



Investigating drivers of biosecurity engagement and approaches for improving this engagement among egg producers in Australia

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A report for Australian Eggs Limited
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Foreword

This project was conducted to investigate biosecurity awareness, understanding and implementation among Australian egg producers, and to provide recommendations for supporting the industry to improve producers' biosecurity engagement.

This project was funded from industry revenue which is matched by funds provided by the Australian Government.

This report is an addition to Australian Eggs Limited's range of peer reviewed research publications and an output of our R&D program, which aims to support improved efficiency, sustainability, product quality, education and technology transfer in the Australian egg industry.

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Executive Summary

Biosecurity in the egg industry is crucial for the prevention of the introduction and spread of emergency and endemic diseases and maintaining adequate flock health, which is essential for supporting productivity, product quality and the sustainability of the industry. Previous research in the Australian poultry industry has identified the need for improving biosecurity implementation among layer enterprises, across all production types, including cage, barn and free-range. In addition, this research recommended to further investigate current biosecurity practices implemented on layer farms focusing on gaining a better understanding of the factors motivating and hindering biosecurity adoption (Scott et al., 2018b). There have been seven outbreaks of Highly Pathogenic Avian Influenza in poultry in Australia since 1976, with the last one being reported in 2013, and all of them affecting chicken. In the last decade, concerns have been raised about the potential increased risk of Avian Influenza outbreaks due to the egg industry shift towards free-range production, with recent modelling research predicting a 6 to 7% increase in this risk for each 25% shift from indoor to free-range systems (Glass et al., 2019). In light of this previous research, having a better understanding of biosecurity engagement in the egg industry would contribute to reduce the disease introduction and spread risk.

The aim of this project was to investigate biosecurity awareness, understanding and implementation among Australian egg producers, and to provide recommendations for supporting the industry to improve producers' biosecurity engagement. More specifically the project aimed to investigate the institutional and policy factors influencing egg producers' engagement with biosecurity and identify how egg producers engage and implement biosecurity and the factors that enable or constraint biosecurity adoption. This project investigates the interpretation and implementation of the concept of shared responsibility in biosecurity across the different players in the egg industry.

To achieve these aims the project used a social constructionist approach (Patton, 2002), which is oriented towards understanding how people construct, in and through their interactions with others, meaning systems for making sense of the world. This approach, which is widely used in social science research on animal health, allowed the investigation of *why* producers interpret biosecurity in the way they do, and *how* their interpretations and practices are shaped by specific social, cultural and organisational contexts. Following this approach, the project used qualitative methods of data collection, including review of documents and reports, semi-structured interviews and observation, organised into two key phases. Phase 1 investigated the institutional and policy context influencing egg producers' awareness and understanding of biosecurity, and used a document review and semi-structured interviews with 17 stakeholders representing government agencies, industry associations and animal health professionals. Phase 2 of the project focused on identifying how egg producers engage with biosecurity, and the social, economic and environmental factors that enable or constrain adoption of recommended practices. This phase consisted of 50 semi-structured interviews with egg producers, stratified by farm type (cage, barn and free-range) and farm size (1,000 to 100,000 hens), complemented by researcher observations of on-farm biosecurity practices and systems on selected farms. Phase 3 of the project used findings from Phases 1 and 2 to develop recommendations at strategic, tactical and operational levels of policy practice for improving producers' engagement with biosecurity. This phase of the project also involved a 1-day national workshop with ten key

government, industry and animal health representatives, with the aim of presenting project findings and discussing and refining recommendations. In addition, five regional workshops (Adelaide, South Australia; Toowoomba, Queensland; Yass, New South Wales; Warragul, Victoria; Perth, Western Australia), involving a total of 76 egg producers and key regional stakeholders, were held to discuss the practical implications of the findings and recommendations arising from the project.

The review of strategies, research reports, and biosecurity manuals as well as stakeholder interviews undertaken have identified the importance of the institutional, socio-economic and political contexts within which egg producers make their biosecurity and animal health decisions. Four key themes with biosecurity significance were identified by the stakeholder interviews:

- i) the need for community engagement and shared responsibility in biosecurity management;
- ii) the importance of scientific management of biosecurity through the biosecurity manuals;
- iii) the difficulties posed by the non-integrated structure of the egg industry and increase in free-range enterprises; and
- iv) the challenges providing biosecurity extension due to a reduction of resources and poultry expertise.

Analysis of the producer interviews identified five key themes in relation to biosecurity. The first one was about the management of flock health and biosecurity, with different attitudes being evident across producers. Whilst most cage and barn egg producers highlighted how scientific and technological management of their flock is essential for flock health and biosecurity; a diversity of views was observed among free-range producers. Some free-range producers had similar perspectives to cage and barn producers, with others considering their production system to bring significant flock health benefits and reduced risk of disease in its own right and therefore were less concerned with biosecurity. The next theme was in relation to producers' understanding of shared responsibility, with the interviews suggesting that the concept is not well-known among producers. Shared responsibility is seen by most as a withdrawal of government services and responsibilities; with a minority accepting their need for adapting to the increase in their biosecurity responsibilities. The third theme identified was in relation to acquisition of biosecurity knowledge, which differed depending on producers' experience in the egg industry. Producers with long experience in the industry use their established networks and very specific sources of information, with the biosecurity manual being one of these sources. However, less-experienced producers reported difficulties accessing useful information and interpreting the relevance of this information, including the biosecurity manuals. The impact of the structure of the egg industry on producers' attitudes towards biosecurity was also identified as a key theme. Among egg producers there is a strong sense of being a family enterprise, and this identity underpins egg production and influences decision-making, with decisions not being only based on cost/benefit considerations, including decisions in relation to biosecurity. In addition, larger cage and barn producers identified the supermarket and consumer pressures as part of the challenges of egg production, due to the increased demand for free-range eggs. The final theme identified among producers was the complex regulatory environment they operate in. For larger commercial producers, although considered complex, this was seen as a cost of being in the industry. However, for smaller producers, the regulatory system was seen too complex, and try to avoid it when possible.

Information generated in this project contributes to an improved understanding of the institutional, social and individual factors that influence egg producers' engagement with biosecurity. This understanding can support the development of a collaborative and shared responsibility approach to biosecurity within the Australian egg industry. The following section provides the overall conclusions and recommendations arising from the project.

Overall Conclusions

The following implications and recommendations aroused from the findings of this project:

Shared responsibility: Rather than being a driver for collaborative biosecurity management, shared responsibility is open to multiple interpretations across stakeholder groups, with resultant implications for system-wide integrated biosecurity management. From an institutional perspective, there can be an emphasis on compliance or what could be called ‘passive cooperation’ where institutional stakeholders provide technical information which may or may not reflect the needs of the diversity of egg producers. For egg producers, the shared responsibility concept is interpreted in diverse ways, from something that is an industry reality to something that is unclear and perceived to be a shifting of responsibility rather than a sharing of responsibility.

Information networks: Whilst there is a tendency for institutional actors to understand biosecurity as a technical process, this research highlights the multiple ways egg producers manage their biosecurity and the challenges they face. Experienced producers rely on technical information and their own networks. However, less experienced producers report difficulties in both understanding technical information and establishing networks. The challenges in accessing relevant information and networks have implications in terms of how producers understand and prioritise biosecurity.

The structure of the egg industry: The research has been able to identify implications for biosecurity management stemming from the structure of the Australian egg industry. While in general the research identified larger producers with well-developed biosecurity management systems in place, it also identified the diversity of decisions and degrees of awareness at farm-level for smaller producers, particularly in the free-range sector. This research highlighted the importance of biosecurity information that is specifically targeted to these producers.

Complex regulations: Producers across flock size and production type have identified complexities in the regulatory environment. Whilst for many producers, the regulatory environment is one which is a reality of production, others – particularly smaller producers who are new to the industry – report needing to manage the benefit/cost components of what is sometimes seen as ‘over-regulation’. This research identified that the regulatory environment may work for some producers, but a well-functioning, collaborative shared responsibility approach will work better for others – particularly smaller-scale producers.

This project identified the need to improve engagement among all stakeholders to strengthen the policy and practice of biosecurity in the egg industry. This reflects not only the international research which has focused on the behavioural and social aspects of producer attitudes and practices (discussed in this report) but is also in keeping with a fundamental assumption of social science understanding – that biosecurity is not merely a technical practice. We know from the social science experience, and the discussions with producers for this research, that decision-making and biosecurity practices are influenced by such things as producer experiences of the egg industry, the assumptions they have regarding the best way to produce, their social identities, the ways the institutional context impacts on their practices and their economic capacity to implement biosecurity management. The

recommendations arising from the project are the following.

Strategic / Tactical

1. Review the content relevance and applicability of biosecurity manuals and codes of practice for different production types and farm size of egg producers. This should specifically address the different information needs identified in this report.
2. Using findings from the review (Recommendation 2 above), and through a process of consultation with all relevant stakeholders, including representative producers, co-create 'plain language' biosecurity information (for example, 'one-pager' format) targeted and tailored to diverse production types and the different producer motivations/identities highlighted in this report. This process of co-creation should include mechanisms to recognise multiple understandings of biosecurity and biosecurity management practices.
3. Investigate the possibility of incorporating biosecurity practices into relevant State regulations which reflect the co-created biosecurity information needs and practices. This should ensure relevant biosecurity practices and regulations are embedded into State-appropriate frameworks.

Tactical / Operational

4. Resources should be allocated for engaging those producer groups identified in the research who consider biosecurity to be irrelevant or of limited relevance for their operation. This should include micro-producers of less than 1,000 birds, given their identification as a specific segment of the industry requiring support:
 - a. Identify key stakeholders who influence those producer groups
 - b. Industry/government extension services work with these identified influencers to increase the awareness of biosecurity and to prioritise biosecurity management among these producer groups.
5. Industry/government extension services, together with producers, identify how to make better use of existing producer networks and highlighted identities/motivations to further engage producers in best-practice biosecurity management.
6. In relation to Recommendation 2 above, industry/government extension services and producers identify ways to promote co-created biosecurity information to ensure its relevance and accessibility for all producers. This should include making more use of identified key influencers, social media and on-going media campaigns.
7. Consideration be given to develop video case studies of biosecurity implementation. Case studies should be representative of producer diversity in farm size and production type.

1 Introduction

Previous research in the Australian poultry industry has identified more appropriate biosecurity implementation among meat chicken farm types than among layer enterprises, across all production types, including cage, barn and free-range (Scott et al., 2018b). Poor biosecurity implementation is evident in egg producers implementing limited practices to prevent contact of their flocks with wild birds, sharing equipment between sheds without disinfection, and the limited use of foot baths. Similar findings have been reported from studies in the Netherlands and Canada (Ssematimba et al., 2012, Racicot et al., 2012a, Racicot et al., 2011). Failing to adhere to these, as well as many other, biosecurity practices is associated with an increased risk of avian influenza (AI) introduction and spread. Furthermore, this risk is estimated to be higher among free-range enterprises than cage and barn ones (Scott et al., 2018a, Scott et al., 2018d, Scott et al., 2018c, Glass et al., 2019).

There have been seven outbreaks of Highly Pathogenic AI (HPAI) in poultry in Australia since 1976, with the last one being reported in 2013, and all of them affecting chicken. In the last decade, there has been an increase in free-range egg and chicken meat farms in Australia, which has raised concerns about the potential increased risk of AI outbreaks associated with this production type (Singh and Cowieson, 2013). Recent modelling work assessing the effect of the increase of free-range enterprises identified that a 25% shift from conventional indoor farms to free-range farming would result in an increase of 6 to 7% in the risk of an HPAI outbreak. This study identified appropriate water treatment, restricting wild bird access to feed storage areas, and improving biosecurity practices as critical in addressing the increased HPAI risks associated with the shift to free-range production (Glass et al., 2019). Therefore, better understanding of biosecurity implementation among chicken producers, and especially among egg enterprises, and the factors influencing this implementation, would support the industry in reducing the risk of disease outbreaks.

The current project aims to conduct an in-depth exploration of egg producers' understanding of biosecurity and the factors motivating and hindering biosecurity adoption. The project uses a social constructionist approach (Patton, 2002), which is oriented towards understanding how people construct, in and through their interactions with others, meaning systems for making sense of the world. This approach is particularly valuable in investigating biosecurity adoption. In contrast to much of the existing research that focuses primarily on investigating what producers think, the current project is aimed at exploring *why* producers interpret biosecurity in the way they do, and *how* their interpretations and practices are shaped in different (and sometimes conflicting) ways by broader meaning systems – ranging from local social norms on 'good' farming to industry priorities for best practice production systems. In line with a social constructionist approach, the project uses qualitative methods of data collection to investigate how egg producers construct meaning in relation to biosecurity, and the ways in which social, cultural and institutional factors and contexts impact on this meaning.

This project addresses concerns identified in Australian Egg's long-term RD&E need, 'Flock Health and Disease Management', and the short-term research priority 'Protect industry from disease through effective biosecurity practices', within the 'Hen welfare and best practice production systems' program. Implementing appropriate biosecurity practices is crucial for minimizing the risk of disease

introduction and spread; and this is not only important for emerging animal diseases (EAD), such as AI, but also for the management of endemic diseases affecting the poultry industry, such as Infectious Laryngotracheitis (ILT), Fowl Cholera, Spotty Liver and those with public health significance, such as *Salmonella* Enteritidis. As such, improving biosecurity implementation, disease recognition and reporting among all layer farm types will minimize the threat of disease outbreaks and the impact of endemic diseases and, subsequently contribute to animal health and welfare, productivity, and social wellbeing of egg producers and as such, to the long-term sustainability of the egg industry.

2 Project aims

The main aim of this project was to investigate biosecurity awareness, understanding and implementation among Australian egg producers, and to provide recommendations for supporting the industry to improve producers' biosecurity engagement. In achieving this aim the project focused on the following research objectives:

1. Investigate the institutional and policy context at national level influencing egg producers' awareness and understanding of biosecurity, recommended biosecurity practices and the management of animal health and disease;
2. Identify how egg producers engage with and implement biosecurity for endemic disease and EAD management, and the social, economic and environmental factors that enable or constrain their adoption of recommended practices; and,
3. Provide recommendations at strategic, tactical and operational levels of policy practice for improving egg producers' engagements with biosecurity.

3 The context: Producer engagement and shared responsibility for biosecurity

Shared responsibility is a key priority underpinning biosecurity in Australia. In principle, shared responsibility involves governments, industry, natural resource managers, custodians or users, and the broader community working together across the biosecurity continuum on 'prevention, emergency preparedness, detection, response, recovery and ongoing management of pests and diseases' (Council of Australian Governments, 2012). This type of approach is important in engaging stakeholders – such as producers – with limited previous input into biosecurity policy and programs. In doing so, shared responsibility has the potential to contribute to more 'innovative and non-uniform solutions' (Enticott, 2008) (p. 1580) to the management of pest and disease problems.

Nevertheless, in practice a number of challenges have been identified in the implementation of a shared responsibility approach. These are well-documented in reviews and reports on Australia's biosecurity system, and include:

- Shared responsibility is not clearly defined, and its application is either poorly understood or is not broadly accepted by stakeholders across the biosecurity system;
- The roles and responsibilities of stakeholders across the biosecurity system are not clearly articulated, and have not been widely understood or accepted;
- Governments have been reluctant to provide opportunities for other participants to take greater ownership of, and responsibility for biosecurity activities;
- There have been ongoing cutbacks in government expenditure at national and state levels, which contribute to government agencies having fewer resources to coordinate with other participants in the system, or for on-ground biosecurity extension; and
- Engagement, communication and coordination across the system is inconsistent

(Beale et al., 2008, Craik et al., 2017, Simpson and Srinivasan, 2014)

Such challenges are significant as they can create potential indeterminacy for policy-makers 'as well as ambiguity and tensions for agencies and farmers tasked with implementing biosecurity in practice, including unclear lines of responsibility, poor communication and lack of transparency' (Higgins et al., 2016) (p. 1136). Nevertheless, despite many of the challenges to shared responsibility being predominantly institutional, much of the current emphasis by government and industry is on producer's attitudes and practices as the main barrier to improving biosecurity implementation.

It is often assumed by government and industry stakeholders that one of the key challenges in implementing a shared responsibility approach is producers' lack of awareness of biosecurity, and they do not understand or accept its importance. As a consequence, producers are viewed as failing to fully appreciate the important role that they play in Australia's biosecurity system. Such assumptions appear to be supported by veterinary and social science research on producers' biosecurity attitudes and practices. This research argues that while many producers have a high concern for disease threats, and believe they are doing all they can to minimise disease risk (Garforth et al., 2013, Sahlström et al., 2014, Nöremark et al., 2010), this does not necessarily translate into on-farm implementation of recommended biosecurity practices (Brennan and Christley, 2013, Barclay, 2005, Azbel-Jackson et al.,

2018). In the case of the poultry sector, research has found generally low levels of biosecurity compliance on poultry farms (Racicot et al., 2012a, Racicot et al., 2012b, Ssematimba et al., 2012), with commercial layer farms having poorer adoption of biosecurity practices than meat chicken farms (Scott et al., 2018b). These low adoption levels are of particular concern with the increase in free-range chicken farming, which it is argued is at higher risk of a highly pathogenic avian influenza (HPAI) outbreak than conventional indoor farms (Glass et al., 2019).

Producer and farm-level characteristics are usually discussed as the main explanations for the gap between producer attitudes to biosecurity, and their actual practices. These include:

- The physical attributes of the enterprise – These determine which biosecurity measures are required and the level of investment needed. For example, an intensive farming operation is likely to require a higher level of investment in animal health processes and practices that contribute either directly or indirectly to biosecurity outcomes;
- The financial situation of the enterprise – Influences what measures the producer can afford to implement;
- A producer's socio-demographic characteristics, such as age, education, experience, goals, beliefs and values – Affects the decisions made by producers;
- Producers' previous exposure to biosecurity risk – Can affect the perceived risk of an outbreak, and the priority given to assimilating information on biosecurity;
- Access to available sources of information on biosecurity measures – Producers are more likely to act on information provided by sources, such as local veterinarians, with whom they have built a relationship of trust; and,
- The attribution by producers of responsibility for biosecurity to governments and their agencies

(Azbel-Jackson et al., 2018, Brennan et al., 2016, Gunn et al., 2008, Heffernan et al., 2008, Palmer et al., 2009, Racicot et al., 2012b, Toma et al., 2013)

The producer and farm-level characteristics outlined above are typically framed in the literature as adoption 'barriers' that need to be addressed through improved communication or education strategies in order to encourage greater success in the implementation of biosecurity protocols and enhanced levels of producer compliance. However, recent research by Higgins et al. (2018), conducted in the beef industry, questions the effectiveness of this compliance-based approach in engaging producers in biosecurity. Rather than viewing these characteristics as 'barriers' to adoption, Higgins et al. argue that greater emphasis needs to be given to what producers already know and do to prevent and manage pest and disease problems. According to Higgins et al. (2018), farm biosecurity tends to be promoted as a set of standardised technical measures, which need to be complied with in order to protect a property from pests and diseases.

Drawing on the UK work of Enticott and Wilkinson (2013), Higgins et al. (2018) argue that this top-down compliance-based approach provides limited scope for recognising the diverse ways in which producers 'perceive and respond to disease risk', or understanding how producers' experiences 'of living with disease influence what biosecurity measures work or do not work for them' (Higgins et al., 2018, p.36). Measures to improve biosecurity adoption that do not take into account producers' existing animal or flock health knowledge and practices run the risk of creating uncertainty and

cynicism from producers, causing them to 'ignore information from governing bodies with whom they have not yet established a relationship of trust' (Higgins et al, 2016, p.1136). Higgins et al. propose an alternative approach that recognises the need for local flexibility in how recommended biosecurity practices are taken up at a farm level – one that focuses on engaging with producer's existing practices of care for their livestock, family and farming enterprise. They contend that an emphasis on producer's practices of care provides a crucial starting point for engaging producers more effectively in biosecurity. From this perspective, 'on-farm biosecurity becomes less about producers complying with specific measures or procedures, and more about governing authorities nurturing producers' care practices' in ways that value and build on existing animal (or flock) health practices (Higgins et al., 2018, p.37).

The work by Higgins et al (2018) provides an important way of rethinking how to engage producers in sharing responsibility. Nevertheless, their work was conducted in the beef industry, an industry highly influenced by export market requirements, which is very different to the egg industry in Australia. This report, with its focus on layer production, provides an opportunity to evaluate, in the context of a more intensive industry, the applicability of a 'care-based' approach in engaging producers in a shared responsibility approach to biosecurity. It also enables a more detailed assessment of the merits and limitations of a compliance-based approach to biosecurity, and the extent to which a compliance or care-based approach (or a combination of both) is likely to be most effective across different layer farm types.

4 Methodology

To address the project objectives, the research adopted a social constructionist approach (Patton, 2002), which enables exploration of how individuals construct meaning and knowledge around biosecurity, and how this meaning is shaped by specific social, cultural and organisational contexts. This approach is widely used in social science research on animal health, and is appropriate for the project as it allows for detailed investigation of producer understandings of biosecurity and its relevance to their everyday practices, and how specific federal, state, industry and regional cultures impact upon these understandings. This is particularly important for understanding why and how producers engage, or do not engage, with biosecurity information and practices. Animal health research drawing on a social constructionist approach typically uses qualitative methods of data collection, such as existing documents and reports, semi-structured interviews, and observation. Consistent with previous research, the current project used these methods for data collection organised into two key phases.

Data collection processes for Phase 1 and Phase 2 of the project were approved by the Human Research Ethics Committee at Charles Sturt University (Protocol numbers Phase 1, 400/2017/33; Phase 2, H18023).

4.1 Phase 1

The first phase focused on the institutional and policy context influencing egg producers' awareness and understanding of biosecurity (Objective 1). Two methods of data collection were used in this phase of the research:

1. **Document review.** A review was undertaken of:
 - a. Relevant government policies, strategies and approaches to biosecurity in general and the poultry industry/egg producers specifically;
 - b. Relevant industry biosecurity manuals, extension materials and quality assurance programmes;
 - c. Any specific campaigns for the chicken/egg industry in Australia; and,
 - d. Relevant scientific literature.

2. **Semi-structured interviews** with relevant stakeholders in government agencies, industry associations and animal health fields. A semi-structured interview guide was developed using broad questions (Appendix 1) and 17 stakeholders participated in the study. Stakeholders were identified by previous knowledge of the research team and experience from previous projects and in consultation with the project Steering Committee. Only those stakeholders with direct involvement with biosecurity regulation and implementation were considered. The list of stakeholders interviewed are shown in Table 1. The purpose of these interviews was to both 'ground truth' what was identified in the document review and to gather a more in-depth understanding of assumed roles in the shared responsibility approach and, consequently, the biosecurity system. The interviews broadly focused on:

- a. The respondent's/organisation's work in biosecurity
- b. A focus on what is working well and why
- c. A focus on any challenges.

The focus on what is working well and any challenges provided the opportunity to identify common themes in how institutional actors have interpreted their roles within the biosecurity system as well as the ways they see the roles and responsibilities of producers. Interviews were analysed to identify emergent commonalities and differences in interpretation of these roles, together with the underlying assumptions and institutional context (such as biosecurity strategies) which underpin them. Important themes which emerged through this process coalesced around understanding biosecurity as a technical/scientific process; assumptions of what shared responsibility is; insights into respondent views of producer decision-making processes and; specific biosecurity issues in the free-range sector.

The literature review above has highlighted the importance of understanding the institutional context as well as some key implications for this research, which the themes identified through the stakeholder interviews reflect. This is further discussed in section 5.2 below.

Stakeholder type	Location and number of interviewees
Industry	Australian Eggs Limited Free Range Egg and Poultry Association Egg Farmers Australia National Farmers Federation
Federal Government	Department of Agriculture and Water Resources
State Government	Agriculture Victoria New South Wales Department of Primary Industries (x2) Department of Primary Industries, Parks, Water and the Environment, Tasmania Primary Industries and Regions, South Australia Department of Agriculture and Fisheries, Queensland Department of Agriculture and Food, Western Australia
Animal Health	Animal Health Australia Poultry health consultant (x4)
Total number	17

Table 1. List of stakeholders participating in Phase 1 of the project

4.2 Phase 2

The second phase of the research focused on identifying how egg producers engage with biosecurity, and the social, economic and environmental factors that enable or constrain adoption of recommended practices (Objective 2). This phase consisted of semi-structured interviews with selected egg producers, complemented by researcher observations of on-farm biosecurity practices and systems on selected farms.

4.2.1 Selection of participants

Semi-structured interviews were planned to be conducted with a total cohort of up to 60 egg producers, representing egg producers keeping between 1,000 and 100,000 birds, the range of producers identified by AE as crucial to their planning. Given the qualitative nature of this project, the methods used do not aim to obtain a representative sample of egg producers in Australia, but include a sufficient number of producers to ensure adequate diversity in different factors impacting biosecurity engagement.

To ensure this diversity, a stratification by farm size and farm type (cage, barn and free-range) was conducted for the selection of egg producers, as these two characteristics are key factors for biosecurity implementation according to previous research (Scott et al., 2018b). Additional stratification criteria was considered by the team but rejected because of the centrality of size and type to biosecurity implementation. Additionally, and given the sample size, we did not want to have the sample so stratified that it ran the risk of having categories with only one or two producers fulfilling the stratification criteria.

However, when the opportunity arose we were able to ensure the following were represented in the sample:

- Gender: Of the total participants, 44 men were interviewed, three women were interviewed and three couples were interviewed, drawn from across production sectors.
- Length of time in the industry: Cage/barn producers tended to be longer in the industry (more than 15 year of experience) than free-range, though we were able to interview two free-range producers with over 15 years in the industry. Other free-range producers typically had less than 10 years' experience.
- Geographic location: Participants were from central and south-east Queensland, northern, north-east, central and south-east NSW, north-east, central and south-east Victoria, Tasmania, the Adelaide region and Kangaroo Island, and south-east Western Australia.

According to the Australian Bureau of Statistics and Australian Eggs Ltd, there are approximately 350 egg farms in Australia with a size distribution presented in Table 2. As seen in the table, the proportion of the three farm types differs between the different farm sizes.

Number of layers	Ratio	Estimated number of farms (n = 350)	Cage farms	Barn farms	Free-range farms
1,000 to 5,000	4	155	35%	15%	50%
5,000 to 20,000	2	78	40%	20%	40%
20,000 – 100,000	2	78	50%	20%	30%
>100,000*	1	39			

*Not included in the study

Table 2. Egg farm distribution according to farm size (Australian Egg Ltd)

Selection and recruitment of participants occurred through:

- 1) A call by Australian Eggs through its newsletter and via email to all their members
- 2) Utilization of researcher networks. The chief investigators have undertaken previous research in the Australian egg industry and previous respondents who had indicated their interest in participating in further research were approached.
- 3) Snow-balling. At the completion of each interview respondents were asked if they knew of any other producers who may be interested in participating. If so, they were asked to make initial contact and advise the researchers if these new producers were wanting to participate.

As a result of this process, a total of 73 potential participants were identified and initial contact made and follow-up undertaken. From this cohort of producers, the research team was able to recruit and engage with a total 50 egg producers. While we realise this process of identification has a tendency to self-selection (that is, producers who are already engaged) we were never-the-less able to reach producers who are less engaged through the use of our own networks and also, to a lesser extent, snowballing. Importantly, we were also able to incorporate some biosecurity issues inherent with the micro-producer segment of the industry (those less than 1,000 birds) through our participants.

Table 3 shows the stratification of the target sample (n = 60), with the total number of participant producers in brackets (Please note that the farm size categories used were those for which data was available through Australian Eggs Ltd).

Farm size		Cage farms	Barn farms	Free-range	Total
> 500,000	Large	0	0	0	
50,000 to 500,000	Medium	5 (5)	1 (1)	2 (1)	8 (7)
5,000 to 50,000	Small	10 (7)	7 (4)	27 (24)	43 (35)
1,000 to 5,000	Micro	1 (0)	1 (0)	7 (8)	9 (8)
	Total	15 (12)	9 (5)	36 (33)	60 (50)

Table 3. Distribution of egg producers participating in Phase 2 of the project according to farm size and farm type.

4.2.2 Data collection

Interviews occurred both over the phone and face-to-face. For those conducted over the phone, recordings were made and transcribed (for respondents who gave their permission, though not all respondents consented to having their interviews recorded). In relation to the face-to-face interviews, those conducted in a public place (for example, a café), or undertaken whilst walking around the farm were not able to be recorded. Methodologically, in face-to-face interviews we wanted more informality so that responses could be compared to the more formal telephone interviews. It should be noted that no material differences were noted between the data collected through telephone and face-to-face interviews.

The interviews gathered information on current animal health management and biosecurity knowledge, practice and attitudes, communication networks and information delivery methods. The

aim of the interviews was to gather information relevant to farm-level practices and challenges as well as the relationships producers have with institutional actors (who formed the focus of Phase 1). As such findings from Phase 1 of the study were also used to design the questions for the producer interviews. Analysis of Phase 1 interviews with stakeholder had highlighted the following important broad areas for further analysis at producer scale:

- Producer understanding of new regulatory environments which are characterised by 'shared responsibilities for biosecurity',
- Producer knowledge frames and assumptions in terms of their understandings of biosecurity,
- Who producers engage with in terms of acquiring biosecurity knowledge, and
- How producers translate their knowledge into biosecurity practices.

The semi-structured interview questions are shown in Appendix 2.

For those interviews conducted on-farm, informal observations were conducted by the interviewer as a way of triangulating the on-farm flock health and biosecurity implementation. This formed part of the face-to-face interaction, as the interviewee pointed out biosecurity measures or the interviewer sought clarification on what was observed.

4.2.3 Description of data analysis processes

Given the use of a social constructionist approach and the consequent use of semi-structured interviews, data are analysed using 'open' and 'axial' coding. This involves three stages. The first identifies common descriptors in the data. The second involves the identification of relationships between these descriptors and the third provides a thematic analysis to derive key themes from across the data (Miles and Huberman, 1994, Guest et al., 2012).

The literature review and the previous experience of team members in the social/political dimensions to biosecurity highlighted a number of key 'contested spaces' which informed common descriptors of the data. These included interpretations of shared responsibility, meanings and interpretations of biosecurity, the potential impacts of changes to the structure of the industry (and more generally, the drivers of these changes), attitudes to (and interpretations of) compliance and regulatory frameworks.

Of course, given that biosecurity is at once a technical, socio-cultural, political and economic system, key relationships emerged from these common descriptors. These included relationships between key stakeholders in the biosecurity system (especially between policy/government agencies and producers), relations between producers themselves and, for many producers, relations between themselves and their consumers.

Ultimately, the research highlighted factors/themes underpinning these relationships. These included different understandings and interpretations of biosecurity and biosecurity management both across and within producer segments, commonalities and differences in producer identity and how that impacts on biosecurity practices, information networks and gaps (and their impacts on biosecurity practices) and a variety of issues related to competing or unclear understandings of shared responsibility/co-responsibility.

Coding and interpretation of data was a collaborative process among the research team. Interviews were conducted by the research fellow, who drafted initial interpretations and analysis. Raw interviews

and initial interpretations and analyses were shared within the team members, and detailed input on interpretations was provided by two additional members of the team. Furthermore, at key times in the research process, the team met through Skype or face-to-face to discuss in depth interpretations and analysis of the interviews.

The analysis focused on the areas indicated above, as well as whatever other factors egg producers indicated were important. Interpretation of the data focused on:

- Current biosecurity knowledge.
- Linkages between knowledge and biosecurity practices/implementation.
- Attitudes towards biosecurity and animal health management.
- Communication networks and processes of information acquisition.

Saturation of the data across the broader, identified themes, began occurring after approximately 35 interviews (which had themselves covered multiple respondents across egg production systems and size of enterprise). This allowed the research to focus some interviews to collect specific information/producer experience in more depth. This was especially useful in discussions of producer relationships with agencies and the specific challenges producers faced in accessing biosecurity information. Importantly, this in turn allowed the research to identify some of the biosecurity implications of those micro-producers below 1,000 birds who all producers had identified as being a significant issue in the biosecurity system.

4.3 Phase 3

4.3.1 Development of recommendations

Phase 3 of the project aimed to use outputs from Phases 1 and 2 to develop recommendations at strategic, tactical and operational levels of policy practice for improving producers' engagement with biosecurity (Objective 3):

a. Strategic level recommendations: Based primarily on data from Phase 1 of the project, recommendations were developed for addressing any identified inconsistencies in biosecurity policy and programs either between states or within the egg industry.

b. Tactical level recommendations: Based on data from Phases 1 and 2 of the project, recommendations were developed to assist the industry in developing an extension strategy and programs that provide a consistent message on recommended biosecurity practices, and which take account of the diverse social, economic and environmental factors that influence how egg producers engage with biosecurity.

c. Operational level recommendations: Based primarily on data from Phase 2 of the project, recommendations were developed on the implementation of biosecurity extension programs to producers targeted to each sector of the layer industry.

This phase of the project aimed to investigate how different approaches for achieving adoption of biosecurity among egg producers, relate to and complement each other, from government and industry stakeholders and producers' perspectives. Perspectives and opportunities on enforcement of biosecurity adoption through a legislative approach versus an extension approach were also investigated.

4.3.2 National and regional workshops

National workshop: A 1-day national workshop was held on the 30th of April 2019 in Sydney with the aim of presenting key findings of the research project, discuss recommendations and to consider how each recommendation could be translated into practical and tangible outcomes that will enhance biosecurity engagement within each sector of the layer industry. The workshop was attended by ten industry, government and animal health representatives, with most attendants having participated in Phase 1 of the project, in addition to four members of the research team. A summary of the national workshop is presented in Appendix 3. Recommendations were reviewed considering the feedback received by workshop participants.

Regional workshops: As part of the last phase of the project, five regional workshop with egg producers were held to discuss the practical implications of the findings and recommendations arising from the project. For this phase of the project the research team engaged with Dr Clive Jackson as an external poultry consultant for presenting and facilitating the workshops. The following workshops were conducted:

- Adelaide (South Australia)
21st of May 2019
Attendants: 17
- Toowoomba (Queensland)
23rd of May 2019
Attendants: 12
- Yass (New South Wales)
28th of May 2019
Attendants: 7
- Warragul (Victoria)
30th of May 2019
Attendants: 21
- Perth (WA)
12 June 2019
Attendants: 19

The duration of the workshop was approximately 2 hours and included a presentation on the key findings and recommendations from the project, a presentation on the relevance of biosecurity for the prevention of *Salmonella* Enteritidis and a group discussion on the feasibility and applicability of the project recommendations. A summary of the regional workshops is provided in Appendix 4.

5 Findings

5.1 Phase 1 document review: The current policy and institutional context

Analysis of the institutional context allows a better understanding of the linkages within the systems of biosecurity – in particular, linkages and relationships between national and state-level strategies, industry associations, the animal health/welfare sector and egg producers themselves. Understanding these in more detail ultimately provide insights into not only any gaps or potential points of contestation within the system itself, but also implications for egg producers' adoption of biosecurity practices.

For this phase of the research, the focus has been on key institutional actors within the Australian egg industry: government agencies, industry associations, animal health professionals and egg producers. This section reviews the role of each of the main actors.

5.1.1 Government agencies

Higgins et al. (2016) discuss the political drivers of the devolution of biosecurity responsibilities. These include the rising costs of biosecurity to governments, a growing reluctance to regulate and the search for more effective ways of engaging farmers and the broader public in biosecurity practices (pp 1-2). Each of these drivers are likely to have important implications in terms of the systemic management of biosecurity risk, government strategies and the ways agencies operationalise strategies and approaches at producer scale.

Federal government: Department of Agriculture and Water Resources

The Department of Agriculture and Water Resources has significant biosecurity responsibilities at a national level, with a particular emphasis on external threat (<http://www.agriculture.gov.au/biosecurity/aus-gov-biosecurity-priorities>). Whilst for this research the state agencies are key institutional actors, it's important to note core components to the Department's approach include building community-based engagement, growing scientific capability and undertaking evidence-based decision-making. Hence, at the federal level, shared responsibility - by bringing communities into the biosecurity management system – is seen as crucial. Importantly, the evidence-based management of biosecurity remains core.

State governments

A review has been undertaken of each state's biosecurity strategies and policies so as to provide a broader state-level understanding of the biosecurity context within which egg producers operate.

It is obvious that shared responsibility is a significant component to biosecurity strategies in each state. All emphasise 'partnerships', 'the community's role', 'collaboration' and 'engagement'. Equally, the importance of evidence-based biosecurity are highlighted in all states, with scientific knowledge providing the basis for evidence-based policy making. These can be seen to be core components to the biosecurity system across states.

However, there are differences as well. Some states (for example, NSW, Tasmania) highlight biosecurity as being of concern for, and integrated into, whole of government approaches. South Australia explicitly uses 'One Health' as its foundational principles.

Whilst some strategies provide a degree of detail on how these engagements, partnerships and collaborations will likely occur others tend to be more general. The following is an overview of the key components of each state's biosecurity strategy/approach.

Agriculture Victoria

Victoria's biosecurity approach has focused on both exotic diseases and widely-established invasive species (<http://agriculture.vic.gov.au/agriculture/biosecurity>). In terms of egg producers and the poultry industry, its priority is Avian Influenza and food safety, particularly *Salmonella*.

Shared responsibility and community engagement are core components to biosecurity management. For example, its widely-established invasive species programme has community groups acting as an intermediary between the agency and community members. In terms of the poultry industry, the focus on AI and food safety has tended to emphasise extension activities and where necessary targeted interventions in terms of public health and disease eradication.

NSW Department of Primary Industries

The NSW Biosecurity Strategy (2013-2021) identifies the following goals (<https://www.dpi.nsw.gov.au/biosecurity/managing-biosecurity/nsw-biosecurity-strategy-2021>):

1. Biosecurity as a shared responsibility
2. Biosecurity contributing to sustainable economic growth
3. Biosecurity protecting the environment and communities
4. Biosecurity being underpinned by a responsive and consistent legislative framework.

These goals are important in that they recognise biosecurity as not only a technical process with shared responsibilities, but also its economic, environmental and community dimensions. This emphasis suggests a broadening of biosecurity management whilst still maintaining the institutional orthodoxies of technical/scientific management and shared responsibilities.

The NSW Department of Primary Industries provides general biosecurity information for livestock producers. In relation to poultry production the focus of the information is Avian Influenza and free-range production; with the NSW Food Authority providing information in relation to food safety and egg production.

Department of Primary Industries, Parks, Water and the Environment, Tasmania

Tasmania's biosecurity strategy brings together multiple components which may require balancing. An important component is that regional differences are recognised. This is crucial because it recognises the difficulties of having a biosecurity system management regime that assumes homogeneity. Yet these regional differences will need to be balanced with other components highlighting the need for cost-benefit analysis, being risk-based and the operationalisation of shared responsibilities (<https://dpiwpe.tas.gov.au/Documents/TBS-2013-2017.pdf>).

Another potential strength of the Tasmanian approach is its stated 'whole of government' approach. Embedding biosecurity as a government responsibility (as distinct from an agriculture or health responsibility) has the potential to normalise biosecurity management – it becomes something that is done as a matter of course rather than a response to an EAD or a single department responsibility.

The Tasmanian Department provides general information on biosecurity for poultry operations, a biosecurity checklist focusing on reducing the risk of Avian Influenza and biosecurity guidelines to reduce the risk of Salmonella to your poultry (<https://dpiptwe.tas.gov.au/biosecurity-tasmania/animal-biosecurity/animal-health/poultry-and-pigeons/biosecurity-poultry-and-pet-birds>).

Primary Industries and Regions, South Australia

The State Biosecurity Policy 2017/2021, establish the purpose and approach to biosecurity in South Australia. The objective of this policy is to 'protect and improve South Australia's economic, environmental and social assets and public health', and to do so the focus is on 'preventing and reducing pest and disease impacts, maintaining food safety and supporting responsible agricultural chemical use' (https://www.pir.sa.gov.au/__data/assets/pdf_file/0008/188189/PIRSA_State_Biosecurity_Policy.pdf).

For South Australia's biosecurity planning and management, 'One Health' provides important guiding principles. 'One Health' is an approach to designing and implementing programmes, policies, legislation and research in which multiple sectors communicate and work together to achieve better animal and public health outcomes. In terms of biosecurity, the One Health approach (and therefore SA's strategy) emphasises collaboration between stakeholders (the shared responsibility approach) but also incorporates biosecurity based on risk management, scientific knowledge, and, importantly, adaptive management.

In terms of the biosecurity management context within which egg producers operate in SA, adaptive management provides some recognition that biosecurity management is an at-times evolving process and forms of flexibility need to be balanced with scientifically-informed biosecurity management. PIRSA provides information to poultry producers in relation to the management of infectious diseases affecting productivity and food safety (https://www.pir.sa.gov.au/biosecurity/animal_health/poultry).

Department of Agriculture and Fisheries, Queensland

The Queensland biosecurity strategy (2018 – 2023) has been developed through a process of community and stakeholder consultations ('co-created' as it is described). Interestingly, shared responsibility in the Queensland biosecurity management context is identified as an opportunity to empower individuals and groups 'to act across the system through shared responsibilities and accessing knowledge' (<https://www.daf.qld.gov.au/business-priorities/biosecurity/enhancing-capability-capacity/qld-biosecurity-strategy>).

This social dimension to biosecurity is found in other parts of the strategy. It talks about collaborative governance amongst stakeholders, continuous learning and innovation through this. It is unclear in the strategy the extent funding is prioritising collaborative governance mechanisms.

In relation to the egg industry, the Queensland Department provides general biosecurity information

for poultry producers, which align with the national biosecurity manuals for chicken meat and egg production. The focus is the management of endemic and emergency infectious diseases affecting productivity and food safety. Specific recommendations on biosecurity for free-range operations are also provided (<https://www.business.qld.gov.au/industries/farms-fishing-forestry/agriculture/livestock/poultry/biosecurity-for-poultry-producers>).

Department of Primary Industries and Regional Development, Western Australia

Western Australia's Biosecurity Strategy 2016-2025 has three principles underpinning it (<https://www.agric.wa.gov.au/sites/gateway/files/WA%20Biosecurity%20Strategy%20%28A1756933%29.pdf>):

1. Biosecurity as a shared responsibility
2. Effective risk management underpinning decision-making
3. Transparent, consistent and evidence-based policies and programmes.

The strategy discusses the importance of collaboration as part of the shared responsibility principle, and highlights the importance of individuals and businesses understanding more about the need for biosecurity and the costs of not having biosecurity management in place. This emphasis on producers understanding biosecurity recognises the need for government extension and engagement.

The Western Australian Department provides general information on poultry production and biosecurity, with a focus on Avian Influenza and Newcastle disease. For more specific biosecurity information links to the Federal Department of Agriculture and the national biosecurity manuals for poultry production are provided. Specific biosecurity information for poultry small landholders is provided within the DPIRD website (<https://www.agric.wa.gov.au/livestock-biosecurity/regulation-poultry-production>).

5.1.2 Relevant industry associations

We use the term industry stakeholders to reflect producer associations which potentially provide both, a link between government agencies and egg producers (through, for example, advocacy and advice) and who engage specifically at a producer level.

As stakeholders within the system, industry associations have roles of advocacy (that is, an engagement with Government decision-making on behalf of egg producers) and act as a clearing house for relevant information for producers. Engagement with producers is a clear part of many associations' roles within the system.

For industry associations, there are two important considerations:

1. Their role in advocacy (that is, an engagement with government biosecurity strategies), and
2. The forms of their relevant linkages with egg producers.

Australian Eggs Limited (AE)

AE is a key institutional stakeholder, with responsibilities for quality assurance programmes, engagement/advocacy and knowledge-to-practice linkages. Along with Animal Health Australia, AE is

a key source of information and knowledge transfer in biosecurity for egg producers. For example, the *Code of practice for biosecurity in the egg industry* supports producers to develop on-farm biosecurity plans, whilst the *National farm biosecurity manual egg production* provides advice on developing a minimum set of standards for biosecurity for egg producers.

Free-Range Egg and Poultry Association (FREPA)

Given the increasing market share of the free-range egg sector (currently estimated at 40%), FREPA's role within the system is an important one. Both the *Code of practice for biosecurity in the egg industry* and the *National farm biosecurity manual egg production* have sections focused on biosecurity for free-range egg producers so there is technical information available.

Egg Farmers of Australia

Egg Farmers of Australia is the peak producer association and is concerned with political advocacy and producer engagement. Currently it represents 85% of egg producers in Australia so is a significant advocacy group. However, its reach into smaller producers is unknown.

5.1.3 Animal health

Animal health actors reflect non-Government stakeholders who operate within the technical sphere, applying specialist knowledge to develop/facilitate systems of biosecurity and engaging with egg producers using this specialist knowledge.

Animal Health Australia (AHA)

Animal Health Australia facilitates partnerships between governments, major livestock industries and other stakeholders to protect animal health and the sustainability of Australia's livestock industry. It is an important stakeholder in terms of biosecurity information and supporting producers in on-farm planning. For example, through their Farm Biosecurity program website, AHA provides biosecurity information for the livestock industries, including the poultry industry, with specific technical information relevant to the egg industry, as well as information focusing on the economic benefits of biosecurity.

Specialist veterinarians

Veterinarians occupy an important place in systems of biosecurity as they have technical knowledge and specifically engage egg producers. In a sense therefore, their role acts as a mediator between producers, technical knowledge and regulatory frameworks. This role is particularly important given the shared responsibility approach of government agencies. Given that one of the drivers of shared responsibility has been the decrease in available government resources, the decline in specialist government veterinarians along with a resultant loss of specialist knowledge within agencies has resulted in private veterinarians having a key institutional role in the biosecurity system.

5.2 Phase 1 Stakeholder interviews: The institutional context

The review of strategies, research reports, and biosecurity manuals as well as interviews undertaken have identified the importance of the institutional context within which egg producers ultimately make their biosecurity and animal health decisions. As mentioned previously, producers make decisions within specific socio-economic and political contexts and the stakeholder interviews shed some light into those decision-making contexts. Phase 1 of the project also highlights the importance of Phase 2 analysis in terms of how relevant biosecurity information is gathered, internalised and put into practice at producer scale.

5.2.1 Commonality across the institutional context

Across federal and state agencies, as well as within associations and animal health professionals, the themes of community engagement in biosecurity management (discussed further below under shared responsibility), scientific capability and information/analysis of the changes to the free-range production system are common.

Scientific management of biosecurity practices

Respondents across all groups highlighted the importance of scientific management to biosecurity. When asked about the availability of scientific information, all respondents highlighted relevant parts of their organisation's websites as well as the relevant egg producer biosecurity manuals. There was therefore a strong belief that relevant scientific information was available. However, amongst some respondents across all groups, there was a recognition that how this information was used by egg producers was unclear.

The free-range production system

Respondents across the groups highlighted the changes occurring within the free-range production system. Whilst there was discussion on the biosecurity implications of free-range production and the market-driven demand for free-range eggs, a second specific set of identified issues related to micro-producers and the difficulties agencies and associations have in knowing how many producers were in the system and where they were located.

As one respondent put it,

We really don't know anything about the smaller free-range producers. They're not on our radar and we can't treat them as a priority. (State agency officer).

The free-range production system is an important focus of Phase 2 interviews. Because the project is only focused on producers with a minimum of 1,000 hens, it was initially thought that the identified concerns with micro-producers would not be able to be captured, except peripherally. However, as will be discussed later in the report under the Phase 2 analysis, the research was able to pick up considerable information and consider some implications in terms of micro-producers.

5.2.2 Shared responsibilities

For state government agencies, community engagement tended to be discussed in unproblematic terms. For example, respondents who raised the importance of this in their management approach invariably used it in ways such as:

We want the community to be engaged in biosecurity (common in state agency respondents)

The community needs to take more responsibility for what they are doing (used by two agency respondents).

It's important to note that these two quotes have a slightly different focus. The first emphasises engagement processes, while the second emphasises responsibility. As discussed later in the report, there can be gaps between forms of engagement and shared responsibilities – particularly within a compliance context. As will be discussed later in the report, producers report being unclear on responsibilities, can find useful information difficult to access or understand, and have to balance their egg production enterprises with complex and sometimes contradictory regulations.

Institutional respondents would also point out that their biosecurity strategies highlighted the importance of this community and/or producer dimension to biosecurity management, something that is clear with all states and which is highlighted in the document review of state approaches.

There are two important points this raises. The first is realising that 'the community', or even egg producers, are not homogenous. Therefore, these generalised usages of the terms tend to cover multiple socio-economic and political complexities at producer scale. So when a respondent talks about 'the community', or policy/strategy documents discuss community responsibility, this tends to either downplay or not recognise the complexities of local practices – something the aims and methodology of this project is specifically focused on.

The second point relates to the ways producers are expected to engage with this responsibility, given changes to budgets and agency priorities the shared responsibility approach contained. Agency interviews provided a mixture of responses to this. Some agencies have continued to provide support/extension to the egg industry, either as part of their strategies or driving biosecurity engagement through other priority programmes such as food or animal health (as described by one respondent, '*we piggy-back off other programmes*'). For others, agency priorities had shifted and therefore, given limited funding, the 'community responsibility' was a political and management reality.

This too was an important point explored in the producer interviews. They were able to focus on both the producer experience of accessing government services/information as well as producer adaptation to the hollowing out of agencies in terms of relevant, specific expertise.

In terms of expectations of producer responsibilities, respondents have highlighted:

1. Some egg producers are either unaware of, or unclear on, their obligations within a shared responsibility regulatory environment (*Industry association respondent*).
2. Some institutional actors (especially government agencies) are unable to provide forms of extension, engagement and awareness-raising of what shared responsibility means amongst producers (*two government agency respondents*).
3. There has been a reduction of expertise available to producers in the egg industry through both government agencies and poultry vets which has put significant pressure on some producers in terms of their own responsibilities (*animal health professionals*)

This points to an issue respondents across stakeholder groups within the system have highlighted during interviews: the link between government agencies, individual communities and egg producers is not always strong, with associations and individual animal health professionals filling linking roles when they can, whilst recognising the reality of a reduction in numbers of poultry vets.

This points to a significant potential gap in the biosecurity system and was an important focus for producer research to identify how this is experienced at producer-scale and how it impacts on biosecurity decision-making.

5.2.3 Producers' understanding of biosecurity

The extent individual producers do or do not have biosecurity on their 'radar' has emerged during Phase 1 interviews and analysis. Respondents across government agencies and animal health professionals have provided some insights into production priorities that may exist. These include the expected economic considerations (for example, costs associated with measures) but have also highlighted factors (which have emerged in biosecurity research elsewhere and in other industries) such as assuming biosecurity is not an issue for 'good producers'.

This leads to questions regarding the extent producers are proactively engaging with biosecurity or the extent they are concerned only in the case of an outbreak or significant event. That is, what are the priorities at producer scale? This is further explored in producer interviews.

5.2.4 Accessing technical information

Respondents have suggested egg producers are able to access relevant biosecurity information in a number of ways, including:

1. Documentation on the net, including the industry's technical manuals,
2. Industry workshops,
3. The Egg Standards of Australia (ESA) quality assurance programme, and
4. Veterinarians and other animal health professionals.

The biosecurity manuals for egg producers are rightly considered an example of providing a best-practice information source for the industry. However, if (and how) they get used is unclear, with some

respondents suggesting they may be better aimed at professionals rather than producers. As one animal health professional put it:

Many of the producers I know would use the manuals if needed. But there are also plenty who wouldn't have the experience to make the most of them.

Understanding this in more detail is an important part of Phase 2 data collection and analysis. Of particular interest in terms of egg producers' access to information that leads to adoption of biosecurity practices are:

- a. The extent egg producers are aware of the sources of information (and, more generally, biosecurity),
- b. The ways egg producers interpret and implement biosecurity practices once this information is accessed, and
- c. Forms of extension (and by who) which are able to reach egg producers.

These points form part of the focus of Phases 2 and 3 of this research project.

5.2.5 Agency outreach

Given the above points, the extent and forms of outreach/extension government agencies undertake is important to understand from a producer perspective. What is of particular interest here, given regulatory frameworks, is the nature of the linkages between state biosecurity strategies focused on shared responsibilities, their application to the specifics of the egg industry and consequently the forms/extent of extension/outreach happening at producer scale.

It's important to note that amongst state government agencies, there is a generalised recognition that a combination of lost in-house expertise, changing budgetary priorities and shifts in policy priorities has meant traditional extension approaches are difficult. This has been a recurrent theme in producer interviews (discussed later in this report).

5.2.6 The structure of the egg industry

The structure of the egg industry appears to be an important issue for biosecurity, with two specific points emerging from the document review and stakeholder interviews. The first, identified by respondents from industry associations and government agencies, is the number of independent producers.

Unlike the poultry meat sector which is highly integrated and biosecurity is embedded in producer contracts with companies (who are also able to broker technical knowledge through their own networks), egg producers are more independent. As a result, there is greater responsibility at producer level to proactively seek out biosecurity information and implement biosecurity practices.

The ways producers seek out information is something analysed in more detail with producers. However, indications from agency and animal health respondents suggest there is a need for much

more targeted engagement strategies to reach egg producers.

The second is the increasing market share of the free-range sector, now estimated at 40%. There has been some research undertaken to better understand practices of the free-range sector of the chicken meat and egg industries. For example, a survey of free-range poultry producers conducted in 2013 (Singh and Cowieson, 2013), was one of the first attempts to understand the demographics and farm structure of the sector. Research was also undertaken looking specifically at AI risk mitigation in the free-range sector (Scott et al., 2018c, Scott et al., 2018d). Additionally, both the *National Farm Biosecurity Manual for Poultry Production* and *National Farm Biosecurity Technical Manual for Egg Production* recognise the specific biosecurity practices required for free-range farms.

The complexities of the structure of the free-range sector has been analysed as part of the egg producer interviews.

5.3 Phase 2 Producer interviews

Both, the literature review and the analysis of Phase 1 interviews have highlighted the need to understand producer understandings of biosecurity, shared responsibility and flock health. The social constructionist approach emphasises that producer understandings are shaped by such things as formal and informal networks, experiences within the industry, and the regulatory environment which influences their production priorities and practices. Therefore, producer interviews are interested not only in what egg producers think and how they undertake biosecurity management, but *why* they do this. Interviews therefore seek information on producer experiences, including their experiences of the institutional components of biosecurity in the egg industry.

The following key themes were identified through this analysis:

- Flock health and biosecurity
- Understanding shared responsibility
- Information knowledge and acquiring knowledge on biosecurity
- The structure of the egg industry
- Complex regulations

The following sections provide an overview of findings in relation to these themes, supported by producer quotes, and how these findings are important for improving engagement of producers with biosecurity. These are consequently considered for developing the project recommendations.

5.3.1 Different ideas of flock health and biosecurity

Different ideas about flock health and biosecurity were evident in the producer interviews. These differences were broadly aligned with the production system used (i.e., cage, barn or free range).

Cage and Barn producers

All cage and barn egg producers interviewed highlighted how scientific and technological management of their flock creates a healthy production system, and is essential for biosecurity. For these producers, scientific management and clear biosecurity procedures reflect not only commercial decision-making (for example, the impact of a disease outbreak on their commercial viability or increased production because of scientific management) but also an animal health ethic. Researcher observations of their on-farm biosecurity systems support this emphasis on scientific management.

As one cage producer put it:

I believe it's helping us have a safer farm by following the directions, doing what we can in making our livelihood and everything safer. I think that's the main part for us of biosecurity, trying to eliminate some of the risk involved in the poultry industry. We'll never eliminate all the risk but there's a lot of risk out there that biosecurity can help control.

In terms of the flock health ethic, discussions with cage and barn producers invariably covered consumer decision-making, and how consumers, if they knew what modern cage systems were like (especially as distinct from some free range systems) their preferences would swing back to purchasing

cage eggs. Producers wished consumers could have the information to make informed decisions.

Cage and barn producers interviewed reflected on their own decisions *vis-a-viz* staying in cage or barn systems when there is commercial pressure to diversify into free range production. For some, moving from cage to free-range systems was viewed as 'going backwards'. This was expressed both in terms of the management of biosecurity (that is, specifically having concerns about biosecurity in free-range systems) and also in highlighting the benefits of scientific and technological management associated with cage systems in terms of production, economic benefit/cost, flock health, biosecurity, and, importantly, producer identity (which is further discussed later in this report).

For others though, decisions around diversification of production into the free-range system have also been influenced by a strategy of risk management – there is a commercial imperative to diversify into free-range systems, but producers recognise the risks of the free-range system in terms of both flock health and biosecurity. Whilst these producers were in one way confident in their ability to manage risks (drawn from their time in the industry, their management practices in their cage egg system for example), they invariably expressed concerns, suggesting it is impossible to manage all flock health and biosecurity risks in the free-range system.

This is also examined later in this report – *The structure of the egg industry*.

Free-range producers

Free-range producers provided a diversity of views on flock health and biosecurity. Producer identity, discussed later in this report, is an important factor in these diverse views.

Some free-range producers emphasised the scientific management of flocks in terms of both flock health and biosecurity. These free-range producers tended to highlight their vaccination programme as an example of flock health management. Here they reflected on the strategies of technical and scientific management. In terms of biosecurity, this group identified the risk factors on their property and how they are managed. Water birds and overflying birds were identified as significant risk factors.

As one small free-range producer put it:

We're definitely not organic, from an animal ethics perspective ... we're totally against organic, we just feel that as discussed previously the birds have been managed for generations with humans and if we were to try and stick them out and ask them to try and live through all the different diseases and flock infections without veterinary chemicals, well I think we're doing the wrong thing by the birds.

Other free-range producers suggested the free-range system brings significant flock health benefits in its own right. These producers tended to talk about their enterprises in terms of what could be described as a rural ideal. Whilst there is no singular rural ideal shaping this, it is possible to discern some important components to it, as identified by respondents.

For some smaller free-range producers, there was a distinct sense that being in a rural landscape and

having free-range production means less risk of diseases and therefore there was less concern with biosecurity. Their production is tied to the view that a free range production system means healthier lives for their flock, themselves and those who purchase their eggs. In this sense, their production is tied into holistic values of ecological, animal and human health.

As one small producer put it:

So, our first port of call, as far as biological security is biological diversity. As far as I'm concerned, if you are reliant in your economic livelihood, on a single species, you are not biologically secure, and I don't really care what precautions you've got in place, I mean that's our philosophy anyway, biosecurity starts with biodiversity.

Being able to show that food production can occur in a localised organic or free range production system is important to some producers. This group encourages consumers to visit their farms and talk about their production. It is important to note however that not all have stringent biosecurity measures in place to manage farm visits. For example:

But the general – the general consumer seems to be a little bit more aware and asking more questions. And we get phone calls all the time asking about our – or emails asking about our system and what we actually do. And we have a small website and also Facebook, so people do search out information. And the fact that our chooks are stocked at a really low density and move regularly, and all those sorts of things seems to be quite important to people.

For these producers, a free-range system is naturally healthier than a cage or barn system, so management of flock health tends to be reactive (that is, if something goes wrong). In terms of biosecurity practices, this group displayed diverse responses. Whilst the majority of free range producers interviewed (approximately 65%) believed biosecurity and flock health management involved implementing risk management strategies, others believed biosecurity was not an issue because their free-range production was, by definition, 'clean and green'. A minority (entirely smaller producers) had little understanding of biosecurity practices in free-range systems.

A small number of organic free-range producers were interviewed. In addition to highlighting their management of biosecurity risks (which reflect those above) these producers highlighted how minimal their flock health/vet expenses were compared to other, non-organic free-range producers.

One organic producer put it this way:

We wanted to be organic anyway. For us it's kinda like an ethical thing. We want to demonstrate to people what's possible. So we haven't really been impacted by this big shift to free-range and the big players taking the free-range label. We're still organic. And as we've been able to get better established, and know more about how to do free-range production, our costs for outside help are now pretty minimal.

5.3.2 Understanding shared responsibility

'Shared responsibility' as a concept is not well-known by all those producers interviewed – something that became very apparent after the first few interviews. While initially the interviewer used the specific term 'shared responsibility' in the interview, when it became apparent that it was an unknown term for producers, interviews were adjusted to highlight the concept of sharing responsibility for biosecurity across relevant stakeholders such as producers, government agencies, industry associations and animal health experts. So the discussion started broadly about shared responsibility in the system, and then producers were asked how they thought the sharing of responsibility was working for them, and especially both if they had concerns about their capacities to provide a biosecure environment and if there were stakeholders who they thought weren't 'pulling their weight'.

Once explained, for a sizeable minority of producers across production systems, 'shared responsibility' was seen as a government or bureaucratic mechanism for 'no responsibility', meaning responsibility for biosecurity was found only at producer scale, though this concern was not shared by all producers.

Producers tended to see motivations behind this as:

- a withdrawal of government *services* they have observed and experienced. For these producers, government services have been in steady decline and shared responsibility is a concept behind which further services can be withdrawn. The lack of expertise relevant to the egg industry within government agencies was highlighted.
- a withdrawal of government *responsibility* in terms of biosecurity. These producers believed there had been a shift in agency approaches to emphasise large-scale commercial production. As a result, an agency's whole-of-industry responsibilities declined.
- a government strategy and/or approach which places regulatory and practical responsibility for biosecurity onto the producer. The driver of this, according to producers, is about risk management with government agencies shifting risk to producers.
- some combination of these.

The distinctions are important as they highlight nuance in what some producers are seeing as a problematic approach to biosecurity *vis-a-vis* their responsibilities in the biosecurity system, their access to support needed to fulfill these responsibilities, and, consequently, their relationships to government agencies.

One small free-range producer encapsulated this nicely. Whilst not being aware of the term, s/he nevertheless summed up the concerns expressed by many producers:

No I haven't (heard of shared responsibility)...how I perceive it is basically a chain of responsibility. And I get that, I get that because... I think everyone's got to be accountable for their own action or in-action. It's just finding a happy medium as to how that chain of responsibility is managed from a government agency's perspective and the producer's perspective

These concerns were evenly shared across free-range, barn and cage producers.

Nevertheless, five respondents were comfortable with the shared responsibility approach, seeing it as just 'something we adapt to' (as one producer put it). These producers tended to be large cage egg producers (50,000-100,000 hens), have clear biosecurity strategies and practices and have been in the industry for a long period (from over 10 years to generations).

An additional significant and more generalised issue producers identified is the number of potential gaps in the system of biosecurity in the egg industry. As increasing degrees of producer responsibility are being imposed through regulations and withdrawal of government services and support (discussed above), producers need to trust other parts of the biosecurity system. Whilst producers are able to exert some control over some parts of the biosecurity system – for example, ensuring employees are trained in biosecurity practices – their control over other parts (for example, a lack of vets with specialist knowledge) is minimal. This has left many producers feeling exposed in terms of responsibility and what they can realistically control.

As one producer put it:

We do as much as we can – we make sure all our staff know about biosecurity practices, we have the signs and the baths. We even make sure that anything that leaves our farm is safe. But what can we say to visitors? We ask them to sign a declaration, but that's putting trust in them – we don't know where they've been. It feels like we end up taking the fall for someone else – at least potentially (Cage producer).

This is an important point. Interviews with biosecurity stakeholders during Phase 1 of the project highlighted some gaps, in particular a decline in relevant professional expertise with biosecurity knowledge applicable to the egg industry. Producers have no control over this (which, in any case, is driven by a variety of factors within agencies and within animal health professions), yet they are expected to inform their decisions and biosecurity practices using the latest technical knowledge, and find industry professionals who can support decision-making when needed. This occurs, as various producers have pointed out, within a compliance-based regulatory system.

Whilst the issues of knowledge access and producer networking is further discussed later in this report, the point about industry professionals is important. As mentioned previously, the withdrawal of relevant government services has meant lost expertise within government agencies.

Additionally, for many producers there are no local vets with relevant poultry expertise. Therefore, there are no readily accessible on-farm services available from either government agencies or the private sector. As one producer succinctly put it, '*We feel really isolated up here*'.

As a consequence, for more geographically isolated producers, farm visits by poultry health professionals are expensive, given travel and, often, accommodation costs which need to be paid for visiting private sector vets with specific expertise. All large cage and barn and a majority of larger free-range producers see this as just a cost of production which is absorbed into their business. However, for other, smaller producers across systems, the additional economic impost significantly affects profitability. Therefore, decision-making in relation to both flock health and biosecurity management

is influenced by commercial cost/benefit analysis undertaken by producers. This is particularly the case for producers who are relatively geographically isolated from major cities where the expertise can be found and, at least for one cage/barn producer, is tied into the withdrawal of government responsibilities and services in his region. One mixed producer, who has been in the industry a long time and is having to deal with increased costs and lower profits, expressed a concern that:

If I'm feeling this, how must the other guys be feeling? It worries me that it'll be only a matter of time before people have to start cutting corners.

For a minority of respondents across different systems, shared responsibility was seen as an opportunity for the industry to take more control of biosecurity (rather than leaving it to government agencies who had lost egg industry or flock health expertise). This concern about lost expertise in government agencies is also widespread.

For one producer in particular, leaving biosecurity to the industry and also letting industry respond to any EAD outbreaks was a *logical* (and positive) outcome of sharing responsibilities. This producer identified the logic as industry actors being more responsive, having the concerns of producers foremost, and having access to the latest technical information and strategies for biosecurity. This producer believed that agencies no longer had the type of expertise necessary to manage egg production/poultry industry EAD/public health outbreaks.

5.3.3 Information networks and acquiring biosecurity knowledge

Interview questions focused on how producers receive biosecurity and flock health knowledge.

Experienced producers

Producers with long experience (over 15 years) in the industry tend to use their established networks and very specific internet sites – they know what they need to know and what they do not know. Producers identified the Australian Eggs site, along with Animal Health Australia and relevant government agencies in particular. This generally held for cage, barn and free-range respondents.

During interviews, six longer-term free-range producers highlighted some of their own experiences when they first started out in free-range production. Whilst their stories and histories are different, there are some important commonalities. The first is the need to learn by mistakes due to a lack of relevant, available information. These producers thought information was now more readily available, but had concerns about how people new to the industry would know what is available and what information is needed. For example, and in the specific context of mentoring:

It was so hard when we were starting. Nobody knew much about free-range, information seemed to be geared towards cage systems and the local vet didn't really know much about poultry. We had to work really hard to get going. That's why I don't mind when someone rings me up to ask something. Or if someone wants to come out to visit our place. (free-range producer).

Others believed there is an important role for institutional actors in this regard. As one medium sized

cage/barn producer put it:

I guess, I was fortunate because when I first started back in the early 70's, we used to have a poultry extension officer here and he'd come out and we'd look at the birds and he showed me what to look for and it was a good grounding in – yeah – poultry husbandry. And people don't get that these days. It's just – it's one of those things. Because once you learn it, it's something you never forget.

The second commonality, which is related to the first, is the ways these producers have always been happy to assist new free-range producers who contact them. Assistance is in the form of information sharing, conversations and farm visits. This informal networking reflects both the difficulties these producers had in getting information (and therefore wanting to support other producers) as well as a desire to ensure the free-range sector remains economically strong.

It should be noted however that there will be producers who at some point balance their information and expertise sharing with their own commercial imperatives. Whilst no producers who have raised the importance of mentoring in interviews have specifically said they see people who contact them as industry competitors, and therefore are reticent to give too much information, producers are aware of the increased competitiveness of the industry.

Less-experienced producers

Those without long experience (that is, less than 5 years in the industry) tend to do general internet searches to collect information and seek advice from other producers they know. There is some filtering of information, though producers very new to the industry indicated the difficulties of knowing what is needed and knowing what is relevant. As one small free-range producer put it:

I can now tell you 100 things not to do. When I started, I couldn't tell you one thing to do.

These general internet searches can be problematic because the producers do not have enough information to discern the useful from the not so useful, the information that will work compared to information which, for example, fits the producers' values and producer identity (for example, producers who believe their production is 'clean and green' seeking out information on disease management practices reflecting their 'clean and green' value orientation).

One experienced free-range producer highlighted that producers new to the system have been known to join Facebook pages. This has the potential for information sharing and reinforcement of knowledge in a closed social media system – self-reinforcing ideas, ideologies and information. This can be both a useful mechanism for learning, or problematic, depending on the information being shared.

Biosecurity manuals and other technical information

The usefulness of the biosecurity manuals and available information can be problematic for some producers. Producers indicated the following:

- For producers new to the industry (less than five years) and who knew of the manual, the information was often too technical.

- Experienced producers use the manual on an ‘as needed’ basis because they have multiple sources of information.
- For many free range producers, the information was seen to be irrelevant.
- For those producers who focus on organic egg production (a total of 6 respondents), there is little information available.
- One producer highlighted how the biosecurity manual provided useful information but they found it difficult to operationalise the information in their own production.
- A small number of free-range producers (eight) had no idea a manual existed.

Localised food markets in the free-range system

Localised food production systems and the paddock-to-plate movement is important to a small number of experienced (over 15 years) small free-range respondents. Because their egg production and distribution systems are highly localised, producers have tended to couch biosecurity in local terms and do not necessarily identify with industry-wide strategies or responses. Because their concerns are highly localised, they seek information directly relevant to them, rather than wanting more general information.

5.3.4 The structure of the egg industry

Not surprisingly, while some emergent issues are shared across the industry, some are confined to components of it.

The family egg enterprise

With all producers, there was a strong sense of ‘family enterprise’, though this is hardly surprising given the research focused on producers with less than 100,000 birds. What is important to note is the ways the family enterprise identity underpins egg production.

For some, family enterprise meant the next generation on the farm. For two larger producers of cage eggs, biosecurity took on an additional component – it is crucial to protect the flock, profitability and the biosecurity of the industry so it is vibrant and their sons/daughters could have as fulfilling experience as they had. Additionally, one interviewee told how he was pleased his daughters had agreed to take over the family enterprise, and how they had good ideas to expand the enterprise beyond egg production and distribution into tourism and hospitality.

This medium size cage producer is typical:

We’ll keep it family. Yeah, and that’s why we’re not the size – because we had permits here to build another five sheds, and we could have grown up to that 200,000, 300,000 number, but when I sat down about ten years ago, I found that a very dangerous place to be when you’re at that size, so we decided to diversify our business instead....so we diversified it into the restaurant, into the retail outlet, and we run a packaging company, as well on the side.

Smaller free-range producers often see the family enterprise identity in terms of a rural ideal characterised by health and sustainability in one form or another. It is worthwhile noting that for many of these respondents, their Facebook page or website had images of their young children with eggs, or

on the farm. For example:

Yeah so the philosophy of (our enterprise) ... is the sustainability of the land we use, along with the ethical treatment of the animals, in relation to our production systems. So that's it in a nutshell.

It is important to note the role of the family enterprise, as it is a distinguishing feature of this project's flock-size cohort. Whilst the research was concerned with flock size from 1,000 to 100,000 birds across sectors and this has picked up a diverse set of motivations, issues and attitudes, the family enterprise separates these producers from the large commercial operators which are characterised by being employees and technical managers. The influence of the family enterprise beliefs amongst the cohort of producers who were interviewed highlight the extent to which their investment in their enterprise is a mixture of commercial, lifestyle and familial factors.

Hence, decisions are not only based on cost/benefit considerations. For example, one cage producer was discussing the rise of the free-range consumer market. For him, incorporating free-range production into his enterprise was:

Going backwards. My father started with free-range back in the 70s, but we've come a long way since then ... I'm comfortable that my customers will stay with me. If not, I'll look for some other way to stay here. (Cage egg producer).

For this small free range producer, the family identity was incorporated into protecting land:

The land is an old family farm, so I bought the land from my grandparents, and so, that's kind of been a step-wise transition. We wouldn't necessarily call our place a permaculture demonstration site, but we do use plenty of the principles there to guide our decision-making

Other small free range producers saw egg production as an opportunity to get back onto the land – rural life being part of their identities. For example:

So the farm, we've been on the farm for about 8 years, so yeah not a family farm, but I'm originally off the land and then I went and did my own thing for a few years. Stock and station agency, land holder liaison for mining companies, yeah, and then I just thought bugger it, I'd like to get home and spend a bit more time at home, and yeah the eggs gave us the opportunity to do that.

Cage and barn egg producers

Larger cage and barn producers identified the economic power of supermarkets as a significant component and challenge within their egg production system, though none identified this as a factor in implementing their biosecurity systems. This was tied into the supermarket move to free-range and withdrawing sales of cage and barn eggs.

These producers also highlighted free-range eggs in the supermarket-driven part of the sector as very problematic in terms of flock health, yet consumers have an image of 'clean and green' production. They believe that consumers would make different purchasing decisions if they knew more about the

health and welfare of caged birds.

As one cage producer put it:

I see the pressure we face being driven by consumers. They need more education about the cage system. Our system is better for the hens – healthier - and better for the consumers – cheaper eggs.

A minority of smaller cage egg producers highlighted how their declining market share, with its economic impacts, has meant they need to take shortcuts with vaccinations and biosecurity practices. 'Shortcuts' in this sense means producers having to make risk management decisions related to, for example, how much to vaccinate or how much capital to invest (for example, in closed water systems). For others, declining market share in the cage and barn systems has resulted in an economic driver to diversify into free-range systems. As one experienced cage egg producer explained it, the decision to diversify into free range was difficult. It meant purchasing more land (eventually purchased well away from the producers' cage system), getting new permits and investing in infrastructure designed to minimise biosecurity hazards. Yet, as the producer explained it:

There are still no guarantees there won't be an issue. (Medium-size cage egg producer)

For these and similar producers, diversifying into free range production was economically driven. 'Risk management' was a term used frequently in interviews in relation to this, especially given that risks in their cage systems had been minimised.

The free-range sector

Many respondents from both Phase 1 and Phase 2 interviews highlighted the free-range sector as potentially significant in terms of EAD and biosecurity. For many cage egg producers and some institutional actors, the free-range sector represents a weakness in the biosecurity system. The types of concerns expressed by cage egg producers tend to echo their views on scientific management of production (that is, cage egg production is a safe, closed system where potential biosecurity threats can be, and usually are, clearly managed).

The following has been typical of cage producer views on some (though not all) free-range production:

And I think too now with this free-range growing so much there's a lot of newcomers in that don't know anything about bio, nothing at all. And I think there's a, there's a lack of education and knowledge there that could impact the whole industry if they don't do the right thing... Backyard breeders, they change birds like there's no tomorrow, "Oh yeah I'll have your rooster here's a hen, so on". They don't, they don't even think about biosecurity...

It should also be noted that those free-range producers with a good knowledge of biosecurity and animal health practices, whilst acknowledging the challenges of the free-range system, believe they have systems in place to manage biosecurity threats.

For example, when asked where they get their biosecurity information, one experienced free-range

producer replied:

It's common sense isn't it? (laughs) No, I don't really need that much information now – I've got my biosecurity system sorted. In terms of management, the only thing I need to keep an eye on are water birds overflying, but I can't really do anything about that and I'm not on a major flight-path. And I'm away from the main road so we don't get people stopping wanting to buy eggs at the farm gate – we have no signs up or anything. (Free-range producer, Victoria)

Respondents nevertheless identified a number of challenges which tend to coalesce around two relatively distinct sets of concerns.

The first relates to knowledge about the sector. Many institutional respondents and some producer respondents highlighted a lack of knowledge about numbers and locations of smaller producers. This was usually couched in terms of smaller producers being able to enter and exit production and, because of their size, 'fly under the radar' in terms of any extension activities, food safety concerns and more generalised management, regulation and outreach to this group.

The second relates to the inherent difficulties in managing a production system with exposure to external threats. Whilst some of the identified concerns are linked to the first set of issues, some are very specific to free-range production systems.

The biosecurity challenges of free-range production systems have been highlighted across all respondent groups from both Phase 1 and Phase 2. It is important to note however that there tends to be a (sometimes significant) difference between respondents when looking at the *management* of risks within the production system. Generally, both cage/barn producers and institutional actors have tended to highlight weaknesses in management, whilst free-range producers have tended to highlight their proactive management of the risks. This may well be an indication of some form of stereo-typing by those outside the free-range system.

For the majority of free-range producer respondents, the management of risks was discussed in two ways. The first was specific management responses – for example, ensuring the flock is not close to water where water birds frequent, moving the flock regularly. The second was a more generalised set of factors such as the free-range system being inherently healthier for hens, therefore if the main biosecurity threats are managed, the free-range system will in a sense self-regulate. A minority of free-range producers emphasised this by identifying how infrequently they have required support from flock health professionals, in particular vets, because of their management of their free-range systems.

The low investment threshold for entry results in people coming into the sector with little or no knowledge of biosecurity or animal health. All respondents who raised this highlighted a lack of knowledge of small producers as both a potential and real weakness in the biosecurity system.

Importantly, some producers were able to reflect on their own entry. One free-range producer's story was common:

We started with just a few hens just for ourselves and our friends. Then we gradually grew it-

we found we really enjoyed the work and what we were wanting to do. But as we increased in size, we found it very hard to get useful information. I guess that's because free-range wasn't that popular at the time, and we had no local vet who could help us - we trained the local vet ourselves (laughs). ... we learnt from our mistakes and luckily they weren't huge ones ... this is why I'm always happy to help out anyone by having people come to our farm or if people contact us (mid-size free-range producer).

Some producers are not economically dependent on egg production (for example, hobby producers) and this can impact on their decision-making in terms of long-term profitability (and investing in biosecurity and animal health management practices). Respondents who mentioned this specifically tended to highlight the 'hobby farmer' as a concern. However, smaller free-range producers highlighted the importance of a diversification of income streams in terms of being able to ensure they can afford to implement biosecurity/animal health measures.

It should also be noted that our research focus of greater than 1000 birds has meant we have not specifically been able to assess the small 'hobby farmer'. However, we have been able to highlight important dimensions to producer identity (see above) which can give some insights into the small hobby farmer end of free-range production.

5.3.5 Complex regulations

Many producers identified the complexities of regulatory, approval and permit systems they have to deal with. For larger commercial producers, this was seen as a cost of being in the industry and, whilst complex and painful to deal with, it gets done in some way.

However, many of the regulations producers have had to deal with are contradictory, adding to the complexity of managing biosecurity. For example:

We had to have wheelchair access into our shed. There's a whole new biosecurity risk. We can't wash, because it's a vehicle or whatever. We can't wash that with the chemicals while the person is sitting in it, those sorts of things. The fire department, we had to have all this fire stuff so we had to have fire access and all that sort of thing. Fair enough, that's alright. We had to have fire extinguishers in the shed. You can't, you go to the animal welfare group and animals aren't allowed to have access to a fire extinguisher but we weren't allowed to put the fire extinguisher in a cupboard because you had to have direct access to it. You weren't allowed to put it on the outside of the building so it had to be in the room. We'd go back with our report from the fire thing to the council and they go no, this is how it's got to be. We go back to our animal welfare report, no, this is how it's got to be. That's my problem, lack of communication through that.

And another:

We walked around the sheds and said this is what you've asked us to do. These trees that you've asked us to plant here to protect the aesthetics of the people down the road actually create a biosecurity risk because they attract the birds in. You want us to have native flowering trees

that look pretty but they attract birds and a biosecurity risk. There's potential disease contamination. They're sitting there going 'oh'. It's just the lack of communication and understanding.

Some smaller producers highlighted that they try and 'fly under the radar' in terms of some regulations. When asked to identify which ones, all small producers highlighted the importance of those related to food safety, and tended to identify local government regulations as being the most difficult to deal with. The above quotes are examples of this.

5.4 Phase 3 Implication of findings

In summary, and drawing from the above analyses contained in the project's phases, the following implications have emerged. These implications have been identified by the respondents, with analysis and interpretation undertaken by the research team.

5.4.1 Shared responsibility

Shared responsibility is a collaborative national approach to biosecurity management that recognises the importance of multiple stakeholders coming together to jointly manage biosecurity and, through that, recognising complementary and different stakeholder realities in this management. It is embedded in all biosecurity strategies and therefore is a key institutional component of biosecurity management.

This research has found that shared responsibility is not always seen as a collaborative enterprise. From an institutional perspective, there can be an emphasis on compliance or what could be called 'passive cooperation' where institutional stakeholders provide technical information which may or may not reflect the needs of the diversity of egg producers – particularly those smaller producers who are new to the industry. For egg producers, the shared responsibility concept is interpreted in diverse ways – from something that is an industry reality to something that is unclear and perceived to be a shifting of responsibility rather than a sharing of responsibility.

Rather than being a driver for collaborative biosecurity management, therefore, shared responsibility is open to multiple interpretations across stakeholder groups, with resultant implications for system-wide integrated biosecurity management. It is therefore important that mechanisms be put into place which facilitate common understandings of shared responsibility and support it as a cooperative endeavour. Developing processes of co-creation will be crucial to this so as to ensure ownership of ideas and practices as well as maintaining an engaged community of producers and institutional actors.

5.4.2 Information networks

Whilst there is a tendency for institutional actors to understand biosecurity as a technical process, this research highlights the multiple ways egg producers manage their biosecurity and the barriers/challenges they face.

Interviews with egg producers have highlighted their reliance on both technical information and their own, informal networks. Experienced producers report being informal 'mentors' for other producers, while less experienced producers have provided insights into their own difficulties in both understanding technical information and establishing networks which provide support or other producers to talk to.

These challenges in accessing relevant information and networks have implications in terms of how producers understand biosecurity, how biosecurity is prioritised in production and the types of information producers need so as to make informed decisions at farm-level.

5.4.3 The structure of the egg industry

The research has been able to identify implications for biosecurity management stemming from the structure of the Australian egg industry. This is in part because of the focus on producers with 1,000 – 100,000 hens and partly because the sample of producers interviewed was able to include smaller free-range producers with varying time in the industry.

While in general the research identified larger producers with well-developed biosecurity management systems in place, it also identified the kinds of decisions and degrees of awareness at farm-level for smaller producers, particularly in the free-range sector. Given the changes to the industry – in particular the rise of smaller-scale free-range producers – the research highlighted the importance of biosecurity information that is specifically targeted to these producers. As discussed in the following sub-section, tensions within and between compliance and shared responsibility policy and institutional approaches to biosecurity management impact parts of the egg production system differently.

5.4.4 Complex regulations

As previously mentioned, producers across flock size and production type have identified complexities in the regulatory environment. Whilst for many producers, the regulatory environment is one which is a reality of production, others – particularly smaller producers who are new to the industry – report needing to manage the benefit/cost components of what is sometimes seen as ‘over-regulation’.

There can be tensions within the production system here. The regulatory environment has significant compliance components. Yet there is also the shared responsibility context within which this occurs – which is based more on cooperation – and the difficulties some producers have in accessing relevant information so they can make informed biosecurity decisions. What this means is the compliance frameworks may well be a push factor to ‘fly under the radar’ for smaller producers in particular, and for larger producers, it is a push factor for compliant biosecurity and animal health management. This in turn means that the regulatory environment may work for some producers, but co-created, well-functioning, collaborative approaches to shared responsibility will work better for others – particularly smaller-scale producers. This flexibility, embedded as it is in local producer practices as well as with Government agencies, will ultimately act to enhance biosecurity frameworks, irrespective of State regulations and frameworks.

However, having said this, the regulatory environment does provide core requirements for producers in, for example, food safety. Therefore, the possibility exists for having biosecurity management incorporated into food safety or other identified core regulations.

6 Recommendations

This report has identified the need to improve engagement among all stakeholders to strengthen the policy and practice of biosecurity in the egg industry. This will have the specific outcome of improved biosecurity within the industry.

The following actions are recommended.

Strategic / Tactical

1. Review the content relevance and applicability of biosecurity manuals and codes of practice for different production types and farm size of egg producers. This should specifically address the different information needs identified in this report.
2. Using findings from the review (Recommendation 2 above), and through a process of consultation with all relevant stakeholders, including representative producers, co-create 'plain language' biosecurity information (for example, 'one-pager' format) targeted and tailored to diverse production types and the different producer motivations/identities highlighted in this report. This process of co-creation should include mechanisms to recognise multiple understandings of biosecurity and biosecurity management practices.
3. Investigate the possibility of incorporating biosecurity practices into relevant State regulations which reflect the co-created biosecurity information needs and practices. This should ensure relevant biosecurity practices and regulations are embedded into State-appropriate frameworks.

Tactical / Operational

4. Resources should be allocated for engaging those producer groups identified in the research who consider biosecurity to be irrelevant or of limited relevance for their operation. This should include micro-producers of less than 1,000 birds, given their identification as a specific segment of the industry requiring support:
 - a. Identify key stakeholders who influence those producer groups
 - b. Industry/government extension services work with these identified influencers to increase the awareness of biosecurity and to prioritise biosecurity management among these producer groups.
5. Industry/government extension services, together with producers, identify how to make better use of existing producer networks and highlighted identities/motivations to further engage producers in best-practice biosecurity management.
6. In relation to Recommendation 2 above, industry/government extension services and producers identify ways to promote co-created biosecurity information to ensure its relevance

and accessibility for all producers. This should include making more use of identified key influencers, social media and on-going media campaigns.

7. Consideration be given to develop video case studies of biosecurity implementation. Case studies should be representative of producer diversity in farm size and production type.

References

- AZBEL-JACKSON, L., HEFFERNAN, C., GUNN, G. & BROWNLIE, J. 2018. Exploring the role of voluntary disease schemes on UK farmer bio-security behaviours: Findings from the Norfolk-Suffolk Bovine Viral Diarrhoea control scheme. *PLoS One*, 13, e0179877.
- BARCLAY, E. 2005. Local Community Preparedness for an Emergency Animal Disease Outbreak. *In: RURAL INDUSTRIES RESEARCH AND DEVELOPMENT CORPORATION & AUSTRALIAN GOVERNMENT* (eds.). Canberra.
- BEALE, R., FAIRBROTHER, J., INGLIS, A. & TREBECK, D. 2008. One Biosecurity: A working partnership. The Independent Review of Australia's Quarantine and Biosecurity Arrangements, Report to the Australian Government. Canberra: Australian Government Department of Agriculture Fisheries and Forestry.
- BRENNAN, M. L. & CHRISTLEY, R. M. 2013. Cattle producers' perceptions of biosecurity. *BMC Veterinary Research*, 9.
- BRENNAN, M. L., WRIGHT, N., WAPENAAR, W., JARRATT, S., HOBSON-WEST, P., RICHENS, I. F., KALER, J., BUCHANAN, H., HUXLEY, J. N., O'CONNOR, H. M. & PHILLIPS, C. J. C. 2016. Exploring Attitudes and Beliefs towards Implementing Cattle Disease Prevention and Control Measures: A Qualitative Study with Dairy Farmers in Great Britain. *Animals : an Open Access Journal from MDPI*, 6.
- COUNCIL OF AUSTRALIAN GOVERNMENTS 2012. Intergovernmental Agreement on Biosecurity.
- CRAIK, W., PALMER, D. & SHELDRAKE, R. 2017. Priorities for Australia's biosecurity system: An independent review of the capacity of the national biosecurity system and its underpinning Intergovernmental Agreement. *In: AUSTRALIA, C. O.* (ed.). Canberra.
- ENTICOTT, G. 2008. The Spaces of Biosecurity: Prescribing and Negotiating Solutions to Bovine Tuberculosis. *Environment and Planning A*, 40, 1568-1582.
- ENTICOTT, G. & WILKINSON, K. 2013. Biosecurity: Whose knowledge counts? . *In: A. DOBSON, K. B., S.L. TAYLOR* (ed.) *Biosecurity: the socio-politics of invasive species and infectious diseases*. Abingdon: Routledge.
- GARFORTH, C. J., BAILEY, A. P. & TRANTER, R. B. 2013. Farmers' attitudes to disease risk management in England: A comparative analysis of sheep and pig farmers. *Preventive Veterinary Medicine*, 110, 456-466.
- GLASS, K., BARNES, B., SCOTT, A., TORIBIO, J. A., MOLONEY, B., SINGH, M. & HERNANDEZ-JOVER, M. 2019. Modelling the impact of biosecurity practices on the risk of high pathogenic avian influenza outbreaks in Australian commercial chicken farms.(Report). *Preventive Veterinary Medicine*, 165, 8.
- GUEST, G., MACQUEEN, K. M. & NAMEY, E. E. 2012. *Applied thematic analysis*, Thousand Oaks, CA, SAGE.
- GUNN, G. J., HEFFERNAN, C., HALL, M., MCLEOD, A. & HOVI, M. 2008. Measuring and comparing constraints to improved biosecurity amongst GB farmers, veterinarians and the auxiliary industries. *Preventive Veterinary Medicine*, 84, 310-323.
- HEFFERNAN, C., NIELSEN, L., THOMSON, K. & GUNN, G. 2008. An exploration of the drivers to bio-security collective action among a sample of UK cattle and sheep farmers. *Preventive Veterinary Medicine*, 87, 358-372.
- HIGGINS, V., BRYANT, M., HERNÁNDEZ-JOVER, M., MCSHANE, C. & RAST, L. 2016. Harmonising devolved responsibility for biosecurity governance: The challenge of competing institutional logics. *Environment and Planning A*, 48, 1133-1151.
- HIGGINS, V., BRYANT, M., HERNÁNDEZ-JOVER, M., RAST, L. & MCSHANE, C. 2018. Devolved Responsibility and On-Farm Biosecurity: Practices of Biosecure Farming Care in Livestock Production. *Sociologia Ruralis*, 58, 20-39.
- MILES, M. & HUBERMAN, A. 1994. *Qualitative data analysis: An expended sourcebook*, Sage Thousand Oaks.

- NÖREMARK, M., FRÖSSLING, J. & LEWERIN, S. S. 2010. Application of Routines that Contribute to On-farm Biosecurity as Reported by Swedish Livestock Farmers. *Transboundary and Emerging Diseases*, 57, 225-236.
- PALMER, S., FOZDAR, F. & SULLY, M. 2009. The Effect of Trust on West Australian Farmers' Responses to Infectious Livestock Diseases. *Sociologia Ruralis*, 49, 360-374.
- PATTON, M. 2002. *Qualitative research and evaluation methods 3rd Ed.*, Thousand Oaks: Sage.
- RACICOT, M., VENNE, D., DURIVAGE, A. & VAILLANCOURT, J. P. 2011. Description of 44 biosecurity errors while entering and exiting poultry barns based on video surveillance in Quebec, Canada. *Preventive Veterinary Medicine*, 100, 193-9.
- RACICOT, M., VENNE, D., DURIVAGE, A. & VAILLANCOURT, J. P. 2012a. Evaluation of strategies to enhance biosecurity compliance on poultry farms in Quebec: effect of audits and cameras. *Preventive Veterinary Medicine*, 103, 208-18.
- RACICOT, M., VENNE, D., DURIVAGE, A. & VAILLANCOURT, J. P. 2012b. Evaluation of the relationship between personality traits, experience, education and biosecurity compliance on poultry farms in Quebec, Canada. *Preventive Veterinary Medicine*, 103, 201-7.
- SAHLSTRÖM, L., VIRTANEN, T., KYIRO, J. & LYYTIKAINEN, T. 2014. Biosecurity on Finnish cattle, pig and sheep farms - results from a questionnaire. *Prev. Vet. Med.*, 117, 59-67.
- SCOTT, A., PHALEN, D., HERNANDEZ-JOVER, M., SINGH, M., GROVES, P. J. & TORIBIO, J.-A. L. M. L. 2018a. Wildlife presence and interactions with chickens on Australian commercial chicken farms assessed by camera traps. *Avian Diseases*, 0, null.
- SCOTT, A. B., SINGH, M., GROVES, P., HERNANDEZ-JOVER, M., BARNES, B., GLASS, K., MOLONEY, B., BLACK, A. & TORIBIO, J.-A. 2018b. Biosecurity practices on Australian commercial layer and meat chicken farms: Performance and perceptions of farmers.(Research Article). *PLoS ONE*, 13, e0195582.
- SCOTT, A. B., TORIBIO, J.-A., SINGH, M., GROVES, P., BARNES, B., GLASS, K., MOLONEY, B., BLACK, A. & HERNANDEZ-JOVER, M. 2018c. Low Pathogenic Avian Influenza Exposure Risk Assessment in Australian Commercial Chicken Farms. *Frontiers in Veterinary Science*, 5.
- SCOTT, A. B., TORIBIO, J.-A. L. M. L., SINGH, M., GROVES, P., BARNES, B., GLASS, K., MOLONEY, B., BLACK, A. & HERNANDEZ-JOVER, M. 2018d. Low- and High-Pathogenic Avian Influenza H5 and H7 Spread Risk Assessment Within and Between Australian Commercial Chicken Farms. *Frontiers in Veterinary Science*, 5.
- SIMPSON, M. & SRINIVASAN, V. 2014. Australia's biosecurity future: preparing for future biological challenges. Canberra.
- SINGH, M. & COWIESON, A. J. 2013. Range use and pasture consumption in free-range poultry production. *Animal Production Science*, 53, 1202-1208.
- SSEMATIMBA, A., HAGENAARS, T. J., DE WIT, J. J., RUITERKAMP, F., FABRI, T. H., STEGEMAN, J. A. & DE JONG, M. C. M. 2012. Avian influenza transmission risks: Analysis of biosecurity measures and contact structure in Dutch poultry farming. *Preventive Veterinary Medicine*.
- TOMA, L., STOTT, A. W., HEFFERNAN, C., RINGROSE, S. & GUNN, G. J. 2013. Determinants of biosecurity behaviour of British cattle and sheep farmers—A behavioural economics analysis. *Preventive Veterinary Medicine*, 108, 321-333.

Plain English Summary

Project Title:	Investigating drivers of biosecurity engagement and approaches for improving this engagement among egg producers in Australia
Australian Eggs Limited Project No	1BC801CS
Researchers Involved	M Hernandez-Jover, B. Furze, V. Higgins, J-A. Toribio, M. Singh, L. Hayes
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Objectives	Investigate biosecurity awareness, understanding and implementation among Australian egg producers, and provide recommendations for supporting the industry to improve producers' biosecurity engagement.
Background	Previous research in the Australian poultry industry has identified the need for improving biosecurity implementation among layer enterprises, across all production types, including cage, barn and free-range. The increase of free-range production in the last decade, has raised concerns of the potential increase on the risk of disease introduction and spread among these enterprises. In light of this previous research, having a better understanding of biosecurity engagement in the egg industry, including those factors motivating and hindering biosecurity adoption, would contribute to reduce the disease introduction and spread risk.
Research	A social science project has been conducted to investigate why producers interpret biosecurity in the way they do, and how their interpretations and practices are influenced by social, cultural and organisational factors. The project has used a document review, interviews with 17 key representatives from government, industry and the animal health profession, and interviews with a cohort of 50 egg producers across all production types (cage, barn and free-range) and farm size (1,000 to 100,000 hens). Project findings were presented a national workshop with government, industry and animal health representatives and five regional workshops with egg producers and key regional stakeholders.
Outcomes	The main outcomes of this project are a better understanding of the factors that influence egg producers' engagement with biosecurity and a set of recommendations for improving this engagement. This project highlights the importance of community engagement and sharing responsibilities in relation to biosecurity, and the need for targeted extension strategies to be able to reach the diversity of producers within the egg industry.
Implications	This project identifies the need of having mechanisms to facilitate common understandings of shared responsibility in biosecurity and support it as a cooperative endeavor. It also highlights the multiple ways egg producers manage their biosecurity and the challenges they face,

with access to relevant information for their enterprises being a significant challenge that influence decision-making at farm level.

Key Words

Egg producers, Biosecurity, Shared responsibility

Publications

B Furze, M Hernandez-Jover, V Higgins, J-Ann Toribio, M Singh. 2018. Making shared responsibilities work? Contested biosecurity spaces in the Australian egg industry. 2nd International Society for Economics and Social Sciences of Animal Health Conference, May 2018, Montpellier, France (oral presentation).

M Hernandez-Jover, B Furze, V Higgins, J-Ann Toribio, M Singh. 2019. Using social sciences to better understand biosecurity challenges in the egg industry. Inaugural Australian Biosecurity Symposium, June 2019, Gold Coast, Australia (oral presentation).

Appendixes

Appendix 1: Phase 1 semi-structured interview framework and questions

The questions provide a framework for and guide to the interviews. All interviews don't follow the same structure or cover the same content as interviews are dependent on respondents, organisations and information collected.

1. (IF NEEDED) Can you tell me about how/where your organisation fits within the egg industry?
2. Can you tell me about how/where your organisation fits within the system of biosecurity in the egg industry?
3. The project's interested in understanding more about (your organisation's) approaches to biosecurity. Can you tell me some more about this?

PROBES

- a. What are the key aspects to biosecurity which the organisation engages with?
 - b. Why this approach?
 - c. What are its strengths?
 - d. What challenges?
 - e. Clarify if needed how the organisation/agency works with egg producers (both in general terms and specifically biosecurity).
 - f. NOTE: follow up if necessary in terms of approaches – eg extension, policy/guidelines, adoption
4. In terms of your organisation's work in biosecurity within the industry, what's working well and why?
 5. Are there some challenges with this?

PROBES

- a. If so, why are they challenges?
 - b. How have you dealt with them?
6. What about across the industry's systems of biosecurity?

PROBES

- a. In your experience, do you see changes to the ways biosecurity is enacted?
 - b. Are there challenges?
 - c. How integrated do you think things are?
 - d. Are there pieces within the system which need to be more fully integrated?
 - e. If so, do you have thoughts on how this could occur?
 - f. Do you collaborate with other organisations/agencies across the industry? If so, how?
7. Can you tell me about your involvements (in terms of biosecurity) with egg producers?

PROBES

- a. What do you see as best practice for egg producers?
- b. Do you think, in general, egg producers are adopting this? Why/why not?
- c. Do you work with producers to improve their biosecurity?
- d. Have egg producers had any inputs into your approaches to biosecurity?

Appendix 2: Phase 2 semi-structured interview topics and questions

1) Production details

Could you tell me about your production in relation to:

- How many layers on the farm/per shed/? How many farms do you have?
- How long have you been in the industry?
- Do you have other chicken/poultry/other livestock production apart from eggs?

2) Flock health practices

Can you describe how you manage and care for the health of your flock. In what ways, and why, is flock health a priority for your enterprise? [*Probe on specific diseases that producers are seeking to prevent*]

What specific practices do you use, and why?

What are the main influences on your flock health practices (e.g., industry best practices, veterinary advice, other producers, etc)?

What do you consider best practice for flock health management? Which if any of these practices are implemented on your enterprise?

What are the main challenges you face in flock health management?

Are there areas of flock health management that you prioritise more than others? If so, why?

3) Biosecurity practices

What does the term biosecurity mean to you?

In what ways is biosecurity relevant to your enterprise? For the Australian layer and poultry industry?

Do you use a biosecurity plan?

If so,

- Please describe it, including how it is implemented in practice (*need to prompt, making sure all recommended biosecurity practices in the Code of Practice are discussed – mainly the critical monitoring points identified in the Code*)
- Are there specific diseases that are a particular focus in your biosecurity planning? Which ones and why?
- Do you have a copy of the Biosecurity Technical Manual for Egg production and the Code of practice? Do you ever refer to these documents when implementing practices on-farm?
- Do you use any of the checklists or recording templates provided in the manuals to help with implementation of the recommended practices?
- What is your opinion in relation to the feasibility of implementation of the manual and code recommended biosecurity practices?
- Which aspects of biosecurity planning and management are most important to you, and why? Which are less important, and why?
- Do you have any challenges with implementation of these biosecurity recommendations? And what about biosecurity in general?

If not,

- What are the main reasons why you do not use a biosecurity plan? (*might need to prompt with follow-up question: economic, time, not needed... etc*)
- Which recommended biosecurity practices do you currently follow (if any)? Why?
- When, and under what circumstances, do you think biosecurity might be necessary for your farm?
- What would motivate you to implement specific biosecurity practices?

4) Shared responsibility

In relation to biosecurity, have you come across the 'shared responsibility' concept anywhere? (*Explain where necessary*)

If so,

- What do you understand it to be?
- What do you think of it as an idea?
- How do you think you currently contribute (or can contribute) to shared responsibility for biosecurity in the poultry industry?

If not,

- Do you see it as important for your production/priorities? Why or why not?
- What are the potential and actual challenges you face in sharing responsibility for biosecurity?

5) Systems of biosecurity

In your experience, how is the system of biosecurity working (a) in the egg industry, and (b) in Australian agriculture more broadly?

What do you see as its strengths?

Are there any weak spots or pieces missing?

- If so, what can be done about that?
- Whose responsibility is it?

6) Knowledge and understanding

- Can you tell me where you get your information in relation to egg production/husbandry practices?
- What about in terms of biosecurity and animal health information specifically?
 - What sources do you use?
 - Is there useful information out there?
 - Is there any information that's missing?
 - Do you have any suggestions about how this information can be improved in terms of both content and accessibility?

(If these stakeholders / sources are not mentioned, ask the following)

- Do you have much to do with government agencies?
- What about private veterinarians?
- Other producers?
- Producer groups?
- Industry organisations?

7) In conclusion

Have we missed anything important in terms of biosecurity in the industry that you would like to tell us?

Appendix 3. Report of the National workshop ‘Egg producer biosecurity engagement project’

30 April, 2019, Sydney

INTRODUCTION

During 2017 and 2018, the Graham Centre for Agricultural Innovation at Charles Sturt University along with researchers from the University of Tasmania and Sydney University has been conducting research on the ways egg producers engage with biosecurity. This research was funded by Australian Eggs.

As an extension component of the project, a national workshop was held to consult with key government and industry stakeholders about findings and recommendations, before their finalisation.

AGENDA

- 9.30-10.00 Tea/coffee
- 10.00-10.15 Welcome and introductions
- 10.15-10.45 Overview of the day; Overview of the project
- 10.45-11.15 Morning tea break
- 11.15-12.00 Presentation of key findings
- 12.00-12.30 Presentation of key recommendations
- 12.30-1.15 LUNCH
- 1.15-2.30 Workshop and group discussion on recommendations
- 2.30-3.00 Overview of regional workshops and next steps ?

PROJECT OVERVIEW

Assoc Prof Marta Hernandez-Jover provided the workshop an overview of the project, its aims/objectives and methodologies.

Discussions of the project highlighted both the importance of understanding more about smaller producers and also the complexities of balancing what is generalizable with what requires highly targeted, specific interventions and analysis. Smaller producers were identified as being especially important to understand more about. An important set of points related to trying to balance a compliance approach with approaches based on incentives to ensure producers in general, and small producers in particular, implement biosecurity measures.

The project overview highlighted the importance of the social sciences in understanding biosecurity as more than a technical management issue. These carried forward into the reporting of the key findings below.

KEY FINDINGS

Dr Brian Furze presented to the workshop an overview of the social science approach and methodologies used as well as the key findings of the research. The following discussions focused on specific findings. Whilst findings were presented, Q&A was encouraged and focused on case studies, examples, questions from workshop participants on methodologies and the specific findings presented.

Flock health & biosecurity

This finding focused on the ways different stakeholders in the biosecurity system (agencies, associations, animal health professionals, egg producers) saw flock health and biosecurity in a general sense. The finding highlighted some of the key ways different stakeholders have prioritised flock health and biosecurity, and the implications of this.

Discussions tended to focus on:

- Relationships between producers and other stakeholders
- The egg industry not being homogenous because of size, production system and roles within enterprises (owners, managers and worker being different stakeholders).
- How producers respond to auditing
- Producer networking
- Forms of benefit/cost producers undertook.

Shared responsibility

A key finding has highlighted the problematic components of 'shared responsibility'.

Discussions focused on:

- Costs of biosecurity
- The role of compliance
- The structure of the free-range sector in terms of producers coming into and moving out of the industry
- The core of decision-making coming down to individuals, but within their own context which influences their priorities

Information networks

The importance of information networks has been clear during producer interviews. Whilst report recommendations presented below specifically focus on information and its dissemination, discussion here focused mainly on examples of the ways information networks have been used by producers.

Biosecurity manuals

Whilst some producers reported using the biosecurity manuals as an important resource, others reported they were too technical, while still others thought them irrelevant for their enterprises.

Discussions amongst workshop participants focused on the difficulties of needing technical information to manage biosecurity, but at the same time needing it to be easily accessible. Much discussion focused on ways this could be achieved – which are reflected in Recommendation 3 below. The central question to be answered here is: What will make it useful for the farmer?

Complex regulations

The discussions of the complex regulatory environment occurred as part of Recommendation 1 below.

RECOMMENDATIONS

The workshop provided significant discussion on the recommendations of the research. There was agreement that the recommendations provided important ways forward in terms of the key findings of the research, especially those related to information dissemination and networking amongst producers.

Strategic / Tactical

- 1. Investigate the possibility of incorporating biosecurity practices into food safety regulation (e.g. Food Safety Code and relevant state regulations)**

Participants discussed this recommendation at length. It was agreed that the idea of incorporating biosecurity practices into existing regulatory arrangements was an important way forward, though food safety codes may not necessarily be the most appropriate. Discussion centred on multiple alternatives for the appropriate regulatory framework within which to embed biosecurity practices.

It was recognised that:

- Structures already exist
- There are benefits in embedding biosecurity practices into regulatory frameworks
- The states would be well-placed to identify how to embed biosecurity practices into which frameworks.
- STANDARD 4.2.2 was provided as an example <https://www.legislation.gov.au/Details/F2012L00292>

2. Review the content relevance and applicability of biosecurity manuals and codes of practice for different production types and farm size of egg producers

It was recognised that the biosecurity manual is a legislated document that AHA must have in order to ensure members are liable under EADRA. Therefore, there needed to be a balance struck between the formal, technical documentation required and its accessibility. Therefore any review under this recommendation would need to be cognisant of the formal legislated requirements.

Discussion therefore focused on Recommendation 3 below.

3. Using findings from the review (Recommendation 2 above), and through a process of consultation with all relevant stakeholders, including representative producers, develop 'plain language' biosecurity information targeted and tailored to diverse production types and the different producer motivations/identities highlighted in this report. This could include:

- a. 'one-pager' biosecurity information
- b. video case studies of biosecurity implementation. Case studies should be representative of producer diversity in farm size and production type.
- c. making more use of identified key influencers, social media and on-going media campaigns.

There was significant discussion of forms of information and dissemination mechanisms. The following key points were made:

- there is a need to check what States have on their checklists to ensure that alternative communication forms such as one-pagers reflect them.
- there are various apps available which could be adapted (for example, <http://www.farmbiosecurity.com.au/farmbiosecurity-app/>)
- small glove-box type booklets would provide more information than just one-pager information.

Tactical / Operational

- 4. Resources should be allocated for engaging those producer groups identified in the research who consider biosecurity to be irrelevant or of limited relevance for their operation:**
- d. Identify key stakeholders who influence those producer groups

- e. **Industry/government extension services work with these identified influencers to increase the awareness of biosecurity and to prioritise biosecurity management among these producer groups.**

During discussions, a role for Australian Eggs was identified to develop the resources and then delegate their roll out to a marketing company or something similar.

Stakeholder networks should include Landcare groups (a broad community network), feed stores and stock supply companies.

During discussions, it was also highlighted that there should be an emphasis on the benefits of positive action every day, couched as an incentive for biosecurity management.

- 5. Industry/government extension services, together with producers, identify how to make better use of existing producer networks and highlighted identities/motivations to further engage producers in best-practice biosecurity management**

The discussions of this recommendation focused on balancing compliance with incentives as well as the feasibility to use existing systems/relationships in agencies and between agencies and producers. It was felt that, given the current funding environment, this will need to be very strategic.

REGIONAL WORKSHOPS

The locations and dates of the regional workshops were presented.

National workshop participants emphasised the following:

- The need to ensure that participants do not get the impression that the workshop is driven by the supermarkets or the large companies, as this may be seen to be aiming to get rid of the smaller producers.
- Keep content simple with Disease Focus concentrated on real actions.
- The importance of ensuring participants feel they are part of consultations stemming from producer-focused research.

Appendix 4. Report of regional workshops ‘Egg producer biosecurity engagement project’

A series of five workshops were held to disseminate the findings of the project and to complete Phase 3 of the project:

Adelaide (South Australia)
21st of May 2019
Attendance: 17

Toowoomba (Queensland)
23rd of May 2019
Attendance: 12

Yass (New South Wales)
28th of May 2019
Attendance: 7

Warragul (Victoria)
30th of May 2019
Attendance: 21

Perth (WA)
12th June 2019
Attendance: 19

Each workshop consisted of a presentation titled ‘Keeping Salmonella off your farm’ delivered by Dr Clive Jackson, followed by a presentation on the research project and recommendations by Dr Brian Furze. In Adelaide and Toowoomba Australian Eggs delivered an update on its activities, especially in relation to Salmonella, and in Victoria there were presentations from the Department of Agriculture and the Department of Health providing updates on salmonella.

In terms of the dissemination of findings of the research project, the Q&A/discussions highlighted the following:

1. Participants generally agreed with the research findings, though these were presented very quickly before getting onto the thinking behind the recommendations.
2. Participants generally agreed with the importance of the research. Comments across workshops highlighted the importance of having smaller egg producer voices heard in decision-making.
3. There was strong agreement by those new to the industry or those relatively new on the need for information to be more readily available in formats that are relevant to the needs of producers. One producer specifically suggested a platform of some kind that could direct producers to key documents and information.

4. The format of Australian Eggs' new salmonella platform was thought to be a useful template for directing producers to relevant information in specific areas such as biosecurity.
5. The need for information in different formats was identified as crucial.

Appendix 5: Summary of Findings

Research finding	Summary	Implications for recommendations
Flock health and biosecurity		
<i>Institutional actors</i>	Tendency to see biosecurity as a technical and compliance-focused practice. From this perspective, there is plenty of biosecurity information available; if producers are not accessing this information they have only themselves to blame.	Greater emphasis needs to be placed on why some producers may not be accessing and using biosecurity information. For example, the information might be excessively technical and not be easily translatable on-farm; or, it may not be tailored to different farm types or farming priorities.
<i>Cage and barn producers</i>	Larger-scale producers in our sample use well-developed biosecurity and flock health strategies. For example, they use poultry vets, and they would use the biosecurity manual if they needed it. Vets are considered a standard cost of production.	The different sources cage and barn producers use could become a resource for other producers Given the benefit/cost drivers in some producer decision-making, does engagement need to include costs of inaction?
	Tendency for small and mid-scale producers to make decisions based on risk management using benefit/cost. There is an economic driver in terms of being able to afford the costs of management.	[If this is the case, could biosecurity be promoted as part of ordinary flock health practices as this presumably is considered as part of normal production costs and crucial to productivity]
<i>Free-range producers</i>	There is a diversity of understanding across the production system:	Given the diversity of the free-range sector, engagement needs to be highly targeted.
	<ul style="list-style-type: none"> Large and mid-scale producers tend to use well-developed biosecurity and flock health management practices – proactive management. 	It would appear to be important to develop engagement strategies rather than just providing information on websites.
	<ul style="list-style-type: none"> Some smaller producers believe ‘clean and green’ production means there needs to be little flock health and biosecurity management and so management tends to be reactive A minority of smaller producers don’t know that biosecurity is important in their production system 	Would some form of producer network targeting the diversity of free-range produces focused on relevant biosecurity knowledge and appropriate strategies be feasible? The minority of smaller producers with little or no knowledge of the importance of biosecurity needs to be specifically targeted for engagement.

NOTE: for some mixed producers (cage and FR), going into FR production, with its biosecurity management issues, has been a difficult decision – yes, the consumer market is heading that way, but there are flock management concerns in terms of health and biosecurity. This is a concern in terms of both the potential for impacting on caged birds, and in reputational damage if there is an issue in the FR production.

Identity issue – FR clean and green... Holistic farming. Connexion with the land.

Shared responsibility

There appears to be a gap within the biosecurity system in terms of operationalising shared responsibility.

Developing shared meanings of shared responsibility would appear to be a priority across the system, not just for egg producers.

Interviews with government agencies have couched shared responsibility in terms of *devolving* responsibility because of other priorities or loss of poultry expertise (though some still try to support producers as best they can within other priorities)

The roles of government agencies and industry associations needs to be looked at in terms of his.

‘The community should take responsibility’ (as quoted by institutional actors in interviews and in government documents/websites) tends to homogenise producers

Common across all producers to believe shared responsibility is placing (often unrealistic) burdens on their production

For larger, experienced producers across the systems, it is part of the context within which they operate – a given reality to be managed.

Concerns have been expressed there are inherent weaknesses in

	<p>the biosecurity systems and egg producers can't manage all weaknesses, but are expected to.</p> <p>General concerns have been expressed about the decline in relevant government services and expertise – resultant senses of 'being on your own' for a minority of producers across all systems</p> <p>A minority see shared responsibility as an opportunity for industry associations to play an important role.</p>	
Information networks		
<i>Institutional actors</i>	<p>Some institutional actors maintain extension activities and priorities – government agencies in some states; Australian eggs; poultry vets.</p> <p>Some government agencies have withdrawn extension services. This has meant cost burden is felt by producers who have to use private sector. This has implications in terms of profitability.</p>	
<i>Experienced producers</i>	<p>Have access to a variety of sources of information</p> <p>They are aware of both what they know and what they don't know/need to know.</p> <p>Some experienced producers essentially rely on poultry vets for very specialised information, when they know they need technical information. Otherwise they're comfortable with what they know based on their own experience in the industry.</p> <p>Biosecurity manuals are useful sources of technical information on an as-needed basis.</p>	<p>Given these producers have well-developed biosecurity systems, they will potentially play an important role in information sharing/engagement with other producers.</p>
<i>Less-experienced producers</i>	<p>Find it difficult to get specific information.</p> <p>A minority use internet groups (which has implications for accessing a wide range of information)</p>	<p>There will need to be an emphasis on engagement and development of relevant information for less-experienced producers. Given that these producers are across the production systems and given the diversity of producers especially in the free-range</p>

		system, this will need to be highly targeted.
<i>Biosecurity manuals</i>	<p>There have been a diversity of responses:</p> <ul style="list-style-type: none"> • Experienced producers use them as a reference when needed • Less experienced producers can find them too technical • A minority of respondents find it difficult to apply the information to their specific circumstances • Majority of free-range producers find them less relevant than do cage/barn producers • A small number of respondents didn't know the manuals existed • There has been a strong tendency across institutional actors to assume because information is available on the net it will be accessed. 	<p>The development of plain-English information sources/biosecurity manuals</p> <p>Targeted information and manuals for the diverse needs of the free-range sector.</p>
<i>Localised food markets</i>	The small number of free-range producers interviewed who have focused their production on farm-to-plate market have tended to see biosecurity in highly localised terms, and therefore have been less concerned with system-wide factors/implications.	This is likely to need very targeted extension strategies, focused on the ways local production fits into broader landscape and systemic biosecurity management.
The structure of the egg industry		
		See previous implications regarding the need for highly targeted engagement strategies.
<i>The family egg enterprise</i>	There is a strong sense of being a family enterprise amongst producers.	
<i>Cage and barn producers</i>	<p>Strong sense of biosecurity and flock health management across respondents from this system (though note that economic considerations are important for some producers).</p> <p>Many producers report they have few problems and if they do have an issue outside their experience, they have poultry vets they call on. Their relationship with the</p>	

	poultry vey is seen as essential to their production.
<i>Free-range producers</i>	<p>The free-range production system continues to have growth.</p> <p>Because this growth is being driven by different forces, different part of the free-range production system are responding differently.</p> <p>Those who are well-aware of biosecurity risks in free-range production have well-developed risk management strategies.</p> <p>The growth in the system has also seen an increase in new entrants and they come with a variety of cultural and personal values associated with their production approach, and these influence biosecurity decision-making (see for example, 'Shared responsibility' above).</p> <p>Across institutional actors, the free-range sector was highlighted as being problematic in terms of reach, knowledge, ease of movement in and out of the sector and statistics to know the size of the sector. Small-scale producers were seen as being particularly problematic in terms of this.</p>
Complex regulations	<p>All producers across systems have highlighted the complex regulatory environment they have to operate in.</p> <p>Some have highlighted there approach is staying 'under the radar'.</p> <p>Institutional actors have also mentioned this, though they have tended to see this regulatory environment as crucial to biosecurity, food safety etc.</p>
	Is it possible to streamline regulations? Is there a role for industry associations to bring the various actors around the table?