Final report

ESAM Analysis Reporting Service 2020–2025

Project code: V.MFS.0450

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Abstract

The ESAM Analysis Reporting Service has been providing data and support to the Australian meat industry since 2007 and after eighteen years, has come to an end at the conclusion of this project. The *E. coli* and *Salmonella* monitoring (ESAM) program, now known as the National Carcase Microbiological Monitoring Program (NCMMP), collects microbiological data from each export slaughter establishment in Australia and the data are now submitted to the Department of Agriculture, Fisheries and Forestry through the Meat Export Data Collection System. Since 2007, SARDI Food Sciences has been providing regular ESAM/NCMMP reports to each participating red meat establishment as well as national reports to MLA and the Department of Agriculture, Fisheries and Forestry.

The ESAM/NCMMP reports provide tabular and graphical summaries of the microbiological levels of total viable counts (aerobic plate counts), coliforms, generic *E. coli*, *Salmonella* and Shiga toxin-producing *E. coli* from carcases and carton product. These data allow establishments and the industry as a whole to benchmark themselves and identify trends over time. In addition to the reports, the ESAM/NCMMP database held at SARDI has been interrogated and used to support many different industry research projects with scientific rigour.

Executive summary

Background

Australian red meat export slaughter establishments provide microbiological data to the Department of Agriculture, Fisheries and Forestry under the National Carcase Microbiological Monitoring Program (NCMMP) and to utilise and analyse these data in a more use-friendly format for interpretation, SARDI has provided the ESAM/NCMMP Analysis Reporting Service for the past 18 years to assist Quality Assurance staff in the meat processing industry.

In the wake of the Jack-in-the-Box illnesses involving *E. coli* O157:H7 in 1993, the United States' Department of Agriculture Food Safety and Inspection Service required meat establishments implement microbiological testing of meat destined for grinding. In Australia in December 1997, the then-regulator Australian Quarantine and Inspection Service (now known as the Department of Agriculture, Water and the Environment (DAWE)) developed a program for *E. coli* and *Salmonella* Monitoring (ESAM) of carcases, to help Australia meet market access requirements for the US. Over the past 23 years, the ESAM program has been extended to include multiple species, carton meat testing and microbiological tests for aerobic plate counts, coliforms, generic *E. coli*, *Salmonella, E. coli* O157:H7 and the 'Big Six' *Shiga* toxin-producing *E. coli* or STECs (O26, O45, O103, O111, O121 and O145).

Objectives

1. Continue the provision of monthly NCMMP reports to participating establishments until June 2025.
2. Provide a monthly report to MLA and the Department that contains national results.
3. Provide milestone reports to MLA which document all user feedback (i.e. phone calls or emails) received over the project's duration.
4. Modify the report as required based on the outcome of feedback surveys and other feedback.

All objectives have been successfully achieved in this project.

Results/key findings

NCMMP reports have been distributed to all participating red meat export slaughter establishments from July 2020 to June 2025. National NCMMP and STEC reports have also been provided to MLA and the Department of Agriculture, Fisheries and Forestry. The ESAM/NCMMP database at SARDI now contains approximately 2 million samples, 5.6 million test results from almost twenty years of data from 2007 to 2025.

Feedback on the NCMMP reports has been very positive and supportive as the red meat industry has been supported by the ESAM/NCMMP Analysis Reporting Service for the past 18 years and the reports, as well as the analysis service, have been a useful, valuable resource for quality assurance, monitoring, process control, reporting to management, risk management, customer relations and market access.

Benefits to industry

A history of long-term results from the ESAM/NCMMP database and reports provided by SARDI has provided valuable information and resources to establishments and the red meat industry as a whole. Scientific background monitoring information on the industry has been supported by

approximately 5.6 million data points accumulated by ESAM/NCMMP and an extensive repertoire of tailored reports.

Future research and recommendations

To continue to provide the support and information delivered by the ESAM Analysis Reporting Service, DAFF are developing an online reporting platform which will generate similar data summaries and graphs for establishments on the BI tool.

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1. Background

The *E. coli* and *Salmonella* Monitoring (ESAM) program was established in 1997 to help Australia meet market access requirements for the US. The program requires all export slaughter establishments to collect and analyse carcase samples from all slaughter animal species for *E. coli* and *Salmonella.* Data are then entered into a national database (now the Meat Export Data Collection (MEDC) system) where it provides useful information for benchmarking Australia's performance. These data along with industry baseline data has proven very useful in market access negotiations and ensuring consumer and client confidence. Over the past 28 years, the ESAM program has been extended to include multiple animal species, carton meat testing and other microbiological tests such as aerobic plate count and the 'Big Six' *Shiga* toxin-producing *E. coli* or STECs (O26, O45, O103, O111, O121 and O145). Since 2021, the ESAM program is now known as the National Carcase Microbiological Monitoring Program (NCMMP).

In 2007, the South Australian Research and Development Institute (SARDI), through an MLA project, developed a fully functional software system for carrying out regular data analysis of ESAM/NCMMP data, providing regular reporting to export establishments and training materials to industry on the interpretation of the ESAM/NCMMP reports. The ESAM Analysis Reporting Service has continued to further develop and extend the reports over time. The impact of the ESAM Analysis Reporting Service on the red meat industry over the last 18 years is two-fold: at the individual establishment level and for the whole of industry. The whole industry has access to data to support claims for the quality of Australia's systems and their implementation. Investigation of trends can occur on a whole industry basis to ensure that Australia's meat quality remains at the highest standards. At the level of individual establishments, value is gained from understanding trends and comparisons with the whole industry. From the analysis of the ESAM/NCMMP data, opportunities are gained for learning and further research, and thus further improvements in meat processing and the ability to monitor process control.

2. Objectives

1. Continue the provision of monthly NCMMP reports to participating establishments until June 2025.
2. Provide a monthly report to MLA and the Department that contains national results.
3. Provide milestone reports to MLA which document all user feedback (i.e. phone calls or emails) received over the project's duration.
4. Modify the report as required based on the outcome of feedback surveys and other feedback.

All objectives have been successfully achieved in this project.

3. Achievement of Project Objectives

3.1 Establishment Reports

NCMMP and *E. coli* O157:H7 and STEC reports were sent to participating red meat export slaughter establishments up to and including June 2025. The mailing list was regularly updated to reflect changes in staff.

3.2 National Reports to MLA and the Department of Agriculture, Fisheries and Forestry (DAFF)

National NCMMP reports and national *E. coli* O157:H7 and STEC reports were provided to MLA (Ian Jenson, Long Huynh, Angelica Pickup) and DAFF (Arefin Chowdhury, Mark Salter, Christine Coulson, Dugald MacLachlan, Maged Tawadros).

3.3 User Feedback and Modification of the Reports

User feedback has been documented in the milestone reports to MLA and all feedback has been easily resolved through explanation of the reports or investigation and correction of data entry errors. No improvements or modifications were suggested during the course of this project and so the reports have not been amended or changed.

3.3.1 Feedback Survey

A feedback survey was distributed by SARDI in January 2024 to users and receivers of the monthly NCMMP reports, asking how they use the reports and what value they find from them. Twelve people provided responses and feedback via Survey Monkey, an online survey and questionnaire tool. The questions of the feedback survey and a summary of the survey results are provided in the Appendix (Section 6.1 and 6.2).

Based on the feedback, it is clear that the NCMMP reports have been a valuable and useful resource to the red meat processing industry over many years.
Some excerpts from the 2024 feedback survey (very similar comments have been provided in all previous feedback surveys):
- *"I have had a few overseas auditors look at the past reports as it is very useful information. I also use it as a "proof of risk" when explaining certain testing and traceability procedures to members of our Establishment."*
- *"The work you and SARDI has done with those reports and data has been so useful."*
- *"We really like seeing how we fare against the rest of establishments because these reports are much nicer than anything MEDC creates. We like seeing the national STEC trends as this is not available anywhere else."*

3.4 Data Utilisation

In addition to the NCMMP reports, SARDI provided data from the NCMMP database for the following purposes:

- Benchmarking summary statistics for a number of sheep abattoirs in Western Australia.
- Average microbial counts for a Victorian abattoir.
- Graphs of the national data for the last ten years for Mark Salter (DAFF) which were presented at each quarterly Export Meat Industry Advisory Committee meeting. The data were graphed as monthly averages for carcases vs carton, Total Viable Counts and *E. coli* for different animal species.
- A data request for inclusion in a journal paper titled 'The Effect of the Active Chilling and Frenching Processes on the Shelf-Life of Lamb Racks Vacuum-Packed in Secondary-Sealing Film' authored by Andreas Kiermeier, Jessica Jolley, Long Huynh and John Sumner.

- Summary statistics for *Salmonella* prevalence for beef and sheep over 2020-24 for an AMPC/MLA presentation in Vietnam on the outstanding hygiene performance of Australian meat (March 2025).
- A SARDI presentation at the JBS Global Food Safety and Quality Assurance conference titled 'Shelf-life – The key to Australia's 150 years of international trade'.

4. Discussion

4.1 Value and Return to Industry

Holistically, the impact on the red meat processing industry from the ESAM/NCMMP Analysis Reporting service is two-fold: at the individual establishment level and for the industry as a whole. The Australian meat industry expends considerable effort complying with the requirements of the NCMMP. One immediate benefit is continued access to specific international markets; MLA and AMPC have used summaries and graphs of the NCMMP data for this purpose. NCMMP has also resulted in an accumulation of data that is valuable as a descriptor of hygienic standards of meat processing in Australia. Coupled with statistical tools, analysis and modelling, the ESAM/NCMMP Analysis Reporting Service has provided easy-to-understand, scientific and longitudinal information and reports to individual establishments so they can monitor hygiene levels, improve processing practices and ensure the safety of their meat. Additionally, the NCMMP reports support evidence-based management of food safety issues and provide a benchmarking reporting service for establishments and the industry.

Another immediate benefit of the NCMMP reporting service is it is a mechanism for maintaining and verifying data quality and will assist processors, the industry and DAFF during market access negotiations. The ESAM/NCMMP database has been integral in being able to utilise over two million NCCMP/STEC samples and 5.6 million test results since 2007 in order to provide the scientific evidence for the good performance of the Australian meat industry and to argue for changes to the way establishments are required to monitor production and test meat products. This has led to significant changes to the NCMMP protocols and requirements which are in the process of being approved by key export markets, bringing efficiencies and cost reductions to the industry.

4.2 Industry Performance from start to current

Graphs of the microbiological performance of the beef, sheep and lamb industries are included in Figs 1–8. The bovine and ovine data have been chosen as a subset for inclusion in this final report, but a spreadsheet of the monthly national averages with standard deviations for all stock types starting from 2007 to 2025 has been submitted with this final report and Table 1 contains summary statistics for all species in the ESAM/NCMMP database.

Table 1: Summary statistics of all species in the ESAM/NCMMP database.

Species	Sample numbers	TVC mean (log$_{10}$ cfu/cm^2)	E. coli mean (log$_{10}$ cfu/cm^2)	E. coli prevalence (%)
Buffalo	150	1.97	-0.62	4.7
Calf	4,968	1.48	0.18	42.2
Camel	306	1.31	-0.38	15.1
Cow/Bull	92,199	0.98	-0.64	5.7
Deer	68	1.91	0.27	13.8
Deer (Game)	278	1.54	0.35	5.9
Emu	37	1.93	0.34	6.5
Goat Skin Off	14,535	1.45	-0.20	20.1
Goat Skin On	7,089	1.88	-0.002	13.2
Horses	304	1.28	-0.28	12.4
Kangaroo (Game)	9,425	1.76	0.84	12.8
Lamb	217,501	1.45	-0.16	12.3
Ostrich	48	1.88	0.33	7.0
Pig Skin Off	372	1.39	-0.59	11.5
Pig Skin On	62,157	1.50	-0.66	6.8
Pig (Game)	1,676	2.41	0.75	18.7
Ratite	139	1.99	0.05	4.9
Sheep	111,208	1.43	0.03	27.6
Steer/Heifer	236,575	1.01	-0.71	3.2
Veal	134	1.51	0.03	41.6

The mean Total Viable Count (TVC) for cow/bull and steer/heifer carcases has remained consistent at 1 log$_{10}$ cfu/cm^2 (10 cfu/cm^2) (Fig. 1). The mean E. coli level over the last 19 years has been -0.68 log$_{10}$ cfu/cm^2 or 0.2 cfu/cm^2 (Fig. 2).
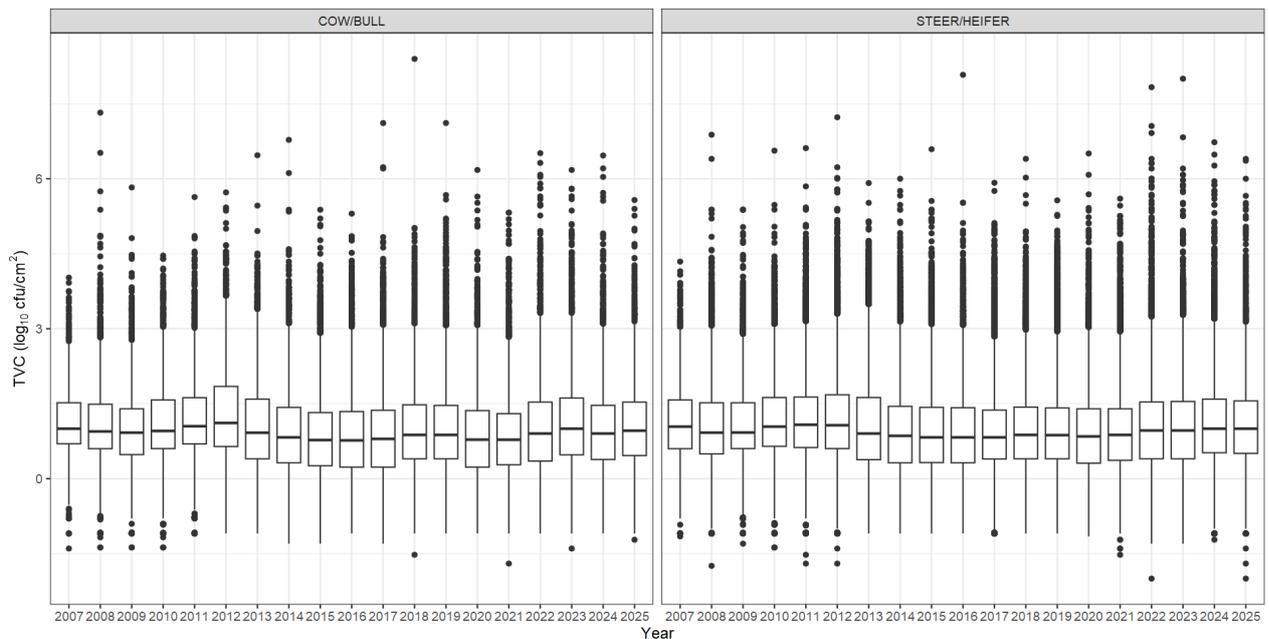

Figure 1: Boxplots of Total Viable Counts (log$_{10}$ cfu/cm^2) on beef carcases nationally for each year from 2007 to 2025.
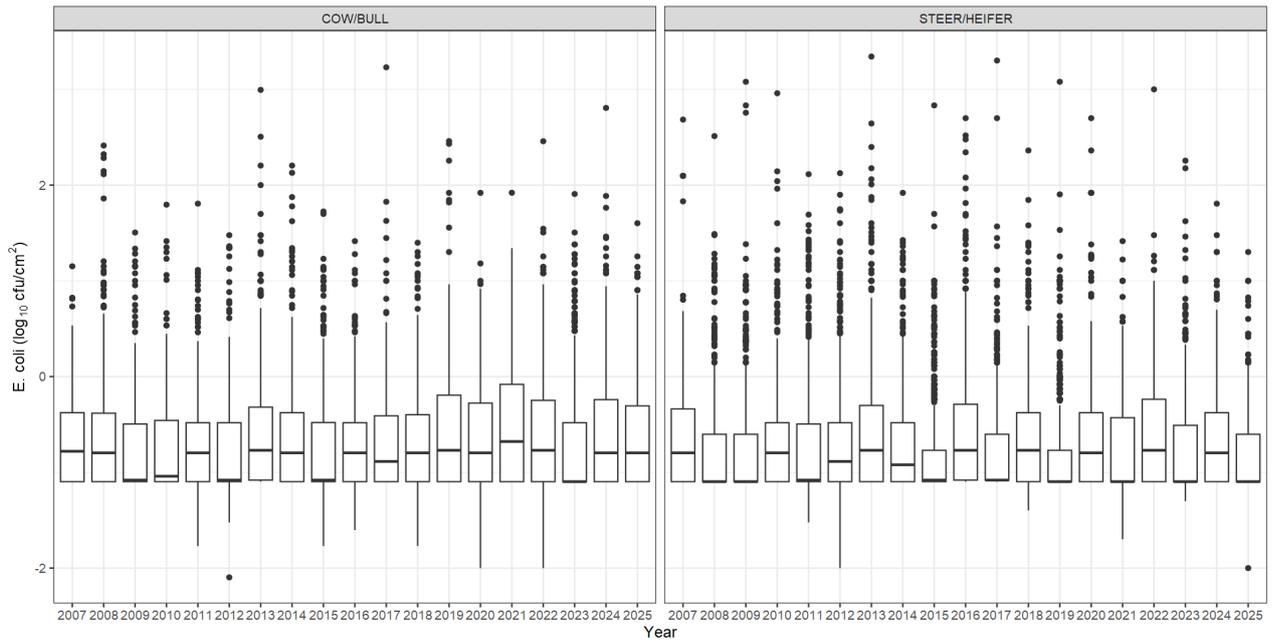
Figure 2: Boxplots of E. coli counts ($\log_{10}$ cfu/cm^2) on beef carcases nationally for each year from 2007 to 2025.

Looking at sheep and lamb carcases, the mean TVC is 1.4 $\log_{10}$ cfu/cm^2 or 25 cfu/cm^2 (Fig. 3) and mean *E. coli* value is 0.03 $\log_{10}$ cfu/cm^2 for sheep carcases and -0.16 $\log_{10}$ cfu/cm^2 for lamb carcases (Fig. 4).
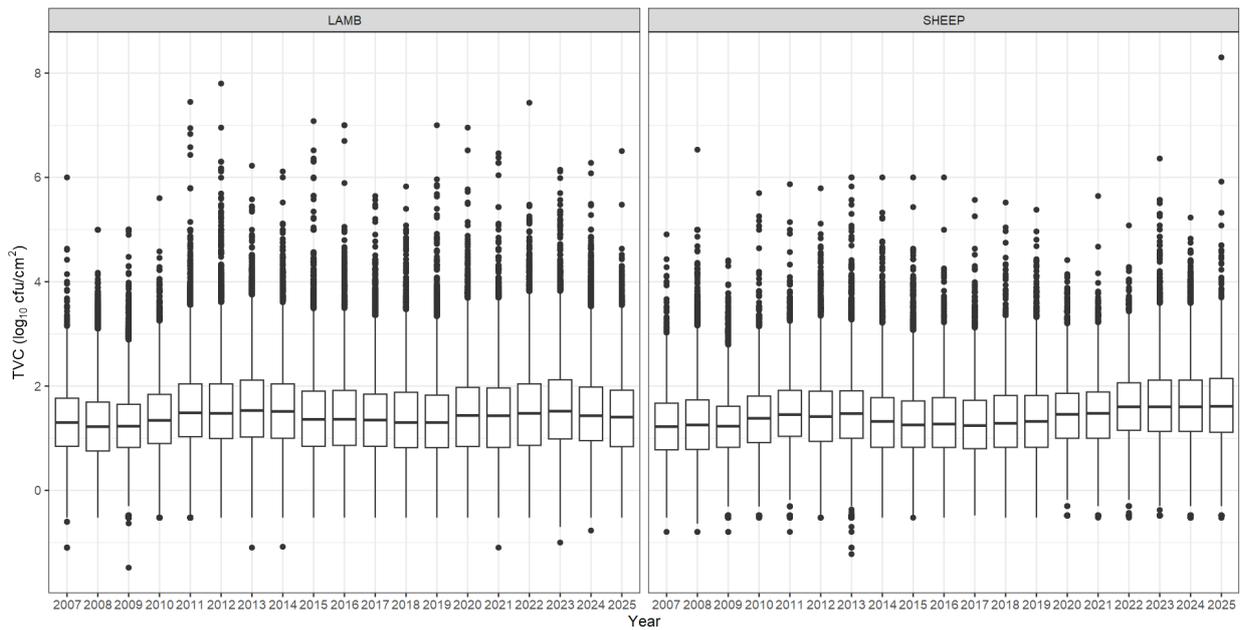

Figure 3: Boxplots of Total Viable Counts ($\log_{10}$ cfu/cm^2) on sheep and lamb carcases nationally from 2007 to 2025.
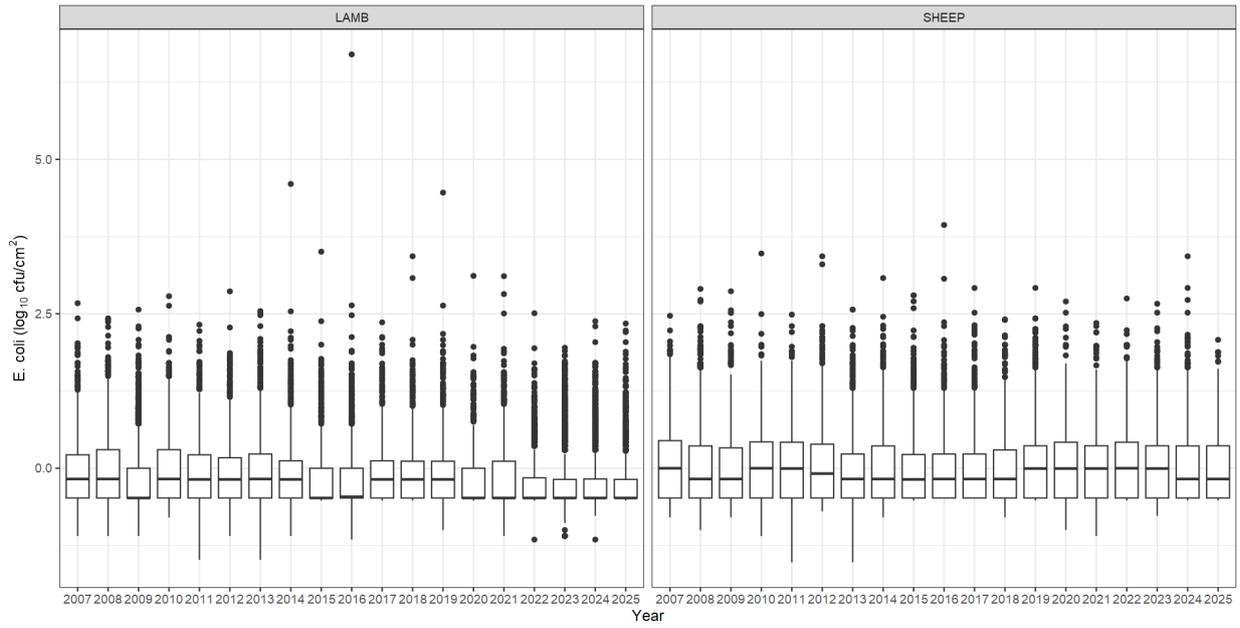
Figure 4: Boxplots of E. coli counts (log$_{10}$ cfu/cm^2) on sheep and lamb carcases nationally from 2007 to 2025.

For carton meat, the mean TVC is 2.4 log$_{10}$ cfu/cm^2 or approximately 251 cfu/cm^2 (Fig. 5) for beef and 2.6 log$_{10}$ cfu/cm^2 or approximately 363 cfu/cm^2 for sheep and lamb combined (Fig. 6).
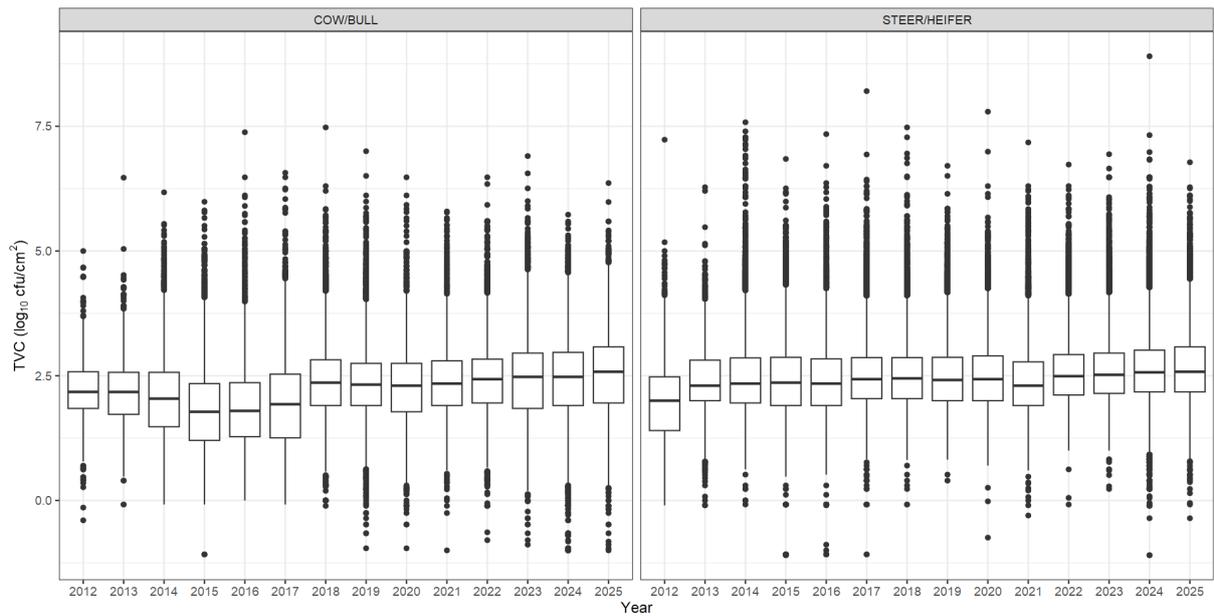

Figure 5: Boxplots of Total Viable Counts (log$_{10}$ cfu/cm^2) on beef carton meat nationally from 2012 to 2025.
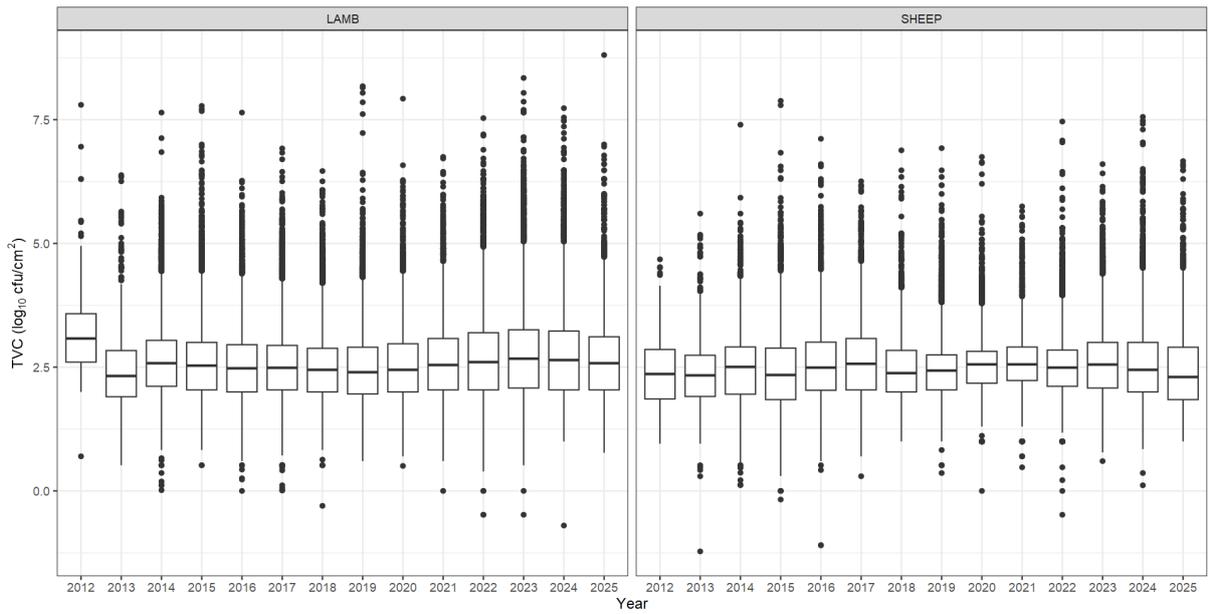
Figure 6: Boxplots of Total Viable Counts (log_{10} cfu/cm²) on sheep and lamb carton meat nationally from 2012 to 2025.

The average national prevalence of *E. coli* was 5.7% for Cow/Bull, 3.2% for Steer/Heifer, 12.3% for Lamb and 27.6% for Sheep carcases (Fig. 7).

Figure 7: Prevalence (%) of E. coli on beef, sheep and lamb carcases nationally from 2007 to 2025.

The average *Salmonella* prevalence over the time period 2007 to 2025 was 0.4% for Cow/Bull, 0.08% for Steer/Heifer, 0.19% for Lamb and 0.43% for Sheep carcases (Fig. 8).

Figure 8: Prevalence (%) of Salmonella on beef, sheep and lamb carcases nationally from 2007 to 2025.

5. Conclusions/Recommendations

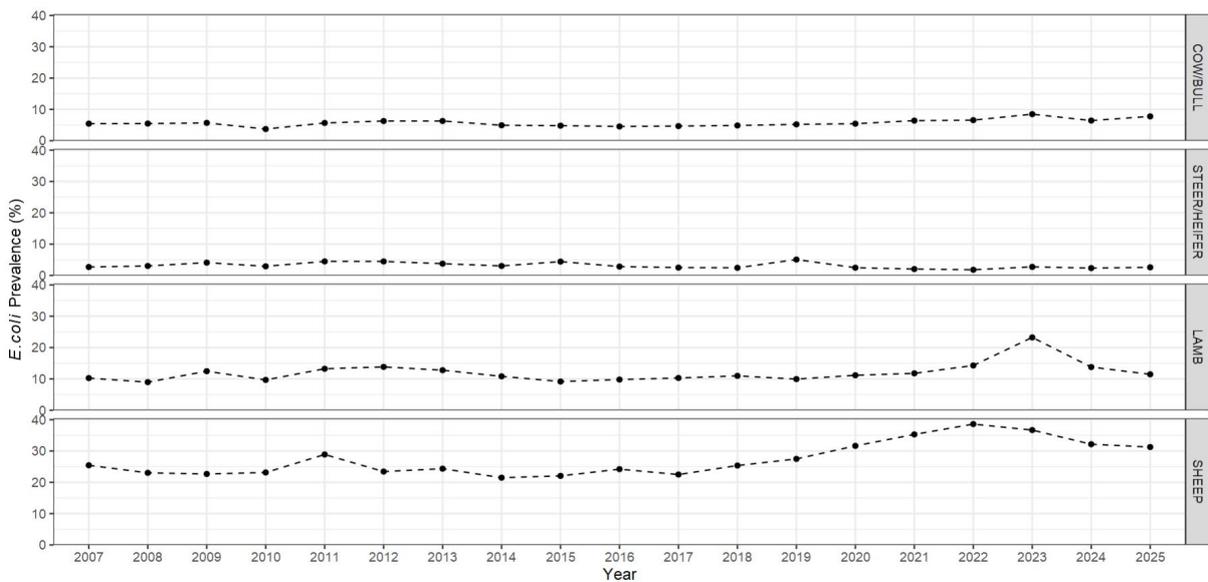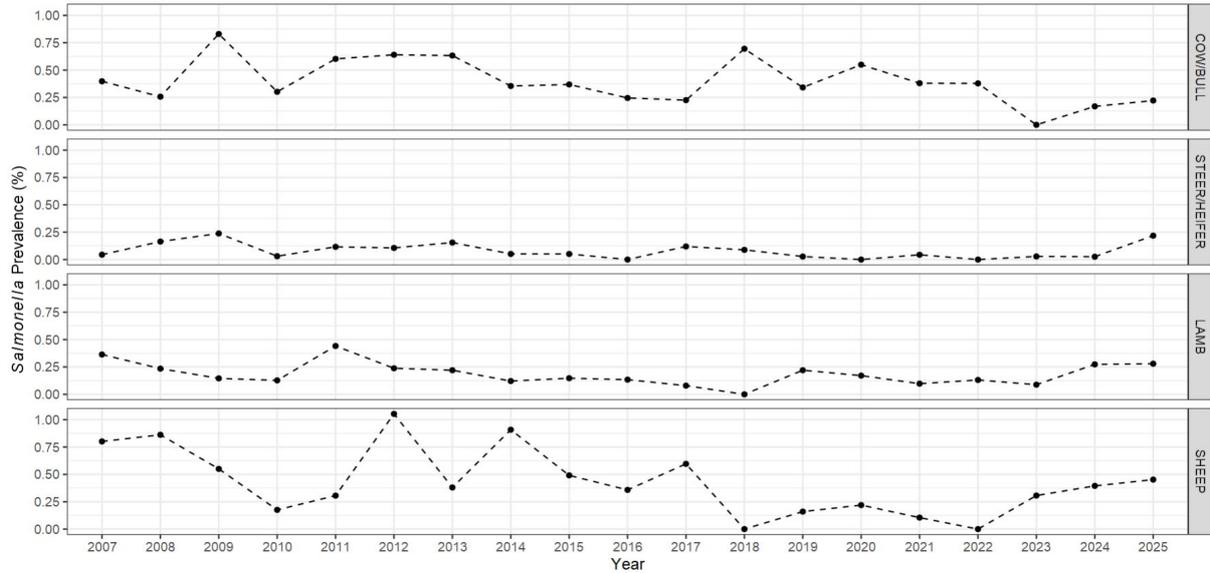A history of long-term results from the ESAM/NCMMP database and reports provided by SARDI have provided valuable information and resources to establishments and the red meat industry as a whole. Scientific background monitoring information on the industry has been supported by approximately 5.6 million data points accumulated by ESAM/NCMMP and an extensive repertoire of tailored reports.

To continue to provide the support and information delivered by the ESAM Analysis Reporting Service, DAFF are developing an online reporting platform which will generate similar data summaries and graphs for establishments on the BI tool.

5.1 Key findings

- The ESAM/NCMMP database at SARDI contains approximately 2 million samples, 5.6 million test results from almost twenty years of data from 2007 to 2025.
- NCMMP reports have been sent on a regular basis to export establishments, MLA and the Department.
- The red meat industry has been supported by the ESAM/NCMMP Analysis Reporting Service for the past 18 years and the reports, as well as the analysis service, have been a useful, valuable resource for quality assurance, monitoring, process control, reporting to management, risk management, customer relations and market access.
- *MLA investments have been via its Market Access Science Technical research sub program.*

6. Appendix

6.1 2024 Feedback Survey: NCMMP Reports

NCMMP Reports - Feedback Survey

1. Thank you for participating in our survey. Your feedback is important and greatly appreciated.

Details
*this contact information will be kept confidential by SARDI and will only be in indication of who has completed the survey so that a thank-you can be sent.

Name/Company/Email Address:

[ ]

2. **NCMMP Reports - Feedback Survey**

This questionnaire is part of an evaluation process we are running for the National Carcase Microbiological Monitoring program (NCMMP) reports which you currently receive.

Please answer the following questions as best you can and remember, the more information the better, so please provide as many comments as you'd like!

3. How often do you read the NCMMP reports?

○ I don't read the reports.

○ I have a quick look, but only when I have time.

○ If I have time, I read them fully.

○ I read them fully every time I receive one.

Any Other Comments (please specify)

[ ]

4. How well do you feel you understand the content of the reports?

○ I don't really understand the reports that well.

○ I have a fairly limited understanding of the reports.

○ I have a pretty good understanding of the reports.

○ I understand the reports really well.

Any Other Comments (please specify)

[ ]

5. Do you find the reports easy to interpret?

◯ Yes

◯ No

If 'No', please give a brief explanation of why they aren't that easy to interpret or indicate which tables and graphs you find difficult to interpret.

[   ]

6. How would you rate the value you get out of the reports?

◯ I don't get any value from the reports.

◯ I don't get a lot of value from the reports.

◯ I get a fair bit of value from the reports.

◯ I get a lot of value from the reports (i.e. have made changes based on the reports, use them to benchmark performance).

Any Other Comments (please specify)

[   ]

7. How, or in what way do you use the reports?
For example, is it just you who reads the reports, or do you read them and pass on to your staff to read them too? Do you have to present a summary to management? Have you made any changes to your hygiene practices because of what the reports show? Do you keep them for future reference?...etc.

[   ]

8. How regularly would you like to receive the reports?

◯ Monthly

◯ Quarterly

◯ Twice annually

◯ Annually

9. The Meat Export Data Collection (MEDC) system provides basic graphs of carcase and carton micro results in the Dashboard section.

Do you prefer the NCMMP reporting format to the MEDC reports and would you like the NCMMP reporting service to continue?

[   ]

6.2 Feedback Survey Results

Comments are reproduced verbatim (except for spelling corrections).

Question 3. How often do you read the NCMMP reports?

Answer Option	Number of responses	%
I don't read the reports.	0	0
I have a quick look, but only when I have time.	4	33
If I have time, I read them fully.	1	9
I read them fully every time I receive one.	7	58
Total	12	100

- I read them fully when I received an alert notice.
- I like to understand how we are going against other sites. We had an increase in *E. coli* detections last year and I used this report to understand if it was a trend nationwide or not.

Question 4. How well do you feel you understand the content of the reports?

Answer Option	Number of responses	%
I don't really understand the reports that well.	0	0
I have a fairly limited understanding of the reports.	4	33
I have a pretty good understanding of the reports.	5	42
I understand the reports really well.	3	25
Total	12	100

- Lack of understanding/interpretation.
- I don't fully understand the box graphs or the log tables. It would be good if this could be explained so the data could be presented to the site leadership.

Question 5. Do you find the reports easy to interpret?

Answer Option	Number of responses	%
Yes	8	67
No	4	33
Total	12	100

- Table 2 I have trouble understanding.
- Lack of understanding/interpretation, possibly cluttered looking.
- Box plots are slow going working out how we compare to the national results.
- Yes, if I look closely.
- Box graphs and the log tables.

Question 6. How would you rate the value you get out of the reports?

Answer Option	Number of responses	%
I don't get any value from the reports.	0	0
I don't get a lot of value from the reports.	4	33
I get a fair bit of value from the reports.	5	42
I get a lot of value from the reports (i.e. have made changes based on the reports, use them to benchmark performance).	3	25
Total	12	100

- The content of the report is similar to the information provided by the OPV during weekly meetings using power BI graphs from MEDC.
- We really like seeing how we fare against the rest of establishments because these reports are much nicer than anything MEDC creates. We like seeing the national STEC trends as this is not available anywhere else.
- It is mainly the overview I get from the reports that we understand and use.
- More the *E. coli* O157 report than the box plots.
- I am getting monthly powerB reports (MEDC) from the OPV, so I know where we are standing from national level.

Question 7. How, or in what way do you use the reports? For example, is it just you who reads the reports, or do you read them and pass on to your staff to read them too? Do you have to present a summary to management? Have you made any changes to your hygiene practices because of what the reports show? Do you keep them for future reference?

- I use the report as a quick check how we compare against other establishments and national. The report is shared with senior management.
- I use the reports to compare our results with the national results; spreadsheets and graphs. Each month I share this with management and key floor personnel. Each quarter I report present to the managers/supervisors meeting.
- It helps us to determine the status of the animals that we received.
- We use the info in our reports to management and DA and we keep them for reference.
- Pass on for other staff members to read and have used to drive hygiene improvements.
- E. coli O157 report for customer queries, other more for comparison/trends year on year.
- As a multi company processor, I use the NCMMP reports to compare our 3 sites against each other so find them extremely valuable. I also use them for reporting purposes for our monthly board meetings to present to our directors.
- I would read them on my own. If there is a significant item raised in the reports, I would raise it with management team. I do my own graphs for management summary.
- At this stage, I am the only one that reads the reports but it would be good to be able to explain other elements of the report to the site leadership team.
- Management review and trending.

Question 8. How regularly would you like to receive the report?

Answer Option	Number of responses	%
Monthly	4	33
Quarterly	6	50
Twice annually	2	17
Annually	0	0
Total	12	100

Question 9. The Meat Export Data Collection (MEDC) system provides basic graphs of carcase and carton micro results in the Dashboard section. Do you prefer the NCMMP reporting format to the MEDC reports and would you like the NCMMP reporting service to continue?

- I prefer the format of the MEDC reports.
- Yes I do and yes I would 😊 .
- No issue for us.
- We really prefer the NCMMP reports compared to the MEDC reports. If the information can either be available electronically (live), then you could more easily see your own Est performance and check in with the national average. I don't mind if it is updated monthly/quarterly or whatever.
- Both reporting service are helpful, yes we would like NCMMP to continue.
- Yes
- Merge NCMMP into MEDC.
- Would like NCMMP to continue.
- I prefer the NCMMP reports and would definitely like to see them continue.
- Prefer MEDC reports.
- I find the MEDC graphs difficult to use. The NCMMP report I find is easier to read the straight graphs and yes I would like the NCMMP reporting service to continue.
- Yes.