2015 *Salmonella* survey of the Queensland egg production environment

Created November, 2015
About this document

This document reports the results of a

Salmonella survey of QLD commercial egg farms sampled in 2015 and is a continuation of survey work initiated in 2014. The purpose of the survey was to create a baseline for the occurrence of Salmonella in QLD egg farms and to promote awareness of the food safety risks of Salmonella and eggs. This information will assist in future evaluations of the performance of egg food safety regulation and support the Safe Food Production Queensland Strategic Plan 2014-2018 and the QLD 2015-2018 Senior Officers Working Group Pathogen Risk Reduction Strategy. This Strategy is a through-chain, collaborative effort by the regulatory agencies responsible for food safety in QLD to reduce foodborne salmonellosis in the community. Any enquiries about this document should be directed to Safe Food Production Queensland on (07) 3253 9800 or email info@safefood.qld.gov.au.

Acknowledgements

Safe Food Production Queensland would like to thank the participating accredited egg businesses for their cooperation during both the 2014 and 2015 Microbiological surveys. Laboratory analysis was conducted by the Queensland Health Forensic and Scientific Services.
## Contents

Document acceptance and authorisation ............................................. Error! Bookmark not defined.

1 Executive summary ................................................................................. 4
   1.1 Background ..................................................................................... 4
   1.2 Strategic objectives ......................................................................... 5
   1.3 Methods ......................................................................................... 5
   1.4 General findings ............................................................................. 6
   1.5 Conclusion ..................................................................................... 6

2 Background ............................................................................................. 8
   2.1 Objectives of the 2015 *Salmonella* survey ..................................... 9

3 Methods .................................................................................................. 9
   3.1 List of participants .......................................................................... 9
   3.2 Environmental sample collection and analysis ................................ 10

4 Results and discussion ........................................................................... 12
   4.1 *Salmonella* is widespread on Queensland egg farms ................ 12
   4.2 *Salmonella* Typhimurium on Queensland egg farms .................... 14
   4.3 *Salmonella* Typhimurium MLVA types ....................................... 16

5 Conclusion .............................................................................................. 18

6 Appendix 1 Sampling methodology ...................................................... 20
1 Executive summary

1.1 Background

*Salmonella* is a bacteria that is commonly found in the environment and in humans can cause the disease salmonellosis. Poultry, egg production facilities and eggs and egg products can easily become contaminated with *Salmonella*, and through mishandling or temperature abuse, can grow to levels that affect consumers further along the supply chain. Increasing numbers of eggs being eaten, as well as changes in the way people consume eggs, may increase the risk of exposure of *Salmonella* to consumers. Food industries and food safety and public health agencies must work together to manage the effect of changes in consumption and market forces on egg food safety risks.

Standard 2.2.2 Egg and Egg Products and Standard 4.2.5 Primary Production & Processing Standard for Eggs and Egg Products of the Australia New Zealand Food Standards Code (FSC) deal with the management of risks associated with *Salmonella* contamination of eggs (in Australia only). The provisions in the Standards are focused on minimising health risks by prohibiting the sale and supply of visually cracked and/or dirty eggs, unpasteurised egg pulp or unidentified eggs. For food retail and foodservice businesses, compliance with Chapter 3 of the FSC is also a central aspect of ensuring the safety of food supplied to consumers. Businesses operating at each point of the supply chain are expected to meet, and where possible, exceed the minimum requirements in the FSC.

In 2015, in response to increasing cases of human salmonellosis in Queensland (QLD), Safe Food Production Queensland (SFPQ), the QLD Department of Agriculture and Fisheries (DAF) and QLD Health undertook to cooperatively reduce the impact of egg-related salmonellosis in the community. These statutory authorities have responsibility for addressing public health risks relating to eggs and egg production inputs at different levels of the supply chain. A collaborative strategy has been developed to implement regulatory and non-regulatory measures aimed at the adoption and improvement of *Salmonella* prevention and control measures through-chain.

SFPQ has responsibility for food safety at the primary production and processing level for eggs and egg products administered under the Food Production (Safety) Regulation 2014. At the farm level, raising awareness of the risks of *Salmonella* in egg production is an important step towards adopting and improving egg handling practices that can control the introduction of *Salmonella* into the egg supply chain. In 2014, SFPQ replicated a survey conducted by the New South Wales Food Authority (NSWFA) in 2010/2011 to document the occurrence and type of *Salmonella* in a sample of QLD commercial egg farms. The findings of the 2014 QLD survey were very similar to those of the 2010/2011 NSWFA survey in that *Salmonella* was widespread on both QLD and NSW farms (the proportion of *Salmonella*-positive farms was 57% and 45% respectively). *Salmonella Typhimurium* (S. Typhimurium) was the most commonly reported type in both states.

The success of the 2014 QLD survey in meeting its objectives led to the continuation of the survey in 2015, the results of which are reported here. This year, the combined number of QLD accredited egg businesses sampled in the *Salmonella* survey was increased from 24% in 2014 to 63% in 2015.
1.2 Strategic objectives

The objectives of the 2015 QLD Salmonella survey were to:

- Provide a snapshot of the QLD egg industry’s Salmonella status by estimating the frequency of occurrence and diversity of Salmonella types on egg farms including multi-locus variable number tandem repeat (MLVA) type profiles of S. Typhimurium.

- Promote awareness of the risks of Salmonella in egg production environments and endorse industry best practices to minimize the occurrence and transfer of Salmonella through the egg production process.

The survey also contributes to SFPQ’s strategic direction that is aligned with, and addresses, the challenges and opportunities faced by the primary production and processing sector (SFPQ Strategic Plan 2014-2018). The survey adds to the strategies of identifying (food safety risk) problem areas and verifying sustainable solutions, as well as working proactively with industry and other stakeholders on issues and solutions. The survey also contributes to the Regulatory Outcome of ensuring stakeholders are actively engaged in compliance and monitoring activities including self-assessment.

1.3 Methods

A list of possible participants for the 2015 survey was drawn from the SFPQ egg accreditation register. The list excluded farms that had already been sampled during the 2014 survey, egg accreditations without a production site and Egg Producer (Schools) accreditations (no commercial supply). At the end of this process, the number of accredited egg production sites eligible for sampling was 55.

By the end of the sampling period, 27 of the 55 (49%) eligible egg businesses were sampled, raising the combined proportion of sampled sites from 24% in 2014 to 63% in 2015 (48/76). The sample collection and analysis methodology was essentially the same as in 2014 except feed and water samples were not included in the 2015 survey. All samples were analysed for the presence of Salmonella at the Queensland Health Forensic and Scientific Services (QHFSS) laboratory using a modified version of the Australian Standard 5013.10-2009. Salmonella isolates were further serotyped and S. Typhimurium isolates were MLVA-typed.

At each farm visit (including compliance visits for egg farms already sampled in 2014), a SFPQ-developed Salmonella Risk Reduction Guide was distributed and discussed with the egg business representative. The guide is a self-assessment checklist of actions or practices that are considered ‘industry best practice’ for preventing or reducing Salmonella contamination on eggs throughout egg production and processing. All farms included in the survey received individual feedback reports of their survey results and Salmonella-positive or S. Typhimurium-positive farms received a follow-up phone call or visit from SFPQ officers to interpret the significance of their results. The Salmonella Risk Reduction Guide was further consulted to ensure the business had adopted appropriate
practices for their particular system and was aware of the importance of maintaining safe egg handling practices to minimize the transference of bacteria from the production environment to finished product. The regulatory requirements that prohibit the supply of cracked or visually contaminated eggs and that carry the greatest risk of *Salmonella* contamination, were reinforced with egg businesses at all stages of the survey.

### 1.4 General findings

The general findings of the survey were as follows:

- The 2015 survey results highlighted the need to maintain and improve effective on-farm *Salmonella* risk reduction strategies as just over half (55%) of the surveyed egg farms were *Salmonella*-positive, a comparable result to the previous year’s survey and the 2010/2011 NSWFA survey (57% and 45% respectively).
- *S*. Typhimurium was again the most commonly isolated *Salmonella* type (33%; 9/27) on surveyed farms. This may be relevant as the predominance of *S*. Typhimurium on commercial egg farms in both QLD and NSW is in accordance with the frequent isolation of this type in egg-related human salmonellosis cases nationwide.
- *S*. Enteritidis (PT26 and PT RNDC) was detected from environmental samples from one small, free range farm in North QLD. Confirmatory testing of poultry produced only negative results. Previously, PT26 has been isolated from a range of sources (cattle, crocodile, meat chickens) from the Atherton Tablelands and appears to be endemic to North QLD. PT26 does not appear to be closely associated to poultry and investigations have indicated little potential for systemic colonization of layers.
- In total, 49 isolates from 35 *Salmonella*-positive samples were typed, yielding 16 different *Salmonella* types. As in 2014, the most common *Salmonella* type was *S*. Typhimurium followed by *S*. Anatum and then *S*. Saintpaul. MLVA typing was carried out on 20 *S*. Typhimurium isolates producing 16 different MLVAs. No phage typing was conducted in this survey.

### 1.5 Conclusion

The overarching aim of egg food safety legislation is to ensure the safety and suitability of eggs and reduce the public health risk associated with consuming eggs. This legislative framework, in partnership with the egg industry, has historically delivered a good record of egg safety in QLD. However, since 2013, QLD salmonellosis cases have increased significantly and eggs may be a key source of contamination. The exact cause of the increase is unknown but it may be a combination of factors that compound *Salmonella* risks along an egg supply chain. Factors may include changes in the types of *Salmonella* associated with layer flocks (e.g. more carriage of *S*. Typhimurium in layer flocks compared to other *Salmonella* types), longer and more complex supply chains and changing patterns of egg consumption (e.g. more raw egg products being prepared and consumed). Poor food
handling practices such as poor storage conditions and temperature abuse, coupled with undercooking of eggs, appear to play a contributing part in some egg-related outbreaks.

In QLD, SFPQ, DAF and QLD Health undertook to cooperatively reduce the impact of egg-related salmonellosis in the community through the QLD 2015-2018 Pathogen Risk Reduction Strategy. During the development of the Strategy, it was highlighted that egg-related salmonellosis in the community is a shared responsibility by all through-chain participants and a greater focus on educating participants of the *Salmonella* risks and eggs is required.

The most effective strategy in lowering egg-related salmonellosis in the community, identified by a risk assessment conducted by Food Standards Australia & New Zealand (FSANZ), is restricting the supply and use of cracked, visually contaminated (dirty) and unstamped eggs which carry the greatest risks of *Salmonella* contamination. However, as even intact, clean eggs are not guaranteed to be *Salmonella*-free, additional steps to reduce the risks associated with *Salmonella* on eggs should be employed to further improve food safety outcomes. Appropriate risk management in regard to *Salmonella* control at the flock level should be incorporated into biosecurity programs, but more importantly, implementing and monitoring egg handling practices that minimise *Salmonella* transference from the production environment to eggs and egg products will be key to achieving food safety objectives.

At the farm level, *Salmonella* environmental surveys including 63% of QLD commercial egg farms were utilised by SFPQ to promote awareness of *Salmonella* risks and egg food safety. The surveys now provide a platform of knowledge to further promote awareness of *Salmonella* on farm and the risks of *Salmonella* contamination on eggs including a baseline for assessing the effectiveness and appropriateness of *Salmonella* risk reduction strategies in the future. The work has allowed SFPQ to work better with industry to promote awareness of the food safety risks around egg production, ensure provisions are in place to control and reduce food safety risks and measure industry commitment to make changes or implement best practices.
2 Background

Salmonella is a bacterium that is common in wild and domestic animals and in humans can cause food poisoning or salmonellosis. In 2010, OzFoodNet reported that Salmonella was the most common disease agent in foodborne illness outbreaks in Australia, and raw or undercooked eggs were implicated in a large proportion of these (OzFoodNet 2010). The economic cost of salmonellosis to the Australian economy has previously been estimated at $44 million per year (Food Standards Australia New Zealand 2011). Salmonella Typhimurium (S. Typhimurium) is the most important Salmonella regarding human cases of salmonellosis in Australia (OzFoodNet 2010, OzFoodNet 2011, OzFoodNet 2012) (Appendix 1). Although non-S. Typhimurium Salmonellae are not considered to pose the same public health risk as S. Typhimurium, all Salmonellae should be considered potentially harmful to human health.

It is important to note the Australian poultry industry is considered free from virulent strains of Salmonella Enteriditis, a type of Salmonella that is an important risk to food safety as it can colonise the ovaries of poultry and contaminate the internal contents of eggs during their formation. In Australia, strains of S. Enteritidis, phage type (PT) 26 and a Reaction Does Not Conform (RDNC) type, have been regularly isolated from a range of sources in North QLD and appear to be endemic to this region (Cox 2002). These strains do not appear to be closely associated with poultry and investigations have suggested little potential for systemic colonisation of layers as found overseas with the virulent SE strains.

Previous research has shown that a relatively high proportion of Australian layer flocks are positive for a range of Salmonella types (Scott 2014). S. Infantis has been reported as the most common Salmonella type in layers and is also common amongst layers elsewhere in the world (Cox 2002, Chousalkar 2012). Two recent surveys including the 2014 SFPQ survey and the 2010/2011 NSWFA survey agreed with previous research in that a high proportion of layer flocks were Salmonella-positive (NSWFA 2013, SFPQ 2014). Both surveys however found that S. Typhimurium, not S. Infantis, was the most common Salmonella type.

Egg-related salmonellosis in Australia is assumed to arise from a combination of surface contamination on cracked or visually contaminated eggs, poor food handling practices and undercooking of eggs. At the farm level, contamination of the eggshell can occur through direct contact with faeces in the egg collection system or poor control of hygiene during processing such as during egg washing. In poultry, Salmonella does not often cause disease, however its presence in the bird’s intestinal tract means eggs and meat can be contaminated with bacterial cells shed in the faeces. Cracks and defects in egg shells can allow Salmonella to enter the egg. If egg washing takes place, contamination of the eggs can occur if the process is poorly controlled, for example by washing in unsanitary water or under temperature conditions that allow bacteria to enter the egg. To reduce these risks, effective biosecurity, the removal of dirty and cracked eggs and good egg handling practices along the egg production and supply chain are the most effective measures to control Salmonella.
The QLD Egg Food Safety Scheme and Standards 2.2.2. and 4.2.5 have the key aim of reducing salmonellosis in the community by restricting the supply and sale of cracked and/or dirty eggs which are known to present the greatest risk. Presently, guidance on the prevention and control of Salmonella for egg business is available through industry codes of practice, national biosecurity guidelines and industry quality assurance programs to achieve a safe and suitable egg product.

In order to avoid additional compliance measures in Australia for Salmonella prevention and control, it is important that the QLD and Australian egg industries be proactive in recognising and managing the through-chain food safety risks in commercial egg production (Scott 2014). Being aware of the potential presence of Salmonella on egg farms through baseline surveys is an important first step to establishing and verifying effective measures for the prevention and control of Salmonella.

2.1 Objectives of the 2015 Salmonella survey

From May to November 2015, SFPQ continued the Salmonella environmental survey of commercial egg businesses in QLD. The survey intended to:

- Provide a snapshot of the QLD egg industry's microbiological status by estimating the frequency of occurrence and diversity of types of Salmonella on egg farms including multi-locus variable number tandem repeat (MLVA) type profiles of Salmonella Typhimurium.
- Promote awareness of the risks of Salmonella in egg production environments and endorse industry best practices to minimise the occurrence and transfer of Salmonella through egg production and into the egg supply chain.

The survey contributes to SFPQ's strategic direction that is aligned with, and addresses, the challenges and opportunities faced by the primary production and processing sector (SFPQ Strategic Plan 2014-2018). The survey adds to the strategies of identifying (food safety risk) problem areas and verifying sustainable solutions, as well as working proactively with industry and other stakeholders on issues and solutions. The survey also contributes to the Regulatory Outcome of ensuring stakeholders are actively engaged in compliance and monitoring activities including self-assessment.

3 Methods

3.1 List of participants

A list of possible participants for the 2015 survey was drawn from the SFPQ egg accreditation register. This list excluded farms that had already been sampled during the 2014 survey, egg accreditations without a production site and Egg Producer (Schools) accreditations (no commercial supply). At the end of this process, the number of accredited egg production sites eligible for sampling was 55.
By the end of the sampling period, 27 of the eligible 55 egg businesses were sampled of which 25 were Egg Producers, 1 was a Producer (PSA) and 1 was a Processor (High Risk). The combined proportion of sampled QLD egg production sites was increased from 24% in 2014 to 63% in 2015 (Table 1).

Table 1. Summary of egg accreditations included in the QLD Salmonella environmental surveys in 2014 and 2015 and number of businesses not yet surveyed.

<table>
<thead>
<tr>
<th>Accreditation type</th>
<th>Sampled in 2014</th>
<th>Sampled in 2015</th>
<th>Total sampled</th>
<th>Total accreditations</th>
<th>Not surveyed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Producer</td>
<td>11</td>
<td>25</td>
<td>36 (75%)</td>
<td>48</td>
<td>12</td>
</tr>
<tr>
<td>Producer (PSA)</td>
<td>3</td>
<td>1</td>
<td>4 (21%)</td>
<td>19</td>
<td>15</td>
</tr>
<tr>
<td>Processor (High)</td>
<td>7</td>
<td>1</td>
<td>8 (88%)</td>
<td>9*</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>27</td>
<td>48 (63%)</td>
<td>76</td>
<td>28</td>
</tr>
</tbody>
</table>

*Total number of Processor accreditations is 15, but 6 do not have an egg production site.

3.2 Environmental sample collection and analysis

Production System

As in 2014, different types of egg production systems were sampled in 2015. In the 2015 survey, a greater proportion of small, free range systems were sampled than in the previous year. Of the 27 sampled farms, 22 were free range and 5 were caged (Table 2). No barn systems remained to be sampled from 2014. In regards to flock size, sampled farms ranged from Lifestyle (< 1500 birds) to Large (> 40,000 birds). The majority of sampled farms (19/27; 70%) were categorised as Lifestyle. A breakdown of the number of farms in each category is presented in Table 4.

Table 2. Queensland egg production systems sampled in the 2014 and 2015 survey periods

<table>
<thead>
<tr>
<th>Production system</th>
<th>Sampled in 2014 (% of total)</th>
<th>Sampled in 2015 (% of total)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cage</td>
<td>9 (43%)</td>
<td>5 (19%)</td>
<td>14 (29%)</td>
</tr>
<tr>
<td>Free range</td>
<td>10 (47%)</td>
<td>22 (81%)</td>
<td>32 (66%)</td>
</tr>
<tr>
<td>Barn</td>
<td>2 (10%)</td>
<td>0 (0%)</td>
<td>2 (4%)</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>27</td>
<td>48</td>
</tr>
</tbody>
</table>
Sample collection and analysis

SFPQ officers collected 90 environmental samples from 27 egg farms for *Salmonella* testing. For free range systems, one boot swab and one pooled faecal sample were collected per laying shed/pen. For caged systems, one sponge swab of manure belts or manure cones (pit system) and one pooled faecal sample were collected per shed. The number of sheds sampled per farm was determined by the farm's production size. All egg businesses with less than 20 000 birds had a maximum of two sheds sampled. Farms with more than 20 000 birds had a maximum of 4 sheds sampled.

Officers used standardised sample collection methods in order to control the effects of sampling on accuracy (Appendix 1). All samples were transported to the laboratory under temperature control within 48 hours and all samples were analysed within 24 hours of receipt in the laboratory.

The sampling for the survey was conducted within a 6 month period between May to October 2015. Environmental factors such as humidity and temperature can influence the *Salmonella* status of a flock or shed so it should be noted that the long sampling period may have had temporal effects on the *Salmonella* detection rate compared to 2014.

Laboratory methods and analysis

All samples were analysed qualitatively for *Salmonella* using a modified version of the Australian Standard 5013.10-2009 at the QHFSS laboratory. For each *Salmonella*-positive sample, 8 isolates were recovered and subjected to serotyping. This method was different from the 2014 survey where only 1 isolate was selected for serotyping. Serotyping more isolates means that in 2015 there was an increased sensitivity in the typing method and thus a greater likelihood of recovering *Salmonella* serotypes.

*Salmonella* isolates identified as S. Typhimurium were also MLVA typed. MLVA typing is a genetic tool that can be used to refine the details about the degree of relatedness of different *Salmonella* strains within a serotype.

Rules regarding the *Salmonella* status of the laying environment was consistent with the 2010/2011 NSWFA survey and 2014 QLD survey. A farm or shed was classified as ‘positive’ if any sample from that farm or shed was positive for a *Salmonella* type. Farms and sheds were classified as ‘negative’ if all relevant samples were negative. It should be noted that due to the limited number of samples collected, negative results did not guarantee the absence of *Salmonella* on the farm. Furthermore, factors that influence the rate of *Salmonella* shedding in infected birds (whether birds were shedding *Salmonella* bacteria at the time of the sampling) may also lead to false negative results.
4 Results and discussion

4.1 Salmonella is widespread on Queensland egg farms

Figure 2 shows that just over half of the QLD commercial egg farms surveyed in 2015 were Salmonella-positive (55%; 15/27). The results were very similar to the 2014 QLD and 2010/2011 NSWFA surveys where 57% and 45% egg farms respectively were Salmonella-positive. The main difference in the 2015 findings was the greater number (33%; 9/27) of S. Typhimurium-positive farms identified than in the previous surveys. This difference is likely due to the increased sensitivity of the laboratory testing in that more Salmonella isolates were typed from each sample and is probably a more accurate representation of the S. Typhimurium prevalence in QLD.

Of note, one North QLD free range farm was positive for S. Enteritidis (PT26 and RDNC) from environmental samples. Further confirmatory testing was undertaken by Biosecurity QLD however all results were negative. S. Enteritidis PT26 has previously been isolated from a limited number of samples from cattle and crocodiles and commercial broilers, all from the Atherton Tablelands (Biosecurity Queensland 2010). PT26 does not appear to be closely associated with poultry and investigations to date have indicated little potential for systemic colonisation of layers (Cox 2002).

The findings of the current survey continue to support previous assumptions about a high carriage rate of Salmonella in Australian layer flocks (Cox 2002, Scott 2014, SFPQ 2014). As agreement between the carriage rate of Salmonella in layer hens and the incidence of egg-related human illness has been suggested, improving Salmonella control at the farm-level should help reduce the entry of Salmonella into the egg supply chain and contribute to a reduction in the risk of egg-related salmonellosis (FAO/WHO 2002, Wales 2007). It is vital to recognise that a through-chain approach to reducing Salmonella risk, including steps of the supply chain beyond the farm gate, is required.

![Figure 2. Comparison of Salmonella detection in QLD commercial egg farms in the 2014 survey, 2015 survey and 2014/2015 survey combined. The NSW 2010/2011 survey results are included for interstate comparison.](image-url)
Table 3 presents the results in regard to the *Salmonella* status of egg businesses by production system (i.e. free range or cage). *Salmonella* was detected across both types of production systems and approximately half of each production type was *Salmonella*-positive.

**Table 3. *Salmonella* detection in different QLD egg farm production systems**

<table>
<thead>
<tr>
<th>Production system</th>
<th>Proportion of farms included in the survey</th>
<th>% <em>Salmonella</em>-Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Free-range</td>
<td>81% (22/27)</td>
<td>55% (12/22)</td>
</tr>
<tr>
<td>Cage</td>
<td>18.5% (5/27)</td>
<td>60% (3/5)</td>
</tr>
</tbody>
</table>

There is currently a lack of research regarding whether, or how, different egg production systems impact on-farm *Salmonella* carriage rates (Holt 2011). Changes from caged systems to cage-free systems have been suggested to affect the safety and quality of eggs through microbiological or chemical contamination, but these effects have not been fully investigated. In our surveys, free range, barn and caged systems have shown comparable *Salmonella* carriage rates, so show no significant evidence of an increased risk based on any particular production system type.

Different production systems face specific challenges of *Salmonella* contamination in flocks and eggs and there is no one solution to minimising these risks. Rather, the success of overcoming these challenges depends on the strategies utilised by egg producers to prevent *Salmonella* introduction in flocks and reduce the bacteria’s transference on eggs through-chain. Effective strategies will place emphasis on production methods (e.g. animal husbandry, egg collection systems) that prevent the occurrence of cracked and dirty eggs in the first instance, as well as removing these eggs at the earliest opportunity. Awareness of the *Salmonella* status of a flock, especially *S. Typhimurium*-positive flocks, may also influence how, or what, risk-reducing strategies are employed.

Table 4 presents the *Salmonella* detection results in farms of varying flock size. The flock sizes surveyed in 2015 ranged from a Lifestyle category (< 1500 birds) to Large (> 40 001). A greater proportion of *Salmonella* was found on Medium and Large farms compared to Small and Lifestyle farms which was a similar result to that reported in the 2014 survey. A possible explanation is that greater numbers of birds lead to concomitant increases in *Salmonella*-contaminated dust, dander and faeces that can spread infections. It is important to note however, that the limited numbers of farms surveyed in each category make it impossible to draw statistically significant conclusions regarding the effect of one factor over another on *Salmonella* status.
Table 4. *Salmonella* detection results in farm flocks by size in the 2015 *Salmonella* environmental survey

<table>
<thead>
<tr>
<th>Category</th>
<th>Category cut-offs</th>
<th>Number of farms (% of survey participants)</th>
<th>% <em>Salmonella</em> Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm Flock Size</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lifestyle</td>
<td>&lt; 1 500</td>
<td>19 (70%)</td>
<td>9 (47%)</td>
</tr>
<tr>
<td>Small</td>
<td>1 600 – 15 000</td>
<td>5 (19%)</td>
<td>3 (60%)</td>
</tr>
<tr>
<td>Medium</td>
<td>15 001 – 40 000</td>
<td>1 (4%)</td>
<td>1 (100%)</td>
</tr>
<tr>
<td>Large</td>
<td>&gt; 40 001</td>
<td>2 (7%)</td>
<td>2 (100%)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>27</td>
<td>15</td>
</tr>
</tbody>
</table>

4.2 *Salmonella Typhimurium* on Queensland egg farms

Figure 3 provides a profile of *Salmonella* types isolated from samples collected in the 2015 survey. Forty-nine isolates were typed from 35 *Salmonella*-positive samples. In total, 16 *Salmonella* types were recovered, which was only slightly more than in 2014 (15 types), and *S. Typhimurium* was the most common type (35%; 17/49). *S. Typhimurium* was also the most common serovar when the results were examined at the farm-level (9/27 farms; 33%). *S. Anatum* was the second most common type in samples reported in 2015 compared to *S. Infantis* in 2014. Seven *Salmonella* types were shared, in that they were isolated in both 2014 and 2015.

The number and proportions of different *Salmonella* types present in the QLD egg production environment appears dynamic and the dominance of a type on farms may change over time. The NSWFA reported apparent changes in the profile of *Salmonella* types in egg farms over the past 15 years using data from the joint NSW/VIC SE Monitoring and Accreditation Program and their recent 2010/2011 survey. There is limited data available on the prevalence and diversity of *Salmonella* serotypes in layer hens and egg production environments in QLD. Table 5 summarises data from the few studies that have been performed in QLD and NSW.
Figure 3. Comparison of *Salmonella* types from *Salmonella*-positive samples collected from egg businesses in the 2014 and 2015 surveys. The number of farms with the *Salmonella* type are shown in brackets.
Table 5. Comparison of the most common Salmonella types recovered from QLD and NSW layer hens over time

<table>
<thead>
<tr>
<th>Year</th>
<th>Location</th>
<th>Dominant type</th>
<th>Year</th>
<th>Location</th>
<th>Dominant type</th>
</tr>
</thead>
</table>
| 1991<sup>a</sup> | SE QLD   | 1. S. Orion  
2. S. Infantis | 1996     | –        | NSW/VIC  
1. S. Sofia  
2. S. Agona |
| 1993-1995<sup>b</sup> | SE QLD   | 1. S. Singapore  
2. S. Cerro  | 2000<sup>c</sup> | NSW/VIC | 1. S. Agona  
2. S. Infantis |
| 2014<sup>e</sup>  | QLD      | 1. S. Typhimurium  
2. S. Infantis | 2004 - 2005<sup>c</sup>  | NSW/VIC | 1. S. Mbandaka  
2. S. Typhimurium |
| 2015     | QLD      | 1. S. Typhimurium  
2. S. Anatum | 2010/2011<sup>d</sup> | NSW      | 1. S. Typhimurium  
2. S. Infantis |

<sup>a</sup> (Cox unpublished)  
<sup>b</sup> (Cox 2002)  
<sup>c</sup> (Arzey 2008)  
<sup>d</sup> (NSWFA 2013)  
<sup>e</sup> (SFPQ 2014)

4.3 *Salmonella Typhimurium* MLVA types

Multi-locus variable tandem number repeat (MLVA) analyses generate DNA ‘fingerprints’ of *S. Typhimurium* isolates and are used to identify links between human foodborne illness cases or to complement trace-back of *Salmonella* isolates to sources for incident response or surveillance. In Australia, a national MLVA typing network for human salmonellosis notifications has been established since 2006.

In QLD, MLVA typing was applied to *S. Typhimurium* isolates from the 2014 and 2015 *Salmonella* surveys to provide information about the diversity and relatedness of isolates in the QLD layer environment. More assessments of the utility of MLVAs are required however before there can be any reliance on these methods for tracing purposes, while further training to develop the technical expertise to interpret MLVA type results is also needed.
In the 2015 QLD survey, *S. Typhimurium* MLVA typing was carried out at QHFSS for 20 *S. Typhimurium* isolates producing 16 different MLVAs (Table 5). No phage typing of *S. Typhimurium* isolates was carried out.

Table 5. *S. Typhimurium* phage and multi-locus variable number tandem repeat (MLVA) types from isolates on egg farms in the 2014 and 2015 QLD *Salmonella* environmental surveys. No phage typing was undertaken in 2015.

<table>
<thead>
<tr>
<th>Isolate</th>
<th>QLD 2014 survey</th>
<th></th>
<th>QLD 2015 survey</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phage type</td>
<td>MLVA</td>
<td>MLVA</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>135</td>
<td>03-17-09-12-525*</td>
<td>03-12-12-09-524</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>135</td>
<td>03-17-09-12-526*</td>
<td>03-13-16-11-524</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>U307</td>
<td>03-12-06-13-525</td>
<td>03-13-15-10-524</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>135a</td>
<td>03-12-12-10-525</td>
<td>03-14-10-10-524</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>135a</td>
<td>03-14-12-10-525</td>
<td>03-14-11-10-524</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>135</td>
<td>03-17-09-11-525</td>
<td>03-14-17-10-524</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>135</td>
<td>03-17-09-11-525</td>
<td>03-14-21-10-524</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>-</td>
<td></td>
<td>03-14-22-10-524</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>-</td>
<td></td>
<td>03-15-13-10-524</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>-</td>
<td></td>
<td>03-16-09-10-524</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>-</td>
<td></td>
<td>03-16-10-10-524</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>-</td>
<td></td>
<td>03-17-09-11-524</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>-</td>
<td></td>
<td>03-11-10-00-524</td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>-</td>
<td></td>
<td>04-13-16-00-490</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>-</td>
<td></td>
<td>05-22-08-14-457</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>-</td>
<td></td>
<td>05-12-11-11-490</td>
<td></td>
</tr>
</tbody>
</table>

* indicates these isolates are considered the same
* 00 indicates a null allele
5 Conclusion

The overarching aim of egg food safety legislation and supporting multi-jurisdictional strategies is to ensure the safety and suitability of eggs and reduce the public health risk associated with consuming eggs. The legislative framework in place, in partnership with the egg industry, has historically delivered a good record of egg safety in QLD, however further reducing this risk means improved monitoring and control of the effectiveness of the through-chain food safety system. This is important in order to respond to continually changing patterns of consumption and foodborne disease.

Since 2013, salmonellosis cases Australia-wide, including QLD, have risen to record levels and the number of outbreaks linking eggs as a possible source has increased in line with this. A recently enhanced testing method for clinical cases has contributed to a proportion of salmonellosis cases Australia-wide, but does not account for all of the increase. A definitive cause of the increase in salmonellosis cases is not known, nor is a single cause likely to be the explanation. More likely is a combination of factors that compound Salmonella risks along the egg supply chain to the consumer, including changing patterns of egg consumption, longer and more complex supply chains and possibly changing on farm epidemiology of more virulent Salmonella types. While Salmonella contamination on eggs may originate from the egg production environment, amplification of the bacteria through poor food handling practices, including poor storage conditions and temperature abuse, appears to contribute to some egg-related outbreaks.

In QLD, SFPQ, DAF and QLD Health are the regulatory bodies responsible for controlling public health risks associated with food at different levels of the food supply chain. In 2015, these agencies undertook to cooperatively reduce the impact of egg-related salmonellosis in the community through the QLD 2015-2018 Pathogen Risk Reduction Strategy. During the development of the Strategy, it was identified that egg-related salmonellosis in the community is a shared responsibility by all through-chain participants and a greater focus on educating participants of the Salmonella risks and eggs is required.

The most effective strategy in lowering egg-related salmonellosis in the community remains the restriction of the sale, supply and use of cracked, visually contaminated (dirty) and unstamped eggs which carry the greatest risk of Salmonella contamination. However, as even intact, clean eggs are not guaranteed to be Salmonella-free, additional steps to reduce the introduction and load of Salmonella on eggs should be employed to further improve food safety outcomes. Appropriate risk management in regard to Salmonella control at the flock level should be incorporated in biosecurity programs, but more importantly, implementing and monitoring egg handling practices that minimise Salmonella transference from the production environment to eggs and egg products will be key to achieving food safety objectives.

The QLD Salmonella environmental surveys of 2014 and 2015 provide a platform of knowledge to promote awareness of the presence of Salmonella on farm and the potential risks of Salmonella contamination on eggs. Collecting information about Salmonella occurrence in the egg production environment has provided a baseline for assessing the effectiveness and appropriateness of Salmonella risk reduction strategies in the future. A baseline also allows SFPQ to work better with
industry to promote awareness of the food safety risks around egg production, ensure provisions are in place to control and reduce food safety risks and measure industry commitment to make changes or implement best practices.

1 References


Biosecurity Queensland (2010). Salmonella enteritidis monitoring and certification program in Queensland, Biosecurity Queensland, Department of Agriculture and Fisheries.


OzFoodNet (2010). OzFoodNet Quarterly Reports.


OzFoodNet (2012). "OzFoodNet Quarterly Reports."


## 6 Appendix 1 Sampling methodology

### Sampling methodology and laboratory methods for *Salmonella* analysis

<table>
<thead>
<tr>
<th>Sample</th>
<th>Sampling methodology</th>
<th>Australian Standard Method</th>
</tr>
</thead>
<tbody>
<tr>
<td>Boot/sponge swab</td>
<td>For free-range systems: One pair of boot swabs (spun-bonded polypropylene boot overshoes) was used per shed. Boot swab sampling involved pre-moistening the swabs with buffered peptone water before placing on feet and taking at least 100 paces within the bird access area. For caged systems: Sponges were pre-moistened with buffered peptone water before swabbing on ends of manure belts of multiple tiers and cage lines. For caged systems without manure belts, swabs were taken of floors or the bottoms of cages.</td>
<td>AS 5013.10-2009</td>
</tr>
<tr>
<td>Faecal material</td>
<td>For free-range systems: Approximately 200 g or 60 pinches of moist faecal material was collected from the floor or nesting boxes of the laying shed. For caged systems: Approximately 200 g or 60 pinches of moist faecal material was collected from the ends of manure belts of multiple tiers and cage lines. For cage systems with a pit manure collection system, moist faecal material was collected along the cages of multiple lines.</td>
<td>AS 5013.10-2009</td>
</tr>
</tbody>
</table>