ACIL ALLEN CONSULTING

REPORT TO
ANIMAL MEDICINES AUSTRALIA
8 AUGUST 2018

ECONOMIC CONTRIBUTION OF ANIMAL HEALTH PRODUCTS TO AUSTRALIA'S LIVESTOCK INDUSTRIES, 2015-16

ACIL ALLEN CONSULTING PTY LTD
ABN 68 102 652 148

LEVEL NINE
60 COLLINS STREET
MELBOURNE VIC 3000
AUSTRALIA
T+61 3 8650 6000
F+61 3 9654 6363

LEVEL ONE
50 PITT STREET
SYDNEY NSW 2000
AUSTRALIA
T+61 2 8272 5100
F+61 2 9247 2455

LEVEL FIFTEEN
127 CREEK STREET
BRISBANE QLD 4000
AUSTRALIA
T+61 7 3009 8700
F+61 7 3009 8799

LEVEL ONE
15 LONDON CIRCUIT
CANBERRA ACT 2600
AUSTRALIA
T+61 2 6103 8200
F+61 2 6103 8233

LEVEL TWELVE, BGC CENTRE
28 THE ESPLANADE
PERTH WA 6000
AUSTRALIA
T+61 8 9449 9600
F+61 8 9322 3955

167 FLINDERS STREET
ADELAIDE SA 5000
AUSTRALIA
T +61 8 8122 4965

ACILALLEN.COM.AU

SUGGESTED CITATION FOR THIS REPORT

ACIL ALLEN CONSULTING (2018), ECONOMIC CONTRIBUTION OF ANIMAL MEDICINES TO AUSTRALIA'S LIVESTOCK INDUSTRIES 2015-16, JUNE 2018

CONTRIBUTING TEAM MEMBERS (ALPHABETICAL)

JOHN BELL
JYOTHI GALI
GUY JAKEMAN

C O N T E N T S

C O N T E N T S

C O N T E N T S

FIGURES

TABLES

C O N T E N T S

BOXES

EXECUTIVE SUMMARY

Animal health products (AHPs) are used to protect and treat animals with illnesses, diseases and injuries. They include vaccines, antimicrobial products, parasiticides, pain relief and other animal health products. They are critical to Australia's livestock industries that rely on them to produce high quality, safe and market ready food and fibre.

Maintaining the health and welfare of livestock is critically important for productive, ethical and sustainable livestock, dairy and poultry industries. There is a virtuous circle where careful management of animal health and welfare is not only good for animals, but also good for human health, the environment and the economy. While this analysis focuses on the economic benefits, the human health, social and environmental benefits from maintaining animal health should not be ignored. These other benefits have not been quantified in this report.

Appropriate and timely access to AHPs supports the economic competitiveness of Australia's livestock industries in several ways:

- Farm input costs are likely to be higher in the absence of AHPs. Sick animals are typically less productive than healthier animals. High prevalence of disease erodes returns on investment.
- AHPs reduce mortality. This reduces on-farm losses and ensures that farmers get the best returns from animals under their care.
- They promote food safety by controlling and treating animal infections and diseases that would make produce unsuitable for human consumption.
- Diseased animals are more labour-intensive to produce. Stock management and control practices are typically more complex, time consuming and expensive for sick animals than for healthy ones.

Animal Medicines Australia (AMA) engaged ACIL Allen Consulting to quantify the economic contribution made by AHPs in seven key commodity groups — Cattle, Dairy, Pigs, Sheep (meat), Sheep (wool), Chicken (meat) and Eggs. The analysis also estimates the consumer price impacts of AHPs on each commodity group. The analysis has been undertaken for the 2015-16 financial year, which is the most recent year of available data for the commodity groups.

The analysis includes three components:

1. An estimation of the production attributable to the responsible use of animal health products (in percentage terms) across the seven commodity groups;
2. An estimation of the contribution made by the animal health industry to economic activity across the seven commodity groups; and
3. An estimation of consumer price impacts that accrue from best practice management of animal health

Estimated production attributable to animal health products (AHPs)

This study provides economic analysis of AHPs that draws on several technical concepts and assumptions about the production of agricultural commodities and consumer price impacts.

The production value of each commodity attributable to AHPs is defined as the production that would not have been possible without the use of AHPs. For the purposes of this study, the production attributable to AHPs is described as the production loss avoided if a disease is treated with AHPs.

These losses can be significant. One study reviewed for this report has estimated that the beef production losses associated with endemic diseases, but not treated with AHPs, vary between 6.5% and 23.4% depending on the type of disease and incidence.

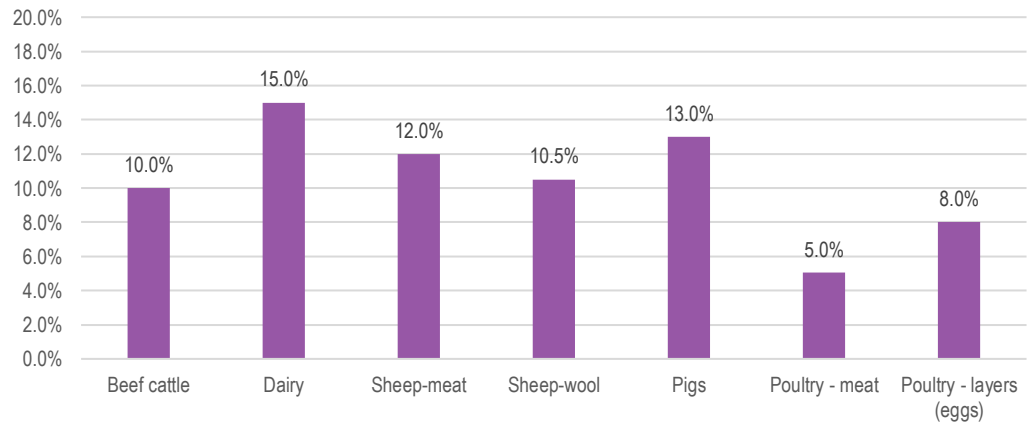
AHPs are a key input to current farming and production practices used in the seven commodity groups analysed in this study. The estimates reported here relate only to the 2015-16 economic activity attributable to the AHPs. They cannot be interpreted as an estimate of the change in output that would occur if different farming and production practices were adopted, for example organic farming, by each industry.

This study estimates the incremental impact of AHPs to 2015-16 production. For each livestock commodity, production data for 2015-16 (with the use of AHPs) is available, and production that would have occurred without the use of AHPs has been estimated. The difference is considered as incremental production that can be attributable to AHPs in 2015-16.

Using this approach, ACIL Allen has estimated livestock production attributable to AHPs, as shown in **Figure ES 1**. It is estimated that overall, **animal health products were responsible for 10.6% of production in seven key commodity groups:**

- 10% of beef cattle
- just over 10% of wool production
- 15% of dairy production
- 12% of sheep meat
- 13% of pig meat production
- 5% of chicken meat production and
- 8% of egg production.

FIGURE ES 1 ESTIMATED LIVESTOCK PRODUCTION ATTRIBUTABLE TO ANIMAL HEALTH PRODUCTS IN 2015-16



SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Economic contribution

ACIL Allen has used an input-output (IO) multiplier analysis to estimate the economic contribution of AHPs to the value-add embodied in each commodity group's production. This methodology is frequently used to understand the full linkages of an industry throughout the economy. The total estimated value-add attributable to AHPs in seven commodity groups is summarised in **Table ES 1**. The estimates show that use of AHPs:

- **created an additional 9,898 FTE jobs in Australia**
- **generated more than $578 million in wages, and**
- **contributed $2,668 million to the Australian economy.**

Total production for the seven commodity groups with the AHPs has been calculated to be $28.5 billion in 2015-16. The estimated direct plus indirect value added that can be attributed to the use of AHPs was $2,668 million in 2015-16. This indicates, for each dollar of commodity group production in 2015-16, the direct and indirect economic value added associated with AHPs is estimated to be approximately $0.094.[1]

TABLE ES 1 TOTAL ESTIMATED CONTRIBUTION ATTRIBUTABLE TO ANIMAL HEALTH PRODUCTS, 2015-16

Industry	Per cent of production	Value-add ($ million)	Compensation of employees ($ million)	FTE jobs
Beef	10.0	1,126	295	5,468
Dairy	15.0	592	87	1,979
Sheep – meat	12.0	353	64	844
Sheep – wool	10.5	283	54	695
Pigs	13.0	159	30	355
Poultry – meat	5.0	101	40	461
Poultry - layers (eggs)	8.0	55	8	96
TOTAL	**10.6**	**2,668**	**578**	**9,898**

Note: Totals may not add due to rounding

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Estimated consumer price impacts

ACIL Allen has applied a Computable General Equilibrium (CGE) model in estimating consumer price impacts. This model is the preferred approach for analysis of economic impacts due to its ability to incorporate market constraints, particularly with respect to labour and capital.

The CGE analysis indicates that the use of AHPs has **reduced the average consumption prices for meat, eggs and dairy products by approximately 12.8%** in 2015-16**.** In that year, average weekly household expenditure on these products was $40.53. Without AHPs, average weekly expenditure of household is estimated to be $45.70. Thus, AHPs are estimated to have **delivered $5.17 of savings (benefits) to average Australian weekly household expenditure** in 2015-16 (**Table ES 2**).

[1] That is $2,668/$28,498= 0.0936

TABLE ES 2 IMPACT ON AVERAGE WEEKLY HOUSEHOLD FRESH MEAT AND MEAT PRODUCTS EXPENDITURE, 2015-16

Broad CPI Group	Commodities	With animal health products used in production	Price impacts from CGE model	Without animal health products used in production
		$	%	$
Meat and eggs		**24.71**	**12.0**	**27.7**
	Beef and veal	7.52	11.3	8.37
	Pork	4.91	14.5	5.62
	Lamb and goat	3.50	13.8	3.98
	Poultry	6.82	11.0	7.57
	Eggs	1.96	9.2	2.14
Dairy and related products		**15.82**	**15.9**	**18.33**
	Milk	5.78	15.9	6.70
	Cheese	4.70	15.9	5.45
	Ice cream and other[a]	5.34	10.0	5.87
TOTAL		**40.53**	**12.8**	**45.70**

[a] Other dairy products include butter, yogurt, powdered milk and canned and bottled baby foods

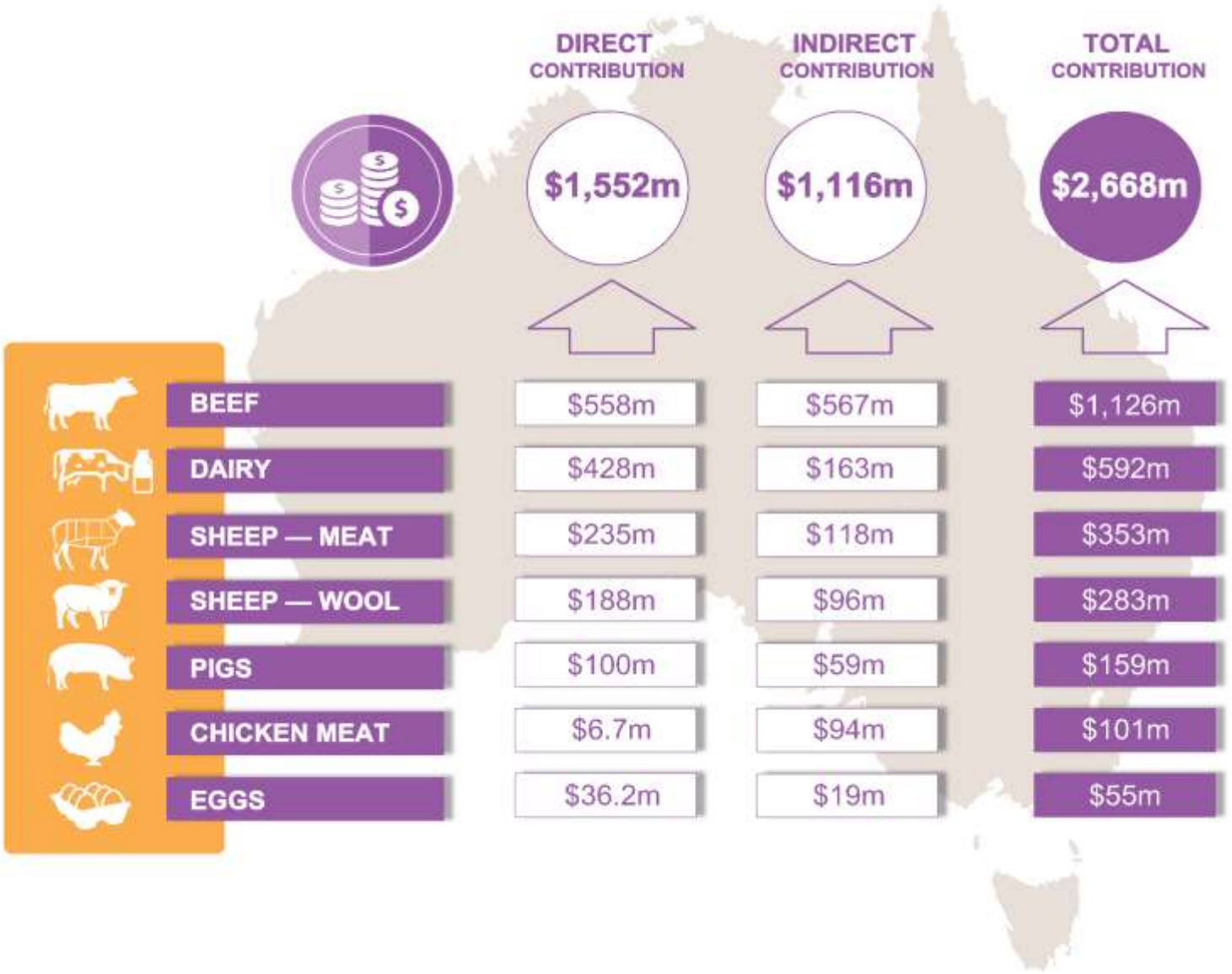
SOURCE: ABS 2017 AND ACIL ALLEN CONSULTING ESTIMATES BASED ON CGE MODELLING

The total economic contribution attributable to AHPs in 2015-16 is depicted in **Figure ES 2**.

The total employment contribution attributable to AHPs in 2015-16 is depicted in **Figure ES 3**.

The total economic and employment contribution attributable to AHPs in 2015-16 is depicted in **Figure ES 4**.

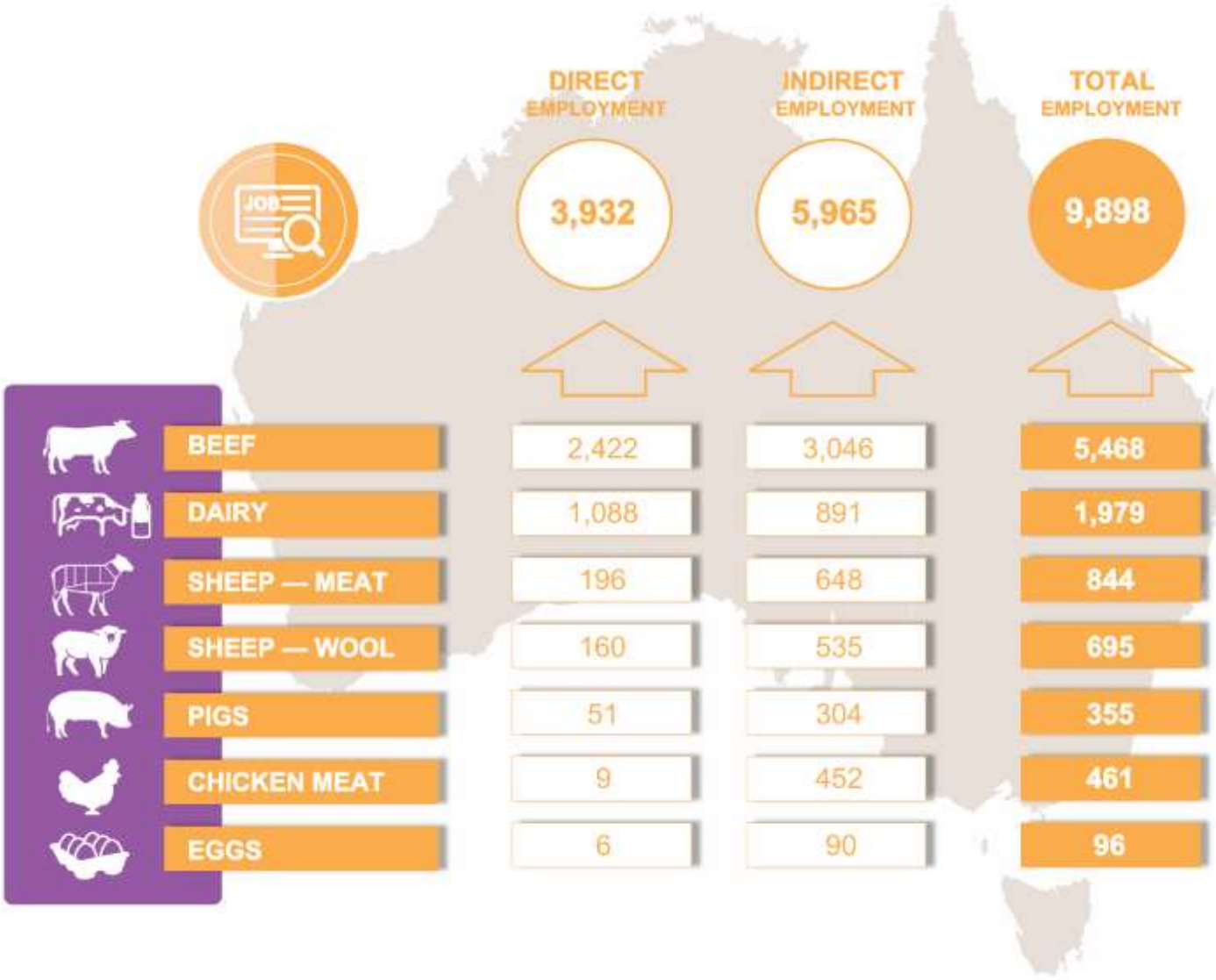
FIGURE ES 2 ESTIMATED TOTAL ECONOMIC CONTRIBUTION ATTRIBUTABLE TO ANIMAL HEALTH PRODUCTS USE IN 2015-16



Note: Totals may not add due to rounding.

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

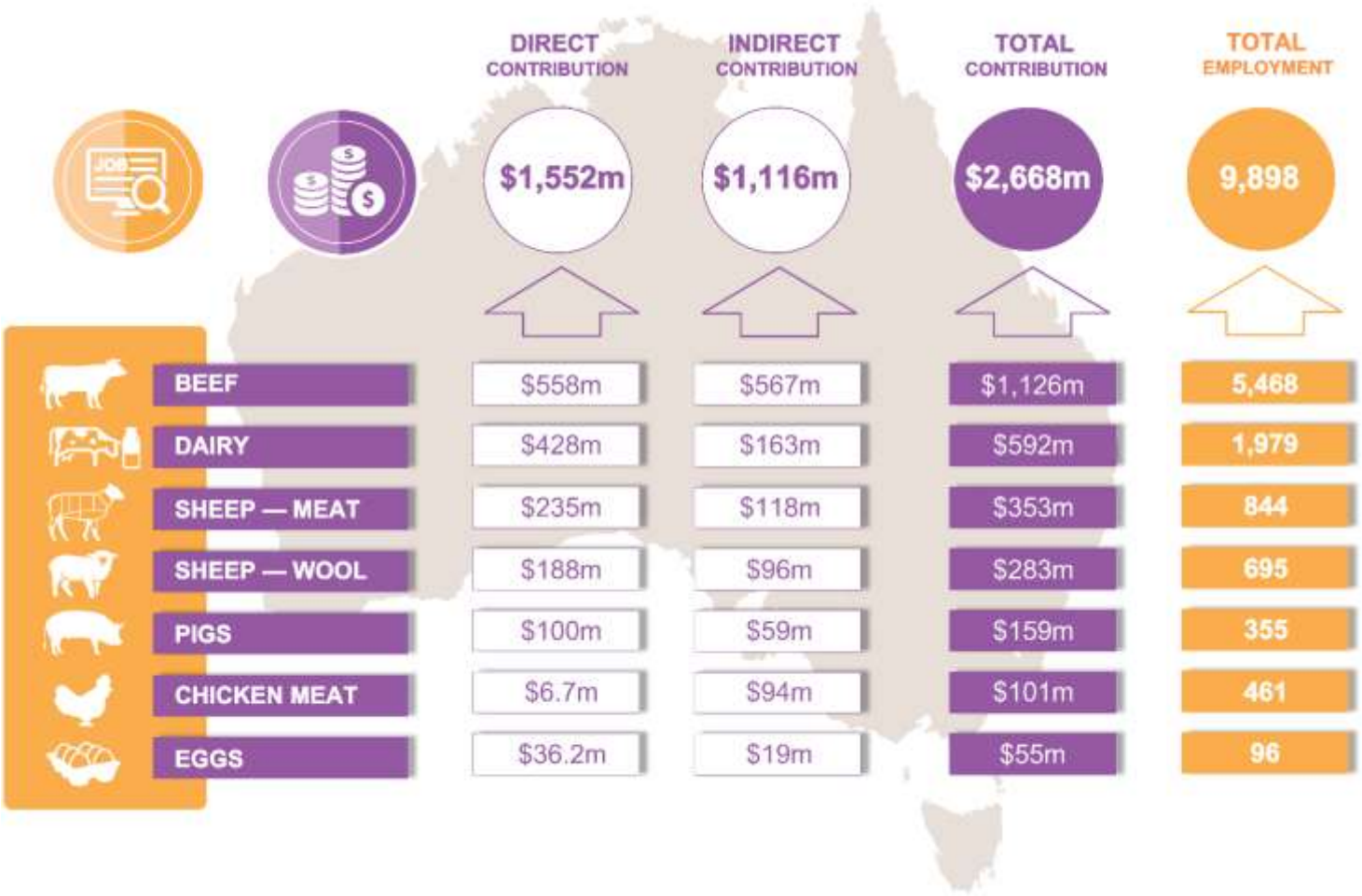
FIGURE ES 3 ESTIMATED TOTAL EMPLOYMENT CONTRIBUTION ATTRIBUTABLE TO ANIMAL HEALTH PRODUCTS USE IN 2015-16



Note: Totals may not add due to rounding.

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

FIGURE ES 4 ESTIMATED TOTAL ECONOMIC AND EMPLOYMENT CONTRIBUTION ATTRIBUTABLE TO ANIMAL HEALTH PRODUCTS USE IN 2015-16



Note: Totals may not add due to rounding.

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

GLOSSARY OF TERMS

ABS	Australian Bureau of Statistics
AHPs	Animal health products
AMA	Animal Medicines Australia
APVMA	Australian Pesticides and Veterinary Medicines Authority
CGE	Computable general equilibrium
COE	Compensation of employees
FTE	Full time equivalent
GDP	Gross Domestic Product
IO Analysis	Input-Output Analysis
MLA	Meat and Livestock Australia
PRDC	Porcine Respiratory Disease Complex
PRRS	Porcine Reproductive and Respiratory Syndrome
SNA93	System of National Accounts 1993

1 INTRODUCTION

Animal health products (AHPs) refer to the range of products that keep animals healthy and resistant to disease and parasites. AHPs are commonly defined as:

> …. the pharmaceuticals, vaccines, and feed additives used to keep animals healthy. Different types of animal medicines include anaesthetics, antacids, anti-infectives (antibiotics, antimicrobials), biologicals (vaccines, immunisations), anti-inflammatories, parasiticides, muscle relaxants — in other words, there is likely to be an animal health product available to treat or prevent most common animal ailments and injuries. Animals get their medicines primarily by injection, in their feed or water, orally (tablets, capsules, bolus, feed blocks), or topically (creams, pastes, ointments, sprays).
>
> *https://healthforanimals.org/our-sector/animal-health-products.html*

AHPs are used to protect animals from diseases that can increase mortality, reduce productivity and/or preclude farm products from being sold. They are also used to treat ill, injured or diseased animals, to return them to full health.

Without access to vaccines, antimicrobial products, parasiticides and other AHPs, farm productivity would be reduced due to:

- higher farm input costs per unit of production — sick animals are less productive, reducing returns on farm investment
- higher animal mortality due to illness or disease, and
- more labour-intensive stock management practices to control and manage disease on farm.

Additionally, consumers receive benefits from farm use of AHPs. Increased farm productivity allows consumers to purchase high quality, safe and nutritious animal products at a lower price.

1.1 Scope of the study

Animal Medicines Australia (AMA) represents registrants and approval holders of AHPs in Australia. AMA's members include the companies which manufacture, formulate and register veterinary and animal medicine products that prevent, control and cure disease across the companion animal, livestock and equine sectors. AMA works on behalf of these companies to help shape the policy and regulatory environment in a way which enhances investment and innovation in new AHPs. AMA uses evidence-based economic and empirical analysis as a core part of its advocacy for more responsive policy and regulation.

In this context, AMA has engaged ACIL Allen Consulting to provide an independent quantitative analysis of the economic contribution that AHPs make to the production of seven commodity groups — beef cattle, dairy, pigs, sheep (meat), sheep (wool), chicken (meat) and eggs — for the financial year 2015-16.

The key objectives of the analysis are to:

— Quantify the net contribution to economic output made by livestock farmers using AHPs to control animal infections, parasites and other diseases, and

— Quantify the economic benefit to consumers from agricultural use of AHPs,

To meet these objectives ACIL Allen developed a unique methodology and economic model that estimates the contribution and impacts of AHPs used by the seven selected commodity groups. The remaining sections of this report explain how ACIL Allen has modelled the impact of AHPs and estimated their impact.

1.2 How to interpret this report

This report provides the outcomes of ACIL Allen modelling and identifies the economic and employment contribution of AHPs used in key livestock industries.

In doing so, the report argues that AHPs are an essential input to productive and sustainable livestock farming. The estimates reported here relate to the 2015-16 production activity attributable to AHPs used by the Australian livestock industry.

Establishing a counterfactual of what would have happened if AHPs were not used in 2015-16 is a difficult task. There is very limited research on production losses when AHPs are not used. For this reason, care has been taken to ensure that the estimates provided in this report are conservative and represent a low estimate for the economic benefits associated with AHP use.

The estimates should not be interpreted as an estimate of the change in output that would occur if different livestock farming practices were adopted.

1.3 Report outline

The remaining sections of this report are:

— *Chapter 2* outlines the methodology used to measure the net contribution of AHPs. The net contribution was estimated using input-output (IO) multiplier analysis under two distinct scenarios: 1) "with" and 2) "without" the use of AHPs in production. The consumer price impacts analysed in the report are measured using computable general equilibrium (CGE) modelling. Various data sources mentioned in this chapter have been used to estimate the counterfactuals.

— *Chapter 3* details the use of AHPs in Australian livestock production. It also considers the sales of AHPs in Australia 2015-16.

— *Chapters 4 to 7* analyse the contribution of AHPs to each commodity group. Each chapter estimates production losses with and without the use of AHPs (the counterfactual) and compares the two estimates to provide a net contribution of AHPs to each of the commodity groups. It considers this contribution through the lens of the major diseases that impact on production in each of the commodity groups.
  - *Chapter 4* analyses the contribution of AHPs to beef and dairy production.
  - *Chapter 5* analyses the contribution of AHPs to sheep and wool production.
  - *Chapter 6* analyses the contribution of AHPs to pig production.
  - *Chapter 7* analyses the contribution of AHPs to chicken meat and egg production.

— *Chapter 8* provides net contribution of AHPs to seven livestock industries in Australia, based on the assessments made in Chapters 4–7.

— *Chapter 9* summarises the productivity estimates from the assessments made in Chapters 4–7 and provides the price impacts based on comparative static CGE modelling. This modelling considers the supply and demand for goods and services in the Australian economy and considers capital and labour resource constraints. It also considers 125 commodities which underpin the livestock production benefits that can be attributed to the AHPs used by the seven commodity groups.

2 MEASURING ECONOMIC CONTRIBUTION AND PRICE IMPACTS

This chapter discusses the analytical framework and data sources used to estimate the economic contribution of AHPs for each commodity group.

ACIL Allen estimated the direct and indirect contribution to production resulting from use of AHPs by employing an IO analysis for each commodity group.

Details of IO analysis is provided in **Appendix A**.

The economic benefit provided to consumers associated with lower food prices was estimated using CGE modelling. Details about the use of CGE modelling to determine consumer price impacts are provided in **Appendix B**.

2.1 Economic contribution analysis

ACIL Allen has used IO multiplier analysis to estimate the economic contribution (or footprint) made by AHPs to the production of selected commodities in Australia. This is a methodology that is frequently used to understand the full linkages of an industry throughout the economy at a point in time. The analysis describes:

— the *direct* contribution that the industry makes to the Australian economy, plus

— the full extent of the *indirect* contribution the industry makes through their demand for intermediate inputs from other industries (active ingredients, packaging materials, electricity, machinery, freight etc.).

For this analysis the estimates of the economic contribution attributable to the use of AHPs have been made using 'simple multipliers'. For example, the report estimates the direct contribution made by the AHP industry to Australia's GDP and employment, and the contribution embodied in the industry's supply chain. The report does *not* estimate the 'consumption-induced effect'. That is, it does not include the economic effects associated with workers within the industry (or its supply chain) spending their after-tax income on other Australian goods and services (such as hairdressers, travel, retail trade etc.).

When properly calculated[2], estimates of value-add attributable to AHP use in livestock production from simple multipliers can be added to similar estimates for other non-overlapping industries (such as fishing, forestry, petroleum, aluminium, etc.) without summing to more than Australia's total GDP or employment. While these estimates of footprint are useful in many contexts, they provide a

[2] It is important to avoid double counting related to the intra-sectoral purchases and vertical supply chain activities. When adding the impact of related industries (where industry A supplies to industry B, for example) it is necessary to exclude the value of A's sales to B when calculating industry B's contribution. Ensuring that industries are completely non-overlapping is complex and certain simplifying assumptions generally need to be made.

conservative estimate of the total economic activity or employment that could be affected by a change in the industry.

A summary of economic contribution and economic impact analysis is provided in **Box 2.1**.

BOX 2.1 ECONOMIC FOOTPRINT ANALYSIS AND ECONOMIC IMPACT ANALYSIS

An economic **contribution** (or **footprint**) analysis differs from an analysis of economic **impact** in that it does not purport to consider how the economy would respond to the closure, contraction or expansion of an industry. More specifically, a footprint analysis considers how much of the economy or how many people are *currently* affected by the activities of the veterinary medicines and animal health products industry. In contrast, an economic impact analysis would consider how the overall economy would look before and after there had been a 'shock' to the industry and consumers and other parts of the economy had adjusted. An impact analysis recognises that there are competing uses for scarce factors of production and therefore considers how, for example, the beef and lamb markets would change in response to, say, increased production and exports of beef products. While IO multiplier analysis can (and are) used for economic impact analysis, it is not the preferred methodology for assessing the impacts of major industry adjustments. The preferred approach for the analysis of economic impacts is CGE modelling. A key feature of CGE models is their ability to incorporate market constraints, particularly regarding the key factors of labour and capital and relative price impacts.

SOURCE: ACIL ALLEN CONSULTING

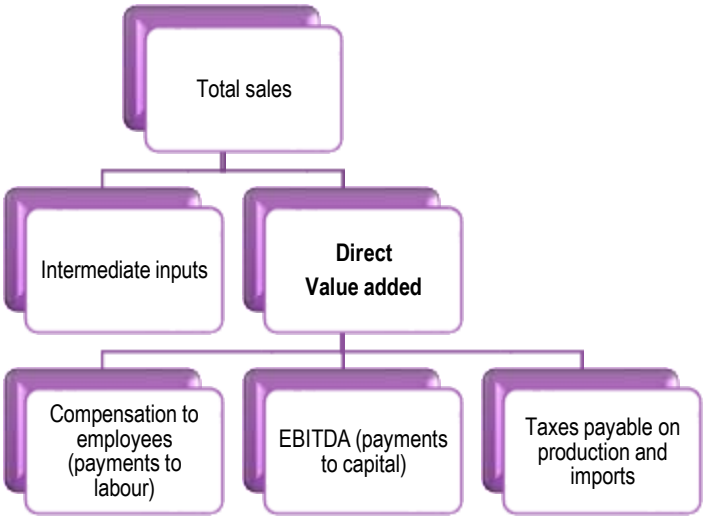
More details of direct and indirect contribution (footprint) analysis are provided below.

2.2 Direct economic contribution

The standard measure of economic contribution is the extent to which it increases the value of goods and services generated by the economy as a whole – in other words, the extent to which it increases economic activity as measured by gross domestic product (GDP).

An economy has a range of factors of production (including labour and capital stock) and access to various intermediate inputs. By using the factors of production appropriately, industries can add value to intermediate inputs by converting them into goods and services for use by consumers or other industries. An industry or business *contribution to GDP* measures the total value added and is defined as the income that an industry or business generates, less the cost of the inputs, plus certain taxes paid. The direct contribution of an industry or a company to the Australian economy can therefore be estimated by determining their payments to the factors of production plus the taxes (less subsidies) payable on production and imports. The direct economic contribution is shown graphically in **Figure 2.1**.

FIGURE 2.1 CALCULATION OF DIRECT VALUE ADDED



Note: EBITDA is equivalent to the SNA93 definition of gross operating surplus

SOURCE: ACIL ALLEN CONSULTING

Box 2.2 summarises definitions used by the ABS as part of the System of National Accounts 1993 (SNA93).

BOX 2.2 ABS DEFINITIONS OF VALUE ADDED

An industry's direct contribution to Gross Domestic Product or Gross State Product is well defined under the standard national accounting framework used by the Australian Bureau of Statistics (ABS), which is known as the System of National Accounts 1993 (SNA93). SNA93 recognises three different measures of value added:

a) Value added at purchasers' prices. This is defined as output valued at purchasers' prices, less intermediate consumption valued at producer prices. This measure is equivalent to the traditional measure of value added at market prices.
b) Value added at basic prices. In this measure, the output is valued at basic prices while intermediate consumption is valued at producer prices. In the case of beer production this measure excludes beer excise as this is viewed as a production tax levied on output.
c) Value added at factor cost. This measure excludes all production taxes net of subsidies. In other words, it excludes all production taxes – such as payroll taxes, fringe benefit taxes etc – and not just those that are levied on output.

The measure of value added to be used depends on the nature of the analysis that is being conducted. When presenting an industry view of GDP for example, the ABS uses value added at basic prices and adds an aggregate estimate of net taxes on products in question to give a total measure of GDP at purchasers' prices (ABS 1999).

SOURCE: ACIL ALLEN CONSULTING

2.3 Indirect economic contribution

Intermediate inputs can be sourced either from within the Australian economy or imported. If purchased within Australia, then the portion of value added embodied in the intermediate input is indirectly associated with the purchaser (e.g. in the manufacture veterinary medicines, consider the chemical formula and active ingredients, chemicals used in preparing the active components, the feedstock used in the chemical manufacturing, and so on). In a global context, the value-added chain can be measured by the value of the final goods and services consumed. In a national context, IO tables and the associated 'multipliers' can be used to estimate indirect economic contributions. IO

multipliers are summary measures generated from IO tables that can be used for predicting the total impact on all industries in the economy of changes in demand for the output of any one industry. Tables and multipliers can also be used to measure the relative importance of production chain linkages to different parts of the economy.

Some assumptions underpinning input-output multipliers can impede credible analysis. Understanding these assumptions is necessary to prevent inappropriately applying input-output multipliers. For example, where economic constraints are present or when the profile of a business or project differs substantially from the industry average. ACIL Allen does not consider that these circumstances apply to this analysis and that the use of IO multipliers is appropriate. Further information on IO tables and the calculation of multipliers can be found in ABS catalogue number 5246.0.[3]

As part of the study, existing documents and datasets on AHP use and livestock production in Australia have been reviewed. This review sought to:

- identify potential sources of data,
- assess the limitations of existing data and potential ways to fill any gaps, and
- gather information about the technical relationship between AHP use and industry outputs.

ACIL Allen has estimated the direct, indirect and total contribution of each livestock industry to the Australian economy with the use of AHPs and without the use of AHPs. The difference is the net economic contribution of AHPs to livestock production.

2.4 Data sources

The study requires the production data for AHPs and production data with and without the use of AHPs for selected seven livestock industries. The production data sources are listed in **Table 2.1**. As highlighted in the table, some information was obtained with assistance from AMA.

TABLE 2.1 POTENTIAL PRODUCTION DATA SOURCES

Source	Type	Relevance	Comments
Australian Bureau of Agricultural and Resource Economics (ABARES)	Australian Commodity Statistics	Provides data on each selected commodity production, exports and imports	The latest year is 2015-16 and it is an aggregate series. It does not provide information by product.
APVMA	Total value of the veterinary medicine and animal health product sales by product	Lists major product sales in Australia. This assisted in estimating the direct economic contribution of the AHPs sector.	Excludes sale value below $5,000. It does not provide data on which industries use these products.
ABS agricultural data (1)	Provides value of agriculture production in Australia for seven selected commodities and other agricultural commodities	Provides historical aggregate data to find relationships between output and inputs	Aggregate data that may not give precise relationships.

[3] ABS 1995, Information Paper, Australian National Accounts: Introduction to Input-Output Multipliers, 1989-90, Cat No: 5246. http://www.abs.gov.au/AUSSTATS/abs@.nsf/DetailsPage/5246.01989-90?OpenDocument

Source	Type	Relevance	Comments
ABS National Accounts Input-Output Tables (2)	Provides production cost structure of Australian major industries and their sales patterns	Due to the backward and forward linkages of supply chain relationships in the IO tables, the indirect economic contribution can be estimated using these tables.	Latest available Australian IO tables are for year 2015-16. Selected livestock commodities are aggregated into two sectors in the database — Sheep, Grains, Beef and Dairy and Poultry and Other Livestock — which require disaggregation to individual industries.

Notes: 1 ABS Cat no: 7218.0.55.001 Livestock and Meat, Australia, ABS Cat no: 7215.0 Livestock Products, AUSTRALIA, ABS Cat no: 7121.0 Agricultural Commodities, Australia, ABS Cat no: 8155 Australian Industry
2. ABS Cat no: 5209.0.55.001 - Australian National Accounts: Input-Output Tables
SOURCE: ACIL ALLEN CONSULTING

The data collected illustrate the current conditions within the commodity groups selected for this report. This picture of the current landscape provided the basis for developing a counterfactual scenario of what would have happened in the absence of AHPs. The picture also provides an understanding of the supply chain and how AHPs interact within the supply chain from being an input into the production process through to final consumption of finished products.

2.4.1 Data and information on disease prevalence, productivity and profitability

Ascertaining the net economic contribution of AHPs to the livestock industries' output requires data on livestock disease prevalence, productivity and profitability of livestock production with and without the use of AHPs in 2015-16.

Estimating the production losses avoided as a result of AHPs use is a difficult task. This is because the range of costs associated with livestock disease, prevalence and incidence rates vary across years, livestock types and location in Australia. The direct cost of treatment and lost market opportunities also differ for various diseases.

ACIL Allen reviewed available literature to understand the scope, costs of diseases and production losses with and without the use of AHPs. These are reported in their respective chapters.

Meat and Livestock Australia (MLA) has commissioned several publications that are useful in understanding disease prevalence, treatment costs and production losses associated with the diseases in red meat industries. These studies have carried out over the last decade in Australia to estimate the economic cost of animal diseases in two major livestock industries — cattle and sheep (goat).

- Australian Farm Institute (2015), The economic importance of Australia's livestock industries and the role of animal medicines and productivity-enhancing technologies, A report prepared for Animal Medicines Australia
- Lane J, Jubb T, Shephard R, Webb-Ware J, Fordyce G (2015) Priority list of endemic diseases for the red meat industries. MLA project B.AHE.0010.
- Sackett D, Holmes P, Abbott K, Jephcott S, Barber M (2006) Assessing the economic cost of endemic disease on the profitability of Australian beef cattle and sheep. MLA project B.AHW.0087.

However, there are only limited similar data available for other livestock industries. Industry expert discussions were undertaken to assess the key production effects of AHPs.

As part of this study, a model was developed for each livestock industry to show the relationships between inputs and outputs and their profitability and productivity relationships in estimating the production losses avoided. A similar approach was employed for each livestock category (or commodity group) to ensure consistency. Given the potential complexity of this work, the findings have been discussed with the AMA and other industry organisations to ensure that our understanding and interpretation of data is as accurate as possible.

3 USE OF ANIMAL HEALTH PRODUCTS IN LIVESTOCK PRODUCTION

This chapter provides an overview of the AHPs use by livestock industries in 2015-16.

There are two different sources of information available on the size of production and use in Australia of AHPs:

- Government sources — APVMA and ABS, and
- Other sources — AMA and IBISWorld.

While all sources provide useful information on the size of the sector; they differ in terms of value of sales reported in 2015-16. The explanation for this lies in differences in scope of coverage and the point at which value is assigned (e.g. factory gate, point of sale, farm gate). The various sources of information are described in this chapter along with ACIL Allen's estimates of the size of the sector and use by the seven key livestock commodity groups analysed.

3.1 Animal health products registered with APVMA

In Australia, agricultural chemicals are regulated by the Australian Pesticides and Veterinary Medicines Authority (APVMA) up until the point of final retail sale. This includes pre-marketing assessment, licensing of manufacturing sites, approval and registration of products as well as defining the content of labels describing instructions for safe and responsible use.

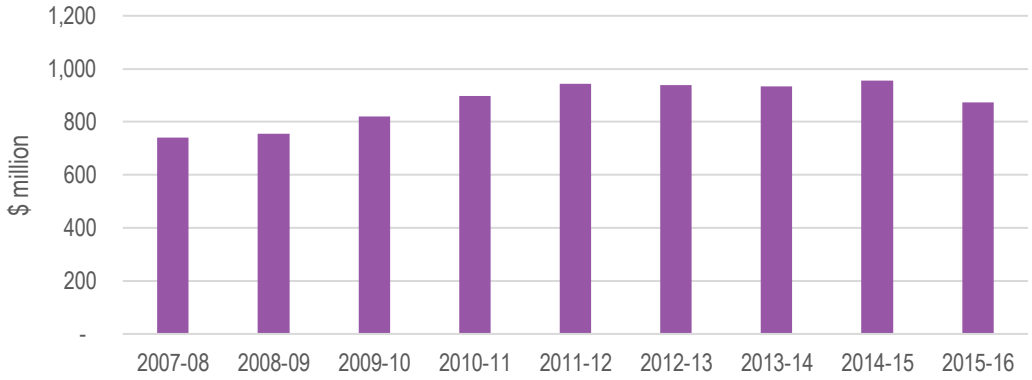
Total sales of AHPs registered with the APVMA are provided in **Figure 3.1**.

The APVMA data does not separate AHP sales for companion animals from those for production animals. Therefore, domestic sales of AHPs for livestock industries covered by this study differs from the sales data reported in **Figure 3.1**. The total sales (in factory gate prices) of all AHPs registered with the APVMA in 2015-16 were $874 million. This includes the livestock, equine and companion animal sectors.

The APVMA provides information on the types of products sold, but it does not include information on how products are used. However, this may be inferred from the product's approvals and label statements. However, the APVMA data does not provide data on use by industry sub-sector (i.e. APVMA data does not indicate which livestock industry the AHPs were used).

The industry produces a wide array of products. Nearly half of the sales are parasiticides followed by immunotherapy products (20%) and antibiotic and related products (8%) (**Table 3.1**).

FIGURE 3.1 APVMA REPORTED SALE VALUE, 2007-08 TO 2015-16



Note: The APVMA will generally waive the whole of the liability to pay a levy for registered products with sales below $5,000
SOURCE: APVMA, VARIOUS YEARS, HTTPS://APVMA.GOV.AU/NODE/10756

TABLE 3.1 VETERINARY MEDICINE PRODUCT SALES, 2015-16

Product types	Product purpose	Number of products	Sale value (A$m)	Per cent of total sales
Alimentary system	Anti bloat	17	1.29	0.1
	Antidiarrhoeals and scour treatments	17	1.47	0.2
	Laxatives, purgatives & lubricants, antispasmodics	14	4.24	0.5
Anaesthetics/analgesics	Anaesthetics—local and general	51	11.48	1.3
	Analgesics	21	5.32	0.6
Antibiotic & related	Antibiotic—intramammary	28	9.39	1.1
	Antibiotic—oral	197	29.00	3.3
	Antibiotic—parenteral	79	23.70	2.7
	Other anti-infective agents	47	1.97	0.2
	Sulfonamides	38	2.94	0.3
Antidotes	Antidotes	16	1.53	0.2
Cardiovascular system	Cardiac reactants, clotting agents	47	7.72	0.9
Central nervous system	Hypnotics, tranquilizers, emetics, antiemetics	43	5.50	0.6
Dermatological preps.	Antibiotics, antifungals, corticosteroid combinations	28	2.85	0.3
	antiseptics (dermatological and general)	134	24.50	2.8
	nonsteroidal antipruritics, keratolytics	35	5.45	0.6
Ear, nose, throat preps.	Aural	27	7.35	0.8
Endocrine system	Anabolic steroids	21	0.15	0.0
	Corticosteroids and adrenal compounds	32	3.65	0.4
	Sex hormones	53	9.22	1.1
	Tropic hormones (pituitary) & insulin preparations	37	7.58	0.9
Genitourinary system	Diuretics, acidifiers, alkanisers	25	1.89	0.2
	Uterine or vaginal acting agents	7	0.96	0.1

Product types	Product purpose	Number of products	Sale value (A$m)	Per cent of total sales
Immunotherapy	Antisera, antivenom	9	2.35	0.3
	Immunomodifying agents	11	2.78	0.3
	Injectable vaccines	179	136.13	15.6
	Nasal, oral, opthalmic vaccines	34	30.89	3.5
Misc	Miscellaneous	96	24.56	2.8
Musculoskeletal system	Anti-inflammatory agents	233	34.14	3.9
	Counter-irritants, rubefacients, poultices	13	2.48	0.3
Nutrition & metabolism	Antibiotic and anti-infective supplements	47	5.58	0.6
	Dietary/therapeutic pet foods	25	3.82	0.4
	Digestive enzyme supplements	13	1.36	0.2
	Electrolytes	53	4.84	0.6
	Growth promotants	65	20.68	2.4
	Iron and haemopoietic agents	22	1.67	0.2
	Probiotic and prebiotic	9	0.52	0.1
	Tonics, stimulants	12	0.46	0.1
	Vitamin, mineral, & nutritional supplements	196	23.69	2.7
Ophthalmic preparations	Ophthalmic preparations	20	2.74	0.3
Parasiticides	Birds—external	9	0.41	0.0
	Birds—internal	29	2.19	0.3
	Large & small animals—external	18	1.93	0.2
	Large animals—external	199	64.47	7.4
	Large animals—internal	294	55.22	6.3
	Large animals—internal & external	97	57.45	6.6
	Small animals—external	208	100.14	11.5
	Small animals—internal	274	71.75	8.2
	Small animals internal and external	39	51.25	5.9
Respiratory system	Expectorants, mucolytics, decongestants, bronchodilators, resp stimulants	18	1.27	0.1
GRAND TOTAL		**3,236**	**873.89**	**100.0**

SOURCE: APVMA

3.2 AMA data

AMA has provided some information on the sale of AHPs as shown in **Table 3.2**. The AMA data provides information on the sale of AHPs to companion, equine and livestock animal sectors. Based on 2015-16 data, nearly 50% of AHPs were used by companion animals. The differences between the AMA and the APVMA data (**Table 3.1**) lie in their different scope and coverage.

TABLE 3.2 ANIMAL HEALTH PRODUCTS USE IN AUSTRALIA, 2015-16

	Companion ($m)	Production ($m)	Total ($m)
Anaesthetics Analgesics and Antibiotics	30.3	40.6	70.9
Anticoccidial anti-inflammatory	14.1	7.7	21.8
Orals and injectables	15.6	95.6	111.3
Nervous, dermatological and other related products	251.2	5.3	256.5
Endocrine related products	6.3	8.4	14.6
Parasites	22.4	135.2	157.6
Vaccines	60.5	118.5	179.0
TOTAL	**400.3**	**411.3**	**811.6**

SOURCE: AMA UNPUBLISHED DATA

3.3 Estimated animal health products use by livestock industries

The gross value of seven commodity groups' production and their estimated AHP use are provided in **Table 3.3**, based on the ABS data sources.[4] This is consistent with the cost structure of the livestock industries published by the ABS. In 2015-16, the estimated gross value of production was nearly $29 billion.

In aggregate, the seven commodity groups use around $1 billion worth of AHPs. It should be noted that the sales revenue reported to the APVMA is lower than the estimates based on the ABS data sources. This is because ABS and APVMA values are calculated at different points in the supply chain. Each series includes different elements of cost. ABS data are calculated at 'basic prices' paid by users at the farm gate. This includes wholesale and retail margins, transport and distribution costs and production taxes (excluding GST). APVMA data are based on a notional wholesale or 'factory gate' price that excludes these components.

The use of AHPs by other industries (for example horse racing), pets, minor livestock industries and other uses have not been considered in this study.

TABLE 3.3 ESTIMATED VETERINARY MEDICINES USE BY LIVESTOCK INDUSTRIES, 2015-16

Livestock category	Gross value of production (A$m)	Estimated value of AHPs used in livestock (A$m)	Per cent of gross value of production (%)	Per cent of AHPs used in livestock (%)
Cattle	13,086.8	490.7	3.7	49.5
Dairy	4,282.2	127.9	3.0	12.9
Pigs	1,393.1	68.4	4.9	6.9
Sheep (meat)	3,239.4	88.5	2.7	8.9
Sheep (wool)	2,964.9	63.1	2.1	6.4
Chicken (meat)	2,748.4	127.3	4.6	12.8
Eggs	782.8	25.8	3.3	2.6
TOTAL	**28,497.6**	**991.7**	**3.5**	**100.0**

Note: Data by estimated value of agricultural operations of $40,000 or greater.

SOURCE: ACIL ALLEN CONSULTING ESTIMATES BASED ON ABS DATA SOURCES

[4] ABS Cat No 7503: Value of Agricultural Commodities Produced, and 5209.0.55.001: Australian National Accounts: Input-Output Tables

4 BEEF AND DAIRY PRODUCTION ATTRIBUTABLE TO ANIMAL HEALTH PRODUCTS

This chapter estimates the level of beef and dairy production that was attributable to AHP use in 2015-16. The estimates are derived from a study by Lane *et al*[5] for MLA in 2015, which was used to estimate the avoided production losses for major types of diseases that affect beef cattle. Lane *et al* estimated the economic cost of each disease through a process in which several diseases were identified and prioritised according to prevalence and distribution. ACIL Allen have subsequently analysed 17 cattle diseases in more detail.

Other studies[6,7] have been used to supplement Lane *et al's* analysis and provide additional data where needed.

4.1 Diseases and estimated economic costs

4.1.1 Beef cattle production

The beef industry is a major agriculture industry operating throughout the country. Based on the Australian Farming Institute (2015), Lane *et al* (2015) and Sackett *et al* (2006) reports, seventeen major cattle diseases have been ranked, and the disease cost estimates provided in Lane *et al* (2015) study have been updated.

The Lane *et al* study's 2010-11 costs associated with curative or preventative treatment of disease have been updated using the ABARES' index of prices paid for AHPs. The value of production losses was updated using the ABARES' weighted average cattle saleyard price. The index of prices paid for AHPs was increased by around 5%, and sale yard prices were increased by around 55% over the last five years (between 2010-11 and 2015-16).

The Lane *et al* study reported costs on a per head of cattle and a per herd basis in 2010-11. Our beef cattle numbers for 2015-16 were sourced from ABARES and total costs were estimated for 2015-16. The ABS reported that, in 2015-16, there were 8.8 million cattle in the southern region and 13.5 million cattle in the northern region of Australia. Disease occurrence and prevalence differs between the northern and southern regions of Australia. For example, bloat is a major problem in the south, while it is a relatively minor problem in the north.

The estimated 2015-16 costs of beef cattle diseases are provided in **Table 4.1**. The costs reported in Lane *et al* were updated using the summary data sourced from a personal communication with Dr Richard Shephard, an expert livestock disease modeller who has previously advised MLA.

[5] Lane J, Jubb T, Shephard R, Webb-Ware J, Fordyce G 2015, Priority list of endemic diseases for the red meat industries. MLA project B.AHE.0010

[6] Such as ACIL Allen's 2006 assessment of the economic cost of endemic disease on the profitability of Australian beef cattle and sheep producers for MLA by Sackett *el al*

[7] Australian Farm Institute study of the economic importance of Australia's livestock industries and the role of animal medicines and productivity-enhancing technologies in livestock production,

TABLE 4.1 ECONOMIC COSTS OF MAJOR BEEF CATTLE DISEASES, 2015-16

	Lane *et al* 2015				ACIL Allen estimates for 2015-16			
	Treatment	Prevention	Production	Total	Treatment	Prevention	Production	Total
	$ million	$ million	$ million	$ million	$ million	$ million	$ million	$ million
Cattle tick	23.1	1.7	136.4	161.2	21.0	1.5	178.9	201.5
Bovine viral diarrhoea)	0.0	7.7	106.7	114.4	0.0	7.0	144.6	151.6
Buffalo fly	0.0	30.6	68.0	98.6	0.0	27.8	92.7	120.5
Dystocia	9.1	39.9	48.7	97.7	8.2	35.9	66.2	110.3
Neonatal mortalities	0.0	0.0	96.1	96.1	0.0	0.0	130.4	130.4
Internal parasites	0.0	50.2	43.4	93.6	0.0	45.2	58.6	103.8
Bloat	3.1	24.9	48.8	76.8	2.8	22.4	65.8	91.0
Bovine ephemeral fever	2.9	0.1	56.7	59.8	2.7	0.1	77.3	80.1
Botulism	0.0	12.5	15.5	28.0	0.0	11.4	21.0	32.4
Grass tetany	1.2	9.7	13.4	24.3	1.1	8.7	18.1	27.9
Calf scours complex	6.4	2.4	14.3	23.1	5.8	2.2	19.3	27.2
Vibriosis	0.0	1.9	19.1	21.0	0.0	1.7	25.9	27.6
Theileriosis	0.3	0.0	19.2	19.6	0.3	0.0	26.0	26.3
Pinkeye	2.1	4.5	6.7	13.3	1.9	4.1	9.1	15.0
Clostridial infection	0.0	2.0	4.7	6.7	0.0	1.8	6.3	8.1
Tick fever	0.0	2.9	1.4	4.3	0.0	2.6	1.9	4.5
Johne's disease	0.0	0.0	2.8	2.8	0.0	0.0	3.8	3.8
TOTAL	**48.3**	**191.1**	**701.9**	**941.2**	**43.7**	**172.4**	**946.0**	**1162.1**

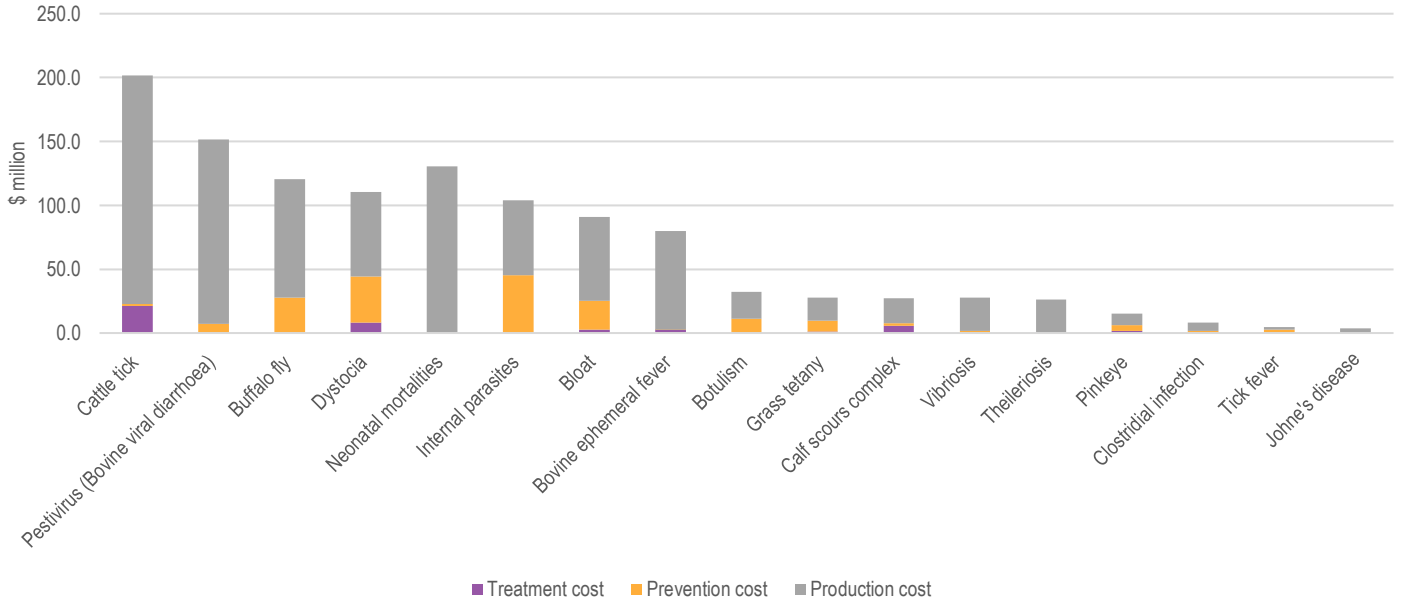
SOURCE: ACIL ALLEN CONSULTING UPDATE BASED ON LANE ET AL 2015 STUDY AND DISCUSSIONS WITH THE LIVESTOCK DISEASE MODELLERS

The estimated economic costs reported in **Table 4.1** are associated with the prevention costs, treatment costs and production losses. Based on ACIL Allen updated costs, cattle tick is the major disease in Australia in terms of economic cost, followed by bovine ephemeral fever and buffalo fly.

In 2015-16 over $43.7 million was spent on treatment and over $172.4 million was spent on preventative measures to control major cattle diseases in Australia. Despite this, estimated production losses were $946 million. The farm gate value of beef cattle production in 2015-16 was $13,087 million. Production losses were therefore 7.2% of value of production in 2015-16.

Economic costs of major cattle diseases also summarised in **Figure 4.1**.

FIGURE 4.1 ECONOMIC COSTS OF MAJOR CATTLE DISEASES, 2015-16



SOURCE: ACIL ALLEN CONSULTING UPDATE BASED ON LANE ET AL 2015 STUDY AND DISCUSSIONS WITH THE LIVESTOCK DISEASE MODELLERS

4.1.2 Dairy production

The analysis of dairy production draws also heavily on Lane *et al*'s 2015 study. It also integrates a 2008 study on dairy disease costs prepared by John Lloyd for the Animal Health Alliance.[8] This Lloyd study reported annual dairy disease prevalence, costs and expenses. The estimated total economic costs reported in **Table 4.2** are associated with the prevention costs, treatment costs and production losses after preventative and treatment measures. These measures relate to the major diseases of dairy such as, dystocia, mastitis, ketosis as well as lameness and reproduction. The study focuses on the south eastern temperate zone of Australia where most of Australia's diary production occurs.

TABLE 4.2 ESTIMATED ECONOMIC COSTS OF MAJOR DAIRY DISEASES, 2015-16

	Lane et al 2015 and Lloyd 2008				ACIL Allen update 2015-16			
	Treatment	Prevention	Production	Total	Treatment	Prevention	Production	Total
	$ million	$ million	$ million	$ million	$ million	$ million	$ million	$ million
Dystocia	32.3	39.0	300.0	371.3	36.2	42.6	322.8	401.6
Mastitis	48.0	19.8	65.8	133.6	52.4	14.3	102.6	169.3
Ketosis	5.3	18.8	14.2	38.3	5.7	20.5	22.4	48.6
Neonatal mortalities	4.0	4.2	10.0	18.2	11.6	4.6	14.9	31.1
Milk fever	5.3	18.8	14.2	38.3	21.8	13.1	121.1	156.0
TOTAL	**94.8**	**100.6**	**404.2**	**599.6**	**127.9**	**95.1**	**583.7**	**806.7**

SOURCE: ACIL ALLEN CONSULTING UPDATE BASED ON LANE ET AL 2015 STUDY AND DISCUSSIONS WITH THE LIVESTOCK DISEASE MODELLERS

Dystocia is the major disease in Australia in terms of economic cost followed by mastitis. ACIL Allen estimates that, in 2015-16, over $127.9 million was spent on treatment of diseases and over $95.1 million was spent on preventative measures to control major dairy diseases in Australia. The estimated resulting production losses were $583.7 million. The farm gate value of dairy production in

[8] John Lloyd 2008, Cost of Diseases, Prepared by Menari Business Solutions for Animal Health Alliance.

2015-16 was $4,282 million. These production losses are estimated to be 13.6% of value of total production in 2015-16.

4.2 Method of attribution

The production that can be attributable to AHPs is a production that would have not been possible without the use of AHPs.

4.2.1 Beef cattle production

Beef production losses from endemic diseases listed in **Table 4.1**, if not treated with AHPs, vary between 10% and 60%. The farm gate value of beef cattle production was $13,087 million in 2015-16. The estimated production losses of $946 million with preventative and treatment measures, reported in **Table 4.1** represented 7.2% of beef cattle production in 2015-16.

The extent to which production is increased by AHPs has had to be estimated. Mark Goodwin Consulting[9] reported that the percentage value attributable to crop protection products in the USA was between 10% and 100%. Approximately 36% of total value of field crop production is made possible by the use of crop protection products in USA. Based on the information from Mark Goodwin Consulting, Deloitte has estimated that up to 68% of total value of crop production in Australia is attributable to crop protection products.[10]

ACIL Allen has not been able to identify a comparable Australian study that could be applied to livestock production in Australia.

ACIL Allen has therefore taken a conservative approach and assumed that beef cattle production in 2015-16 would have been 10% lower if the industry had not used AHPs. Of this 10% attributable to AHPs, 7.2% is accounted for in **Table 4.1** and an additional 2.8% has been estimated based on data supplied by Dr Shepherd. Dr Shepherd has estimated an indicative figure for production losses for each disease, for a given prevalence (low, medium and high) if no prevention and treatment methods were used. These production losses have been assumed to be more than double the production losses with the treatment and control.

The attribution approach used by ACIL Allen is detailed in **Box 4.1** below, with the results of the approach reported in the sections that follow.

BOX 4.1 ATTRIBUTION APPROACH USED BY ACIL ALLEN FOR THE LIVESTOCK INDUSTRY

1. A priority list of diseases was developed for each livestock category and confirmed with the AMA and its stakeholders.
2. Prevention and treatment costs were inferred from previous studies. This was updated to 2015-16 using the farm input price index from ABARES.
3. Production losses associated with various diseases were estimated in a manner similar to that used in the Lane *et al* (2015) study and consultations with the previous MLA disease cost modellers.
4. Production of each livestock category was summarised with and without AHPs, and
5. The profitability and productivity were estimated with and without AHPs for each livestock industry.

SOURCE: ACIL ALLEN CONSULTING

[9] Mark Goodwin Consulting M 2011, The contribution of crop protection products to the United States economy, accessed on 15 May 2018 at https://static1.squarespace.com/static/59b55b2b37c581fbf88309c2/t/5a2a8074f9619a97da953a70/1512734840313/The+Contribution+of+Crop+Protection+Products+to+the+US+Economy.pdf

[10] Deloitte Access Economics 2013, Economic activity attributable to crop protection products, report to CropLife Australia, accessed on 15 May 2018 at https://www2.deloitte.com/content/dam/Deloitte/au/Documents/finance/deloitte-au-fas-economic-activity-attributable-crop-protection-product-nov-2013-250914.pdf

4.2.2 Dairy production

The dairy production that can be attributable to AHPs is the production that would have occurred if the dairy producers had not used AHPs. The production losses assumed in this study are based on the literature reviewed in and industry consultation. It was estimated that the production losses from endemic diseases in dairy would have been 15% if AHPs had not been used in 2015-16. The estimated 13.6% of production losses *with AHP treatment* reported in **Table 4.2** ($583.7 million) are included in the overall production losses.

4.3 Contribution of animal health products to production

To estimate the economic contribution of the use of AHPs for beef and dairy production, simple multiplier analysis was applied to determine the contribution of production with and without AHPs. The difference between the two scenarios was then used to determine the contribution of AHPs to beef and dairy production in Australia. The detailed breakdown of the estimates for the scenarios of with and without AHPs is provided in **Appendix C**.

The direct, indirect and total estimated impacts of AHPs in beef cattle and dairy production in Australia are provided in **Table 4.3**.

TABLE 4.3 CONTRIBUTION OF ANIMAL HEALTH PRODUCTS TO BEEF AND DAIRY PRODUCTION, 2015-16

	Beef cattle			Dairy		
Impacts	Compensation of employees	Value-add	Employment	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE	$ million	$ million	FTE
Direct	47	558	2,422	15	428	1,088
Indirect	248	567	3,046	72	163	891
Total	295	1,126	5,468	87	592	1,979

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

4.3.1 Direct economic contribution of animal health products

Beef cattle production

The value of beef cattle production in 2015-16 was $13,087 million. It has been assumed that AHPs increased beef cattle production in 2015-16 by 10% or $1,309 million. The direct economic contribution (value-add) embodied in revenue is estimated to have been $558 million (**Table 4.3**).

It is estimated that AHPs used in beef cattle production increased employment in the beef cattle industry by 2,422 FTE persons in 2015-16.

Dairy production

The farm gate value of dairy production was $4,282 million in 2015-16. It has been assumed that AHP use in 2015-16 increased dairy production by 15%, or $642 million. The direct economic contribution (value-add) embodied in the revenue is estimated to have been $428 million (**Table 4.3**).

The direct employment contribution from AHP use in dairy production is estimated at 1,088 FTE persons in 2015-16.

4.3.2 Indirect economic contribution of animal health products

Beef cattle production

It is estimated that:

— The use of AHPs in beef cattle production indirectly contributed $567 million to the Australian economy,

— Around $248 million in compensation to employees was indirectly supported by AHPs in beef cattle production, and
— Around 3,046 FTE jobs were indirectly supported by AHPs in beef cattle production.

Dairy production

It is estimated that:

— The additional production attributable to AHPs in dairy production indirectly contributed $163 million to the Australian economy,
— Around $72 million in compensation to employees was indirectly supported by AHP use in dairy, and

Around 891 FTE jobs were indirectly supported by AHP use in dairy.

4.3.3 Total economic contribution of animal health products

Beef cattle production

Adding the direct and indirect economic contributions attributable to AHP use in beef cattle production provides the economic footprint of AHP use in Australian beef cattle production.

It is estimated that the AHP use in beef cattle production in Australia in 2015-16 resulted in:

— a total contribution of $1,126 million to GDP, comprising:
  – $558 million directly from the industry (direct contribution),
  – $567 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution), and
— around 5,468 FTE jobs.

Dairy production

Adding the direct and indirect economic contributions attributable to AHP use in dairy production provides economic footprint of the AHP use in Australian dairy production.

It is estimated that the AHP use in dairy production in Australia in 2015-16 resulted in:

— a total contribution of $592 million to GDP, comprising:
  – $428 million directly from the industry (direct contribution),
  – $163 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution), and
— around 1,979 FTE jobs.

4.4 Summary

The estimated impacts that are attributable to AHP use in beef cattle production are summarised in **Figure 4.2**.

FIGURE 4.2 ESTIMATED CONTRIBUTION OF ANIMAL HEALTH PRODUCTS USE TO BEEF CATTLE PRODUCTION, 2015-16

Note: Totals may not add due to rounding

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

The estimated impacts that are attributable to AHP use in dairy production are summarised in **Figure 4.3**

FIGURE 4.3 ESTIMATED CONTRIBUTION OF ANIMAL HEALTH PRODUCTS USE TO DAIRY PRODUCTION, 2015-16

Note: Totals may not add due to rounding

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

In summary:

- it is estimated that around 10% of beef cattle production and 15% of dairy production in 2015-16 was attributable to AHP use, and
- the contribution to Australian GDP of AHP use in beef cattle production in 2015-16 was $1,126 million, and $592 million of GDP was attributable to AHP use in dairy production.

5 SHEEP MEAT AND WOOL PRODUCTION ATTRIBUTABLE TO ANIMAL HEALTH PRODUCTS

This chapter estimates the level of sheep production that was attributable to AHP use in 2015-16. The estimates were derived from a study by Lane *et al* for MLA in 2015,[11] which was used to estimate the avoided production losses for major diseases that affect sheep production. Lane *et al* estimated the economic cost of each disease through a process in which several diseases were identified and prioritised according to prevalence and distribution. ACIL Allen have subsequently analysed 23 sheep diseases in more detail.

Other studies[12,13] were used to supplement Lane *et al's* analysis and provide additional data where needed.

5.1 Sheep diseases and estimated economic costs

5.1.1 Sheep meat production

There have been various estimates of annual costs to production from sheep disease. Most studies have concluded that the largest cost in Australia is associated with treatment and control of internal parasites.[14]

The estimated updated costs of sheep diseases are provided in **Table 5.1**.

Sheep meat production losses from diseases were estimated at $357.7 million in 2015-16. Sheep meat farm gate value was $3,239 million. Thus, production losses were 11% of value of sheep meat production.

The estimated economic costs reported in **Table 5.1** are associated with prevention and treatment costs, and production losses notwithstanding preventative and treatment measures. Total production losses were $357.7 million, which were part of the 11% of the value of sheep production in 2015-16.

[11] Lane J, Jubb T, Shephard R, Webb-Ware J, Fordyce G 2015 Priority list of endemic diseases for the red meat industries. MLA project B.AHE.0010
[12] Meat and Livestock Australia 2006, Assessing the economic cost of endemic disease on the profitability of Australian beef cattle and sheep producers. Prepared by Sackett D, Holmes P, Abbott K, Jephcott S, Barber M, MLA project B.AHW.0087.
[13] Australian Farm Institute 2015, The economic importance of Australia's livestock industries and the role of animal medicines and productivity enhancing technologies, a report prepared for Animal Medicines Australia.
[14] Australian Farm Institute op cit.

TABLE 5.1 ECONOMIC COSTS OF SHEEP DISEASES ON SHEEP PRODUCTION, 2015-16

	Lane *et al.* 2015 study				ACIL Allen update 2015-16			
	Treatment	Prevention	Production	Total	Treatment	Prevention	Production	Total
	$ million	$ million	$ million	$ million	$ million	$ million	$ million	$ million
Neonatal mortalities	0.0	7.2	34.2	41.4	0.0	7.0	17.7	24.7
Internal parasites	0.0	56.3	205.1	261.4	0.0	54.7	106.4	161.2
Dystocia	0.0	38.9	92.6	131.5	0.0	17.6	48.0	65.7
Weaner ill thrift	0.0	21.7	90.8	112.5	0.0	21.1	47.1	68.3
Flystrike	6.8	34.4	62.7	103.9	6.6	33.4	32.5	72.6
PRGT	0.0	3.6	59.4	63.0	0.0	3.5	30.8	34.3
Lice	2.3	24.7	15.3	42.3	2.2	24.0	7.9	34.2
Mastitis	0.1	0.0	31.2	31.3	0.1	0.0	16.2	16.3
Footrot	0.0	1.6	5.7	7.3	0.0	1.6	3.0	4.5
Arthritis	0.4	3.0	20.3	23.7	0.4	2.9	10.5	13.8
Ovine Johne's disease	0.0	8.4	12.4	20.8	0.0	8.2	6.4	14.6
Clostridial diseases	0.0	16.1	2.9	19.0	0.0	15.7	1.5	17.2
Liver fluke	0.0	0.8	14.1	14.9	0.0	0.8	7.3	8.1
Pneumonia	0.4	0.0	11.8	12.2	0.4	0.0	6.1	6.5
Caseous Lymphadenitis	0.0	5.7	5.0	10.7	0.0	5.5	2.6	8.1
Pregnancy toxaemia	0.3	4.3	4.9	9.5	0.3	4.1	2.6	7.0
Hypocalcaemia	0.6	2.6	3.4	6.7	0.6	2.6	1.8	5.0
Foot abscess	1.1	0.1	5.1	6.3	1.1	0.1	2.6	3.8
Bacterial enteritis	0.3	0.0	5.9	6.2	0.3	0.0	3.1	3.3
Pyrrolizidine alkaloidosis	0.0	0.0	4.0	4.1	0.0	0.1	2.1	2.1
Sheep measles (Taenia ovis)	0.0	0.0	0.5	0.5	0.0	0.0	0.3	0.3
Campylobacter abortion	0.0	0.0	1.6	1.6	0.0	0.0	0.8	0.8
Sarcocystis	0.0	0.0	0.4	0.4	0.0	0.0	0.2	0.2
TOTAL	**12.3**	**229.3**	**689.4**	**931.1**	**12.0**	**203.0**	**357.7**	**572.7**

SOURCE: ACIL ALLEN CONSULTING UPDATE BASED ON LANE ET AL 2015 STUDY AND DISCUSSIONS WITH THE LIVESTOCK DISEASE MODELLERS

5.1.2 Wool production

The estimated updated costs of sheep diseases on wool production are provided in **Table 5.2**. Some sheep diseases, such as flystrike, significantly affect the quality and value of wool.

The estimated economic costs reported in **Table 5.2** are associated with the prevention and treatment costs and production losses after preventative and treatment measures. The estimated wool production losses from sheep diseases were estimated at $238.5 million. This is 8% of value of wool production in 2015-16. An additional 2.5% of losses would have occurred if AHPs had not been used. This gives a total production loss of 10.5% if the AHPs were not used.

5.2 Method of attribution

The production that can be attributable to AHP use is production that would not have not been possible if sheep meat and wool producers did not use AHPs.

TABLE 5.2 ECONOMIC COSTS OF SHEEP DISEASES ON WOOL PRODUCTION, 2015-16

	Lane *et al.* 2015 study				ACIL Allen update 2015-16			
	Treatment	Prevention	Production	Total	Treatment	Prevention	Production	Total
	$ million	$ million	$ million	$ million	$ million	$ million	$ million	$ million
Neonatal mortalities	0.0	23.4	55.5	78.9	0.0	4.7	11.8	16.5
Internal parasites	0.0	13.0	54.5	67.5	0.0	36.5	70.9	107.4
Dystocia	4.1	20.6	37.6	62.3	0.0	11.8	32.0	43.8
Weaner ill thrift	0.0	2.1	35.7	37.8	0.0	14.1	31.4	45.5
Flystrike	1.4	14.8	9.2	25.4	4.4	22.3	21.7	48.4
PRGT	0.1	0.0	18.7	18.8	0.0	2.3	20.6	22.9
Lice	0.0	1.0	3.4	4.4	1.5	16.0	5.3	22.8
Mastitis	0.2	1.8	12.2	14.2	0.1	0.0	10.8	10.9
Footrot	0.0	5.1	7.4	12.5	0.0	1.1	2.0	3.0
Arthritis	0.0	9.7	1.7	11.4	0.3	1.9	7.0	9.2
Ovine Johne's disease	0.0	0.5	8.5	8.9	0.0	5.5	4.3	9.8
Clostridial diseases	0.2	0.0	7.1	7.3	0.0	10.5	1.0	11.5
Liver fluke	0.0	3.4	3.0	6.4	0.0	0.5	4.9	5.4
Pneumonia	0.2	2.6	2.9	5.7	0.3	0.0	4.1	4.3
Caseous Lymphadenitis	0.4	1.6	2.1	4.0	0.0	3.7	1.7	5.4
Pregnancy toxaemia	0.7	0.0	3.1	3.8	0.2	2.8	1.7	4.7
Hypocalcaemia	0.2	0.0	3.5	3.7	0.4	1.7	1.2	3.3
Foot abscess	0.0	0.0	2.4	2.4	0.7	0.0	1.8	2.5
Bacterial enteritis	0.0	0.0	0.3	0.3	0.2	0.0	2.0	2.2
Pyrrolizidine alkaloidosis	0.0	0.0	1.0	1.0	0.0	0.0	1.4	1.4
Sheep measles (Taenia ovis)	0.0	0.0	0.2	0.2	0.0	0.0	0.2	0.2
Campylobacter abortion	7.4	137.6	413.6	558.6	0.0	0.0	0.6	0.6
Sarcocystis	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1
TOTAL	**14.8**	**237.1**	**683.7**	**935.6**	**8.0**	**135.3**	**238.5**	**381.8**

SOURCE: ACIL ALLEN CONSULTING UPDATE BASED ON LANE ET AL 2015 STUDY AND DISCUSSIONS WITH THE LIVESTOCK DISEASE MODELLERS

Sheep meat production

It was estimated that the production losses with the endemic diseases in sheep were 12% if AHPs had not been used in 2015-16. The estimated 11% of production losses ($357.7 million reported in **Table 5.1** with the treatment) are part of the 12% total production losses.

Wool production

The production that can be attributed to AHP use is production that would have not been possible if the wool growers had not used AHPs. Losses assumed in this study are based on the literature and industry consultation.

Wool production losses from endemic diseases in sheep were estimated at 10.5% of the value of wool production if AHPs had not been used in 2015-16. The farmgate value of wool production was $2,965 million in 2015-16. The estimated production losses of $238.5 million reported in **Table 5.2** — 8% of production losses with treatment are part of the 10.5% production losses without the use of AHPs.

5.3 Contribution of animal health products to production

The difference between sheep meat production with and without the use of AHPs provides the contribution of AHPs to sheep meat production in Australia. The detailed breakdown of the estimates for the scenarios of with and without AHPs is provided in **Appendix C**.

The direct, indirect and total impacts of AHPs to sheep meat and wool production in Australia are provided in **Table 5.3**.

TABLE 5.3 CONTRIBUTION OF ANIMAL HEALTH PRODUCTS TO SHEEP MEAT AND WOOL PRODUCTION, 2015-16

	Sheep meat production			Wool production		
Impacts	Compensation of employees	Value-add	Employment	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE	$ million	$ million	FTE
Direct	12	235	196	11	188	160
Indirect	52	118	648	43	96	535
Total	64	353	844	54	283	695

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

5.3.1 Direct economic contribution of animal health products

Sheep meat production

The farm gate value of sheep production for meat was $3,239 million in 2015-16. It been assumed that AHPs increased sheep meat production by 12%, or $389 million in 2015-16.

The direct economic contribution (value-add) is estimated to have been $235 million.

The direct employment contribution from AHP use in sheep meat production is estimated at 196 FTE persons in 2015-16.

Wool production

It is estimated that AHPs increased wool production by 10%, or $311.3 million in 2015-16.

The direct economic contribution (value add) is estimated to have been $188 million.

The direct employment contribution attributable to AHP use in wool is estimated at 160 FTE persons in 2015-16.

5.3.2 Indirect economic contribution of animal health products

Sheep meat production

It is estimated that, for sheep meat:

- the additional production attributable to AHPs indirectly contributed $118 million to the Australian economy in 2015-16,
- $52 million in compensation to employees was indirectly supported by AHP use, and
- 648 FTE jobs were indirectly supported by AHP use.

Wool production

It is estimated that, for wool production AHPs indirectly contributed:

- $96 million to the Australian economy,
- $43 million in compensation to employees, and
- around 535 FTE jobs.

5.3.3 Total economic contribution to animal health products

Sheep meat production

Adding the direct and indirect economic contributions attributable to AHP use in sheep meat production provides economic footprint of the AHP use in Australian sheep production in 2015-16.

It is estimated that the AHP use in sheep meat production in Australia in 2015-16 resulted in a total contribution of $353 million to GDP, comprising:

- $235 million directly from the industry (direct contribution),
- $118 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution), and
- around 844 FTE jobs.

Wool production

Adding the direct and indirect economic contributions attributable to AHP use in wool production provides an economic footprint of the AHP use in wool production in 2015-16.

It is estimated that the AHP use in wool production in Australia in 2015-16 resulted in a total contribution of $283 million to GDP, comprising:

- $188 million directly from the industry (direct contribution),
- $96 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution), and
- around 695 FTE jobs.

5.4 Summary

The estimated impacts that would be attributable to AHPs in sheep meat production are summarised in **Figure 5.1**.

FIGURE 5.1 ESTIMATED CONTRIBUTION OF ANIMAL HEALTH PRODUCTS TO SHEEP MEAT PRODUCTION, 2015-16

Note: Totals may not add due to rounding.

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

The estimated impacts that would be attributable to AHPs in sheep meat production are summarised in **Figure 5.2**.

FIGURE 5.2 ESTIMATED CONTRIBUTION OF ANIMAL HEALTH PRODUCTS TO WOOL PRODUCTION, 2015-16

Note: Totals may not add due to rounding.

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

In summary:

- 12% of sheep meat production and 10.5% wool production was attributable to AHP use in 2015-16, and
- the Australian GDP attributable to AHP use in sheep production in 2015-16 was $353 million for wool production was $283 million.

6 PIG PRODUCTION ATTRIBUTABLE TO ANIMAL HEALTH PRODUCTS

This chapter estimates the level of pig production that was attributable to AHP use in 2015-16. Unlike estimates for beef, dairy, sheep and wool, there have been no recent, relevant, published studies of pig disease costs in Australia. ACIL Allen has relied on various published sources of information to estimate the costs that would have been related to the diseases in pig production.

6.1 Key diseases in pig production and estimated costs

The key diseases in pig production in Australia are listed in **Table 6.1**.

TABLE 6.1 MAJOR PIG DISEASES

Disease	Symptoms	Treatment	Prevention
Pre-weaning period			
Colibacillosis (*E. coli*)	Diarrhoea (scours) sudden death	Fluid therapy; antibiotics (warmth	Improve hygiene; vaccinate sow/gilts; provide a warm clean creep area
Coccidiosis	Diarrhoea at 10-21 days of age	Fluid therapy; coccidiostats	Improve hygiene; provide a warm, clean creep area
Overlay / trauma	Sudden death	None	Provide a warm, clean creep area; check farrowing crate design
Starvation (hypo-glycaemia)	Weakness; death	Dextrose solutions; supplementary feeding	Improve sow's milk supply
Stillbirths	Born dead	None	Various methods
Miscellaneous infections	Lameness; sudden death	Antibiotics	Improve hygiene; repair flooring
Exudative epidermitis (greasy pig)	Skin lesions; death	Antibiotics; skin protectant; vitamins	Improve hygiene; provide a dry, warm, clean creep area; prevent skin abrasions
Post weaning period			
Colibacillosis (*E. coli*)	Diarrhoea; sudden death	Fluid therapy; antibiotics	Vaccinate; improve hygiene; provide warmth for weaners; reduce stress at weaning
Respiratory disease	Coughing; sneezing; reduced growth rate; sometimes death	Antibiotics; improved ventilation and environment	Improve ventilation; reduce stocking density; reduce stress; antibiotics; vaccinate
Swine dysentery	Diarrhoea with blood; diarrhoea; reduced growth rates; death	Antibiotics; reduced stocking density	Improve hygiene; antibiotics

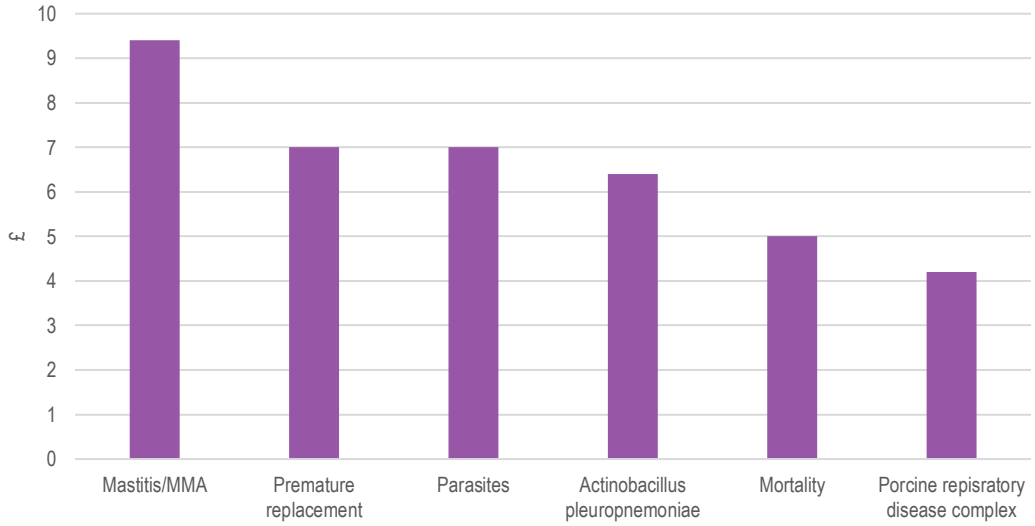
Disease	Symptoms	Treatment	Prevention
Proliferative enteropathy (PE)(ileitis)	Diarrhoea with blood; diarrhoea; reduced growth rate; sudden death	Antibiotics; iron; vitamin B	Antibiotics
Sarcoptic mange	Itching; dermatitis; rubbing; scratching; reduced growth rate	Miticidal sprays; pour-ons; injection and in-feed premix	Strategically treat breeder pigs and weaners/growers
Intestinal torsion	Sudden death	Diet manipulation	None
Gastric ulceration	Loss of appetite; vomiting; death	Rarely effective	Manipulate diet, including feed coarseness; reduce stress; reduce disease
Erysipelas	Arthritis; skin lesions; reduced growth rate; condemnations at slaughter	Antibiotics	Vaccinate
Internal parasites(worms)	Diarrhoea; reduced growth rate; pneumonia	Parasiticides in-feed or injection	Parasiticides
Exudative epidermitis (greasy pig)	Skin lesions; death	Antibiotics; skin protectant; vitamins	Improve hygiene; provide a dry, warm, clean weaner pen; prevent skin abrasions
Breeder pigs			
Farrowing sickness (mastitis, metritis, agalactia - MMA)	Reduced milk production; loss of appetite; higher body temperature	Antibiotics; oxytocin; anti-inflammatory drugs	Reduce feeding prior to farrowing; ensure good hygiene in farrowing crate; reduce stress on sows
Lameness	Premature culling; reduced herd fertility	Rarely effective	Improve floor design; control erysipelas; prevent injuries; reduce conformation defects
Porcine parvovirus	Mummification; returns to service; stillborn and weak-born piglets	None	Vaccinate
Vaginal discharge syndrome	Reproductive tract infections	Antibiotics; antibiotic treatment of boar's prepuce	Cull affected animals; improve hygiene of mating pens and dry-sow shed
Bladder infection (cystitis) Kidney infection	Blood-stained urine Reluctance to stand; sudden death	Antibiotics Antibiotic infection of boar's prepuce	Antibiotics Increase water intake; improve hygiene in dry sow shed
Leptospirosis	Stillborn or weak-born pigs; abortion; returns to service	Antibiotics	Vaccinate
Erysipelas	Abortions; reproductive failure	Antibiotics	Vaccinate
Gastric torsion (see intestinal torsion)	Sudden death	None	Feed twice or three times per day; do not overfeed hungry pigs
Gastric ulcers	Loss of appetite; vomiting; depraved appetite; blood in dung; sudden death	Antibiotics; wet feed	Investigate feed, fineness, crude fibre and vitamin E/selenium; reduce stress
Farrowing sickness (mastitis, metritis, agalactia – MMA)	Reduced milk production; loss of appetite; higher body temperature	Antibiotics; oxytocin; anti-inflammatory drugs	Reduce feeding prior to farrowing; ensure good hygiene in farrowing crate; reduce stress on sows

SOURCE: QUEENSLAND DEPARTMENT OF AGRICULTURE AND FISHERIES, COMMON PIG DISEASES, HTTPS://WWW.DAF.QLD.GOV.AU/ANIMAL-INDUSTRIES/PIGS/PIG-HEALTH-AND-DISEASES/A-Z-PIG-DISEASES/COMMON-PIG-DISEASES

A recent UK study, Nathues H *et al*[15] has estimated pig disease costs on pig producers. These are illustrated in **Figure 6.1**.

[15] http://www.fp7-prohealth.eu/news-index/newsletter-november-2015/production-diseases-cost-pig-producers/

FIGURE 6.1 DISEASE COSTS PER PIG



Note: This study was published based on 2015 data and an average 2015 exchange rate was used to convert into A$.

SOURCE: HTTP://WWW.FP7-PROHEALTH.EU/NEWS-INDEX/NEWSLETTER-NOVEMBER-2015/PRODUCTION-DISEASES-COST-PIG-PRODUCERS/

Nathues H *et al* conducted an extensive literature analysis to establish the overall estimated cost of different pig production diseases. These are diseases that are persistent in animal production systems. Interventions to prevent them and to treat sick animals require labour and other resources. Alongside the costs of such interventions, these diseases can also reduce productivity and income. This reduces the profitability of a farm, as well as affecting animal health and welfare.

Determining the impact of disease pig production is complex. The severity and consequences of disease can vary substantially from farm to farm.

Nathues H *et al* analysed endemic diseases in pigs. In a herd facing disease problems, the study found the likely disease cost is between £30 and £40 per fattened pig. For example, the costs of tail biting was estimated at €2 per pig. The costs of parasites in pigs was estimated at almost £7 per affected pig.

Respiratory diseases are an economically important issue in pig production. Nathues H *et al* suggests that a single type of respiratory disease present in pigs can reduce economic returns by around £4.7 per fattened pig. Realistically, several diseases can occur in the herd simultaneously, pushing up total costs well above the estimates mentioned above. On average, the study estimated, *Mycoplasma hyopneumoniae* and Porcine Respiratory Disease Complex (PRDC) reduced the return by £4.2 per pig, and *Actinobacillus pleuropneumoniae* reduced returns by £6.4 per pig in an affected herd. By comparison, the impact of a well-studied non-production disease, Porcine Reproductive and Respiratory Syndrome (PRRS), has been estimated to result in a loss of about £7 per pig.[16]

Mortality, reproductive failures and lameness can cause high incidental losses in pigs. The impacts of mortality are significant and the individual animal the cost is very high, but when absorbed at herd level the impact can be smaller. In the studies analysed by Nathues H *et al,* , the reduction in returns due to pre-weaning mortality was between £12 and £23 per litter, with post-weaning mortality costing between £2 and £4 per pig. Case-by-case costs of reproductive failures and lameness could be substantial.

For instance, premature replacement of a sow because of disorders in reproduction could cost between £148 and £167 per replaced sow. The costs of mastitis or the complex syndrome 'Mastitis, Metritis and Agalactia' (MMA) could range up to £95 per affected sow. In the most severe cases the

[16] Nathues H *et al* 2017, Cost of porcine reproductive and respiratory syndrome virus at individual farm level – An economic disease model, Preventive Veterinary Medicine 141:16–29, accessed on 18 May 2018 at https://www.sciencedirect.com/science/article/pii/S0167587716305517

impacts could be even larger. The best estimates of costs of lameness were available on a 'per lame pig' basis. Depending on the cause of lameness, the cost in finishing pigs reported by the literature ranged from £12 to £67 per lame pig. In sows, the costs ranged from £145 to £180 per lame sow.

Disease cost estimates from Nathues may not be comparable to the pig disease costs in Australia, but they may provide some indication of the magnitudes involved.

In 2008, the Animal Health Alliance commissioned Menari Business Solutions to prepare costs of diseases in various livestock industries including pig production.[17] The study was based on the literature and updates from various previous studies.

The Menari study's estimated costs are provided in **Table 6.2** (increased expenses are treatment costs). ACIL Allen has updated these costs based on the saleyard price of pigs, which can be used to calculate reduced income. Income reductions are indicative of value of production losses.

It is estimated that production losses (notwithstanding treatment) in Australia were $145 million in 2015-16. The farm gate value of pig production was $1,393 in 2015-16. The losses of $145 million thus represent 10.4% of value of pig production in 2015-16.

TABLE 6.2 PIG DISEASE COSTS—MENARI BUSINESS SOLUTIONS, 2008, AND ACIL ALLEN UPDATE, 2015-16

Disease	Menari Business Solutions 2008			ACIL Allen's update to 2015-16		
	Reduced income ($m)	Increased expenses ($m)	Total ($m)	Reduced income ($m)	Increased expenses ($m)	Total ($m)
Mycoplasma	20.0		20.0	34.5	0.0	34.5
Pleuropneumonia	18.3		18.3	31.6	0.0	31.6
Swine Dysentery	28.6		28.6	49.3	0.0	49.3
Atrophic Rhinitis		10.4	10.4	0.0	18.0	18.0
Mange	17.2		17.2	29.6	0.0	29.6
Leptospirosis		6.5	6.5	0.0	11.2	11.2
Total	**84.1**	**16.9**	**101.0**	**145.0**	**29.2**	**174.2**

SOURCE: LLOYD JOHN 2008, ABARES AND ACIL ALLEN

A 2001 study by Garner *et al*[18] assessed the expected economic impact of three exotic diseases on the pig industry of Australia. An integrated epidemiological/economic approach was used to assess the effects of classical swine fever, Nipah virus and porcine reproductive and respiratory syndrome. Scenarios involving either an epidemic event, in which the outbreaks were confined to selected regions and were eradicated, or an endemic situation in which the diseases became established in Australia. Based only on loss of sales and disposal costs, the study estimated epidemics resulted in regional losses in income of the order of $10-30 million (16 – 37% of production) depending on disease and region. Garner *et al* indicated that if any of these diseases became established, opportunity losses in gross national pig income of 5–11% per year would occur, with classical swine fever the most serious of the three diseases.

A study commissioned by the Australian Pig Research Council in 1988[19] estimated disease costs based on a comprehensive survey of farms. The disease cost estimates from this study are summarised in **Table 6.3**.

[17] Lloyd J 2008, Cost of diseases, a study commissioned by Animal Health Alliance, prepared by Menari Business Solutions 15 December 2008.
[18] Garner MG *et al* 2001, The expected economic impact of selected exotic disease on the pig industry of Australia, Review of Science and Technology 2001 Dec, 20(3) 671–685.
[19] Cutler R and Garner I 1988, A blue print for pig health research, a study commissioned by the Australian Pig Research Council.

TABLE 6.3 CUTLER AND GARNER 1988 STUDY

Diseases	Costs of disease ($) per sow in 1988	Costs of disease ($) per sow in 2015-16 (ACIL Allen update)
Preweaning diseases		
Stillbirths	53	93
Overlay	26	46
Neonatal diarrhoea	23	40
Savaged pigs	16.5	29
Small pigs	13	23
Splay leg	3.9	7
Diseases of sows		0
Farrowing sickness	12	21
Cystitis/Nephritis	9.1	16
Gastric accidents	7.8	14
Parvovirus	5.8	10
Lameness	5.9	10

SOURCE: CUTLER R AND IAN GARNER 1988, A BLUE PRINT FOR PIG HEALTH RESEARCH. A STUDY COMMISSIONED BY THE AUSTRALIAN PIG RESEARCH COUNCIL

6.2 Method of attribution

The production that can be attributable to AHP use is production that would have not been possible if the pig farmers had not used AHPs. The production losses assumed in this study are based on the literature and industry consultation. It was assumed that pig production losses in 2015-16 from endemic diseases would have been 13% if they had not used AHPs in 2015-16. The estimated 10.4% of production losses with the treatment reported in **Section 6.1** are part of the 13% total production losses. This is a lower bound estimate from the Garner *et al* (2001) study.

6.3 Estimated contribution of animal health products

The difference between pig production with and without the use of AHPs provide the contribution of AHPs to pig production in Australia. The detailed breakdown of the estimates for the scenarios of with and without AHPs are provided in **Appendix C**.

The direct, indirect and total impacts of AHPs to pig production in Australia are provided in **Table 6.4**.

TABLE 6.4 CONTRIBUTION OF ANIMAL HEALTH PRODUCTS TO PIG PRODUCTION, 2015-16

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	4	100	51
Indirect	25	59	304
Total	30	159	355

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

6.3.1 Direct economic contribution of animal health products

The farmgate value of pig production was $1,393 million in 2015-16. It was estimated that the AHPs increased pig production by 13%, or $181 million in 2015-16.

The direct economic contribution (value-add) is estimated to have been $100 million.

The direct employment contribution from AHP use in pig production is estimated at 51 FTE persons in 2015-16.

6.3.2 Indirect economic contribution animal health products

It is estimated that in 2015-16:

- the additional production that is attributable to AHPs in pig production indirectly contributed $59 million to the Australian economy,
- around $25 million in compensation to employees was indirectly supported by AHPs use in pig production, and
- around 304 FTE jobs were indirectly supported by AHP use in pig production.

6.3.3 Total economic of contribution animal health products

Adding the direct and indirect economic contributions attributable to AHP use in pig production provides economic footprint of the AHP use in Australian pig production industry.

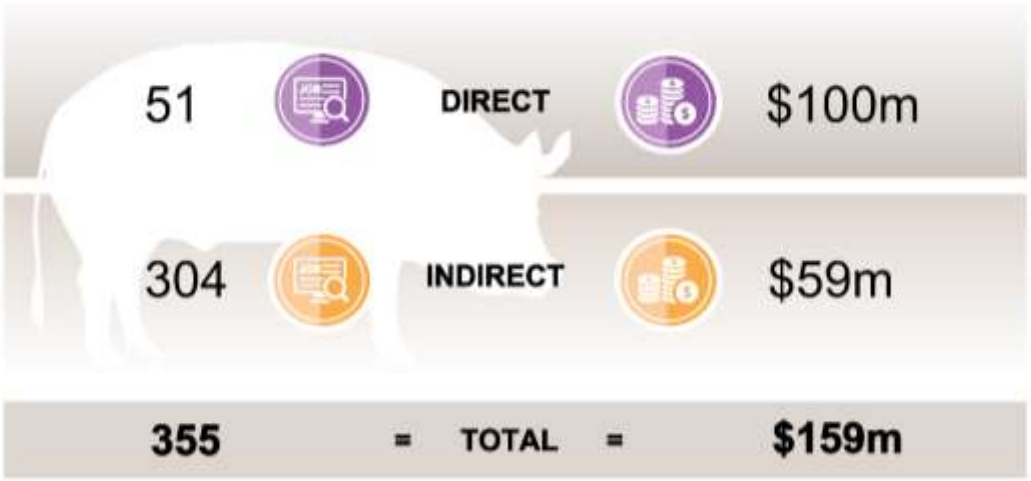
It is estimated that the AHP use in pig production in Australia in 2015-16 resulted in a total contribution of $159 million to Australian GDP, comprising:

- $100 million directly from the industry (direct contribution)
- $59 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution), and
- around 355 FTE jobs.

6.4 Summary

The estimated impacts that are attributable to AHPs in pig production are summarised in **Figure 6.2**.

FIGURE 6.2 ESTIMATED ECONOMIC CONTRIBUTION OF ANIMAL HEALTH PRODUCTS TO PIG PRODUCTION, 2015-16



Note: Totals may not add due to rounding.

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

In summary:

- some 13% of pig production was attributable to AHP use in 2015-16, and
- the Australian GDP attributable to AHP use in pig production in 2015-16 was $159 million.

7 BROILER POULTRY AND EGG PRODUCTION ATTRIBUTABLE TO ANIMAL HEALTH PRODUCTS

This chapter provides an estimate of poultry meat (broiler) and layer poultry production attributable to the use of AHPs in 2015-16.

7.1 Key diseases and costs in poultry meat and layer poultry production

7.1.1 Poultry meat production

Diseases in poultry can lead to substantial economic losses through reduced revenues, for example, from reduced volume or quality of meat or eggs produced, and increased costs of inputs such as feed and labour. However, there is little consensus about the level of the economic losses resulting from individual poultry diseases in Australia. In addition, while the costs of prevention measures and treatments may be known to individual producers, the total economic costs in Australia are not well understood.

The PROHEALTH project[20] was initiated in Europe in 2013 to explore the full economic impacts of poultry production diseases. This project carried out an extensive survey of recent studies, collecting information on the costs of controlled and uncontrolled diseases, and the benefits resulting from various prevention or treatment measures.[21]

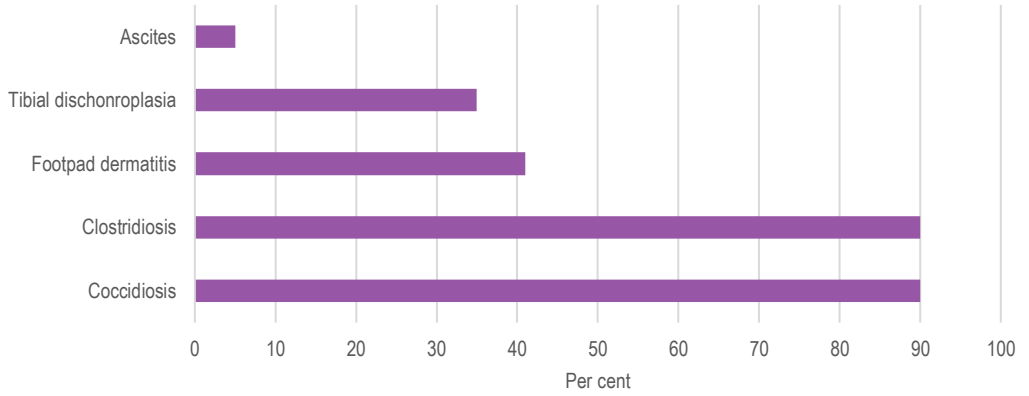
The PROHEALTH project reviewed several production diseases relevant to modern, commercial poultry production, covering a wide range of production scale, from a few birds in a single pen, to tens of thousands of birds across multiple farms. As noted earlier, the economic risks from production diseases are related to the level of incidence and severity. The incidence of the production diseases recorded in the PROHEALTH project studies are shown in **Figure 7.1**.

The most prevalent diseases reviewed by PROHEALTH project studies were enteric diseases, i.e. coccidiosis and clostridiosis.

[20] The ProHealth (Production HEALTH – *Sustainable intensive pig and poultry production*) consortium is a healthy blend of 10 academic partners, 1 European association, 4 industry partners, and 7 SMEs (Small and Medium-Sized Enterprises) coordinated by Newcastle University with expertise in veterinary science and epidemiology, animal physiology and immunology, socioeconomics, genetics and nutrition, as well as the welfare and production science of pigs and poultry. It draws its members from United Kingdom, Belgium, Cyprus, Czech Republic, Denmark, Finland, France, The Netherlands, Poland, Spain and Switzerland. In 2014, the ProHealth consortium had been awarded the largest ever grant given by the European Union (EU) in the Animal Health field to identify new solutions to reconcile modern animal production systems and sustainability.

[21] Production diseases: the costs to poultry producers, accessed on 18 May 2018 via http://www.fp7-prohealth.eu/news-index/newsletter-april-2016/production-diseases-costs-poultry-producers/

FIGURE 7.1 PROHEALTH PROJECT INCIDENCE RATES FOR POULTRY DISEASES IN EUROPE, 2016



SOURCE: HTTP://WWW.FP7-PROHEALTH.EU/NEWS-INDEX/NEWSLETTER-APRIL-2016/PRODUCTION-DISEASES-COSTS-POULTRY-PRODUCERS/

The PROHEALTH project reported losses due to controlled and uncontrolled diseases in broiler flocks, per bird, in Europe (see **Table 7.1**).

ACIL Allen has converted the PROHEALTH estimated costs into Australian currency. Although they are not strictly comparable, the estimated costs are considered indicative of Australian costs. The total costs of $37.46 million after intervention represent 1.4% of Australia's broiler poultry production in 2015-16.

The estimated total costs due uncontrolled diseases represent the production losses that would have occurred if the industry had not been using AHPs in 2015-16. These costs amounted to $138.5 million, which represents 5% of the value of Australian production in 2015-16.

TABLE 7.1 POULTRY DISEASE COSTS ESTIMATED BY PROHEALTH

Disease	PROHEALTH estimates		ACIL Allen conversion to A$			
	Costs due to uncontrolled disease	Costs after intervention	Costs due to uncontrolled disease	Costs after intervention	Total costs due to uncontrolled disease	Total costs after intervention
	€/bird	€/bird	A$/bird	A$/bird	A$m	A$m
Coccidiosis	0.21	0.17	0.30	0.25	24.62	19.93
Clostridiosis	0.95	0.13	1.37	0.19	111.39	15.24
Tibial dyschondroplasia	0.05	0.05	0.07	0.07	2.28	2.28
Ascites	0.03		0.04	0.00	0.20	0.00
TOTAL	**1.24**	**0.35**	**1.79**	**0.51**	**138.49**	**37.46**

SOURCE: HTTP://WWW.FP7-PROHEALTH.EU/NEWS-INDEX/NEWSLETTER-APRIL-2016/PRODUCTION-DISEASES-COSTS-POULTRY-PRODUCERS/

7.1.2 Layer poultry production

The layer poultry industry is characterised by intensive production, potential for disease outbreak and therefore costs in disease prevention. This is due to the longer lifespan of the layer, a high incidence of intensive care production and specific diseases of increased prevalence to egg layers, for example egg drop syndrome.

Australia has regulations to control the outbreak of poultry exotic diseases. Endemic diseases are controlled through a combination of prevention and treatment.

In 2008, the Animal Health Alliance commissioned Menari Business Solutions to study cost of diseases. That report reviewed the literature and estimated the costs and expenses for 2007. ACIL Allen has updated the study estimates, and they are provided in **Table 7.2**. ACIL Allen has updated

the reduced income estimates using CPI egg price index changes and expenses, together with the ABARES' index of price changes for farm chemicals between 2006-07 and 2015-16.

TABLE 7.2 ESTIMATED LAYER POULTRY DISEASES AND COSTS

	Menari Business Solutions 2008			ACIL Allen's update to 2015-16		
	Reduced income ($m)	Increased expenses ($m)	Total ($m)	Reduced income ($m)	Increased expenses ($m)	Total ($m)
Coccidiosis	0.10	0.60	0.70	0.20	0.56	0.75
Necrotic Enteritis	0.02	0.90	0.92	0.03	0.84	0.87
Fowl Pox	0.10	1.20	1.30	0.19	1.12	1.31
Mareks Disease	0.72	2.40	3.12	1.44	2.24	3.68
Infectious Bronchitis	1.20	1.80	3.00	2.40	1.68	4.08
Newcastle Disease	0.00	3.00	3.00	0.00	2.79	2.79
ILT	0.00	0.84	0.84	0.00	0.78	0.78
Egg Drop Syndrome (EDS)	1.44	1.20	2.64	2.88	2.84	4.00
Mycoplasma	0.61	2.40	3.01	1.23	2.24	3.46
Infectious Coryza	0.29	2.88	3.17	0.59	2.68	3.27
Fowl Cholera	1.39	2.88	4.27	2.78	2.68	5.46
Spotty Liver	2.07	0.90	2.97	4.15	0.84	4.98
Salmonella	1.26	4.80	6.06	2.52	4.47	7.00
TOTAL	**9.19**	**25.80**	**34.99**	**18.41**	**25.76**	**42.45**

SOURCE: LLOYD JOHN 2008, ABS, ABARES AND ACIL ALLEN

The estimated reduced income of $18.41 million would represent the production losses notwithstanding the treatment and control of typical endemic diseases in layer poultry. The value of eggs produced at farm gate prices in 2015-16 was $783 million. The production losses represent 2.4% of value of eggs produced in 2015-16.

The estimated total production losses if the industry had not been used AHPs in 2015-16 would have been 8% of the value of eggs produced.

7.2 Method of attribution

7.2.1 Poultry meat production

The production attributable to the use of AHPs is production that would have not been possible if the poultry meat producers had not used AHPs. This production loss assumed in this study are based on the literature and industry consultation. It was estimated that the poultry meat production loss with the endemic diseases were 5%.

7.2.2 Egg production

It was estimated that the egg production losses from endemic diseases in 2015-16 would have been 8% if they had not used AHPs. The estimated 2.4% of production losses with treatment reported in Section 7.1 are included in the 8% production losses.

7.3 Contribution of animal health products

The difference between poultry farming with and without the use of AHPs provide the contribution of AHPs to production in Australia. The direct, indirect and total impacts of AHPs to poultry farming in Australia are provided in **Table 7.3**.

TABLE 7.3 CONTRIBUTION OF ANIMAL HEALTH PRODUCTS TO POULTY MEAT AND EGG PRODUCTION, 2015-16

	Poultry meat production			Egg production		
Impacts	Compensation of employees	Value-add	Employment	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE	$ million	$ million	FTE
Direct	1.1	6.7	9	0.1	36.2	6
Indirect	38.7	93.8	452	7.7	18.7	90
Total	39.8	100.5	461	7.9	55.0	96

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

7.3.1 Direct economic contribution of animal health products

Poultry meat production

It was estimated that AHPs increased broiler poultry farming output by $138.5 million in 2015-16, an increase of 5%. The direct economic contribution (value-add) is estimated at $6.7 million.

The direct employment contribution in 2015-16 is estimated at 9 FTE persons.

Poultry layer production

It was estimated that the AHPs have increased poultry layer production by $62.6 million in 2015-16, an increase of 8%. The direct economic contribution (value-add) embodied in the revenue is estimated at $36.2 million.

The direct employment contribution from AHPs in egg production in 2015-16 is estimated at 6 FTE persons.

7.3.2 Indirect economic contribution of animal health products

Poultry meat production

It is estimated that in 2015-16, for poultry meat production:

- the additional production that is attributable to AHPs indirectly contributed $93.8 million to the Australian economy
- around $38.7 million in compensation to employees was indirectly supported by AHP use, and
- around 452 FTE jobs were indirectly supported by AHP use.

Poultry layer production

It is estimated that with the use of AHPs in 2015-16 for poultry layer production:

- the additional production that is attributable to AHPs indirectly contributed $18.7 million to the economy
- around $7.7 million in compensation to employees was indirectly supported by AHP use, and
- around 90 FTE jobs were indirectly supported by AHP use.

7.3.3 Total economic contribution of animal health products

Poultry meat production

Adding the direct and indirect economic contributions attributable to AHP use in poultry meat production provides economic footprint of the AHP use for that industry.

It is estimated that the AHP use in poultry farming in Australia in 2015-16 resulted in:

- a total contribution of $100.5 million to GDP, comprising:
  - $6.7 million directly from the industry (direct contribution)

- $93.8 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)

— around 461 FTE jobs attributable to AHP use.

Poultry layer production

Adding the direct and indirect economic contributions attributable to AHP use in poultry layer production provides economic footprint of the AHP use for that industry.

It is estimated that the AHP use in egg production in 2015-16 resulted in:

— a total contribution of $55 million to GDP, comprising:
- $36.2 million directly from the industry (direct contribution)
- $18.7 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)

— around 96 FTE jobs attributable to AHP use.

7.4 Summary

The estimated impacts attributable to AHPs in poultry meat production are summarised in **Figure 7.2**.

FIGURE 7.2 ESTIMATED CONTRIBUTION OF ANIMAL HEALTH PRODUCTS TO CHICKEN MEAT PRODUCTION, 2015-16

Note: Totals may not add due to rounding.

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

The estimated impacts attributable to AHPs in egg production are summarised in **Figure 7.3**.

FIGURE 7.3 ESTIMATED CONTRIBUTION OF ANIMAL HEALTH PRODUCTS TO EGG PRODUCTION, 2015-16

Note: Totals may not add due to rounding.

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

In summary:

- some 5% of poultry meat production was attributable to AHP use in 2015-16, while 5% was attributable to poultry layer production, and
- the Australian GDP attributable to AHP use in poultry meat production in 2015-16 was $100.5 million, while the $55 million is attributable to poultry layer production.

8 TOTAL ECONOMIC CONTRIBUTION OF ANIMAL HEALTH PRODUCTS IN MAJOR LIVESTOCK PRODUCTION

The total estimated value-add that can be attributable to AHP use in seven livestock commodity groups is summarised in **Table 8.1**.

The estimated livestock production attributable to AHPs:

- created an additional 9,898 FTE jobs in Australia
- generated more than $577.5 million in compensation to employees
- contributed $2,668 million to the Australian economy.

TABLE 8.1 TOTAL ESTIMATED CONTRIBUTION ATTRIBUTABLE TO ANIMAL HEALTH PRODUCTS, 2015-16

Industry	Per cent of production	Value-add ($ million)	Per cent of GDP	Compensation of employees ($ million)	FTE jobs
Beef cattle	10.0	1,126	0.068	295	5,468
Dairy	15.0	592	0.036	87	1,979
Sheep-meat	12.0	353	0.021	64	844
Sheep-wool	10.5	283	0.017	54	695
Pigs	13.0	159	0.010	30	355
Poultry - meat	5.0	101	0.006	40	461
Poultry - layers (eggs)	8.0	55	0.003	8	96
TOTAL	**10.6**	**2,668**	**0.161**	**578**	**9,898**

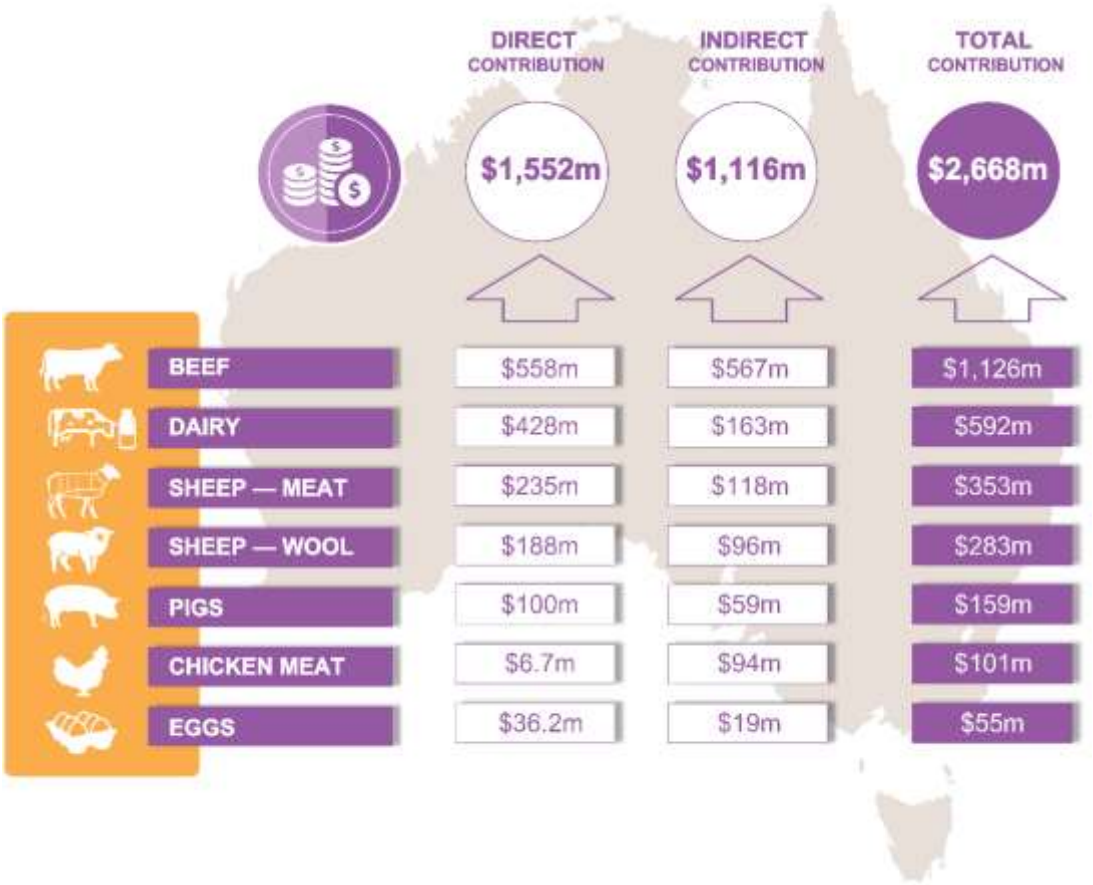
Note: Totals may not add due to rounding

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

On average, for each dollar of livestock production, the (direct plus indirect) economic value added associated with the use of AHPs is approximately $0.09. Therefore, for $28.5 billion of Australian livestock production in 2015-16 this equates to (direct plus indirect value added) $2,669 million attributable to the use of AHPs.

Total econometric contribution (direct plus indirect) is summarised in **Figure 8.1** and **Figure 8.2**.

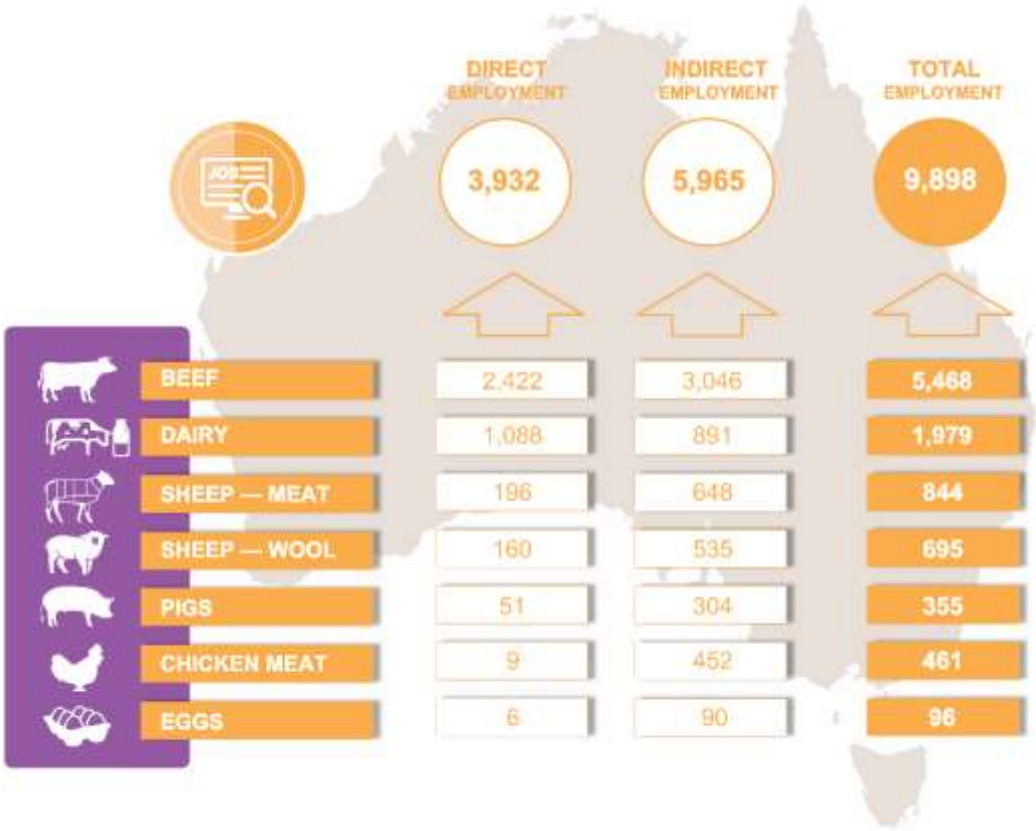
FIGURE 8.1 ESTIMATED TOTAL ECONOMIC CONTRIBUTION ATTRIBUTABLE TO ANIMAL HEALTH PRODUCTS IN 2015-16



Note: Totals may not add due to rounding.

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

FIGURE 8.2 ESTIMATED TOTAL EMPLOYMENT CONTRIBUTION ATTRIBUTABLE TO ANIMAL HEALTH PRODUCTS IN 2015-16



Note: Totals may not add due to rounding.

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

9 CONSUMER PRICE IMPACTS

To assess the role of AHPs on consumer prices in Australia, it is useful to compare prices for livestock products grown under current agricultural production methods where AHPs were used, with prices for livestock products grown without using AHPs. This analysis estimates the average meat, egg and dairy product prices for Australian consumers if AHPs had not been used in their production in 2015-16.[22]

The estimated productivity associated with AHPs in various livestock industries is summarised in **Table 9.1**.

Productivity reflects the overall efficiency with which land, labour and capital inputs are used together in production. The growth in productivity is the growth in output that is not explained by the growth in land, labour and capital and can be attributed to AHP use. The estimated productivity that can be attributable to AHPs in 2015-16 ranges from 14% for poultry meat to 28.5% in dairy farming in 2015-16.[23]

TABLE 9.1 PRODUCTIVITY ESTIMATES ATTRIBUTABLE TO ANIMAL HEALTH PRODUCTS, 2015-16

Livestock	Production attributable to animal health products (%)	Productivity attributable to animal health products (%)
Beef	10.0	14.7
Dairy	15.0	18.0
Sheep - meat	12.0	16.0
Sheep - wool	10.5	15.0
Pigs	13.0	14.5
Poultry meat	5.0	8.6
Poultry layers (eggs)	8.0	10.9

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

The estimated production attributable to AHPs was used as an input into the Australian CGE model to estimate the productivity growth and the impact on consumer prices in 2015-16.

The details of the CGE model are provided in Appendix B.

[22] Another channel through which the AHPs would impact the Australian economy is by enhancing the trade balance as most of the livestock products are exported. This effect is beyond the scope of the study and is not estimated in this study.

[23] This productivity is estimated in the CGE model by targeting the output growth estimated in previous chapters for each livestock industry. A short-run economic environment is assumed to estimate the productivity and price impacts in this study. This model closure treats the rate of return changes for a given capital in the capital market. In the labor market, for a given real wages the employment will change.

In the CGE model, the supply chains of livestock production and consumption are explicitly considered through both prices, quantities and optimisation by different participants in the Australian economy.

The estimated consumer price impacts are provided in **Table 9.2**.

It was estimated that the use of AHPs in livestock production reduced the average consumption prices for meat, eggs and dairy products by 12.8% in 2015-16.

It is estimated that AHP use provided a $5.17 savings to average Australian weekly household expenditure in 2015-16.[24] This equates to nearly $270 per annum on an average household's grocery savings.

TABLE 9.2 IMPACT ON AVERAGE WEEKLY HOUSEHOLD FRESH MEAT AND MEAT PRODUCTS EXPENDITURE, 2015-16

Broad CPI Group	Commodities	With AHPs	Price impacts from CGE model	Without AHPs
		$	%	$
Meat and eggs		**24.71**	**12.0**	**27.7**
	Beef and veal	7.52	11.3	8.37
	Pork	4.91	14.5	5.62
	Lamb and goat	3.50	13.8	3.98
	Poultry meat	6.82	11.0	7.57
	Poultry layers (eggs)	1.96	9.2	2.14
Dairy and related products		**15.82**	**5.9**	**15.9**
	Milk	5.78	15.9	6.70
	Cheese	4.70	15.9	5.45
	Ice cream and other dairy products[a]	5.34	10.0	5.87
TOTAL		**40.53**	**12.8**	**45.70**

[a] includes butter, yogurt, powdered milk and canned and bottled baby foods

SOURCE: ABS 2017 AND ACIL ALLEN CONSULTING ESTIMATES BASED ON CGE MODELLING

[24] The study undertaken by Mark Goodwin Consulting's 2011 report "The Contribution of Crop Protection Products to the United States Economy" has estimated that crop protection products provide a 47.9% savings in overall grocery bills for a family of four in the United States. Though the ACIL Allen estimate is for animal health products for major livestock products, the reference provides a perspective for the current analysis.

A INPUT-OUTPUT ANALYSIS

A.1 Overview

Input-output tables provide a snapshot of an economy at a particular time. The tables used in this study were for the 2015-16 financial year.

Input-output tables can be used to derive input-output multipliers. These multipliers show how changes to a given part of an economy impact on the economy as a whole.

The input-output multipliers allow analysis of the economic footprint of a particular facility, industry or event for the region of interest. Although input-output multipliers may also be suitable tools for analysing the impact of various types of economic change, caution needs to be adopted in their application for this purpose. Misuse of input-output multipliers for the purpose of impact analysis has led to scepticism of their general use in favour of other tools such as computable general equilibrium (CGE) modelling. Notwithstanding this, they are still eminently suitable for understanding the economic linkages between a given facility or industry to gain an appreciation of the wider interactions of the industry beyond its direct contribution.

A.2 Multiplier types

Input-output multipliers estimate the economic impact on a region's economy from a one dollar change in final demand for the output of one of the region's industries. Generally, four types of multipliers are used:

- Output – measures the impact on the output of all industries in the economy
- Income – measures the effect on the wages and salaries paid to workers within the economy
- Employment – measures the jobs creation impact, and
- Value-added – measures the impact on wages and salaries, profits and indirect taxes.

The sum of wages and salaries, profits and indirect taxes for a given industry provides a measure of its contribution to the size of the economy – its contribution to gross state product (GSP). The value-added multiplier can therefore also be the GDP multiplier.

Input-output multipliers are a flexible tool for economic analysis. Their flexibility stems from the different forms of each multiplier type. For each region, multipliers were estimated in the following forms:

- initial effects
- first round effects
- industrial support effects
- production induced effects

- consumption induced effects
- simple multipliers
- total multipliers
- type 1A multipliers
- type 1B multipliers
- type 2A multipliers
- type 2B multipliers.

The above multiplier types are defined in full in Johnson (2004) for output, income, employment and value-added multipliers; however, a brief overview of the different types of output multipliers is presented below.

A.2.1 Multiplier effects

When additional sales to final demand are made, for example through increased exports or sales to the public, production increases to meet the increased demand, and this is the initial effect. Since production increases to exactly match the increased final demand, the increase is always equal to one (noting that the multipliers are defined in terms of a one dollar increase in final demand).

An industry producing additional outputs purchases additional inputs to enable it to increase production. These new purchases require production increases in other industries—a first round effect. First-round production increases cause other industries to also increase their purchases, and these purchases cause other industries to increase their production, and so on. These 'flow-on' effects eventually diminish, but when 'added together constitute the industrial support effect.

The industrial support effect added to the first-round effect is known as the production induced effect. So far this chain of events has ignored one important factor, the effect on labour and its consumption. When output increases, employment increases, and increased employment translates to increased earnings and consumption by workers, and this translates to increased output to meet the increased consumption. This is the consumption effect.

A.2.2 Multipliers

The simple and total multipliers are derived by summing the effects. The simple multiplier is the sum of the initial and production induced effects. The total multiplier is larger, because it also adds in the consumption effect. All the effects and multipliers listed above have one thing in common — they all measure the impact on the economy of the initial increase in final demand.

The remaining multipliers take a different point of view, they are ratios of the above multiplier types to the initial effect. The type 1A multiplier is calculated as the ratio of the initial and first round effects to the initial effect, while the type 1B multiplier is the ratio of the simple multiplier to the initial effect. The type 2A multiplier is the ratio of the total multiplier to the initial effect, while the type 2B multiplier is the ratio of the total multiplier less the initial effect to the initial effect.

Given the large number of multiplier types to choose from (output, income, employment and value-added multipliers, and each with numerous variations (simple, total, type 2A, etc)) it is important that the analysis uses the most appropriate multipliers. Usually, the multipliers that include consumption effects (i.e. the added impact that comes from wage and salaries earners spending their income) are used. These are the total and type 2A multipliers. The total and type 2A multipliers will generally provide the biggest projected impact. Simple or type 1B (which omit the consumption effect) may be used to provide a more conservative result.

For this analysis, the Simple multipliers were used to calculate the estimates of the total contribution the AHPs make to the livestock production and the Australian economy.

A.3 Limitations of input-output analysis

Although input-output analysis is valid for understanding the contribution a sector makes to the economy, when used for analysing the potential impacts of a change in production of a particular

sector, input-output analysis is not without its limitations. Input-output tables are a snapshot of an economy in a given period, the multipliers derived from these tables are therefore based on the structure of the economy at that time, a structure that it is assumed remains fixed over time. When multipliers are applied, the following is assumed:

- prices remain constant;
- technology is fixed in all industries;
- import shares are fixed.

Therefore, the changes predicted by input-output multipliers proceed along a path consistent with the structure of the economy described by the input-output table. This precludes economies of scale. That is, no efficiency is gained by industries getting larger – rather they continue to consume resources (including labour and capital) at the rate described by the input-output table. Thus, if output doubles, the use of all inputs doubles as well.

One other assumption underpinning input-output analysis which is worth considering is that there are assumed to be unlimited supplies of all resources, including labour and capital. With input-output analysis, resource constraints are not a factor. It is thus assumed that no matter how large a development, all required resources are available, and that there is no competition between industries for these resources.

It is important to understand the limitations of input-output analysis, and to remember that the analysis provides an estimate of economic contribution of AHPs, not a measurement of economic impact if the AHPs weren't used.

B COMPUTABLE GENERAL EQUILIBRIUM MODELLING

A comparative static computable general equilibrium model is developed based on the ORANI model[25] and 2014-15 ABS input-output tables[26] to assess the price impacts of AHPs use in livestock production.

ACIL Allen's comparative static computable general equilibrium (CGE) model that has been developed for undertaking economic impact analysis at the regional, state and national level. CGE model captures the interlinkages between the markets of all commodities and factors, considering resource constraints, to find a simultaneous equilibrium in all markets.

This model is confined to comparative-static analysis and does not contained dynamic elements, arising from stock/flow accumulation relations: between capital stocks and investment, and between foreign debt and trade deficits.

B.1 Theoretical structure

The CGE model developed and used for estimating the price impacts has a theoretical structure which is typical of a static CGE model. It consists of equations describing, for 2015-16:

- producers' demands for produced inputs and primary factors
- producers' supplies of commodities
- demands for inputs to capital formation
- household demands
- export demands
- government demands
- the relationship of basic values to production costs and to purchasers' prices
- market-clearing conditions for commodities and primary factors
- numerous macroeconomic variables and price indices.

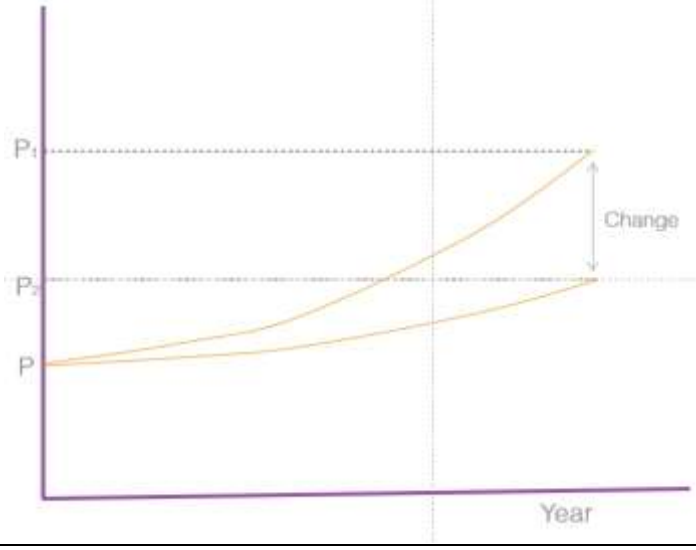
Demand and supply equations for private-sector agents are derived from the solutions to the optimisation problems (cost minimisation, utility maximisation, etc.) which are assumed to underlie the behaviour of the agents in conventional neoclassical microeconomics. The agents are assumed to be price-takers, with producers operating in competitive markets which prevent the earning of pure profits.

[25] https://www.copsmodels.com/ftp/gpextra/oranig06doc.pdf
[26] http://www.abs.gov.au/ausstats/abs@.nsf/mf/5209.0.55.001

B.2 Comparative static model

Like the majority of CGE models, the CGE used in this study is designed for comparative-static simulations. Its equations and variables refer implicitly to the economy at a point time of time. The interpretation of comparative static solution is illustrated by **Figure B.1**, which graphs the values of some variable, say meat product prices. P_1 is the level of meat product prices in 2015-16 without AHPs use and P_2 is the level which it would attain if AHPs were used. With the use of AHPs, meat product prices would reach P_2, all other things being equal. In a comparative-static simulation, the model generates the percentage change in meat product prices.

FIGURE B.1 COMPARATIVE STATIC INTERPRETATION



SOURCE: BASED ON THE ORANI MODEL

In this study, simulations have analysed the short-run effects. For these simulations, capital stocks have usually been held constant with or without the AHP use. The model tells nothing of adjustment paths.

B.2.1 The database

A key advantage of ACIL Allen comparative static model is the level of detail in the database underpinning the model. The database used for this analysis is derived from the latest ABS's input-output tables. The ABS input-output tables are fully documented and frequently updated which was well suited for this study.

The ABS input-output tables have 114 sectors as shown in **Table B.1**. To accommodate specific livestock industry price impacts, the ABS 114 sectors are disaggregated into 125 sectors. The disaggregation is displayed in **Table B.1**.

TABLE B.1 MODEL DATABASE

No	Industry	No	Industry	No	Industry
1	Sheep, Grains, Beef and Dairy	39	Veterinary Pharmaceutical and Medicinal Product	77	Food and Beverage Services
2	Poultry and Other Livestock	40	Basic Chemical Manufacturing	78	Road Transport
3	Other Agriculture	41	Cleaning Compounds and Toiletry Preparation	79	Rail Transport
4	Aquaculture	42	Polymer Product Manufacturing	80	Water, Pipeline and Other Transport
5	Forestry and Logging	43	Natural Rubber Product Manufacturing	81	Air and Space Transport

No	Industry	No	Industry	No	Industry
6	Fishing, hunting and trapping	44	Glass and Glass Product Manufacturing	82	Postal and Courier Pick-up and Delivery Service
7	Agriculture, Forestry and Fishing Support Services	45	Ceramic Product Manufacturing	83	Transport Support services and storage
8	Coal mining	46	Cement, Lime and Ready-Mixed Concrete Manufacturing	84	Publishing (except Internet and Music Publishing)
9	Oil and gas extraction	47	Plaster and Concrete Product Manufacturing	85	Motion Picture and Sound Recording
10	Iron Ore Mining	48	Other Non-Metallic Mineral Product Manufacturing	86	Broadcasting (except Internet)
11	Non Ferrous Metal Ore Mining	49	Iron and Steel Manufacturing	87	Internet Service Providers, Internet Publishing and Broadcasting
12	Non Metallic Mineral Mining	50	Basic Non-Ferrous Metal Manufacturing	88	Telecommunication Services
13	Exploration and Mining Support Services	51	Forged Iron and Steel Product Manufacturing	89	Library and Other Information Services
14	Meat and Meat product Manufacturing	52	Structural Metal Product Manufacturing	90	Finance
15	Processed Seafood Manufacturing	53	Metal Containers and Other Sheet Metal Product manufacturing	91	Insurance and Superannuation Funds
16	Dairy Product Manufacturing	54	Other Fabricated Metal Product manufacturing	92	Auxiliary Finance and Insurance Services
17	Fruit and Vegetable Product Manufacturing	55	Motor Vehicles and Parts; Other Transport Equipment manufacturing	93	Rental and Hiring Services (except Real Estate)
18	Oils and Fats Manufacturing	56	Ships and Boat Manufacturing	94	Ownership of Dwellings
19	Grain Mill and Cereal Product Manufacturing	57	Railway Rolling Stock Manufacturing	95	Non-Residential Property Operators and Real Estate Services
20	Bakery Product Manufacturing	58	Aircraft Manufacturing	96	Professional, Scientific and Technical Services
21	Sugar and Confectionery Manufacturing	59	Professional, Scientific, Computer and Electronic Equipment Manufacturing	97	Computer Systems Design and Related Services
22	Other Food Product Manufacturing	60	Electrical Equipment Manufacturing	98	Employment, Travel Agency and Other Administrative Services
23	Soft Drinks, Cordials and Syrup Manufacturing	61	Domestic Appliance Manufacturing	99	Building Cleaning, Pest Control and Other Support Services
24	Beer Manufacturing	62	Specialised and other Machinery and Equipment Manufacturing	100	Public Administration and Regulatory Services
25	Wine, Spirits and Tobacco	63	Furniture Manufacturing	101	Defence
26	Textile Manufacturing	64	Other Manufactured Products	102	Public Order and Safety
27	Tanned Leather, Dressed Fur and Leather Product Manufacturing	65	Electricity Generation	103	Primary and Secondary Education Services (incl Pre-Schools and Special Schools)
28	Textile Product Manufacturing	66	Electricity Transmission, Distribution, On Selling and Electricity Market Operation	104	Technical, Vocational and Tertiary Education Services (incl undergraduate and postgraduate)
29	Knitted Product Manufacturing	67	Gas Supply	105	Arts, Sports, Adult and Other Education Services (incl community education)
30	Clothing Manufacturing	68	Water Supply, Sewerage and Drainage Services	106	Health Care Services
31	Footwear Manufacturing	69	Waste Collection, Treatment and Disposal Services	107	Residential Care and Social Assistance Services
32	Sawmill Product Manufacturing	70	Residential Building Construction	108	Heritage, Creative and Performing Arts

No	Industry	No	Industry	No	Industry
33	Other Wood Product Manufacturing	71	Non-Residential Building Construction	109	Sports and Recreation
34	Pulp, Paper and Paperboard Manufacturing	72	Heavy and Civil Engineering Construction	110	Gambling
35	Paper Stationery and Other Converted Paper	73	Construction Services	111	Automotive Repair and Maintenance
36	Printing	74	Wholesale Trade	112	Other Repair and Maintenance
37	Petroleum and Coal Product Manufacturing	75	Retail Trade	113	Personal Services
38	Human Pharmaceutical and Medicinal Product	76	Accommodation	114	Other Services

SOURCE: ABS

The Sheep, Grains, Beef and Dairy industry is disaggregated into five separate sectors in this study. They are:

- Beef cattle
- Dairy
- Sheep for meat
- Sheep for wool
- Grains

The Poultry and Other Livestock industry is disaggregated into four separate sectors in this study. They are:

- Poultry for meat
- Poultry for eggs
- Pigs
- Other livestock

The Meat and Meat Product Manufacturing industry is disaggregated into five separate sectors in this study. They are:

- Beef meat
- Sheep meat
- Chicken meat
- Pork
- Other meats

C DETAILED ESTIMATES BY COMMODITY GROUP (WITH AND WITHOUT ANIMAL HEALTH PRODUCTS)

C.1 Beef cattle production

C.1.1 Contribution of beef cattle production "with AHPs"

To estimate the economic contribution of AHPs use, simple multiplier analysis was used to determine the contribution of beef cattle production with and without AHPs. The difference between the two scenarios was then used to determine the contribution of AHPs to beef cattle production.

The direct, indirect and total impacts of beef cattle production "with AHPs" use is provided in **Table C.1**.

TABLE C.1 CONTRIBUTION OF BEEF CATTLE PRODUCTION "WITH AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	786	4,880	40,506
Indirect	3,271	6,890	43,080
Total	4,057	11,770	83,586
Contribution	%	%	%
Direct	0.097	0.294	0.379
Indirect	0.405	0.415	0.403
Total	0.503	0.709	0.781

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Direct economic contribution "with AHPs"

The total beef cattle production in 2015-16 was $13,087 million. The direct economic contribution (value-add) embodied in the revenue is estimated to have been $4,880 million, mostly comprising employee wages and gross operating profits. The industry is thus a low value-adding industry with a value-add to revenue ratio of 0.37. In 2015-16, Australian Gross Domestic Product (GDP) was $1,660 billion[27] implying that the direct value-add economic contribution of beef cattle production was 0.294% of Australia's 2015-16 GDP.

[27] ABS (2016), Australian System of National Accounts, 2015016, Cat No: 5204.0, Table 1. http://www.abs.gov.au/ausstats/abs@.nsf/PrimaryMainFeatures/5204.0?OpenDocument

The direct income contribution (household income) from beef cattle production with AHPs is estimated to have been $786.2 million. In 2015-16, the Australian Compensation of Employees (COE)[28] was $807.1 billion[29] implying that the direct economic contribution of beef cattle production with AHPs use was 0.097% of Australia's household labour income.

The direct employment contribution from beef cattle production is estimated at 40,506 full-time equivalent (FTE) persons in 2015-16. Total FTE employment in the Australian economy was 10.7 million[30] implying that the direct employment contribution accounted for 0.379% of Australia's total employment.

Indirect economic contribution "with AHPs"

The total Australian value added, and employment embodied in the Australian produced inputs and services demanded by the beef cattle production industry has been estimated by allocating Australian intermediate inputs to their corresponding input-output industries and applying the appropriate multipliers for the Australian value added, household income and employment.

It is estimated that Australian beef cattle producers spent $8,207 million on goods and services in 2015-16. Of this, it is estimated that $7,307 million was on domestically produced goods and services. The industry spent over $490.7 million on AHPs in 2015-16.

It is estimated that with the use of AHPs:

- The spend of $8,207 million by beef cattle producers, indirectly contributed $6,890 million to the Australian economy, which is 0.415% of GDP in 2015-16. This is in addition to the direct contribution of 0.294 percent.
- Around $3,271 million in household income was indirectly supported by beef cattle production activities with AHPs use in their production in the Australian economy.
- Around 43,080 FTE jobs were indirectly supported by beef cattle production with AHPs use in the Australian economy.

Total economic contribution "with AHPs"

Adding the direct and indirect economic contributions for the beef cattle production sector from above provides total economic footprint of the Australian beef cattle production with the AHPs use. It is estimated that the beef cattle production sector using AHPs in Australia resulted in:

- a total contribution of $11,770 million to Australian GDP, comprising:
  - $4,880 million directly from the industry (direct contribution)
  - $6,890 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)
  - as a whole, the beef cattle production sector using AHPs to treat and control animal diseases contributed a 0.709% to Australian GDP in 2015-16, and
- In 2015-16, the beef cattle production sector with AHPs in Australia supported up to 83,586 FTE jobs. To put this estimate in another way, for every, one million dollars of revenue received from beef cattle production, there are up to 6.4 FTE jobs that are supported elsewhere in the Australian economy.

C.1.2 Contribution of beef cattle production "without AHPs"

The direct, indirect and total impacts of beef cattle production "without AHPs" use is provided in **Table C.2**.

[28] Total remuneration, in cash or in kind, payable by an enterprise to an employee in return for work done by the employee during the accounting period. It is further classified into two sub-components: wages and salaries; and employers' social contributions. Compensation of employees is not payable in respect of unpaid work undertaken voluntarily, including the work done by members of a household within an unincorporated enterprise owned by the same household. Compensation of employees excludes any taxes payable by the employer on the wage and salary bill (e.g. payroll tax).

[29] ABS (2016), Australian System of National Accounts, 2015016, Cat No: 5204.0, Table 8. http://www.abs.gov.au/ausstats/abs@.nsf/PrimaryMainFeatures/5204.0?OpenDocument

[30] ABS (2017), Labour Force Australia, Detailed, Electronics Delivery, Cat No: 6291.0.55.001, Table 8.

TABLE C.2 CONTRIBUTION OF BEEF CATTLE PRODUCTION "WITHOUT AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	739	4,322	38,084
Indirect	3,023	6,322	40,034
Total	3,762	10,644	78,118
Contribution	%	%	%
Direct	0.092	0.260	0.356
Indirect	0.375	0.381	0.374
Total	0.466	0.641	0.730

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Direct economic contribution "without AHPs"

It is estimated that total beef cattle production in 2015-16 would have been $11,778.1 million if AHPs had not been used.

The direct economic contribution (value-add) is estimated to have been $4,322 million, mostly comprising employee wages and gross operating profits. In 2015-16, GDP was $1,660 billion, implying that the direct value-add economic contribution of beef cattle production without the AHPs use was 0.260% of Australia's 2015-16 GDP.

The direct income contribution (compensation to employees) from the beef cattle production without AHPs use is estimated to have been $739 million. In 2015-16, the Australian total COE was $807.1 billion, implying that the direct economic contribution of beef cattle production without the AHPs use was 0.092% of Australia's wage income.

The direct employment contribution from beef cattle production without the use of AHPs is estimated at 38,084 FTE persons in 2015-16. Total FTE employment in the Australian economy was 10.7 million implying that the direct employment contribution of beef cattle production without the AHPs use is accounted for 0.356% of Australia's total employment.

Indirect economic contribution "without AHPs"

It is estimated that without the use of AHPs:

- the spend of $7,456.5 million by beef cattle producers (without the use of AHPs), indirectly contributed $6,322 million to the Australian economy, which is 0.381% of GDP in 2015-16
- around $3,023 million in household income was indirectly supported by beef cattle production activities without the use of AHPs in the Australian economy, and
- around 40,034 FTE jobs were indirectly supported by beef cattle production without AHPs use in the Australian economy.

Total economic contribution "without AHPs"

Adding the direct and indirect economic contributions for the beef cattle production sector from above provides total economic footprint of the Australian beef cattle production if they had not been used AHPs in 2015-16.

It is estimated that, if AHPs had not been used in beef cattle production in 2015-16 in Australia there would have been a total contribution of $10,644 million to Australian GDP, comprising:

- $4,322 million directly from the industry (direct contribution)
- $6,322 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)

— as a whole, the beef cattle production sector if they had not used AHPs to treat and control animal diseases contributed a 0.641% to Australian GDP in 2015-16

In 2015-16, beef cattle production in Australia supported up to 78,118 FTE jobs.

C.2 Dairy production

C.2.1 Contribution of dairy production "with AHPs"

To estimate the economic contribution of AHPs, a simple multiplier analysis was undertaken to estimate the contribution of dairy production with AHPs and without AHPs. The difference between the two figures provides the contribution of AHPs to the dairy production.

The direct, indirect and total impacts of dairy production "with AHPs" use is provided in **Table C.3**.

TABLE C.3 CONTRIBUTION OF DAIRY PRODUCTION "WITH AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	257	1,597	18,187
Indirect	1,074	2,256	14,117
Total	1,331	3,853	32,305
Contribution	%	%	%
Direct	0.032	0.096	0.170
Indirect	0.133	0.136	0.132
Total	0.165	0.232	0.302

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Direct economic contribution "with AHPs"

The total dairy production in 2015-16 was $4,282 million. The direct economic contribution (value-add) is estimated to have been $1,597 million, mostly comprising employee wages and gross operating profits. In 2015-16, Australian GDP was $1,660 billion[31] implying that the direct value-add economic contribution of dairy production was 0.096% of Australia's 2015-16 GDP.

The direct income contribution (household income) from the dairy production with the AHPs' use is estimated to have been $257 million. In 2015-16, the COE[32] was $807.1 billion[33] implying that the direct economic contribution of dairy production with AHPs was 0.032% of Australia's household labour income.

The direct employment contribution from dairy production is estimated at 18,187 FTE persons in 2015-16. Total FTE employment in the Australian economy was 10.7 million[34] implying that the direct employment contribution accounted for 0.170% of Australia's total employment.

Indirect economic contribution "with AHPs"

The total Australian value added, and employment embodied in the Australian produced inputs and services demanded by the dairy production industry has been estimated by allocating Australian

[31] ABS (2016), Australian System of National Accounts, 2015016, Cat No: 5204.0, Table 1. http://www.abs.gov.au/ausstats/abs@.nsf/PrimaryMainFeatures/5204.0?OpenDocument

[32] Total remuneration, in cash or in kind, payable by an enterprise to an employee in return for work done by the employee during the accounting period. It is further classified into two sub-components: wages and salaries; and employers' social contributions. Compensation of employees is not payable in respect of unpaid work undertaken voluntarily, including the work done by members of a household within an unincorporated enterprise owned by the same household. Compensation of employees excludes any taxes payable by the employer on the wage and salary bill (e.g. payroll tax).

[33] ABS (2016), Australian System of National Accounts, 2015016, Cat No: 5204.0, Table 8. http://www.abs.gov.au/ausstats/abs@.nsf/PrimaryMainFeatures/5204.0?OpenDocument

[34] ABS (2017), Labour Force Australia, Detailed, Electronics Delivery, Cat No: 6291.0.55.001, Table 8.

intermediate inputs to their corresponding input-output industries and applying the appropriate multipliers for the Australian value added, household income and employment.

It is estimated that Australian dairy producers spent $2,685.5 million on goods and services in 2015-16. Of this, it is estimated that $2,391 million was on domestically produced goods and services. The industry spent over $128 million on AHPs in 2015-16.

It is estimated that with the use of AHPs:

- the spend of $2,685.5 million by dairy producers, indirectly contributed $2,256 million to the Australian economy, which is 0.136 of GDP in 2015-16—this is in addition to the direct contribution of 0.096%
- around $1,074 million in household income was indirectly supported by dairy production activities with AHPs use in the Australian economy, and
- around 14,117 FTE jobs were indirectly supported by dairy production with AHPs use in the Australian economy.

Total economic contribution "with AHPs"

Adding the direct and indirect economic contributions for the dairy production sector from above provides total economic footprint of the Australian dairy production.

It is estimated that the dairy production sector using AHPs in Australia resulted in:

- a total contribution of $3,853 million to Australian GDP, comprising:
  - $1,597 million directly from the industry (direct contribution)
  - $2,256 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)
  - as a whole, the dairy production sector using AHPs to treat and control animal diseases contributed a 0.232% to Australian GDP in 2015-16
- the support of up to 32,305 FTE jobs. To put this estimate in another way, for every, one million dollars of revenue received by the dairy producers, there are up to 7.5 FTE jobs that are supported elsewhere in the Australian economy.

C.2.2 Contribution of dairy production "without AHPs"

The estimated direct, indirect and total impacts of dairy production if the sector had not used the AHPs in 2015-16 is provided in **Table C.4**.

TABLE C.4 CONTRIBUTION OF DAIRY PRODUCTION "WITHOUT AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	242	1,168	17,100
Indirect	1,002	2,093	13,226
Total	1,244	3,261	30,326
Contribution	%	%	%
Direct	0.030	0.070	0.160
Indirect	0.124	0.126	0.124
Total	0.154	0.196	0.283

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Direct economic contribution "without AHPs"

The estimated total dairy production would have been $3,640 million if the industry had not used AHPs in 2015-16. The direct economic contribution (value-add) is estimated to have been $1,168 million, mostly comprising employee wages and gross operating profits. In 2015-16, Australian GDP

was $1,660 billion implying that the direct value-add economic contribution of dairy production without the use of AHPs was 0.070% of Australia's 2015-16 GDP.

The direct income contribution (compensation to employees) from the dairy production without AHPs use estimated to have been $242 million. In 2015-16, the COE was $807.1 billion, implying that the direct economic contribution of dairy production without AHPs was 0.03% of Australia's household labour income. The direct employment contribution from dairy production is estimated at 17,100 FTE persons in 2015-16. Total FTE employment in the Australian economy was 10.7 million, implying that the direct employment contribution was 0.16% of Australia's total employment.

Indirect economic contribution "without AHPs"

It is estimated that without the use of AHPs:

- the spend of $2,471.5 million by dairy producers would have indirectly contributed $2,093 million to the Australian economy, which is 0.126% of GDP in 2015-16
- around $1,002 million in compensation to employees would have indirectly supported by dairy production activities without AHPs use, and
- around 13,226 FTE jobs would have been indirectly supported in the Australian economy by dairy production without the AHPs use.

Total economic contribution "without AHPs"

Adding the direct and indirect economic contributions for the dairy production sector from above provides total economic footprint of the Australian dairy production if it had not used AHPs in 2015-16. It is estimated that the dairy production would have resulted in a total contribution of $3,261 million to Australian GDP, comprising:

- $1,168 million directly from the industry (direct contribution)
- $2,093 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)
- as a whole, the dairy production sector contributed a 0.196% to Australian GDP in 2015-16
- In 2015-16, dairy production would have supported up to 30,326 FTE jobs in Australia.

C.3 Sheep meat production

C.3.1 Contribution of sheep production "with AHPs"

To estimate the economic contribution of AHPs, a simple multiplier analysis is undertaken for contribution of sheep meat production with AHPs and without AHPs. The difference between with and without AHPs provides the contribution of AHPs use to the sheep meat production. The direct, indirect and total impacts of sheep meat production "with AHPs" use is provided in **Table C.5**.

TABLE C.5 CONTRIBUTION OF SHEEP MEAT PRODUCTION "WITH AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	195	1,208	3,280
Indirect	813	1,707	10,685
Total	1,008	2,915	13,965
Contribution	%	%	%
Direct	0.024	0.073	0.031
Indirect	0.101	0.103	0.100
Total	0.125	0.176	0.131

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Direct economic contribution "with AHPs"

The estimated sheep meat cattle production in 2015-16 was $3,239 million. The direct economic contribution (value-add) is estimated to have been $1,208 million, mostly comprising employee wages and gross operating profits. In 2015-16, Australian Gross Domestic Product (GDP) was $1,660 billion implying that the direct value-add economic contribution of sheep production with the AHPs was 0.073% of Australia's 2015-16 GDP.

The direct income contribution (household income) from the sheep production with AHPs is estimated to have been $195 million. In 2015-16, the Australian Compensation of Employees (COE) was $807.1 billion implying that the direct economic contribution of dairy production with AHPs was 0.024% of Australia's household labour income.

The direct employment contribution from sheep for meat production is estimated at 3,280 FTE persons in 2015-16. Total FTE employment in the Australian economy was 10.7 million implying that the direct employment contribution accounted for 0.031% of Australia's total employment.

Indirect economic contribution "with AHPs"

It is estimated that Australian sheep meat producers spent $2,031.6 million on goods and services in 2015-16. Of this, it is estimated that $1,808.7 million was on domestically produced goods and services. The industry spent over $88.51 million on AHPs in 2015-16.

It is estimated that with the use of AHPs:

— the spend of $2,031.6 million by sheep meat cattle producers, indirectly contributed $1,707 million to the Australian economy, which is 0.103% of GDP in 2015-16 —this is in addition to the direct contribution of 0.073 percent

— around $813 million in household income in the Australian economy was indirectly supported by sheep meat cattle production in Australia

— around 10,685 FTE jobs were indirectly supported by sheep meat production activities with AHPs use in the Australian economy.

Total economic contribution "with AHPs"

Adding the direct and indirect economic contributions for the sheep production for meat from above provides total economic footprint of the Australian sheep meat production with AHPs use.

It is estimated that the sheep meat production sector using AHPs in Australia resulted in a total contribution of $2,915 million to Australian GDP, comprising:

— $1,208 million directly from the industry (direct contribution)

— $1,707 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)

— as a whole, the sheep production sector using AHPs to treat and control animal diseases contributed a 0.176% to Australian GDP in 2015-16.

In 2015-16, sheep production sector with AHPs in Australia supported up to 13,965 FTE jobs. To put this estimate in another way, for every, one million dollars of revenue received, there are up to 4.3 FTE jobs that are supported elsewhere in the Australian economy.

C.3.2 Contribution of sheep production "without AHPs"

The direct, indirect and total impacts of sheep production "without AHPs" use is provided in **Table C.6**.

TABLE C.6 CONTRIBUTION OF SHEEP MEAT PRODUCTION "WITHOUT AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	183	973	3,084
Indirect	761	1,589	10,037

Impacts	Compensation of employees	Value-add	Employment
Total	944	2,562	13,121
Contribution	%	%	%
Direct	0.023	0.059	0.029
Indirect	0.094	0.096	0.094
Total	0.117	0.154	0.123

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Direct economic contribution "without AHPs"

The estimated sheep production without the use of AHPs would have been $2,850 million. The direct economic contribution (value-add) embodied in the revenue is estimated to have been $973 million, mostly comprising employee wages and gross operating profits. In 2015-16, Australian Gross Domestic Product (GDP) was $1,660 billion implying that the direct value-add economic contribution of sheep production without the use of AHPs was 0.059% of Australia's 2015-16 GDP.

The direct income contribution (compensation to employees) from the sheep production without AHPs use estimated to have been $183 million. In 2015-16, the Australian Compensation of Employees (COE) was $807.1 billion implying that the direct economic contribution of sheep meat cattle production n without AHPs was 0.023% of Australia's household labour income.

The direct employment contribution from sheep meat cattle production is estimated at 3,084 FTE persons in 2015-16. Total FTE employment in the Australian economy was 10.7 million implying that the direct employment contribution accounted for 0.029% of Australia's total employment.

Indirect economic contribution "without AHPs"

It is estimated that Australian sheep producers spent $1,877.6 million on other goods and services in 2015-16. Of this, it is estimated that $1,668.1 million was on domestically produced goods and services.

It is estimated that without the use of AHPs:

— the spend of $1,877.6 million by sheep meat producers, would have indirectly contributed $1,589 million to the Australian economy, which would have been 0.096% of GDP in 2015-16 — this is in addition to the direct contribution of 0.059 percent

— around $761 million in compensation to employees would have been indirectly supported in the Australian economy by sheep meat production activities without AHPs' use

— around 10,037 FTE jobs would have been indirectly supported in the Australian economy by sheep meat production without AHPs' use.

Total economic contribution "without AHPs"

Adding the direct and indirect economic contributions for the sheep meat production sector from above provides total economic footprint of the Australian sheep production for meat. It is estimated that the sheep meat production sector without the use of AHPs in Australia would have resulted in a total contribution of $2,562 million to Australian GDP, comprising:

— $973 million directly from the industry (direct contribution)

— $1,589 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)

— as a whole, the sheep meat production sector without using AHPs contributed a 0.154% to Australian GDP in 2015-16.

In 2015-16, the sheep meat production sector without the use of AHPs would have supported up to 13,121 FTE jobs in Australia.

C.4 Wool production

C.4.1 Contribution of wool production "with AHPs"

To estimate the economic contribution of AHPs, a simple multiplier analysis is undertaken for contribution of wool production with AHPs and without AHPs. The difference between with and without AHPs provides the contribution of AHPs to the wool production.

The direct, indirect and total impacts of wool production "with AHPs" use is provided in **Table C.7**.

TABLE C.7 CONTRIBUTION OF WOOL PRODUCTION "WITH AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	178	1,106	2,684
Indirect	746	1,563	9,791
Total	924	2,669	12,475
Contribution	%	%	%
Direct	0.022	0.067	0.025
Indirect	0.092	0.094	0.092
Total	0.115	0.161	0.117

SOURCE: ACIL CONSULTING ALLEN ESTIMATES

Direct economic contribution "with AHPs"

The estimated wool production in 2015-16 was $2,965 million. The direct economic contribution (value-add) embodied in the revenue is estimated to have been $1,106 million, mostly comprising employee wages and gross operating profits.

In 2015-16, Australian Gross Domestic Product (GDP) was $1,660 billion implying that the direct value-add economic contribution of wool production with the AHPs was 0.067% of Australia's 2015-16 GDP.

The direct income contribution (household income) from the wool production with AHPs is estimated to have been $178 million.

In 2015-16, the Australian Compensation of Employees (COE) was $807.1 billion implying that the direct economic contribution of wool production with AHPs was 0.022% of Australia's household labour income.

The direct employment contribution from wool production is estimated at 2,684 FTE persons in 2015-16. Total FTE employment in the Australian economy was 10.7 million implying that the direct employment contribution accounted for 0.025% of Australia's total employment.

Indirect economic contribution "with AHPs"

It is estimated that Australian wool producers spent $1,859.4 million on goods and services in 2015-16. Of this, it is estimated that $1,655.4 million was on domestically produced goods and services. The industry spent over $63.1 million on AHPs in 2015-16.

It is estimated that:

— the spend of $1,859.4 million by wool producers, indirectly contributed $1,563 million to the Australian economy, which is 0.094% of GDP in 2015-16—this is in addition to the direct contribution of 0.067 percent

— around $746 million in household income in the Australian economy was indirectly supported by wool production, and

— around 9,791 FTE jobs were indirectly supported by wool production with AHPs use in the Australian economy.

Total economic contribution "with AHPs"

Adding the direct and indirect economic contributions for the wool production from above provides total economic footprint of the Australian sheep wool production in 2015-16.

It is estimated that the sheep raised for sheep wool production using AHPs in Australia resulted in a total contribution of $2,669 million to Australian GDP, comprising:

— $1,106 million directly from the industry (direct contribution)

— $1,563 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)

— as a whole, the wool production contributed 0.161% to Australian GDP in 2015-16.

In 2015-16, wool production with AHPs use in Australia supported up to 12,475 FTE jobs. To put this estimate in another way, for every, one million dollars of revenue received, there are up to 4.2 FTE jobs that are supported elsewhere in the Australian economy.

C.4.2 Contribution of wool production "without AHPs"

The direct, indirect and total impacts of wool production "without AHPs" use is provided in **Table C.8**.

TABLE C.8 CONTRIBUTION OF WOOL PRODUCTION "WITHOUT AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	167	918	2,523
Indirect	703	1,467	9,256
Total	871	2,385	11,779
Contribution	%	%	%
Direct	0.021	0.055	0.024
Indirect	0.087	0.088	0.087
Total	0.108	0.144	0.110

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Direct economic contribution "without AHPs"

The estimated sheep wool production without the use of AHPs was $2,653.6 million.

The direct economic contribution (value-add) embodied in the revenue would have been $918 million, mostly comprising employee wages and gross operating profits. In 2015-16, Australian GDP was $1,660 billion, implying that the direct value-add economic contribution of wool production without the use of AHPs would have been 0.055% of Australia's 2015-16 GDP.

The direct income contribution (compensation to employees) from the wool production without AHPs use would have been $167 million. In 2015-16, the COE was $807.1 billion, implying that the direct economic contribution of sheep raised for wool production without AHPs would have been 0.021% of Australia's household labour income.

The direct employment contribution from wool production is estimated at 2,523 FTE persons in 2015-16. Total FTE employment in the Australian economy would have been 10.7 million implying that the direct employment contribution would have accounted for 0.024% of Australia's total employment.

Indirect economic contribution "without AHPs"

Allocating Australian intermediate inputs to their corresponding input-output industries and applying the appropriate multipliers for the Australian value added, household income and employment, it is possible to estimate the total Australian value added and employment embodied in the Australian produced inputs and services demanded by the wool production industry.

It is estimated that Australian wool producers would have spent $1,736 million on goods and services in 2015-16. Of this, it is estimated that $1,544 million would have been on domestically produced goods and services.

It is estimated that without the use of AHPs:

- the spend of $1,736 million by wool producers would have indirectly contributed $1,467 million to the Australian economy, which would have been 0.088% of GDP in 2015-16—this would have been in addition to the direct contribution of 0.055 percent
- around $703 million in compensation to employees would have indirectly supported in the Australian economy by wool production activities
- around 9,256 FTE jobs would have indirectly supported in the Australian economy by wool production.

Total economic contribution "without AHPs"

Adding the direct and indirect economic contributions for the wool production from above provides total economic footprint of the Australian wool production, if AHPs were not used in 2015-16. It is estimated that the wool production without the use of AHPs in Australia resulted in a total contribution of $2,385 million to Australian GDP, comprising:

- $918 million directly from the industry (direct contribution)
- $1,467 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)
- as a whole, the wool production would have contributed only a 0.144% to Australian GDP in 2015-16.

In 2015-16 the wool production sector would have supported up to 11,799 FTE jobs in Australia.

C.5 Pig production

C.5.1 Contribution of pig production "with AHPs"

To estimate the economic contribution attributable to AHPs in pig production, a simple multiplier analysis is undertaken for contribution of pig production with AHPs use and without AHPs use. The difference between with and without AHPs use provides the contribution of AHPs to the pig production. The direct, indirect and total impacts of pig production "with AHPs" use is provided in **Table C.9**.

TABLE C.9 CONTRIBUTION OF PIG PRODUCTION "WITH AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	279	538	3,161
Indirect	356	714	4,864
Total	634	1,252	8,025
Contribution	%	%	%
Direct	0.035	0.032	0.029
Indirect	0.044	0.043	0.045
Total	0.078	0.075	0.075

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Direct economic contribution "with AHPs"

Australia's estimated pig production in 2015-16 was $1,393 million. The direct economic contribution (value-add) is estimated to have been $538 million, mostly comprising employee wages and gross operating profits. In 2015-16, Australian GDP was $1,660 billion, implying that the direct value-add economic contribution of pig production with the AHPs was 0.0324% of Australia's 2015-16 GDP.

The direct income contribution (household income) from the pig production with AHPs is estimated to have been $279 million. In 2015-16, the Australian COE was $807.1 billion implying that the direct economic contribution of pig production with AHPs was 0.0345% of Australia's household labour income.

The direct employment contribution from pig production is estimated at 3,161 FTE persons in 2015-16. Total FTE employment in the Australian economy was 10.7 million implying that the direct employment contribution accounted for 0.0295% of Australia's total employment.

Indirect economic contribution "with AHPs"

It is estimated that Australian pig producers spent $855 million on goods and services in 2015-16. Of this, it is estimated that $793.3 million was on domestically produced goods and services. The industry spent over $68.41 million on AHPs in 2015-16.

It is estimated that:

- the spend of $855 million by pig producers, indirectly contributed $714 million to the Australian economy, which was 0.043% of GDP in 2015-16—this is in addition to the direct contribution of 0.0324 percent
- around $356 million in household income in the Australian economy was indirectly supported by pig production, and
- around 4,864 FTE jobs were indirectly supported by pig production with the use of AHPs in the Australian economy.

Total economic contribution "with AHPs"

Adding the direct and indirect economic contributions for the pig production from above provides total economic footprint of the Australian pig production industry with AHPs use. That is current pig production.

It is estimated that the pig production using AHPs in Australia resulted in a total contribution of $1,252 million to Australian GDP, comprising:

- $538 million directly from the industry (direct contribution)
- $714 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)
- as a whole, the pig production using AHPs to treat and control diseases contributed a 0.0754% to Australian GDP in 2015-16

In 2015-16, pig production with AHPs use in Australia supported up to 8,025 FTE jobs. To put this estimate in another way, for every, one million dollars of revenue received, there are up to 6 FTE jobs that are supported elsewhere in the Australian economy.

C.5.2 Contribution of pig production "without AHPs"

The direct, indirect and total impacts pig production "without AHPs" use is provided in **Table C.10**.

TABLE C.10 CONTRIBUTION OF PIG PRODUCTION "WITHOUT AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	274	438	3,110
Indirect	330	655	4,559

Impacts	Compensation of employees	Value-add	Employment
Total	605	1,093	7,670
Contribution	%	%	%
Direct	0.034	0.026	0.029
Indirect	0.041	0.039	0.043
Total	0.075	0.066	0.072

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Direct economic contribution "without AHPs"

The estimated pig production without the use of AHPs would have been $1,212 million.

The direct economic contribution (value-add) embodied in the revenue would have been $438 million, mostly comprising employee wages and gross operating profits. In 2015-16, Australian Gross Domestic Product (GDP) was $1,660 billion implying that the direct value-add economic contribution of pig production without the use of AHPs would have been 0.026% of Australia's 2015-16 GDP.

The direct income contribution (compensation to employees) from the pig production without AHPs use would have been $274 million. In 2015-16, the Australian Compensation of Employees (COE) was $807.1 billion implying that the direct economic contribution of pig production without AHPs would have been 0.034% of Australia's household labour income.

The direct employment contribution from pig production would have been estimated at 3,110 FTE persons in 2015-16. Total FTE employment in the Australian economy was 10.7 million implying that the direct employment contribution would have accounted for 0.029% of Australia's total employment.

Indirect economic contribution "without AHPs"

It is estimated that Australian pig producers spent $774 million on goods and services in 2015-16. Of this, it is estimated that $718 million was on domestically produced goods and services.

It is estimated that without the use of AHPs:

— the spend of $774 million by pig producers would have indirectly contributed $655 million to the Australian economy, which would have been 0.039% of GDP in 2015-16—this is in addition to the direct contribution of 0.026 percent

— around $330 million in compensation of employees would have been indirectly supported in the Australian economy by pig production activities.

— around 4,559 FTE jobs would have been indirectly supported in the Australian economy by pig production without using AHPs.

Total economic contribution "without AHPs"

Adding the direct and indirect economic contributions for the pig production from above provides total economic footprint of the Australian pig production which would have been produced if it had not used AHPs. It is estimated that the pig production sector without the use of AHPs in Australia resulted in a total contribution of $1,094 million to Australian GDP, comprising:

— $438 million directly from the industry (direct contribution)

— $655 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)

— as a whole, the pig production without using AHPs contributed a 0.066% to Australian GDP in 2015-16.

In 2015-16, the pig production sector without AHPs would have supported up to 7,670 FTE jobs in Australia.

C.6 Poultry meat production

C.6.1 Contribution of poultry meat production "with AHPs"

To estimate the economic contribution attributable to AHPs use in poultry meat production, a simple multiplier analysis is undertaken for contribution of production with AHPs use and without AHPs use. The difference between them provides the contribution of AHPs to poultry meat production.

The direct, indirect and total impacts of poultry production "with AHPs" use in 2015-16 is provided in **Table C.11**.

TABLE C.11 CONTRIBUTION OF POULTRY PRODUCTION "WITH AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	236.5	1,650.9	1,914
Indirect	396.2	902.8	5,484
Total	632.6	2,553.6	7,398
Contribution	%	%	%
Direct	0.029	0.099	0.018
Indirect	0.049	0.054	0.051
Total	0.078	0.154	0.069

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Direct economic contribution "with AHPs"

The estimated poultry meat production in 2015-16 was $2,748.4 million. The direct economic contribution (value-add) is estimated to have been $1,650.9 million, mostly comprising employee wages and gross operating profits. In 2015-16, Australian GDP was $1,660 billion, implying that the direct value-add economic contribution of chicken meat production with the AHPs was 0.099% of Australia's 2015-16 GDP.

The direct income contribution (household income) from the production with AHPs use is estimated to have been $236.5 million.

In 2015-16, the Australian COE was $807.1 billion implying that the direct economic contribution of poultry production with AHPs use was 0.029% of Australia's household labour income.

The direct employment contribution from poultry production is estimated at 1,914 FTE persons in 2015-16. Total FTE employment in the Australian economy was 10.7 million, implying that the direct employment contribution accounted for 0.018% of Australia's total employment.

Indirect economic contribution "with AHPs"

It is estimated that Australian poultry producers spent $1,097.5 million on goods and services in 2015-16. Of this, it is estimated that $990.8 million was on domestically produced goods and services. The industry spent over $127.3 million on AHPs in 2015-16.

It is estimated that:

- the spend of $1,097.5 million by chicken meat producers, indirectly contributed $902.8 million to the Australian economy, which was 0.054% of GDP in 2015-16—this is in addition to the direct contribution of 0.099 percent
- around $396.2 million in household income in the Australian economy was indirectly supported by poultry production
- around 5,484 FTE jobs were indirectly supported in the Australian economy by poultry production.

Total economic contribution "with AHPs"

Adding the direct and indirect economic contributions for the chicken meat production from above provides total economic footprint of the Australian poultry production industry with AHPs use in 2016-17.

It is estimated that the poultry production using AHPs in Australia resulted in a total contribution of $2,553.6 million to Australian GDP, comprising:

— $1,650.9 million directly from the industry (direct contribution)
— $902.8 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)
— as a whole, the poultry production using AHPs to treat and control diseases contributed a 0.154% to Australian GDP in 2015-16.

In 2015-16, poultry production with AHPs use in Australia supported up to 7,398 FTE jobs. To put this estimate in another way, for every, one million dollars of revenue received, there are up to 3 FTE jobs that are supported elsewhere in the Australian economy.

C.6.2 Contribution of chicken meat production "without AHPs"

The direct, indirect and total impacts of poultry production "without AHPs" use is provided in **Table C.12**.

TABLE C.12 CONTRIBUTION OF POULTRY PRODUCTION "WITHOUT AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	235.4	1,644.2	1,905
Indirect	357.5	809.0	5,032
Total	592.8	2,453.1	6,937
Contribution	%	%	%
Direct	0.029	0.099	0.018
Indirect	0.044	0.049	0.047
Total	0.073	0.148	0.065

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Direct economic contribution "without AHPs"

The estimated poultry meat production without the use of AHPs would have been $2,610 million in 2015-16.

The direct economic contribution (value-add) embodied in the revenue would have been $1,644.2 million, mostly comprising employee wages and gross operating profits. In 2015-16, Australian GDP was $1,660 billion implying that the direct value-add economic contribution of chicken meat production without the use of AHPs would have been 0.099% of Australia's 2015-16 GDP.

The direct income contribution (compensation to employees) from poultry farming without AHPs use would have been $235.4 million. In 2015-16, the Australian COE was $807.1 billion implying that the direct economic contribution poultry farming without AHPs would have been 0.029% of Australia's household labour income.

The direct employment contribution from poultry farming is estimated at 1,905 FTE persons in 2015-16. Total FTE employment in the Australian economy was 10.7 million implying that the direct employment contribution would have accounted for 0.018% of Australia's total employment.

Indirect economic contribution "without AHPs"

It is estimated that Australian poultry farmers spent $965.7 million on goods and services in 2015-16. Of this, it is estimated that $865.4 million was on domestically produced goods and services.

It is estimated that without the use of AHPs:

— the spend of $965.7 million by poultry farmers, indirectly contributed $809 million to the Australian economy, which would have been 0.049% of GDP in 2015-16—this is in addition to the direct contribution of 0.099 percent

— around $357.5 million in household income as a compensation to employees would have been indirectly supported in the Australian economy by poultry production activities without using AHPs

— around 5,032 FTE jobs would have been indirectly supported in the Australian economy by poultry production.

Total economic contribution "without AHPs"

Adding the direct and indirect economic contributions for the poultry production from above provides total economic footprint of the Australian poultry production in the absence of the use of AHPs. It is estimated that the poultry production sector without the use of AHPs in Australia resulted in a total contribution of $2,453.1 million to Australian GDP, comprising:

— $1,644.2 million directly from the industry (direct contribution)

— $809 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)

— as a whole, the poultry production without using AHPs contributed a 0.148% to Australian GDP in 2015-16.

In 2015-16, the poultry production sector without AHPs would have supported up to 6,937 FTE jobs in Australia.

C.7 Poultry layer production

C.7.1 Contribution of layer poultry production "with AHPs"

To estimate the economic contribution of AHPs, a simple multiplier analysis is undertaken for contribution of poultry layer production with AHPs use and without AHPs use. The difference between them provides the contribution of AHPs to the poultry production. The direct, indirect and total impacts of egg production "with AHPs" use is provided in **Table C.13**.

TABLE C.13 CONTRIBUTION OF POULTRY LAYER PRODUCTION "WITH AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	67.3	470.2	2,953
Indirect	114.2	258.2	1,587
Total	181.6	728.4	4,540
Contribution	%	%	%
Direct	0.008	0.028	0.028
Indirect	0.014	0.016	0.015
Total	0.022	0.044	0.042

SOURCE: ACIL ALLENCONSULTING ESTIMATES

Direct economic contribution "with AHPs"

The estimated poultry layer production in 2015-16 was $783 million. The direct economic contribution (value-add) is estimated to have been $470.2 million, mostly comprising employee wages and gross operating profits. In 2015-16, Australian GDP was $1,660 billion, implying that the direct value-add economic contribution of poultry layer production with the AHPs was 0.028% of Australia's 2015-16 GDP.

The direct income contribution (household income) from poultry layer production with AHPs' use is estimated to have been $67.3 million. In 2015-16, the Australian COE was $807.1 billion implying that the direct economic contribution of poultry layer production with AHPs' use was 0.008% of Australia's household labour income.

The direct employment contribution from egg production is estimated at 2,953 FTE persons in 2015-16. Total FTE employment in the Australian economy was 10.7 million, implying that the direct employment contribution accounted for 0.028% of Australia's total employment.

Indirect economic contribution "with AHPs"

Allocating Australian intermediate inputs to their corresponding input-output industries and applying the appropriate multipliers for the Australian value added, household income and employment, it is possible to estimate the total Australian value added and employment embodied in the Australian produced inputs and services demanded by the poultry layer production.

It is estimated that Australian poultry layer producers spent $312.6 million on goods and services in 2015-16. Of this, it is estimated that $282.2 million was on domestically produced goods and services. The industry spent over $25.8 million on AHPs in 2015-16.

It is estimated that:

- the spend of $312.6 million by egg producers, indirectly contributed $258.2 million to the Australian economy, which was 0.016% of GDP in 2015-16—this is in addition to the direct contribution of 0.028 percent
- around 114.2 million in household income in the Australian economy was indirectly supported by poultry layer production
- around 1,587 FTE jobs were indirectly supported in the Australian economy by poultry layer production which uses AHPs to control diseases.

Total economic contribution "with AHPs"

Adding the direct and indirect economic contributions for the egg production from above provides total economic footprint of the Australian poultry layer production industry who use AHPs to control diseases in 2015-16

It is estimated that the egg production using AHPs in Australia resulted in a total contribution of $728.4 million to Australian GDP, comprising:

- $470.2 million directly from the industry (direct contribution)
- $258.2 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution)
- as a whole, the egg production using AHPs to treat and control diseases contributed a 0.044% to Australian GDP in 2015-16.

In 2015-16, egg production with the use of AHPs in Australia supported up to 4,540 FTE jobs. To put this estimate in another way, for every, one million dollars of revenue received, there are up to 6 FTE jobs that are supported elsewhere in the Australian economy.

C.7.2 Contribution of poultry layer production "without AHPs"

The direct, indirect and total impacts of poultry layer production "without AHPs" use is provided in **Table C.14**.

TABLE C.14 CONTRIBUTION OF POULTRY LAYER PRODUCTION "WITHOUT AHPS"

Impacts	Compensation of employees	Value-add	Employment
Contribution	$ million	$ million	FTE
Direct	67.2	434.0	2,947

Impacts	Compensation of employees	Value-add	Employment
Indirect	106.5	239.4	1,497
Total	173.7	673.4	4,444
Contribution	%	%	%
Direct	0.008	0.026	0.028
Indirect	0.013	0.014	0.014
Total	0.022	0.041	0.042

SOURCE: ACIL ALLEN CONSULTING ESTIMATES

Direct economic contribution "without AHPs"

The estimated poultry layer production without the use of AHPs was $720.2 million. The direct economic contribution (value-add) embodied in the revenue would have been $434 million, mostly comprising employee wages and gross operating profits. In 2015-16, Australian GDP would have been $1,660 billion, implying that the direct value-add economic contribution of egg production without the use of AHPs would have been 0.026% of Australia's 2015-16 GDP.

The direct income contribution (compensation of employees) from the egg production without AHPs would have been $67.2 million. In 2015-16, the Australian COE would have been $807.1 billion implying that the direct economic contribution of egg production without AHPs would have been 0.008% of Australia's household labour income. The direct employment contribution from egg production without the use of AHPs would have been 2,947 FTE persons in 2015-16. Total FTE employment in the Australian economy was 10.7 million, implying that the direct employment contribution would have accounted for 0.028% of Australia's total employment.

Indirect economic contribution "without AHPs"

It is estimated that Australian poultry layer producers spent $286.2 million on goods and services in 2015-16. Of this, it is estimated that $257.6 million was on domestically produced goods and services. It is estimated that, without the use of AHPs:

- the spend of $286.2 million by egg producers would have indirectly contributed $239.4 million to the Australian economy, which would have been 0.014% of GDP in 2015-16—this is in addition to the direct contribution of 0.026 percent
- around $106.5 million in household income would have been indirectly supported in the Australian economy by egg production activities and around 1,497 FTE jobs were indirectly supported in the Australian economy by egg production.

Total economic contribution "without AHPs"

Adding the direct and indirect economic contributions from above provides total economic footprint of the Australian poultry layer production which would not have used AHPs in 2015-16. It is estimated that the egg production sector without the use of AHPs in Australia resulted in a total contribution of $673.4 million to Australian GDP, comprising:

- $434.0 million directly from the industry (direct contribution)
- $239.4 million indirectly from demand generated through producers purchases of inputs and services (indirect contribution) and as a whole, the egg production sector without using AHPs would have contributed a 0.041% to Australian GDP in 2015-16

In 2015-16, the egg production sector without using AHPs would have supported up 4,444 FTE jobs in Australia.

ACIL ALLEN CONSULTING PTY LTD
ABN 68 102 652 148

ACILALLEN.COM.AU

ABOUT ACIL ALLEN CONSULTING

ACIL ALLEN CONSULTING IS THE LARGEST INDEPENDENT, AUSTRALIAN OWNED ECONOMIC AND PUBLIC POLICY CONSULTANCY.

WE SPECIALISE IN THE USE OF APPLIED ECONOMICS AND ECONOMETRICS WITH EMPHASIS ON THE ANALYSIS, DEVELOPMENT AND EVALUATION OF POLICY, STRATEGY AND PROGRAMS.

OUR REPUTATION FOR QUALITY RESEARCH, CREDIBLE ANALYSIS AND INNOVATIVE ADVICE HAS BEEN DEVELOPED OVER A PERIOD OF MORE THAN THIRTY YEARS.