenario 8**	**Scenario 9**	**Scenario 10**	**Scenario 11**	**Scenario 12**
	Weaner production research	**Grass-finishing research**	**Back-grounding research**	**Feedgrain industry research**	**Feedlot research**	**Processing research**	**Domestic marketing research**	**Export marketing research**	**Export-grainfed beef promotion**	**Export-grassfed beef promotion**	**Domestic-grainfed beef promotion**	**Domestic-grainfed beef promotion**
Farmers												
Weaner producers	*30.4%*	*22.0%*	*23.3%*	*21.1%*	*23.3%*	*22.3%*	*17.8%*	*26.2%*	*27.2%*	*27.4%*	*20.3%*	*20.0%*
Grass-finishers	*2.0%*	*4.1%*	*3.3%*	*3.0%*	*3.3%*	*2.3%*	*1.8%*	*3.5%*	*3.6%*	*3.7%*	*2.1%*	*2.0%*
Backgrounders	*0.9%*	*1.0%*	*2.2%*	*0.2%*	*0.2%*	*1.0%*	*0.8%*	*0.5%*	*0.5%*	*0.5%*	*0.9%*	*0.8%*
sub-total	33.3%	27.2%	28.8%	24.3%	26.8%	25.6%	20.4%	30.2%	31.3%	31.6%	23.3%	22.8%
Feedgrain grower	4.0%	4.6%	1.0%	12.0%	1.1%	4.3%	3.4%	2.1%	2.2%	2.3%	3.9%	3.8%
Feedlotters	0.1%	0.1%	0.1%	0.1%	2.1%	0.1%	0.1%	0.3%	0.3%	0.3%	0.1%	0.1%
Processors	1.7%	1.8%	1.1%	1.0%	1.1%	3.8%	1.5%	1.2%	1.3%	1.3%	1.7%	1.6%
Exporters	0.0%	0.0%	0.5%	0.4%	0.5%	0.0%	0.0%	2.6%	0.7%	0.7%	0.0%	0.0%
Domestic retailers	5.4%	5.9%	4.1%	3.7%	4.1%	5.9%	8.9%	3.6%	3.7%	3.7%	7.9%	7.8%
Overseas consumers												
grainfed beef	*4.9%*	*5.3%*	*3.4%*	*3.0%*	*3.6%*	*5.3%*	*3.2%*	*4.3%*	*5.1%*	*3.2%*	*3.7%*	*3.7%*
grassfed beef	*4.2%*	*4.6%*	*5.6%*	*5.2%*	*5.4%*	*4.6%*	*2.8%*	*7.4%*	*5.3%*	*6.3%*	*3.2%*	*3.1%*
sub-total	9.1%	9.9%	9.0%	8.2%	9.0%	9.9%	6.0%	11.7%	10.4%	9.5%	6.9%	6.8%
Domestic consumers	46.4%	50.5%	55.4%	50.3%	55.3%	50.4%	59.7%	48.3%	50.1%	50.6%	56.2%	57.1%
Total surplus	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

130 Mounter, S., Tighe, K., Pollock, K., and Griffith, G. (2012), Updating and Recalibrating an Equilibrium Displacement Model of the Australian Beef Market, Meat & Livestock Australia Limited, North Sydney.

131 Zhao, X., Mullen, J.D., Griffith, G.R., Griffiths, W.E. and Piggott, R.R. (2000), An Equilibrium Displacement Model of the Australian Beef Industry, Economic Research Report No. 4, NSW Agriculture, Orange.

24.2 Sheep

The most recent analysis of the distribution of benefit flows for the sheep industry was undertaken by Mounter, Griffith, Piggott, Fleming & Zhao (2008)[132]. This study illustrated the flow of benefits to different market participants (e.g. farmers, processors, retailers, consumers) from two types of activities:

- lamb production research: this is defined as 'any new technology that successfully reduces the cost of prime lamb'[133]. This type of change is simulated as a shift to the right in the supply curve of lambs produced; and
- greasy wool export promotion. This type of change is simulated as a shift to the right in the export demand curves for greasy wool.

The study applied an equilibrium displacement model to estimate the flow of benefits to each of the market participants.

The results of the study are summarised in Table 49.

Table 49: Impact on different segments and the community

Market participant	Lamb production research	Greasy wool export promotion
Farmers	23.7%	33.3%
Wool warehouse/brokers	0.4%	0.9%
Wool processors	0.6%	-0.4%
Wool exporters	0.5%	1.1%
Sheepmeat processors	7.6%	2.4%
Sheepmeat exporters	0.2%	0.1%
Domestic sheepmeat retailers	5.5%	1.2%
Overseas customers	30.6%	53.8%
Domestic consumers	30.8%	7.6%
Total welfare gain	**100.0%**	**100.0%**

132 Mounter, S., Griffith, G., Piggott, R. Fleming, E. and Zhao, X. (2008), An Equilibrium Displacement Model of the Australian Sheep and Wool Industries, Economic Research Report No. 38, April 2008, NSW Department of Primary Industries 2008.

133 Mounter, S., Griffith, G., Piggott, R. Fleming, E. and Zhao, X. (2008), An Equilibrium Displacement Model of the Australian Sheep and Wool Industries, Economic Research Report No. 38, April 2008, NSW Department of Primary Industries 2008, page 71.

PART E: DETAILED INVESTMENT PERFORMANCE INFORMATION FOR ALL THREE PROGRAMS

This section provides more detailed investment performance information in aggregate across all three product integrity programs. We present information for both counterfactual 1 for the LPA (Figure 14) and counterfactual 2 for the LPA (Figure 15).

Figure 14: Investment performance information across all three programs (counterfactual 1)

Benefits and costs — Counterfactual 1 for LPA

Finance and reinvestment rate	5%
IRR	28%
Modified IRR	12%

Real dollars ($m)

Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
INCREMENTAL BENEFITS																						
Livestock traceability: NLIS	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$616.3	$616.0	$615.8	$615.6	$615.3	$615.1	$614.8	$614.6
On-farm food safety systems: LPA	$0.0	$3.5	$5.5	$5.4	$5.4	$5.3	$5.2	$5.1	$5.0	$5.0	$4.8	$4.8	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0
Scientific research	$0.0	$0.0	$0.0	$0.0	$0.0	$9.6	$9.3	$10.5	$10.6	$11.9	$10.6	$10.5	$10.5	$10.4	$33.9	$33.2	$32.4	$31.6	$29.8	$29.8	$29.0	$28.2
Total benefits	**$0.0**	**$3.5**	**$5.5**	**$5.4**	**$5.4**	**$14.9**	**$14.5**	**$15.6**	**$15.6**	**$16.8**	**$15.5**	**$15.3**	**$15.5**	**$15.4**	**$655.1**	**$654.2**	**$653.2**	**$652.2**	**$650.1**	**$649.9**	**$648.8**	**$647.8**
INCREMENTAL COSTS																						
Livestock traceability: NLIS	-$3.6	-$3.5	-$3.4	-$3.3	-$3.2	-$109.5	-$43.9	-$44.2	-$44.5	-$43.1	-$42.4	-$43.3	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4
On-farm food safety systems: LPA	-$8.2	-$4.1	-$4.1	-$4.0	-$4.0	-$3.9	-$3.8	-$3.7	-$3.6	-$3.6	-$3.4	-$3.4	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Scientific research	-$1.1	-$0.7	-$1.3	-$0.8	-$1.4	-$6.1	-$5.7	-$5.5	-$5.2	-$5.3	-$5.4	-$5.5	-$4.8	-$5.4	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Total costs	**-$12.9**	**-$8.4**	**-$8.8**	**-$8.2**	**-$8.6**	**-$119.5**	**-$53.3**	**-$53.4**	**-$53.3**	**-$51.9**	**-$51.2**	**-$52.3**	**-$51.7**	**-$52.3**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**
NET BENEFITS	**-$12.9**	**-$4.9**	**-$3.3**	**-$2.7**	**-$3.2**	**-$104.6**	**-$38.9**	**-$37.8**	**-$37.7**	**-$35.1**	**-$35.7**	**-$37.0**	**-$36.3**	**-$37.0**	**$604.6**	**$603.7**	**$602.7**	**$601.6**	**$599.5**	**$599.3**	**$598.3**	**$597.3**

Time from base year (years)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**
INCREMENTAL BENEFITS																						
Livestock traceability: NLIS	$614.4	$614.1	$613.9	$613.6	$613.4	$613.2	$612.9	$612.7	$612.4	$612.2	$612.0	$611.7	$611.5	$611.2	$611.0	$610.8	$610.5	$610.3	$610.0	$609.8	$609.6	$609.3
On-farm food safety systems: LPA	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0	$5.0
Scientific research	$27.4	$25.6	$25.8	$25.0	$24.2	$23.4	$21.6	$21.9	$21.1	$20.3	$19.5	$17.6	$17.9	$17.1	$16.3	$15.5	$13.6	$13.9	$13.1	$12.3	$11.5	$9.6
Total benefits	**$646.7**	**$644.7**	**$644.7**	**$643.6**	**$642.6**	**$641.6**	**$639.5**	**$639.5**	**$638.5**	**$637.4**	**$636.4**	**$634.3**	**$634.3**	**$633.3**	**$632.3**	**$631.2**	**$629.1**	**$629.1**	**$628.1**	**$627.1**	**$626.0**	**$623.9**
INCREMENTAL COSTS																						
Livestock traceability: NLIS	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4
On-farm food safety systems: LPA	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Scientific research	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Total costs	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**
NET BENEFITS	**$596.2**	**$594.1**	**$594.2**	**$593.1**	**$592.1**	**$591.1**	**$589.0**	**$589.0**	**$588.0**	**$586.9**	**$585.9**	**$583.8**	**$583.8**	**$582.8**	**$581.7**	**$580.7**	**$578.6**	**$578.6**	**$577.6**	**$576.6**	**$575.5**	**$573.4**

Discounted dollars ($m)

Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**
INCREMENTAL BENEFITS																						
Livestock traceability: NLIS	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$586.9	$558.8	$531.9	$506.4	$482.1	$459.0	$437.0	$416.0
On-farm food safety systems: LPA	$0.0	$3.5	$5.5	$5.4	$5.4	$5.3	$5.2	$5.1	$5.0	$5.0	$4.8	$4.8	$5.0	$5.0	$4.7	$4.5	$4.3	$4.1	$3.9	$3.7	$3.5	$3.4
Scientific research	$0.0	$0.0	$0.0	$0.0	$0.0	$9.6	$9.3	$10.5	$10.6	$11.9	$10.6	$10.5	$10.5	$10.4	$32.3	$30.1	$28.0	$26.0	$23.3	$22.2	$20.6	$19.1
Total benefits	**$0.0**	**$3.5**	**$5.5**	**$5.4**	**$5.4**	**$14.9**	**$14.5**	**$15.6**	**$15.6**	**$16.8**	**$15.5**	**$15.3**	**$15.5**	**$15.4**	**$623.9**	**$593.4**	**$564.2**	**$536.5**	**$509.3**	**$484.9**	**$461.1**	**$438.4**
INCREMENTAL COSTS																						
Livestock traceability: NLIS	-$3.6	-$3.5	-$3.4	-$3.3	-$3.2	-$109.5	-$43.9	-$44.2	-$44.5	-$43.1	-$42.4	-$43.3	-$43.4	-$43.4	-$41.3	-$39.3	-$37.5	-$35.7	-$34.0	-$32.4	-$30.8	-$29.4
On-farm food safety systems: LPA	-$8.2	-$4.1	-$4.1	-$4.0	-$4.0	-$3.9	-$3.8	-$3.7	-$3.6	-$3.6	-$3.4	-$3.4	-$3.6	-$3.6	-$3.4	-$3.2	-$3.1	-$2.9	-$2.8	-$2.7	-$2.5	-$2.4
Scientific research	-$1.1	-$0.7	-$1.3	-$0.8	-$1.4	-$6.1	-$5.7	-$5.5	-$5.2	-$5.3	-$5.4	-$5.5	-$4.8	-$5.4	-$3.4	-$3.2	-$3.1	-$2.9	-$2.8	-$2.7	-$2.5	-$2.4
Total costs	**-$12.9**	**-$8.4**	**-$8.8**	**-$8.2**	**-$8.6**	**-$119.5**	**-$53.3**	**-$53.4**	**-$53.3**	**-$51.9**	**-$51.2**	**-$52.3**	**-$51.7**	**-$52.3**	**-$48.1**	**-$45.8**	**-$43.6**	**-$41.6**	**-$39.6**	**-$37.7**	**-$35.9**	**-$34.2**
NET BENEFITS	**-$12.9**	**-$4.9**	**-$3.3**	**-$2.7**	**-$3.2**	**-$104.6**	**-$38.9**	**-$37.8**	**-$37.7**	**-$35.1**	**-$35.7**	**-$37.0**	**-$36.3**	**-$37.0**	**$575.8**	**$547.6**	**$520.6**	**$495.0**	**$469.8**	**$447.2**	**$425.2**	**$404.3**
Benefit-cost ratio																						

Time from base year (years)	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Year	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**TOTAL**
INCREMENTAL BENEFITS																							
Livestock traceability: NLIS	$396.0	$377.0	$358.9	$341.7	$325.3	$309.7	$294.8	$280.7	$267.2	$254.4	$242.2	$230.6	$219.5	$209.0	$198.9	$189.4	$180.3	$171.6	$163.4	$155.6	$148.1	$141.0	$9,433.2
On-farm food safety systems: LPA	$3.2	$3.1	$2.9	$2.8	$2.6	$2.5	$2.4	$2.3	$2.2	$2.1	$2.0	$1.9	$1.8	$1.7	$1.6	$1.5	$1.5	$1.4	$1.3	$1.3	$1.2	$1.2	$141.1
Scientific research	$17.7	$15.7	$15.1	$13.9	$12.9	$11.8	$10.4	$10.0	$9.2	$8.4	$7.7	$6.6	$6.4	$5.8	$5.3	$4.8	$4.0	$3.9	$3.5	$3.1	$2.8	$2.2	$477.1
Total benefits	**$416.9**	**$395.8**	**$376.9**	**$358.4**	**$340.8**	**$324.0**	**$307.6**	**$293.0**	**$278.6**	**$264.9**	**$251.8**	**$239.1**	**$227.7**	**$216.5**	**$205.8**	**$195.7**	**$185.8**	**$176.9**	**$168.2**	**$160.0**	**$152.1**	**$144.4**	**$10,051.5**
INCREMENTAL COSTS																							
Livestock traceability: NLIS	-$28.0	-$26.6	-$25.4	-$24.1	-$23.0	-$21.9	-$20.9	-$19.9	-$18.9	-$18.0	-$17.2	-$16.3	-$15.6	-$14.8	-$14.1	-$13.4	-$12.8	-$12.2	-$11.6	-$11.1	-$10.5	-$10.0	-$1,141.5
On-farm food safety systems: LPA	-$2.3	-$2.2	-$2.1	-$2.0	-$1.9	-$1.8	-$1.7	-$1.6	-$1.6	-$1.5	-$1.4	-$1.3	-$1.3	-$1.2	-$1.2	-$1.1	-$1.1	-$1.0	-$1.0	-$0.9	-$0.9	-$0.8	-$111.7
Scientific research	-$2.3	-$2.2	-$2.1	-$2.0	-$1.9	-$1.8	-$1.7	-$1.6	-$1.6	-$1.5	-$1.4	-$1.3	-$1.3	-$1.2	-$1.2	-$1.1	-$1.1	-$1.0	-$1.0	-$0.9	-$0.9	-$0.8	-$109.1
Total costs	**-$32.6**	**-$31.0**	**-$29.5**	**-$28.1**	**-$26.8**	**-$25.5**	**-$24.3**	**-$23.1**	**-$22.0**	**-$21.0**	**-$20.0**	**-$19.0**	**-$18.1**	**-$17.3**	**-$16.4**	**-$15.7**	**-$14.9**	**-$14.2**	**-$13.5**	**-$12.9**	**-$12.3**	**-$11.7**	**-$1,362.3**
NET BENEFITS	**$384.3**	**$364.7**	**$347.4**	**$330.3**	**$314.0**	**$298.5**	**$283.3**	**$269.8**	**$256.5**	**$243.9**	**$231.9**	**$220.0**	**$209.6**	**$199.2**	**$189.4**	**$180.1**	**$170.9**	**$162.7**	**$154.7**	**$147.1**	**$139.8**	**$132.7**	**$8,689.2**
Benefit-cost ratio																							**7.4**

Figure 15: Investment performance information across all three programs (counterfactual 2)

Benefits and costs

Counterfactual 2 for LPA

Finance and reinvestment rate	5%
IRR	481%
Modified IRR	18%

Real dollars ($m)

Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
INCREMENTAL BENEFITS														
Livestock traceability: NLIS	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
On-farm food safety systems: LPA	$0.0	$70.4	$71.3	$69.2	$68.3	$80.1	$79.2	$76.0	$72.8	$75.2	$72.7	$70.8	$70.5	$70.5
Scientific research	$0.0	$0.0	$0.0	$0.0	$0.0	$9.6	$9.3	$10.5	$10.6	$11.9	$10.6	$10.5	$10.5	$10.4
Total benefits	**$0.0**	**$70.4**	**$71.3**	**$69.2**	**$68.3**	**$89.7**	**$88.5**	**$86.5**	**$83.4**	**$87.0**	**$83.3**	**$81.3**	**$81.0**	**$80.8**
INCREMENTAL COSTS														
Livestock traceability: NLIS	-$3.6	-$3.5	-$3.4	-$3.3	-$3.2	-$109.5	-$43.9	-$44.2	-$44.5	-$43.1	-$42.4	-$43.3	-$43.4	-$43.4
On-farm food safety systems: LPA	-$8.2	-$4.1	-$4.1	-$4.0	-$4.0	-$3.9	-$3.8	-$3.7	-$3.6	-$3.6	-$3.4	-$3.4	-$3.6	-$3.6
Scientific research	-$1.1	-$0.7	-$1.3	-$0.8	-$1.4	-$6.1	-$5.7	-$5.5	-$5.2	-$5.3	-$5.4	-$5.5	-$4.8	-$5.4
Total costs	**-$12.9**	**-$8.4**	**-$8.8**	**-$8.2**	**-$8.6**	**-$119.5**	**-$53.3**	**-$53.4**	**-$53.3**	**-$51.9**	**-$51.2**	**-$52.3**	**-$51.7**	**-$52.3**
NET BENEFITS	**-$12.9**	**$62.0**	**$62.5**	**$61.1**	**$59.7**	**-$29.8**	**$35.2**	**$33.1**	**$30.1**	**$35.1**	**$32.2**	**$29.0**	**$29.2**	**$28.5**

Time from base year (years)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
INCREMENTAL BENEFITS															
Livestock traceability: NLIS	$616.3	$616.0	$615.8	$615.6	$615.3	$615.1	$614.8	$614.6	$614.4	$614.1	$613.9	$613.6	$613.4	$613.2	$612.9
On-farm food safety systems: LPA	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5
Scientific research	$33.9	$33.2	$32.4	$31.6	$29.8	$29.8	$29.0	$28.2	$27.4	$25.6	$25.8	$25.0	$24.2	$23.4	$21.6
Total benefits	**$720.6**	**$719.7**	**$718.7**	**$717.6**	**$715.5**	**$715.3**	**$714.3**	**$713.3**	**$712.2**	**$710.1**	**$710.2**	**$709.1**	**$708.1**	**$707.1**	**$705.0**
INCREMENTAL COSTS															
Livestock traceability: NLIS	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4
On-farm food safety systems: LPA	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Scientific research	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Total costs	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**
NET BENEFITS	**$670.1**	**$669.2**	**$668.2**	**$667.1**	**$665.0**	**$664.8**	**$663.8**	**$662.8**	**$661.7**	**$659.6**	**$659.7**	**$658.6**	**$657.6**	**$656.5**	**$654.4**

Time from base year (years)	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
Year	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**
INCREMENTAL BENEFITS															
Livestock traceability: NLIS	$612.7	$612.4	$612.2	$612.0	$611.7	$611.5	$611.2	$611.0	$610.8	$610.5	$610.3	$610.0	$609.8	$609.6	$609.3
On-farm food safety systems: LPA	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5	$70.5
Scientific research	$21.9	$21.1	$20.3	$19.5	$17.6	$17.9	$17.1	$16.3	$15.5	$13.6	$13.9	$13.1	$12.3	$11.5	$9.6
Total benefits	**$705.0**	**$704.0**	**$702.9**	**$701.9**	**$699.8**	**$699.8**	**$698.8**	**$697.7**	**$696.7**	**$694.6**	**$694.6**	**$693.6**	**$692.6**	**$691.5**	**$689.4**
INCREMENTAL COSTS															
Livestock traceability: NLIS	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4	-$43.4
On-farm food safety systems: LPA	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Scientific research	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6	-$3.6
Total costs	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**	**-$50.5**
NET BENEFITS	**$654.5**	**$653.4**	**$652.4**	**$651.4**	**$649.3**	**$649.3**	**$648.3**	**$647.2**	**$646.2**	**$644.1**	**$644.1**	**$643.1**	**$642.0**	**$641.0**	**$638.9**

Discounted dollars ($m)

Time from base year (years)	-13	-12	-11	-10	-9	-8	-7	-6	-5	-4	-3	-2	-1	0
Year	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
INCREMENTAL BENEFITS														
Livestock traceability: NLIS	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0	$0.0
On-farm food safety systems: LPA	$0.0	$70.4	$71.3	$69.2	$68.3	$80.1	$79.2	$76.0	$72.8	$75.2	$72.7	$70.8	$70.5	$70.5
Scientific research	$0.0	$0.0	$0.0	$0.0	$0.0	$9.6	$9.3	$10.5	$10.6	$11.9	$10.6	$10.5	$10.5	$10.4
Total benefits	**$0.0**	**$70.4**	**$71.3**	**$69.2**	**$68.3**	**$89.7**	**$88.5**	**$86.5**	**$83.4**	**$87.0**	**$83.3**	**$81.3**	**$81.0**	**$80.8**
INCREMENTAL COSTS														
Livestock traceability: NLIS	-$3.6	-$3.5	-$3.4	-$3.3	-$3.2	-$109.5	-$43.9	-$44.2	-$44.5	-$43.1	-$42.4	-$43.3	-$43.4	-$43.4
On-farm food safety systems: LPA	-$8.2	-$4.1	-$4.1	-$4.0	-$4.0	-$3.9	-$3.8	-$3.7	-$3.6	-$3.6	-$3.4	-$3.4	-$3.6	-$3.6
Scientific research	-$1.1	-$0.7	-$1.3	-$0.8	-$1.4	-$6.1	-$5.7	-$5.5	-$5.2	-$5.3	-$5.4	-$5.5	-$4.8	-$5.4
Total costs	**-$12.9**	**-$8.4**	**-$8.8**	**-$8.2**	**-$8.6**	**-$119.5**	**-$53.3**	**-$53.4**	**-$53.3**	**-$51.9**	**-$51.2**	**-$52.3**	**-$51.7**	**-$52.3**
NET BENEFITS	**-$12.9**	**$62.0**	**$62.5**	**$61.1**	**$59.7**	**-$29.8**	**$35.2**	**$33.1**	**$30.1**	**$35.1**	**$32.2**	**$29.0**	**$29.2**	**$28.5**
Benefit-cost ratio														

Time from base year (years)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Year	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**
INCREMENTAL BENEFITS															
Livestock traceability: NLIS	$586.9	$558.8	$531.9	$506.4	$482.1	$459.0	$437.0	$416.0	$396.0	$377.0	$358.9	$341.7	$325.3	$309.7	$294.8
On-farm food safety systems: LPA	$67.1	$63.9	$60.9	$58.0	$55.2	$52.6	$50.1	$47.7	$45.4	$43.3	$41.2	$39.2	$37.4	$35.6	$33.9
Scientific research	$32.3	$30.1	$28.0	$26.0	$23.3	$22.2	$20.6	$19.1	$17.7	$15.7	$15.1	$13.9	$12.9	$11.8	$10.4
Total benefits	**$686.3**	**$652.8**	**$620.8**	**$590.4**	**$560.6**	**$533.8**	**$507.6**	**$482.8**	**$459.1**	**$436.0**	**$415.2**	**$394.9**	**$375.5**	**$357.1**	**$339.1**
INCREMENTAL COSTS															
Livestock traceability: NLIS	-$41.3	-$39.3	-$37.5	-$35.7	-$34.0	-$32.4	-$30.8	-$29.4	-$28.0	-$26.6	-$25.4	-$24.1	-$23.0	-$21.9	-$20.9
On-farm food safety systems: LPA	-$3.4	-$3.2	-$3.1	-$2.9	-$2.8	-$2.7	-$2.5	-$2.4	-$2.3	-$2.2	-$2.1	-$2.0	-$1.9	-$1.8	-$1.7
Scientific research	-$3.4	-$3.2	-$3.1	-$2.9	-$2.8	-$2.7	-$2.5	-$2.4	-$2.3	-$2.2	-$2.1	-$2.0	-$1.9	-$1.8	-$1.7
Total costs	**-$48.1**	**-$45.8**	**-$43.6**	**-$41.6**	**-$39.6**	**-$37.7**	**-$35.9**	**-$34.2**	**-$32.6**	**-$31.0**	**-$29.5**	**-$28.1**	**-$26.8**	**-$25.5**	**-$24.3**
NET BENEFITS	**$638.2**	**$607.0**	**$577.2**	**$548.8**	**$521.1**	**$496.1**	**$471.7**	**$448.6**	**$426.6**	**$405.0**	**$385.7**	**$366.7**	**$348.7**	**$331.6**	**$314.8**
Benefit-cost ratio															

Time from base year (years)	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Year	**2030**	**2031**	**2032**	**2033**	**2034**	**2035**	**2036**	**2037**	**2038**	**2039**	**2040**	**2041**	**2042**	**2043**	**2044**	**TOTAL**
INCREMENTAL BENEFITS																
Livestock traceability: NLIS	$280.7	$267.2	$254.4	$242.2	$230.6	$219.5	$209.0	$198.9	$189.4	$180.3	$171.6	$163.4	$155.6	$148.1	$141.0	$9,433.2
On-farm food safety systems: LPA	$32.3	$30.7	$29.3	$27.9	$26.6	$25.3	$24.1	$22.9	$21.8	$20.8	$19.8	$18.9	$18.0	$17.1	$16.3	$2,029.8
Scientific research	$10.0	$9.2	$8.4	$7.7	$6.6	$6.4	$5.8	$5.3	$4.8	$4.0	$3.9	$3.5	$3.1	$2.8	$2.2	$477.1
Total benefits	**$323.0**	**$307.1**	**$292.1**	**$277.8**	**$263.7**	**$251.2**	**$238.9**	**$227.2**	**$216.0**	**$205.1**	**$195.4**	**$185.8**	**$176.7**	**$168.0**	**$159.5**	**$11,940.2**
INCREMENTAL COSTS																
Livestock traceability: NLIS	-$19.9	-$18.9	-$18.0	-$17.2	-$16.3	-$15.6	-$14.8	-$14.1	-$13.4	-$12.8	-$12.2	-$11.6	-$11.1	-$10.5	-$10.0	-$1,141.5
On-farm food safety systems: LPA	-$1.6	-$1.6	-$1.5	-$1.4	-$1.3	-$1.3	-$1.2	-$1.2	-$1.1	-$1.1	-$1.0	-$1.0	-$0.9	-$0.9	-$0.8	-$111.7
Scientific research	-$1.6	-$1.6	-$1.5	-$1.4	-$1.3	-$1.3	-$1.2	-$1.2	-$1.1	-$1.1	-$1.0	-$1.0	-$0.9	-$0.9	-$0.8	-$109.1
Total costs	**-$23.1**	**-$22.0**	**-$21.0**	**-$20.0**	**-$19.0**	**-$18.1**	**-$17.3**	**-$16.4**	**-$15.7**	**-$14.9**	**-$14.2**	**-$13.5**	**-$12.9**	**-$12.3**	**-$11.7**	**-$1,362.3**
NET BENEFITS	**$299.8**	**$285.1**	**$271.1**	**$257.8**	**$244.7**	**$233.1**	**$221.6**	**$210.7**	**$200.4**	**$190.2**	**$181.2**	**$172.2**	**$163.8**	**$155.7**	**$147.8**	**$10,577.9**
Benefit-cost ratio																**8.8**